HP 8902A
MEASURING RECEIVER
Operation and Calibration Manual

SERIAL NUMBERS

This manual provides complete information for instruments with serial-number prefixes:

2305A to 2914A and all *MAJOR* changes that apply to your instrument.

rev.22AUG90

For additional important information about serial numbers, refer to "INSTRUMENTS COVERED BY THIS MANUAL" in Section 1.

Fourth Edition

This material may be reproduced by or for the U.S. Government pursuant to the Copyright License under the clause at DFARS 52.227-7013 (APR 1988).

Copyright©HEWLETT-PACKARD COMPANY 1985
EAST 24001 MISSION AVENUE, TAF C-34, SPOKANE, WASHINGTON, U.S.A. 99220

Operation and Calibration Manual HP Part 08902-90029

Other Documents Available:
Basic Operation and Application Guide HP Part 5953-8458
Quick Reference Guide HP Part 08902-90060
Service Manual HP Part 08902-90031
Microfiche Operation and Calibration Manual HP Part 08902-90030
Microfiche Service Manual HP Part 08902-90032

Printed in U.S.A. : December 1990

HEWLETT PACKARD

COPYRIGHT AND DISCLAIMER NOTICE

Copyright – Agilent Technologies, Inc. Reproduced with the permission of Agilent Technologies Inc. Agilent Technologies, Inc. makes no warranty of any kind with regard to this material including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Agilent Technologies, Inc. is not liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material or data.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed.

SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

SAFETY SYMBOLS


Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).


Indicates hazardous voltages.


Indicates earth (ground) terminal.

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

WARNING

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection).

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

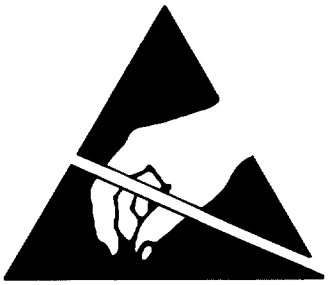
If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

Servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

For continued protection against fire hazard, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.



ATTENTION
Static Sensitive Devices

This instrument was constructed in an ESD (electrostatic discharge) protected environment. This is because most of the semiconductor devices used in this instrument are susceptible to damage by static discharge.

Depending on the magnitude of the charge, device substrates can be punctured or destroyed by contact or mere proximity of a static charge. The results can cause degradation of device performance, early failure, or immediate destruction.

These charges are generated in numerous ways such as simple contact, separation or materials, and normal motions of persons working with static sensitive devices.

When handling or servicing equipment containing static sensitive devices, adequate precautions must be taken to prevent device damage or destruction.

Only those who are thoroughly familiar with industry accepted techniques for handling static sensitive devices should attempt to service circuitry with these devices.

In all instances, measures must be taken to prevent static charge build-up on work surfaces and persons handling the devices.

For further information on ESD precautions, refer to "SPECIAL HANDLING CONSIDERATIONS FOR STATIC SENSITIVE DEVICES" in Section 8, Service.

CONTENTS

Section 1
General Information

Introduction to This Manual 1–1
Specifications 1–2
Safety Considerations 1–2
Recommended Test Equipment 1–2
Instruments Covered by This Manual 1–2
Documentation Updating 1–2
Hewlett-Packard Interface Bus (HP-IB) 1–3
Additional Equipment Information 1–3
Description of the Measuring Receiver 1–6
Principles of Operation Using a Simplified Block Diagram 1–9
Modulation Basics 1–12

Section 2
Installation

Introduction to This Section 2–1
Initial Inspection 2–1
Preparation for Use 2–1
Storage and Shipment 2–9

Section 3
Operation

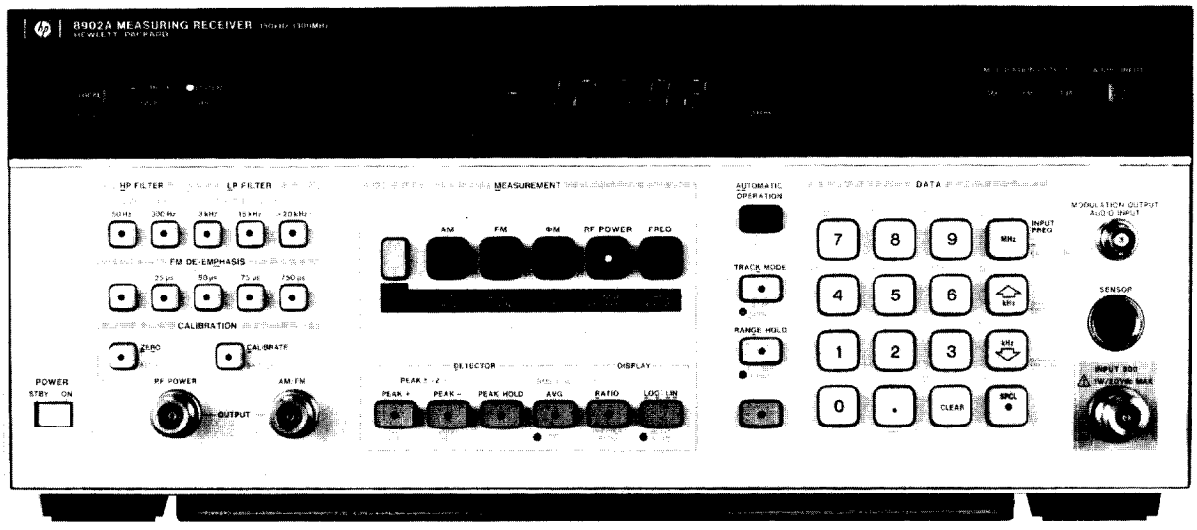
Introduction to This Section 3–1
Operating Characteristics of the Measuring Receiver 3–2
Operator's Information 3–2
Turn–On Procedure 3–3
Instrument Features 3–4
Remote Section Contents 3–11
Basic Functional Checks of the Measuring Receiver 3–47
Basic Functional Checks of the Hewlett-Packard Interface Bus (HP-IB) 3–59
Detailed Operating Instructions 3–71
RF Power and Level Contents 3–73
Frequency Measurements (RF, LO, IF) Contents 3–135
Modulation Measurements Contents 3–159
Audio Measurements Contents 3–225
Additional Capabilities Contents 3–235

Section 4
Performance Tests

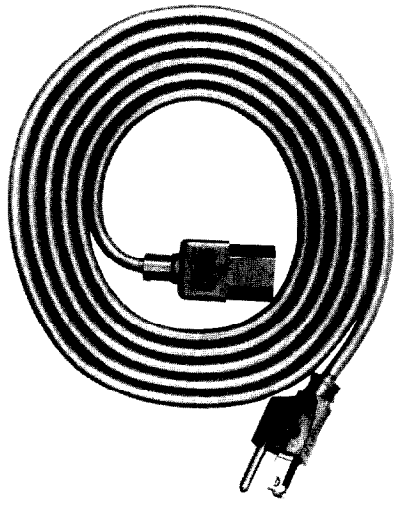
Table of Contents 4–0

Section 5
Adjustments

Table of Contents 5–0



MODEL 8902A



LINE POWER CABLE

Figure 1–1. *HP 8902A Measuring Receiver and Supplied Accessories*

Section 1
GENERAL INFORMATION

1-1. INTRODUCTION TO THIS MANUAL

The HP 8902A *Operating and Service Manual* is comprised of an *Operation and Calibration Manual* and the three volume *Service Manual.* These four volumes contain all the information required to install, operate, test, adjust, and service the Hewlett-Packard Model 8902A Measuring Receiver.

The information to operate and service this instrument is made available as follows: Sections 1 through 5 are contained in the *Operation and Calibration Manual* (that includes the *Basic Operation and Application Guide*) which is provided with each instrument. Sections 6 through 8 are contained in the *Service Manual* that is not included with the instrument but which can be obtained by mailing in the *Service Manual Request Card* included in this manual.

The Measuring Receiver is shown in Figure 1-1 with all supplied accessories. These manuals document Measuring Receivers supplied with Options 001, 002, 003, 004, series 030 and 050.

Operation and Calibration Manual

Section 1, General Information describes the instruments documented by this manual and covers instrument description, options, accessories, specifications and other basic information. This section also contains instrument theory of operation on a simplified block diagram level.

Section 2, Installation provides information about initial inspection, preparation for use (including address selection for remote operation), and storage and shipment.

Section 3, Operation provides information about panel features and includes operating checks, and operating instructions for both local and remote operation.

Section 4, Performance Tests provides the information required to check performance of the instrument against the critical specifications in Table 1-1.

Section 5, Adjustments provides the information required to properly adjust the instrument.

Service Manual

Section 6, Replaceable Parts provides ordering information for all replaceable parts and assemblies.

Section 7, Instrument Changes provides backdating information, and retrofitting and modification information.

Section 8, Service provides the information required to repair the instrument.

Additional copies of the *Operation and Calibration Manual* or the *Service Manual* can be ordered separately through your nearest Hewlett-Packard office. The part numbers are listed on the title page of this manual.

1-2. SPECIFICATIONS

Instrument specifications are listed in Table 1-1. These are the performance standards, or limits, against which the instrument may be tested. Information listed in this table as *Supplemental Characteristics,* are not warranted specifications but are typical characteristics included as additional information for the user.

1-3. SAFETY CONSIDERATIONS

This product is a Safety Class I instrument (that is, provided with a protective earth terminal). The Measuring Receiver and all related documentation must be reviewed for familiarization with safety markings and instructions before operation. Refer to the *Safety Considerations* page found at the beginning of this manual for a summary of the safety information.

Safety information pertinent to the task at hand (installation, operation, performance testing, adjustment or service) is found throughout these manuals.

1-4. RECOMMENDED TEST EQUIPMENT

Table 1-2 lists the test equipment and accessories recommended for use in testing, adjusting, and servicing the Measuring Receiver. If any of the recommended equipment is unavailable, instruments with equivalent minimum specifications may be substituted. Table 1-2 also includes some alternate equipment listings. Table 1-3 lists a number of accessories required in addition to those contained in the Service Accessory Kit, HP 08901-60287.

1-5. INSTRUMENTS COVERED BY THIS MANUAL

Options

Electrical options 001, 002, 003, 004, series 030, 050, and various mechanical options are documented in these manuals. The differences are noted under paragraph 1-8, *Options*, in Table 6-3, *Replaceable Parts*, and in the schematic diagrams in Section 8.

Serial Numbers

Attached to the instrument is a serial number plate. The serial number is in the form 1234A00123. The first four digits and the letter are the serial prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of these manuals apply directly to instruments having the same serial number prefix(es) as listed under SERIAL NUMBERS on the respective manual title pages.

For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-6. DOCUMENTATION UPDATING

An instrument manufactured after the printing of these manuals may have a serial number prefix that is not listed on the manual title page. Having a serial number prefix that is greater than that shown on the title page indicates that the instrument is slightly different from those documented in the manual. In this case, your manual is provided with updating information to make it as current as possible. This updating information includes any hardware or software changes that have occurred as well as corrections to the documentation.

A Description of the Manual Update Packet

A *Manual Update* packet consists of replacement and addition pages which should be incorporated in your manual to bring it up to date.

Signing Up for the Documentation Update Service

Hewlett-Packard offers a Documentation Update Service that will provide you with further updates and changes as they become available. If you have not received update information that matches the serial number of your instrument, you can receive this information through the Update Service.

If you operate or service instruments with different serial prefixes, we strongly recommend that you join this service immediately to ensure that your manual is kept current. For more information, refer to the Documentation Update Service reply card included in this manual or contact:

Hewlett-Packard Company
Technical Writing Department
24001 E. Mission—TAF C-34
Spokane, WA 99220
(509) 922-4001

Also, if you join the update service, you can indicate whether you choose to be contacted in the future about the quality of the documentation you receive. We are trying to improve the documentation we provide and periodically survey customers as to their expectations of the manuals.

1–7. HEWLETT-PACKARD INTERFACE BUS (HP-IB)

Compatibility

The Measuring Receiver's capabilities are defined by the following interface functions: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP0, DC1, DT1, C0. The Measuring Receiver interfaces with the bus via open-collector TTL circuitry. An explanation of the compatibility code may be found in IEEE Standard 488–1978, *IEEE Standard and Digital Interface for Programmable Instrumentation* or the identical ANSI Standard MC1.1.

For more detailed information relating to programmable control of the Measuring Receiver, refer to *Remote Operation, Hewlett-Packard Interface Bus* in Section 3 of this *Operating Information* manual.

Selecting the HP-IB Address

The HP-IB address switches are located within the Measuring Receiver. The switches represent a five-bit binary number. This number represents the talk and listen address characters which controller must generate. In addition, two more switches allow the Measuring Receiver to be set to talk only or to listen only. A table in Section 2 shows all HP-IB talk and listen addresses. Refer to *HP-IB Address Selection* in Section 2 of this *Operation and Calibration* manual.

1–8. ADDITIONAL EQUIPMENT INFORMATION

Options

Options are variations on the standard instrument which can be ordered during the purchase. The following list defines all currently available options. Refer to *Electrical Equipment Available* in this section for retrofit part numbers that can be ordered after the purchase.

Option 001 This option provides rear-panel (instead of front-panel) connections for RF INPUT, SENSOR input, MODULATION OUTPUT/AUDIO INPUT, and AM/FM and RF POWER CALIBRATION OUTPUTs.

Option 002 This option provides a high-stability (1×10^{-9}/day) internal reference oscillator in place of the standard reference oscillator. In addition, a 10 MHz time base output is provided on the rear panel.

Option 003 This option provides both an output for the internal local oscillator signal and an input for an external local oscillator signal. Both connections are located on the rear panel. (This output is provided automatically with option 030 series instruments.)

Option 004 This option allows operation at line frequencies ranging from 48 to 400 Hz. Operation at frequencies greater than 66 Hz is restricted to less than 126.5 Vac line input.

Option 030 The High Selectivity Measurement option provides the capability to measure single-sideband carrier noise (AM or phase) quickly and accurately up to 1.3 GHz with an external LO. (An output for the internal local oscillator and an input for an external local oscillator signal is provided with these options.) This option is ordered with one of the following filter options:

Option 032 This option provides a 12.5 kHz adjacent channel filter.

Option 033 This option provides a 25 kHz adjacent channel filter.

Option 035 This option provides a 30 kHz (Cellular Radio) alternate channel filter.

Option 037 This option provides a carrier noise filter.

Option 050 This option provides increased power measurement accuracy.

Options 907-909 These options are described in *Mechanical Equipment Available.*

Option 910 This option provides an extra copy of the *Operation and Calibration Manual,* the *Service Manual,* and the *Quick Reference Guide.*

Accessories Supplied

The Accessories Supplied are pieces of equipment which are shipped automatically with every Measuring Receiver.

Line Power Cable The line power cable may be supplied in several plug configurations, depending on the destination of the original shipment. Refer to *Power Cables* in Section 2 of this *Operating Information* manual.

Fuses Fuses with a 2.5A rating for 115 Vac (HP 2110-0083) and a 1.5A rating for 230 Vac (HP 2110-0043) are supplied. One fuse is factory installed according to the voltage available in the country of original destination. Refer to *Line Voltage and Fuse Selection* in Section 2 of this *Operating Information* manual.

Electrical Equipment Available

This equipment is available to be ordered for the Measuring Receiver after the time of sale.

HP-IB Controller The Measuring Receiver has an HP-IB interface and can be used with any HP-IB compatible computing controller or computer for automatic systems applications.

Sensor Module The HP 11722A and 11792A Sensor Modules enable you to characterize a signal using a single input connector. Switching back and forth between the Measuring Receiver's SENSOR input and RF INPUT connectors happens automatically with these modules (which contain an internal switch). The HP 11722A covers the frequency range 100 kHz to 2.6 GHz; the HP 11792A covers the range 50 MHz to 26.5 GHz and is intended for use with the HP 11793A Down Converter. Special care is taken with each sensor module to minimize input SWR and resulting errors. A low SWR attenuator isolates the power sensor from the source-under-test, reducing mismatch. Microwave hardware and a selected RF input cable further improve SWR and insertion loss.

Down Converter The HP 11793A Down Converter, when used with a suitable local oscillator, extends the useful range of the Measuring Receiver into the microwave region. Provisions have been made in the Measuring Receiver to account for the frequency of the local oscillator and provide direct display of the frequency of the microwave input signal.

Test Source The HP 11715A AM/FM Test Source produces extremely linear AM and FM at high rates as well as a low-noise CW signal. This source is required for performance testing and adjusting the Measuring Receiver; however, it is an excellent stand-alone instrument for generating very low-distortion FM in the broadcast band.

Verification Kit A Verification Kit (HP 11812A) is available (which contains a step attenuator, two 10 dB pads, and cable) for verifying the performance of the HP 8902A Option 050 Tuned RF Level function to reduced specifications.

Service Accessory Kit A Service Accessory Kit (HP 08901-60287) is available which contains accessories (such as extender boards and cables) useful in servicing the Measuring Receiver.

Front-to-Rear-Panel Connectors Retrofit Kit (Option 001) This kit contains all the necessary components and full instructions for converting front-panel connections to rear-panel connections. Order HP part number 08902-60026.

Rear-to-Front-Panel Connectors Retrofit Kit (Standard) This kit contains all the necessary components and full instructions for converting Option 001 instruments with rear-panel connections to instruments with front-panel connections. Order HP part number 08902-60027.

High-Stability, Internal-Reference Retrofit Kit (Option 002) This kit contains all the necessary components and full instructions for installation of the high-stability, internal-reference oscillator. Order HP part number 08902-60281.

Rear-Panel Local Oscillator Connections Retrofit Kit (Option 003) This kit contains all the necessary components and full instructions for installation of rear-panel local oscillator connections. Order HP part number 08901-60280. (These connections are already included in all Option 030 Series instruments.)

Conversion to 400 Hz Line Operation Measuring Receivers not equipped to operate at line power frequencies greater than 66 Hz may be converted to operate at line frequencies from 48 to 440 Hz. However, operation at line frequencies greater than 66 Hz will be restricted to line voltages less than or equal to 126.5 Vac. To convert to 400 Hz operation, order HP part number 08902-60029. After installation, performance will be identical to the HP 8902A Option 004.

Mechanical Equipment Available

The following kits might have been ordered and received with the Measuring Receiver as options. If they were not ordered with the original shipment and are now desired, they can be ordered from the nearest Hewlett-Packard office using the appropriate part number.

Front-Handle Kit (Option 907) Ease of handling is increased with the front-panel handles. Order HP part number 5061-9690 for the basic kit and 2190-0048 for lockwashers (8 required).

Rack-Flange Kit (Option 908) The Measuring Receiver can be solidly mounted to the instrument rack using the flange kit. Order HP part number 5061-9678.

Rack-Flange and Front-Handle Combination Kit (Option 909) This is not a front-handle kit and a rack-flange kit packaged together; it is composed of a unique part which combines both functions. Order HP part number 5061-9684 for the basic kit and 2190-9609 for lockwashers (8 required).

Chassis Slide-Mount Kit This kit is extremely useful when the Measuring Receiver is rack mounted. Access to internal circuits and components or the rear panel is possible without removing the instrument from the rack. Order HP part number 1494-0017 for 432 mm (17 in.) fixed slides. (To order adapters for non-HP rack enclosures, use HP part number 1494-0023.)

Chassis-Tilt, Slide-Mount Kit This kit is the same as the Chassis Slide Mount Kit above except it also allows the tilting of the instrument up or down 90°. Order HP part number 1494-0025 for 432 mm (17 in.) tilting slides. To order adapters for non-HP rack enclosures, use HP part number 1494-0023.

1-9. DESCRIPTION OF THE MEASURING RECEIVER

The HP Model 8902A Measuring Receiver is a complete measurement system for accurately characterizing signals in the 150 kHz to 1300 MHz frequency range. It combines the capabilities of four separate instruments in its ability to measure RF power, tuned RF level, carrier frequency, modulation and the characteristics of the demodulated audio signal (as well as those of external audio signals). This flexibility allows you to make those measurements most commonly needed to totally characterize a signal.

The Measuring Receiver can measure an RF signal's frequency, frequency drift, power level (broadband, tuned, and off-channel), amplitude modulation (AM), frequency modulation (FM), phase modulation (ΦM), and AM and FM noise components. It recovers the modulating signal and can measure the audio signal's frequency and distortion.

The Measuring Receiver is fully automatic and all major measurements can be made by pushing a single key. The Measuring Receiver's large digital display shows measurement results with excellent resolution and is easy to read. All Measuring Receiver operations can be controlled and all measurement results can be transferred via the Hewlett-Packard Interface Bus (HP-IB). (HP-IB is Hewlett-Packard's implementation of IEEE Standard 488 and ANSI Standard MC1.1.)

Power Measurements

RF Power

The Measuring Receiver delivers the accuracy and resolution of a high-performance power meter. The HP 8902A, with the HP 11722A Sensor Module, measures power from +30 dBm to −20 dBm at frequencies from 100 kHz to 2.6 GHz. (Refer to Table 1-1, *Specifications,* for specified frequencies limits using other power sensors. The HP 8902A also accepts all HP 8480 series power sensors for extended measurement capability.)

Input Power Protection The Measuring Receiver is equipped with input power protection to prevent damage from the accidental application of excessive power. (This is a common cause of damage in equipment used to measure transmitters.) The Measuring Receiver is tested for inputs up to 2W. Protection is provided by limiting diodes and an RF relay. When excessive power is applied, the relay opens and protects sensitive components, and the Measuring Receiver displays an error message. The circuit automatically resets whenever a key is depressed.

RF Power Calibration RF Power Calibration is accomplished with the 50 MHz, 1 mW standard available in every instrument. Also, the front-panel ZERO function enables you to zero the sensor module without removing it from the source-under-test. After the ZERO key is pressed, the new zero offsets are stored automatically.

RF Power Calibration Factors RF Power Calibration Factors can be entered from the power sensor into the Measuring Receiver's non-volatile memory. The instrument automatically compensates for the power sensor's efficiency and mismatch loss at each frequency.

Tuned RF Level The Measuring Receiver has a minimum sensitivity of −127 dBm with exceptional accuracy. Relative-level measurements with accuracy expected only from a transfer standard can be made.

High Selectivity Measurements Options 030–037 add selective power measurement capability to the HP 8902A Measuring Receiver. Used with a low-noise external LO, the HP 8902A performs fast, accurate single-sideband (SSB) carrier noise measurements to 1.4 GHz.

RF Frequency Measurements

In automatic operation, the Measuring Receiver has the performance of a high-quality, 150 kHz to 1300 MHz frequency counter. The frequency counter automatically adjusts itself as the input level changes. There is no need to manually set or adjust the input attenuator. Because the Measuring Receiver is usually used to measure modulated signals, its frequency counter also accurately measures signals with significant levels of AM.

Modulation Measurements

The Measuring Receiver has extremely low internal noise. Incidental AM, FM, and ΦM can be measured on a wide range of simple and complex modulated signals. To complement its modulation measurement capability, the HP 8902A characterizes audio signal level, frequency, and distortion. (These features are also available for external audio signals.)

Filters, De-emphasis Networks and Modulation Calibrators

Post-Detection Audio Filters The Measuring Receiver has two high-pass and three low-pass post-detection audio filters for filtering the recovered modulation. These filters can be selected individually or in combination. Their cutoff frequencies have been chosen to match those needed for applications such as transmitter or signal generator testing. The ¿20 kHz filter is a Bessel filter. It minimizes overshoot for square-wave modulation so that this type of modulating waveform can also be accurately measured.

De-Emphasis Networks The Measuring Receiver contains four de-emphasis networks that can be used in addition to the audio filters. These are the ones commonly used in FM communications—25, 50, 75, and 750 μs. When selected, the de-emphasis networks always affect the demodulated output. You can select whether the de-emphasis network affects the deviation measured. The ability to select either the actual or "de-emphasized deviation" increases the usefulness of the Measuring Receiver in many applications.

Modulation Calibrators One of the most difficult problems involved in making very accurate measurements of AM depth or FM deviation is generating a precisely modulated signal to use as a calibration standard. In all instruments, a precise AM and FM modulation standard is included.

When the output of the calibrator is connected to the Measuring Receiver's input, the amount of modulation is measured to create a calibration factor. The calibration factor can be used to automatically compensate all subsequent measurements. The calibration factor is the ratio of the measured modulation to the internally-computed modulation of the calibrator, expressed in %.

Additional Features

Tuning Features In automatic operation, the Measuring Receiver automatically tunes to the input signal and measures it.

In manual operation, you can determine the frequency to which the Measuring Receiver tunes. Entering the approximate frequency on the keyboard causes all but very close interfering signals to be eliminated. This allows the Measuring Receiver to selectively measure signals other than the largest.

A track mode feature enables you to track a signal, as it changes frequency, from either automatic or manual tune operation.

Store and Recall functions These functions enable you to store eight complete instrument settings in non-volatile memory and recall them as needed.

Display Flexibility The Measuring Receiver offers numerous data-display formats. For example, RF power and tuned RF level can be displayed in watts, dBm, V, dBV, mV, dBmV, μV, and dBμV. Use the RATIO and LOG/LIN keys to display results in dB or % relative to either a measured value or a value entered from the keyboard. These features eliminate the need for recalculating measurement results.

Special Functions

The Measuring Receiver can do more than is apparent from the front panel. Many functions are accessed using the numeric keys and a Special Function key. The Special Functions provide access to other measurements and functions, manual control of instrument functions, instrument operation verification, and service aids.

All instrument functions not set using these Special Functions remain in the automatic mode. This allows you to select any combination of manual or automatic operations. By depressing the special key alone, the display shows ten digits that indicate which functions are in automatic and the state of those manually set.

There are also numerous Special Functions that can be used in verifying that the instrument and its various sections are operating properly. These, along with service special functions, make diagnosing and repairing the Measuring Receiver faster and easier.

Those Special Functions that are most commonly used in operating the Measuring Receiver are described on the *Special Function Information* pull-out card under the front panel.

Extending Measurement Range

Operation to 42 GHz is accomplished when an external LO and mixer are included in the measurement path. This system then functions as a single instrument making microwave modulation, frequency, power, and level measurements. You control operation from the Measuring Receiver's front panel. When the external LO frequency must be changed, the Measuring Receiver requests an external controller to make the change. A separate, non-volatile calibration factor table is available in Frequency Offset mode for your microwave power sensor.

Programmability

The Measuring Receiver is completely programmable via the Hewlett-Packard Interface Bus (HP-IB). This, coupled with the diversity of measurements the Measuring Receiver can make, the speed with which these measurements can be made, and the flexibility of the Special Functions, make the instrument ideal for systems applications. In many instances it can reduce the number of instruments in a system, speed measurements, reduce complexity and improve accuracy.

When the Measuring Receiver is in remote, the front-panel annunicators make it very easy to determine the state the instrument is in; whether it is in the talk, listen, or service request state.

1-10. PRINCIPLES OF OPERATION USING A SIMPLIFIED BLOCK DIAGRAM

The Measuring Receiver is a calibrated, superheterodyne receiver, which converts the incoming signal to a fixed, intermediate frequency (IF), which is then demodulated. As in a radio receiver, the Measuring Receiver contains an RF amplifier, a local oscillator (LO), a mixer, an IF amplifier and bandpass filter, a demodulator (detector or discriminator), and audio filters (tone controls). The Measuring Receiver, however, contains additional features which make it much more versatile:

- automatic tuning,
- selectable measurement mode: signal frequency, power level, or modulation (AM, FM, or Phase Modulation (ΦM)),
- RF power level measurements on tuned signals to −127 dBm (0.1 μV),
- relative RF level measurements on out-of-channel signals to −129 dBc (Option Series 030),
- selectable audio detector (peak, average, or rms responding),
- audio counter,
- audio distortion analyzer,
- measurement calibrators (AM, FM, or power level), and
- HP-IB programmability.

The entire operation of the instrument is governed by a microprocessor-based Controller. The Controller sets up the instrument at turnon, interprets keyboard entries, executes changes in internal hardware, and displays measurement results and error messages. The computing capability of the Controller is also used to simplify circuit operation. For example, it forms the last stage of the Counter, calculates the AM or FM generated by the AM and FM Calibrators, and converts measurement results into ratios (in % or dB). The Controller also contains routines useful for servicing the instrument.

RF Circuitry

The RF input signal normally enters an external Sensor Module such as an HP 11722A. (See Figure 1-2.) For all measurements except RF Power, the Sensor Module routes the signal to the RF input conector of the Measuring Receiver. For the RF Power measurement, the input signal passes directly into the Power Sensor, which converts the RF power absorbed by the RF Power Sensor into a low-frequency, chopped, ac voltage whose amplitude is proportional to the average RF power. The Power Meter amplifies the chopped signal and converts it to a dc voltage which is then measured by the voltmeter. (The voltmeter includes the Audio Peak Detector, Audio Average Detector, Voltage-to-Time Converter, and Counter.) The calibration of the Power Meter can be verified by connecting the Sensor Module to the CALIBRATION RF POWER OUTPUT connector on the front panel. (The 50 MHz Power Reference Oscillator is an accurate 1 mW reference.)

CAUTION

The Power Sensor is unprotected against and is easily damaged by sudden, large overloads. Refer to Table 1–1 under RF Power, Supplemental Characteristics, RF Power Ranges of HP 8902A Measuring Receiver with HP 11722A Sensor Module, for information on maximum operating levels.

The broadband, low-noise RF Amplifier improves the sensitivity of the Tuned RF Level measurement. The amplifier is normally bypassed in the other measurement modes.

CAUTION

An RF detector in the RF Amplifier (not shown in Figure 1–2) causes the RF Amplifier to be bypassed when an overload occurs. However, because of the relatively long switching time (approximately 30 ms), the RF Amplifier can be damaged by a large overload. Refer to Table 1–1, under RF Input, Operating Level, for information on maximum operating levels.

When the RF Peak Detector senses that the input signal level exceeds 1W, it opens the Overpower Relay. This is done without intervention of the Controller. The output from the RF Peak Detector, read by the voltmeter, is used to set the Input Attenuator to optimize the level applied to the Input Mixer.

The Input Mixer converts the input signal to the intermediate frequency (IF). For frequencies greater than 10 MHz, the IF is 1.5 MHz with the Local Oscillator (LO) tuned 1.5 MHz above the input frequency; an IF of 455 kHz can be manually selected for this frequency range. The 455 kHz IF is selected automatically for input signals between 2.5 MHz and 10 MHz and for the Tuned RF Level measurement at all frequencies. Below 2.5 MHz, the input passes directly through the Input Mixer without down-conversion. (The Tuned RF Level measurement is invalid below 2.5 MHz.)

NOTE

For the input signal to pass through the Input Mixer without down-conversion, the LO must still be present to turn the mixer diodes on. An LO frequency of 101.5 MHz is arbitrarily used. Thus the instrument will respond to input frequencies of 100 or 103 MHz as well as frequencies between 150 kHz and 2.5 MHz.

The instrument can be manually tuned to a desired signal even in the presence of larger signals, although filtering may be necessary since low-frequency signals pass directly into the IF. The RF High-Pass Filter can be inserted (via a Special Function) in the RF path for this purpose.

To measure the input frequency, the Counter measures the frequency of the LO and the frequency of the IF from the output of the IF Amplifier and Filter. The Controller computes and displays the difference between the two frequencies. For input frequencies below 2.5 MHz, only the IF is counted, which equals the input frequency.

LO Circuitry

The LO drives the high-level port of the Input Mixer and is one of several inputs to the Counter. The LO has four main modes of operation:

- tuning to the frequency required to down-convert a signal whose frequency is entered from the keyboard (manual tune mode),
- automatically searching for an input signal, then tuning the LO to the frequency required to down-convert the signal (automatic tune mode),

- automatically searching for an input signal, then configuring the LO in a feedback loop that automatically tracks the signal (automatic tune track mode), and
- tuning to the frequency required to down-convert a signal whose frequency is entered from the keyboard, then configuring the LO in a feedback loop that automatically tracks the input signal (manual tune track mode).

The manual tune track mode is useful when it is desired to follow an unstable signal in the presence of other signals. The non-track modes are used when the LO noise (residual FM) must be minimized.

IF Circuitry

The gain of the IF Amplifier is fixed except for the Tuned RF Level measurement mode (described below). The IF Filters determine the frequency response of the IF. The IF Filters can be manually selected with Special Function 3 as described in the following table. When the 1.5 MHz IF is selected, the IF filter consists of a 150 kHz to 2.5 MHz bandpass filter (with a nominal center frequency of 1.5 MHz). When the 455 kHz IF is selected, the IF filter is the Wide 455 kHz Bandpass Filter (with a bandwidth of 200 kHz) except for the Tuned RF Level measurement mode where the Narrow 455 kHz Bandpass (with a bandwidth of 30 kHz) is also inserted. (Other exceptions are noted in the following table.)

Frequency Range	Special Function	
	Tuned RF Level	All Others
10 to 1300 MHz	3.6	3.2
2.5 to 10 MHz	3.5	3.1
150 kHz to 2.5 MHz	–	3.2

In the Tuned RF Level measurement mode, the signal (after amplification by IF Amplifier, which is now a precision, variable-gain amplifier) is detected by the IF Synchronous Detector, which phase locks to and tracks the IF signal. The narrow bandwidth of the phase lock loop (150 Hz) makes it possible for the detector to measure the signal level even when the signal is buried in noise.

To enhance the accuracy of this low-level measurement, the operator must first provide a high-level signal at the desired frequency. (The range of acceptable levels depends on the type of Power Sensor used.) The level is measured by both the Power Meter (which is assumed to be the calibration standard) and the IF Synchronous Detector. From the two power measurements, the Controller computes a calibration factor, which corrects subsequent level measurements made at the same frequency.

Another way of making a tuned RF level measurement is with the IF Average Detector (accessed with Special Function 4), which is part of the AM Demodulator. (Refer to *Tuned RF Level* in the *Detailed Operating Instructions* of Section 3 in this *Operating Information* manual.) Although somewhat less sensitive than the IF Synchronous Detector, the IF Average Detector has a wider bandwidth, which gives it the ability to make measurements on signals with higher residual FM.

In instruments with Option Series 030, the IF signal is further processed by the Channel Filters (which also includes a precision, variable-gain amplifier) and detected by the IF RMS Detector. The Channel Filters set the IF bandwidth and gain for the Adjacent Channel measurement. The measurement is made by entering a series of Special Functions which establish an IF reference in the center of the Channel Filter, then allow the relative IF level to be displayed as the IF frequency is detuned by a pre-determined offset.

Audio Circuitry

The modulation on the IF is demodulated by either the AM or the FM Demodulator. Phase modulation is recovered by integrating the demodulated FM in the Audio Filters and Gain Control circuitry.

The demodulated signal is amplified and filtered in the Audio Filters and Gain Control circuitry. The filters are selected from the front panel, and for FM, the filtering may also include de-emphasis. The processed signal is passed to the front-panel MODULATION OUTPUT/AUDIO INPUT connector and the voltmeter.

The audio signal from the Audio Filters and Gain Control is converted to a dc voltage by the Audio Peak Detector, the Audio Average Detector or the Audio RMS detector. The Audio Average and RMS Detectors are used primarily for measuring noise. The output from the detectors is routed into the Voltage-to-Time Converter.

The Voltage-to-Time Converter within the voltmeter converts the dc input into a time interval. During the interval, the 10 MHz Time Base Reference is counted by the Counter, and the resultant count represents the dc voltage. Other inputs to the voltmeter, which are not shown, include outputs from an audio level detector and the AM calibrator.

The Distortion Analyzer measures the distortion of either the internal demodulated signal or an audio signal applied externally to the MODULATION OUTPUT/AUDIO INPUT connector. The frequency of the input signal must be either 1 kHz or 400 Hz. The distortion on the signal is determined by measuring the amplitude of the signal before and after a notch filter that is set to 1 kHz or 400 Hz. The two ac signals are converted to dc by a the Audio RMS Detector and then measured by the voltmeter. Distortion is computed as the ratio of the voltage out of the notch filter to the voltage into the filter. (The Audio RMS Detector can also be used to measure the demodulated AM, FM, or ΦM internally or the ac level of an external audio signal applied to the MODULATION OUTPUT/AUDIO INPUT connector.)

The frequency of the audio signal at the MODULATION OUTPUT/AUDIO INPUT connector, whether internal or external, is measured by a reciprocal-type Audio Counter. In the Audio Counter, the input signal is used to gate the 10 MHz Time Base Reference into the main Counter. (This gating function is also used by the Voltage-to-Time Converter.) The number of time base pulses received during the count is read by the Controller which computes and displays the signal frequency.

The AM and FM Calibrators provide a nominal 10.1 MHz signal with a precisely known amount of AM or FM. When this signal is applied to the instrument's RF INPUT connector (either directly or via the Sensor Module), the modulation is measured and the calibration factor of the AM or FM Demodulator is computed and displayed. Related front-panel functions are automatically set for proper demodulation of the calibrator signal.

1–11. MODULATION BASICS

The Measuring Receiver can demodulate and measure three types of modulation: amplitude modulation (AM), frequency modulation (FM), and phase modulation (ΦM). In general, modulation is that characteristic of a signal which conveys the information. A signal without modulation is said to be a continuous-wave (CW) signal. CW signals contain two information-carrying parameters: amplitude and frequency. These two parameters, however, are static (time invariant). Consequently, the information conveyed by them is scant—you know only that a signal is present at a certain frequency. When one or both of these parameters is altered as a function of time, the signal is said to be modulated.

The RF signal which is modulated is called the carrier. The modulating signal is referred to as the baseband signal and can be of any arbitrary form (for example, voice, tone, noise). Demodulation is the process of recovering the baseband signal from the modulated carrier. The Measuring Receiver can measure the modulation on carriers in the range of 150 kHz to 1300 MHz. Measurement accuracy is specified for modulation rates generally between 20 Hz and 100 kHz. The demodulated signal is present at the MODULATION OUTPUT connector.

Amplitude Modulation

As the name implies, a carrier is amplitude modulated when its amplitude is varied as a function

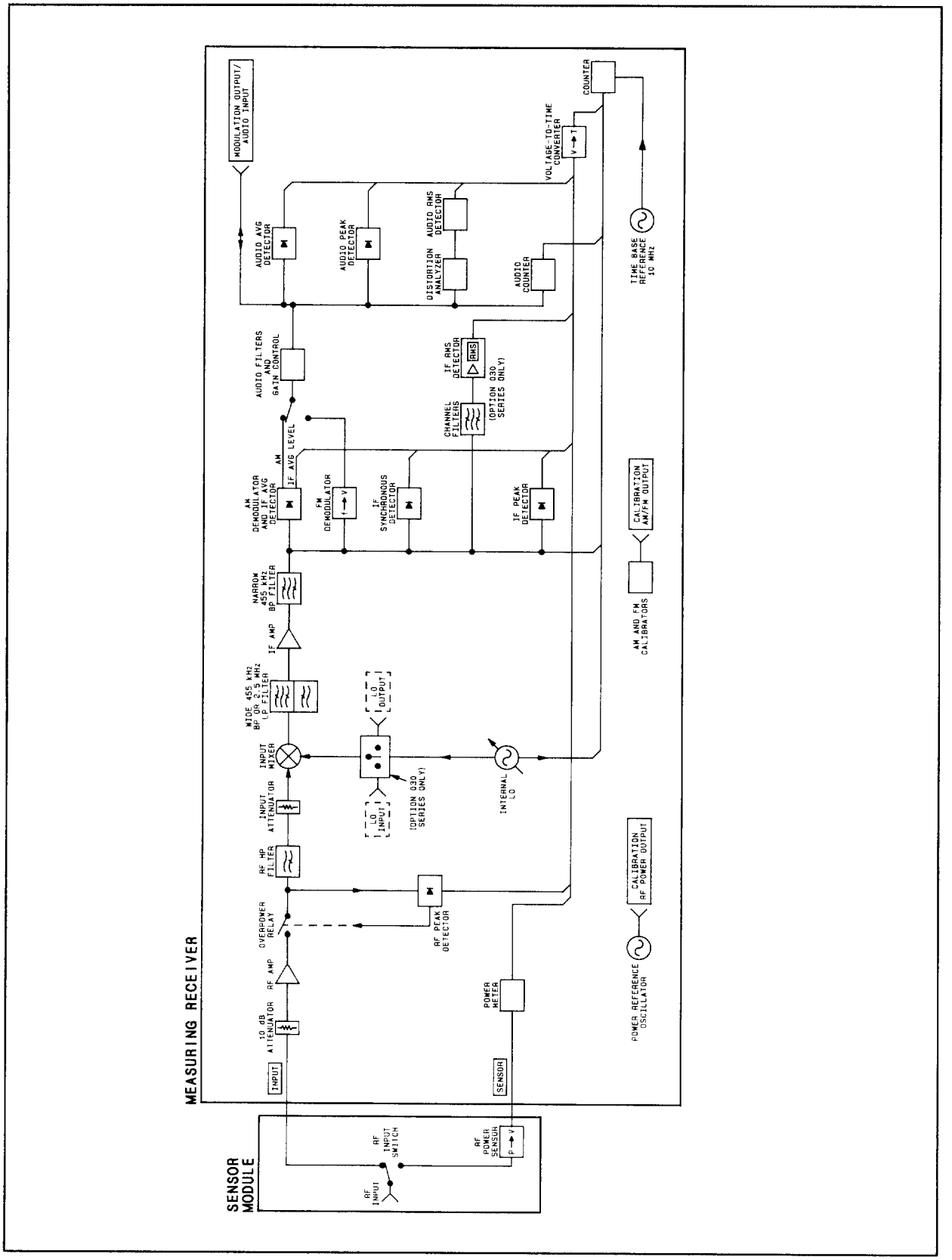


Figure 1–2. HP 8902A Measuring Receiver Simplified Block Diagram

of time. Figure 1–3 shows a carrier with amplitude modulation and, for reference, also shows the baseband signal. As you can see, the tips of the carrier trace out a waveform that resembles the baseband signal. This trace is called the envelope. The envelope rises to a maximum called the peak and drops to a minimum called the trough.

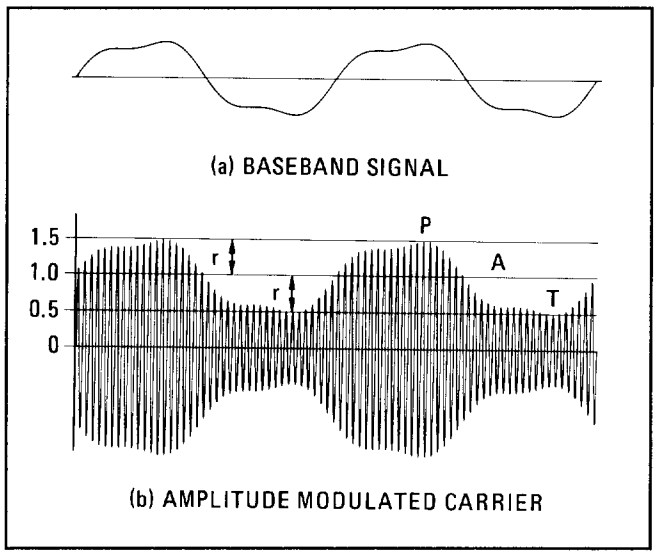


Figure 1–3. *A Baseband Signal and the Corresponding Amplitude Modulated Carrier*

A quantity which describes the amount of AM or the AM depth is the modulation index. If the peak amplitude is called P and the trough amplitude is called T, the modulation index m (usually expressed in %) is defined as

$$m = \frac{P - T}{P + T} \times 100\%.$$

In the example of Figure 1–3, $P = 1.5$ and $T = 0.5$; therefore,

$$m = \frac{1.5 - 0.5}{1.5 + 0.5} \times 100\% = 50\%.$$

Figure 1–4 shows AM signals with modulation indexes varying from 0 to 100%.

When the baseband signal is symmetrical, the modulation index can also be expressed in terms of the average carrier level, A, and the envelope peak, r, relative to the carrier. Then $P = A + r$, and $T = A - r$, and the expression for modulation index becomes

$$m = \frac{A + r - A + r}{A + r + A - r} \times 100\% = \frac{2r}{2A} \times 100\% = \frac{r}{A} \times 100\%.$$

This is the expression which the Measuring Receiver evaluates when making an AM measurement. Referring back to Figure 1–3, it is apparent that $A = 1$ and $r = 0.5$ so

$$m = \frac{0.5}{1} \times 100\% = 50\%$$

as before.

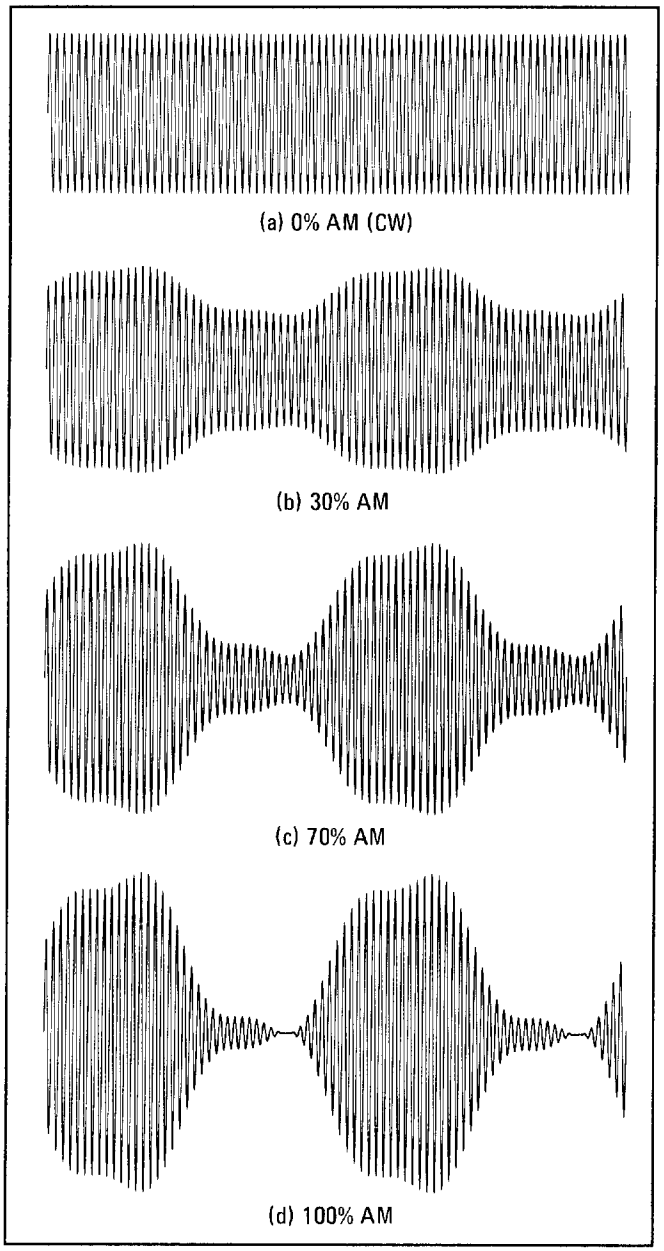


Figure 1–4. *AM for Various Depths*

The Measuring Receiver makes an AM measurement by forcing the average carrier level, A, to a known, fixed level by means of an automatic level control (ALC) circuit. The signal is then demodulated, and the amplitude of the recovered baseband signal is measured with a peak detector. The output of the detector is r, which is (in effect) multiplied by the constant $100/A$ and displayed as the % AM.

Figure 1–5 illustrates an AM signal with an asymmetrical baseband source. The first definition of modulation index still applies here. For it, $m = 46\%$. The second definition, however, does not apply since $P - A \neq A - T$. The Measuring Receiver detects a different value for r if the positive peak of the recovered signal is detected than if the negative peak is detected. Thus a different modulation index is measured in PEAK+ than PEAK–.

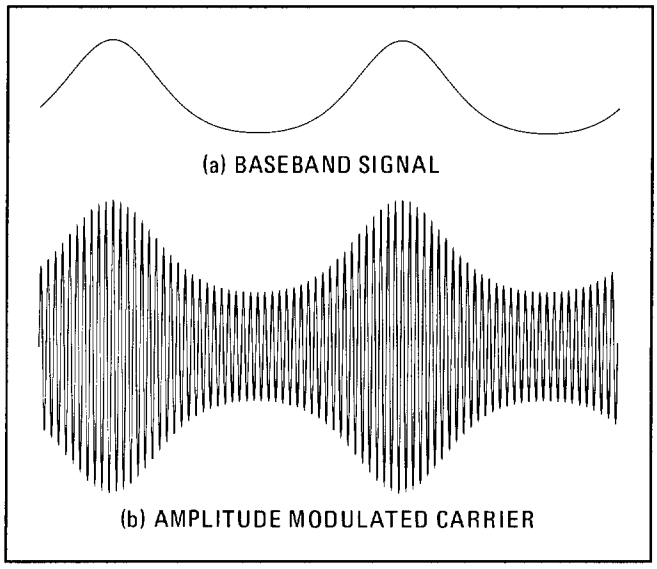


Figure 1—5. *AM with an Asymmetrical Baseband Signal*

The range of modulation indexes for AM measurements by the Measuring Receiver is essentially 0 to 100%. There are, however, types of modulation that produce modulation indexes greater than 100%. An example of such is suppressed-carrier AM. The Measuring Receiver is not intended for measuring such signals. Nevertheless, there are cases, when the Measuring Receiver will display a modulation index that exceeds 100%. This can occur, for example, on an asymmetrical waveform where a narrow peak is greater than the average carrier level. This is illustrated in Figure 1–6.

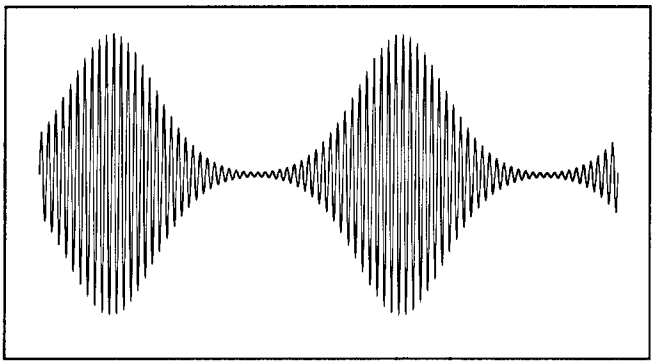


Figure 1—6. *AM with Modulation Exceeding 100% as Measured by the PEAK+ Detector*

Exponential Modulation

Exponential (or angular) modulation is the generic name given to modulation in which the frequency or phase of the carrier is varied. Frequency and phase modulation are very closely related. In fact, it is impossible to tell whether the signal was produced by a frequency modulator or phase modulator by analyzing the received signal unless specific information about the baseband signal is given.

It is certainly true to say that a signal is frequency modulated when the modulation is generated by a frequency modulator. A varactor diode across the tank circuit of an LC oscillator will produce FM when the varactor bias is varied. It is also true that a signal is phase modulated when the modulation is generated by a phase modulator. A varactor diode across an RF filter will produce ΦM when the varactor bias is varied. (It is assumed that the carrier is on the slope of the filter and that the filter is

driven from a well-buffered carrier source. This modulator simultaneously produces AM.)

The signal from both modulators will show readings on the Measuring Receiver when in both the FM and ΦM measurement modes. When in FM, the quantity being measured is the peak frequency deviation, which is the maximum frequency excursion from the average carrier frequency. When measuring ΦM, the peak phase deviation is measured, which is the maximum phase excursion from the average carrier phase. Phase and frequency have the relationship that phase is the integral of the frequency or frequency is the derivative of the phase. In fact, the Measuring Receiver demodulates ΦM by integrating the demodulated FM.

This relationship is most easily visualized by some examples. Look at Figure 1–7. The first baseband signal shown is a square wave. The three waveforms under it are the result of applying this signal to an FM, ΦM, and AM modulator respectively. (The AM waveform is included only for reference.) It is assumed that the phase modulator doesn't produce AM—only ΦM. The FM waveform is as expected. The frequency goes up on the positive peak of the baseband signal and down on the negative peak. The phase modulated signal, however, is peculiar. The frequency is generally constant throughout except for a discontinuity where the baseband signal switches amplitude. The waveform of the figure was contrived so that a 180° phase shift occurred exactly at a zero crossing of the carrier. In general, a discontinuity will occur when the baseband signal switches amplitude, but the phase shift is not necessarily 180° and does not need to occur at a zero crossing of the carrier. Mathematically, the derivative of a square wave is the constant zero except for a positive spike (impulse) where the baseband signal switches positive and a negative spike where the square wave switches negative.

Now look at the triangle wave. The frequency modulator produces a continually increasing frequency as the baseband signal slopes upward and a continually decreasing frequency as the signal slopes downward. The phase modulator produces a signal that resembles the signal from the frequency modulator for the square wave baseband signal. This is because the derivative of a constant slope is a constant. When the slope is positive, the phase shift is continually increasing, thus producing a uniform frequency shift upward. When the slope is negative, the phase shift is continually decreasing and produces a downward frequency shift. For the triangle wave baseband signal, the shift in frequency when the slope changes is proportional to the change in slope.

Now note the sine wave of Figure 1–7(c). The signals from the frequency and phase modulators look the same except for the 90° phase shift between the two. For the frequency modulated signal, the frequency is highest when the baseband signal is most positive and lowest when most negative. For the phase modulated signal, the frequency is highest when the slope of the baseband signal is steepest in a positive direction. This occurs at the positive-going zero crossing. Similarly, the frequency is lowest when the slope is most negative.

If in the last example, the rate, but not the amplitude, of the baseband signal is increased, the highest and lowest frequencies of the signal from the frequency modulator stay the same—they just occur more often. However, for the signal from the phase modulator, not only do the frequency peaks occur more often, but the excursions are large because the slopes of the baseband signal are steeper at the zero crossings. See Figure 1–7(d).

The maximum frequency deviation which can be measured is 400 kHz. The maximum phase deviation is 400 rad or 400 kHz divided by the modulation rate, whichever is smaller. As with AM, an asymmetrical baseband waveform will result in different readings in PEAK+ than PEAK−.

Other Considerations

In practice, it is difficult to produce an FM or ΦM signal which does not also have a small amount of AM—called incidental AM or AM-on-FM. Likewise, an AM signal usually contains a small amount of incidental FM and ΦM. In order to accurately measure this incidental modulation, the Measuring Receiver itself must not contribute to it. This contribution is specified as AM rejection and FM rejection.

A typical CW signal also contains a small amount of residual AM, FM, and ΦM. The residual

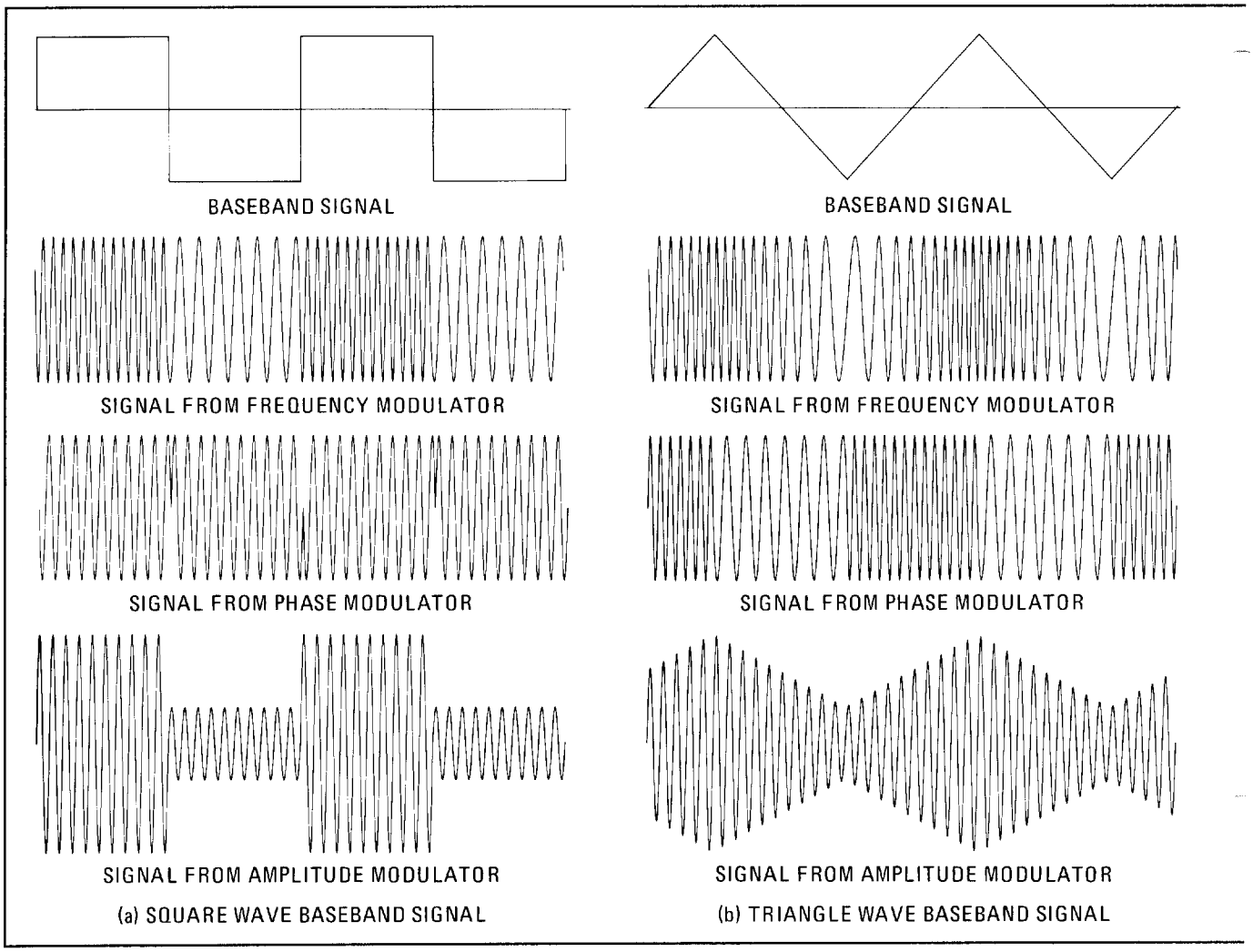
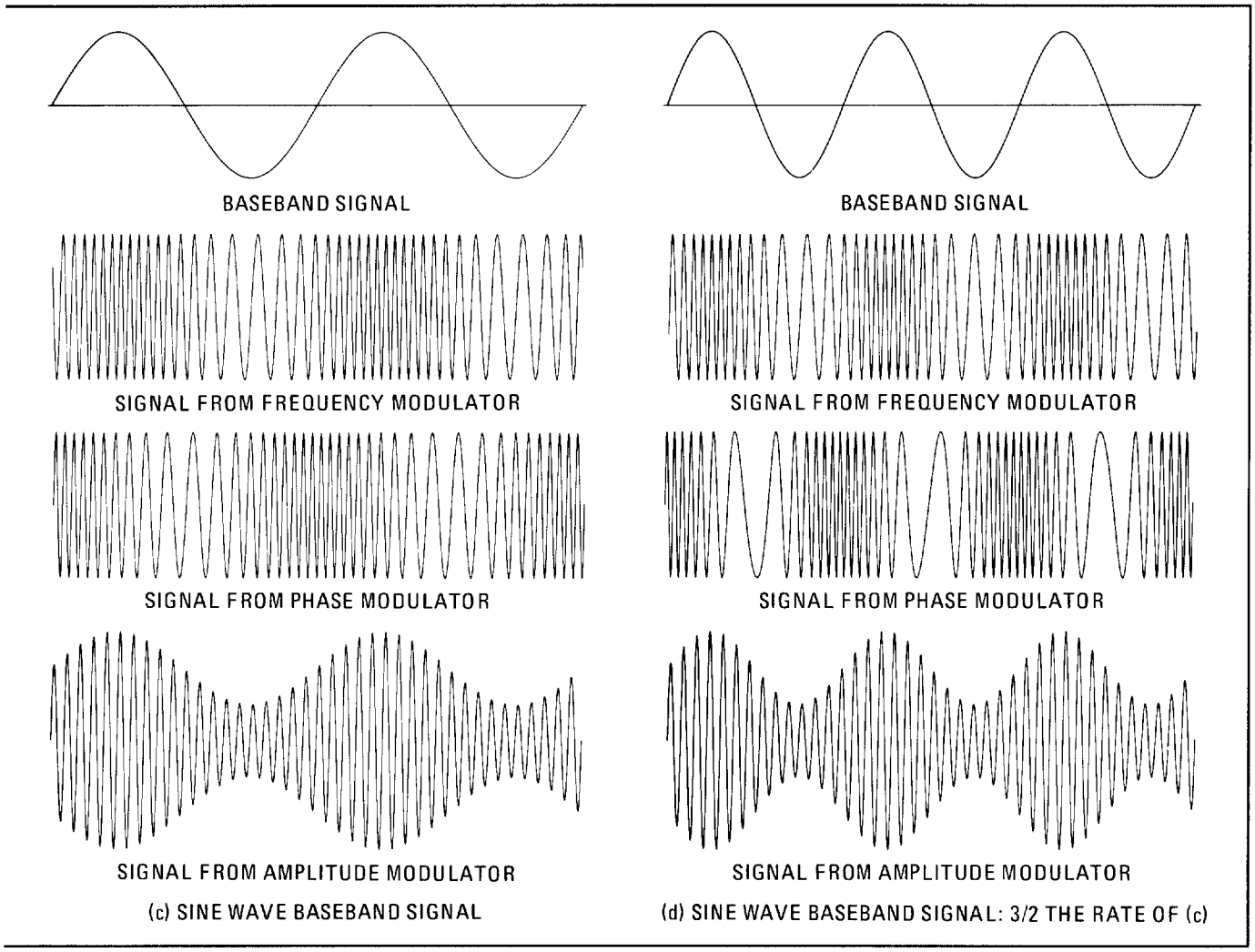


Figure 1-7. *Signals from Frequency, Phase, and*

modulation is generated by such things as line hum, noise, and microphonics. The residual AM and FM specifications quantify the residual modulation internal to the Measuring Receiver.

Residual modulation affects the modulation readings in a manner which depends on the detector used, the nature of the residuals, and the signal-to-noise ratio. If the residual is predominately noise, when the peak detector is used, the residuals add in a way that is statistically related to the signal-to-noise ratio. This is discussed under *Residual Noise Effects* in the *Detailed Operating Instructions* in Section 3. When the average detector is used, the residuals add approximately in an rms manner, that is, the square root of the sum of the squares of the noise and the signal. The effect of this noise becomes insignificant, however, when the signal-to-noise ratio rises above a few dB. Noise can be further reduced by filtering the demodulated signal.

In FM broadcasting and communications, the signal-to-noise ratio is improved by giving the baseband signal a high-frequency boost before applying it to the modulator. This is called pre-emphasis. The boost is a simple 6 dB per octave with the 3 dB corner specified by a time constant; for example, 75 μs (which corresponds to a 3 dB corner of 2.12 kHz) for commercial broadcast FM. If desired, the demodulated FM can be de-emphasized to equalize the signal at the modulation output and at the display.



Amplitude Modulators for Various Baseband Signals

Table 1—1. Specifications (1 of 7)

SPECIFICATIONS describe the instrument's warranted performance.
SUPPLEMENTAL CHARACTERISTICS (shown in ***italics***) are intended to provide information useful in applying the instrument by giving typical, but non-warranted performance parameters.

Frequency Modulation

RATES[6]:

20 Hz to 10 kHz, 150 kHz $\leq f_c <$10 MHz.
20 Hz to 200 kHz, 10 MHz $\leq f_c \leq$1300 MHz.

DEVIATIONS[8]:

40 kHz_{peak} maximum, 150 kHz $\leq f_c <$10 MHz.
400 kHz_{peak} maximum, 10 MHz $\leq f_c \leq$1300 MHz.

ACCURACY[1,2,6]:

FM Accuracy	Frequency Range	Rates	Deviations
±2% of reading ±1 digit	250 kHz–10 MHz	20 Hz–10 kHz	≤40 kHz_{peak}
±1% of reading ±1 digit	10 MHz–1300 MHz	50 Hz–100 kHz	≤400 kHz_{peak}
±5% of reading ±1 digit	10 MHz–1300 MHz	20 Hz–200 kHz	≤400 kHz_{peak}

For rms detector add ±3% of reading.

DEMODULATED OUTPUT DISTORTION[6,7]:

THD	Frequency Range	Rates	Deviations
<0.1%	400 kHz–10 MHz	20 Hz–10 kHz	<10 kHz
<0.1%	10 MHz–1300 MHz	20 Hz–100 kHz	<100 kHz

AM REJECTION (50 Hz to 3 kHz BW)[2]:

AM Rejection	Frequency Range	Rates	AM Depths
<20 Hz peak deviation	150 kHz–1300 MHz	400 Hz or 1 kHz	≤50%

RESIDUAL FM (50 Hz to 3 kHz BW): <8 Hz_{rms} at 1300 MHz, decreasing linearly with frequency to <1 Hz_{rms} for 100 MHz and below.

Supplemental Characteristics:

MAXIMUM FM DEVIATION, RESOLUTION, AND MAXIMUM DEMODULATED OUTPUT SENSITIVITY ACROSS AN OPEN CIRCUIT (600Ω output impedance)[5]:

Maximum Resolution	*Maximum Demodulated Output Sensitivity*	*Deviations (ΔF)*
100 Hz	*0.01 mV/Hz*	$\Delta F_{peak} \geq 40$ *kHz*
10 Hz	*0.1 mV/Hz*	*4.0 kHz* $\leq \Delta F_{peak} <$ *40 kHz*
1 Hz	*1.0 mV/Hz*	$\Delta F_{peak} <$ *4 kHz*
0.1 Hz (rms detector only)	*1.0 mV/Hz*	$\Delta F_{rms} <$ *0.3 kHz*

Resolution is increased one digit with 750 μs de-emphasis and pre-display on.

The demodulated output signal present at the Modulation Out/Audio In connector is increased in amplitude by a factor of 10 with 750 μs de-emphasis.

DEMODULATED OUTPUT DISTORTION[7]:

THD	*Frequency Range*	*Rates*	*Deviations*
<0.3%	*150 kHz–400 kHz*	*20 Hz–10 kHz*	*<10 kHz*

DETECTORS: *+peak, −peak, ±peak/2, peak hold, average (rms sinewave calibrated), rms.*

STEREO SEPARATION (50 Hz to 15 kHz): *>47 dB.*

Amplitude Modulation

RATES:

20 Hz to 10 kHz, 150 kHz $\leq f_c <$10 MHz.
20 Hz to 100 kHz, 10 MHz $\leq f_c \leq$1300 MHz.

DEPTH: to 99%.

ACCURACY[1,2,3]:

AM Accuracy	Frequency Range	Rates	Depths
±2% of reading ±1 digit	150 kHz–10 MHz	50 Hz–10 kHz	5%–99%
±3% of reading ±1 digit	150 kHz–10 MHz	20 Hz–10 kHz	to 99%
±1% of reading ±1 digit	10 MHz–1300 MHz	50 Hz–50 kHz	5%–99%
±3% of reading ±1 digit	10 MHz–1300 MHz	20 Hz–100 kHz	to 99%

For rms detector add ±3% of reading.

FLATNESS[4,5]:

Flatness	Frequency Range	Rates	Depths
±0.3% of reading±1 digit	10 MHz–1300 MHz	90 Hz–10 kHz	20%–80%

DEMODULATED OUTPUT DISTORTION:

<0.3% THD for ≤50% depth.
<0.6% THD for ≤95% depth.

FM REJECTION (50 Hz to 3 kHz BW)[2]:

FM Rejection	Frequency Range	Rates	FM Deviations
<0.2% AM	250 kHz–10 MHz	400 Hz or 1 kHz	<5 kHz_{peak}
<0.2% AM	10 MHz–1300 MHz	400 Hz or 1 kHz	<50 kHz_{peak}

RESIDUAL AM (50 Hz to 3 kHz BW): <0.01%$_{rms}$.

[1] Not to exceed for stated accuracy: 50 Hz to 40 kHz rates with rms detector.

[2] Peak residuals must be accounted for in peak readings.

[3] For peak measurements only: AM accuracy may be affected by distortion generated by the measuring receiver. In the worst case this distortion can decrease accuracy by 0.1% of reading for each 0.1% of distortion.

[4] Flatness is the variation in indicated AM depth for constant depth on input signal.

[5] For optimum flatness, cables should be terminated with their characteristic impedance.

[6] But not to exceed: 20 kHz rates and 40 kHz peak deviations with 750 μs de-emphasis filter.

[7] With 750 μs de-emphasis and pre-display "off," distortion is not specified for modulation outputs >4V peak. This condition can occur near maximum deviation for a measurement range, at rates <2 kHz.

Table 1—1. Specifications (2 of 7)

Amplitude Modulation, continued

Supplemental Characteristics:

DETECTORS: *+peak, −peak, ±peak/2, peak hold, average (rms sinewave calibrated), rms.*

MAXIMUM DEPTH, RESOLUTION, AND MAXIMUM DEMODULATED OUTPUT SENSITIVITY ACROSS AN OPEN CIRCUIT (600Ω output impedance)[5]:

Maximum Resolution	Maximum Demodulated Output Sensitivity	Depths
0.1%	0.01 V/percent	$AM_{peak} \geq 40.0\%$
0.01%	0.1 V/percent	$AM_{peak} < 40.0\%$
0.001% (rms detector only)	0.1 V/percent	$AM_{rms} < 3.0\%$

Phase Modulation

RATES:

200 Hz to 10 kHz, 150 kHz $\leq f_c <$10 MHz.
200 Hz to 20 kHz, 10 MHz $\leq f_c \leq$1300 MHz.

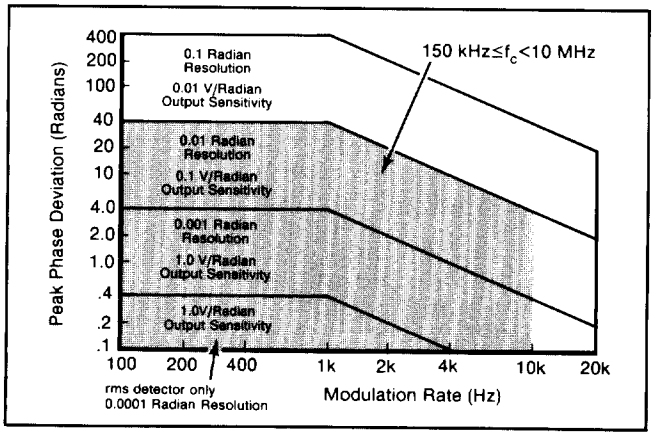
ACCURACY[2]:

±4% of reading ±1 digit, 150 kHz $\leq f_c <$10 MHz.
±3% of reading ±1 digit, 10 MHz $\leq f_c \leq$1300 MHz.
For rms detector add ±3% of reading.

DEMODULATED OUTPUT DISTORTION: <0.1% THD.

AM REJECTION (for 50% AM at 1 kHz rate)[2]:
<0.03 radians peak (50 Hz to 3 kHz BW).

MAXIMUM DEVIATION, RESOLUTION, AND MAXIMUM DEMODULATED OUTPUT SENSITIVITY ACROSS AN OPEN CIRCUIT (600Ω output impedance)[5]:



Supplemental Characteristics:

MODULATION RATES: *usable from 20 Hz to 100 kHz with degraded performance.*

DETECTORS: *+peak, −peak, ±peak/2, peak hold, average (rms sinewave calibrated), rms.*

[2] Peak residuals must be accounted for in peak readings.

[5] For optimum flatness, cables should be terminated with their characteristic impedance.

[8] After 30-day warm-up.

Modulation Reference

AM CALIBRATOR DEPTH AND ACCURACY: 33.33% depth nominal, internally calibrated to an accuracy of ±0.1%.

FM CALIBRATOR DEVIATION AND ACCURACY: 34 kHz_{peak} deviation nominal, internally calibrated to an accuracy of ±0.1%.

Supplemental Characteristics:

CARRIER FREQUENCY: *10.1 MHz.*

MODULATION RATE: *10 kHz.*

OUTPUT LEVEL: *−25 dBm.*

Frequency Counter

RANGE: 150 kHz to 1300 MHz.

SENSITIVITY:

12 mV_{rms} (−25 dBm), 150 kHz $\leq f_c \leq$650 MHz.
22 mV_{rms} (−20 dBm), 650 MHz $< f_c \leq$1300 MHz.

MAXIMUM RESOLUTION: 1 Hz.

ACCURACY:

±reference accuracy ±3 counts of least-significant digit, $f_c <$100 MHz.
±reference accuracy ±3 counts of least-significant digit or 30 Hz, whichever is larger, $f_c \geq$100 MHz.

Supplemental Characteristics:

MODES: *Frequency and Frequency Error (displays the difference between the frequency entered via the keyboard and the actual RF input frequency).*

SENSITIVITY IN MANUAL TUNING MODE: *Approximate frequency must be entered from keyboard. 0.22 mV_{rms} (−60 dBm).*

Using the RF amplifier and the IF amplifiers, sensitivity can be increased to approximately −100 dBm.

Internal Time Base Reference

FREQUENCY: 10 MHz.

AGING RATE: $< 1 \times 10^{-6}$/month.
$< 1 \times 10^{-9}$/day (Option 002)[8].

Supplemental Characteristics:

INTERNAL REFERENCE ACCURACY: *Overall accuracy is a function of time base calibration, aging rate, temperature effects, line voltage effects and short-term stability.*

	Standard	Option 002
Aging Rate	$< 1 \times 10^{-6}$/mo.	$< 1 \times 10^{-9}$/day
Temperature Effects	$< 2 \times 10^{-7}$/°C	$< 2 \times 10^{-10}$/°C
Line Voltage Effects (+5%, −10% Line Voltage Change)	$< 1 \times 10^{-6}$	$< 6 \times 10^{-10}$
Short-Term Stability	—	$< 1 \times 10^{-9}$ for 1 sec. average

Table 1—1. Specifications (3 of 7)

RF Power

The HP 8902A Measuring Receiver, with HP 11722A Sensor Module, performs RF power measurements from −20 dBm (10 μW) to +30 dBm (1W) at frequencies from 100 kHz to 2.6 GHz. The HP 8902A can be used with the HP 11792A Sensor Module and any of the HP 8480 series Power Sensors (HP 8481A/1B/1H/2A/2B/2H/3A/4A/5A/6A) to make power measurements from −70 dBm (10 pW) to +44 dBm (25W) at frequencies from 100 kHz to 50 GHz. The HP 8480 Series Sensors also work with the HP 435A, HP 436A and HP 438A Power Meters. Unless otherwise specified, the specifications shown below refer to the HP 8902A only. A detailed explanation of how the uncertainty specifications provided below affect the absolute power measurement accuracy of the HP 8902A is provided in Application Note 64-1.

RF POWER RESOLUTION[9]:
0.01% of full scale in watts or volts mode.
0.01 dB in dBm or $dB_{relative}$ mode.

LINEARITY (includes sensor non-linearity): RF range linearity ±RF range-to-range change error.

RF RANGE LINEARITY (using Recorder Output)[10]:
±0.02 dB, RF ranges 2 through 5.
±0.03 dB, RF range 1.
Using front-panel display add ±1 count of least-significant digit.

RF RANGE-TO-RANGE CHANGE ERROR (using Recorder Output): ±0.02 dB/RF range change from reference range. Using front-panel display add ±1 count of least-significant digit.

INPUT SWR: <1.15, using HP 11722A Sensor Module.

ZERO SET (digital settability of zero): ±0.5%±1 count of full scale on lowest range. Decrease by a factor of 10 for each higher range.

Supplemental Characteristics:

ZERO DRIFT OF METER: *±0.03% of full scale/°C on lowest range. Decrease by a factor of 10 for each higher range.*

NOISE (at constant temperature, peak change over any 1-minute interval for the HP 11722A Sensor Module and HP 8481A/1B/1H/2A/2B/2H/3A/5A/6A Sensors):
0.4% of full scale on range 1 (lowest range).
0.13% of full scale on range 2.
0.013% of full scale on range 3.
0.0013% of full scale on range 4.
0.00013% of full scale on range 5.
For HP 8484A Sensor multiply noise by 5 on all ranges.

ZERO DRIFT OF SENSORS (1 hour, at constant temperature after 24-hour warm-up):
±0.1% of full scale on lowest range for HP 11722A Sensor Module and HP 8481A/1B/1H/2A/2B/2H/3A/5A/6A Sensors.
±2.0% of full scale on lowest range for HP 8484A Sensor. Decrease by a factor of 10 for each higher range.

RF POWER RANGES OF HP 8902A MEASURING RECEIVER WITH HP 11722A SENSOR MODULE:
−20 dBm to −10 dBm (10 μW to 100 μW), range 1.
−10 dBm to 0 dBm (100 μW to 1 mW), range 2.
0 dBm to +10 dBm (1 mW to 10 mW), range 3.
+10 dBm to +20 dBm (10 mW to 100 mW), range 4.
+20 dBm to +30 dBm (100 mW to 1W), range 5.

RESPONSE TIME (0 to 99% of reading):
<10 seconds, range 1.
<1 second, range 2.
<100 milliseconds, ranges 3 through 5.

DISPLAYED UNITS: *Watts, dBm, $dB_{relative}$, $\%_{relative}$, volts, mV, μV, dB V, dB mV, dB μV.*

INTERNAL NON-VOLATILE CAL FACTOR TABLES (user modifiable using special functions):

Maximum Number of Cal Factor/Frequency Entries:
Table #1 (primary): *16 pairs plus Reference Cal Factor.*
Table #2 (frequency offset): *22 pairs plus Reference Cal Factor.*
Maximum Allowed Frequency Entry: *200 GHz.*
Frequency Entry Resolution: *50 kHz.*
Cal Factor Range: *40 to 120%.*
Cal Factor Resolution: *0.1%.*

Power Reference

POWER OUTPUT: 1.00 mW. Factory set to ±0.7%, traceable to the U.S. National Bureau of Standards.

ACCURACY: ±1.2% worst case (±0.9% rss) for one year (0°C to 55°C).

Supplemental Characteristics:

FREQUENCY: *50 MHz nominal.*

SWR: *1.05 nominal.*

FRONT PANEL CONNECTOR: *Type-N female.*

Tuned RF Level

POWER RANGE: −127 dBm to 0 dBm, using IF synchronous detector (200 Hz BW).
−100 dBm to 0 dBm, using IF average detector (30 kHz BW).

FREQUENCY RANGE: 2.5 MHz to 1300 MHz.

DISPLAYED RESOLUTION[11]:
4 digits in watts or volts mode.
0.01 dB or 0.001 dB in dBm or $dB_{relative}$ mode.

[9] The HP 8902A fundamental RF Power measurement units are watts. Further internal processing is done on this number to display all other units.

[10] When using HP 8484A Sensor the noise specification may mask the linearity specification and become the predominant error. When operating on the top RF power range, add the power sensor linearity percentages found in the power sensor specifications.

[11] The HP 8902A fundamental Tuned RF Level measurement units are volts. Further internal processing is done on this number to display all other units.

Table 1–1. Specifications (4 of 7)

Tuned RF Level, continued

RELATIVE MEASUREMENT ACCURACY (at constant temperature and after RF range calibration is completed)[12]: Detector linearity + IF range-to-range error + RF range-to-range error + frequency drift error + noise error ± 1 digit.

DETECTOR LINEARITY:

For IF Synchronous Detector:

±0.007 dB/dB change, but not more than ±0.02 dB/10 dB change.

Typically <±0.004 dB/dB change and <±0.01 dB/10 dB change.

For IF Average Detector (0°C to +35°C):

±0.013 dB/dB change, but not more than ±0.04 dB/10 dB change.

Typically <±0.008 dB/dB change and <±0.02 dB/10 dB change.

IF RANGE-TO-RANGE ERROR (see Tuned RF Level range plot)[13]:

±0.02 dB/IF range change, IF ranges 1 through 5.
±0.05 dB/IF range change, IF ranges 6 and 7.

RF RANGE-TO-RANGE ERROR:

±0.04 dB/RF range change (Tuned RF Level only).
±0.06 dB/RF range change, RF Power to Tuned RF Level.

FREQUENCY DRIFT ERROR: ±0.05 dB/kHz frequency drift from center of IF (using IF synchronous detector).

NOISE ERROR: ±0.18 dB for levels <−120 dBm, or for levels <−110 dBm if Special Function 1.9 is selected.

INPUT SWR:

<1.18, at HP 8902A RF input, RF range 1 and 2.
<1.40, at HP 8902A RF input, RF range 3.
<1.33, at HP 11722A RF input, RF range 1 and 2.
<1.50, at HP 11722A RF input, RF range 3.
<1.33, at HP 11722A RF input, RF range 3 with Special Function 1.9.

Supplemental Characteristics:

ABSOLUTE LEVEL MEASUREMENT ACCURACY AT LOW LEVELS (at constant temperature and after RF range calibration is completed)[12]:

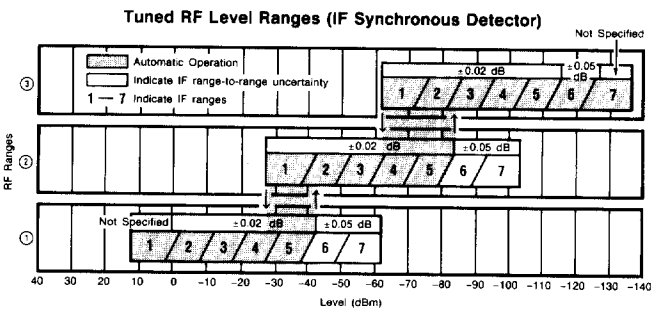
Absolute level measurement accuracy is a function of the RF Power and Tuned RF Level measurement accuracy. Product Note 8902A-1 explains how both of these measurements affect absolute level measurement accuracy. For a source with an output SWR of 1.7 and level of −110 dBm the typical absolute level measurement accuracy is 0.46 dB rss and 1.02 dB worst case.

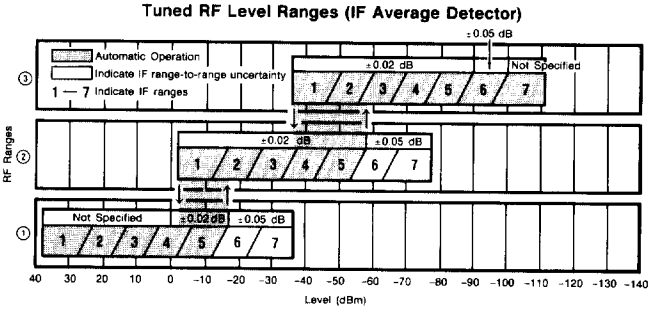
IF FREQUENCY: *455 kHz.*

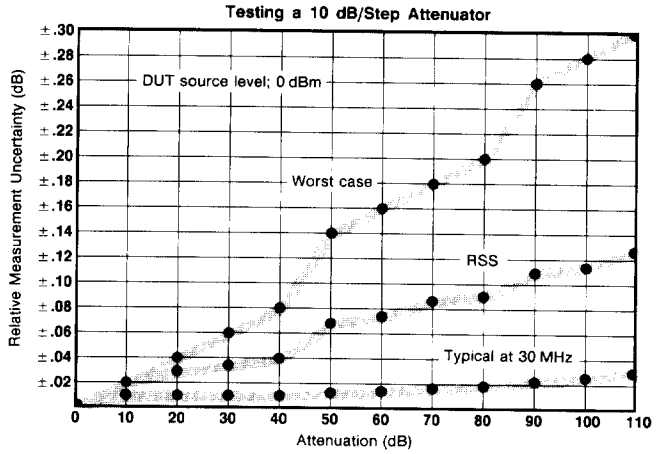
ACQUISITION TIME: *<4 seconds, ≥−110 dBm.*
<10 seconds, ≥−127 dBm.

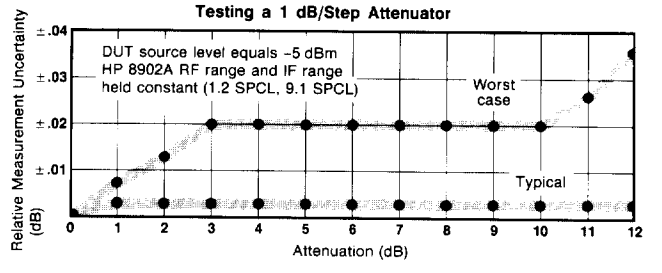
RESPONSE TIME (responding to changes in level of an acquired signal): *<2 seconds, ≥−110 dBm.*
<5 seconds, ≥−127 dBm.

DISPLAYED UNITS: *Watts, dBm, $dB_{relative}$, $\%_{relative}$, volts, mV, μV, dB V, dB mV, dB μV.*









[11] The HP 8902A fundamental Tuned RF Level measurement units are volts. Further internal processing is done on this number to display all other units.

[12] Tuned RF Level accuracy will be affected by residual FM of the source-under-test. If the residual FM_{peak} is >50 Hz measured over a 30 second period in a 3 kHz BW, Tuned RF Level measurements should be made using the IF average detector (30 kHz BW) by using Special Function 4.4. The Tuned RF Level measurement sensitivity when using the IF average detector is −100 dBm.

[13] IF Ranges 6 and 7 (see Tuned RF Level range plots) are only used in automatic operation for Tuned RF Level measurements below approximately −110 dBm for the IF synchronous detector, and below approximately −85 dBm for the IF average detector.

Table 1–1. Specifications (5 of 7)

Carrier Noise (Options 030–037)

FREQUENCY RANGE: 10 MHz to 1300 MHz.

CARRIER POWER RANGE: +30 dBm to −20 dBm; 12.5 kHz, 25 kHz and 30 kHz filters.
+30 dBm to −10 dBm; carrier noise filter.

DYNAMIC RANGE: 115 dB.

CARRIER REJECTION (temp. ≤35°C): >90 dB; for offsets of at least 1 channel spacing or 5 kHz, whichever is greater.

RELATIVE MEASUREMENT ACCURACY: ±0.5 dB; levels ≥−95 dBc; 12.5 kHz, 25 kHz and 30 kHz filters.
±0.5 dB; levels ≥−129 dBc/Hz; carrier noise filter.

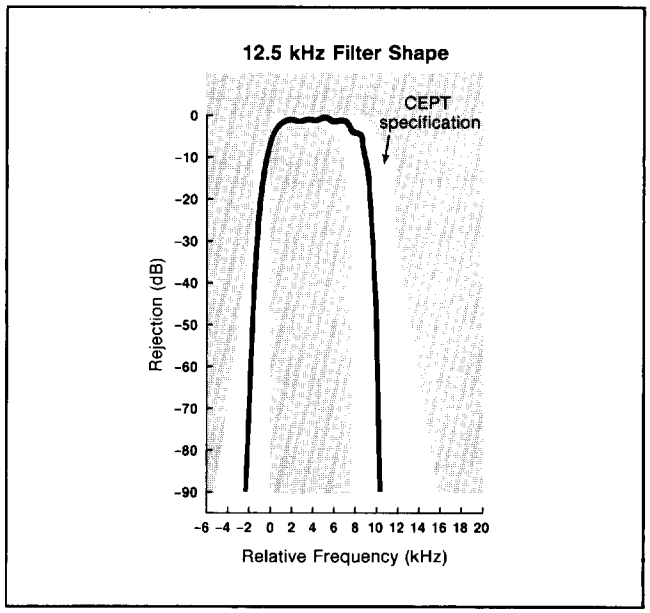
CARRIER NOISE FILTER:
Filter Noise Bandwidth: 2.5 kHz nominal.

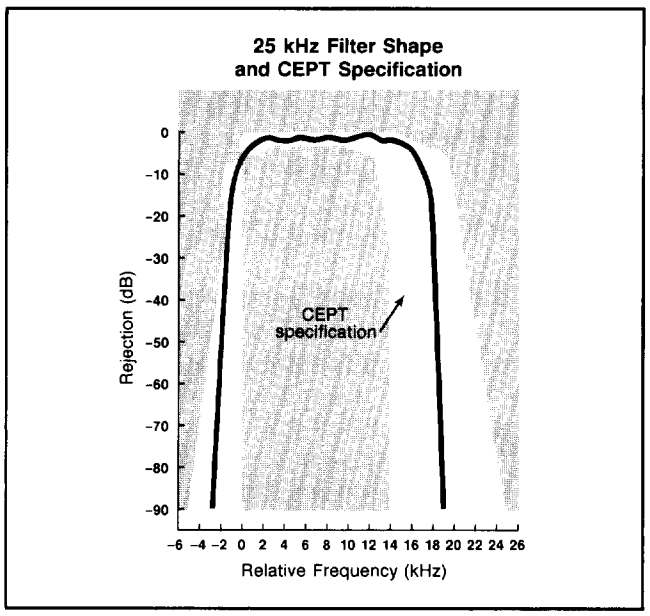
Noise Bandwidth Correction Accuracy (stored in non-volatile memory): ±0.2 dB.

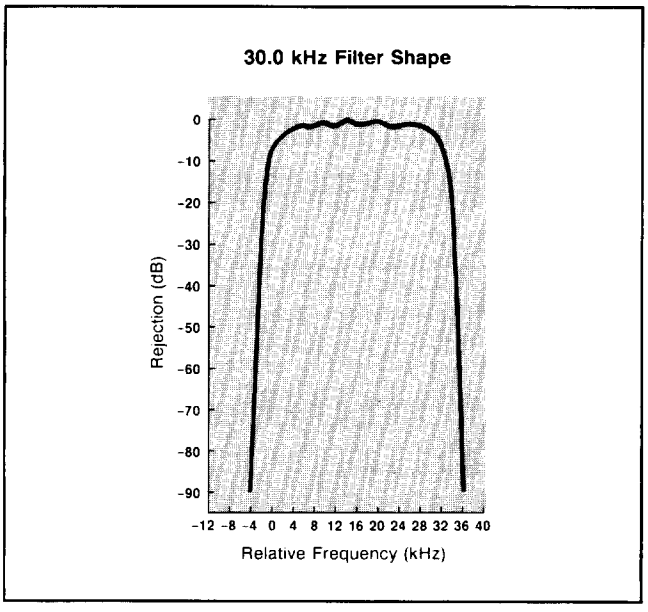
Supplemental Characteristics:

ADJACENT/ALTERNATE CHANNEL FILTERS:
6 dB Filter Bandwidth:
8.5 kHz, 12.5 kHz adjacent-channel filter.
16.0 kHz, 25 kHz adjacent-channel filter.
30.0 kHz, 30 kHz (cellular radio) alternate-channel filter.

TYPICAL NOISE FLOOR: *−150 dBc/Hz, 0 dBm carrier power level. For System noise performance add LO contribution.*







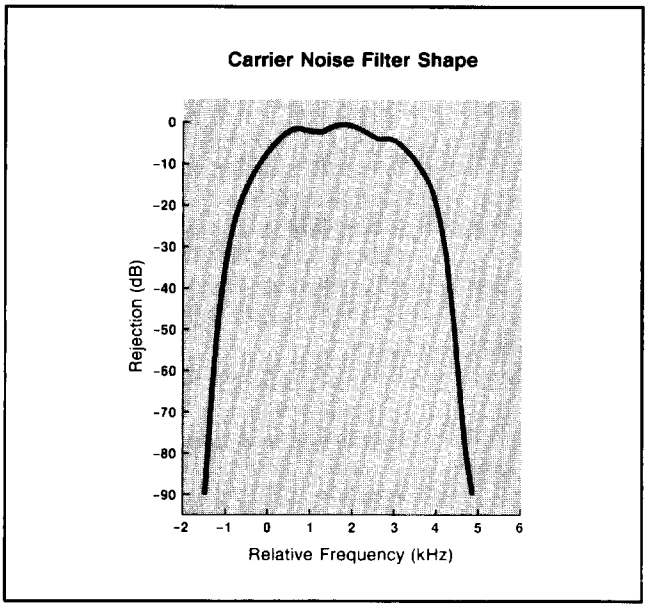


Table 1-1. Specifications

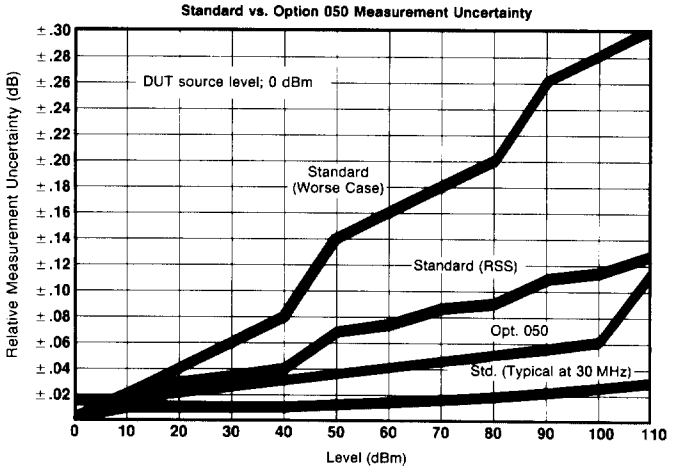
Increased Power Measurement Accuracy (Option 050)

POWER RANGE: −120 to 0 dBm

FREQUENCY RANGE: 2.5 MHz to 1300 MHz

MEASUREMENT ACCURACY[14,15]:

Measurement	Range	Accuracy
Absolute (Using an HP 11722A Sensor Module)	0 dBm to −100 dBm	±0.005 dB/10 dB step ±0.120 dB ± 1 digit
	−100.001 dBm to −120.000 dBm	±0.050 dB/10 dB step ±0.120 dB ± 1 digit
Relative	0 dBm to −100 dBm	±0.005 dB/10 dB step ±0.015 dB ± 1 digit
	−100.001 dBm to −120.000 dBm	±0.050 dB/10 dB step ±0.015 dB ± 1 digit



(See Tuned RF Level for other specifications.)

Supplemental Characteristics:

MEASUREMENT TIME: *10 to 30 seconds.*

[14] Option 050 specifications are warranted when using a Hewlett-Packard synthesized source with less than 100 Hz peak residual FM measured in a 3 kHz post-detection bandwidth over a 30 second period.

[15] Accuracy specifications do not include mismatch uncertainty.

Table 1—1. Specifications (6 of 7)

Audio Frequency Counter

FREQUENCY RANGE: 20 Hz to 250 kHz (usable to 600 kHz).

MAXIMUM EXTERNAL INPUT VOLTAGE: $3V_{rms}$.

ACCURACY (for demodulated signals)[16]:

Accuracy	Frequency	Modulation (Peak)
±3 counts of least-significant digit ±Internal Reference Accuracy	>1 kHz	AM ≥10% FM ≥1.0 kHz ϕM ≥1.5 radians
±0.02 Hz ±Internal Reference Accuracy	≤1 kHz	AM ≥10% FM ≥1.0 kHz ϕM ≥1.5 radians
±0.2 Hz ±Internal Reference Accuracy (3 kHz low-pass filter inserted)	≤3 kHz	1.5%≤AM<10% 0.15 kHz≤FM <1.0 kHz 0.15 radian≤ϕM <1.5 radians

ACCURACY (for external signals)[16]:

Accuracy	Frequency	Level
±3 counts of least-significant digit ±Internal Reference Accuracy	>1 kHz	≥100 mV_{rms}
±0.02 Hz ±Internal Reference Accuracy	<1 kHz	≥100 mV_{rms}

Supplemental Characteristics:

DISPLAYED RESOLUTION: *6 digits.*

MEASUREMENT RATE: *2 readings per second.*

COUNTING TECHNIQUE: *Reciprocal with internal 10 MHz time base.*

AUDIO INPUT IMPEDANCE: *100 kΩ nominal.*

Audio RMS Level

FREQUENCY RANGE: 50 Hz to 40 kHz.

VOLTAGE RANGE: 100 mV to 3V.

ACCURACY: ±4.0% of reading.

Supplemental Characteristics:

FULL RANGE DISPLAY: *.3000V, 4.000V.*

AC CONVERTER: *True-rms responding for signals with crest factor of ≤3.*

MEASUREMENT RATE: *2 readings per second.*

AUDIO INPUT IMPEDANCE: *100 kΩ nominal.*

Audio Distortion

FUNDAMENTAL FREQUENCIES: 400 Hz ±5% and 1 kHz ±5%.

MAXIMUM EXTERNAL INPUT VOLTAGE: 3V.

DISPLAY RANGE: 0.01% to 100.0% (−80.00 dB to 0.00 dB).

DISPLAYED RESOLUTION: 0.01% or 0.01 dB.

ACCURACY: ±1 dB of reading.

SENSITIVITY:

Modulation: 0.15 kHz peak FM, 1.5% peak AM or 0.6 radian peak ϕM.

External: 100 mV_{rms}.

RESIDUAL NOISE AND DISTORTION[17]:
0.3% (−50 dB), temperature <40°C.

Supplemental Characteristics:

MEASUREMENT 3 dB BANDWIDTH: *20 Hz to 50 kHz.*

DETECTION: *True rms.*

MEASUREMENT RATE: *1 reading per second.*

AUDIO INPUT IMPEDANCE: *100 kΩ nominal.*

Audio Filters

DE-EMPHASIS FILTERS: 25 μs, 50 μs, 75 μs, and 750 μs. De-emphasis filters are single-pole, low-pass filters with 3 dB frequencies of: 6366 Hz for 25 μs, 3183 Hz for 50 μs, 2122 Hz for 75 μs, and 212 Hz for 750 μs.

50 Hz HIGH-PASS FILTER (2 pole):
Flatness: <1% at rates≥200 Hz.

300 Hz HIGH-PASS FILTER (2 pole):
Flatness: <1% at rates ≥1 kHz.

3 kHz LOW-PASS FILTER (5 pole):
Flatness: <1% at rates ≤1 kHz.

15 kHz LOW-PASS FILTER (5 pole):
Flatness: <1% at rates ≤10 kHz.

>20 kHz LOW-PASS FILTER (9 pole Bessel)[18]:
Flatness: <1% at rates ≤10 kHz.

Supplemental Characteristics:

DE-EMPHASIS FILTER TIME CONSTANT ACCURACY: *±3%.*

HIGH-PASS AND LOW-PASS FILTER 3 dB CUTOFF FREQUENCY ACCURACY: *±3%.*

>20 kHz LOW PASS FILTER 3 dB CUTOFF FREQUENCY: *100 kHz nominal.*

OVERSHOOT ON SQUARE WAVE MODULATION[18]: *<1%.*

---

[16] With the low-pass and high-pass audio filters used to stabilize frequency readings.

[17] For demodulated signals, the residual noise generated by the HP 8902A must be accounted for in distortion measurements (i.e., residual AM, FM or ϕM.)

[18] The >20 kHz low-pass filter is intended for minimum overshoot with square wave modulation.

Table 1–1. Specifications (7 of 7)

RF Input

FREQUENCY RANGE: 150 kHz to 1300 MHz.

OPERATING LEVEL:

Minimum Operating Level	Maximum Operating Level	Frequency Range
12 mV_{rms} (−25 dBm)	7 V_{rms} (1W_{peak}) Source SWR <4	150 kHz–650 MHz
22 mV_{rms} (−20 dBm)	7 V_{rms} (1W_{peak}) Source SWR <4	650 MHz–1300 MHz

Supplemental Characteristics:

TUNING:

Normal Mode: *Automatic and manual frequency entry.*

Track Mode: *Automatic and manual frequency entry, $f_c \geq 10$ MHz.*

Acquisition Time (automatic operation): *~1.5 seconds.*

INPUT IMPEDANCE: *50Ω nominal.*

MAXIMUM SAFE DC INPUT LEVEL: *5V.*

General Specifications

TEMPERATURE: **Operating:** 0°C to 55°C. **Storage:** −55°C to 75°C.

REMOTE OPERATION: HP-IB; all functions except the line switch are remotely controllable.

HP-IB COMPATIBILITY (defined in IEEE 488-1978): SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.

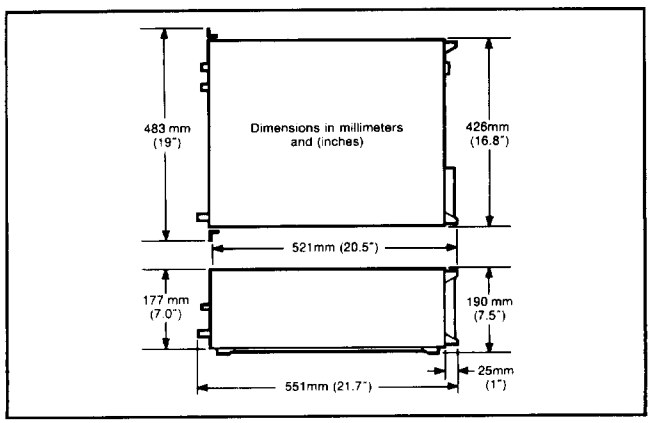
EMI: Conducted and radiated interference is within the requirements of VDE 0871 (Level B), and CISPR publication 11.

POWER: 100, 120, 220, or 240V (+5%, −10%); 48–66 Hz; 200 VA maximum.

WEIGHT: Net 23.6 kg. (52 lb.); Shipping 31.4 kg (69 lb).

DIMENSIONS: 190 mm. H × 426 mm. W × 551 mm. D (7.5" × 16.8" × 21.7").

HP SYSTEM II MODULE SIZE: 177.0 H × 1 MW × 497.8 D.



HP 8902A Rear Panel Inputs/Outputs

Supplemental Characteristics:

FM OUTPUT: *10 kΩ impedance, −9V to 6V into an open circuit: ~6V/MHz, dc coupled, 16 kHz bandwidth (one pole).*

AM OUTPUT: *10 kΩ impedance, −4V to 0V into an open circuit, ~8 mV/%, dc coupled, 16 kHz bandwidth (one pole).*

RECORDER OUTPUT: *DC voltage proportional to the measured results, 1 kΩ impedance, 0V to 4V for each resolution range into an open circuit.*

IF OUTPUT: *50Ω impedance, 150 kHz to 2.5 MHz, −27 dBm to −3 dBm.*

10 MHz REFERENCE OUTPUT: *50Ω impedance, TTL levels (0V to >2.2V into an open circuit). Available only with Option 002 1×10^{-9}/day internal reference.*

10 MHz REFERENCE INPUT[19]: *>500Ω impedance, $0.5V_{peak\text{-}to\text{-}peak}$ minimum input level.*

LO INPUT (Option 003): *50Ω impedance, ~1.27 MHz to 1301.5 MHz, 0 dBm nominal.*

RF SWITCH REMOTE CONTROL OUTPUT: *Provides output signals necessary to remotely control either an HP 33311B/C Option 011 or an HP 8761A RF switch.*

FREQUENCY OFFSET MODE REMOTE CONTROL OUTPUT: *TTL high output if in frequency offset mode (Special Function 27.1 or 27.3) with an external LO frequency >0, TTL low output for all other cases.*

[19] External reference accuracy affects accuracy of all measurements.

Table 1—2. Recommended Test Equipment (1 of 4)

Instrument Type	Critical Specifications	Suggested Model	Use*
AM/FM Test Source	Carrier Frequency: within range 10 to 1300 MHz Output Level: >−20 dBm FM Deviation: 400 kHz peak maximum FM Distortion: <−72 dB at 12.5 MHz carrier with 12.5 kHz deviation and <10 kHz rate <−72 dB at 400 MHz carrier and 400 kHz deviation at <100 kHz rate FM Flatness: ±0.1% from 20 Hz to 100 kHz rates ±0.25% to 200 kHz rates CW Residual FM: <3 Hz rms in a 50 Hz to 3 kHz bandwidth at 560 MHz Incidental AM: <0.08% AM at 100 MHz with <50 kHz peak deviation and 1 kHz rate in a 50 Hz to 3 kHz bandwidth AM Depth: 5% to 99% AM Distortion: <−66 dB at <50% AM at 20 Hz to 100 kHz rates <−60 dB at <95% AM at 20 Hz to 100 kHz rates AM Flatness: ±0.1% from 50 Hz to 50 kHz ±0.25% from 20 Hz to 100 kHz Incidental ΦM: <0.008 rad peak at 12.5 MHz with 50% AM at a 1 kHz rate in a 50 Hz to 3 kHz bandwidth Residual AM: <0.01% rms in a 50 Hz to 3 kHz bandwidth AM Linearity: ±0.1% at <95% AM ±0.2% at <99% AM	HP 11715A	P,A,T
Attenuator, 3 dB (2 required)	Frequency: 30 MHz SWR Maximum: 1.2 (Used as alternate equipment.)	HP 8491A Option 03	P
Attenuator, 6 dB	Frequency Range: 0.15 to 1300 MHz SWR Maximum: 1.2 Attenuation Accuracy: ±0.4 dB	HP 8491A Option 06	P
Audio Analyzer	Fundamental Frequency Range: 20 Hz to 100 kHz Distortion Range: −70 dB minimum Distortion Accuracy: ±2 dB Low-Pass Filters: 30 and 80 kHz Oscillator Level: 3V maximum into 600Ω Oscillator Distortion: <−70 dB Oscillator Frequency Accuracy: ±2%	HP 8903B	P,A,T

*C=Operator's Checks; P=Performance Tests; A=Adjustments; T=Troubleshooting

Table 1-2. *Recommended Test Equipment (2 of 4)*

Instrument Type	Critical Specifications	Suggested Model	Use*
Audio Synthesizer	Frequency Range: 20 Hz to 400 kHz Output Level: +16 dBm (50Ω) maximum Frequency Accuracy: ±0.1% Attenuator Accuracy: ±0.1 dB from 0 to 20 dB Level Flatness: ±0.07 dB from 20 Hz to 200 kHz Distortion: ¡−50 dB from 20 Hz to 200 kHz	HP 3336C Option 005	P,A,T
Computing Controller	HP-IB compatibility as defined by IEEE Std 488 and the identical ANSI Std MC1.1: SH1, AH1, T2, TE0, L2, LE0, SR0, PP0, DC0, DT0, and C1, 2, 3, 4, 5.	HP 9825A and HP 98034A and HP 98213A or HP 85B Option 007	C,P,T
Digital Multimeter	DC Range: 0 to 50V DC Accuracy: ±0.01% at 1V AC Range: 0 to 100V AC Accuracy: ±0.01% at 2V and 2 kHz Ohms Range: 0 to 1 MΩ Ohms Accuracy: ±1%	HP 3455A	P,A,T
Divider Probe (2 required)	Divider Ratio: 10:1 Input Impedance: 1 MΩ Input Capacitance: ¡10 pF	HP 10040A	A,T
Extender Cable	No substitution is recommended.	HP 08901-60179	A,T
Frequency Standard	Accuracy: ±0.1 ppm recommended	House Standard	A
Oscilloscope	Bandwidth: less than 3 dB down 0 to 100 MHz Sensitivity: 5 mV per division minimum Input Impedance: 10 MΩ and 50Ω Triggering: External and Internal	HP 1740A	C,A,T
Piston Attenuator	Accuracy: ±(0.005 dB/10 dB + 0.03 dB) at 30 MHz (Used as alternate equipment.)	Eaton Type 32	P

*C=Operator's Checks; P=Performance Tests; A=Adjustments; T=Troubleshooting

Table 1–2. Recommended Test Equipment (3 of 4)

Instrument Type	Critical Specifications	Suggested Model	Use*
Power Meter or Power Reference	Power Range: 1 mW Frequency Range: 50 MHz SWR: 1.05 Accuracy: ±0.5%; NBS calibrated Power Output: 1.00 mW, factory set to ±0.7%, NBS calibrated Accuracy: ±(1.2% worst case +0.9% rss) for one year; 0 to 50° C	HP 432A and HP 478A Option H75 HP 435A Option K05	P,A
Power Supply	Output Range: 0 to 25 Vdc	HP 6215A	T
Range Calibrator	Calibration Functions: outputs corresponding to power displays of 10 μW, 100 μW, 1 mW, 10 mW, and 100 mW Calibration Uncertainty: ±0.25% in all ranges	HP 11683A	P,A,T
RF Spectrum Analyzer	Frequency Range: 0 to 2 GHz Input Level: ±10 dBm maximum Display Range: 60 dB	HP 8559A and HP 182T	A,T
Sensor Module	Compatible with HP 8902A Input SWR: <1.3, at RF Input, RF Ranges 1 and 2 <1.5, at RF Input, RF Range 3 <1.3, at RF Input, RF Range 3 with Measuring Receiver's Special Function 1.9	HP 11722A	P,A,T
Service Accessory Kit	No substitution recommended.	HP 08901-60287	T
Signal Generator	Frequency Range: 0.5 to 1100 MHz Output Level: +19 dBm maximum to 500 MHz +13 dBm maximum to 1100 MHz Output Level Accuracy: ±1 dB Frequency Accuracy: ±1% Frequency Resolution: 1 kHz Modulation Capability: AM and FM AM Depth: 0 to 95% AM Accuracy: ±10% FM Range: 0 to 400 kHz peak deviation FM Accuracy: ±10%	HP 8640B Options 001 and 002	C,P,A T

*C=Operator's Checks; P=Performance Tests; A=Adjustments; T=Troubleshooting

Table 1–2. Recommended Test Equipment (4 of 4)

Instrument Type	Critical Specifications	Suggested Model	Use*
Signature Analyzer	External Count Range: to 15 MHz Because the signatures documented are unique to a given signature analyzer, no substitution is recommended.	HP 5005A	T
Step Attenuator	Step Accuracy: ±0.01 dB between 10 and 20 dB at 50 MHz	HP 355D Option J25	P
SWR Bridge	Frequency Range: 150 kHz to 1300 MHz Impedance: 50Ω Directivity: >40 dB Connectors: Type-N	Wiltron 60N50	P

*C=Operator's Checks; P=Performance Tests; A=Adjustments; T=Troubleshooting

Table 1–3. *Recommended Test Accesories*

Accessory Type*	Recommended Part
Adapter (Type N Male to BNC Female connectors)	HP 1250-0067
Capacitor, 620 pF	HP 0160-3536
IC Extender Clip, 16 Pin	HP 1400-0734
Resistor, 909Ω1% 1/4W	HP 0757-0422
Resistor, 1210Ω1% 1/4W	HP 0757-0274
Resistor, 2150Ω1% 1/4W	HP 0698-0084
Resistor, 4640Ω1% 1/4W	HP 0698-3155
Tee (Coaxial, BNC, one Male and two Female connectors)	HP 1250-0781
50ΩLoad (Male, BNC, coaxial)	HP 1250-0207
Adjustment Tool	HP 8710-0772
*Accessories listed in this table are only those not already contained in the Service Accessory Kit HP 08901-60287	

Section 2
INSTALLATION

2–1. INTRODUCTION TO THIS SECTION

This section provides the information needed to install the Measuring Receiver. Included is information pertinent to initial inspection, power requirements, line voltage selection, power cables, interconnection, operating environment, instrument mounting, storage and shipment. This section also contains a procedure for setting the internal HP-IB talk and listen address switches and a procedure for removing the pull-out cards.

2–2. INITIAL INSPECTION

WARNING

To avoid hazardous electrical shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section 4. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection.

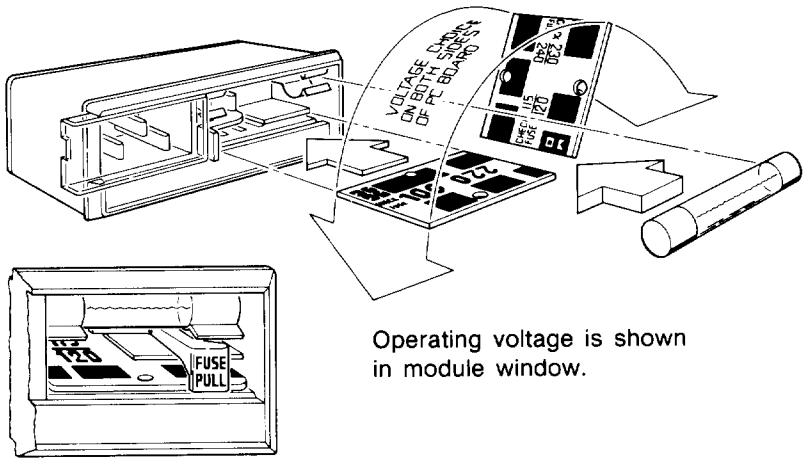
2–3. PREPARATION FOR USE

Power Requirements

WARNING

To avoid the possibility of hazardous electrical shock, do not operate this instrument at line voltages greater than 126.5 Vac with line frequencies greater than 66 Hz. Leakage currents at these line settings may exceed 3.5 mA.

The Measuring Receiver requires a power source (+5% to −10%) of 100, 120, 220, or 240 Vac, 48 to 66 Hz single phase. Option 004 also operates from 48 to 440 Hz single phase, 120 Vac, (+5% to −10% only). Power consumption is 200 VA maximum.



Operating voltage is shown in module window.

Selection of Operating Voltage and Fuse Replacement

1. Open cover door, pull the FUSE PULL lever and rotate to left. Remove the fuse.
2. Remove the Line Voltage Selection Card. Position the card so the line voltage appears at top-left corner. Push the card firmly into the slot.
3. Rotate the FUSE PULL lever to its normal position. Insert a fuse of the correct value in the holder. Close the cover door.

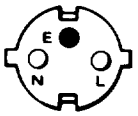
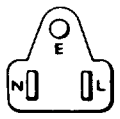
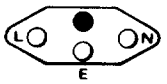
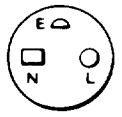
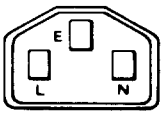
Figure 2–1. *Line Voltage and Fuse Selection*

WARNING

This is a Safety Class I product (that is, provided with a protective earth terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an external autotransformer, make sure the autotransformer's common terminal is connected to the earthed pole of the power source.

Table 2-2. AC Power Cables Availiable

Plug Type	Cable HP Part Number	C D	Plug Description	Cable Length (inches)	Cable Color	For Use In Country
250V 	8120-1351 8120-1703	0 4	90°/STR BS1363A* 90°/90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Rhodesia, Singapore
250V 	8120-1369 8120-0696	0 4	STR/STR NZSS198/ASC112* STR/90°	79 80	Gray Gray	Austrailia, New Zealand
250V 	8120-1689 8120-1692	7 2	STR/STR* STR/90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, (unpolarized in many nations)
125V 	8120-1378 8120-1521 8120-1751	1 6 1	STR/STR NEMA5-15P* STR/90° STR/STR	80 80 90	Jade Gray Jade Gray Jade Gray	United States, Canada, Mexico, Phillipines, Taiwan U.S./Canada
100V (Same plug as above)	8120-4753 8120-4754	2 3	STR/STR STR/90°	90 90	Dark Gray Dark Gray	Japan only Japan only
250V 	8120-2104 8120-2296 8120-3997	3 4 4	STR/STR SEV1011 1959-24507 Type 12 STR/90° STR/90°	79 79 177	Gray Gray Gray	Switzerland
250V 	8120-0698	6	STR/STR NEMA6-15P	90	Black	United States, Canada
250V 	8120-2956 8120-2957 8120-3997	3 4 4	90°/STR 90°/90° STR/STR	79	Gray	Denmark
250V 	8120-4211 8120-4600	7 8	STR/STR*IEC83-B1 STR/90°	79 79	Black Gray	South Africa, India
250V 	8120-1860 8120-1575 8120-2191 8120-4379	6 0 8 8	STR/STR*CEE22-V1 (Systems Cabinet Use) STR/STR STR/90° 90°/90°	59 31 59 80	Jade Gray Jade Gray Jade Gray Jade Gray	

* Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug. E = Earth Ground; L = Line; N = Neutral; STR = Straight

Line Voltage and Fuse Selection

CAUTION

BEFORE PLUGGING THIS INSTRUMENT into the Mains (line) voltage, be sure the correct voltage and fuse have been selected.

Verify that the line voltage selection card and the fuse are matched to the power source. Refer to Figure 2–1, *Line Voltage and Fuse Selection.*

Fuses may be ordered under HP part numbers 2110-0083, 2.5A (250V normal blow) for 115 Vac operation and 2110-0043, 1.5A (250V normal blow) for 230 Vac operation.

Power Cables

WARNING

BEFORE CONNECTING THIS INSTRUMENT, the protective earth terminals of this instrument must be connected to the protective conductor of the (Mains) power cord. The Mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding).

This instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Table 2–1 for the part numbers of the power cables available.

HP-IB Address Selection

The HP-IB address switches are located within the Measuring Receiver. The switches represent a five-bit binary number. This number represents the talk and listen address characters which an HP-IB controller must generate. In addition, two more switches allow the Measuring Receiver to be set to talk only or to listen only.

WARNING

Setting of the HP-IB address should be performed only by service trained persons who are aware of the potential shock hazard of working on an instrument with protective covers removed.

To avoid hazardous electrical shock, the line (Mains) power cable should be disconnected before attempting to change the HP-IB address.

In the Measuring Receiver, the HP-IB talk and listen addresses are selectable by an internal switch (Figure 2–2). This address can be read by selecting BUS ADRS (Blue Key, LOCAL). The following procedure explains setting of the switches. Refer to Table 2–2 for a listing of the talk and listen addresses. In the factory, the address is set for a talk address of "N" and a listen address of "." (period). In binary, this is 01110; in decimal it is 14.

1. Disconnect the line (Mains) power cable.
2. Remove any HP-IB cables or connectors from the HP-IB connector.
3. Remove the Measuring Receiver's top cover.

a. Remove the two plastic feet from the rear of the top cover by removing the pan-head Pozidriv screw within each foot.

b. Unscrew the Pozidriv screw at the center of the rear edge of the top cover. This is a captive screw and will cause the top cover to pull away from the front frame.

c. Lift off the top cover.

4. Locate the HP-IB address switch on the A14 Remote Interface Assembly near the front right of the instrument. The A14 assembly may be recognized as having one brown and one yellow printed circuit board extractor.

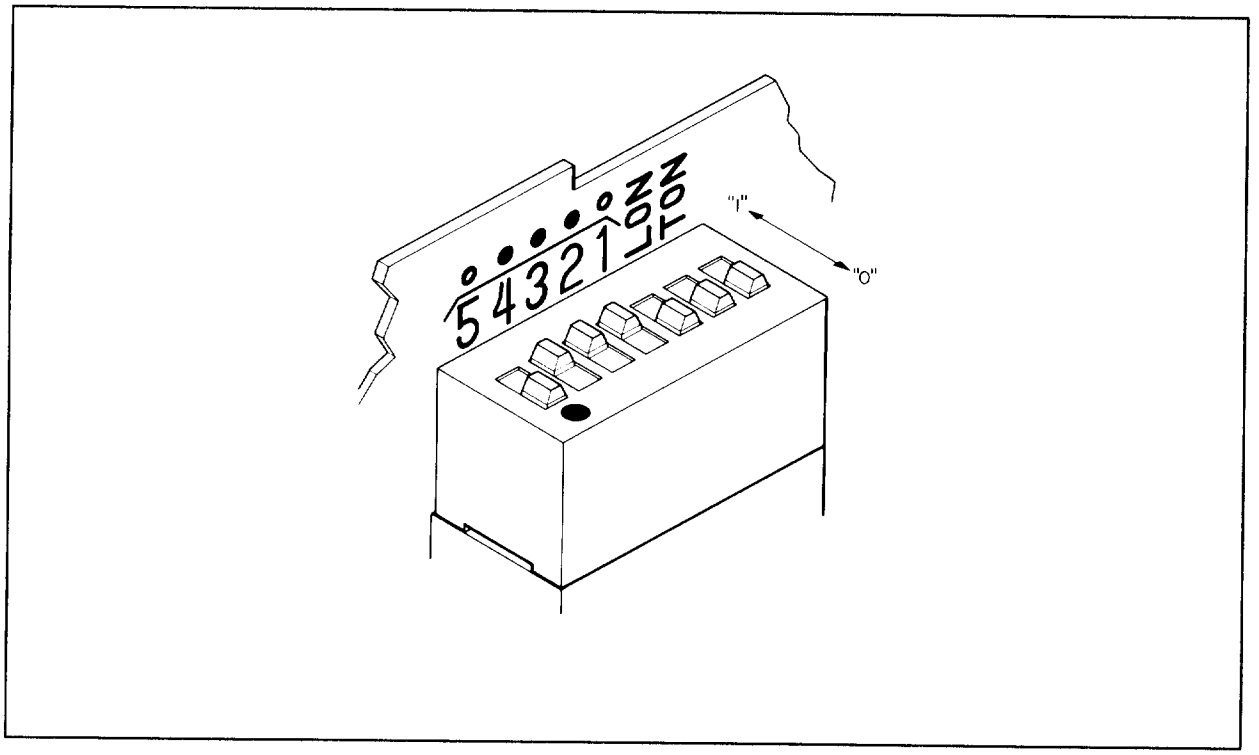


Figure 2–2. *The HP-IB Address Switch Shown as Set by the Factory*
The Address Shown is 01110 in Binary (14 in Decimal) With Both Talk Only and Listen Only Off

5. Use a pencil to set the switches to the desired HP-IB address and Talk Only (TON) or Listen Only (LON) condition. The switch is illustrated in Figure 2–2. Facing the board, the left hand switch (marked with a "5") is the most significant address bit (A5 in Table 2–2). Setting a switch toward the printed circuit board places it in its "1" position. If the TON and LON switches are both set to "1", the Talk Only setting will override. If the address switches and the TON switch are all set to "1", the Measuring Receiver will output one byte (the status byte) each measurement cycle. (Setting all switches to "1" defeats HP-IB operation.)

6. Reinstall the top cover by reversing the procedure in previous step 3.

7. Connect the line (Mains) power cable to the Line Power Module and reconnect the HP-IB cable to the HP-IB connector.

8. To confirm the address, turn on the instrument and select BUS ADRS (Blue Key, LOCAL). To confirm a talk only or listen only setting, key in 21.0 SPCL. The display shows a binary

number in the form AAAAA.TLS where AAAAA is the HP-IB address in binary and T,L, and S indicate talk, listen, and service request status.

Table 2–2. Allowable HP-IB Address Codes

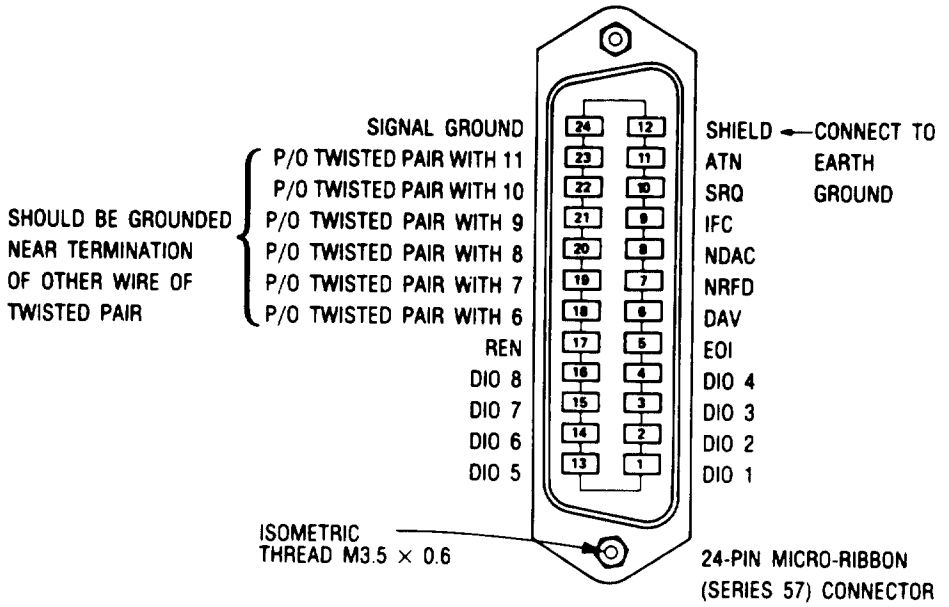
Address Switches					Talk Address Character	Listen Address Character	Decimal Equivalent
A5	A4	A3	A2	A1			
0	0	0	0	0	@	SP	0
0	0	0	0	1	A	!	1
0	0	0	1	0	B	"	2
0	0	0	1	1	C	#	3
0	0	1	0	0	D	$	4
0	0	1	0	1	E	%	5
0	0	1	1	0	F	&	6
0	0	1	1	1	G	'	7
0	1	0	0	0	H	(	8
0	1	0	0	1	I	)	9
0	1	0	1	0	J	*	10
0	1	0	1	1	K	+	11
0	1	1	0	0	L	,	12
0	1	1	0	1	M	-	13
0	1	1	1	0	N	.	14
0	1	1	1	1	O	/	15
1	0	0	0	0	P	0	16
1	0	0	0	1	Q	1	17
1	0	0	1	0	R	2	18
1	0	0	1	1	S	3	19
1	0	1	0	0	T	4	20
1	0	1	0	1	U	5	21
1	0	1	1	0	V	6	22
1	0	1	1	1	W	7	23
1	1	0	0	0	X	8	24
1	1	0	0	1	Y	9	25
1	1	0	1	0	Z	:	26
1	1	0	1	1	[	;	27
1	1	1	0	0	\	<	28
1	1	1	0	1	]	=	29
1	1	1	1	0	^	>	30
1	1	1	1	1	Invalid	Invalid	31

Interconnections

Interconnection data for the Hewlett-Packard Interface Bus is provided in Figure 2–3.

Mating Connectors

Interface Connector The HP-IB mating connector is shown in Figure 2–3. Note that two securing screws are metric.



Logic Levels

The Hewlett-Packard Interface Bus logic levels are TTL compatible, that is, the true (1) state is 0.0 Vdc to +0.4 Vdc and the false (0) state is 2.5 Vdc to +5 Vdc.

Programming and Output Data Format

Refer to Section 3 "Operation".

Mating Connector

HP 1251-0293; Amphenol 57-30240

Mating Cables Available

HP 10833A, 1 meter (3.3 ft.), HP 10833B 2 meters (6.6 ft.)
HP 10833C 4 meters (13.2 ft.), HP 10833D, 0.5 meters (1.6 ft.)

Cabling Restrictions

1. A Hewlett-Packard Interface Bus system may contain no more than 2 meters (6.6 ft.) of connecting cable per instrument.
2. The maximum accumlative length of connecting cable for any Hewlett-Packard Interface Bus system is 20 meters (65.6 ft.).

Figure 2–3. *Hewlett-Packard Interface Bus Connection*

Coaxial Connectors Coaxial mating connectors used with the Measuring Receiver should be the 50Ω BNC male connectors or 50Ω Type-N male connectors that are compatible with those specified in US MIL-C-39012.

The application note, "Principles of Microwave Connector Care" (HP part number 5958-7442) can help you improve measurements and reliability. Suggestions in the application note will help you get the best performance from all microwave connectors. It will show what to look for when cleaning and inspecting connectors (in order to preserve their precision and extend their life) and how to make the best possible microwave connections (improving the accuracy and repeatability of all your measurements).

Operating Environment

The operating environment should be within the following limitations:

Temperature	−0°C to +55°C
Humidity	<95% relative
Altitude	4570 meters (15 000 feet)

Bench Mounting

The instrument cabinet has plastic feet and fold-away tilt stands for convenience in bench operation. (The plastic feet are shaped to ensure self-aligning of the instruments when stacked.) The tilt stands raise the front of the instrument for easier viewing of the front panel.

Rack Mounting

WARNING

The Measuring Receiver is heavy for its size (23.6 kg, 52 lb). Care must be exercised when lifting to avoid personal injury. Use equipment slides when rack mounting.

Rack mounting information is provided with the rack mounting kits. If the kits were not ordered with the instrument as options, they may be ordered through the nearest Hewlett-Packard office. (Refer to paragraph 1–8, *Additional Equipment Information* under *Mechanical Equipment Available*. Before rack mounting the Measuring Receiver, the *Operating Information* pull-out tray (attached to the bottom of the instrument) must first be removed. To remove the pull-out card assembly, refer to the procedure that follows.

Removal and Installation of Operating Information Pull-Out Cards

Steps for Removal Follow the procedure below to remove the *Operating Information* pull-out card assembly:

1. Remove the two front feet of the instrument.
2. Remove the Operating Information tray assembly by sliding the tray toward the rear of the instrument and then down.
3. Remove the information cards by bowing them slightly in the middle and pulling it straight up (away from the tray).

Steps for Installation Follow the procedure below to reinstall the *Operating Information* pull-out card assembly:

1. Install the information card by bowing it slightly in the middle and carefully guiding the edges into the plastic guide slots near the front of the tray.
2. Push the information card all the way into the tray.
3. Place the information tray assembly between the rear feet of the instrument and slide it forward until the tabs are locked under the rear feet.
4. Replace the front feet of the instrument.

2–4. STORAGE AND SHIPMENT

Environment

The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature	−55°C to +75°C
Humidity	<95% relative
Altitude	15 300 meters (50 000 feet)

Packaging

Original Packaging Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number and full serial number. Also mark the container FRAGILE to assure careful handling. In any correspondence refer to the instrument by model number and full serial number.

Other Packaging The following general instructions should be used for re-packaging with commercially available materials:

1. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the service required, return address, model number and full serial number.)
2. Use a strong shipping container. A double-wall carton made of 2.4 MPa (350 psi) test material is adequate.
3. Use enough shock-absorbing material (75 to 100 mm layer; 3 to 4 in.) around all sides of instrument to provide firm cushion and prevent movement in the container. Protect the front panel with cardboard.
4. Seal the shipping container securely.
5. Mark the shipping container FRAGILE to assure careful handling.

Section 3
OPERATION

3–1. INTRODUCTION TO THIS SECTION

This section provides advanced operating information for the Measuring Receiver. Included in this section are descriptions of all front- and rear-panel controls, connectors, and indicators, remote and local operator's checks, operating instructions, and operator's maintenance.

Local Operation Section

Information regarding front-panel operation of the Measuring Receiver is provided in the sections described in the following paragraphs. To most rapidly learn the basic operation of the instrument, refer to the separate *Basic Operation and Application Guide* and/or perform the *Operator's Checks.* Once familiar with the general operation of the instrument, use the *Detailed Operating Instructions* for the most in-depth and complete information on operating the Measuring Receiver.

Remote Operation Section

The Measuring Receiver is capable of remote operation via the Hewlett-Packard Interface Bus (HP-IB). Provided in this section are instructions pertinent to HP-IB operation including all specific considerations and instructions (including capabilities, address formats, input and output formats, the status byte, and service requests). At the end of the discussion is a complete summary of all codes and formats.

HP-IB information concerning remote information also appears in several other locations. Address setting is discussed in Section 2, a summary of HP-IB codes and output formats appears on the *Operating Information* pull-out card, and a list of relevant program codes for each function appears in the *Detailed Operating Instructions*. (Detailed Operating Instructions are described above in the paragraph, *Local Operation Section*.)

Basic Functional Checks Section

Basic Functional Checks are simple procedures designed to be performed by the operator. These checks verify the proper operation of the Measuring Receiver's main functions and HP-IB capabilities. These checks can also be used to familiarize the first-time operator with basic Measuring Receiver measurements and HP-IB capabilities. Two procedures are provided:

Basic Functional Checks of the Measuring Receiver

This procedure assures that most front-panel controlled functions are being properly executed by the Measuring Receiver. The checks require the use of a sensor module, a signal generator, an oscilloscope, and interconnecting cables and adapters.

Basic Functional Checks of the Hewlett-Packard Interface Bus (HP-IB)

This series of procedures requires only an HP-IB compatible computing controller and an HP-IB interface and connecting cable. The *HP-IB Functional Checks* assume that front-panel operation has been verified (for example, by performing the *Basic Functional Checks*).

Detailed Operating Instructions Section

The *Detailed Operating Instructions* provide a complete operating reference for the Measuring Receiver user. The instructions are organized into tabbed sections oriented toward specific measurement types. Besides information on the various measurements, the instructions contain individual discussions of nearly all controls, inputs, and outputs. Also included are instructions for using the many user special functions. A guide to using the *Detailed Operating Instructions* is provided ahead of the instructions themselves.

Other Sources of Operating Information

Pull-Out Cards

The *Operating Information* and *Special Function Information Pull-Out Cards* are flexible plastic reference sheets attached to the Measuring Receiver by a tray located beneath the front panel. They contain a brief summary of front-panel operation and displays. Also included on the cards is a complete listing of HP-IB codes, data, and error output formats, error codes, and user special functions. The cards show a simplified block diagram for the Measuring Receiver and provide basic instructions for RF Power and Tuned RF Level Measurement operation. The pull-out cards are intended to be a reference for the user who already has a basic understanding of front-panel operation.

Supplemental Information

Other information, pertinent to operating the Measuring Receiver to its fullest capabilities, are contained in *Section 1*, "Principles of Operation for a Simplified Block Diagram" (in paragraph 1–10) is a fundamental description of what the Measuring Receiver is and how it works. This information supplements the block diagrams provided on the pull-out card and in the *Detailed Operating Instructions*. "Modulation Basics" (in paragraph 1–11) is a discussion about the way the Measuring Receiver makes modulation measurements. All of this information helps to provide a basis for applying the Measuring Receiver to various measurement situations.

3–2. OPERATING CHARACTERISTICS OF THE MEASURING RECEIVER

The major operating characteristics of the Measuring Receiver are provided in paragraph 1–6, *Description*, and Table 1–1, *Specifications*. For information on HP-IB capabilities, refer to *Remote* section in this manual.

3–3. OPERATOR'S INFORMATION

Fuses

WARNING

For continued protection against fire hazard, replace the line fuse only with a 250V normal blow fuse of the same rating. Do not use repaired fuses or short-circuited fuseholders.

The only maintenance the operator should normally perform is the replacement of the primary power fuse located within the Line Power Assembly (A30). For instructions on how to change the fuse, refer to Figure 2–1, steps 1 and 3.

Fuses can be ordered using HP part number 2110-0083, 2.5A (250V, normal blow) for 100/120 Vac operation or 2110-0043, 1.5A (250V, normal blow) for 220/240 Vac operation.

Time Base 10 MHz Input and Time Base 10 MHz Output

WARNING

Do not apply greater than 20V peak (ac + dc) into the TIME BASE 10 MHz INPUT or damage to the instrument may result.

Do not apply greater than 3 Vdc or greater than +20 dBm into the TIME BASE 10 MHz OUTPUT or damage to the instrument may result.

Description

Time Base 10 MHz Input. Provides an input for an external 10 MHz time base reference. This input is ac coupled and requires an input signal level greater than 0.5 Vpp. The input impedance is approximately 500Ω.

The time-base circuitry of the Measuring Receiver automatically switches to the external time base when an external time base of sufficient amplitude is applied.

When using an external time base reference, the acccuracy of all measurements depends on the accuracy of the external reference. Frequency-related measurements are most noticeably affected by time-base innacuracy.

To determine whether the Measuring Receiver has actually switched in the externally applied time base, select 15.1 SPCL. If an external time base is being used, the display will show a 1. If the internal time base is being used, the display will show a 0.

If the Measuring Receiver is using the internal, Option 002 time base, you can determine whether the time base oven is warm enough to create a stable source by selecting 15.0. The display will show a 0 if the time base oven is adequately warm. The display will show Error 12 if the time base is cold.

To drive several instruments from a single external reference, simply use a BNC tee at the Measuring Receiver's TIME BASE 10 MHz INPUT.

If the internal time base fails, an external time base may still be used. Connect the external time base to TIME BASE 10 MHz INPUT, then switch the instrument's POWER switch to STBY and back to ON.

Time Base 10 MHz Output. (This output is available only with the high-stability reference, Option 002.) Provides an output for the internal 10 MHz reference. The output is a 50Ω, TTL compatible output (0V to greater than 2.2V into an open circuit).

When driven from an external reference, the Measuring Receiver outputs the internal reference (not the external input signal). TIME BASE 10 MHz INPUT provides an input for an external 10 MHz time base reference. This input is ac coupled and requires an input signal level greater than 0.5 Vpp. The input impedance is approximately 500Ω.

3–4. TURN-ON PROCEDURE

WARNING

Before the Measuring Receiver is switched on, all protective earth terminals, extension cords, auto-transformers, and devices connected to it should be connected to a protective earth socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

For continued protection against fire hazard, replace the line fuse with a 250V normal blow fuse of the same rating. Do not use repaired fuses or short-circuited fuseholders.

CAUTION

Before the Measuring Receiver is switched on, it must be set to the voltage of the power source, or damage to the instrument may result. Refer to paragraph 2–3, Power Requirements.

Do not apply greater than 40V (ac + dc) to the RF INPUT connector or damage to the instrument may result.

The Measuring Receiver has a standby state and an on state. Whenever the power cable is plugged in, an internal power supply is activated. In instruments supplied with the high-stability reference (Option 002) the supply energizes the internal reference oven. If the Measuring Receiver is already plugged in, set the POWER switch to ON. If the power cable is not plugged in, follow these instructions:

1. Check that the line voltage setting matches the power source. (See Figure 2–1, *Line Voltage and Fuse Selection*.)
2. Check that the fuse rating is appropriate for the line votage used. (See Figure 2–1, *Line Voltage and Fuse Selection*.) Fuse ratings are provided in the paragraph *Operator's Maintenance* in this section.
3. Plug in the power cable.
4. Set the POWER switch to ON.

NOTE

When the POWER switch is set to ON, all front-panel indicators light for approximately 10 seconds after which the instrument is ready to be operated.

3–5. INSTRUMENT FEATURES

Front-panel controls, indicators, and connectors are illustrated and referenced to text in Figure 3–1. The text for this figure describes the various functions of the Measuring Receiver. At the end of each description is a reference to a detailed operating instruction that contains more details on this topic.

Rear-panel features are shown and referenced to text in Figure 3–2. The text for this figure provides a quick reference for rear-panel signal levels and frequencies and also includes the impedances at the rear-panel connections.

The information in parenthesis at the end of each feature summary provides the title of the *Detailed Operating Instructions* relevant to the feature.

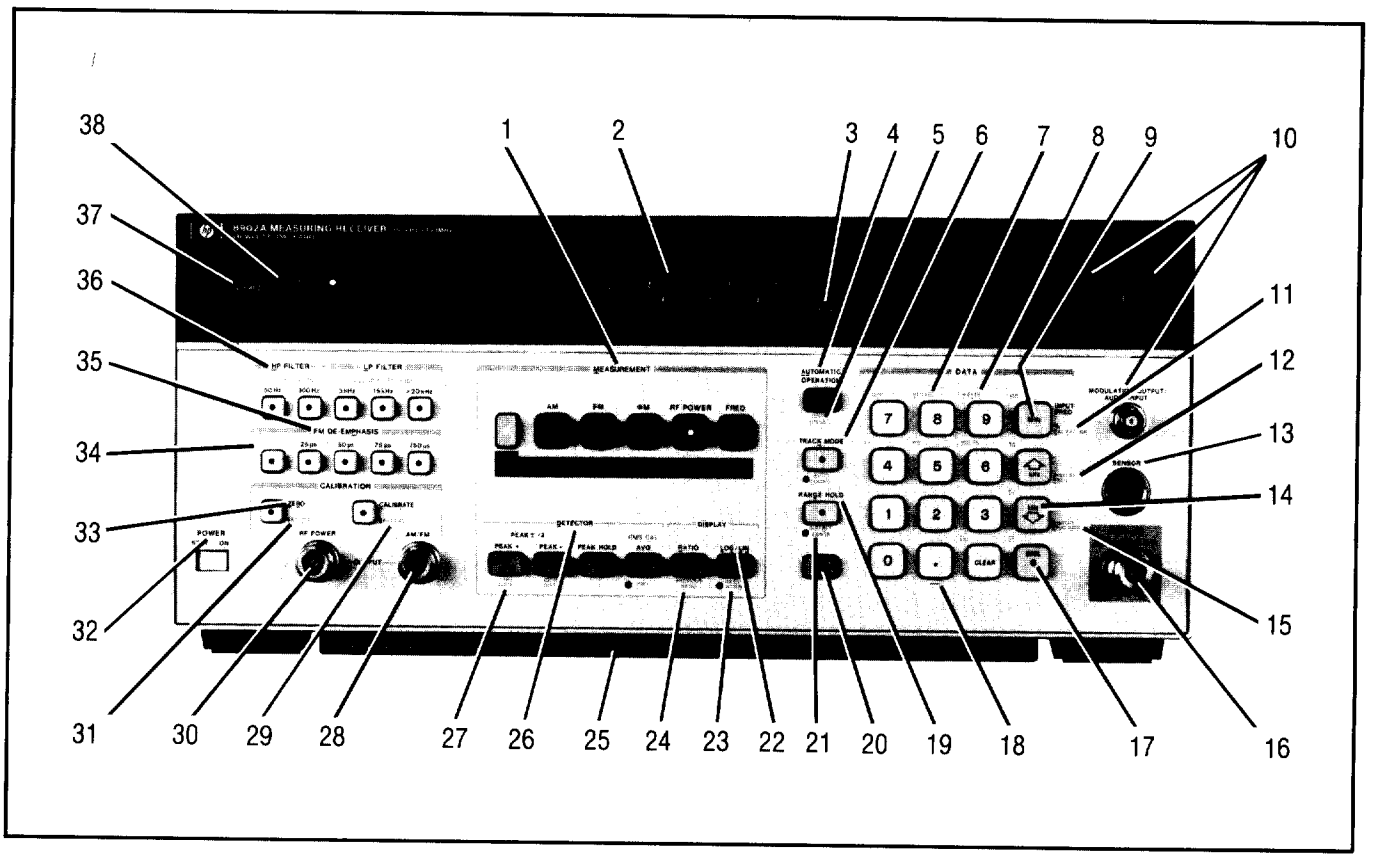


Figure 3–1. Front-Panel Features

Front-Panel Features

The following list provides a brief description of each feature. The information in brackets provides the title of the *Detailed Operating Instructions* relevant to the feature. The index lists page numbers for the instructions.

1. MEASUREMENT keys enable the Measuring Receiver to make and display the selected measurement. [See *AM, FM, ΦM, RF Power, RF Input Frequency, Audio Frequency, Audio Distortion, IF Level, Tuned RF Level, RF Frequency Error.*]
2. Numeric Display shows measurement results, error codes, or instrument or Special Function status.
3. Display Annunciators indicate the measurement result units. They also indicate that some measurement functions are enabled. All these annunciators are displayed when the Measuring Receiver is first turned on.
4. AUTOMATIC OPERATION enables the Measuring Receiver to automatically tune and to autorange to make the selected measurement. [See *Automatic Operation.*]
5. INSTR PRESET (Blue Key) configures the Measuring Receiver to its power-up condition. [See *Instrument Preset.*]
6. TRACK MODE and AUTO TUNING (Blue Key) select the tuning mode of the Measuring Receiver. [See *RF Frequency Tuning.*]
7. STORE (Blue Key) and RECALL (Blue Key) enable the Measuring Receiver to store and recall up to eight measurement states. [See *Store/Recall.*]
8. WATTS, μV, mV, and VOLTS keys (all used with the Blue Key) enable selection of different units for level measurements.
9. MHz completes the keyboard entry of frequencies for various functions. This key is also used to complete the entry of frequencies used with RF Power calibration factors. [See *RF Frequency Tuning, Frequency Offset Mode, RF Power.*]
10. MODULATION OUTPUT/AUDIO INPUT connector provides either an output for the modulation recovered from the RF INPUT connector or an input for external audio signals to be processed by the audio circuitry. The MODULATION OUTPUT annunciators indicate the type of recovered modulation available as the output. The AUDIO INPUT key selects whether the internally demodulated signal or an external audio signal is to be processed by the Measuring Receiver's audio circuitry. [See *Modulation Output/Audio Input, Audio Frequency, Audio Distortion and Level, SINAD.*]
11. % CAL FACTOR (Blue Key) causes the Measuring Receiver to display the current calibration factor for the selected measurement. This key is also used to complete the entry of calibration factors for various functions. [See *AM Calibration, FM Calibration, RF Power, Tuned RF Level.*]
12. DISPLAY FREQ (Blue Key) causes the Measuring Receiver to display the RF frequency that it tuned to last. [See *Frequency Offset Mode, RF Power Calibration Factors.*]
13. SENSOR connector provides the input for the power sensor. [See *RF Power.*]
14. kHz ⇑ and kHz ⇓ complete keyboard entry of frequency step-size (in kHz) for step tuning, or change the frequency in the increments specified. [See *RF Frequency Tuning.*]
15. DISPLAY FREQ INCR (Blue Key) causes the Measuring Receiver to display the increment step-size. [See *RF Frequency Tuning.*]
16. INPUT couples the RF input signal into the instrument. [See *RF Input Frequency.*]
17. SPCL completes entry of Special Function codes that access additional instrument operations. Without a preceeding numeric entry, the SPCL key causes a display of the status of Special Functions 1 through 10. [See *Special Functions.*]

18. (−) (Blue Key) enables input data to be entered as a negative value.
19. RANGE HOLD freezes the current ranges being used by the Measuring Receiver. [See *Range Hold.*]
20. Blue Key is a shift key that enables some keys to have two different functions. Any function printed in blue can be selected when the key associated with it is pressed after the Blue Key. (The Blue Key flashes at the current measurement rate whenever it is pressed.)
21. DISABLE ERROR (Blue Key) disables Error 01 through Error 04. [See *Error Message Disable Control.*]
22. LOG/LIN causes measurements to alternate between logarithmic and linear units. [See *Ratio and Log/Lin.*]
23. dB EXT ATTEN (Blue Key) enables level measurements to be offset with external attenuation or gain. [See *External Attenuation.*]
24. RATIO and PREVIOUS RATIO (Blue Key) cause the current measurement to be compared to a reference. [See *Ratio and Log/Lin.*]
25. *Operating Information* pull-out cards are quick operating references that list Special Function, HP-IB, and Error codes, show a simplified block diagram for the Measuring Receiver, and provide basic information for RF Power and Tuned RF Level operation.
26. DETECTOR keys select the audio detector used to measure the modulation. [See *Audio Detectors, Audio Distortion and Level, SINAD.*]
27. 1 kHz DISTN (Blue Key) and 400 Hz DISTN (Blue Key) enable the Measuring Receiver to make audio measurements on either 1 kHz or 400 Hz audio signals. [See *Audio Distortion and Level, SINAD.*]
28. CALIBRATION AM/FM OUTPUT makes available a precisely modulated signal used to improve the Measuring Receiver's AM or FM accuracy. [See *AM Calibration, FM Calibration.*]
29. CALIBRATE and SAVE CAL (Blue Key) enable the Measuring Receiver to calibrate and save the resulting calibration factor for either RF Power, AM, or FM. The CALIBRATE key also initiates tuned RF level calibration operations. [See *AM Calibration, FM Calibration, RF Power, Tuned RF Level.*]
30. CALIBRATION RF POWER OUTPUT makes available a 50 MHz, 1 mW power reference used to precisely determine the sensitivity of the external power sensor. [See *RF Power.*]
31. SET REF (Blue Key) enables the Measuring Receiver to accurately measure relative power changes; for example, in attenuator or amplifier measurements. [See *Attenuator Measurements.*]
32. POWER switch applies power to the Measuring Receiver when set to ON. [See *Instrument Preset.*]
33. ZERO causes the Measuring Receiver to cancel any dc offset that may be present in the power sensor. [See *RF Power.*]
34. PRE DISPLAY enables FM deviation to be measured before or after de-emphasis. [See *FM De-Emphasis.*]
35. FM DE-EMPHASIS networks equalize pre-emphasized FM. [See *FM De-Emphasis.*]
36. HP (High-Pass) and LP (Low-Pass) FILTERS limit the demodulated signal bandwidth. [See *Audio Filters.*]
37. LOCAL returns the Measuring Receiver to keyboard control from remote (HP-IB) control.
38. HP-IB Annunciators indicate remote operation status.

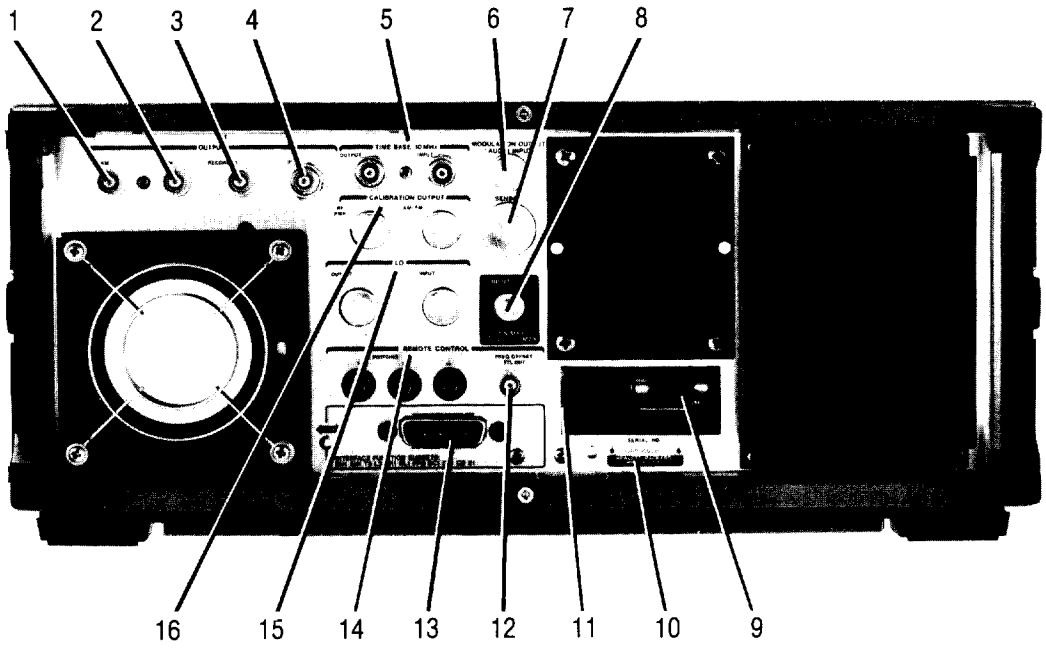


Figure 3–2. Rear-Panel Features

Rear-Panel Features

1. AM OUTPUT produces an ac signal, whose amplitude is proportional to the AM depth, with a dc component related to the IF level. The output is dc coupled with a 16 kHz bandwidth and a 10 kΩ output impedance. [See *AM Output.*]
2. FM OUTPUT produces an ac signal, whose amplitude is proportional to the FM deviation, with a dc component related to the IF frequency. The output is dc coupled with a 16 kHz bandwidth and a 10 kΩ output impedance. [See *FM Output.*]
3. RECORDER OUTPUT allows user-access to all internal measurement voltages. [See *Recorder Output.*]
4. IF OUTPUT produces a 150 kHz to 2.5 MHz modulated IF signal. The output level ranges from −27 to −3 dBm (50Ω output impedance). [See *IF Output.*]
5. TIME BASE 10 MHz OUTPUT and INPUT. The input connector provides an input for an external 10 MHz time base reference. The external input signal must be greater than 0.5V peak-to-peak (into a 500Ω input impedance). The output connector provides an output for the internal, high-stability 10 MHz reference. Output signal is TTL compatible (50Ω nominal output impedance). (Refer to paragraph 3–3. *Time Base 10 MHz Input and Time Base 10 MHz Output.*)
6. MODULATION OUTPUT/AUDIO INPUT is a rear-panel output and input supplied on Option 001 instruments. Refer to MODULATION OUTPUT/AUDIO INPUT referenced from Figure 3–1.
7. SENSOR is a rear-panel input for the power sensor supplied on Option 001 instruments. Refer to SENSOR referenced from Figure 3–1.
8. INPUT is a rear-panel input for the RF input signal. This input is supplied on Option 001 instruments. Refer to INPUT referenced from Figure 3–1.
9. Fuse. 2.5A (250V normal blow) for 100 or 120 Vac. 1.5A (250V normal blow) for 220 or 240 Vac.
10. Serial Number Plate. The first four numbers and letter comprise the prefix that denotes the instrument configuration. The last five digits form the suffix that is unique to each instrument.
11. Line Power Module permits operation from 100, 120, 220, or 240 Vac. The number visible in the window indicates the nominal line voltage to which the instrument must be connected. (See Figure 2–1, *Line Voltage and Fuse Selection*) The center conductor is safety earth ground.
12. FREQ OFFSET TTL OUT outputs a voltage that can be used to switch an external mixer in and out of the path between a microwave input signal and the Measuring Receiver when the instrument is in Frequency Offset Mode. The TTL output is always 0V if Frequency Offset Mode is not selected or while Frequency Offset Mode is selected with an entered external LO value of 0 Hz. If the entered external LO frequency is less than or equal to 18 GHz, the TTL output is +5V. If the entered external LO frequency is greater than 18 GHz, the TTL output is 3V. [See *Frequency Offset Control.*]
13. HP-IB Connector connects the Measuring Receiver to the Hewlett-Packard Interface Bus for remote operations. When the HP-IB is being used, the annunciators next to the LOCAL key light as appropriate (REMOTE, LISTEN, TALK, SRQ).
14. REMOTE CONTROL RF SWITCHES enable the user to build an internal sensor module that can switch between the RF INPUT connector and the SENSOR connector. [See *Remote Control RF Switch.*]
15. LO OUTPUT and INPUT (Option 003 and Option Series 030 only). Option 003 provides an LO output connector and an LO input connector. The LO output connector is provided to output the Local Oscillator signal. The output signal is 1.27 to 1301.5 MHz at approximately 0 dBm (50Ω) nominal output impedance. The LO input connector provides an input for an external Local Oscillator. External input signal required is 1.27 to 1301.5 MHz at approximately

0 dBm (50Ω) nominal input impedance (LO Input and LO Output). Two jumpers are provided to allow the internal LO signal to be routed to the LO input connector when no external LO is in use.

The Option Series 030 instruments are provided with an LO input connector, an LO output connector and a remotely controllable switch which selects between them. If an external LO is connected but the signal is not in use, the switch routes the external LO signal back out the LO output connector. [See *High Selectivity Measurements*.]

CAUTION

Do not apply reverse power into the LO OUTPUT or damage to the instrument may result. Do not apply greater than 40 Vdc or +5 dBm of RF power into the LO INPUT or damage to the instrument may result.

16. CALIBRATION OUTPUT RF PWR and AM/FM produces a rear-panel output for RF Power and AM and FM calibrators. This output is supplied on Option 001 instruments instead of the standard front-panel connection. Refer to both CALIBRATION RF POWER OUTPUT and CALIBRATION AM/FM OUTPUT referenced from Figure 3–1.

LOCAL OPERATION

This space is provided for you to store the *HP 8902A Basic Operation and Application Guide* (HP part number 5953-8458) that is included separately with this manual package.

This guide contains all basic information about the local and remote operation of the Measuring Receiver. If you have not yet operated the Measuring Receiver, you should use this document to become familiar with basic operation of the instrument. After you learn basic operation of the Measuring Receiver, you may want to put that supplement here for easy reference.

(Put this page behind the "Local" tab in the *Operation and Calibration Manual*.)

Remote Section Contents

REMOTE OPERATION VIA THE HEWLETT PACKARD INTERFACE BUS (HP-IB) 3-13
- Introduction to the Section 3-13
- How to Use this Section to Make a Measurement 3-13

PROGRAMMING THE MEASURING RECEIVER 3-13
- Overview 3-13
- Valid Programming Codes 3-13
- Invalid Characters 3-14
- Programming Syntax 3-15
- Code String Syntax (Sequence Dependency) 3-16
- Programming Examples 3-17
- Reference Tables 3-17

DATA OUTPUT 3-18
- Data Output Format 3-18

HP-IB INFORMATION 3-19
- HP-IB Capabilities 3-19
- HP-IB Address 3-20

MEASURING RECEIVER REMOTE CAPABILITIES (IEEE-488) 3-21
- Triggering Measurements 3-22
- Clear 3-25
- Remote/Local 3-26
- Local Lockout 3-26
- Clear Lockout/Set Local 3-27
- Service Request Message (SRQ) 3-27
- Status Byte 3-32
- Abort 3-33
- Pass Control/Take Control 3-33
- Status Bit 3-33

ADDITIONAL INFORMATION 3-33
- Annunciators 3-33
- Reading the HP-IB Address Switch and SRQ Status 3-34
- TALK and LISTEN Status Descriptions 3-35
- Code Execution in the Measuring Receiver 3-35

3–6. REMOTE OPERATION VIA THE HEWLETT PACKARD INTERFACE BUS (HP-IB)

Introduction to the Section

This section documents how the instrument interacts with a controller over HP-IB in remote operation. This section is intended as a reference document for operators who are familiar with their controller protocol and programming language, and is designed to be used after you have been introduced to basic front-panel and remote operation by the *HP 8902A Basic Operation and Application Guide* (HP part number 08902-90049) which is included with this documentation package.

Accurate measurements are dependent on the proper functioning of the both the HP-IB and the Measuring Receiver. The *Basic Functional Checks of the Measuring Receiver* and the *Basic Functional Checks of the Hewlett Packard Interface Bus (HP-IB)* verify that the Measuring Receiver and HP-IB are operating properly and can respond to or send bus messages.

How to Use this Section to Make a Measurement

Beginning Users: You will need to read the *HP 8902A Basic Operation and Application Guide* and perform the procedures described there to become familiar with the basic operation of the instrument. Then read the portions of the *Detailed Operating Instructions* (in this manual) describing the measurement you want to make. Then return to this section and read "Programming the Measuring Receiver", paragraph 3-7. This information should be enough to enable you to make most measurements.

Intermediate Users: If you are familiar enough with programming the instrument to feel you can skip the above steps, you may be interested in more specific information. In this case read the paragraphs titled, "Data Output", "Hewlett Packard Interface Bus", "Measuring Receiver Remote Capabilities", and/or "Additional Information" as appropriate to your needs.

Advanced Users: You may be able to program the instrument just using the tables in the back of this section which list the codes required to make measurements, the modifiers for each measurement, and other related information. Specific subjects such as Triggering, the Service Request Message and the Status Byte may be of interest. Explanations can be found in paragraphs of the same name.

3–7. PROGRAMMING THE MEASURING RECEIVER

Overview

All Measuring Receiver functions are fully programmable, except the POWER switch.

The Measuring Receiver can be externally triggered (Refer to "Triggering Measurements", under paragraph 3-10.) Triggering can be used to allow the Measuring Receiver to settle before making a measurement. It can be used to control when the Measuring Receiver takes a measurement and outputs the result.

Valid Programming Codes

The HP 8902A will execute:

- The function codes described in Table 3-11, "Measuring Receiver Function to Code Summary"
- Valid special functions (refer to page 3-275 for a list of special functions). All special function codes are formed by the special function number followed by the code "SP"
- The HP-IB commands described in Table 3-7, "Measuring Receiver Remote Capabilities Table".

As a convenience, all lower case alpha characters are treated as upper case. Commas and spaces between program codes are ignored by the instrument and therefore may be used to improve readability in programming.

Measurement Codes All front-panel keys except the LOCAL key have corresponding instrument-dependent program codes. These codes consist of either two alphabetic characters, or an alphabetic character and a number; e.g., M3. The underlined letters on the front-panel key labels are both letters or the initial letter of the programming code for that function. For example, the code for AUTOMATIC OPERATION is AU, and the codes for TRACK MODE are K1 and K0. The entire list of programming codes required to make measurements with the HP 8902A (not including special functions) are contained in Tables 3-11 and 3-12.

Turning Off Functions When operating in local operation, many of the functions toggle on and off with successive keystrokes. In remote operation, a specific code turns off the functions. The HP-IB Codes for turning off these functions are given in Table 3-1, "Turning Off Functions".

Table 3-1. Turning Off Functions

Functions Off	Code
Audio Input Off (Mod. Output On)	A0
Calibrate Off	C0
Disable Error Function Off	B0
Range Hold Off (Auto Range On)	G0
All HP Filters Off	H0
Track Mode Off (Lock Mode On)	K0
All LP Filters Off	L0
dB Ext. Attenuator Off	N0
Pre-display and De-emphasis Off	P0
Ratio Off	R0

Invalid Characters

The following Table 3-2, "Response to Unused ASCII Characters" lists the Measuring Receiver's response to various ASCII characters not used in its code set. The characters in the left-hand column are ignored unless they appear between two characters of a program code (e.g. M 3, space between the characters of a function code); in which case, they generate Error 24. The characters in the right-hand columns, if received by the Measuring Receiver, will always cause Error 24 (invalid HP-IB code) and a Service Request message to be generated.

Table 3-2. Response to Unused ASCII Characters

Ignored *	Generates Error 24
!	@
"	J
'	Q
‘	}
#	Y
%	DEL
&	~
(	[
)	]
*	{
blank space	^
/	|
, (comma)	\
	_

*Except when inserted between two characters of a program code.

Programming Syntax

Function Code Syntax The function code syntax is typically equivalent to the front-panel keystroke sequence used in local operation. (Refer to *Basic Operation and Application Guide* or the *Detailed Operating Instructions* for keystroke sequences.)

There are three different syntax which execute functions. Refer to Table 3-3, "Function Code Syntax Examples" for examples.

1) Using a two character code or suffix alone, which is the common case.

2) Using a number and a suffix.

3) Using a prefix (usually a special function), a number and a suffix.

Table 3-3. Function Code Syntax Examples

Code	Operation Performed
MZ	Center I.F. Frequency
100 MZ	Tune to 100 MHz
27.3SP 100 MZ	Enter and enable external L.O. frequency of 100 MHz
CF	Read current Calibration Factor
98 CF	Enter a Calibration Factor of 98%
37.3SP 98 CF	Enter an automatic RF Power calibration factor of 98%

Numeric Data Syntax When entering input frequency, entering ratio or limit references, or entering any numeric data (other than two-character function codes) into the Measuring Receiver, certain requirements must be met:

- Numeric data may consist of a signed mantissa of up to eight digits, with one decimal point, and a one- or two-digit, signed exponent.
- The decimal point may fall between any two digits of the mantissa. If a decimal point is entered before the first digit, a leading zero will be inserted by the Measuring Receiver.
- Any digit beyond the eight allowed for the mantissa will be received as zero.

The following table shows examples of the differences between data entered into the Measuring Receiver and the data accepted.

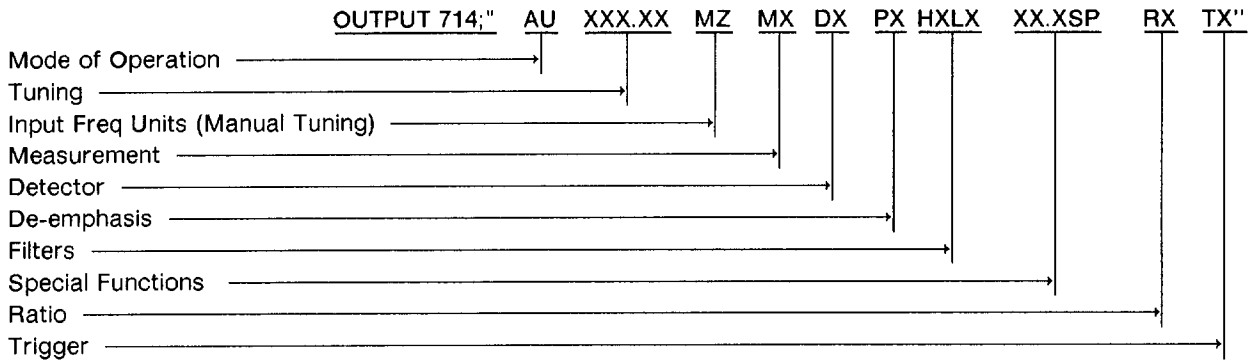
Table 3-4. Data Input Examples

Number Entered in Code	Number Accepted by Instrument
.1234567899999	0.1234567
1234567890	12345678 E02

Code String Syntax (Sequence Dependency)

For accurate measurement results, functions should be programmed in the following order to insure proper sequencing of events and switching in the instrument as appropriate to the measurement. The letter X in the following example represents a number.

Function codes that have the same alpha-character should be entered in numeric order to ensure proper execution; e.g., P1 should come before P4.



The following information should be considered in addition to the information above when writing programming strings.

- AU (Automatic Operation). When Automatic Operation is used, it should appear at the beginning of a program string. Automatic Operation sets all special functions prefixed 1 through 10 to their zero-suffix mode. Most other special functions are also set to zero-suffix.
- P0 (Pre-Display Off and De-Emphasis Off). When pre-display is turned off using P0, all FM de-emphasis is turned off.

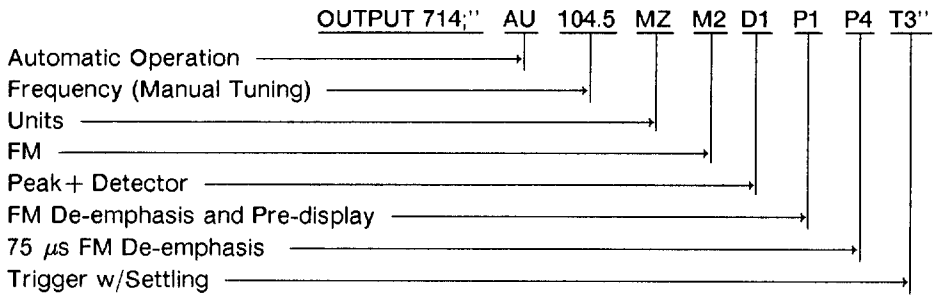
NOTE

Pre-Display is not turned off if the Audio RMS Detector (D8) is on when P0 is selected. In this case, FM De-emphasis will be turned off, but Pre-display will be left on. Pre-display is required by the Audio RMS hardware.

- T2 and T3 (Trigger Immediate and Trigger With Settling). Trigger codes should always appear at the end of a program string, and the triggered measurement results must be read before any additional program codes are sent to ensure an accurate measurement. When either of the trigger codes T2 or T3 is received by the Measuring Receiver, a measurement cycle is immediately initiated.

Programming Examples

Code String Example Function codes may be sent to the instrument in a continuous string as shown below. The code string shown will program the instrument to determine the positive peak de-emphasized (75 μs) FM deviation of an input signal at 104.5 MHz. The measurement is triggered with T3, Trigger with Settling.



Example Measurement Program The following example provides you with a sample of how the previous information might be used to program the HP 8902A to make a particular measurement. This example demonstrates measuring AM in the 50 Hz to 15 KHz bandwidth of a 100 MHz carrier using Trigger Hold and Trigger with Settling.

```
10 OUTPUT 714; "IP"                    Instrument Preset to configure instrument
                                       to a known state.
20 OUTPUT 714; "M1 100 MZ H1 L2 T1"    Send code to configure instrument for measurement.
30 OUTPUT 714; "T3"                    Trigger settled measurement.
40 ENTER 714;A                         Read data into variable A.
50 PRINT A                             Print variable A
60 END
```

Reference Tables

Table 3-11, "Measuring Receiver Function to Code Summary" This table lists the instrument-specific function code for each Measuring Receiver function described in the *Detailed Operating Instructions* of this manual.

Table 3-12, "Code to Measuring Receiver Function Summary" This table has the same information as Table 3-11, "Measuring Receiver Function to Code" but is organized alpha-numerically by code.

NOTE

The following tables are intended as a reference for advanced users who are familiar with the HP 8902A measurement capabilities.

Table 3-13, "Measurement Modes and Codes" All of the functions listed on this table are defined as "measurement modes" in the instrument. The instrument can only be in one Measurement Mode at a time. If a measurement mode is volatile, pushing the CLEAR key or entering CL over the bus, will return the instrument to the last selected, non-volatile measurement mode.

This table lists all the measurement modes of the HP 8902A Measuring Receiver and their programming codes. This table also lists whether or not the measurement mode is volatile, whether the receiver section of the HP 8902A is used to make the measurement, and whether the Demodulation Output is blanked during the measurement.

Table 3-14, "Measurement Modifiers" Whenever a measurement is selected, the Measuring Receiver sets up its internal circuitry so it can make the most accurate measurement possible. These settings can be altered by the operator to modify the measurement.

This table lists the measurement modifiers for the primary measurement modes listed in Table 3-13, "Measurement Modes and Codes".

To see what modifiers are being automatically selected,

- use the Special Special display to read the Range in use,
- read the front-panel lights for the Detectors, Filters and De-Emphasis in use and
- see Table 3-15 or -16, "Enabling/Disabling Variable Parameters (Front Panel or Remote)" for a summary of how to read the Calibration Factors, the Frequency Offset, the dB external Attenuation, the Limits set, and whether Ratio has been selected.

Table 3-15, "Enabling/Disabling Variable Parameters (Front Panel)" This table lists ways of verifying from the front panel the values of the Calibration Factors, Frequency Offset, dB External Attenuator, Limit/Ratio and Set Reference functions.

Table 3-16, "Enabling/Disabling Variable Parameters (Remote)" This table is the same as Table 3-15 except that it shows the programming codes required instead of the front-panel keystrokes.

Table 3-17, "HP 8901A/02A Code Differences" This table lists the function code differences for identical functions of the HP 8902A and the HP 8901A, and should be useful in modifying existing HP 8901A control programs to drive an HP 8902A.

3–8. DATA OUTPUT

Data Output Format

Numeric Data As shown below, the output data is always in the form of an implicit-point exponential constant. Data is always output in fundamental units (for example, Hz, watts, radians, dB, %, etc.), and the decimal point (not sent) is assumed to be to the right of the tenth digit of the mantissa.

Data values never exceed +9 000 000 000E+01. Output values greater than this are Error Messages.

Output data is displayed using the following format: first the sign, then 10 digits (leading zeros not suppressed) followed by the letter E and a signed two-digit exponent. The last two characters of the string are a carriage return (CR) and a line feed (LF) in string positions 16 and 17. Refer to Table 3-5, "Data Output Examples" for examples.

Table 3-5. Data Output Examples

Instrument Display	Data Output
969.21346 MHz	+0096921346E+01<CR><LF>
34.92 kHz	+0000003492E+01<CR><LF>

Error Messages Error message format and syntax are described in the *Error Messages Summary* section on page 3-286.

3–9. HP-IB INFORMATION

HP-IB Capabilities

The interface functions that the HP 8902A implements are defined in Table 3-6, "IEEE Std 488 Interface Function Capabilities". The Measuring Receiver's HP-IB command capabilities are compatible with the IEEE Standard 488, and the identical ANSI Standard MC1.1.

For more information about the Hewlett-Packard Interface Bus (HP-IB), refer to:

- IEEE Standard 488,
- ANSI Standard MC1.1,
- the Hewlett-Packard Electronic Systems and Instruments catalog,
- the booklets, "Improving Measurements in Engineering and Manufacturing" (HP part number 5952-0058), and "Tutorial Description of HP-IB" (HP part number 5952-0156).

Table 3-6. IEEE Std 488 Interface Function Capabilities Table

Bus Command	Capability	
Source Handshake	SH1	Complete Capability
Acceptor Handshake	AH1	Complete Capability
Talker Function	T5	Complete Capability including Talk Only *
Extended Talker	TE0	No Capability
Listener Function	L3	Complete Capability including Listen Only mode
Extended Listener	LE0	No Capability
Service Request	SR1	Complete Capability
Remote Local	RL1	Complete Capability
Parallel Poll	PP0	No Capability
Device Clear	DC1	Complete Capability
Device Trigger	DT1	Complete Capability
Controller	C0	No Capability
Driver Electronics	E1	Open Collector Drivers

* Instrument also has a Talk Status Only mode

HP-IB Address

Factory Set Address

The Measuring Receiver's HP-IB address is set to decimal 14 at the factory with Talk Only and Listen Only modes disabled. The address can be changed by following the instructions in paragraph 2-3 under "HP-IB Address Selection".

Reading the Address

To display the HP-IB address in decimal on the front panel, select BUS ADRS by pressing the Blue key and then the LOCAL key. The displayed address is in the form:

Addr=NN

Where NN is the two-digit address in decimal. The display will time out after a few seconds.

Refer to "Additional Information", paragraph 3-11 for more information about HP-IB address.

3-10. MEASURING RECEIVER REMOTE CAPABILITIES (IEEE-488)

The capabilities of the HP 8902A in remote operation and their related IEEE Std 488 terms are described in Table 3-7, "Measuring Receiver Remote Capabilities Table". The twelve capabilities described there are further described in the paragraphs following the table.

Table 3-7. Measuring Receiver Remote Capabilities (1 of 2)

Measuring Receiver Capabilities			IEEE Std 488 *	
Capability	**Enabled**	**Response**	**Commands and Control Lines**	**Interface Functions**
Data	Yes	All front-panel functions, special functions, and remote-only functions are programmable, except the POWER switch. The Measuring Receiver can send the Status Byte, and message and setting information. All measurement results, special displays, and error outputs (except dashed displays) are available via the bus.	MLA MTA	AH1 SH1 T5 L3
Trigger	Yes	If in remote and addressed to listen, the Measuring Receiver makes a settled measurement. It responds equally to bus command GET and program code T3, Trigger with Settling.	GET	DT1
Clear	Yes	Clears Status Byte, RQS bit, Service Request message (if issued), and sets the SRQ Mask to the 22.0SP state. Responds equally to DCL and SDC bus commands. Resets many additional parameters as shown in Table 3-8, "Response to a Clear Message."	DCL SDC	DC1
Remote	Yes	The Measuring Receiver's remote mode is enabled when the REN bus line is true. However, it remains in local (i.e., the front panel is active) until it is first addressed to listen. The output signal and internal settings are unchanged when the Measuring Receiver enters remote mode. All front-panel keys are disabled except LOCAL and CLEAR, unless the instrument is in Local Lockout.	REN MLA	RL1
Local	Yes	The Measuring Receiver returns to front-panel control when it receives the Local message. No instrument settings or functions are changed except Trigger is set to Free-Run (T0). Responds either to the GTL command or the keyboard Local key. The LOCAL key will not work if the instrument is in LOCAL LOCKOUT.	GTL	RL1
Local Lockout	Yes	All front-panel keys including the LOCAL and CLEAR keys are disabled during Local Lockout so that only the controller or the POWER switch can return the instrument to Local.	LLO	RL1
Clear Lockout/ Set Local	Yes	The Measuring Receiver returns to Local and Local Lockout is no longer true when the REN bus lines go false.	$\overline{\text{REN}}$	RL1

* Commands, Control Lines, and Interface Functions are defined in IEEE Std 488 (and the identical ANSI Standard MC1.1). Knowledge of these might not be necessary if your controller describes its capabilities in terms of the HP-IB capabilities shown in the left column.

Table 3-7. Measuring Receiver Remote Capabilities (2 of 2)

Measuring Receiver Capabilities			IEEE Std 488*	
Capability	**Enabled**	**Response**	**Commands and Control Lines**	**Interface Functions**
Pass Control/ Take Control	No	The Measuring Receiver cannot pass or take control of HP-IB.		C0
Service Request	Yes	The Measuring Receiver sets the SRQ bus line true if any of the conditions defined in the Status Byte occurs and has been enabled by the SRQ Mask (Special Function 22) to send the Service Request message.	SRQ	SR1
Status Byte	Yes	The Measuring Receiver responds to a Serial Poll Enable (SPE) bus command by sending an 8-bit byte when addressed to talk. Bit 6 is true if the instrument has sent the Service Request Message.	SPE SPD MTA	T6
Status Bit	No	The Measuring Receiver does not respond to a parallel poll.		PP0
Abort	Yes	The Measuring Receiver stops talking or listening.	IFC	T6 L3

* Commands, Control Lines, and Interface Functions are defined in IEEE Std 488 (and the identical ANSI Standard MC1.1). Knowledge of these might not be necessary if your controller describes its capabilities in terms of the HP-IB capabilities shown in the left column.

Triggering Measurements

In remote operation, two triggering modes are available: Free-run and Trigger Hold. In Free-run mode, measurements are continually, automatically taken. In Trigger Hold mode, the instrument sets up for the measurement and then waits for a trigger to be received. Valid triggers to use in Trigger Hold are: T2, T3, GET or the CLEAR key.

The instrument goes into Trigger Hold mode after it receives a trigger (except the CLEAR key) even if it was in Free-run before it received the trigger.

TRIGGER MODES (T0 and T1)

Free Run Mode (T0) This trigger mode is in effect in local operation, and is also in effect in remote when Trigger Hold mode has not been selected. Measurements are made and measurement data updated as rapidly as settings can be changed without regard for settling of ANY internal or external circuitry or setting changes.

NOTE

- *The Measuring Receiver is always in Free-run trigger mode (T0) after receiving a Device Clear (DCL) message, entering remote from local, or receiving Instrument Preset (IP).*
- *Measurements might NOT be completed if Free-run (T0) is used if there is HP-IB activity between other HP-IB devices (e.g. a controller talking to another instrument) during the measurement. Trigger Immediate (T2) or Trigger with Settling (T3) should be used under these conditions.*

Trigger Hold Mode (T1) In Trigger Hold mode, internal settings can be changed by the instrument itself or by the user via the bus; however, the instrument is inhibited from outputting any data to the front-panel key lights and display, or to the HP-IB until it receives a trigger. The following data can be sent before the trigger is received:

- A Service Request message if an enabled LIMIT is reached, or if an HP-IB code error occurs.
- The Status Byte if the instrument is serial polled. (A serial poll, however, will trigger a new measurement, update displays and return the instrument to Trigger Hold.)

Measurement data is replaced with data acquired from subsequent triggered measurement cycles.

NOTE

When a trigger is received, the Measuring Receiver will not allow its measurement cycle to be interrupted. (Indeed, handshake of bus commands is inhibited until the measurement cycle is complete.)

Entering Trigger Hold The instrument is placed in this mode after it receives the programming code T1 or after a triggered measurement has been executed. This mode can then be used to set up the instrument for new measurements which are executed by a trigger.

Triggering Measurements from Trigger Hold When a measurement is triggered from Trigger Hold mode, the instrument makes the measurement. The display is updated as the new measurement cycle begins. The Status Byte will be updated (and the Service Request message issued if required) by the events that occur during the new measurement cycle.

Any of the following events will trigger a new measurement cycle when the instrument is in Trigger Hold:

a. instrument receives a trigger,

b. instrument receives its listen address,

c. instrument receives GTL (Go To Local),

After the measurement is made, the instrument waits for the measurement results to be read. While waiting, the instrument can process most bus commands without losing the measurement results. Once the data (measurement results) are read onto the bus, the Measuring Receiver returns to the Trigger Hold mode.

Leaving Trigger Hold The instrument leaves Trigger Hold mode when it receives a trigger until the measurement is complete. The Measuring Receiver also leaves Trigger Hold when it receives:

a. the Free Run code (T0), or

b. when it is returned to local operation,

c. a Device Clear Message (DCL or SDC), or

d. Instrument Preset (IP).

TRIGGERS (T2, T3, GET, and the CLEAR Key)

All triggers are available in both Free Run and Trigger Hold modes, but after a trigger is received (except the CLEAR key), the instrument enters Trigger Hold mode.

Trigger Immediate (T2) When the Measuring Receiver receives the Trigger Immediate code, it makes one measurement and displays the result without a settling time delay.

Measurement results obtained via Trigger Immediate are normally valid only when the instrument is in a steady, settled state. The first result received from the instrument (using T2) may not be accurate.

Trigger With Settling (T3)

NOTE

- *The use of Trigger With Settling does not remove the need to observe the normal warm-up precautions when using either the RF Power, AM, or FM Calibrator. Refer to the procedures "RF Power Calibration", "AM Calibration", or "FM Calibration" in the* Detailed Operating Instructions.
- *If the settling time povided with T3 is not adequate to produce accurate measurements, use T0 (Free-run) and write a sub-program which compares measurement values until they are within a specified tolerance. (Delays, not included in the T3 settling time, in the source and/or the thermocouple in the Power Sensor can prevent accurate measurements.)*

Trigger With Settling is identical to Trigger Immediate except the Measuring Receiver inserts a settling-time delay before taking the requested measurement.

Group Execute Trigger (GET) Message When in remote and addressed to listen, the Measuring Receiver responds to a Trigger message (GET) by executing a settled-measurement cycle. The Measuring Receiver responds exactly as if it had received the program code T3 (Trigger With Settling).

Triggering Measurements With the CLEAR Key (CL) When the Measuring Receiver is in Trigger Hold mode (T1) and not in Local Lockout, the front-panel CLEAR key may be used to issue a Trigger With Settling. Each time the CLEAR key is pressed, the Measuring Receiver performs a settled-measurement cycle. The CLEAR key will not cause the instrument to enter Trigger Hold mode.

In Free Run mode the CLEAR key will clear the display, but not affect the timing of measurements and will not cause the instrument to enter Trigger Hold.

NOTE

The CLEAR key (CL) does not perform any of the functions of the Clear message (DCL or SDC).

Clear

The Measuring Receiver responds to the Clear message (DCL and SDC) the same way it responds to Instrument Preset (IP). The Clear message clears any pending Service Request message and clears the SRQ Mask (22.0SP). The settings the instrument will assume after receiving the Clear message are listed below in Table 3-8. Refer to "Instrument Preset" in *Detailed Operating Instructions* on page 3-239 for more information on the Instrument Preset default conditions.

The Clear message also clears any incomplete message or entries. For example, "M5100" (RF Frequency Measurement, 100, no terminator) would be cleared because no units terminator has been entered.

Table 3-8. Response to a Clear Message

Parameter	Setting
High-Pass Filters	All Off
Low-Pass Filters	All Off
FM De-emphasis	Off
Pre-display	Off
Calibration	Off
Measurement	Frequency
Detectors	Peak +
Ratio	Off
Limit	Not Enabled
Lower Limit Reference	150 kHz
Upper Limit Reference	1300 MHz
Limit Measurement Mode	Frequency
Automatic Operation	On
Manual Operation	
MHz Input Frequency	Automatic Tuning [1]
⇑ and ⇓ Step Size	0 kHz
SPCL	Special Functions prefixed 1 through 10 in zero-suffix mode; all others off
Modulation Output	FM (least sensitive range)
Service Request Mask	HP-IB code error enabled only (22.2SP)
Status Byte	Cleared
Trigger Mode	Free-run (T0)

[1] If MHz (code MZ) is selected immediately after the Clear message is received or after power-up, the Measuring Receiver will tune to 100 MHz.

Remote/Local

Mode Descriptions

Remote Mode In remote, the Measuring Receiver's front-panel controls are disabled except for the LOCAL and CLEAR keys. The LOCAL and CLEAR keys are only disabled by Local Lockout. However, front-panel displays and the output signal at MODULATION OUTPUT/AUDIO INPUT remain active and valid. Two triggering modes are available in remote operation: Free Run and Trigger Hold.

Displays which time out in Local do not time out in Remote. In Remote operation, the CLEAR key will clear the display and works as a trigger when Trigger Hold is used.

Local Mode In local, the Measuring Receiver's front-panel controls are fully operational. When the Measuring Receiver goes to local operation, the front-panel REMOTE annunciator turns off. However, when the Measuring Receiver is being addressed (whether in remote or local), its front-panel LISTEN or TALK annunciator lights. Free Run is the only triggering mode available in local operation.

Mode Transitions

Local to Remote Transitions The Measuring Receiver switches to remote operation upon receipt of the Remote message. No instrument settings are changed by the transition from local to remote. The Trigger mode will always be Free Run (T0) on entry to remote operation.

Remote to Local Transitions The Measuring Receiver always switches to local from remote whenever it receives the Local or the Clear Lockout/Set Local message. No instrument settings are changed by the transition from remote to local, except the Trigger mode will always be reset to Free Run.

If it is not in Local Lockout mode, the Measuring Receiver switches to local from remote whenever its front-panel LOCAL key is pressed.

NOTE

Remote to Local transitions will not clear a Service Request message.

Local Lockout

Local lockout disables the LOCAL key (and the CLEAR key) and allows return-to-local only under program control.

When a data transmission is interrupted, which can happen if the LOCAL key is pressed, the data being transmitted may be lost. This would leave the Measuring Receiver in an unknown state. To prevent this, a local lockout is recommended.

Clear Lockout/Set Local

The Measuring Receiver returns to local operation when it receives the Clear Lockout/Set Local message.

NOTE

Clear Lockout/Set Local can be accomplished by switching the power to STBY and back to ON. Returning to Local operation in this way has the following disadvantages:

- *It defeats the purpose of Local Lockout (that is, the system controller will lose control of the Measuring Receiver).*
- *Instrument configuration is reset to Power-up conditions listed in the* Detailed Operating Instructions *under "Instrument Preset" on page 3-239.*

Service Request Message (SRQ)

The Service Request Message (SRQ message) is being issued when the SRQ bus line is asserted and the SRQ light on the front panel is lit by the instrument. The Service Request message may be issued under following conditions:

- the instrument requires re-calibration or is uncalibrated,
- there has been a Frequency Offset mode change,
- an enabled limit has been exceeded,
- an instrument error has occurred,
- an HP-IB code error has occurred,
- measurement data is ready to be read.

The Measuring Receiver uses its Status Byte and the SRQ Mask (Special Function 22) to determine whether or not to issue a SRQ message. Refer to Figure 3-4, "Issuing a Service Request Message" throughout the following discussion of the Service Request Message, SRQ Mask and the Status Byte.

The Service Request Message is asserted when the RQS bit of the Status Byte is set by the instrument. The RQS bit is set automatically when one or more of the other bits in the Status Byte are set. For the bits other than the RQS bit of the Status Byte to be set, those bits must be enabled by the SRQ Mask before the instrument condition which will set them occurs.

The instrument can send the Service Request message in either local or remote operation.

Clearing the Service Request Message After the Service Request message has been sent, it will be cleared when the Status Byte is cleared which is described below under "Status Byte".

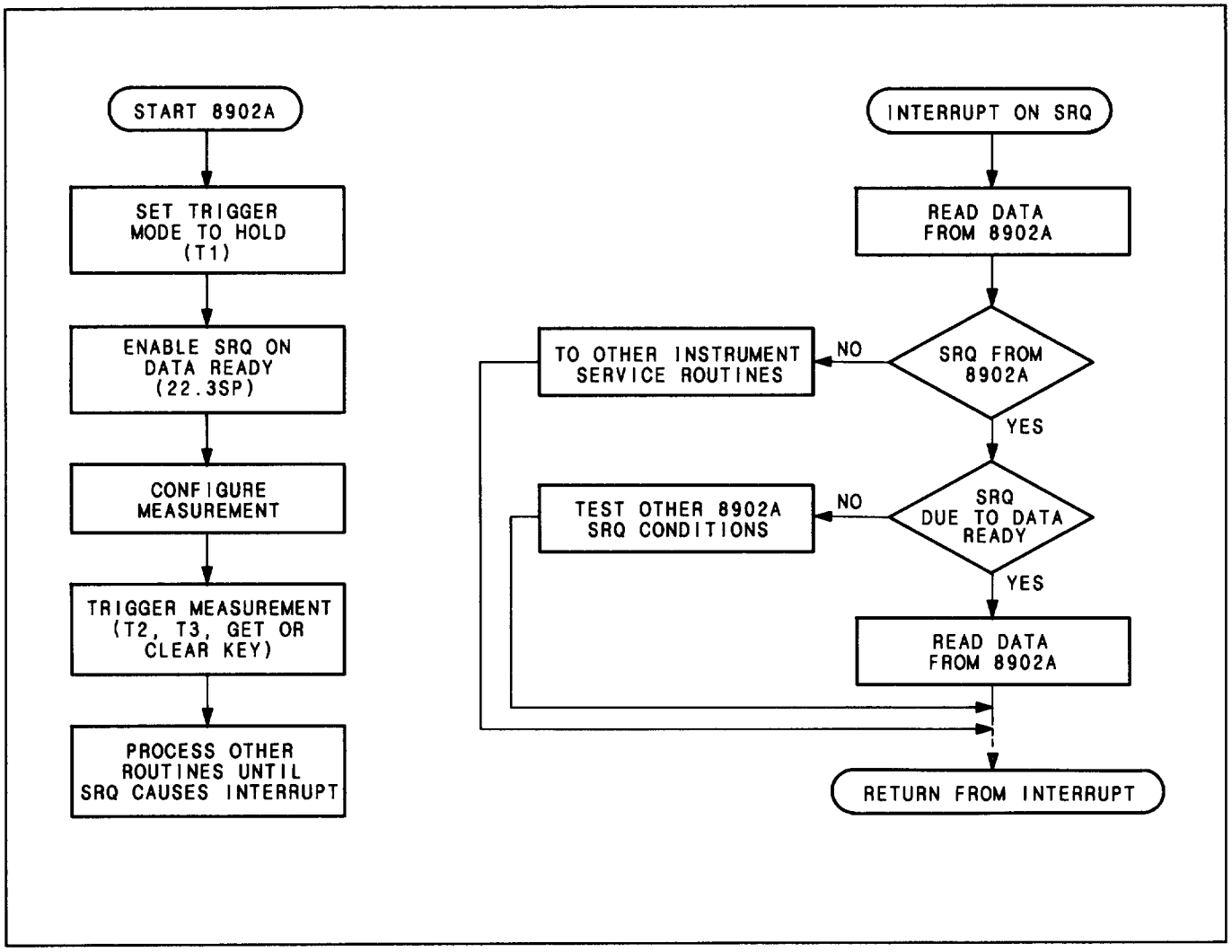


Figure 3-3. Example Flowchart Using the Service Request Message.

Using the Service Request Message The Service Request message can be used for detecting instrument conditions and instrument or HP-IB code errors.

The Service Request Message can also be used for signaling measurement data ready. Remote measurements are usually performed simply by triggering measurements, then reading the output data. In certain applications, the controller must control other instruments while the HP 8902A is making a measurement. Using the instrument's ability to issue the Service Request message when data is ready, frees the controller to process other routines until the Measuring Receiver is ready with data.

See Figure 3-3, "Example Flowchart Using the Service Request Message" for an example of using the SRQ message to signal the controller that the HP 8902A has completed its measurement and the data is ready.

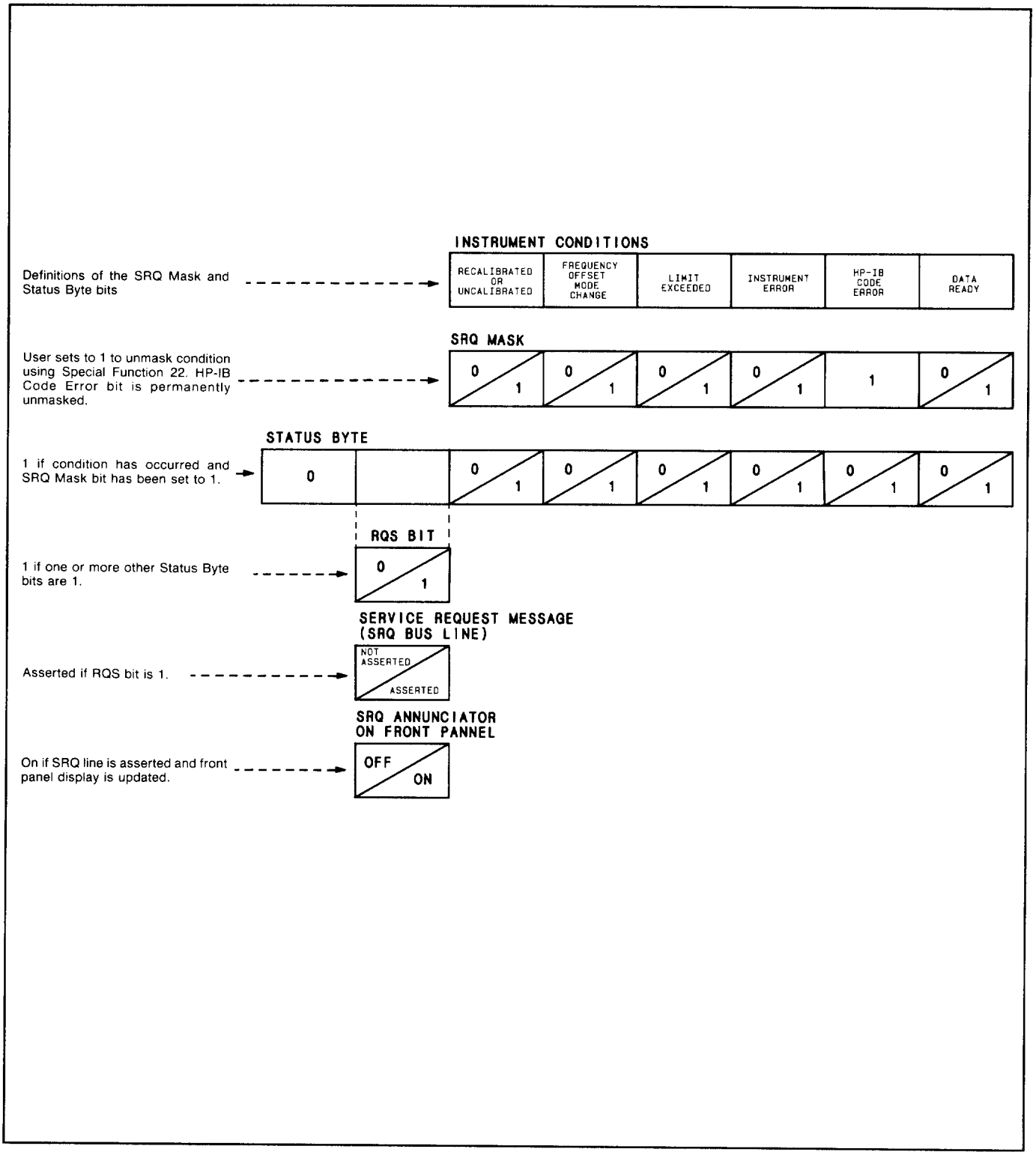


Figure 3-4. Issuing a Service Request

SRQ MASK (Special Function 22)

Overview Special Function 22 is used to set the bits of the SRQ Mask. The set SRQ Mask bits unmask the bits of the Status Byte. At power-up or Instrument Preset, all Status Byte bits are masked except the HP-IB Error Code bit. The appropriate SRQ Mask bits must be set to 1 by the operator to unmask any other Status Byte bit. Refer to Figure 3-4, "Issuing a Service Request" for a graphic example of these relationships.

NOTE

Bit 1 of the SRQ Mask is permanently set to 1; therefore, an HP-IB code error will ALWAYS generate a Service Request message. This means that the Service Request message CANNOT be disabled.

Setting the SRQ Mask Only bits 0, 2, 3, 4 and 5 can be set. Bit 1 (weight=2) is permanently set.

To set the SRQ Mask bits and unmask the Status Byte bits which you want to cause the Service Request Message to be issued:

- Sum the weights of the desired conditions using Table 3-9 below. Use this sum as the suffix of Special Function 22.

NOTE

Since Bit 1 (HP-IB Code Error) is permanently enabled, if the weight is not summed in, it will be assumed by the instrument, for example 22.0SP is equivalent to 22.2SP.

- Enter the special function code (and suffix) via the front panel, then select SPCL; or, for remote operation, enter 22.<suffix>SP.

Example To set the SRQ Mask so that the Measuring Receiver will issue a Service Request message for all conditions except Data Ready, first compute the Special Function suffix by summing the corresponding weights.

$$4 + 8 + 16 + 32 = 60$$

Key in 22.60SP. (22.62SP would also work because of the permanently set HP-IB Error Code bit.)

Table 3-9. SRQ Mask and Status Byte Bit Descriptions

Bit Number	Mask Weight	Condition	Description
0	1	Data Ready	Asserted if unmasked when valid data is ready after a measurement. This can be used for any function which outputs to the bus.
1	2	HP-IB Code Error (Permanently Set)	Asserted when an invalid code is sent to the bus, or an error is made in programming the instrument. (Always unmasked.)
2	4	Instrument Error	Asserted if unmasked when an error is displayed on the instrument. Note that invalid bus codes are also instrument errors
3	8	Limit Exceeded	Asserted if unmasked when limits are enabled (14.XSP) and exceeded
4	16	Frequency Offset Mode Change	Asserted if unmasked when in Frequency Offset Mode and Manual Tune frequency is changed, or when entering or exiting the mode through 27.0/1/3 SPCL.
5	32	Recalibrate or Uncalibrated	Asserted if unmasked when the RECAL or UNCAL annunciators turn on.
6		RQS (Request Service)	This bit will always be set if any of the other bits are set.
7		Unused	Always 0.

Reading the SRQ Mask Read the SRQ Mask by entering 22.64SP. This initiates a "measurement" of the mask value which is displayed and available over the bus. This value will be displayed in decimal and can be interpreted using Table 3-9 "SRQ Mask and Status Byte Bit Descriptions".

Clearing the SRQ Mask Clear the SRQ Mask by any of the following operations:

- entering 22.0SP (Remember this will not clear the HP-IB Code Error bit.)
- Sending the Device Clear (DCL) message, sending Instrument Preset (IP) or powering up the instrument .

Status Byte

Overview

The Status Byte bits 0-5 reflect the status of the unmasked Instrument Conditions. Refer to Table 3-9, "SRQ Mask and Status Byte Bit Descriptions" for bit definitions. At power-up and Instrument Preset, the only Status Byte bit which is unmasked is the HP-IB Error Code bit.

The RQS bit (bit 6) is automatically set if any other bit in the Status Byte is set true. When the RQS bit is set, the Service Request message is sent. The front-panel SRQ annunciator turns on at the next front-panel display update. Once any Status Byte bit has been set, it remains set until the Status Byte is read.

If one of these Instrument Conditions occurs, while it is masked by the SRQ Mask, NEITHER the Status Byte bit corresponding to the condition NOR the RQS bit will be set, and the Service Request message will not be sent.

Reading the Status Byte

NOTE

- *A Status Byte Bit that is not unmasked by the SRQ Mask will ALWAYS read as a zero when the Status Byte is read. Only an unmasked bit can be read as a one, and then only if its initiating Instrument Condition occurs AFTER it is unmasked.*
- *Reading the Status Byte is the only accurate way to determine the condition of the SRQ bus line (Service Request message). The SRQ annunciator is only updated as the front panel is updated. It is NOT tied directly to the SRQ bus line.*
- *The Measuring Receiver cannot alter the Status Byte while in serial poll mode; therefore, it is not possible to continually poll the Status Byte while waiting for a condition to cause a bit to be set.*
- *Reading Status of non-existent devices (HP-IB addresses not in use) will hang the HP 8902A HP-IB and requires a Device Clear (DCL) message to clear the bus.*

The Status Byte can be read using a serial poll, only if the instrument sends a Service Request Message. Only those bits which are unmasked by the SRQ Mask can be read accurately.

Talk Status Only causes the instrument to only output the Status Byte. Refer to "TALK and LISTEN Status Descriptions" for more information.

Clearing the Status Byte

NOTE

Remote-to-Local transitions will not clear the Status Byte.

Once bits in the Status Byte are set, they can be cleared by the following operations.

- Reading the Status Byte by serial polling AFTER the condition is cleared. If the condition which set the bits persists, those bits and the RQS bit will again be set.
- Sending the Device Clear (DCL) message, presetting or powering up the instrument.
- In Talk Status Only, the Status Byte is cleared each time the one-byte Data message is issued to the bus
- Sending the Serial Poll Disable (SPD) bus command, or
- Sending the Abort message.

Abort

Abort abruptly terminates all listener/talker activity on the interface bus and prepares all instruments to receive a new command from the controller. Typically this is an initialization command used to place the bus in a known starting condition. The Measuring Receiver stops listening or talking when it receives the Abort message.

Pass Control/Take Control

The Measuring Receiver does not respond to the Pass Control/Take Control message because it cannot act as a controller.

Status Bit

The Measuring Receiver does not implement parallel poll operations and therefore cannot send the Status Bit message. The Status Bit should not be confused with the Status Byte which was discussed previously under "Status Byte".

3–11. ADDITIONAL INFORMATION

Annunciators

REMOTE Light: Lights when the instrument is operating in remote mode. When the Measuring Receiver goes to local operation, the front-panel REMOTE annunciator turns off.

LISTEN Light: Lights when the instrument is addressed to Listen.

TALK Light: Lights when the instrument is addressed to Talk.

SRQ Light: Lights when the Service Request message has been sent (SRQ line true), and the front panel has been updated.

Reading the HP-IB Address Switch and SRQ Status

The HP-IB switch sets the instrument address and the Talk and Listen modes of the instrument. To display the state of the HP-IB address switch and the SRQ Line in binary, enter 21.0SP.

This display does not time out. To clear the instrument display, press the CLEAR key.

The format of the display is as follows;

AAAAA.TLS

where AAAAA is a five-bit binary address with leading zeros blanked and TLS represent the status of the TON switch, LON switch and SRQ bus line repectively.

NOTE

- *If T and L are both 1, the instrument is set to Talk Only (Talk Only overrides Listen Only).*
- *If all A bits are 1 and T is 1, the instrument will Talk Status Only (that is, output the status byte only).*

A list of possible conditions of the TLS digits of the display is provided in the following table:

Table 3-10. TLS Table

Operating Mode	T Digit	L Digit	S Digit
Talk and Listen	0	0	1 or 0
Talk Only	1	1 or 0	1 or 0
Talk Status Only	1*	1 or 0	1 or 0
Listen Only	0	1	1 or 0

*Instrument address must be 11111 in binary. (31 in Decimal.)

Example If 1110.001 is the address displayed, then the HP-IB address is 1110 in binary (that is, 14 in decimal). The T digit is "0", and the L digit is "0" indicating that the instrument is set to be able to Talk and Listen. The S digit is 1 indicating that the instrument is issuing a Service Request Message.

For the same example, if the BUS ADRS key is used, Addr = 14 will be displayed. (No information about Talk Only, Listen Only, or SRQ is displayed.)

Setting the HP-IB Address The Measuring Receiver's talk and listen addresses are switch selectable as described in paragraph 2-7. Refer to Table 2-2 for a comprehensive listing of all valid HP-IB address codes.

Updating the HP-IB Address Display The HP-IB address display is continuously updated. When the switch setting is changed, the result is immediately visible on the display.

TALK and LISTEN Status Descriptions

Talk Only Mode If the internal address switches are set to a valid address and the TON (Talk Only) switch is set to "1", the Measuring Receiver is placed in the Talk Only mode. This mode causes the instrument to output data each time a measurement is made. Each time the measurement is completed, data will be output to the bus unless the listening device is not ready for data. If the listener is not ready, and the Measuring Receiver is in Free Run mode (T0), another measurement cycle is executed.

Talk Status Only Mode If the five internal address switches and the TON (Talk Only) switch are set to "1", the Measuring Receiver is placed in the Talk Status Only mode. In this mode the instrument is configured to send a one-byte data message whenever the bus is in the data mode. The byte sent is an exact copy of the Status Byte. Each time this byte is successfully sent on the bus, the internal Status Byte is cleared. The Data Valid (DAV) handshake line is pulsed each time the one-byte Data message is sent.

Listen Only Mode Listen Only mode is provided to allow the Measuring Receiver to accept programming from devices other than controllers (for example, card readers).

If the internal LON (Listen Only) switch is set to "1" and the TON (Talk Only) switch is set to "0", the Measuring Receiver is placed in the Listen Only mode when the remote enable bus control line (REN) is set true. The instrument then responds to all Data messages, and the Trigger, Clear, and Local Lockout messages. However, it is inhibited from responding to the Local or Abort messages and from responding to a serial poll with the Status Byte message.

Code Execution in the Measuring Receiver

Some things to consider when programming the HP 8902A are listed below. The following discussion of the Software Supervisor is included to elaborate on these considerations.

- Every two-letter command is acted upon, in order, in software state.
- Hardware State equals the Software State only after the end of the HP-IB code string AND a pause occurs allowing the instrument to implement the commands it has received (e.g., time delay between code strings when data is read from the instrument).
- Only one measurement mode may be loaded from Software state to Hardware state at a time; e.g., M2 D2 P1 H1 L2. For fail-safe operation, only use one measurement code per code string before reading a measurement back from the instrument. Refer to Table 3-13, "Measurement Modes and Codes" for a complete list of all the functions defined as Measurement Modes.
- Keyboard or HP-IB commands may not be implemented in hardware state during a measurement if the instrument decides the command is not significant to a particular measurement. Refer to Table 3-13, "Measurement Modes and Codes" and Table 3-14, "Measurement Modifiers" for more information.

The Software Supervisor is the program that controlls overall instrument operation and controls the implementation of commands received from the external controller. (See Figure 3-5, "Software Supervisor Flowchart".) It is a loop that is continuously executed, with measurements made near the end after checks for proper frequency tuning, proper RF and IF level, and correct audio range. After arithmetic manipulation (e.g., for the RATIO function), the program loops back up to display the measurement.

The Software Supervisor controls the setup of the instrument for a measurement by making use of two concepts called Software State and Hardware State. Each of these is updated independently. The Software State is located in RAM and contains a software image of the state of the instrument. On power-up, the initialization procedure loads the initial Software State from ROM. (Refer to

"Instrument Preset" in the *Detailed Operating Instructions* on page 3-239 for a description of the intial instrument condtions.) The [Set Up Hardware] block in the supervisor is where the hardware state is made to conform with the software state.

The hardware state is the actual, current state of the internal settings of the instrument and is only updated when enough time is allowed between commands for the Software Supervisor measurement loop to be completed successfully without interruption; e.g., when a trigger is received.

The [Frequency Tuning], [Signal Leveling], and [Audio Ranging] blocks manipulate hardware as well and also verify that the instrument is adjusted to make an accurate measurement. A measurement is not made until all blocks are successfully completed in succession. If a block is not completed, a negative [Continue?] decision after that block then forces the program back to the top of the supervisor, bypassing the measurement for that loop.

In a normal, stable measurement cycle, the program takes the [Measurement Display] branch at the top of the supervisor and so avoids the extra time associated with the [Setup Hardware] block. However, if the program loops back before taking a measurement, or if an error condition exists, the [Non-Measurement Display] branch will be traversed. This will light an appropriate display, which is usually "- - - -", and send the program back through the [Setup Hardware] block.

After power-up, the external system controller can be thought of as a medium through which the user requests a certain instrument setup which is first implemented in software state and then in hardware state. Controller commands ([Keyboard or HP-IB Interrupts]) are treated as non-returnable interrupts and break the flow around the Software Supervisor loop, forcing the internal microprocessor to execute a short program to change the software state and then return to the loop as shown in the diagram. The commands applicable to the measurement mode are implemented in software state and then in hardware state at the next [Setup Hardware].

NOTE

Controller routines modify only the software state and do not affect the hardware immediately.

Since a [Keyboard or HP-IB Interrupt] *can interrupt the Supervisor at any point and return it to the point in the loop before* [Set Up Hardware], *these interrupts abort the current measurement and start a new measurement cycle.*

The actual instrument setup is guaranteed to conform to the Keyboard request only at the moment a measurement is taken ([Measure] *).*

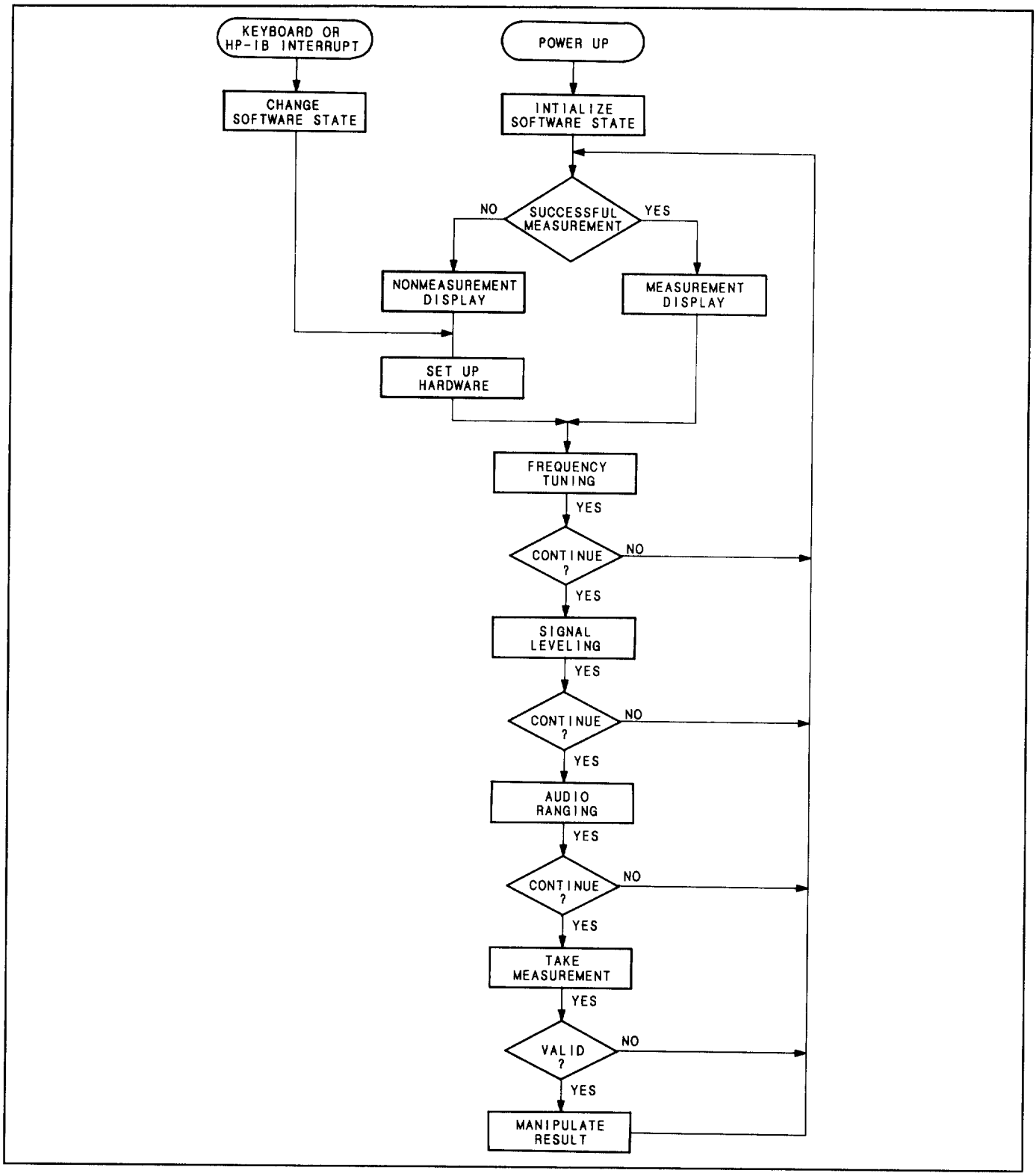


Figure 3-5. Software Supervisor Flowchart

Table 3-11. Measuring Receiver Function to Code Summary

Function	Code	Function	Code
MEASUREMENTS		**CALIBRATION**	
AM	M1	CALIBRATE Off	C0
FM	M2	CALIBRATE On	C1
ΦM	M3	% CAL FACTOR	CF
RF POWER	M4	SET REF	RF
FREQ	M5	ZERO	ZR
AUDIO FREQ	S1	SAVE CAL	SC
AUDIO DISTN	S2		
IF LEVEL	S3	**MANUAL OPERATIONS**	
TUNED RF LEVEL	S4	AUTO TUNING	AT
FREQ ERROR	S5	ENABLE ERRORS	B0
		DISABLE ERRORS	B1
DETECTORS		CLEAR (KEY)	CL
PEAK+	D1	DISPLAY FREQ	FR
PEAK−	D2	DISPLAY INCREMENT	FN
PEAK HOLD	D3	INPUT FREQUENCY (Hz)	HZ
AVG (RMS Calibrated)	D4	⇑ Hz	HU
1 kHz DISTN	D5	⇓ Hz	HD
400 Hz DISTN	D6	TRACK Mode Off (Lock Mode)	K0
RMS	D8	TRACK Mode On	K1
PEAK±/2	D9	⇑ kHz	KU
		⇓ kHz	KD
DISPLAYS		MHz (INPUT FREQ)	MZ
Display LOG Result	LG	RECALL	RC
Display LIN Result	LN	STORE	TR
dB EXT ATTEN off	N0	SPECIAL FUNCTION	SP
dB EXT ATTEN on	N1	SPECIAL, SPECIAL	SS
RATIO Off	R0	mV Units	MV
RATIO On	R1	μV Units	UV
PREVIOUS RATIO	R2	V Units	VL
		W Units	WT
FILTERS		**MISCELLANEOUS**	
HP (High-Pass) FILTERS Off	H0	MODULATION OUTPUT	A0
50 Hz FILTER On	H1	AUDIO INPUT	A1
300 Hz FILTER On	H2	AUTOMATIC OPERATION	AU
LP (Low-Pass) FILTERS Off	L0	Auto-Ranging (RANGE HOLD Off)	G0
3 kHz FILTER On	L1	RANGE HOLD	G1
15 kHz FILTER On	L2	Identify Instrument	ID
>20 kHz FILTER On	L3	INSTR PRESET (same as DCL)	IP
		Trigger Off	T0
FM DE-EMPHASIS		Hold	T1
PRE-DISPLAY Off and		Trigger Immediate	T2
FM DE-EMPHASIS Off	P0	Trigger with Settling	T3
PRE-DISPLAY On and		Hexidecimal A	X0
FM DE-EMPHASIS On	P1	Hexidecimal B	X1
25 μs DE-EMPHASIS	P2	Hexidecimal C	X2
50 μs DE-EMPHASIS	P3	Hexidecimal D	X3
75 μs DE-EMPHASIS	P4	Hexidecimal E	X4
750 μs DE-EMPHASIS	P5	Hexidecimal F	X5

Table 3-12. Code to Measuring Receiver Function Summary

Code	Function	Code	Function
A0	MODULATION OUTPUT	M1	AM
A1	AUDIO INPUT	M2	FM
AT	AUTO TUNING	M3	ΦM
AU	AUTOMATIC OPERATION	M4	RF POWER
		M5	FREQ
B0	ENABLE ERRORS	MV	mV Units
B1	DISABLE ERRORS	MZ	MHz (INPUT FREQ)
C0	CALIBRATE Off	N0	dB EXT ATTEN Off
C1	CALIBRATE On	N1	dB EXT ATTEN On
CF	% CAL FACTOR	P0	PRE-DISPLAY Off and FM DE-EMPHASIS Off
CL	CLEAR (KEY)	P1	PRE-DISPLAY On and DE-EMPHASIS On
D1	PEAK+	P2	25 μs DE-EMPHASIS
D2	PEAK−	P3	50 μs DE-EMPHASIS
D3	PEAK HOLD	P4	75 μs DE-EMPHASIS
D4	AVG (RMS Calibrated)	P5	750 μs DE-EMPHASIS
D5	1 kHz DISTN	R0	RATIO Off
D6	400 Hz DISTN	R1	RATIO On
D8	RMS	R2	PREVIOUS RATIO
D9	PEAK±/2	RC	RECALL
FR	DISPLAY FREQ	RF	SET REF
FN	DISPLAY INCREMENT	S1	AUDIO FREQ
G0	Auto-Ranging (RANGE HOLD Off)	S2	AUDIO DISTN
G1	RANGE HOLD	S3	IF LEVEL
H0	HP (High-Pass) FILTERS Off	S4	TUNED RF LEVEL
H1	50 Hz FILTER On	S5	FREQ ERROR
H2	300 Hz FILTER On	SC	SAVE CAL
HU	⇑ Hz	SP	SPECIAL FUNCTION
HD	⇓ Hz	SS	SPECIAL, SPECIAL
HZ	INPUT FREQUENCY (Hz)	T0	Trigger Off
ID	Identify Instrument	T1	Hold
IP	INSTR PRESET (same as DCL)	T2	Trigger Immediate
K0	TRACK Mode Off (lock mode)	T3	Trigger with Settling
K1	TRACK Mode On	TR	STORE
KU	⇑ kHz	UV	μV Units
KD	⇓ kHz	VL	V Units
L0	LP (Low-Pass) FILTERS Off	WT	W Units
L1	3 kHz FILTER On	X0	Hexidecimal A
L2	15 kHz FILTER On	X1	Hexidecimal B
L3	>20 kHz FILTER On	X2	Hexidecimal C
LG	Display LOG Result	X3	Hexidecimal D
LN	Display LIN Result	X4	Hexidecimal E
		X5	Hexidecimal F
		ZR	ZERO

Table 3-13. Measurement Modes and Codes (1 of 2)

Measurement Mode	Program Code	Receiver Used?	Volatile?	Blanks Demod. Output?
AM	M1	Yes	No	No
AM Calibration	C0, C1	Yes	No	No
AM Calibration Actual	13.0SP	No	No	Yes
AM Residual Calibration	13.1SP	Yes	No	No
AM Peak Residual Calibration	13.2SP	Yes	No	No
Read AM Calibration Factor	16.2SP	No	Yes	No
FM	M2	Yes	No	No
FM Calibration	C0, C1	Yes	No	No
FM Calibration Actual	12.0SP	No	No	Yes
FM Residual Calibration	12.1SP	Yes	No	No
FM Peak Calibration	12.2SP	Yes	No	No
Read FM Calibration Factors	17.2SP	No	Yes	No
ΦM	M3	Yes	No	No
RF Power (Power Sensor)	M4	No	No	Yes
RF Power Zeroing	ZR	No	Yes	Yes
RF Power Calibration Factor Status	37.2SP	No	Yes	No
RF Power Calibration Factor Table Size	37.4SP	No	Yes	No
RF Level (RF Peak Detector)	35.XSP	No	No	Yes
Tuned RF Level	S4	Yes	No	Yes
Tuned RF Level (Synchronous and Average)	4.XSP	Yes	No	Yes
Peak Tuned RF Level	36.XSP	Yes	No	Yes
IF Level	S3	Yes	No	No
Frequency	M5	Yes	No	No
LO Frequency	33.XSP	Yes	No	No
IF Frequency	34.XSP	Yes	No	No
Frequency Error	S5	Yes	No	No
Audio				
Audio Frequency (External)*	S1 A2	No	No	Yes**
Audio Distortion (External)*	S2 A2	No	No	Yes**
Audio SINAD (External)*	29.0SP A2	No	No	Yes**
Audio RMS Level (External)	30.XSP	No	No	Yes**

* Use A1 to select Internal audio measurements. Internal audio measurements use the Receiver.

** The demodulated Output is not blanked during Internal Audio measurements.

Table 3-13. Measurement Modes and Codes (2 of 2)

Measurement Mode	Program Code	Receiver Used?	Volatile?	Blanks Demod. Output?
Other Measuring Capabilities				
Squelched Tone Receiver	18.XSP	Yes	Yes	No
Timebase Oven Hot/Cold	15.0SP	No	Yes	No
Timebase Internal/External	15.1SP	No	Yes	No
Reading Internal User Information				
HP-IB Address	21.XSP	No	Yes	No
Display Ext. LO Freq	27.2SP	No	Yes	No
Display Operator Selected Special Functions	SP	No	Yes	No
Display Instrument Selected Special Functions	SS	No	Yes	No
Display Ext. Atten.	25.2SP	No	Yes	No
HP-IB Identify (8901B or 8902A?)	ID	No	Yes	No
Display SRQ Mask	22.64SP	No	Yes	No
Software Date Code	42.XSP	No	Yes	No
Read Ratio Reference	11.2SP	No	Yes	No
Read Lower Limit	14.5SP	No	Yes	No
Read Upper Limit	14.6SP	No	Yes	No
Read Lower Limit Measurement Code	14.7SP	No	Yes	No
Read Upper Limit Measurement Code	14.8SP	No	Yes	No

Table 3-14. Measurement Modifiers (1 of 2)

Measurement and Code	Variable Parameters							
	Ranges	Detectors (D1–9)	Filters (H0–2 and L0–3	De-emphasis (0–5)	Calibration Factors	Frequency Offset	dB Ext. Attenuator	Limit/ Ratio
AM Measurement (M1)	3 (2.XSP)	Peak (+ or –), Avg, or RMS	Yes	N/A	Yes	Tuning	N/A	Yes
AM Calibration (C0, C1 and CF)	N/A	Peak (+ or –)	N/A	N/A	Yes	N/A	N/A	N/A
AM Calibrator (13.XSP)	Fixes (2.XSP)	Peak (+ or –)	N/A	N/A	N/A	N/A	N/A	N/A
FM Measurement (M2)	4 (2.XSP)	Peak (+ or –), Avg, or RMS	Yes	Yes	Yes	Tuning	N/A	Yes
FM Calibration (C0, C1 and CF)	N/A	Peak (+ or –)	N/A	N/A	Yes	N/A	N/A	N/A
FM Calibrator (12.XSP)	Fixes (2.XSP)	Peak (+ or –)	N/A	N/A	N/A	N/A	N/A	N/A
ΦM Measurement (M3)	4 (2.XSP)	Peak (+ or –), Avg, or RMS	Yes	N/A	Yes (FM)	Tuning	N/A	Yes
RF Power Measurement (M4)	5* (10.XSP)	RF Power Sensor	N/A	N/A	Yes	Yes	Yes	Yes
Tuned RF Level Measurement (S4) (includes Synchronous and Average)	3 RF (1.XSP) + 1 (Power Sensor)	IF Synch., IF Avg. (4.XSP)	N/A	N/A	Yes	Tuning	Yes	Yes
Peak RF Level (35.XSP)	N/A	RF Peak	N/A	N/A	N/A	N/A	Yes	Yes
Peak Tuned RF Level (36.XSP)	N/A	IF Peak	N/A	N/A	N/A	Tuning	Yes	Yes
Set Reference (RF)	3 (1.XSP)	IF Synch., IF Avg. (4.XSP)	N/A	N/A	Yes	Tuning	Yes	Yes
IF Level Measurement (S3)	N/A	IF Avg	N/A	N/A	N/A	Tuning	N/A	Yes

* RF Power has two completely independent tables for calibration factors, one used in normal operation and one used when Frequency Offset mode is active.
** 0.15–2.5 MHz, 2.5–10 MHz, and 10–1300 MHz.

Table 3-14. Measurement Modifiers (2 of 2)

Measurement and Code	Variable Parameters							
	Ranges	Detectors (D1–9)	Filters (H0–2 and L0–3	De-emphasis (0–5)	Calibration Factors	Frequency Offset	dB Ext. Attenuator	Limit/ Ratio
RF Frequency Measurement (M5)	3**	N/A	N/A	N/A	N/A	Yes	N/A	Yes
LO Frequency (33.XSP)	N/A	1	N/A	N/A	N/A	N/A	N/A	Yes
IF Frequency (34.XSP)	N/A	1	N/A	N/A	N/A	N/A	N/A	Yes
Frequency Error Measurement (S5)	3**	N/A	N/A	N/A	N/A	Tuning	N/A	Yes
Audio Measurements								
Audio Frequency (S1)	N/A	N/A	N/A	N/A	N/A	Tuning	N/A	Yes
Audio Distortion (S2)	N/A	RMS	Yes	Yes (FM)	N/A	Tuning	N/A	Yes
External Audio RMS Level (30.XSP)	N/A	RMS	N/A	N/A	N/A	N/A	N/A	Yes
SINAD (29.XSP)	N/A	RMS	Yes	Yes (FM)	N/A	Tuning	N/A	Yes

** 0.15–2.5 MHz, 2.5–10 MHz, and 10–1300 MHz.

Table 3-15. Enabling/Disabling Variable Parameters (Front Panel)

Parameter and Code	Default Value	To See Value/s	To Re-enable	Dis-able	To See Status	To Enter Value and Enable	Misc.
Calibration Factors							
AM (16.XSP)	100%	16.2SP, or AM/ % Cal Factor *	16.1SP	16.0SP	AM % Cal Factor *	AM/ CAL/ SAVE CAL	N/A
FM (17.XSP)	100%	17.2SP, or FM/ % Cal Factor *	17.1SP	17.0SP	FM/ % CAl Factor *	FM/ CAL/ SAVE CAL	N/A
RF Power ** (37.XSP)	N/A	RF Power/ %Cal Factor *	37.0SP (Automatic) 37.1SP (Manual)	Auto Op, or 37.0SP	37.2SP	RF Power/ nnn/ % Cal Factor, or 37.1SP	37.3-6, 9SP (edit CF Tables)
Tuned RF Level (38.XSP and 39.XSP)	ROM Table	38.1-3SP/ or Tuned RF Level/ %Cal Factor *	Freq back to valid point (Valid) 39.9SP (Default)	Change freq.,	Uncal light, or Tuned RF Level/ % Cal Factor *	Tuned RF Level/ CAL or 39.1, 2, 3SP	N/A
Frequency Offset (27.XSP)	0 MHz	27.2SP	27.1SP	27.0SP	f OFS light	27.3SP/ nn/ MHz	N/A
dB External Attenuation (25.XSP)	0 dB	25.2SP	dB EXT ATTEN	dB EXT ATTEN	dB Ext Atten Light	nn/dB EXT ATTEN	N/A
Ratio (11.XSP)	100	11.2SP	Previous Ratio	Ratio Key	Ratio Key Light	Ratio Key/ or nnn/ Ratio Key	N/A
Limits (14.XSP)	0.15 and 1300 (Code 5=freq)	14.5SP, or 14.6SP	14.3SP, or 14.4SP	14.0SP	14.9SP	14.1SP, or 14.2SP (from Ratio)	14.7SP, or 14.8SP (measurement mode)
Set Reference (26.XSP)	0 dBm	N/A	26.1SP	Tuned RF Level, or 26.0SP	dB Annunciator	Tuned RF Level/ Set Ref.	N/A

* % Cal Factor alone shows the value currently being used. For AM, FM, and Synch. and Avg. Tuned RF Level, it also indicates enabled/disabled status by display resolution. 0.01% resolution indicates enabled and 1% resolution indicates disabled.

** Two tables of RF Power Calibration Factors are available. The table being used is determined by the status of the Frequency Offset Mode.

Table 3-16. Enabling/Disabling Variable Parameters (Remote)

Parameter and Code	Default Value	To See Value/s	To Re-enable	Dis-able	To See Status	To Enter Value and Enable	Misc.
Calibration Factors							
AM (16.XSP)	100%	16.2SP or M1 CF *	16.1SP	16.0SP	M1 CF *	M1 C1 SC	N/A
FM (17.XSP)	100%	17.2SP or M2 CF *	17.1SP	17.0SP	M2 CF *	M2 C1 SC	N/A
RF Power ** (37.XSP)	N/A	M4 CF *	37.0SP (Automatic) 37.1 (Manual)	AU or 37.0SP	37.2SP	M4 nnn CF or 37.1SP	37.3-6, 9SP (edit CF Tables)
Tuned RF Level (38.XSP and 39.XSP)	ROM Table	38.1-3SP or S4 CF *	Freq set to valid point (Valid) 39.9SP (Default)	Change freq.	Uncal light, or S4 CF *	S4 C1 or 39.1, 2, 3SP	N/A
Frequency Offset (27.XSP)	0 MHz	27.2SP	27.1SP	27.0SP	f OFS light	27.3SP nn MZ	N/A
dB External Attenuation (25.XSP)	0 dB	25.2SP	N1	N0	dB Ext Atten Light	nn N1	N/A
Ratio (11.XSP)	100	11.2SP	R2	R0	Ratio Key Light	R1 or nnn R1	N/A
Limits (14.XSP)	0.15 and 1300 (Code 5=freq)	14.5SP, or 14.6SP	14.3SP, or 14.4SP	14.0SP	14.9SP	14.1SP, or 14.2SP (from Ratio)	14.7SP, or 14.8SP (measurement mode code)
Set Reference (26.XSP)	0 dBm	N/A	26.1SP	S4 or 26.0SP	dB Annunciator	S4 RF	N/A

* % Cal Factor alone shows the value currently being used. For AM, FM, and Synch. and Avg. Tuned RF Level, it also indicates enabled/disabled status by display resolution. 0.01% resolution indicates enabled and 1% resolution indicates disabled.

** Two tables of RF Power Calibration Factors are available. The table being used is determined by the status of the Frequency Offset Mode.

Table 3-17. HP 8901A/02A Code Differences

HP 8901A	HP 8902A	Functions
A1 (or AU)	AU	AUTOMATIC OPERATION
F1 (or MZ)	MZ	MHz (INPUT FREQ)
F2 (or KU)	KU	⇑ kHz
F3 (or KD)	KD	⇓ kHz
F4 (or Z4 or SP)	SP	SPECIAL
F5 (or Z5 or SS)	SS	SPECIAL, SPECIAL
K1 (or CL)	CL	CLEAR
U1 (or D1)	D1	PEAK+
U2 (or D2)	D2	PEAK−
U3 (or D3)	D3	PEAK HOLD
U4 (or D4)	D4	Average Detector (RMS Calibrated)
Z1 (or HZ)	HZ	Hz INPUT FREQ
Z2 (or HU)	HU	⇑ Hz
Z3 (or HD)	HD	⇓ Hz
M4	35.0SP	Peak RF Level
S4	36.0SP	Peak Tuned RF Level
R1	LN, R1	% RATIO
R2	LG, R1	dB RATIO
4.0SP	AT, K0	Auto Tuning, low-noise lock mode
4.1SP	AT, K1	Auto Tuning, track mode
4.2SP	MZ, K0	Manual Tuning, low-noise lock mode
7.1SP	7.1SP	10 Hz frequency resolution
7.2SP	7.3SP	1000 Hz frequency resolution
9.0SP	G1	Hold Setting (RANGE HOLD)
10.0SP	34.0SP	IF Frequency
11.0SP	LN, R2	% PREVIOUS RATIO
11.1SP	LG, R2	dB PREVIOUS RATIO
11.3SP	use "-" key	Make Ratio Reference Negative
15.0SP	15.0SP	Oven Check (returns "0" if oven OK or not installed, rather than doing nothing as in the 8901A)
Status Byte	Status Byte	Status Byte Bits "Upper Limit" (weight 8) and "Lower Limit" (weight 16) are merged together into "Limit Reached" (weight 8)

3-12. BASIC FUNCTIONAL CHECKS OF THE MEASURING RECEIVER

Description

Using a signal generator, an oscilloscope, and a sensor module, the overall operation of the Measuring Receiver is verified.

Equipment

Oscilloscope	HP 1740A
Sensor Module	HP 11722A
Signal Generator	HP 8640B Option 001 and 002

The HP 8656B, HP 8662A, HP 8663A, HP 8654A or HP 8654B can also be used if an HP 8640B Option 001 and 002 is not available. However, with these other signal generators you will need to modify some tests.

Procedure

Preliminary Check

1. Connect the multi-conductor cable of the sensor module to the SENSOR input connector. Connect the RF coaxial cable of the sensor module to the INPUT 50Ω connector (see Figure 3-6). Select INSTR PRESET (Blue Key, AUTOMATIC OPERATION). Observe the front-panel LED annunciators, display segments and decimal points, and key lights. All LEDs should light for approximately 10 seconds at turn on and then all should momentarily turn off.
2. After the turn-on sequence, the instrument should display "– –". The MHz annunciator, the FM annunciator under MODULATION OUTPUT, the AUTO TUNING annunciator (under the TRACK MODE key), and the FREQ key should be lighted.

RF Power Calibration Check

3. Connect the sensor module input to the RF POWER CALIBRATION OUTPUT connector. (See Figure 3–6.)

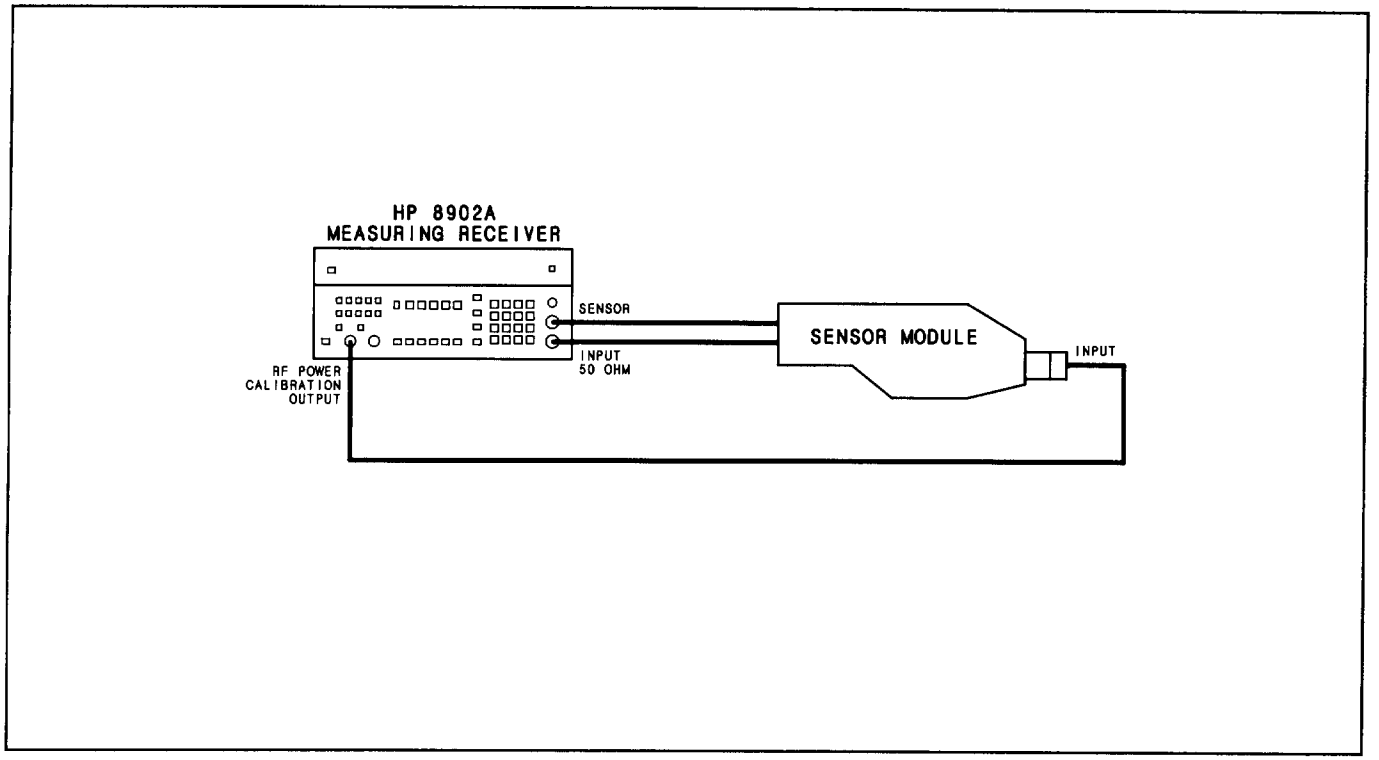


Figure 3–6. RF Power Calibration Setup

4. Press the RF POWER key. If the instrument does not display Error 15, proceed with step 6. If the instrument displays Error 15 (indicating the RF power calibration factors have not been entered), proceed with step 5.

5. If the instrument displays Error 15, enter the RF power calibration factors that are given on the cover of the sensor module. (Note that a software driven alternative is available. See *RF Power* for a program list in BASIC for the HP Series 200 computers.):

a. Enter the reference calibration factor by keying in 37.3 and pressing the SPCL key. Then, key in the value of the reference calibration factor and press the Blue key then the % CAL FACTOR key (the MHz key).

b. Enter each frequency/calibration factor pair by first keying in 37.3 and pressing the SPCL key. Next, key in the frequency (in MHz) and press the MHz key. Then, key in the value of the calibration factor and press the Blue key then the % CAL FACTOR key.

NOTE

Error 15 will continue to be displayed until the Measuring Receiver is able to interpolate between a frequency/calibration factor pair from those pairs entered. (For more information, refer to RF Power Calibration *and* RF Power Calibration Factors *in the* Detailed Operating Instructions *in this section.)*

6. Press the ZERO key. "– – – –" should be displayed for approximately 15 seconds, 0.0 00 W should then be displayed briefly, and then a value less than 3.0 –06 W (that is, 3.0 μW) should be displayed. (Ignore the RECAL and UNCAL annunciators if they are displayed.)

7. Press the CALIBRATE key. When a value appears in the display, press the Blue key and SAVE CAL key (the CALIBRATE key). The display should show between 0.999 –03 and 1.000 –03 W (that is, 0.999 and 1.000 mW) or between 999 –06 and 1000 –06 W (that is, 999 and 1000 μW). The RECAL and UNCAL annunciators should be off. Turn off the calibrator by pressing the CALIBRATE key again.

RF Power Check

8. Set the signal generator to 100 MHz CW at –10 dBm (as measured on its level meter).

9. Connect the input of the sensor module to the RF output of the signal generator. Connect the MODULATION OUTPUT/AUDIO INPUT to the vertical input of the oscilloscope. (See Figure 3–7.)

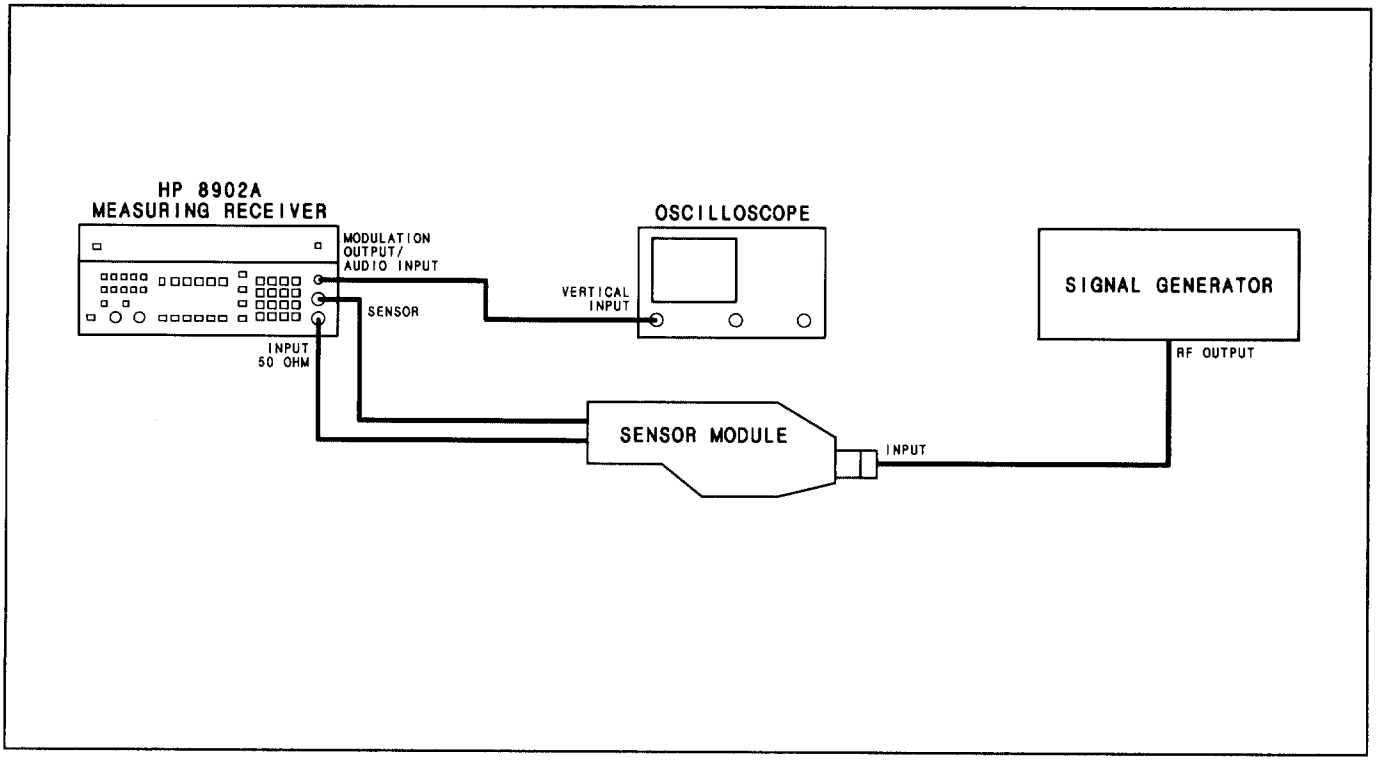


Figure 3–7. RF Power Check Setup

10. Press the LOG/LIN key to display power in dBm. The Measuring Receiver should display between –11.00 and –9.00 dBm.

RF Peak Level Check

11. Key in 35.0 and press the SPCL key (uses a peak detector to measure power). The Measuring Receiver should display between −16.00 and −6.00 dBm.

Frequency Check

12. Press the FREQ key. Key in 7.1 and press the SPCL key to set the RF frequency resolution to 10 Hz. Set the signal generator's frequency as shown in the following table. For each frequency, allow the Measuring Receiver to tune to the signal then compare the signal generator's frequency display with the Measuring Receiver's display. The two displays should agree within the limits indicated.

Signal Generator Frequency (MHz)	Frequency Difference Limits (±Hz)
2	40
4	50
8	70
16	100
25	130
50	230
100	430
200	830
400	1600
800	3200

13. Set the signal generator frequency to 50 MHz. When the Measuring Receiver has tuned to the signal, press the MHz key to disable the automatic tuning and enable manual tuning. Press the S (Shift) key and the FREQ ERROR key (the FREQ key). The Measuring Receiver should display between −1 and 1 kHz.

14. Key in 100 and press the ⇑ kHz key. The Measuring Receiver should display between −101 and −99 kHz. Key in 7.0 and press the SPCL key to return the RF frequency resolution to automatic selection.

Track Mode Tuning Check

15. Press the AUTOMATIC OPERATION key then the FREQ key. Press the TRACK MODE key. Manually sweep the signal generator's frequency to 64 MHz. The Measuring Receiver's frequency display should track the frequency as it changes. Press the TRACK MODE key again to turn off the function.

AM and FM Calibration Check

16. Connect the input of the sensor module to the AM/FM CALIBRATION OUTPUT connector. (See Figure 3–8.)

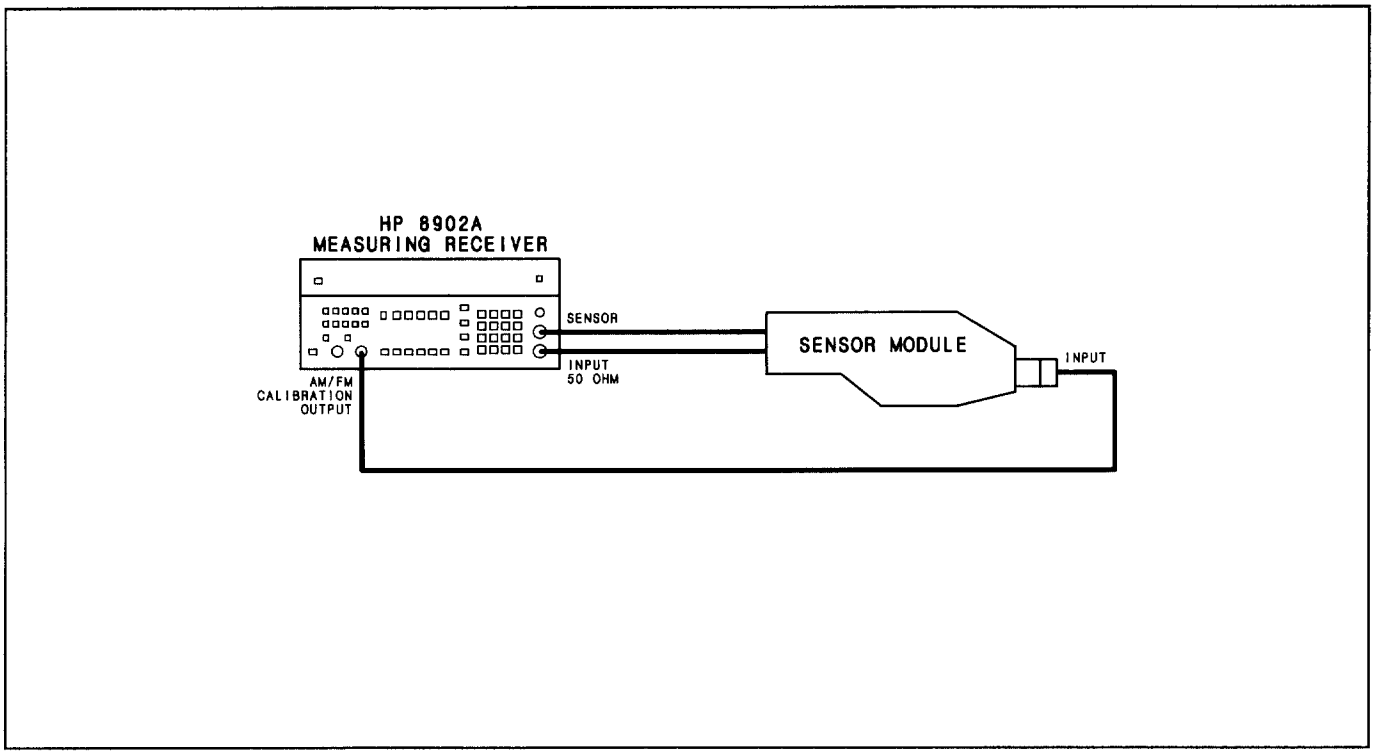


Figure 3–8. AM and FM Calibration Check Setup

17. Press the AM key then the CALIBRATE key. After approximately 20 seconds, the AM calibration factor should be displayed. The displayed value should be between 99.00 and 101.00%.

18. Press the FM key then CALIBRATE key. After approximately 20 seconds, the FM calibration factor should be displayed. The displayed value should be between 99.00 and 101.00%. Press the CALIBRATE key again to turn off FM calibration. (If you remove the sensor with the calibrator still on it might return Error 08.)

AM Check

19. Reconnect the sensor module input to the signal generator's output. (See Figure 3–9.)

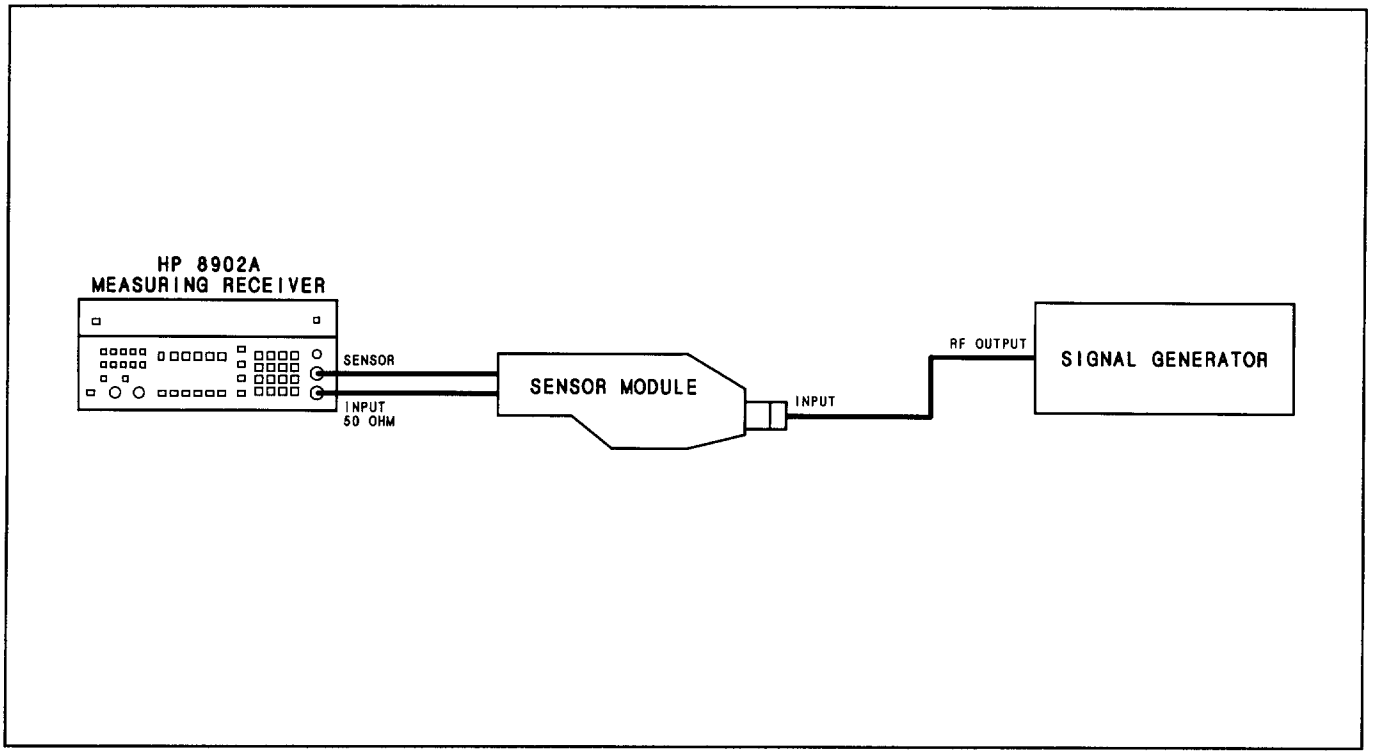


Figure 3–9. AM Check Setup

20. Press the Measuring Receiver's MHz key. Set the signal generator for 50% AM (as measured on its AM meter) at a 1 kHz rate.

21. Press the AM key. The Measuring Receiver should display between 46.0 and 54.0%.

22. Set the signal generator's AM to 25% (as measured on its AM meter). The Measuring Receiver should display between 22.00 and 28.00% with 0.01% resolution.

FM and Phase Modulation (ΦM) Checks

23. Set the signal generator's AM off and set FM to 50 kHz peak deviation (as measured on its FM meter) at a 1 kHz rate. Press the FM key. The Measuring Receiver should display between 45.0 and 55.0 kHz.

24. Adjust the signal generator's FM peak deviation for 50 kHz as displayed by the Measuring Receiver.

25. Press the ΦM key. The instrument should display between 45.0 and 55.0 rad.

FM De-emphasis Check

26. Press the FM key. Press the RATIO key. If the display is in dB, press the LOG/LIN key to display %. The instrument should display between 99.8 and 100.2% REL. The oscilloscope should show a sinusoidal waveform with a peak-to-peak amplitude between 0.9 and 1.1V and a period of 1 ms.

27. Press the LOG/LIN key. Press the RATIO key. Press the PRE-DISPLAY key. Set the FM rate as listed in the following table. For each setting, perform the following steps:

    a. Set the FM DE-EMPHASIS off if it is on. (Leave PRE-DISPLAY on.)
    b. Set the signal generator's FM modulation rate to a value approximate to that listed in the table.
    c. Press the RATIO key to establish a reference of 0 dB.
    d. Press the FM DE-EMPHASIS time constant key listed in the table.
    e. Adjust the modulation rate (but not the level) until the displayed modulation is −3.0 dB.
    f. Press the S (Shift) key then press the AUDIO FREQ key (the AM key). The Measuring Receiver should display a rate within the limits listed. Also, the oscilloscope waveform should change proportionately with the display. (Allow for a times 10 amplitude at the output of MODULATION OUTPUT/AUDIO INPUT when FM DE-EMPHASIS is set to 750 μs.)

Approximate FM Modulation Rate (Hz)	FM DE-EMPHASIS Time Constant (μs)	Frequency Limits (Hz)	
		Minimum	Maximum
6366	25	6175	6557
3183	50	3088	3278
2122	75	2058	2187
212	750	205.8	218.7

Audio Frequency and Audio Filters Check

28. Set FM DE-EMPHASIS and PRE-DISPLAY off. Set the FM rate as listed in the following table. For each setting, perform the following steps:

    a. Set the HP FILTER and LP FILTER to ALL OFF.
    b. Set the signal generator's FM rate as listed in the table.
    c. Press the FM key then press the RATIO key to establish a reference of 0 dB.
    d. Set the HP or LP FILTER as listed in the table, and fine adjust the FM rate for a reading of −3.0 dB REL.
    e. Press the S (Shift) key then the AUDIO FREQ key and note the FM rate. The Measuring Receiver should display a rate within the limits listed.

Approximate FM Modulation Rate (Hz)	HP or LP Filter	Frequency Limits (Hz)	
		Minimum	Maximum
50	50 Hz HP	47.5	52.5
300	300 Hz HP	285	315
3 000	3 kHz LP	2 850	3 150
15 000	15 kHz LP	14 250	15 750
90 000	>20 kHz LP	80 000	140 750

Audio Distortion and SINAD Check

29. Press the AM key and set the LP FILTER to ALL OFF. Set the signal generator's FM off, and set the AM depth to 50% (as measured on the Measuring Receiver's display) at a 1 kHz rate. Press the S (Shift) key then the AUDIO DISTN key (the FM key). The displayed distortion should be less than 3%. (The display should also indicate 1 kHz. If 400 Hz is displayed, press the Blue key then the 400 Hz DISTN key (the PEAK– key).)

30. Set the signal generator's AM for a 400 Hz rate. Press the Blue key then the 400 Hz DISTN key (the PEAK– key). The displayed distortion should be less than 3%.

31. Press the LOG/LIN key to display the distortion in dB. Key in 29.0 and press the SPCL key. The displayed SINAD should be greater than 30 dB.

External Audio RMS Level Check

32. Connect the audio (AM or trigger) output of the signal generator to the input of the oscilloscope. (See Figure 3–10.) Set the signal generator's audio output level for 3 Vpp as read on the oscilloscope.

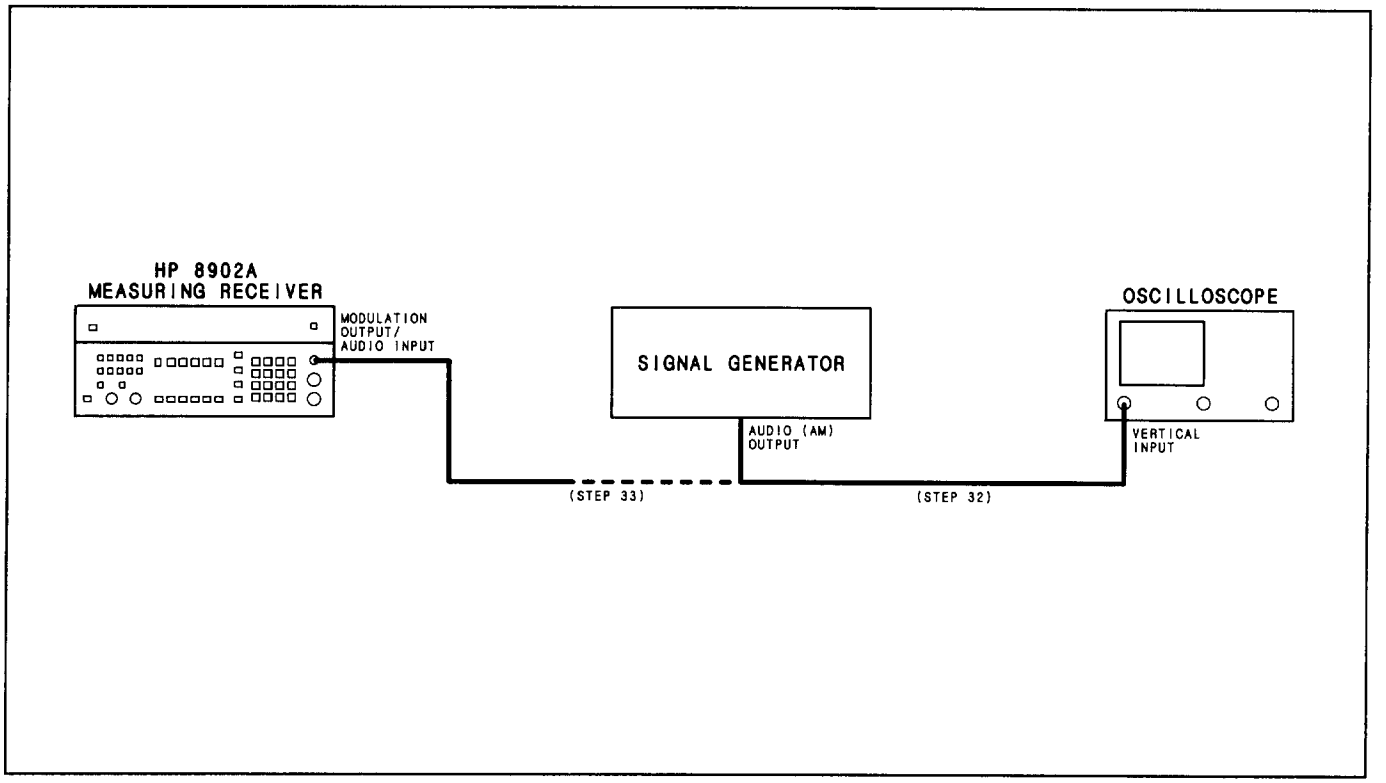


Figure 3–10. External Audio RMS Level Check Setup

33. Connect the audio output of the signal generator to the MODULATION OUTPUT/AUDIO INPUT of the Measuring Receiver. (See step 33 of Figure 3–10.) Key in 30.0 and press the SPCL key. If the display is in dB V, press the LOG/LIN key to display V. The Measuring Receiver's displayed level should be between 0.95 and 1.17V.

Audio Detector Check

34. Disconnect the signal generator's audio output. Press the FM key. Set the signal generator's AM off and set the FM on with a peak deviation of 50 kHz and a rate of 1 kHz. Press the RATIO key then the LOG/LIN key to % to establish a reference of 100%. Set DETECTOR to PEAK−. The Measuring Receiver should display between 95 and 105% REL depending upon the signal generator's FM distortion.

35. Set DETECTOR to PEAK±/2 by pressing both the PEAK+ and PEAK− keys simultaneously. The Measuring Receiver should display a value between 100% and the value read in step 34.

36. Press the AVG key. The instrument should display between 69.3 and 72.1% REL. Turn the ratio function off by pressing the RATIO key again.

37. Press the PEAK+ key then press the PEAK HOLD key. Switch the signal generator's FM off. The Measuring Receiver's display should retain the largest value obtained after pressing PEAK HOLD. Turn off the peak hold function by pressing the PEAK+ key.

IF Level Check

38. Press the S (Shift) key then the IF LEVEL key (the ΦM key). The Measuring Receiver should display between 99.9 and 100.1%.

IF Frequency and LO Frequency

39. Set the signal generator to 100.000 MHz CW at 0 dBm. (Accurately set its frequency.) Press the AUTOMATIC OPERATION key then key in 34.0 and press the SPCL key to display the IF frequency. The frequency displayed should be between 1.45 and 1.55 MHz.

40. Key in 33.0 and press the SPCL key to display the LO frequency. The frequency displayed should be between 101.45 and 101.55 MHz.

41. Key in 3.1 and press the SPCL key. (Special Function 3.1 switches the IF bandwidth back to 455 kHz.) The frequency displayed should be between 100.44 and 100.46 MHz.

Peak Tuned RF Level and RF High-Pass Filter Check

42. Set the signal generator to 5.25 MHz CW at 0 dBm. Key in 36.0 and press the SPCL key. The display should read between 0.500 and 2.000 −03 W (that is, between 0.5 and 2 mW).

43. Press the RATIO key. If the display is in % REL, press the LOG/LIN key to display dB REL. Key in 3.3 and press the SPCL key (to insert the RF high-pass filter). The Measuring Receiver should display between −2 and −8 dB REL. Turn off the ratio function by pressing the RATIO key again. Key in 3.0 and press the SPCL key to return the RF high-pass and IF filter selection to automatic.

Synchronous and Average Tuned RF Level Check

44. Set the signal generator for 20 MHz CW at 0 dBm. Press the S (Shift) key then the TUNED RF LEVEL key (the RF POWER key) to measure the signal using the IF synchronous detector. When the Measuring Receiver displays a reading, press the MHz key. Press the CALIBRATE key. Adjust the signal generator's level so the Measuring Receiver displays 0.00 dBm.

45. Step down the signal generator's level in 10 dB steps as listed in the following table. When the RECAL annunciator is displayed, press the CALIBRATE key while keeping the signal generator's level constant. At each step the Measuring Receiver's display should be within the limits indicated in the table.

Signal Generator Output Level (dBm)	Display Limits (dBm)	
	Minimum	Maximum
–10	–10.06	–9.94
–20	–20.12	–19.88
–30	–30.27	–29.73
–40	–40.48	–39.52
–50	–50.75	–49.25
–60	–61.08	–58.92
–70	–71.68	–68.53
–80	–81.92	–78.08
–90	–92.43	–87.57
–100	–103.00	–97.00

46. Return the level of the signal generator to 0.00 dBm. Key in 4.4 and press the SPCL key to measure the signal using the IF average detector. Press the CALIBRATE key. Set the signal generator's level so the Measuring Receiver displays 0.00 dBm.

47. Step down the level of the signal generator, in 10 dB steps, using the same measurement limits as in the previous table.

Error Check

48. Set the signal generator to 200 MHz CW at 0.0 dBm. On the Measuring Receiver, press the AUTOMATIC OPERATION key then press the FM key. Press the PEAK+ key. After the Measuring Receiver is tuned, press the RANGE HOLD key. Key in 100 then press the ⇑ kHz key. The Measuring Receiver should display Error 01. Press the RANGE HOLD key again to turn off the function.

49. Press the ⇓ kHz key. Key in 2.1 and press the SPCL key. Set the signal generator's FM on and adjust the peak deviation for 5 kHz (as read on its FM meter). The Measuring Receiver should display Error 04.

50. Key in 8.4 and press the SPCL key. The instrument should display Error 07.

High-Selectivity Level Check (Option Series 030)

51. Set the signal generator to 10 MHz CW at 0.0 dBm. On the Measuring Receiver, press the Blue key then press the INSTR PRESET key (the AUTOMATIC OPERATION key) to preset the instrument. Key in 24.0 then press the SPCL key to initialize the high-selectivity level measurement.

52. Key in 24.1 then press the SPCL key. Slowly fine tune the signal generator up and down until a maximum level is found. At that frequency key in 24.2 then press the SPCL key. (This establishes an IF level reference.)

53. Slowly fine tune the signal generator down until the Measuring Receiver displays –6.0 dB. Note the signal generator's frequency.

54. Slowly fine tune the signal generator up until the Measuring Receiver again displays −6.0 dB. Subtract the displayed frequency from the frequency of step 53. The difference should be between the limits shown in the following table for the option combination given.

Option Combination	Frequency Difference Limits (kHz)	
	Minimum	Maximum
032 and 035 033 and 035 035 and 037	25.0	35.0
032 and 033 033 and 037	12.4	16.9
032 and 037	6.4	10.4

55. On the Measuring Receiver, press the Blue key then press the INSTR PRESET key. Key in 24.0 then press the SPCL key.

56. Key in 24.3 then press the SPCL key. Slowly fine tune the signal generator up and down until a maximum level is found. At that frequency key in 24.4 then press the SPCL key. (This establishes an IF level reference.)

57. Slowly fine tune the signal generator down until the Measuring Receiver displays −6.0 dB. Note the signal generator's frequency.

58. Slowly fine tune the signal generator up until the Measuring Receiver again displays −6.0 dB. Note the signal generator's frequency. Subtract the displayed frequency from the frequency of step 57. The difference should be between the limits shown in the following table for the option combination given.

Option Combination	Frequency Difference Limits (kHz)	
	Minimum	Maximum
032 and 037 033 and 037 035 and 037	2.0	3.0
032 and 033 032 and 035	6.4	10.4
033 and 035	12.4	16.9

59. Fine tune the signal generator for a reading of 0.0 dB. Step down the signal generator's level in 10 dB steps as listed in the following table. At each step the Measuring Receiver's display should be within the limits indicated in the table.

Signal Generator Output Level (dBm)	Display Limits (dB)	
	Minimum	Maximum
−10	−11.0	−9.0
−20	−21.0	−19.0
−30	−31.0	−29.0
−40	−41.0	−39.0
−50	−51.0	−49.0
−60	−61.0	−59.0
−70	−71.0	−69.0
−80	−81.0	−79.0
−90	−91.0	−89.0

External LO Check (Option Series 030)

60. Set the signal generator to 51.50 MHz CW at 0 dBm. Connect the signal generator's output to the rear-panel LO INPUT connector. Connect the sensor module's input to CALIBRATION RF POWER OUTPUT connector. (See Figure 3-11.)

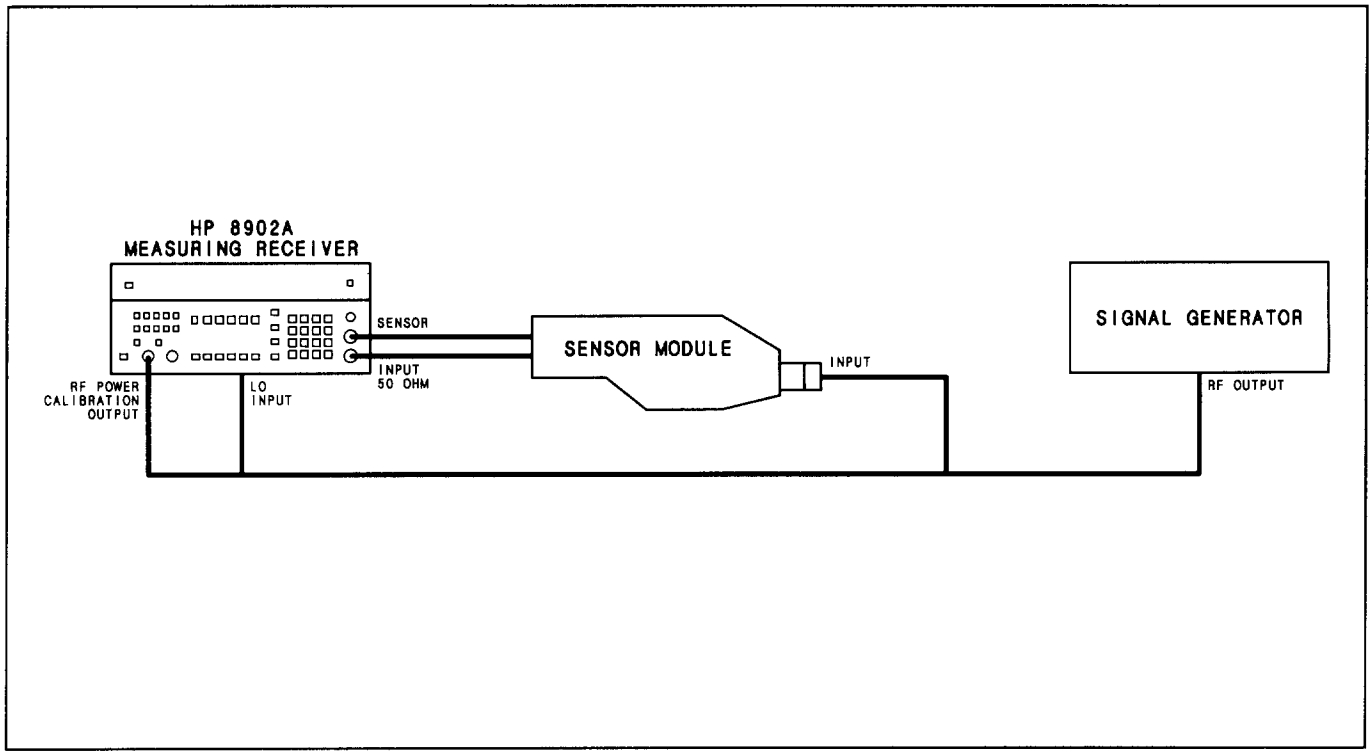


Figure 3-11. External Lo Check (Option 030) Setup

61. On the Measuring Receiver, key in 45.16 and press the SPCL key then key in 23.1 SPCL and press the SPCL key. (This turns on the RF power calibrator and switches the LO to external.) Key in 50 then press the MHz key. The display should read between 48 and 52 MHz.

3–13. BASIC FUNCTIONAL CHECKS OF THE HEWLETT-PACKARD INTERFACE BUS (HP-IB)

Description

The following ten procedures check the Measuring Receiver's ability to process or send all of the applicable HP-IB messages described in paragraphs 3-12 through 3-31. In addition, the Measuring Receiver's ability to recognize its HP-IB address is checked and all of the bus data, handshake and control lines except DIO8 (the most significant data line which is not used by the Measuring Receiver) are set to both their true and false states. These procedures do not check whether or not all Measuring Receiver program codes are being properly interpreted and executed by the instrument; however, if the front panel operates as expected, the program codes, in all likelihood, will be correctly implemented.

The validity of these checks is based on the following assumptions:

- The Measuring Receiver performs properly when operated via the front-panel keys (that is, in local mode). This can be verified with the preceding Basic Functional Checks of the Measuring Receiver in paragraph 3-11.
- The bus controller properly executes HP-IB operations.
- The bus controller's HP-IB interface properly executes the HP-IB operations.

If the Measuring Receiver appears to fail any of these HP-IB checks, the validity of the above assumptions should be confirmed before attempting to service the instrument.

The select code of the controller's HP-IB interface is assumed to be 7. The address of the Measuring Receiver is assumed to be 14 (its address as set at the factory). This select code-address combination (that is, 714) is not necessary for these checks to be valid. However, the program lines presented here would have to be modified for any other combination.

These checks are intended to be as independent of each other as possible. Nevertheless, the first four checks should be performed in order before other checks are selected. Any special initialization or requirements for a check are described at its beginning.

Initial Setup

The test setup is the same for all of the checks. Connect the Measuring Receiver to the bus controller via the HP-IB interface. Do not connect any equipment to any of the Measuring Receiver's input connectors.

Equipment

HP-IB Controller ..... HP 9825A/98213A(General and Extended I/O ROM)
or ..... HP 9835A/98332A(I/O ROM)
or ..... HP 9845A(with HP-IB capability)
HP-IB Interface.....HP 98034A (use "revised" version with 9835A and 9845A)

The HP 9825A uses HPL. The HP 9835A and HP 9845A use BASIC. You can also use HP Series 200 Controllers which use BASIC. (Code differences exist between the BASIC used by the HP 9835A and HP 9845A and the BASIC used by the HP Series 200 Controllers. These code differences are specified in the procedure.)

Procedures

Using the table of instructions under each function, read the description of the purpose of the commands and then enter the commands appropriate to your controller exactly as described. Check that the instrument responds correctly.

Address Recognition Check

This check determines whether or not the Measuring Receiver recognizes when it is being addressed and when it is not. This check assumes only that the Measuring Receiver can properly handshake on the bus. Before beginning this check, set the Measuring Receiver's POWER switch to STBY, then to ON.

Description	HPL	BASIC
Set the Remote Enable (REN) bus control line false.	lcl 7	LOCAL 7
Send the Measuring Receiver's listen address.	wrt 714	OUTPUT 714
Check that the Measuring Receiver's LISTEN annunciator is on.		
Unaddress the Measuring Receiver by sending a different address	wrt 715	OUTPUT 715
Check that the Measuring Receiver's LISTEN annunciator is turned off.		

Remote/Local Messages and the LOCAL Key Check

This check determines whether the Measuring Receiver properly switches from local to remote control, from remote to local control, and whether the LOCAL key returns the instrument to local control. This check assumes that the Measuring Receiver is able to both handshake and recognize its own address. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Send the Remote Message (by setting Remote Enable, REN, true and addressing the Measuring Receiver to Listen). Check that the Measuring Receiver's REMOTE and LISTEN annunciators are on.	rem 714	REMOTE 714
Send the Local Message to the Measuring Receiver Check that the Measuring Receiver's REMOTE annunciator is off but its LISTEN annunciator is on.	lcl 714	LOCAL 714
Send the Remote message to the Measuring Receiver. Check that the Measuring Receiver's REMOTE and LISTEN annunciators are on. Press the LOCAL key on the Measuring Receiver. Check that the Measuring Receiver's REMOTE annunciator is now off, but that its LISTEN annunciator remains on.	rem 714	REMOTE 714

Sending the Data Message Check (Data Output)

This check determines whether or not the Measuring Receiver properly issues Data messages when addressed to talk. This check assumes that the Measuring Receiver is able to handshake and recognize its own address. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Address the Measuring Receiver to talk and store its output data in variable V. (The output is Error 96 since there is no signal at its INPUT.)	red 714,V	ENTER 714;V
Display the value of V.	dsp V	PRINT V
Check that the Measuring Receiver's TALK annunciator is on. The controller's display should read 90000096000.00 (HP 9825A) or 90000096000 (HP 9835A and 9845A).		

Receiving the Data Message Check (Data Input)

This check determines whether or not the Measuring Receiver properly receives Data messages. The Data messages sent also cause the 7 least-significant HP-IB data lines to be placed in both their true and false states. This check assumes the Measuring Receiver is able to handshake, recognize its own address, and properly make the remote/local transitions. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Send the first part of the Remote message (enabling the Measuring Receiver to remote.	rem 7	REMOTE 7
Address the Measuring Receiver to listen (complete the Remote message), then send a Data message (manually tuning the Measuring Receiver to 1 MHz.	wrt 714,"1MZ"	OUTPUT 714;"1MZ"
Check that the Measuring Receiver's REMOTE and LISTEN annunciators are on. Check also that its 15 kHz LP FILTER key light is on and the AUTO TUNING light is off.		

Local Lockout and Clear Lockout/Set Local Messages Check

This check determines whether or not the Measuring Receiver properly receives the Local Lockout message, disabling all front-panel keys. The check also determines whether or not the Clear Lockout/Set Local message is properly received and executed by the Measuring Receiver. This check assumes that the Measuring Receiver is able to handshake, recognize its own address, and properly make the remote/local transitions. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Send the first part of the Remote message (enabling the Measuring Receiver to remote).	rem 7	REMOTE 7
Send the Local Lockout message	llo 7	LOCAL LOCKOUT 7
Address the Measuring Receiver to listen (completing the Remote message).	wrt 714	OUTPUT 714
Check that the Measuring Receiver's REMOTE and LISTEN annunciators are on. Press the Measuring Receiver's LOCAL key. Both its REMOTE and LISTEN annunciators remain on.		
Send the Clear Lockout/Set Local message.	lcl 7	LOCAL 7
Check that the Measuring Receiver's REMOTE annunciator is off but its LISTEN annunciator remains on.		

Clear Message Check

This check determines whether or not the Measuring Receiver properly responds to the Clear message. This check assumes that the Measuring Receiver is able to handshake, recognize its own address, make the remote/local changes, and receive Data messages. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Send the first part of the Remote message (enabling the Measuring Receiver to remote).	rem 7	REMOTE 7
Address the Measuring Receiver to listen (completing the Remote message). Then send a Data message that sets the Measuring Receiver's tuning to manual. Check that the Measuring Receiver's REMOTE and LISTEN annunciators are on and that the AUTO TUNING light is off.	wrt 714,"MZ"	OUTPUT 714;"MZ"
Send the Clear message (setting the Measuring Receiver's tune mode back to automatic). Check that the Measuring Receiver's REMOTE and LISTEN annunciators are on and that the AUTO TUNING light is on.	clr 714	RESET 714 **For Series 200:** CLEAR 714

Abort Message Check

This check determines whether or not the Measuring Receiver becomes unaddressed when it receives the Abort message. This check assumes that the Measuring Receiver is able to handshake, recognize its own address, make the remote/local changes, and enter serial-poll mode. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Send the Remote message to the Measuring Receiver.	rem 714	REMOTE 714 **For Series 200:** REMOTE 7 REMOTE 714
Check that the Measuring Receiver's REMOTE and LISTEN annunciators are on.		
Send the Abort message, unaddressing the Measuring Receiver.	cli 7	ABORTIO 7 **For Series 200:** ABORT 7
Check that the Measuring Receiver's LISTEN annunciator is off. Note that the HP 9835A and 9845A ABORTIO statement sends both the Abort message and the Local message. Thus, if the HP 9825A is being used, the Measuring Receiver's REMOTE annunciator should remain on. If the HP 9835A or 9845A is being used, the Measuring Receiver's REMOTE annunciator should turn off.		
Send the Local message (HP 9825A) only.	lcl 7	(The local message was already sent with the ABORTIO 7 statement above.)
Address the Measuring Receiver to talk and then store its output data in variable V.	red 714,V	ENTER 714;V
Check that the Measuring Receiver's LISTEN annunciator is off but that its TALK annunciator is on.		
Send the Abort message unaddressing the Measuring Receiver to talk.	cli 7	ABORTIO 7 **For Series 200:** ABORT 7

Abort Message Check (cont'd)

Description	HPL	BASIC
Check that all the Measuring Receiver's HP-IB annunciators are off.		
Send the serial-poll-enable bus command (SPE) to place the Measuring Receiver in serial-poll mode.	wti 0,7;wti 6,24	SENDBUS 714;1,24 **For Series 200:** SEND 7;CMD"?5X" &CHR$(24)
On the Measuring Receiver, key in 61.3 and then press the SPCL key. The display should show 1.0. This indicates the Measuring Receiver is in serial-poll mode (indicated by the "1").		
Send the Abort message, removing the Measuring Receiver from serial-poll mode.	cli 7	ABORTIO 7 **For Series 200:** ABORT 7
Check that the Measuring Receiver's display shows 0.0. This indicates the Measuring Receiver properly left serial-poll mode upon receiving the Abort message.		

Status Byte Message Check

This check determines whether or not the Measuring Receiver sends the Status Byte message in both the local and remote modes. This check assumes that the Measuring Receiver is able to handshake, recognize its own address, and make the remote/local changes. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Place the Measuring Receiver in serial-poll mode and address it to talk (causing it to send the Status Byte message).	rds (714) → V	STATUS 714;V **For Series 200:** V =SPOLL(714)
Display the value of V.	dsp V	PRINT V
Depending on the vintage of the HP-IB interface (HP 98034A) used, the Measuring Receiver's TALK annunciator may be either on or off. The controller's display should read 0.00 (HP 9825A) or 0 (HP 9835A and HP 9845A).		
Send the Remote message	rem 714	REMOTE 714
Place the Measuring Receiver in serial-poll mode and address it to talk (causing it to send the Status Byte message).	rds (714) → V	STATUS 714;V **For Series 200:** V =SPOLL(714)
Display the value of V.	dsp V	PRINT V
Check that the Measuring Receiver's REMOTE annunciator is on. Depending upon the vintage of the HP-IB interface (HP 98034A) used, the Measuring Receiver's TALK annunciator may be either on or off. The controller's display should read 0.00 (HP 9825A) or 0 (HP 9835A and HP 9845A).		

Service Request Message Check

This check determines whether or not the Measuring Receiver can issue the Service Request message (set the SRQ bus control line true). This check assumes that the Measuring Receiver is able to handshake, recognize its own address, make the remote/local changes, and receive Data messages. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Send the first part of the Remote message (enabling the Measuring Receiver to remote).	rem 7	REMOTE 7
Address the Measuring Receiver to listen (completing the Remote message) then send a Data message (enabling a Service Request to sent upon Instrument Error).	wrt714,"22.4SP"	OUTPUT 714;"22.4SP"
Make the controller wait 2 seconds to allow time for the Measuring Receiver message. (This step is not necessary if sufficient time is allowed.)	wait 2000	WAIT 2000
Read the binary status of the controller's HP-IB interface and store the data in variable V (in this step,7 is the interface's select code).	rds(7) → V	STATUS 7;V **For Series 200:** STATUS 7,7;V
Display the value of the SRQ bit.	dsp"SRQ =",bit (7,V)	PRINT "SRQ =";BIT (V,7) **For Series 200:** PRINT "SRQ =";BIT(V,10)
Check that the Measuring Receiver's REMOTE, LISTEN, and SRQ annunciators are on and that the controller's display reads an SRQ value of 1, indicating the Measuring Receiver issued the Require Service message.		

Trigger Message and Clear Key Triggering Check

This check determines whether or not the Measuring Receiver responds to the Trigger message and whether the CLEAR key serves as a manual trigger in remote. This check assumes that the Measuring Receiver is able to handshake, recognize its own address, make the remote/local changes, and send and receive Data messages. Before beginning this check, select 40.0 SPCL.

Description	HPL	BASIC
Send the first part of the Remote message (enabling the Measuring Receiver to remote).	rem 7	REMOTE 7
Address the Measuring Receiver to listen (completing the Remote message), then send a Data message (placing the Measuring Receiver in Hold mode).	wrt 714,"T1"	OUTPUT 714;"T1"
Send the Trigger message.	trg 7	TRIGGER 7
Address the Measuring Receiver to talk and store the data in variable V.	red 714,V	ENTER 714;V
Display the value of V.	dsp V	PRINT V
Check that both the Measuring Receiver's REMOTE and TALK annunciators are on. The controller's display should read 90000096000.00 (HP 9825A) or 90000096000 (HP 9835A and HP 9845A) or 9.00000 96E+10 (HP Series 200).		
Address the Measuring Receiver to talk and store the data in variable V.	red 714,V	ENTER 714;V
Check that the controller's "run" indicator is still on indicating that it has not received data from the Measuring Receiver. Press the Measuring Receiver's CLEAR key. The controller's "run" indicator should turn off.		

3–14. DETAILED OPERATING INSTRUCTIONS

Introduction to the Section

These Detailed Operating Instructions provide a complete operating reference for the Measuring Receiver user. As an operating reference, this section contains all relevant information regarding operating the Measuring Receiver. (If you intend to operate the Measuring Receiver remotely, the *Remote* section contains information about how the Measuring Receiver interacts with a controller.)

This section is intended to be a reference document for users who have already learned how to make basic measurements using the *HP 8902A Basic Operation and Application Guide* (part number 08902-90049) included with this documentation package. For your application, the Basic Operation and Application Guide may be all you need to make measurements. However, the Detailed Operating Instructions will enable you to use the full capabilities of the Measuring Receiver.

Section Organization

The section is organized into tabbed sections oriented toward specific measurement types. Each tabbed section contains all measurement capabilities and support functions involved in making that measurement type.

For example, the tabbed section, *Modulation*, contains all information about specific AM, FM, and ΦM measurements as well as:

- selecting an audio detector,
- selecting an audio filter,
- selecting an audio range,
- using the Modulation Output, and
- accounting for residual noise effects.

How To Find Information About a Specific Measurement

Behind most tabs is a table of contents for that tabbed section. Use this table of contents to find the Detailed Operating Instruction relevant to the measurement you are trying to make.

For example, if looking for information about making an FM measurement, find the tab "Modulation". Find the table of contents behind that tab. Then look up the Detailed Operating Instruction, *FM*. Turn to the page listed for that instruction. Within that Detailed Operating Instruction, you will find the following categories of information:

Functions lists all the Measuring Receiver functions to be discussed that pertain to FM.

Description introduces the FM measurement and any of the listed Functions.

Procedure provides specific instructions about making the FM measurement.

HP-IB lists all the Hewlett-Packard Interface Bus (HP-IB) codes relevant to making the FM measurement in remote operation.

Measurement Technique decribes the basic circuitry used to make the measurement. Sometimes, this information can provide an experienced user with a basis for adapting the Measuring Receiver to varied measurement situations.

Comments provide miscellaneous information that is not essential to the basic measurement but could be valuable to an experienced user attempting to use the Measuring Receiver in measurement situations not explicitely described in the "Procedure".

RF Power and Level Contents

BROADBAND RF POWER

RF Power 3-75
- How to measure broadband RF power.
- How to calibrate an RF power sensor (zero, calibrate, and save calibration) using the 1 mW reference.
- How to enter the power sensor's calibration factors into the instrument.

RF Power Calibration Factor Entry (HP-IB) 3-85
- How to enter the power sensor's calibration factors into the instrument using a program list in BASIC (for the the HP Series 200 computers.)

RF Level 3-89
- How to measure (uncalibrated) broadband RF power measurement without an RF power sensor.

Recorder Output 3-91
- How to use the rear-panel RECORDER OUTPUT to monitor measurements via a dc voltmeter.
- How to use the rear-panel RECORDER OUTPUT to improve the accuracy of RF power measurements.

TUNED RF LEVEL

Tuned RF Level 3-95
- How to make low-level, tuned RF power measurements.
- How to select the IF detector (synchronous or average).
- How to select the optimum IF detector averaging time.
- How to make Tuned RF Level measurements with Option 050.
- How to calibrate the tuned RF level measurement when prompted by the UNCAL and RECAL annunciators).

IF Level 3-109
- How to measure the relative ALC level of AM demodulator.

Peak Tuned RF Level 3-113
- How to measure (uncalibrated) peak, tuned RF power.

Attenuator Measurements 3-115
- How to make relative, tuned RF level measurements.

Selective Power Measurements (Option Series 030) 3-119
- How to make selective, off-channel power or noise measurements (Option Series 030).

IF Output 3-129
- How to use the rear-panel IF OUTPUT to obtain the 455 kHz or 1.5 MHz IF signal.

GENERAL LEVEL MEASUREMENT FUNCTIONS

External Attenuation 3-131
- How to obtain a direct reading of the RF level into an externally connected input attenuator.

Remote Control RF Switch 3-133
- How to use the rear-panel REMOTE CONTROL connectors to control a remote RF switch similar to the way the RF switch is controlled in the HP 11722A Sensor Module.

RF Power

FUNCTIONS

RF POWER, % CAL FACTOR, ZERO, CALIBRATE, SAVE CAL, DISPLAY FREQ, Special Function 37 (Calibration Factors:RF Power)

DESCRIPTION

The Measuring Receiver can make calibrated measurements of RF and microwave power levels when used with a power sensor or sensor module.[1] (Refer to Table 1-1, *Specifications* for a list of compatible power sensors. Note that the Measuring Receiver automatically determines the type and sensitivity of the sensor.) Absolute level accuracy and sensitivity are determined by the particular power sensor selected and the SWR of the signal source.

Calibration. Specified measurement accuracy is ensured if calibration is performed with each power sensor. Calibration consists of four steps:

1. Entering the 1 mW, 50 MHz reference calibration factor and the frequency-dependent calibration factors from the power sensor's calibration label.

   Calibration factors (cal factors) are used to compensate the external power sensor's frequency response relative to a 1 mW reference calibration made at 50 MHz using the Power Reference Oscillator. The cal factors, including a reference cal factor, are usually printed on the power sensor or sensor module.

   Cal factors can be entered and stored in an internal table (Automatic Cal Factors) in the instrument's non-volatile memory. The table is automatically accessed during RF power measurements (after the Measuring Receiver has tuned to the frequency) to correct for the non-linear frequency response of the power sensor. If no entry in the table directly corresponds to the frequency being measured, the Measuring Receiver derives a cal factor through linear interpolation using the nearest calibration points in the table (on either side of the frequency being measured). Up to sixteen frequency/calibration-factor pairs can be entered (plus the reference cal factor).

   You can enter, review, and manually alter cal factors. Also, you can manually override the selection of automatic cal factors without altering the table.
2. Zeroing the power sensor.

   The zeroing process cancels any inherent dc offset that may be present within the power sensor under zero power condition.
3. Configuring the Measuring Receiver to measure the power from the 1 mW RF power reference (the 1 mW Power Reference Oscillator).

   The internal 1 mW Power Reference Oscillator, used in RF power calibration is an extremely amplitude-stable RF power source that has been set to 1 mW (0 dBm) into 50Ω, traceable to the National Bureau of Standards (NBS). This power reference enables the Measuring Receiver to precisely determine the sensitivity of the external power sensor at 50 MHz (voltage out vs. power in).
4. Scaling subsequent power measurements to the 1 mW calibration.

   In scaling, the Measuring Receiver equates the output from the power meter to 1 mW.

[1] A sensor module contains a power sensor path and a through path for RF measurements as well as an RF switch to switch between the two paths. The Measuring Receiver controls the switching of the input signal depending on the measurement selected.

PROCEDURE

Determine Cal Factor Status. Determine the status of the calibration factors and enter new calibration factors if necessary. Connect the power sensor or sensor module to the Measuring Receiver's SENSOR input. (The power sensor cable need not be connected to the source at this time.)

1. Select RF POWER. If Error 15 is displayed, no calibration factors have been entered. Enter calibration factors as described in steps a and b below. If Error 15 is not displayed, proceed to step 4.
2. Enter the reference cal factor (the reference cal factor is the cal factor for 50 MHz; all other cal factors are relative to it):
   37.3 SPCL, reference cal factor value (printed on a label on the power sensor),
   % CAL FACTOR (Blue Key, MHz).
   Example: Enter a reference cal factor of 98.5% into the Automatic Cal Factor table.

LOCAL (keystrokes)	CODE: 3 7 . 3 — FUNCTION: SP SPCL • — CODE: 9 8 . 5 — FUNCTION: (Blue Key) • MHz % CAL FACTOR
HP-IB (program codes)	37.3 SP 98.5 CF Code — Function Function — Code

3. Enter each frequency/cal-factor pair:
   37.3 SPCL, frequency value (in MHz), cal-factor value, %CAL FACTOR (Blue Key, MHz).
   Repeat this step until all frequency/cal-factor pairs have been entered.
   - Disregard Error 15 if it is displayed during cal factor entry.
   - If an error is made during entry of any value, select CLEAR and immediately re-enter the correct value.

   Example: Enter a cal factor of 99.0% at a frequency of 1 MHz.

LOCAL (keystrokes)	CODE: 3 7 . 3 — FUNCTION: SP SPCL • — DATA: 1 — FUNCTION: MHz — DATA: 9 9 — FUNCTION: (Blue Key) • MHz % CAL FACTOR
HP-IB (program codes)	37.3 SP 1 MZ 99 CF Code — Function Function — Data Data — Function

4. Verify that the Automatic Cal-Factor table was entered correctly.
   Recall the reference cal factor and compare the value to that on the label on the power sensor:
   37.5 SPCL, % CAL FACTOR (Blue Key, MHz)
5. Recall each frequency/cal-factor pair and compare each value to its counterpart on the power sensor:
   37.6 SPCL;
   DISPLAY FREQ (Blue Key, ⇑) to display the frequency value,
   % CAL FACTOR (Blue Key, MHz) to display the cal factor value.
   Repeat this step until all frequency/cal-factor pairs have been verified.
   • Attempting to read beyond the end of the table results in Error 26.
   • To replace an existing cal-factor entry, enter the new cal factor at the frequency previously used in the entry (refer to step 1).
   • To remove an existing cal factor from the table in memory, enter 0% as the cal factor at the frequency previously used in the entry (refer to step 1).
6. To re-enter the Automatic Cal Factor mode, select AUTOMATIC OPERATION, then reselect RF POWER.

Zero the Sensor. If the instrument has just been turned on, allow at least a half-hour continuous operation. Connect the sensor between the Measuring Receiver's SENSOR input and CALIBRATION RF POWER OUTPUT.

7. Select ZERO. If a power sensor is being used (rather than a sensor module) the CALIBRATE key light must be off for proper zeroing. (A sensor module has an internal switch that will automatically switch out any input signal.) After a few seconds, 0.0 00 W is displayed, then a measurement result of near zero power is displayed.

Configure the 1 mW RF Power Reference

8. Select CALIBRATE. The instrument displays the power from the RF power reference using the last calibration scaling.

Enable Calibration Scaling

9. Select SAVE CAL (Blue Key, CALIBRATE). Read 1.000 mW. The calibration scaling stays in effect until another SAVE CAL operation is done. Select CALIBRATE again to turn off the calibrator (CALIBRATE key light off) . (If the calibrator is not turned off, the RF power measurements will not range properly.)

THE MEASURING RECEIVER IS NOW CALIBRATED.
Measure power levels by selecting RF POWER.

(Note that when calibrating the Measuring Receiver over HP-IB, use T3 settling time code between the CALIBRATE (C1) and SAVE CAL (SC) codes. For example: C1T3SC.)

Additional Recommendations:

• Re-zero the sensor frequently, especially at low power levels or when ambient conditions change.

• Whenever the source frequency is changed, either select the new frequency manually (in MHz) or select FREQ to let the instrument automatically tune to the signal, then re-enter the RF Power measurement mode. Also, if the tuned frequency moves more that ±5 kHz from the frequency at which the power sensor reference was taken, the instrument must be retuned.

• Use the table on the following page, "Summary of Special Function 37" for a quick overview of all the codes that manipulate the RF power cal factors.

Summary of Special Function 37

SPCL	Special Function Description	Comments
37.0	Selects the Automatic Cal Factor mode. This enables the Measuring Receiver to automatically select cal factors based on those entered using Special Function 37.3.	• This mode is selected upon instrument power-up and with Automatic Operation. • Can be keyed from any Measurement mode.
37.1	Selects the Manual Cal Factor Mode. This enables the user to override the automatic selection of cal factors. Procedure: To enter a manual cal factor, select: 37.1 SPCL, cal factor value, % CAL FACTOR (Blue Key, MHz)	• If no cal factor is entered, the Measuring Receiver uses the cal factor recalled last from the table as the manual entry. • The manual cal factor remains in effect when the Measuring Receiver is retuned. • The automatic cal factor table is not affected by any manual cal factor entries. • Can be keyed only after selecting RF POWER.
37.2	Displays the status of the cal factor mode (0=Automatic, 1=Manual).	• Can be keyed from any Measurement mode.
37.3	Prepares to enter a reference cal factor or a frequency/cal-factor pair into the appropriate table in memory. Procedures: To enter the reference cal factor, select: 37.3 SPCL, cal factor value, % CAL FACTOR (Blue Key, MHz). To enter each frequency/cal-factor pair, select: 37.3 SPCL, frequency value (in MHz), MHz key, cal factor value, % CAL FACTOR (Blue Key, MHz). (It's unnecessary to wait until the values are displayed before continuing with subsequent entries.) (See examples in this section.)	• If an error is made **during** entry of any value, select CLEAR and immediately re-enter the correct value. • To replace an existing cal factor entry, enter the new cal factor at the frequency previously used in the entry. The Measuring Receiver will automatically save the entry in the correct order in the table. • To remove an existing cal factor from the table in memory, enter 0% as the cal factor at the frequency previously used in the entry. • Can be keyed from any Measurement mode.
37.4	Displays the number of entries in the table.	• The number of table entries displayed also includes the reference calibration factor. • Can be keyed from any Measurement mode.
37.5	Prepares to recall the reference cal factor from the table. Procedure: To display the reference cal factor, select: 37.5 SPCL, % CAL FACTOR (Blue Key, MHz).	• This special function configures the Measuring Receiver to use manual cal factors with the reference cal factor from the table as the manual entry. To re-enter the Automatic Cal Factor mode, select AUTOMATIC OPERATION or 37.0 SPCL. • Can be keyed only after selecting RF POWER.
37.6	Prepares to recall the next frequency/cal-factor pair from the table. Procedure: To display the frequency, select: 37.6 SPCL, DISPLAY FREQ (Blue Key, kHz). To display the cal factor, select: % CAL FACTOR (Blue Key, MHz). 37.6 SPCL sequentially accesses frequency/cal-factor pairs. (See example in this section.)	• The table in memory is accessed sequentially (the lowest frequency accessed first). To access the lowest frequency in the table, select 37.5 SPCL before selecting 37.6 SPCL. • This special function configures the Measuring Receiver to use manual cal factors with the cal factor recalled last from the table as the manual entry. To re-enter the Automatic Cal Factor mode, select AUTOMATIC OPERATION, then reselect RF POWER. • An attempt to read beyond the end of the table results in Error 26.
37.9	Clears the table of cal factors from memory. To enter a manual cal factor, use 37.1 SPCL. To enter a new table of calibration factors, use 37.3 SPCL.	• Displays Error 15 if automatic cal factors were being used. • Can be keyed from any Measurement mode.

HP-IB PROGRAM CODES

% CAL FACTOR = CF	Hz = HZ	RF POWER = M4
CALIBRATE on = C1	LIN results = LN	SAVE CAL = SC
CALIBRATE off = C0	LOG results = LG	WATTS Units = WT
DISPLAY FREQ = FR	MHz = MZ	ZERO = ZR

MEASUREMENT TECHNIQUE

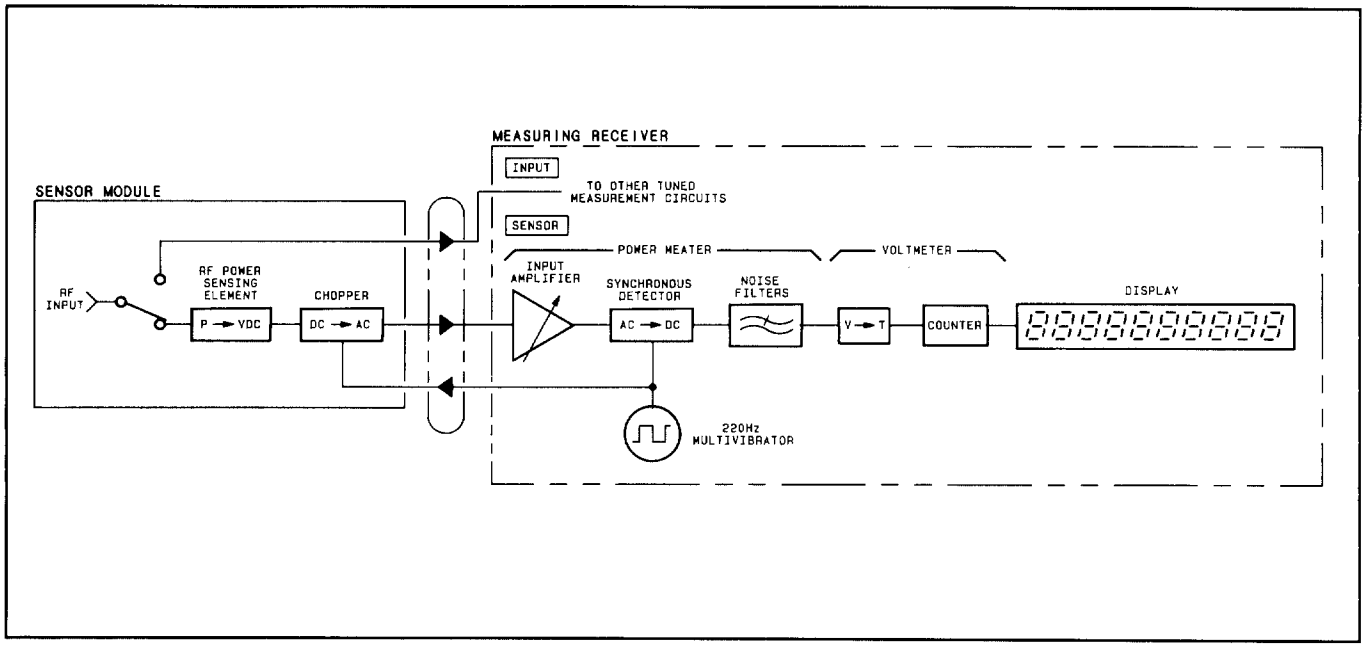
The RF Power Measurement

The power sensor produces a small dc voltage which is proportional to the power dissipated in the sensor's input load. The dc voltage is then converted to ac, amplified, and converted back to dc. The Measuring Receiver's internal dc voltmeter measures the voltage and displays the reading in terms of power.

Five ranges of amplification are used to encompass the power sensor's wide dynamic range. Special Function 10 permits manual selection of the five ranges: Range 1 (10.1 SPCL) has the most amplification (the most sensitivity), while Range 5 (10.5 SPCL) has the least amplification (the least sensitivity). The ranges are not specified in terms of absolute power because the sensor type determines the sensitivity.

The chopper in the power sensor converts the dc voltage (generated by the power sensing element) to a 220 Hz, chopped, ac signal. The ac signal is then amplified and rectified by a synchronous detector whose configuration alternates between a non-inverting and an inverting amplifier in step with the chopper. (The 220 Hz Multivibrator is the source for both chopping signals.) The result is a rechopped, dc level proportional to the dc output of the RF power sensing element of the power sensor. This chopping and rechopping method reduces the power meter's susceptibility to dc drift and noise.

The dc level from the Synchronous Detector is filtered, to reduce noise then measured by the Voltmeter. On the more sensitive ranges, filtering is increased to smooth out the large noise component on the signal and thus stabilize the displayed reading.

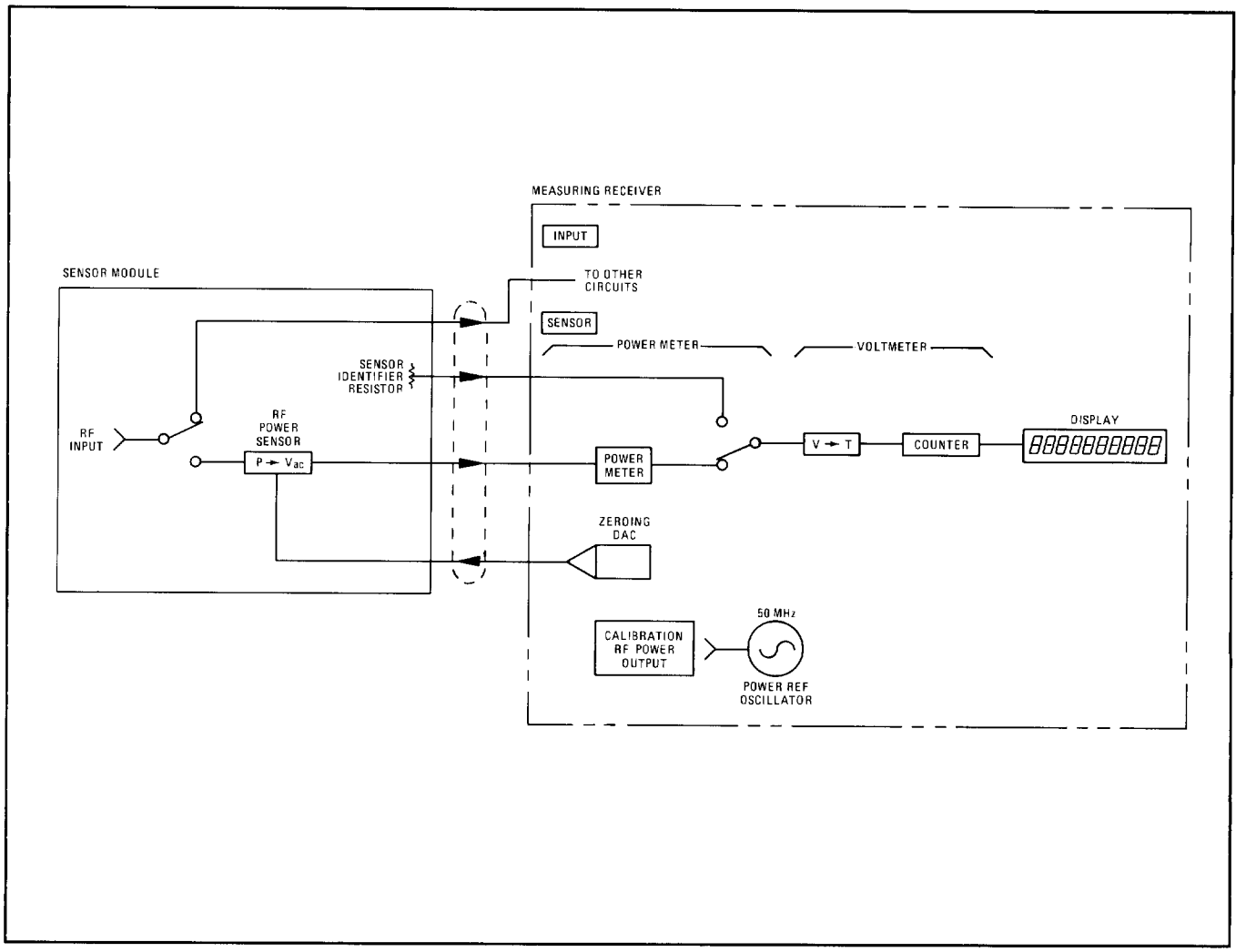


RF Power Block Diagram

RF Power Calibration

With the external power sensor properly connected to the Measuring Receiver, and the sensor's RF input connected to the CALIBRATION RF POWER OUTPUT, calibration begins by first determining the sensor type. (See the Simplified Block Diagram of RF Power Calibration.) A switch at the input of the Voltmeter connects the power sensor's resistor to the Voltmeter. The voltage across the resistor indicates, to the Measuring Receiver, the type of power sensor being used. UNCAL and RECAL annunciators are displayed if the sensor type differs from that used in a previous calibration.

When the ZERO key is pressed, the internal controller sends out a signal to the sensor module to switch out the RF input to the power sensor and directs the power meter to make a power measurement. (The Measuring Receiver assumes that 0W is at the power sensor input. If the Calibrate function is on, the 1 mW RF Power Reference stays on. If power sensor with no RF switch is connected to the calibrator output, the instrument will not zero properly.) The controller uses the zeroing digital-to-analog converter (DAC) in the power meter to output a dc voltage to cancel any dc offset that may be present at the power sensor. The zeroing process persists until the reading is zero, which may take several seconds to complete.



Simplified Block Diagram of RF Power Calibration

When CALIBRATE is selected, the power reference oscillator outputs a calibrated, 1 mW signal at 50 MHz. When SAVE CAL is selected, the controller equates the output from the power meter to 1 mW.

The calibration procedure allows the instrument to set the power-measurement transfer function so the displayed power correctly represents the actual power. This procedure can be visualized as a process that adjusts the intercept and slope of the sensor's transfer function. The ZERO key sets the zero crossing (intercept), and the SAVE CAL key sets the gain (slope). (See the following figure.) The displayed power is given by the equation:

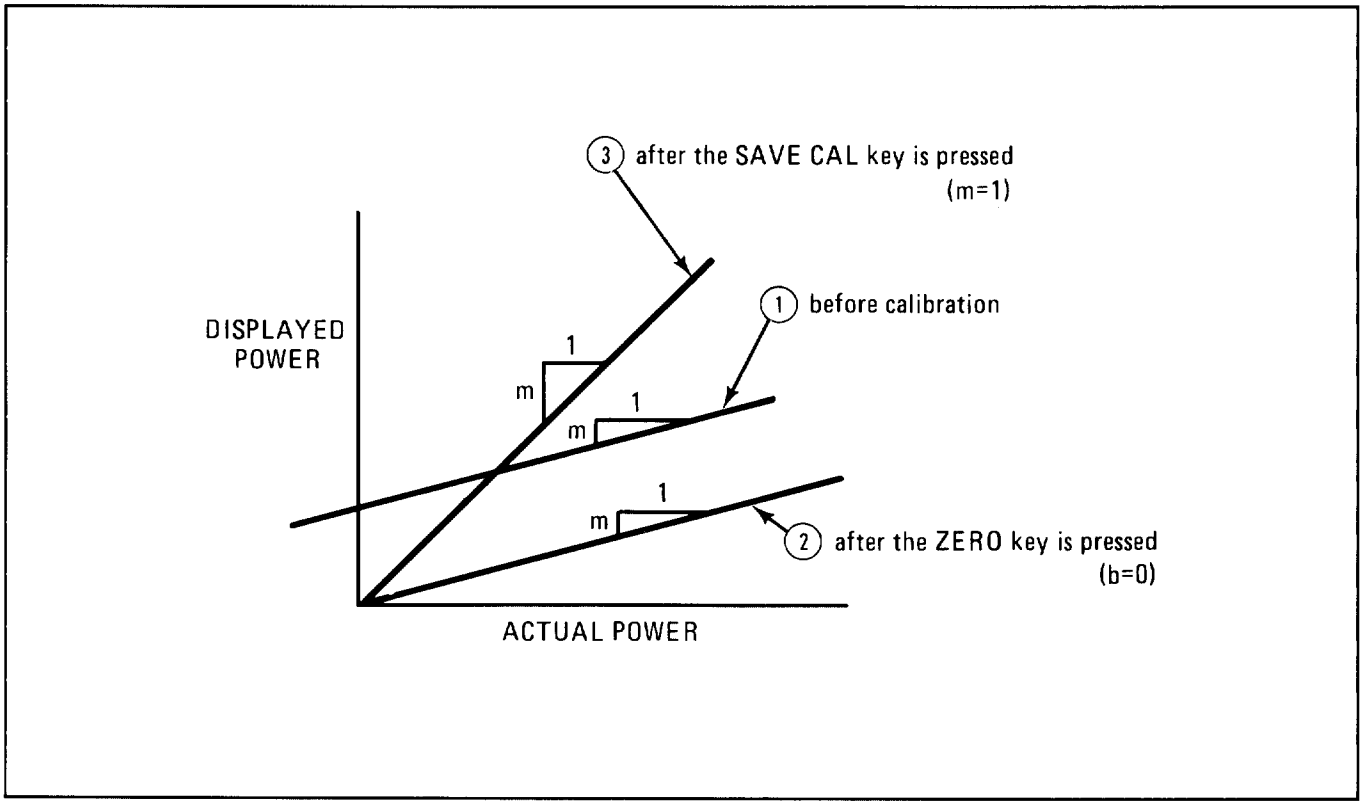
$$P_{dis} = mP_{act} + b$$

where;

P_{dis} is the Displayed Power,
P_{act} is the Actual Power,
b is the zero crossing, and
m is the slope.

The calibration routine forces $b = 0$ and $m = 1$.

The following example shows the different responses that occur during calibration:



Minor adjustments in the slope are made by the controller, based on the calibration factors, to correct for variations in the power sensor's sensitivity due to frequency and mismatch.

COMMENTS

Reasons to Recalibrate.

Any time the power-sensor type is changed (for example, from an HP 8482A to an HP 8484A), and RF POWER is selected, the Measuring Receiver displays the need for recalibration by lighting the RECAL annunciator.

Any time power sensors of the same type are exchanged (for example, from one HP 11722A to another), and RF POWER is selected, the Measuring Receiver DOES NOT recognize the need for recalibration. When in doubt about whether the calibration factors match the power sensor, use Special Function 37 to display the calibration factors as described in *Procedure step #4* in this operating instruction.

Calibration information is retained in the Measuring Receiver's non-volatile memory even when the Measuring Receiver is disconnected from its power source.

Finer Resolution for dB Measurements [2]

Special Function 32.1 enables a resolution of 0.001 dB. For audio frequency measurements, this special function enables a resolution of 0.1 Hz for frequencies from 100 to 250 kHz instead of the normally displayed resolution of 1 Hz. The selection of Special Function 32.0 or 32.1 is maintained through instrument power down.

32.0 Power is displayed with the normal measurement resolution of 0.01 dB.

32.1 Power is displayed with a measurement resolution of 0.001 dB.

32.2 Displays 0 if the normal measurement resolution is enabled (32.0 SPCL) and displays 1 if a finer resolution is enabled (32.1).

Error 15.

Error 15 is displayed until all necessary cal factor entries are made. Two calibration factors must be available for the Measuring Receiver to make RF power measurements; a reference calibration factor, and a calibration factor at the signal frequency (entered manually or derived automatically from the Automatic Calibration Factor table). Also, if RF power measurements are attempted at frequencies higher or lower than any frequency in the table, interpolation is not possible and Error 15 is displayed.

Specifications for Cal-Factor Entry

RF Frequency Range:	0-42 GHz RF Frequency
Resolution:	50 kHz
Calibration Factor Range:	40-120%
Calibration Factor Resolution:	0.1%
Maximum number of entries/table:	17 for first table, 23 for second table

[2] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

A Second Cal-Factor Table for High-Frequency Measurements.

A second table having up to 22 pairs of frequency/cal-factor pairs (plus a reference cal factor), is available for use with an external down-converter in the Frequency Offset mode. (Refer to *Frequency Offset Control* on page 3-255 for more information about this mode.)

When measuring power levels at high frequencies using a high-frequency power sensor or sensor module (such as the HP 11792A), enter the reference cal factor as an entry in the table at 50 MHz. If this frequency/cal factor pair is not entered, the instrument will not measure power at frequencies less than the lowest frequency entered in the cal factor table (2 GHz in the case of the HP 11792A).

Storing of Calibration Factor Tables.

The Store/Recall function cannot store a cal-factor table. However, to avoid re-entering tables when frequent interchanging of power sensors is necessary, either use Manual Calibration Factors, or use the second table for the second power sensor. Select 27.3 SPCL and use 0 Hz as the external, Local Oscillator (LO) value. (Refer to *Frequency Offset Control* on page 3-255 for a procedure on entering an external LO value.)

These two Automatic Calibration Factor tables are retained in the instrument's non-volatile memory for use in all subsequent RF power measurements. Every time you use the second table, you must enter the external LO value.

User-Built Sensor Module.

Any compatible power sensor can be configured as a sensor module using an external RF switch wired to the remote control connectors on the Measuring Receiver's rear panel. (Refer to *Remote Control RF Switch* on page 3-133.)

Calibration Factor Resolution.

Calibration factors have a resolution of 0.1%.

HP-IB: Interaction Between Calibration On and Zero.

C0 aborts ZR, but when ZR is timed out, C1 is not aborted.

HP-IB: Using Save Cal.

When calibrating the Measuring Receiver over HP-IB, use T3 settling time code between the Calibrate and Save Cal codes. For example:

C1T3SC

Input/Output Status.

MODULATION OUTPUT/AUDIO INPUT is disabled during RF power measurements.

Relative Measurements.

If RF power is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Frequency-Selective Level Measurements.

Use the Tuned RF Level function to make frequency-selective, absolute level measurements.

Source Impedance.

All measurement units assume a source impedance of 50Ω.

Power Measurements Alter Some Instrument States.

The instrument exits the automatic tuning mode when the RF Power function is selected. The RF, LO, and IF sections are inactive since power is being measured at the external sensor.

Reference Cal Factor Not Affected by Changing the Cal Factor Mode.

The SAVE CAL key, used in conjunction with RF Power Calibration, scales subsequent RF power measurements to the 1 mW RF Power Reference and saves the Scaling Factor in non-volatile memory. Changing the calibration factor mode does not change the reference calibration factor in use; for example, if the Measuring Receiver is calibrated from the manual cal factor mode and then the Automatic Cal Factor mode is selected, the instrument will continue to use the manually-entered reference calibration factor until another SAVE CAL operation is initiated from the Automatic Calibration Factor mode.

Manual Cal Factors

Manual Cal Factors are not frequency selective; that is, as frequency is changed, the instrument will continue to use the calibration factor entered last. To obtain accurate measurements when using Manual Cal Factors, a new calibration factor should be entered each time the frequency is changed.

The Manual Calibration Factor is not retained in the Measuring Receiver's non-volatile memory and therefore, must be re-entered after AUTOMATIC OPERATION or INSTR PRESET is selected.

RF Power Calibration Factor Entry Example Program

3–2. DESCRIPTION

The program list can be used to enter the RF power calibration factor (cal factor) table using an HP series 200 controller loaded with BASIC 3.0. (Cal factors are entered and stored in an internal table in the Measuring Receiver's non-volatile memory—refer to *RF Power*.) It might be useful to use this program to enter the cal factor table rather than entering the cal factors manually.

You may want to modify this program. For example, to increase the number of cal factors that can be entered into the table, change program lines 220, 300, and 500 to specify to 16 rather than to 10. When running this program, softkeys are set up with the following labels:

`Address`

Allows you to enter the HP-IB address of the Measuring Receiver.

`Display Table`

Displays the table of cal factors just entered. These are not necessarily the cal factors being used by the Measuring Receiver.

`Enter Table`

Enables you to enter individual cal factors into the cal factor table.

`Read Cal`

Displays the calibration factor table currently being used by the Measuring Receiver.

`Send`

Loads the calibration factor table into the Measuring Receiver that was entered with `Enter Table`.

3–3. PROCEDURE

Enter the program into an HP series 200 controller and connect the Measuring Receiver (via HP-IB) to the controller. Connect the power sensor or sensor module to the Measuring Receiver's SENSOR input. (The power sensor cable need not be connected to the source at this time.)

Follow the steps below to use the program. (Note that words that have brackets around them like this:**<RUN>**, are keys on the controller. Words in boxes like this: `Address`, are softkeys displayed on the controller's screen.)

1. Select **<Run>**.
2. Select softkey, `Address` and enter the three-digit code that comprises the controller's select code (for example, 7) and the Measuring Receiver's address (for example, 14). (Display the Measuring Receiver's address by selecting BUS ADRS—Blue Key, LOCAL—on the Measuring Receiver.) For these examples, you would type in:

7 1 4 <ENTER>

3. If you want to display the cal factors currently being used by the measuring receiver, go to step 7.
4. Enter the new frequency/cal factor pairs by selecting [Enter Table].
   a. The controller will prompt:

      "New Cal Factor for REF position cal factor?"

      Enter the reference calibration factor. For example, enter 100% as:

      1 0 0 <ENTER>

   b. The controller will prompt:

      "New Frequency for number '1' cal factor?"

      Enter the frequency (in MHz) for the first frequency/cal factor pair. For example, enter 100 kHz as:

      . 1 <ENTER>

   c. The controller will prompt:

      "New Cal Factor for number '1' frequency?"

      Enter the cal factor for the first frequency/cal factor pair, for example, enter 99.0% as:

      9 9 . 0 <ENTER>

   d. Continue entering the nine other frequency/cal factor pairs until the table is complete.

   Note that selecting **ENTER** as a response to a prompt withour specifying a value will automatically select the value currently in the table.
5. Select [Display Table] to see the cal factors that you have entered.
6. Select [Send] to put those cal factors into the cal factor table in the Measuring Receiver.
7. To display the cal factors currently used by the Measuring Receiver, select [Read Cal]. The controller will query the Measuring Receiver and then display a list of frequency/cal-factor pairs currently in the table. The cal factors are listed in the format:

50	98.9
.1	99.0
.3	97.2
1.0	99.8
3.0	99.5
10	98.7
30	99.3
100	97.9
300	98.1
1000	99.1
2600	99.7

The first column lists each frequency (in MHz) of the frequency/cal factor pair. The second column lists each cal factor (in %) of the frequency/cal factor pair. (The first frequency/cal factor pair listed is the reference cal factor that is measured at 50 MHz. This frequency cannot be changed.) To enter new frequency/cal factor pairs, go to step 4.

3-3. PROGRAM LISTING

```
10          COM /Cal_factor/ Freq(0:16),Cal(0:16),Hpib
20          DIM A$[40]
30 Relabel:CALL Clearscreen
40          PRINT
50          PRINT "Use the softkeys below to ENTER, READ, or SEND cal factors."
60          PRINT "-------------------------------------------------------------"
70          ON KEY 5 LABEL "Address" GOTO Address
80          ON KEY 6 LABEL "Display Table" GOTO Print
90          ON KEY 7 LABEL "Enter Table" GOTO Enter
100         ON KEY 8 LABEL "Read Cal" GOTO Read
110         ON KEY 9 LABEL "Send" GOTO Send
120 Idle:   DISP "Waiting for command . ."
130         GOTO Idle
140 Address:DISP "What is the 8901B/8902A HP-IB address";
150         LINPUT Hpib$
160         Hpib=VAL(Hpib$)
170         GOTO Relabel
180 Print:  CALL Clearscreen
190         PRINT
200         PRINT " CAL FACTORS"
210         PRINT "--------------------------"
220         FOR I=0 TO 10
230            PRINT Freq(I),Cal(I)      ! Print out cal factors.
240         NEXT I
250         GOTO Idle
260 Enter:  OFF KEY
270         DISP "New Cal Factor for REF position cal factor";
280         INPUT Cal(0)
290         Freq(0)=50
300         FOR I=1 TO 10
310            DISP "New Frequency for number'";I;"' cal factor";
320            INPUT Freq(I)
330            DISP "New Cal Factor for number'";I;"' frequency";
340            INPUT Cal(I)
350         NEXT I
360         GOTO Relabel
370 Read:   CALL Clearscreen
380         OUTPUT Hpib;"41.SPM4TO"       ! Set to RF POWER mode.
390         OUTPUT Hpib;"37.4SP"          ! Ask how many cal factors there are.
400         ENTER Hpib;Pairs              ! Enter the number of cal factors.
410         OUTPUT Hpib;"37.5SP CF"       ! Ask for reference cal factor-50 MHz.
420         ENTER Hpib;Cal(0)             ! Enter reference cal factor.
430         Freq(0)=50                    ! Ref cal is always 50 MHz.
440         FOR I=1 TO Pairs
450            OUTPUT Hpib;"37.6SP FR"    ! Ask for next frequency.
460            ENTER Hpib;Frequency       ! Enter next frequency.
470            Freq(I)=Frequency/1.E+6    ! Divide by 1 million to get MHz.
480            OUTPUT Hpib;"CF"           ! Ask for next cal factor
490            ENTER Hpib;Cal(I)          ! Enter next cal factor.
500         NEXT I
510         GOTO Print
520 Send:   OUTPUT Hpib;"41.SPM4TO37.9SP" ! Clears the current cal factors.
530         IMAGE "37.3SP",4D.2D,"CF"
```

```
540         OUTPUT Hpib USING 530;Cal(0)  ! Send reference cal factor.
550         FOR I=1 TO 10
560            IMAGE "37.3SP",8D.2D,"MZ",4D.2D,"CF"
570            OUTPUT Hpib USING 560;Freq(I),Cal(I)    ! sending new cal factors.
580         NEXT I
590         BEEP
600         GOTO Relabel
610         END
620   !!
630 Clearscreen:SUB Clearscreen
640   !!
650            OUTPUT 1 USING "#,@"
660            DISP
670         SUBEND
```

RF Level

FUNCTIONS

Special Function 35 (RF Level)

DESCRIPTION

The RF Level function enables the Measuring Receiver to measure and display the peak, RF power. RF level measurements are initiated with Special Function 35 or with the RF POWER key when there is no sensor at the Measuring Receiver's SENSOR input.

RF level measurements are not calibrated, so they are not as accurate as measurements made with an external power sensor as with RF Power measurements. (Refer to *RF Power* on page 3-75.)

PROCEDURE

To make a broadband RF power measurement with an RF cable connected from the signal source to RF INPUT (rather than a power sensor connection), select RF POWER.

To make the measurement with the power sensor connected, key in 35.0 SPCL.

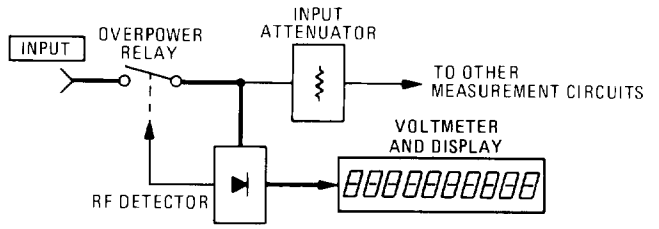
HP-IB PROGRAM CODES

LIN = LN
LOG = LG
RF POWER = M4
SPCL = SP

MEASUREMENT TECHNIQUE

The broadband RF power at RF INPUT is detected by an RF peak detector. The output of the detector is measured and displayed.

When RF Level is selected, the Measuring Receiver sets its RF input attenuation to 50 dB to minimize SWR. Any manual setting of RF input attenuation/gain (Special Function 1) is overridden.



RF Level Measurement Block Diagram

COMMENTS

Input/Output Status.

MODULATION OUTPUT/AUDIO INPUT is turned off during this measurement. However, AM OUTPUT and FM OUTPUT (rear panel) remain active but uncalibrated. The tuning of the instrument remains unchanged.

Relative Measurements.

If RF level is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Measuring RF Level on Signals with AM.

If the RF input signal has AM, the peak envelope power is measured.

Previous Input High-Pass Filter Selection.

The input high-pass filter (Special Function 3) remains inserted if previously selected.

Error 06.

The maximum allowable input level is 1W into 50Ω. Input levels greater than 1W cause the overpower relay to open and the display to show Error 06. To reset the relay, remove the input signal and select any measurement key.

Recorder Output

FUNCTIONS

Special Functions 49 and 50 (Display Internal Voltages)

CAUTION

Voltages greater than 10 Vdc applied to the RECORDER OUTPUT could cause damage to the internal circuitry.

DESCRIPTION

The RECORDER OUTPUT makes available the voltage that is being read by the instrument's internal dc voltmeter. Accuracy can be improved for some measurements by connecting to the RECORDER OUTPUT a dc voltmeter that has greater accuracy, linearity, offset, and resolution than the internal voltmeter. This procedure significantly improves the accuracy of the RF Power and Tuned RF Level measurements.

In normal operation, the internal voltmeter is constantly taking readings at various points throughout the instrument as part of its measurement process. The signal at the RECORDER OUTPUT then, is a random series of pulses of varying level. When Special Function 49 or 50 is not enabled, the RECORDER OUTPUT is useful mostly as a troubleshooting aid.

However, Special Functions 49 and 50 can set the internal voltmeter to suspend normal operation and to measure one input only. The voltmeter's input is displayed and delivered to the RECORDER OUTPUT. This feature has two general applications: data logging (for example on a stripchart recorder) and accuracy improvement.

Special Functions 49 and 50 are Service Special Functions which are documented more fully in *Section 8* of the *Service Manual*. Use the following partial list of Special Functions to "freeze" the instrument (no ranging, retuning, etc.) and deliver to the RECORDER OUTPUT a dc voltage equal to the level being read by the internal dc voltmeter:

Special Function	Measurement Voltage Displayed and Delivered to RECORDER OUTPUT
49.00 SPCL	Ground
49.01 SPCL	RF Peak Detector Ground
49.02 SPCL	RF Peak Detector (divide by 3)
49.03 SPCL	RF Peak Detector
49.04 SPCL	x10 AM Calibrator
49.05 SPCL	x1 AM Calibrator
49.06 SPCL	Audio Range Detector
49.07 SPCL	RMS-to-DC Converter
49.09 SPCL	Audio Average Detector
49.0A SPCL*	Audio Peak Detector
49.0B SPCL*	IF Average Detector
49.0D SPCL*	IF Peak Detector
49.0E SPCL*	ALC Current
49.0F SPCL*	RF Average Power**
50.06 SPCL	IF Synchronous Detector(without DC-to-RMS Converter)
50.07 SPCL	IF Synchronous Detector(with DC-to-RMS Converter)

* A is Gold Shift, 0; B is Gold Shift, 1; D is Gold Shift, 3; E is Gold Shift, 4; and F is Gold Shift, 5; "B" is displayed as "b" and "D" as "d". For HP-IB programming use "X" in place of the Gold Shift Key.

** For this Special Function, preceed with Special Function 0.212. Ignore the display after keying in Special Function 0.212.

PROCEDURE

To do analog data logging with the Measuring Receiver:

1. Connect the logging device to the RECORDER OUTPUT.
2. Select the desired measurement. Since the instrument will not be safeguarded (no ranging, retuning, error messages, etc.), be sure the instrument is set up properly for worst-case expected signal conditions.
3. Key in the appropriate special function using the preceeding table as a guide.

NOTE

The measurement unit is volts. Readings in excess of 4 are not valid. Most measurements satisfy calibration requirements since the measured voltage is directly proportional to the normal measurement display. For example, if a normal FM reading is 35.0 kHz, a RECORDER OUTPUT of 3.50, using Special Function 49.0A, corresponds to 35.0 kHz peak FM deviation.

For data logging RF power, use the following procedure.

To increase accuracy of RF Power measurements:

1. Connect an accurate dc voltmeter to the RECORDER OUTPUT. The voltmeter should have at least a 1 MΩ input impedance. Let the instruments warm up for at least one-half hour.
2. Connect a compatible power sensor or sensor module to the SENSOR input. Connect the power sensor's input to the CALIBRATION RF POWER OUTPUT.
3. Select RF POWER, then ZERO. Wait for the ZERO key light to go out.

4. Key in the following Special Functions in order and record the external dc voltmeter readings. (The "S" in the Special Function code is the Gold Shift key. After keying in S 5, an "F" is displayed.)

Special Function	Variable Name	Voltmeter Reading in V
10.3, 0.212, 49.0 S 5	$Vz3, Vz4, Vz5$	_____
10.2, 0.212, 49.0 S 5	$Vz2$	_____
10.1, 0.212, 49.0 S 5	$Vz1$	_____

NOTE

For best accuracy on the most sensitive range (range 1), the zero offset voltage (Vz1) should be averaged for many voltmeter measurement cycles. This is most easily done via a programmable voltmeter under HP-IB control.

5. Key in 10.0 SPCL then CALIBRATE. Key in 49.0, S, 5, SPCL. Record the voltmeter reading (Vc). Select SAVE CAL (Blue Key and CALIBRATE key) to calibrate the Measuring Receiver's display. The display should read 1 mW.

$Vc =$ _____V

6. Select SPCL twice. Record the least-significant digit (the tenth digit) on the display (Rc). (This digit indicates the RF Power range for the calibration.)

$Rc =$ _____

7. Select AUTOMATIC OPERATION. Select CALIBRATE to turn off the Recorder Output Mode.

8. Connect the signal source to the power sensor's input. Allow the Measuring Receiver to make a normal RF power measurement.

9. Key in 0.212 SPCL. Key in 49.0 S 5 and record the voltmeter reading (Vp).

$Vp =$ _____V

10. Select SPCL twice. Record the least-significant digit (the tenth digit) on the display (Rp). (This digit indicates the RF Power range.)

$Rp =$ _____

11. Compute the RF power (P, in mW) from the following formula:

$$P = \frac{CFc}{CFp} \times \frac{Vp - VzRp}{Vc - VzRp} \times 10(Rp - Rc)$$

where

CFc is the reference (50 MHz) calibration factor from the chart on the power sensor;

CFp is the calibration factor at the signal frequency from the chart on the power sensor;

$VzRc$ is the voltage from step 4 for range Rc;

$VzRp$ is the voltage from step 4 for range Rp.

12. Begin subsequent RF power measurements at step 2 as long as the results of step 4 exhibit drift; otherwise, begin at step 9.

COMMENTS

For further details on Special Functions 49 and 50, refer to Service Special Functions in *Section 8*.

Internal Voltmeter Offset.

The RF power circuits do not zero to 0V. Instead they "zero" to between 0.5V and 0.8V which permits the internal dc voltmeter to operate over its most linear range. The internal controller subtracts this offset from subsequent power readings.

Tuned RF Level

FUNCTIONS

Synchronous and Average TUNED RF LEVEL, CALIBRATE, SET REF, Special Functions 38 and 39 (Display and Enter Tuned RF Level Calibration Factors), Special Function 4 (Tuned RF Level Selection and Display Averaging)

DESCRIPTION

The Measuring Receiver can accurately measure the absolute or relative level of extremely low-level, continuous wave (CW), RF signals. At each measurement frequency, the instrument must be calibrated to correct for frequency-dependent measurement variations. Calibration over the full dynamic range requires calibration at three different levels. The calibration remains valid for any CW signal at that frequency ±5% (or ±10 MHz, whichever is smaller).

Requirements for the Tuned RF Level Measurement

Before an absolute Tuned RF Level measurement can be made, the following 3 requirements must be met. Before a relative Tuned RF Level measurement can be made, only requirements 2 and 3 must be met (since no power sensor is used during relative measurements):

1. The RF Power measurement must be calibrated.

   The accuracy of the Tuned RF Level measurement depends on a calibrated RF Power measurement made with an external power sensor. (RF Power calibration is discussed in detail in *RF Power* on page 3-75.)

2. The Measuring Receiver must be properly tuned.

   The Measuring Receiver can be tuned manually or automatically. When manually tuning, enter a frequency value into the Measuring Receiver within ±2.5 kHz for frequencies ≤2.5 MHz, within ±2 kHz for frequencies between 2.5 MHz and 10 MHz, and within ±50 kHz for frequencies ≥10 MHz. When automatically tuning, select FREQ and ensure that the initial input signal level is greater than −20 dBm. (*RF Frequency Tuning* on page 3-141 has more details on the different types of tuning available.)

3. The Tuned RF Level calibration factors for the frequency being measured must be in place.

   To calibrate the Tuned RF Level measurement (and allow the Measuring Receiver to create calibration factors), step the input signal down and select the CALIBRATE key (while keeping the signal level constant) each time RECAL is displayed. Each time the CALIBRATE key is pressed, the Measuring Receiver creates a calibration factor from a comparison of the two measured levels.

   Up to three calibration factors will be created. These three Tuned RF Level calibration factors remain valid regardless of power level as long as the signal frequency is the same.

   Each individual calibration factor is tagged with the frequency at which it is valid, and the status of the first three filters in the front of the instrument (Special Function 3 and Special Functions 1.0 and 1.9). If any of these conditions change, the calibration factor becomes invalid.

   The Tuned RF Level measurement must be recalibrated if the frequency is changed.

   Tuned RF Level calibration can be performed during the actual measurement. Tuned RF Level calibration factors can be entered (using the Store/Recall function or Special Functions 38 and 39) if you have measured that frequency before.

Sensitivity vs. Selectivity; Special Function 4

Tuned RF level measurements can be made with one of two internal detectors: a narrow-band, tracking IF synchronous detector (4.0 SPCL) or a wider-band IF average detector (4.4 SPCL). The IF synchronous detector is more sensitive (it measures to −127 dBm) than the average detector (it measures to −113 dBm). Although the IF synchronous detector can track a drifting input signal over a ±5 kHz range, it is less tolerant of signal drift and residual FM than the IF average detector. When measuring noisy signals, use the IF average detector (4.4 SPCL). The IF synchronous detector (4.0 SPCL) is automatically selected on power-up.

If the signal drifts too much even for the IF average detector, use track mode tuning with this detector (not available with the IF synchronous detector). Refer to *Comments*, "Special Function 32.9; Tuned RF Level Measurements Using Track Mode Tuning" on page 3-105.

Storing Calibration Factors for the Tuned RF Level Measurement

Calibration at every frequency of interest is time consuming. So, when making repetitive Tuned RF Level measurements at many different frequencies, use the Store/Recall function to recall the calibration factor for each frequency of interest. Eight storage registers are available. If more than eight frequencies are to be measured, use Special Functions 38 and 39 to display and enter the calibration factors for each frequency of interest. A procedure below explains how to use these special functions.

PROCEDURE

The following procedures are provided in this *Procedure* section:

1. Calibration for Absolute Measurements
   a. Using a Sensor Module[3]: Calibrating a Tuned RF Level Measurement.
   b. Using a Power Sensor: Calibrating a Tuned RF Level Measurement.
2. Calibration for Relative Measurements.
3. Using Special Function 4 To Select the IF Detector.
4. Using Special Functions 38 and 39 to Display and Enter Tuned RF Level Calibration Factors.
   a. Special Function 38; Display Tuned RF Level Calibration Factors.
   b. Special Function 39; Enter Tuned RF Level Calibration Factors.
   c. Considerations When Using Special Functions 38.

CALIBRATION FOR ABSOLUTE MEASUREMENTS

Before attempting one of these procedures, be sure that 1) the RF Power measurement is calibrated, 2) the input signal is within the range required by the power sensor but not greater than 0 dBm (for example, 0 to −20 dBm for the HP 11722A), and 3) the Measuring Receiver is properly tuned. The following procedures enable the Measuring Receiver to obtain its calibration factors for the frequency being measured.

Two procedures are provided. If a sensor module is used, use the first procedure. If a power sensor only is used, use the second procedure.

[3] A sensor module contains a power sensor path and a through path for RF measurements as well as an RF switch to switch between the two paths. The Measuring Receiver controls the switching of the input signal depending on the measurement selected. Examples of sensor modules are the HP 11722A and the HP 11792A.

Using a Sensor Module: Calibrating a Tuned RF Level Measurement

1. Select INSTR PRESET (Blue Key, AUTOMATIC OPERATION). (Since the Frequency measurement is automatically selected with INSTR PRESET, the instrument tunes to the signal at this time.)
2. Connect the sensor module to the RF source. The signal level should be greater than −20 dBm.
3. If the measurement can be made and the display is stable, go to the next step. (You will be using the IF synchronous detector.) If the input signal is noisy or has display jitter, select 4.4 SPCL. (You will be using the IF average detector.) The Measuring Receiver will not be able to make a measurement on a signal that has too much noise.
4. Select TUNED RF LEVEL (S, RF POWER); wait for the measurement result to be displayed. Observe the RECAL annunciator in the display. (If RECALI is not displayed and the sensor module has not been changed since the last calibration, go to step 7.)
5. the LOG/LIN key enables the Measuring Receiver to display the result in either logarithmic or linear units. If desired, select LOG/LIN to change the displayed units.
6. Do not change the input signal while pressing the CALIBRATE key to enable the Measuring Receiver to create a calibration factor for the first range. Wait for the CALIBRATE light to go out before stepping the input signal further.
7. Tuned RF level measurements can now be made, but as the signal level is stepped down its full range, the RECAL annunciator will be displayed up to two more times when recalibration is required. (When the RECAL annunciator lights, do not change the source level.) Select CALIBRATE. Then wait until the light in the CALIBRATE key goes out before stepping the input signal further. Selecting the CALIBRATE key enables the Measuring Receiver to create a second and thired calibration factor.

   (If the RECAL annunciator is no longer displayed, but the UNCAL annunciator is displayed, re-adjust the source level until the RECAL annunciator lights, then select CALIBRATE.)

Using a Power Sensor: Calibrating a Tuned RF Level Measurement

1. Select INSTR PRESET (Blue Key, AUTOMATIC OPERATION).
2. Connect a power sensor between the output of the RF source and the SENSOR input of the Measuring Receiver. Input a signal with an amplitude value within the range of the power sensor.
3. Manually tune the Measuring Reveiver by entering the frequency of the RF source into the Measuring Receiver. The display should read "– –".
4. Select AUTO TUNING (Blue Key, TRACK MODE). The display will again read "– –".
5. Selcet TUNED RF LEVEL (S, RF POWER). Wait for a display of "– –".
6. Select CALIBRATE. Again wait for the "– –".
7. Disconnect the power sensor from the signal source. Connect the signal source to the Measuring Receiver's RF INPUT. Wait for the CALIBRATE key to go out and a valid measurement result to be displayed.
8. If the measurement can be made and the display is stable, go to the next step. (You will be using the IF synchronous detector.) If the input signal is noisy or has display jitter, select 4.4 SPCL. (You will be using the IF average detector.) The Measuring Receiver will not be able to make a measurement on a signal that has too much noise.

NOTE

If a valid measurement result is not displayed, manually tune the Measuring Receiver again by entering the frequency of the RF source into the Measuring Receiver. If manually tuning the signal does not display a valid measurement result, start the procedure from the beginning.

9. The LOG/LIN key enables the Measuring Receiver to display the result in either logarithmic or linear units. If desired, select LOG/LIN to change the displayed units.
10. Tuned RF level measurements can now be made, but as the signal level is stepped down its full range, the RECAL annunciator will be displayed up to two more times when recalibration is required. When the RECAL annunciator lights, hold the source level steady, select CALIBRATE, and wait until the light in the CALIBRATE key goes out. Selecting the CALIBRATE key enables the Measuring Receiver to create a second and third calibration factor.

    (If the RECAL annunciator is no longer displayed, but the UNCAL annunciator is displayed, re-adjust the source level until the RECAL annunciator lights, then select CALIBRATE.)

CALIBRATION FOR RELATIVE MEASUREMENTS [4]

Even though no power sensor is used, the Measuring Receiver still makes a reference measurement (the value you set to be 0 dB) and calibrates subsequent ranges to that value. Use the following procedure for relative Tuned RF Level measurements:

1. Select INSTR PRESET (Blue Key, AUTOMATIC OPERATION). (Since the Frequency measurement is automatically selected with INSTR PRESET, the instrument tunes to the signal at this time.)
2. Connect an RF cable between the output of the RF source and the RF INPUT of the Measuring Receiver. The signal level should be greater than −20 dBm.
3. If the input signal is stable, go to the next step. (You will be using the IF synchronous detector.) If the input signal is noisy or has display jitter, select 4.4 SPCL. (You will be using the IF average detector.)
4. Select TUNED RF LEVEL (S, RF POWER); wait for the uncalibrated display.
5. Tuned RF level measurements can now be made, but as the signal level is stepped down its full range, the RECAL annunciator will be displayed up to two more times when recalibration is required. When the RECAL annunciator lights, hold the source level steady, select CALIBRATE, and wait until the light in the CALIBRATE key goes out. Selecting the CALIBRATE key enables the Measuring Receiver to create a second and third calibration factor.

    (If the RECAL annunciator is no longer displayed, but the UNCAL annunciator is displayed, re-adjust the source level until the RECAL annunciator lights, then select CALIBRATE.)
6. Set the RF level of the source to the level that is to be used as a reference. (Select the LOG/LIN key to change the display to the preferred display of % or dB.)
7. Select SET REF (Blue Key, ZERO). The display should read approximately 100% or 0 dB. Subsequent measurements will be made relative to this level.

[4] More information about relative Tuned RF Level measurements can be found in *Attenuator Measurements*.

USING SPECIAL FUNCTION 4 TO SELECT THE IF DETECTOR

Special Functions 4.0 through 4.3 select the IF synchronous detector. Special Functions 4.4 through 4.7 the IF average detector.

Special Functions 4.1 through 4.3 and 4.5 through 4.7 enable manual selection of the measurement display averaging time for each detector. The Measuring Receiver automatically selects these if Special Function 4.0 or 4.4 is selected. It is usually unnecessary to manually select these times. (Refer to *Comments*,"Special Function 4 Also Controls Selection of Measurement Display Averaging".)

To select the IF synchronous detector, select 4.0 SPCL. (This detector is selected on power-up or after INSTRUMENT PRESET or AUTOMATIC OPERATION is selected.)

To select the IF average detector, select 4.4 SPCL.

To manually select the display averaging time refer to *Comments*, "Special Function 4 Also Controls Selection of Measurement Display Averaging".

MAKING TUNED RF LEVEL MEASUREMENTS WITH OPTION 050

Instruments equipped with Option 050, Increased Power Measurement Accuracy, provide tuned RF level measurement accuracy of ±0.012 dB ±0.005 dB per 10 dB for absolute power measurements, and ±0.014 dB ±0.005 dB per 10 dB step for relative power measurements. These instruments have been calibrated to −120 dBm in compliance with MIL-STD-45662 using calibration standards traceable to the National Bureau of Standards.

Requirements for Option 050 Measurements. The accuracy specifications provided by Option 050 are warranted when using an HP synthesized signal source with less than 100 Hz peak residual FM measured in a 3 kHz post-detection bandwidth over a 30 second period. This allows the HP 8902A to use its narrow band IF synchronous detector.

Procedure for Making Option 050 Measurements.

1. Select Special Function 32.1 to increase the HP 8902A's display resolution to 0.001.
2. Select Special Function 4.1 to increase the averaging time to 10 seconds. (The increased averaging minimizes any digit flicker.)
3. Adjust the source level to between −10 dBm and 0 dBm for absolute measurements, or set the reference within ±0.003 dB for relative power measurements.
4. Perform the calibration procedures described in this section for the type of Tuned RF Level measurement you wish to make (absolute or relative).

Condiderations When Making Option 050 Measurements

Making Relative Level Measurements. The closer the reference source level is set to 0 dBm when performing the initial tuned RF level calibration the greater your calibration certainty will be when starting your relative measurements.

To achieve the greatest resolution, adjust the source level to the top of the IF synchronous detector's range. To do this, select the Tuned RF Level measurement and then key in Special Function 50.05 (or 48.0). The HP 8902A will display the rms voltage level at the detector. Increase the voltage level to approximately 3 Vrms to optimize measurement resolution.

Residual Noise Level. The residual noise level of the HP 8902A increases in its lowest tuned RF level range.

Minimizing Mismatch Uncertainty. The accuracy specifications for Option 050 do not include mismatch uncertainty. A 10 dB pad positioned at the HP 8902A's input and a 10 dB pad at the source's output can help minimize mismatch uncertainty. Also, using well shielded cables can help reduce leakage.

USING SPECIAL FUNCTIONS 38 AND 39 TO DISPLAY AND ENTER TUNED RF LEVEL CALIBRATION FACTORS

These functions are especially useful in remote operation when making repetitive Tuned RF Level measurements at many different frequencies. After a measurement is calibrated, you can display the calibration factors for that frequency using Special Function 38. These values can then be re-entered using Special Function 39. When operating the instrument remotely, measurement time is decreased when it is not necessary to perform calibration. (Note: if the number of test frequencies is less than or equal to eight, consider using the Store/Recall function.)

To display and then re-use Tuned RF Level calibration factors, perform calibration at the frequency of interest; read the calibration factors using Special Function 38 (and record the values somewhere; for example, in a test program).

Then re-enter the calibration factors using Special Function 39 before making measurements at that frequency. (Before using Special Function 39 , ensure that the instrument is tuned to the same frequency as calibrated at before.)

Special Function 38; Display Tuned RF Level Calibration Factors.

38.1 Display the calibration factor for Range #1.

38.2 Display the calibration factor for Range #2.

38.3 Display the calibration factor for Range #3.

38.4[5] Display the SET REF reference calibration value. (This value is displayed with a maximum of eight digits and a resolution of 0.01%.)

To display Tuned RF Level calibration factors:

a. Select the TUNED RF LEVEL mode.

b. Perform calibration for either absolute of relative Tuned RF Level measurements as described in the previous paragraphs.

c. Select 38.N SPCL (where N is the desired suffix)

d. Select % CAL FACTOR (Blue Key, MHz).

e. Record the displayed value.

[5] This special function is not available with firmware date codes 234.1985 and below (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

Special Function 39; Enter Tuned RF Level Calibration Factors.

39.1 Enter the calibration factor for Range #1.

39.2 Enter the calibration factor for Range #2.

39.3 Enter the calibration factor for Range #3.

39.4[6] Enter the SET REF calbration reference vale.

39.9 Clear all calibration factors.

To enter Tuned RF Level calibration factors:

a. Select the TUNED RF LEVEL mode.

b. Select 39.N SPCL (when N is the desired suffix). The input signal level will be displayed.

c. Key in the desired calibration factor value (for example, 120).

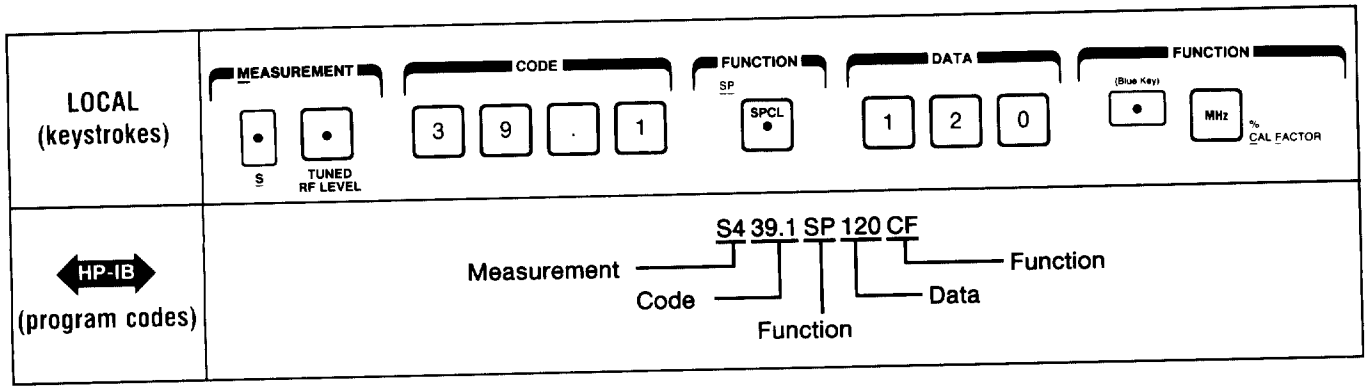
d. Select % CAL FACTOR (Blue key, MHz).

Considerations When Using Special Functions 38 and 39.

- Since different Tuned RF Level calibration factors are created depending on the IF detector being used (4.0 SPCL or 4.4 SPCL), the first calibration factor (38.1 SPCL) should be reselected when re-entering the first calibration factor (391 SPCL). The second and third calibration factors do not depend on the IF detector being used. (for more information about this consideration, refer to *Comments*, "4.0 SPCL, 4.4 SPCL, and SET REF affect the First Calibration")
- The state of Special Function 3 must remain the same when re-entering Tuned RF Level calibration factors.
- The state of Special Function 1.0 or 1.9 must remain the same when re-entering Tuned RF Levelcalibration factors.

EXAMPLE

To enter a Tuned RF Level Calibration Factor of 120 % for the RF power range 1:



[6] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

HP-IB PROGRAM CODES

CALIBRATE on = C1
CALIBRATE off = C0
% CAL FACTOR = CF
LIN results = LN
LOG results = LG
TUNED RF LEVEL = S4

VOLTS units = VL
mV units = MV
μV units = UV
WATTS units = WT

INDICATIONS

During routine measurement:

When TUNED RF LEVEL is selected, the following responses are displayed: four dashes (– – – –) to indicate the signal has been found, then six dashes (– – – – – –) to indicate the instrument is fine tuning to the signal, then four again (– – – –) to indicate settling. If two dashes (– –) are displayed, no signal can be found.

Six dashes (– – – – – –) will not be displayed if the Average Tuned RF Level measurement is selected.

MEASUREMENT TECHNIQUE

The tuned RF level measurements use an IF substitution technique to attain high measurement accuracy over a wide range of signal levels. The basic measurement technique is discussed in Tuned RF Level. The discussion that follows focuses on calibration details.

Power Calibration

An initial absolute power level calibration is made by applying a signal to the Measuring Receiver via a calibrated power sensor. The signal must be within both the sensor's and Measuring Receiver's power and frequency range. (Power should not exceed 0 dBm.) An initial relative power level calibration is made by applying a signal to the Measuring Receiver's RF INPUT and selecting SET REF.

The absolute power is first measured with the calibrated power sensor. The signal is then routed to the RF INPUT connector of the instrument where the level is measured by the IF detector. (If using a sensor module with an internal switch, such as the HP 11722A, the switching is automatic. If using a power sensor alone, the signal source must be reconnected to the instrument's RF INPUT connector.) The signal level must be held steady during calibration.

The first time the CALIBRATE key is selected, the Measuring Receiver compares the level read by the Tuned RF Level IF detector to the reference level. The ratio of the two measurements is stored as a calibration factor. (The reference level for absolute measurements is the RF Power measurement, the reference level for relative measurements is the set by the user with the SET REF key.)

The calibration factors are used to compensate for the non-linearity of the RF input gain steps (Special Function 1).

RF Input Ranging Calibration

As the power level of the input signal is varied, the IF amplifier gain is stepped to keep the IF level within the linear range of the IF detector. When the IF level approaches the lower limit of the IF range, the RF input attenuation is reduced to nominally 10 dB. The IF gain then compensates for the change in RF input attenuation.

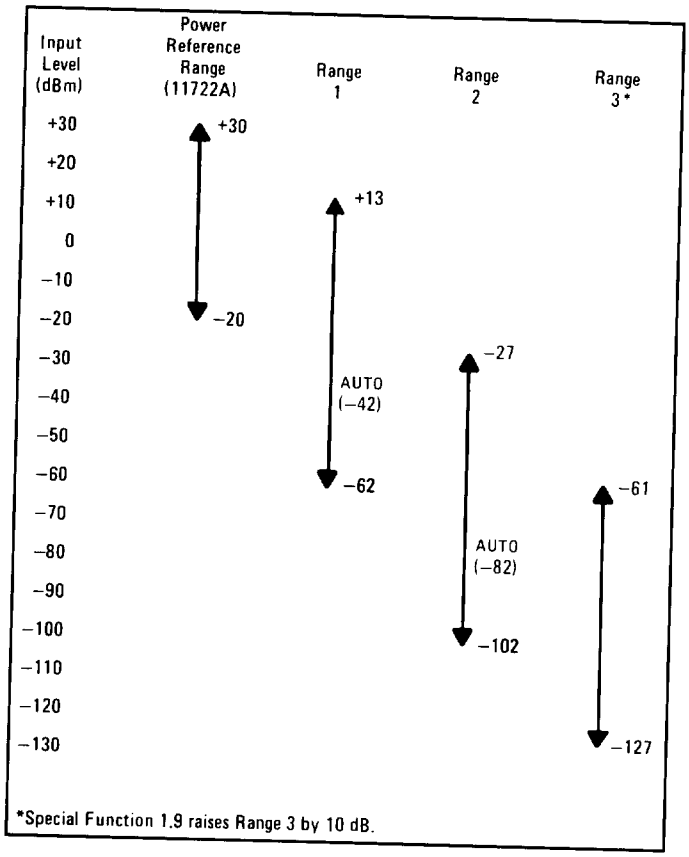
The Calibrate function enables the Measuring Receiver to create a second calibration factor by equating the power level measured before the RF range change with the power level after the change. (The input signal level must not change during this recalibration.) This new calibration

factor is multiplied by the calibration factor made previously (with the reference) to be used in all subsequent measurements for that RF range and frequency.

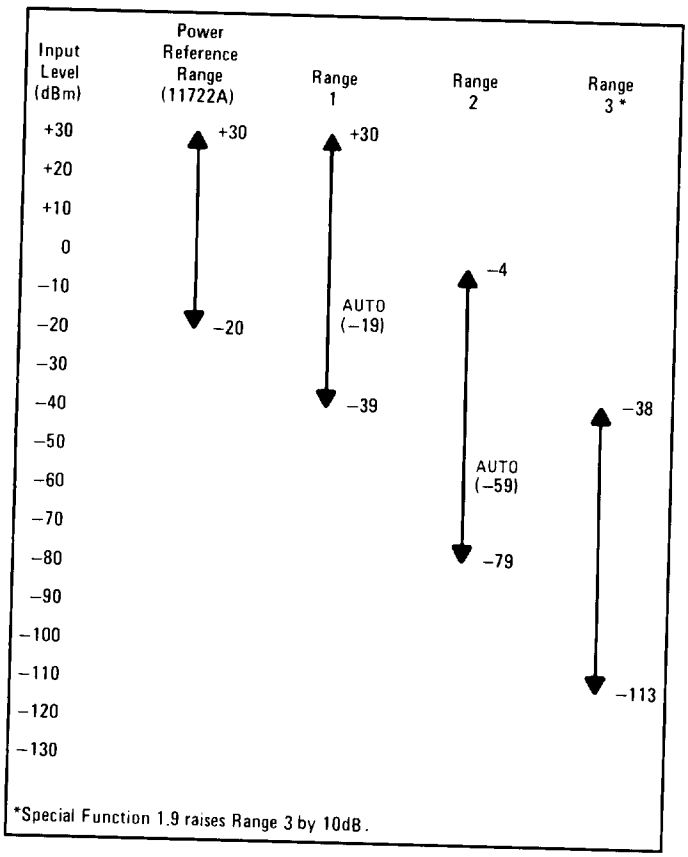
A third recalibration is required if the input signal level approaches the lower limit of the IF detector in the second IF range. This time, RF input gain (24 dB) is added and IF gain is reduced and a third calibration factor is created for that RF range and frequency. The three calibration factors remain in effect as long as the frequency of the input signal is within ±5% of the initial frequency.

Calibration Limitations

The approximate limits of the three RF ranges for both the IF synchronous and average detectors are shown in the following graphs. The ranging points used in Automatic Operation are also indicated. (The range can be held manually. Refer to *Range Hold* on page 3-243.) The range limits listed for the Power Reference Range apply only for power sensors with the same sensitivity as the HP 11722A Sensor Module. Other sensors might shift the Power Reference Range up or down (but 0 dBm is the overall maximum level).



Synchronous Tuned RF Level Ranges



Average Tuned RF Level Ranges

The absolute power refererence for many power sensors may overlap ranges other than the top range, it is possible to make the initial calibration against the power sensor on Range 2 or 3 (or even in the overlap region of two ranges) instead of Range 1.

IF Detectors and Filters After the IF signal has been detected, the dc output from the detector is filtered and read by the internal voltmeter. Filtering combines a 10 Hz, low-pass filter in hardware

with digital averaging of successive voltmeter readings in software. Measurements can be averaged for 0.1, 1, and 10s. The equivalent noise bandwidths are 10, 1, and 0.1 Hz respectively. The 10 Hz low-pass filter is always in.

A narrow 455 kHz IF bandpass filter (30 kHz passband) improves sensitivity to enable the instrument to measure low-level signals (where the signal-to-noise ratio is very poor). This filter primarily determines the frequency response for the 455 kHz IF and is bypassed when not needed.

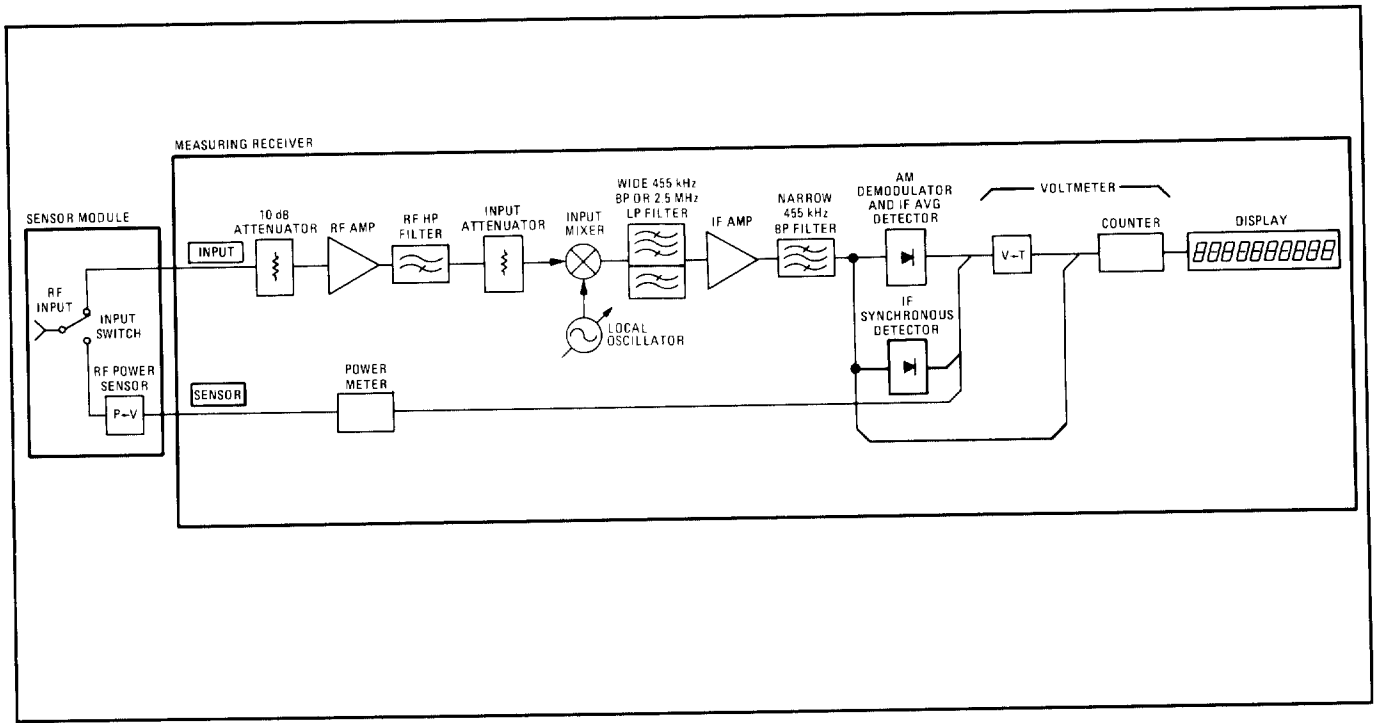
Measurement sensitivity is further improved by the IF synchronous detector which locks onto and tracks the IF signal. Tracking is maintained over a 10 kHz range. Phase locking, coupled with the synchronous detection technique, reduces the measurement bandwidth to 150 Hz—giving a corresponding increase in sensitivity.

The phase lock loop locks a 455 kHz voltage-controlled oscillator (VCO, not shown in the block diagram) to the IF signal. The locked VCO then becomes the synchronized drive to the detector. As the IF signal drifts, the VCO drifts with it to maintain synchronism.

The instrument's controller monitors the detector output to determine if lock has been acquired. If no signal is sensed, the controller initiates a search routine that sweeps the VCO over the IF bandwidth. During this search, six dashes (– – – – – –) are displayed. If four dashes (– – – –) are displayed after the search, the signal has been found. If two dashes (– –) are displayed, no signal has been found. The sweep can take up to 20s.

Tuned RF Level measurements made with the IF average detector are similar to those made with the IF synchronous detector except that the AM detector, operating with its ALC loop open, is used to measure the IF level. (Refer to *AM* on page 3-162 for the block diagram.) The IF average detector does not phase lock to the signal as the IF synchronous detector does, so the measurement bandwidth is much wider and enables measurement of less pure signals.

The wide 455 kHz bandpass filter (200 kHz passband) primarily determines the frequency response for the 455 kHz IF.



Tuned RF Level Simplified Block Diagram

Calibration Factors

An individual calibration factor is computed for each RF range-to-range change by comparing the level measured during the initial power sensor calibration to the level measured for each RF range. This individual level measurements are ratioed to determine the relative, range-to-range calibration factors actually used in tuned RF level measurements. Display the individual calibration factors with Special Function 38. Display the ratioed calibration factors with the % CAL FACTOR key.

The following table describes the equations used to calculate the ratioed calibration factors using individual calibration factors.

In this table, the Power Reference Range is the range used for initial calibration to the power sensor, and CF_1, CF_2, and CF_3 are the "individual" calibration factor values for the range reference to 1, to 2, or 3 (respectively)

Power Reference Range	Current Range		
	1	2	3
1	CF_1	CF_1CF_2	$CF_1CF_2CF_3$
2	$\frac{CF_2}{CF_1}$	CF_2	CF_2CF_3
3	$\frac{\frac{CF_3}{CF_2}}{CF_1}$	$\frac{CF_3}{CF_2}$	CF_3

Only four calibration factors are retained in the instrument's non-volatile memory. Separate calibration factors are maintained for the Power Reference Range of both the IF synchronous and IF average detectors; the calibration factors for subsequent ranges are shared by both detectors.

If no actual calibration factors are available, an approximate calibration factor (accurate within a few dB) is derived.

COMMENTS

If the Tuned RF Level Calibration Is Not Possible.

If the Measuring Receiver is not making the measurement, it is probably because calibration is not possible. Following the guidelines below may enable the Measuring Receiver to complete a Tuned RF Level measurement:

- Change the level of the input signal until only the RECAL annunciator is displayed.
- Calibrate the power sensor. (Refer to *RF Power* on page 3-75.)
- Change the IF Gain to automatic selection (9.0 SPCL).
- Change the RF Input Attenuation and Gain to automatic selection (1.0 or 1.9 SPCL).
- Ensure that the input-signal level does not change when the CALIBRATE key is pressed.

Recovering from Mistakes in Entering Calibration Factor Values.

If an error is made in entering any calibration factor value with Special Function 39, selecting CLEAR allows the user to immediately re-entering the Special Function Code.

Calibration Factors Valid for a Frequency Change of ±5% or ±5 MHz When Track-Mode Tuning Is Not Used.

The calibration factors obtained during calibration are valid and are used by the instrument as long as the signal frequency remains within ±5% of the frequency of the signal at calibration (or ±5 MHz, whichever frequency is less). However, because of tuning limitations, a frequency change of ±5 MHz necessitates retuning, but the previous calibration factors will be retained unless the the ±5% or ±5 MHz limit has been exceeded.

Finer Resolution for dB Measurements [7]

Special Function 32.1 enables a resolution of 0.001 dB. (For audio frequency measurements, this special function also enables a resolution of 0.1 Hz for frequencies for 100 to 250 kHz instead of the normally displayed resolution of 1 Hz.) The selection of Special Function 32.0 or 32.1 is maintained through instrument power down.

32.0 Power is displayed with the normal measurement resolution of 0.01 dB.

32.1 Power is displayed with a measurement resolution of 0.001 dB.

32.2 Displays 0 if the normal measurement resolution is enabled (32.0 SPCL) and displays 1 if a finer resolution is enabled (32.1)

Special Function 32.9; Tuned RF Level Measurements Using Track-Mode Tuning. [8] Use this special function when making level measurements on low-level signals (greater than 40 MHz into the HP 8902A) that tend to drift. The track mode tuning is available only with the IF average detector (Special Functions 4.4 through 4.7) which can measure levels to -110 dBm. (Note that Special Functions 32.1 and 32.9 can be enabled simultaneously.)

To select track-mode tuning for a low-level Tuned RF Level measurement:

a. Instrument Preset the HP 8902A (blue key, green key).

b. If using a down converter to measure microwave signals, key in 27.3 SPCL. Key in the external L.O. frequency. Make sure that the L.O. frequency results in an IF frequency to the HP 8902A of greater than 40 MHz when mixed with the RF signal.

c. Set the RF signal to a level greater than -10 dBm.

d. Allow the HP 8902A to tune to the signal. (Wait for a frequency display.)

e. Select 32.9 SPCL. (This is the same as entering 4.4 SPCL, 8.1 SPCL, Log units, Track Mode and 27.3 SPCL.) The light in the TRACK MODE key should be on at this point.

f. Press the MHz key to enter the manual tune mode.

g. Select Tuned RF Level (yellow shift key, RF Power key).

h. If using an HP 11722A or HP 11792A sensor module, press the CALIBRATE key to make an absolute level measurement or set a relative reference by pressing the blue key and the ZERO key.

i. Step the signal level down in amplitude and press the CALIBRATE key whenever the RECAL annunciator is displayed.

[7] This special function is not available with firmware date codes 234.1985 and below. (to display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

[8] Instrument serial-number prefix 2305A to 2530A do not contain this feature. For retrofit information, contact the nearest HP sales office.

Comments About Special Function 32.9.

If the signal appears to be lost, set the signal level of the device-under-test to greater than -90 dBm. Then select Blue Key, CLEAR (HP-IB code: BC). This key sequence forces a retune of the VCO during Tuned RF Level measurements and should recapture the signal if it has not drifted more than 5 MHz. Once the signal has been recaptured, step the signal down for low-level measurements.

If the signal frequency into the HP 8902A drifts past one of the following frequency boundaries, the Measuring Receiver will lose the signal and the measurement process must be restarted.

Frequency Boundaries:

40MHz, 80 MHz, 160MHz, 320 MHz, and 640 MHz.

Special Function 31. Tuned RF Level Noise Correction. [9] Use this special function in conjunction with the IF Average Detector (Special Functions 4.4 through 4.7) when making Tuned RF Level measurements on low-level signals. The selection of Special Function 31 is maintained through instrument power down (the Measuring Receiver being turned off and then on).

The Tuned RF Level measurement calibrated three RF input attneuation ranges to achieve accurate low-level measurements. (the *Operating Information Pull-Out Card* illustrates these.) When Special Function 31.1 is enabled, the normal Tuned RF Level measurement procedure is followed (that is, stepping down in level and pressing the CALIBRATE key whenever the RECAL annunciator is displayed.) However, when the Measuring Receiver calibrates the third RF range, it causes the sensor module to switch out the signal from the device-under-test momentarily (placing 50Ω at the output). Then the Hp 8902A measures the noise between the RF input and the IF Syncronous Detector circuity. In subsequent measurements (in this third range), the Measuring Receiver subtracts the measured noise from the total signal-plus-noise to display the measured signal level.

31.0 Turn off noise correction.

31.1 Turn on noise correction.

31.2 Display 0 if noise correction is off and display 1 if it is on.

Comments About Special Function 31.

NOTE

Special Function 31.1 (for noise correction) should be entered once before making level measurements. To clear Special Function 31.1 you MUST enter 31.0.

Special Function 31 can be especially useful when making measurements on down-converted signals.

Special Functions 31.0 and 31.1 can be toggled once the Tuned RFl Level calibration has been done with 31.1 enabled. That is, the signal can be measured alternately with the noise added to the signal and without the noise.

The Measuring Receiver uses a default noise value (that might be invalid) in its mesurement response if Special Function 31.1 is enabled after (instead of before) completing the Tuned RF Level calibration sequence. (The default noise value is the last value that was measured. This value is saved through Instrument Preset and power down.)

[9] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

CAUTION

Do not use 31.1 SPCL when making any uncalibrated, or relative signal level measurement in Tuned RF Level mode without a power sensor. The Sensor Module must be used when making Tuned RF Level range-to-range calibrations with the AVG Detector.

If You Prefer Manually-Entered RF Power Calibration Factors.

Not to be confused with Tuned RF Level calibration factors. RF power calibration factors are used during the RF Power measurement and during the first Tuned RF Level absolute calibration to compensate the external power sensor's frequency response relative to a 1 mW reference calibration. Selecting AUTOMATIC OPERATION or INSTRUMENT PRESET causes the Measuring Receiver to use Automatic Cal Factors. Any Manual Cal Factor used during RF power calibration is erased when these funcions are initiated, and will not be usd in the first Tuned RF Level calibration. (Refer to RF *Power* on page 3-75.)

4.0 SPCL, 4.4 SPCL, and SET REF Affect the First Calibration.

- **For Absolute Measurements.** Different detectors are used by 4.0 SPCL and 4.14 SPCL. (These detectors are described in previous paragraphs.) This means that the first calibration factor will be different depending on the detector used when CALIBRATE is selected the first time. So if the test signal is unstable enough at low levels to require measurement with the average detector, you will need to make a first calibration for both 4.0 SPCL and 4.4 SPCL at the tuned frequency.
- **For Relative Measurements.** Relative Measurements are made with the SET REF key. When you use SET REF, you do not use a power sensor. (If you use a sensor module, the power sensor within it will be bypassed for SET REF measurements.) This means that the first calibration compares the level measured by either detector to the level that you set to be 0 dB when you select the SET REF key. As with absolute measurements, the first calibration factor will be different for each detector.
- **For Both Absolute and Relative Measurements.** Because of these four variables (absolute measurement with either detector and relative measurement with either detector), the first calibration factor can be four different values. However, the second and third calibration factor will be the same for each of these four cases.

Special Function 4 Also Controls Selecton of Measurement Display Averaging.

Measurement averaging time is automatically selected by the Measuring Receiver during the Tuned RF Level measurement. Measurement averaging time is automatically selected by the Measuring Receiver during the Tuned RF Level measurement. The Measuring Receiver chooses these times based on the requirements of its internal circuitry. However, experienced operators may want to increase or decrease the measurement time using Special Function 4:

High Residual FM Can Affect Accuracy.

Tuned RF Level measurement accuracy can be affected by residual FM on the input signal. If the residual FM is too high (refer to Table 1-1 for Measuring Receiver specifications), the Average Tuned RF Level Measurement mode can be used

Approximate Measurement When UNCAL is Displayed.

Approximate calibration factors enable the Tuned RF Level measurement until the Calibrate function is used. The UNCAL annunciator indicates that approximate calibration factors are being used.

Attenuator/Gain Automatic Ranging.

The instrument automatically ranges as shown in the "Measurement Technique". Refer to *Range Hold* on page 3-243 for ways to avoid automatic ranging.

High Residual FM Can Affect Accuracy.

Tuned RF Level measurement accuracy can be affected by residual FM on the input signal. If the residual FM is too high (refer to Table 1-1 for Measuring Receiver specifications), the Average Tuned RF Level Measurement mode can be used

Approximate Measurement When UNCAL is Displayed.

Approximate calibration factors enable the Tuned RF Level measurement until the Calibrate function is used. The UNCAL annunciator indicates that approximate calibration factors are being used.

Attenuator/Gain Automatic Ranging.

The instrument automatically ranges as shown in the "Measurement Technique". Refer to *Range Hold* on page 3-243 for ways to avoid automatic ranging.

IF Level

FUNCTIONS

IF LEVEL

DESCRIPTION

The signal level in the Measuring Receiver's IF can be measured and displayed as a percent of the optimum level. An IF level display of 100% indicates sufficient signal strength to guarantee accurate modulation measurements. AM accuracy is directly affected by the IF level. FM and ΦM accuracy is affected only if the IF level is very low.

PROCEDURE

To display the IF level as a percent of optimum, select IF LEVEL (Shift, ΦM).

HP-IB PROGRAM CODE

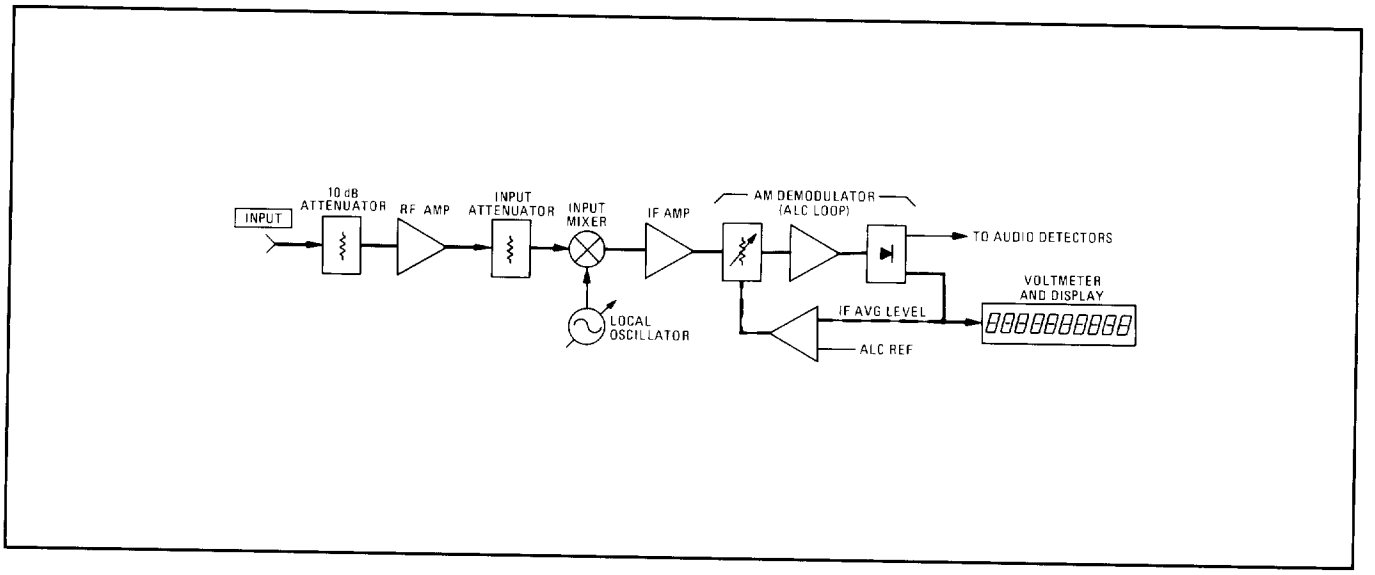
IF LEVEL = S3

MEASUREMENT TECHNIQUE

Once the instrument is tuned and the IF Level function is selected, the automatic level control (ALC) loop of the AM Demodulator detects the average level of the IF. If the ALC loop is closed and there is sufficient IF signal available, the ALC loop automatically adjusts the IF gain within the loop to force the detected IF to equal the ALC reference. When the instrument is running in automatic operation, the input attenuation is adjusted to keep the IF level within range of the ALC loop.

In the IF Level measurement mode, the detected IF level is compared to the ALC reference and the ratio of the t· ·vels is expressed as a ratio in %. If the ALC loop is closed and if there is sufficient IF level, the lay will read 100%. If the ALC loop is open (Special Function 6.2) or if there is insufficient IF level, the display will not read 100%. If the IF level is too high the display will read greater than 100%. If the IF level is too low, the display will read less than 100%.

BLOCK DIAGRAM



IF Level Measurement Block Diagram

COMMENTS

Acceptable IF Level Display.

An IF level display between 99.9% and 100.1% is considered acceptable for all measurements.

Input/Output Status.

When IF LEVEL is selected, the output at MODULATION OUTPUT/AUDIO INPUT continues to output the demodulated signal corresponding to the last modulation measurement selected as indicated by the MODULATION OUTPUT annunciator. If the IF level is not 100%, the calibration of the output is directly affected for AM and degraded for FM and ΦM if the IF level is very low.

Relative Measurements.

If IF level is to be displayed relative to a reference level, enter the ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

IF Levels Less Than 100%.

Error 03 (input circuits underdriven) is generated whenever the IF level is less than 100% unless the ALC loop is open. Override this Error Message using Special Function 8. (Refer to *Error Message Disable Control* on page 3-267.)

AM Depth When IF Level is Insufficient.

When operating with the AM ALC loop open or when the IF level is insufficient, the displayed AM is proportional to the actual AM depth, and the displayed IF level is proportional to the average carrier level. The actual AM depth can computed as the ratio of the two readings with the following formula:

$$AM\ in\ \% = \frac{demodulated\ ac}{average\ carrier\ level} \times 100\% = \frac{displayed\ AM}{displayed\ IF\ level} \times 100\%$$

The Ratio feature can be used to simplify this calculation: First, measure the IF level, then press the AM key and enter the IF level on the numeric keys. Then press the RATIO key. AM is now displayed although the IF level is not optimum.

Guidelines for Measurements when AM ALC is Off.

In most circumstances, when the AM ALC is off (loop open), use IF levels greater than or equal to 100% for FM measurements and less than or equal to 100% for AM measurements.

Peak Tuned RF Level

FUNCTIONS

Special Function 36 (Peak Tuned RF Level)

DESCRIPTION

Another method the Measuring Receiver can use to measure level is Special Function 36. The average power measured in this case is actually the peak level of the down-converted RF input falling in the IF. The term "peak level" refers to the fact that a peak-responding IF detector is used to measure the signal level. The internal controller converts this level to average power and displays the result. (See the block diagram in "MEASUREMENT TECHNIQUE".) The Peak Tuned RF Level function is not calibrated, and so it is not as accurate or sensitive as the Tuned RF Level function (initiated with the TUNED RF LEVEL key) that must be specifically calibrated for each frequency. The Peak Tuned RF Level function enables the instrument to measure the level of frequencies that are drifting, or to determine flatness as a function of carrier frequency. This function is more sensitive than the RF Power or RF Level (Special Function 35) measurement modes.

PROCEDURE

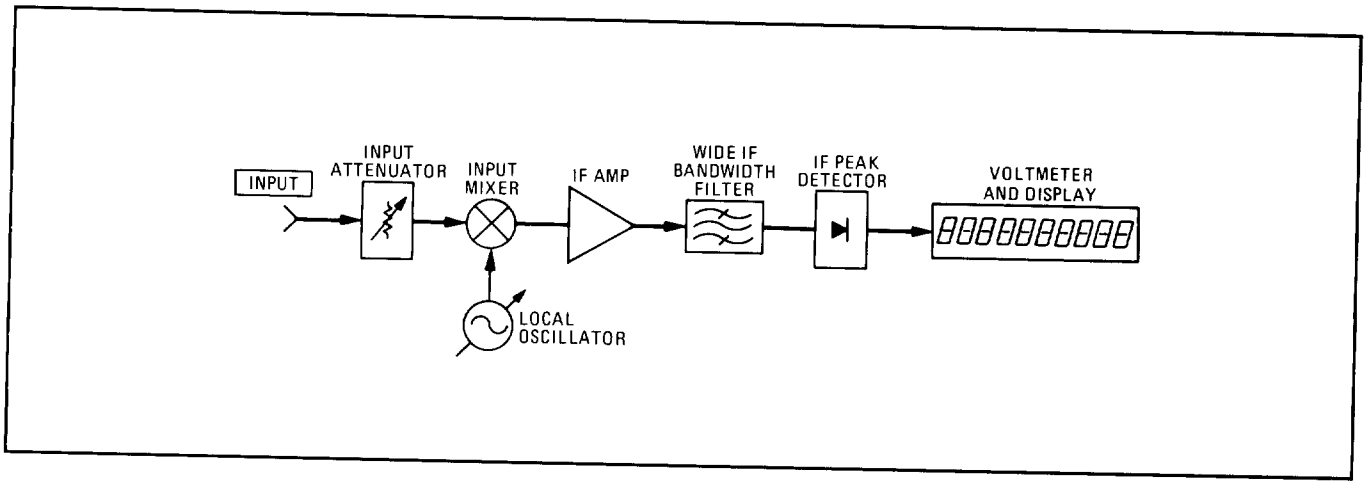
To make a peak tuned RF level measurement, first tune the instrument to the input signal by selecting AUTOMATIC OPERATION. Key in 36.0 SPCL.

HP-IB PROGRAM CODES

LIN results = LN
LOG results = LG
SPCL = SP
VOLTS units = VL
mV units = MV
uV units = UV
WATTS units = WT

MEASUREMENT TECHNIQUE

When the Measuring Receiver is tuned, all the power falling within the IF bandpass filter is amplified and peak detected. The detected power is then measured by the voltmeter and displayed in the selected measurement units.



Peak Tuned RF Level Measurement Block Diagram

COMMENTS

Input/Output Status.

When the peak tuned RF level measurement is selected, MODULATION OUTPUT/AUDIO INPUT is blanked. AM OUTPUT and FM OUTPUT (rear panel) remain active during this measurement.

Relative Measurements.

If the peak tuned RF level is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Accurate Power Measurements.

Use an external power sensor to make accurate, absolute power measurements. (Refer to *RF Power* on page 3-75 or to *Tuned RF Level* on page 3-95.)

Attenuator Measurements

FUNCTIONS

SET REF, Special Function 26 (Set Reference)

DESCRIPTION

By setting a zero-reference at the current measurement level, the gain of linear devices (such as attenuators and amplifiers) can be measured directly and accurately. The current RF level then becomes the reference for all subsequent tuned RF level measurements made at that frequency.

Special Function 26 enables the Measuring Receiver to exit or to re-enter (using the previous reference) the Attenuator Measurement mode.

The SET REF key should be used instead of the RATIO key for relative power measurements. (The Ratio function is still available but with restrictions. Refer to "COMMENTS" for an elaboration of the restrictions.)

PROCEDURE

To make relative power measurements in the Attenuator Measurement mode, connect an RF signal through an RF cable (or sensor module) to the RF INPUT connector of the Measuring Receiver. Tune the RF source to the frequency of interest by selecting FREQ.

Select TUNED RF LEVEL (Shift, RF POWER) and wait for the measurement result to be displayed.

Select SET REF (Blue Key, ZERO) to set the initial reference for subsequent relative measurements. Select LOG/LIN to change the display to read in % or dB units. As the input level changes, the level relative to the initial reference is displayed.

As the input signal level approaches a maximum or minimum limit, the RF input circuits must re-range to accomodate the new level. If the input circuits are re-ranging for the first time at the signal frequency, the instrument must recalibrate. If RECAL is displayed, press the CALIBRATE key and hold the signal level steady until a valid measurement is displayed. If UNCAL is displayed, set the input signal to a level at which RECAL is displayed and press the CALIBRATE key. (Two input range-to-range calibration factors are stored for each of the two IF detectors. Refer to Tuned RF Level Calibration and Calibration Factors for a description of calibration factors and their derivation.)

Key in 26.0 SPCL or TUNED RF LEVEL to exit the Attenuator Measurement mode and re-enter the absolute Tuned RF Level mode. (Refer to Special Functions for a more specific selection procedure.)

Key in 26.1 SPCL to re-enter the Attenuator Measurement mode using the previous reference.

HP-IB PROGRAM CODES

CALIBRATE on = C1
LIN results = LN
LOG results = LG
SET REF = RF
SPCL = SP
TUNED RF LEVEL = S4

INDICATIONS

Selecting TUNED RF LEVEL might elicit all of the following responses:

Two dashes (--) indicate that the instrument is searching for the input signal but has not found it. This is the normal automatic tune mode.

Four dashes (----) indicate that the signal has been found and the instrument is awaiting a settled measurement.

Six dashes (------) indicate that the instrument is fine tuning the IF synchronous detector's VCO to locate the signal in its narrow IF filter. (This indication is used only with the IF synchronous detector.)

When entering Tuned RF Level for the first time, the normal display sequence is: ----, ------, ----, then the measurement result.

If the signal level approaches a maximum or minimum limit of the RF input circuits and if the next input range has not been previously calibrated at that signal frequency, the RECAL annunciator lights to indicate the need for range calibration. Hold the signal level steady and select CALIBRATE.

If the signal level goes beyond a maximum or minimum limit of the RF input circuits, and it cannot be calibrated at that level, the UNCAL annunciator lights. Re-adjust the signal level until the UNCAL annunciator goes off and the RECAL annunciator lights, then hold the signal level steady and select CALIBRATE.

If both the UNCAL and RECAL annunciators are lighted, the instrument can still be calibrated, but the displayed reading is not yet calibrated.

The LED within the SET REF key (the ZERO key) will not light when pressed.

MEASUREMENT TECHNIQUE

The SET REF key sets the Measuring Receiver to make tuned RF level measurements relative to an initially-set reference. Measurement restrictions that apply are the same as for the normal Tuned RF Level measurement mode.

The major difference between absolute and relative tuned RF level measurements is the way the initial reference is obtained. For absolute measurements, the initial level measurement made with the IF detector is equated to a measurement made on the same signal with a power sensor (essentially the RF Power measurement). For relative measurements, the initial level measurement made with the IF detector is equated to 100%.

Since the relative measurement uses the same IF detectors and RF input ranges as the absolute measurement, the absolute and relative measurements share the calibration factors for the two internal RF input range changes. Thus relative level measurements can be made on signal levels ranging from 0 to −127 dBm. Also, when measurement modes are switched between relative and absolute, the only recalibration necessary is for the initial reference.

(Refer to *Tuned RF Level* on page 3-95 for a more detailed description of all aspects of tuned RF level measurement technique.

COMMENTS

Input/Output Status

Accurate level measurements can be made only on cw signals. The MODULATION OUTPUT/AUDIO INPUT is blanked during tuned RF level measurements.

Measurement Limits

Relative measurements cannot be made on RF signals with absolute levels outside the range 0 to −127 dBm.

Valid Measurements Can Only Be Made on Tuned Signals

The Measuring Receiver must be tuned to the input frequency before valid tuned RF level measurements can be made. The instrument can be manually tuned to the frequency of interest either before or after the TUNED RF LEVEL Key is pressed. (Refer to *RF Frequency Tuning* on page 3-141.)

If the tuned frequency moves more than ±5 kHz from the frequency at which the power sensor reference was taken, the instrument must be retuned.

Using Ratio with Tuned RF Level Measurements

For most measurement modes, when the Ratio feature is used, a known reference is first established either by keying in the desired reference or by using the displayed measurement as the reference. Furthermore, the established reference can always be recalled (using PREVIOUS RATIO or Special Function 11.2). In the Attenuator Measurement mode the initial SET REF reference cannot be recalled.

Also, when using the Ratio feature with Tuned RF Level, the input RF range recalibration data is ignored.

CAUTION

Do not use 31.1 SPCL when making any uncalibrated, or relative signal level measurement in Tuned RF Level mode without a power sensor. The Sensor Module must be used when making Tuned RF Level range-to-range calibrations with the AVG Detector.

Selective Power Measurements (Option 030)

FUNCTIONS

Special Functions 23 (External LO) and 24 (Selective Power Measurements)

DESCRIPTION

The Series 030, Selective Power Measurement Options enable the Measuring Receiver to measure adjacent-channel power and single-sideband noise on continuous wave (CW) RF signals.[1] Both measurements basically consist of tuning the instrument to the RF signal, measuring the IF level in the passband of a selected IF filter, then offsetting the signal onto the skirt of the IF filter and re-measuring the IF level. Offsetting the signal places a portion of the sideband noise of the carrier in the passband of the IF filter. The ratio of the out-of-band IF level to the in-band IF level is the desired measurement result (expressed in dB).

The measurement procedure requires that the operator step through a sequence of special functions and increment either the local oscillator (LO) or the signal source. For RF signal frequencies above 300 MHz, an external LO is recommended for greatest sensitivity and accuracy. Special Function 23 switches the LO between internal and external. The external LO connects to a rear-panel connector. (Since Option Series 030 provide rear-panel LO input and output connectors, Option 003 is not available in conjunction with the 030 Series Options.)

The 030 Series Options include the choice of two IF bandpass filters installed. The bandwidths of these IF filters match the requirements of specific industry standards for measuring adjacent-channel power. The following table lists the optional filters and their bandwidths.

Filters	Options
12.5 kHz Adjacent Channel Filter	Option 032
25 kHz Adjacent Channel Filter	Option 033
30 kHz (Cellular Radio) Filter	Option 035
Carrier Noise Filter	Option 037

All selective power measurements consist of three processes. The first two are identical for either adjacent channel power or single-sideband noise measurements. However, the third step is different depending on the measurement being made:

1. Setting up the LO:

   Put the Measuring Receiver in its selective power measurement mode. If using an external LO, enter an LO value into the Measuring Receiver that is offset 455 kHz from the incoming signal. If using the Measuring Receiver's internal LO, just tune to the input signal.

2. Setting the reference:

   Measure the voltage reference and set that reference to be 0 dB. (Adjust the LO frequency to ensure that the peak value is being measured.) Then measure the peak voltage reference and set it to be 0 dB.

3a. Measuring the adjacent channel power:

   Tune the LO to the 6 dB point of the filter and move the LO the spacing required for the appropriate adjacent channel filter.

3b. Measuring the single-sideband noise:

   Choose whether to display the data as total power in the 2.5 kHz filter bandwidth or as dBc in a 1 Hz bandwidth. Tune the Measuring Receiver (or the external LO) to the offset frequency desired and measure the noise.

[1] This option can be retrofitted to instruments with serial-number prefixes 2535A and above. For retrofit information, contact the nearest HP sales office.

PROCEDURE

The following procedures are examples of typical measurement applications. These procedures describe the steps for measuring adjacent-channel power and single-sideband noise.

ADJACENT CHANNEL POWER MEASUREMENTS

Two procedures are available. The first procedure measures the lower adjacent channel power. The second procedure measures the upper adjacent channel power.

To Measure the Lower Adjacent Channel Power

Setting Up the LO

1. Tune to the input frequency. (Selecting the FREQ key automatically tunes the Measuring Receiver to the input frequency. Keying in the input frequency value (in MHz) followed by the MHz key manually tunes the Measuring Receiver to the frequency value keyed in. For more information about tuning, refer to *RF Frequency Tuning* on page 3-141.)
2. Press the MHz key to manually tune and center the IF.
3. Select 24.0 SPCL to enter the Selective Power Measurement mode.
4. Select whether an external LO or the Measuring Receiver's internal LO will be used. If the internal LO will be used, go to step 7. If an external LO will be used, connect the LO signal source to the LO INPUT connector on the rear panel of the Measuring Receiver. (More information about the LO INPUT is available in *LO Input and LO Output* on page 3-155.)
5. Set the external LO source frequency to 455 kHz greater than the input frequency, and its amplitude to 0 dBm.
6. Key in 23.1 SPCL to set the LO to external.

Setting the Reference

7. Select 24.1 SPCL to establish the IF reference value (in volts).
8. Select 24.2 SPCL to set the reference to 0 dB.
9. Adjust the LO frequency until the maximum value is displayed. The Measuring Receiver's automatic tuning capability measures an IF value close to the peak, but the internal circuitry does not specifically check for a peak. This step enables you to fine tune to the peak of the signal.
   a. If using an external LO, step the LO frequency in small increments until the peak value is measured.
   b. If using the internal LO, set the desired increment value (in kHz) and step the LO using the ⇑ kHz and ⇓ kHz keys until the maximum value is displayed. (It is possible to tune the input signal instead of the LO. Refer to *Comments*, "Frequency Offsetting" on page 3-127.)
10. Reselect 24.1 SPCL to establish the IF reference value (since that value has now been peaked).
11. Reselect 24.2 SPCL to set the reference to 0 dB.

Measuring the Lower Adjacent Channel Power

12. Decrease the LO frequency value until −6 dB is displayed. Note the frequency difference between the source and the LO. This frequency difference is relative to the 6 dB corner of the IF bandpass filter. (Once the 6 dB corner frequency has been determined, the corner need not be remeasured when new measurements are made with that filter.)

13. Decrease the LO frequency by an offset of either 8.25 kHz, 13 kHz, or 17 kHz depending on the adjacent channel being measured (refer to the table below).

Channel Spacing in kHz	Displacement of the 6 dB Point per CEPT (in kHz)
12.5 kHz	8.25 kHz
20 kHz	13 kHz
25 kHz	17 kHz

14. The value displayed is the adjacent channel power measurement result.

To Measure the Upper Adjacent Channel Power

Setting Up the LO

1. Tune to the input frequency. (Selecting the FREQ key automatically tunes the Measuring Receiver to the input frequency. Keying in the input frequency value (in MHz) followed by the MHz key manually tunes the Measuring Receiver to the frequency value keyed in. For more information about tuning, refer to *RF Frequency Tuning* on page 3-141.)
2. Press the MHz key to manually tune and center the IF.
3. Select 24.0 SPCL to enter the Selective Power Measurement mode.
4. Select whether an external LO or the Measuring Receiver's internal LO will be used. If the internal LO will be used, go to step 7. If an external LO will be used, connect the LO signal source to the LO INPUT connector on the rear panel of the Measuring Receiver. (More information about the LO INPUT is available in *LO Input and LO Output* on page 3-155.)
5. Set the external LO source frequency to 455 kHz less than than the input frequency, and it's amplitude to 0 dBm.
   a. If using the internal LO, on the Measuring Receiver select 910 ⇓ kHz. This tunes the Measuring Receiver to the image frequency of the LO. At this time, the RF frequency display will not match the input frequency value.
6. Key in 23.1 SPCL to set the LO to external.

Setting the Reference

7. Select 24.1 SPCL to establish the IF reference value (in volts).
8. Select 24.2 SPCL to set the reference to 0 dB.
9. Adjust the LO frequency until the maximum value is displayed. The Measuring Receiver's automatic tuning capability measures an IF value close to the peak, but the internal circuitry does not specifically check for a peak. This step enables you to fine tune to the peak of the signal.
   a. If using an external LO, step the LO frequency in small increments until the peak value is measured.
   b. If using the internal LO, set the desired increment value (in kHz) and step the LO using the ⇑ kHz and ⇓ kHz keys until the maximum value is displayed. (It is possible to tune the input signal instead of the LO. Refer to *Comments*, "Frequency Offsetting" on page 3-127.)
10. Reselect 24.1 SPCL to establish the IF reference value (since that value has now been peaked).
11. Reselect 24.2 SPCL to set the reference to 0 dB.

Measuring the Upper Adjacent Channel Power

12. Increase the LO frequency value until −6 dB is displayed. Note the frequency difference between the source and the LO. This frequency difference is relative to the 6 dB corner of the IF bandpass filter. (Once the 6 dB corner frequency has been determined, the corner need not be remeasured when new measurements are made with that filter.)
13. Increase the LO frequency by an offset of either 8.25 kHz, 13 kHz or 17 kHz depending on the adjacent channel being measured (refer to the table below).

Channel Spacing in kHz	Displacement of the 6 dB Point per CEPT (in kHz)
12.5 kHz	8.25 kHz
20 kHz	13 kHz
25 kHz	17 kHz

14. The value displayed is the adjacent channel power measurement result.

SINGLE-SIDEBAND NOISE MEASUREMENTS

Use this procedure only when Option 037 has been installed.

Setting Up the LO

1. Tune to the input frequency. (Selecting the FREQ key automatically tunes the Measuring Receiver to the input frequency. Keying in the input frequency value (in MHz) followed by the MHz key manually tunes the Measuring Receiver to the frequency value keyed in. For more information about tuning, refer to *RF Frequency Tuning* on page 3-141.)
2. Press the MHz key to manually tune and center the IF.
3. Select 24.0 SPCL to enter the Selective Power Measurement mode.
4. Select whether an external LO or the Measuring Receiver's internal LO will be used. If the internal LO will be used, go to step 7. If an external LO will be used, connect the LO signal source to the LO INPUT connector on the rear panel of the Measuring Receiver. (More information about the LO INPUT is available in *LO Input and LO Output* on page 3-155.)
5. Set the external LO source frequency to 455 kHz greater than the input frequency, and it's amplitude to 0 dBm.
6. Key in 23.1 SPCL to set the LO to external.

Setting the Reference

7. Select 24.5 SPCL to establish the IF reference value (in volts).
8. Select 24.6 SPCL to set the reference to 0 dB.
9. Adjust the LO frequency until the maximum value is displayed. The Measuring Receiver's automatic tuning capability measures an IF value close to the peak, but the internal circuitry does not specifically check for a peak. This step enables you to fine tune to the peak of the signal.
   a. If using an external LO, step the LO frequency in small increments until the peak value is measured.
   b. If using the internal LO, set the desired increment value (in kHz) and step the LO using the ⇑ kHz and ⇓ kHz keys until the maximum value is displayed. (It is possible to tune the input signal instead of the LO. Refer to *Comments*, "Frequency Offsetting" on page 3-127.)
10. Reselect 24.5 SPCL to establish the IF reference value (since that value has now been peaked).
11. Reselect 24.6 SPCL to set the reference to 0 dB.

Making the Single-Sideband Noise Measurement

11. If you want the measurement to be displayed as total power in the 2.5 kHz bandwidth, go to the next step. If you want the measurement to be normalized to 1 Hz, select 24.7 SPCL.

12. Adjust the LO frequency by the desired offset to display the noise value. The value displayed is the single-sideband noise measurement result.

Additional Special Functions for Single-Sideband Noise

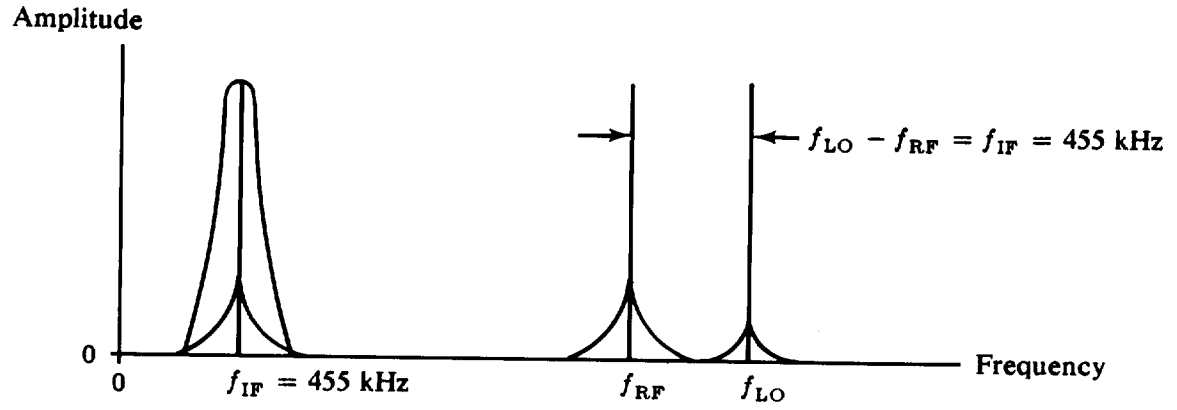
These special functions enable you to change and display the noise measurement bandwidth. The noise measurement bandwidth is measured and entered at the factory and probably does not need to be remeasured unless operating conditions for the Measuring Receiver change radically.

1. **Special Function 24.8** Changes the noise measurement bandwidth used in single-sideband noise measurements. The value entered (in units of MHz) must be between 100 Hz and 20 kHz (0.0001 and 0.02 MHz). To enter a noise measurement bandwidth key in 24.8 SPCL then key in the bandwidth expressed in MHz and press the MHz key. This factor is stored in non-volatile memory. Determination of the noise measurement bandwidth is usually done by numerical integration of the IF filter response.

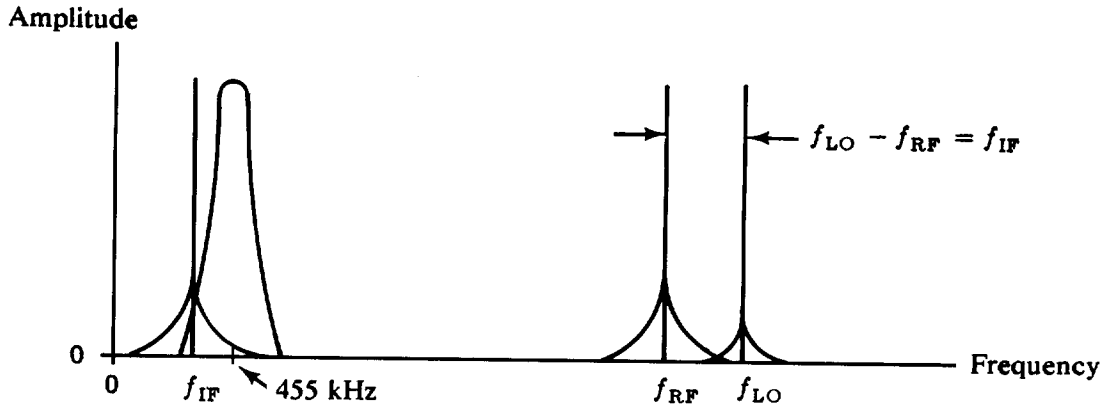
2. **Special Function 24.9** Displays the value of the noise measurement bandwidth used in conjunction with Special Function 24.7. The displayed value times out after a few seconds.

Summary of Special Functions 23 and 24

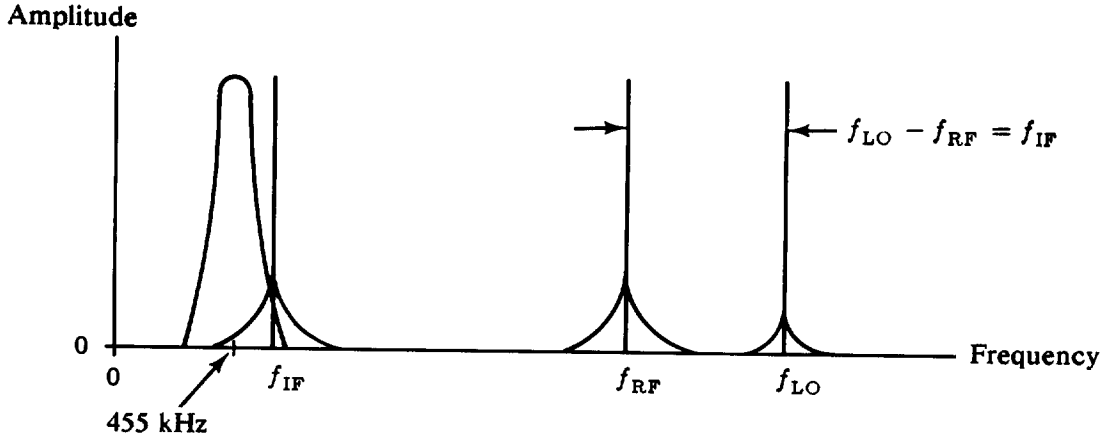
SPCL	Special Function Description	Comments
23.0	Sets the LO to internal.	
23.1	Sets the LO to external.	
23.2	Displays the status of the LO: (0=Internal, 1=External).	The display times out after a few seconds.
24.0	Sets the Measuring Receiver to the Selective Power Measurement Mode.	This special function must be selected before any selective power measurements can be made.
24.1	Selects the wide-bandwidth IF filter for adjacent-channel or cellular radio power measurements. Displays the IF level (in volts).	Used with 24.2 SPCL. The bandwidth of the IF is determined by the Option Series 030 Filter installed.
24.2	Establishes the level measured with 24.1 SPCL as the 0 dB reference.	
24.3	Selects a narrower bandwidth IF filter than 24.1 SPCL for adjacent channel power measurements. Displays the IF level (in volts).	Used with 24.4 SPCL.
24.4	Establishes the level measured with 24.3 SPCL as the 0 dB reference.	
24.5	Selects a very narrow bandwith IF filter (2.5 kHz) for the single-sideband noise measurement. Displays the IF level (in volts).	Used with 24.6 SPCL. Can only be used with Option 037.
24.6	Establishes the level measured with 24.5 SPCL as the 0 dB reference.	Can only be used with Option 037.
24.7	Displays the noise measurement as normalized to a 1 Hz bandwidth.	Can only be used with Option 037.
24.8	Enables setting of the value of the noise measurement bandwidth.	Can only be used with Option 037.
24.9	Displays the value of the noise measurement bandwidth.	Can only be used with Option 037.



(a.) No Frequency Offset



(b.) Frequency Offset by Increasing RF Signal Frequency



(c.) Frequency Offset by Increasing LO Frequency

Signal Tuning Illustrating Frequency Offsetting

MEASUREMENT TECHNIQUE

The Series 030 Options add more IF signal processing circuitry to the Measuring Receiver including programmable IF amplifiers and filters and a true rms IF detector. (Refer to the Selective Power Measurement Option simplified block diagram.)

Initializing.

The Measuring Receiver must be set up for the first part of the measurement which establishes the IF reference level. This is most easily done by keying in Special Function 24.0 which:

- holds the RF input attenuation;
- sets the IF to 455 kHz, retunes the LO to accommodate the 455 kHz IF, and sets the LO to the manual-tune, low-noise mode;
- inserts the RF Input High-Pass Filter (which limits the lowest RF input frequency to 10 MHz but filters any low-frequency RF input signals from interfering with the measurement); and
- disables Error Messages 01 through 04.

The Measurement Sequence.

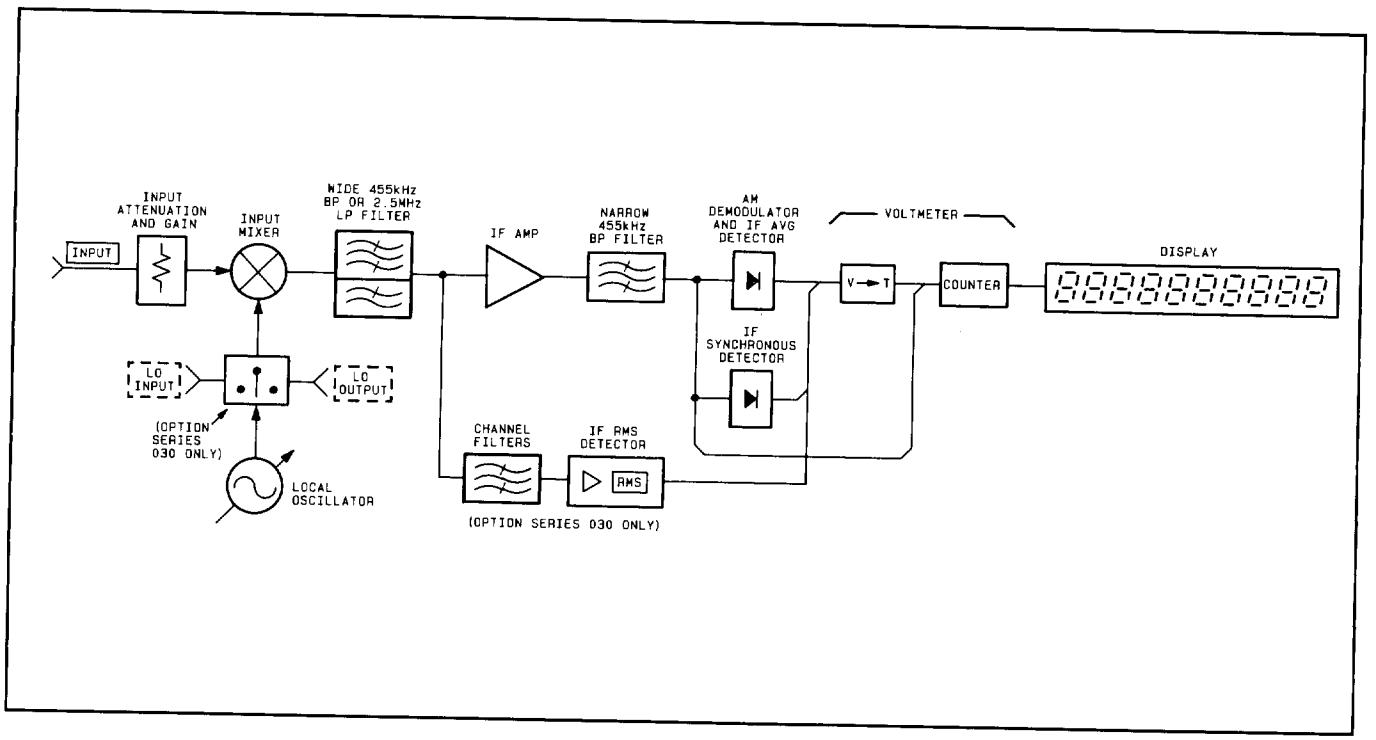
The first step in the measurement sequence is to tune to LO to the RF input signal to center the IF in the IF filter passband. Refer to (a.) in the previous figure "Signal Tuning Illustrating Frequency Offsetting". After the instrument is properly tuned the IF (in-band) level is measured with the IF RMS Detector. The in-band IF level is defined as a ratio reference.

Next the frequency is offset either by tuning the RF input signal (if this is possible) or by tuning the LO as illustrated in (b.) and (c.) of the same figure. Note that tuning is in opposite directions. If it is desired to offset the IF to the upper skirt of the IF filter, the RF frequency must be decreased or the LO frequency increased.

After the signal if offset, a second (out-of-band) IF level measurement is made with the same IF RMS Detector. Since the IF level has decreased considerably, the IF gain is adjusted to bring the IF level within the optimum range of the IF RMS Detector. The ratio of the out-of-band IF level to the in-band level is computed and displayed. Out-of-band IF signal appears in the IF passband because of

- sideband noise on the RF input signal,
- modulation sidebands on the RF input signal (if the signal is modulated),
- sideband noise on the LO, and
- the limited signal rejection in the stopband of the IF bandpass filter.

Since it is desired to measure only the first two contributions (that is, the contributions of only the RF input signal), care must be taken to choose the correct frequency offset, the proper LO, and the proper IF filter.



Selective Power Measurement Simplified Block Diagram

COMMENTS

Frequency Modes Possible During the Selective Power Measurement.

During the selective power measurement, the instrument must be properly tuned to the signal and must be in one of the following RF Frequency measurement modes:

- RF Frequency (the FREQ key, HP-IB Code: M5),
- RF Frequency Error (the S, FREQ ERROR keys, HP-IB Code: S5),
- IF Frequency (Special Function 34, HP-IB Code: 34,0SP), or
- LO Frequency (Special Function 33, HP-IB Code: 33.0SP).

When To Use an External LO.

A low-noise, external LO is recommended for RF input frequencies above 300 MHz. Also, an external LO can be selected for lower phase noise and finer resolution in its frequency steps.

When an external LO is used, the internal LO should be manually tuned to an arbitrary frequency (such as 100 MHz) to defeat automatic signal search. Refer to *RF Frequency Tuning* on page 3-141 for tuning information. (Note that the 455 kHz IF will be used.)

Frequency Offsetting.

The IF frequency can be offset by one of the following three methods:

- offsetting the RF input signal.
- offsetting the external LO, or
- offsetting the internal LO using the ⇑ kHz or ⇓ kHz keys.

An increase in the RF input signal moves the IF signal down the lower skirt of the IF bandpass filter. An increase in the LO frequency (either external or internal) moves the IF signal down the upper skirt. Refer to *Measurement Technique* on page 3-125 for an illustration of this.

The measurement specification may require that the frequency offset be made from the 6 dB corner frequency of the IF bandpass filter.

Finding the IF Peak.

For maximum accuracy, the frequency offset should be relative to the frequency at which the IF signal is peaked in the IF bandpass filter. (IF filter ripple can be as high as 2 dB.) Automatic tuning brings the IF close to the peak, but the instrument controller does not specifically check for an IF peak. Finding the IF peak is most easily accomplished by tuning the RF input signal (if this is possible) or by tuning the external LO while Special Function 24.1, 24.3, or 24.5 is active. The RF input signal or external LO is tuned until the displayed IF voltage is at its peak. Finding the IF peak by incrementing the internal LO is similar, but the active special function must be re-entered after each frequency increment. Tuning requeires a range of only a few kHz.

In all the measurements, you can tune the input signal instead of the LO. This is the easiest way if the source is tuneable. However, you must tune the source opposite to the direction you would tune the LO. For example, if you tune the LO down, you would tune the source up in frequency.

IF Output

CAUTION

Do not apply greater than 40 Vdc or greater than +15 dBm into the rear-panel IF OUTPUT connector.

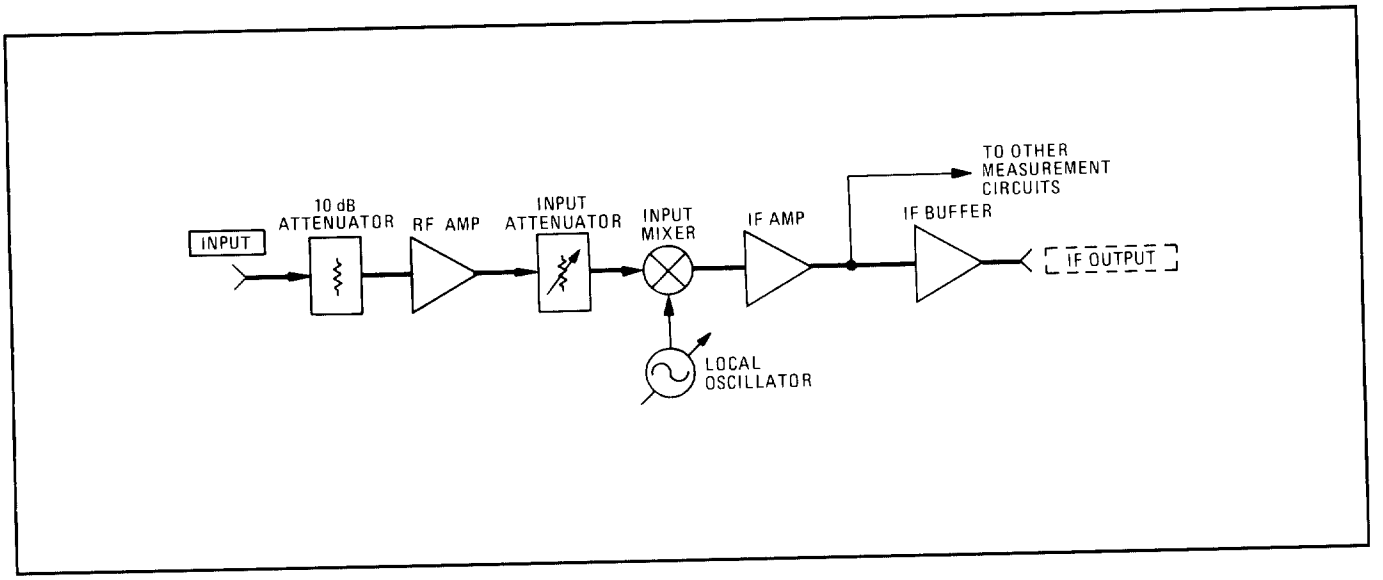
DESCRIPTION

The rear-panel IF OUTPUT (a female BNC connector) provides a buffered output to enable monitoring of the Measuring Receiver's IF signal. The ac-coupled signal ranges from 150 kHz to 2.5 MHz and normally varies in level from −27 to −3 dBm (into 50 ohms). The level variation depends on the RF input signal level, RF input attenuation or gain setting, and the measurement selected.

The 3 dB bandwidth of the signal at IF OUTPUT is approximately 3 MHz when the instrument uses the wide, 2.5 MHz low-pass filter; approximately 200 kHz when the instrument uses the wide, 455 kHz bandpass filter; and approximately 30 kHz when the instrument uses the narrow, 455 kHz bandpass filter.

At any particular input level and front-panel setting, the flatness of the IF OUTPUT, as input frequency varies, is typically within ±5%.

BLOCK DIAGRAM



IF Output Block Diagram

COMMENTS

Use the Measuring Receiver as a Down Converter.

The Measuring Receiver can be used as a high-quality, automatically tuneable, down-converter. Use the IF OUTPUT as the down-converter's output.

Adjacent Spurious Signals.

Check for close-in spurious signals on the RF input by connecting a spectrum analyzer to IF OUTPUT.

When connecting instruments such as counters to the IF OUTPUT, check that they do not inject spurious signals into the IF path. Spurious signals in the Measuring Receiver's IF may generate measurement error.

External Attenuation (dB)

FUNCTIONS

dB EXT ATTEN, Special Function 25 (External Attenuation dB)

DESCRIPTION

Level measurements can be scaled to correctly indicate the power at the input of an external attenuator or amplifier connected to the instrument.

Special Function 25.2 causes display of the value of the selected external dB attenuation or gain.

PROCEDURE

To enter external attenuation:

1. Select the keys corresponding to the magnitude of external attenuation or gain expressed in dB.
2. If the offset is gain rather than attenuation, designate the value as negative by selecting the Blue Key and minus-sign (−) key (the decimal key). No sign indication is necessary for entering attenuation.
3. Select dB EXT ATTEN (Blue Key, LOG/LIN).

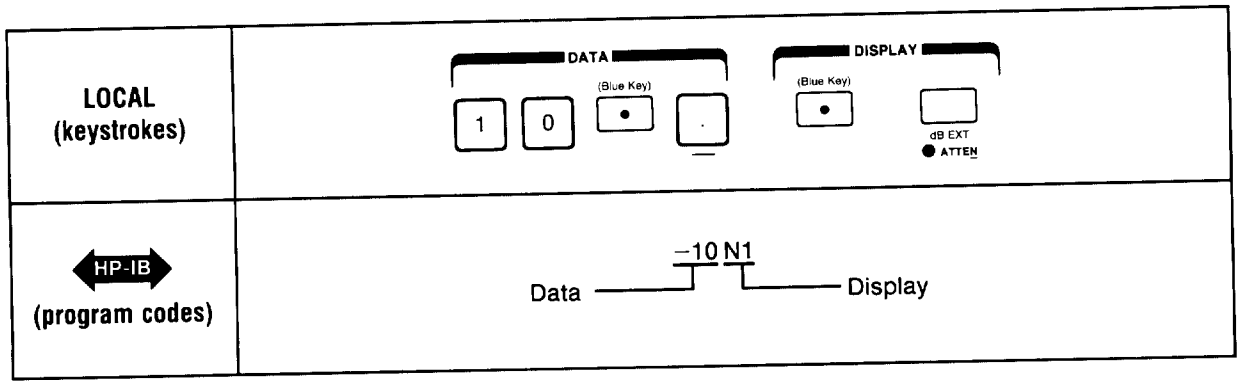
To display the current offset in dB, key in 25.2 SPCL.

To exit external attenuation, select dB EXT ATTEN again.

To re-enter external attenuation, select dB EXT ATTEN again.

EXAMPLE

To account for an external 10 dB amplifier connected to the instrument:



HP-IB PROGRAM CODES

dB EXT ATTEN off = N0
dB EXT ATTEN on = N1
SPCL = SP

When the dB EXT ATTEN key is pressed, the Measuring Receiver displays subsequent level measurements using the entered dB offset.

COMMENTS

Input/Output Status.

MODULATION OUTPUT/AUDIO INPUT is blanked during most level measurements.

External Attenuation Value is Stored Through Other Measurement Selection.

If another Measurement mode is selected while the external attenuation function is enabled and a level Measurement mode is re-entered, the instrument automatically re-enters the external attenuation mode with the previous offset.

Remote Control RF Switch

DESCRIPTION

A compatible, external power sensor is required for making accurate, absolute RF power or tuned RF level measurements. The Measuring Receiver can be used with the following sensor configurations:

•A power sensor selected from the HP 8480 series sensors.

•A sensor module (such as the HP 11722A) that contains a power sensor, an RF switch, and an RF coaxial cable. The Measuring Receiver controls the RF switch in the sensor module to automatically switch the RF input signal between the RF INPUT of the Measuring Receiver and the power sensor as measurements require.

•A sensor module, built by the user, that includes a power sensor (from the HP 8480 series sensors), an RF cable, and an RF switch (such as the HP 33311 series or the HP 8761A). The rear-panel REMOTE CONTROL RF SWITCH outputs enable the Measuring Receiver to automatically switch the RF input signal between the RF input of the Measuring Receiver and the power sensor as measurements require.

NOTE

An HP 478A is a standard sensor but is not compatible with the Measuring Receiver.

For relative power measurements, no sensor is needed.

PROCEDURE

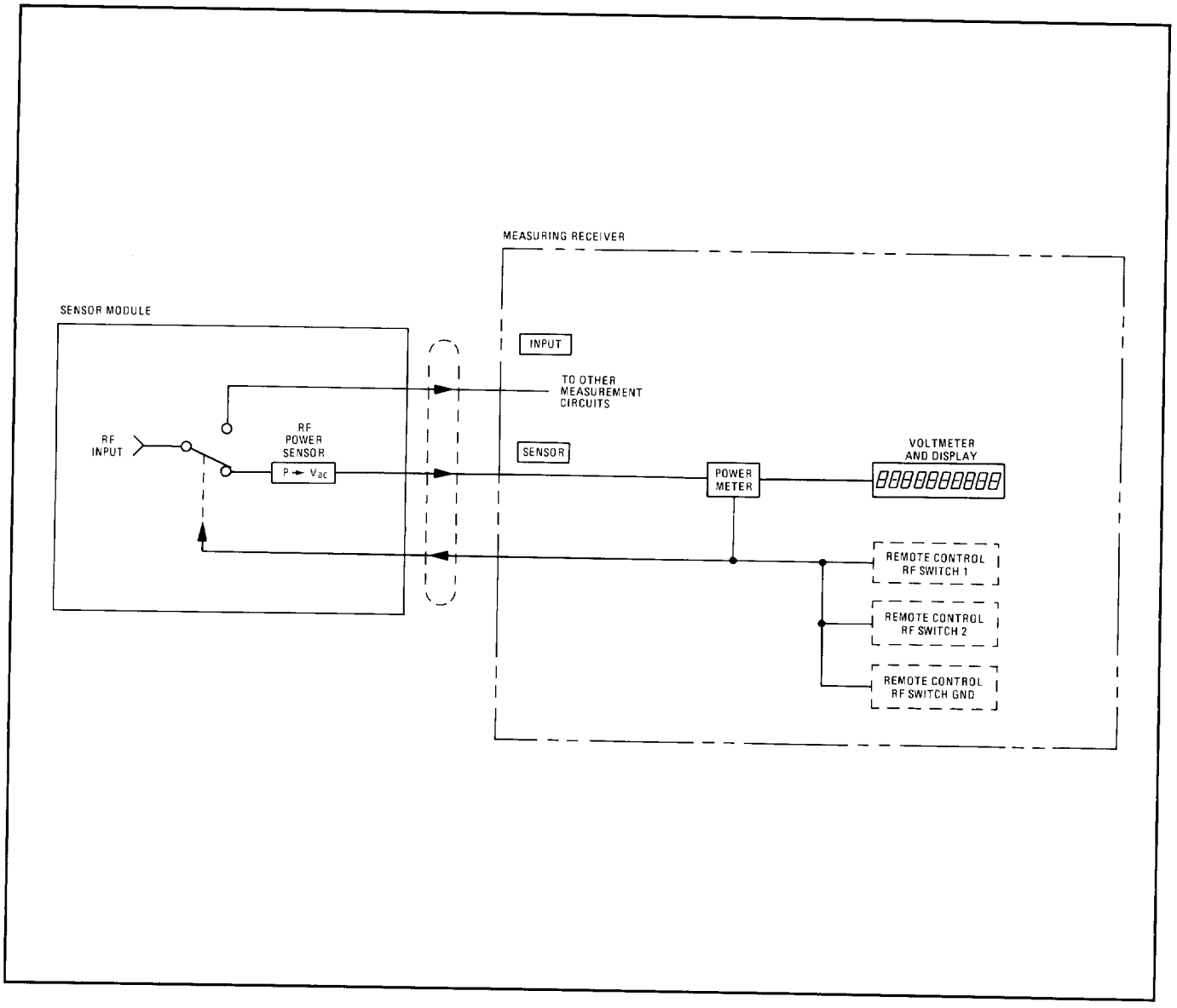
The following procedure provides a few guidelines for setting up and operating a remotely controlled sensor module.

Connect the RF switch, power sensor, RF cable, and Measuring Receiver as shown in the BLOCK DIAGRAM. Do not connect a sensor module (such as the HP 11722A) to the SENSOR input if the rear-panel remote control switches are to be used with a user-built sensor module. The control lines are in parallel, and the internal switch drive circuits cannot drive both.

The remote outputs are capable of driving both 5V and 12V to 15V switch solenoids. The solenoids should be of a latching type, but they need not have automatic drive disconnect. Examples of compatible RF switches are the HP33311B, Option 011 (5V solenoid) or the HP 8761A (12V to 15V solenoid).

Proceed with selected measurements. This user-built module will enable the Measuring Receiver to automatically switch between its inputs as measurements require.

BLOCK DIAGRAM



Block Diagram of Remote Control RF Switch

COMMENTS

REMOTE CONTROL Outputs are Exclusive to Compatible Switches.

The rear-panel REMOTE CONTROL outputs are not intended as general-purpose switch drives. The output should only be used with compatible RF switches.

Frequency Measurements (RF, LO, IF) Contents

RF INPUT FREQUENCY MEASUREMENTS

RF Input Frequency 3-137
- How to measure the frequency of the RF input signal.

RF Frequency Tuning 3-141
- How to select the different automatic and manual tune modes.

RF Frequency Error 3-147
- How to measure the difference between the input frequency and the frequency to which the instrument is tuned.

IF FREQUENCY

IF Frequency 3-151
- How to measure the instrument's IF frequency (the down-converted RF input signal).

LO FREQUENCY

LO Frequency 3-153
- How to measure the instrument's local oscillator (LO) frequency.

LO Input and LO Output 3-155
- How to provide an input for an external LO.
- How to provide an output for the internal LO.

GENERAL FREQUENCY MEASUREMENT FUNCTIONS

RF Frequency Resolution 3-157
- How to manually set the display resolution (except audio frequency).

RF Input Frequency

FUNCTIONS

FREQ

DESCRIPTION

The Measuring Receiver can measure RF input signals from 150 kHz to 1300 MHz. (Higher frequencies can be measured using an external mixer as described in *Frequency Offset Control* on page 3-255 .)

To count input frequencies between 2.5 and 1300 MHz, the Measuring Receiver uses heterodyning; to count input frequencies from 150 kHz to 2.5 MHz, it counts the input directly.

In most circumstances, when using manual tuning and when the approximate frequency is known, the instrument can count signals with power levels less than −60 dBm. When used in conjunction with Tuned RF Level, the range can be extended below −100 dBm.

PROCEDURE

To make an input frequency measurement, first tune the instrument to the input signal (select AUTOMATIC OPERATION or refer to *RF Frequency Tuning* on page 3-141 to learn about more ways to tune the Measuring Receiver.) Select FREQ.

Manual tuning will be necessary when measuring low-level signals (inputs less than −25 dBm from 150 kHz to 650 MHz or less than −20 dBm from 650 to 1300 MHz).

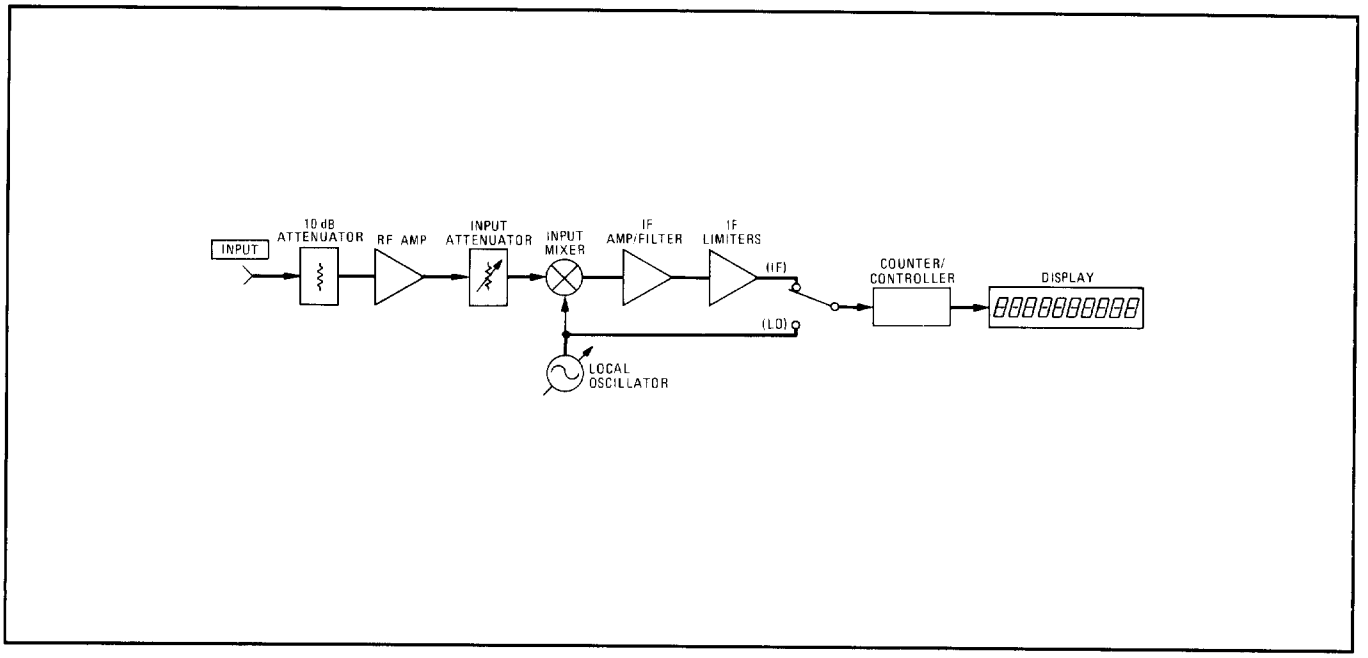
HP-IB PROGRAM CODE

FREQ = M5

MEASUREMENT TECHNIQUE

For input frequencies between 2.5 and 1300 MHz, the Measuring Receiver tunes its local oscillator (LO) to the signal and down-converts it to an intermediate frequency (IF). The IF signal is amplified, limited, and counted. The LO frequency is also counted. The IF is subtracted from the LO frequency and the result is displayed.

For input frequencies below 2.5 MHz the RF input signal passes directly into the IF without down-conversion. The IF is counted and displayed.



RF Input Frequency Measurement Block Diagram

COMMENTS

Input/Output Status.

When the instrument is measuring input frequency, the output signal at MODULATION OUTPUT/AUDIO INPUT represents the last modulation measurement made as indicated by the MODULATION OUTPUT annunciator.

Relative Measurements.

If RF frequency is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-243.)

Increasing Measurement Sensitivity.

The RF Amplifier can be inserted (using Special Function 1) to increase the Measuring Receiver's sensitivity when the input signal level is less than −25 dBm. (Refer to *RF Input Attenuation and Gain* on page 3-265.)

Limiting Low-Level Signal Measurements.

When the Error Message Disable Control special function is in the automatic selection mode (Special Function 8.0), very low-level signals can be counted without generating error messages (Error 03 for example). However, other Special Function 8 codes enable error messages at much higher signal levels. (Refer to *Error Message Disable Control* on page 3-267.)

Centering the IF Does Not Affect Frequency Measurements.

It is important to note that when FREQ is selected, the IF need not be exactly centered to make valid frequency measurements. A frequency is displayed as long as a signal is present in the IF. Using the kHz (up arrow) or kHz (down arrow) functions will not change the displayed input frequency

even though tuning has been altered. If desired, the frequency error function can be used to indicate tuning error if desired.

Frequency Agile Sources.

For best results, use the manual-tune mode when working with frequency agile sources. With agile frequency sources (such as frequency synthesizers), it is possible for the carrier or its harmonics to hop unexpectedly into the IF passband either directly (for frequencies below 2.5 MHz), by normal down-conversion, or by down-conversion of an image (the signal frequency minus the LO approximately equals the IF). Depending on the frequency, amplitude, and timing of the signal source and the tuning mode of the Measuring Receiver, a tuning error may or may not be sensed. If the instrument does not retune, frequency and level measurement results may not be as expected.

When Measuring Frequency Agile Sources or Multiple Signal Sources.

Whenever tuning to signals less than 2.5 MHz, the input signal passes directly into the IF. The LO is used only to turn on the mixer. However, since the Measuring Receiver arbitrarily sets the LO to 101.5 MHz, a passband is created from 99 to 104 MHz. If this frequency band causes a measurement problem, manually tune the LO so the passband for the down converted signal falls in an unoccupied region of the input spectrum. This method is not a preferred way to make measurements, but it might enable you to make some desired measurements. Note that when using this method you should disable Error 01 (by selecting 8.1 SPCL) to prevent the Measuring Receiver from trying to tune to a down-converted signal rather than the signal that is less than 2.5 MHz.

Manual Tuning.

When tuning manually, it is possible to accidentally adjust the LO so that the input signal falls in the image passband; for example, when using the kHz (up arrow) and kHz (down arrow) keys. Frequency measurements are inaccurate when the instrument is tuned to an image. (Refer to *RF Frequency Tuning* on page 3-141 for an illustration of the image passbands.)

Measuring Frequencies below −60 dBm.

The high gain of the IF Amplifier and Limiters makes it possible to measure the frequency of input signals below −60 dBm. In automatic tuning, the instrument tunes to the strongest signal at the input. When manually tuned to the approximate input frequency, the instrument ignores more powerful signals when they or their images fall outside the IF passband.

Extend the range of measurable signal levels for automatic and manual tuning by inserting the RF amplifier (Special Function 1). (Refer to *RF Input Attenuation and Gain* on page 3-265.)

Input/Output Status.

When the FREQ key selected, the MODULATION OUTPUT signal continues to be the last selected modulation signal, filtered, and/or de-emphasized (except PRE DISPLAY) as previously selected (as indicated by the MODULATION OUTPUT annunciator). Calibration of this output depends on the IF signal level and should be assumed only when all errors are enabled (Special Function 8.8).

RF Frequency Tuning

FUNCTIONS

TRACK MODE, AUTO TUNING, DISPLAY FREQ INCR, kHz ⇑ and kHz ⇓ keys

DESCRIPTION

The Measuring Receiver is considered tuned to an input signal when the frequency of the Local Oscillator (LO) produces an IF signal centered in the IF passband. Normally the LO frequency is tuned either 1.5 MHz or 455 kHz above the input signal, depending on which IF is selected. When the input signal is less than 2.5 MHz, the LO is tuned to 101.5 MHz and the input passes directly into the IF.

The Measuring Receiver can be automatically or manually tuned to the input signal:

In automatic tuning, the instrument searches for the presence of a signal over the entire input spectrum. Once found, the LO is tuned so that the signal is centered properly in the IF.

In manual tuning, the desired input frequency is entered via the numeric keyboard or kHz ⇑ and kHz ⇓ keys, and the LO is tuned so that a signal of that frequency would be centered properly in the IF.

For both of these tuning modes, the LO can be configured to lock itself to an internal crystal oscillator (for low-noise measurements) or to track the input signal as it drifts (keeping the down-converted signal centered in the IF).

The four tuning modes are listed below:

- Automatic Tuning; Low-noise LO
- Automatic Tuning; Track Mode,
- Manual Tuning; Low-noise LO, and
- Manual Tuning; Track Mode.

Automatic Tuning–Low-Noise LO.

If not already tuned, the Measuring Receiver searches throughout its frequency range for an input signal. If two input signals have similar power levels, the higher frequency signal is usually selected. The RF input signal's second and third harmonic levels must be at least 10 dB below the level of the fundamental, and all other signals at the input must be at least 30 dB below the level of the desired signal. Once tuned, the LO is locked to an internal, voltage-controlled, crystal oscillator for highly-stable, low-noise measurements. Tuning is maintained as long as a detectable signal is present. If the input signal disappears (drops below −20 to −25 dBm), the Measuring Receiver initiates a signal search. This tuning mode is selected whenever Automatic Operation is pressed and when the instrument powers-up.

Automatic Tuning–Track Mode.

The instrument searches for the input signal in the same way as described in the previous paragraph; however, it does not lock to the internal reference oscillator. Instead, the LO is locked to the input signal itself and tracks it as it drifts. This function is useful for checking modulation or level as a function of carrier frequency. If the input signal disappears (for example, when the LO switches bands) the Measuring Receiver searches for, and re-acquires the input signal. Track Mode tuning is not allowed with the 455 kHz IF or with input signals below 10 MHz. Track Mode tuning somewhat attenuates low-rate FM on the input signal; thus, FM measurements should only be made in track

mode when modulation rates exceed 1 kHz. Also, Track Mode tuning is not recommended where optimum noise performance is required.

Manual Tuning–Low-Noise LO.

The instrument tunes to the frequency keyed into it, via the keyboard, regardless of whether a signal is present. Once tuned, the LO is locked to an internal voltage-controlled, crystal oscillator for high stability and low noise. Once locked, tuning does not change unless a new frequency is entered, Track Mode is selected, the tuning is stepped up or down using the kHz ⇑ or kHz ⇓ keys, Automatic Operation or Instrument Preset is selected. The manual tune mode is entered immediately when either MHz, kHz ⇑, or kHz ⇓ is selected; or if Range Hold is selected. (Note that this tune mode can be used for tuned RF level measurements when used in conjunction with Special Function 32.9.[1] Refer to *Tuned RF Level* comment, "32.9 SPCL: Tuned RF Level Measurements Using Track-Mode Tuning" on page 3-105.)

Manual Tuning–Track Mode.

The Measuring Receiver tunes to the keyed-in frequency in the same way as described in the previous paragraph. However, the LO is not locked to an internal oscillator; instead the LO is locked to the input signal itself and tracks it as it drifts. This function is useful for measuring second or third harmonic signals and for tracking spurious signals.

PROCEDURE

Select FREQ.

Tune Mode Selection:

- Select automatic tuning with AUTOMATIC OPERATION or AUTO TUNING (Blue Key, TRACK MODE).
- Select manual tuning with either MHz or one of the kHz keys (with or without a preceding numeric entry), or with RANGE HOLD.
- Select track mode with TRACK MODE. (Return from the track mode to the low-noise mode, by selecting TRACK MODE again.)

Manual Tuning by Keyboard Entry:

To manually tune to a specific signal frequency, enter the frequency in MHz via the numeric keyboard, then press the MHz key.

The MHz key can also be used alone to aid in tuning: if the Measuring Receiver is tuned close but not exactly to the input signal, select MHz to center the signal in the IF passband. If in automatic tuning mode, and no signal is present, select MHz alone to tune the Measuring Receiver to the last frequency at which a signal was successfully tuned. (If no previous successful tuning has been made, the Measuring Receiver tunes to 100 MHz.)

RF Frequency Stepping:

To step the tuning of the Measuring Receiver, enter the desired frequency step size in kHz via the numeric keyboard, then press either kHz ⇑ or kHz ⇓. Once the step size has been set, either kHz key will change the tuning by that step size each time the key is pressed. (At power-up, the step size is set to 0 kHz.)

[1] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

HP-IB PROGRAM CODES

When operating the Measuring Receiver via HP-IB, the units for the frequency steps can be either Hz or kHz.

AUTO TUNING = AT
AUTOMATIC OPERATION = AU
Display Frequency = FR
Display Increment = FN
Hz, Input Frequency Entry = HZ
MHz, Input Frequency Entry = MZ
Ranging Automatic = G0
RANGE HOLD = G1
Step Up (Hz) = HU
Step Down (Hz) = HD
Step Up (kHz) = KU
Step Down (kHz) = KD
TRACK MODE off = K0
TRACK MODE on = K1

COMMENTS

RF Frequency Stepping.

Using the kHz ⇑ and kHz ⇓ keys, the tuning of the Measuring Receiver can be changed by a selectable frequency step (in kHz). This feature is most often used in conjunction with the frequency error function. The kHz keys can be used regardless of tune mode, but when pressed, the tuning mode reverts to manual tuning. If these keys are pressed in an automatic tuning mode, the instrument will tune tuning to the last successfully tuned frequency plus or minus the frequency step. Once a frequency step is entered on the keyboard (refer to "PROCEDURE"), pressing either of the kHz keys alone will change tuning by that step size until a new step frequency is defined. At power-up, the step size is zero.

HP-IB

RF frequencies can be changed in fundamental-units (Hz) steps via the HP-IB. These steps are not possible from the front panel:

Hz Step Up = HU
Hz Step Down = HD

Tuning to Signals with Low-Rate, High-Deviation FM.

The instrument will not automatically tune to a signal that has low-rate, high-deviation FM. Use a manual tune mode to measure such signals.

Tuning to Signals with Narrow-Band FM and ΦM.

The automatic tuning, low-noise LO mode is adequate for most common measurements. It should always be used for measuring narrow-band FM and ΦM.

Measuring Flatness as a Function of Carrier Frequency.

Automatic tuning, track mode is useful for measuring modulation or peak tuned RF level flatness as a function of carrier frequency. (Select Peak Tuned RF Level with Special Function 36.)

Tuning to Low-Level Signals.

Manual tuning, low-noise mode should be used with signals that may drop below the minimum threshold for automatic tuning. Manual tuning makes it possible to make tuned modulation and frequency measurements on very low-level signals.

Measuring Drift.

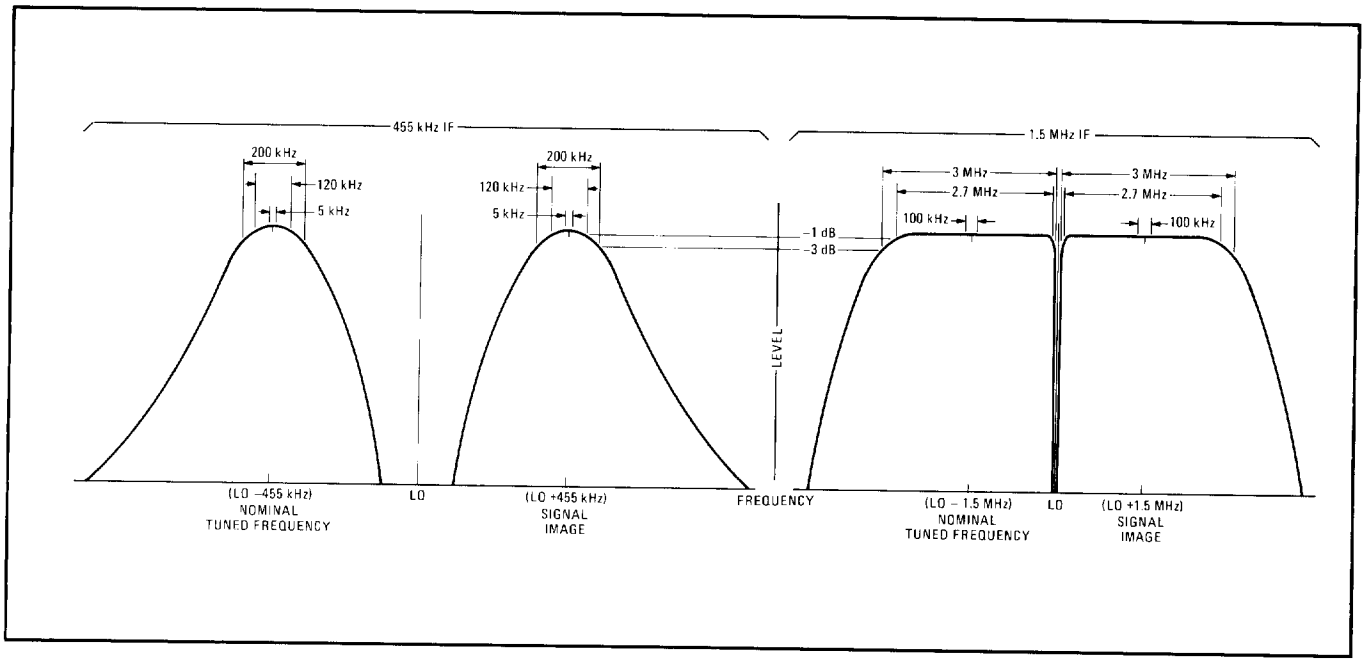
Manual tuning, track mode is useful for measuring drift on low-level signals in the presence of higher-level signals.

Determine Tuning Accuracy.

When manually tuning or frequency stepping, use the frequency error measurement to determine tuning accuracy.

Image Frequencies.

When the Measuring Receiver tunes to an input signal greater than 2.5 MHz, the IF frequency positions the internal LO above the nominal tuning. The Measuring Receiver, however, will respond equally well to a signal at the image frequency, that is, when the signal frequency minus the LO is within the IF passband. (For example, if the LO is at 101.5 MHz, signals at either 100 MHz or 103 MHz (the image) generate a 1.5 MHz IF.) When the instrument is tuned to an image, measurement errors may result with no Error Message displayed. (The input frequency measurement will always be in error. For FM and ΦM measurements, the Peak+ and Peak− functions are reversed. One way to solve this problem is to step the tuning down by twice the IF frequency, or let the instrument automatically tune. The following IF response plot illustrates the image passbands for each IF frequency. (Tuned RF Level does not apply.)



455 kHz and 1.5 MHz IF Passband Responses

When Measuring Frequency Agile Sources or Multiple Signal Sources.

Whenever tuning to signals less than 2.5 MHz, the input signal passes directly into the IF. The LO is used only to turn on the mixer. However, since the Measuring Receiver arbitrarily sets the LO to 101.5 MHz, a passband is created from 99 to 104 MHz. If this frequency band causes a measurement problem, manually tune the LO so the passband for the down converted signal falls in an unoccupied region of the input spectrum. This method is not a preferred way to make measurements, but it might enable you to make some desired measurements. Note that when using this method you should disable Error 01 (by selecting 8.1 SPCL) to prevent the Measuring Receiver from trying to tune to a down-converted signal rather than the signal that is less than 2.5 MHz.

Frequencies Greater Than 10 MHz.

When making measurements on inputs with frequencies greater than 10 MHz, signals present at the input that are less than 2.5 MHz pass directly into the IF. These low-frequency signals can be removed by inserting the RF input high-pass filter. (Refer to *Filters, RF and IF* on page 3-259).

Searching for a Signal.

When manually tuning, often the exact input frequency is unknown. If during tuning, Error 01 (signal out of IF range) is displayed, select the MHz key alone to center the signal in the IF. Also, if searching for a signal using the kHz keys, it is best to search down from above the signal frequency while monitoring IF LEVEL. (Refer to *IF Level* on page 3-109.) When the IF level rises significantly, switch to FREQ ERROR and enter the displayed value as a frequency step and complete tuning using the kHz keys.

Default Conditions.

When the Instrument Preset key is pressed, or on power-up, the Measuring Receiver selects the automatic tuning, low-noise LO mode.

Responding to Frequency Changes.

Using the automatic tune mode, the Measuring Receiver might not retune when the frequency changes, but its spectrum still has sufficient power within the tuned passband of the Measuring Receiver's RF INPUT. It will appear that the carrier simply changed its level. If the instrument does not retune, frequency and level measurement results might not be as expected. Use a manual tune mode, if possible, in the following situations:

- When working with frequency agile sources (such as frequency synthesizers) that have a frequency hopping function.
- When changing frequency in harmonic steps.

Extending Tuned Measurements Below 2.5 MHz.

Use the following procedure to extend the range of tuned measurements below 2.5 MHz.

NOTE

Only the 455 kHz IF can be selected. The minimum input frequency is 795 kHz. Measurement accuracy may be degraded. IF signal may appear at the modulation monitoring connectors.

1. Select INSTR PRESET (Blue Key, AUTOMATIC OPERATION).
2. Set the signal source to a carrier frequency between 3 and 9 MHz and to the level of the intended measurement.
3. Connect the signal source to the Measuring Receiver's INPUT (or to a properly connected sensor module). Allow the Measuring Receiver to tune to the input signal.
4. Select RANGE HOLD. Select DISABLE ERROR (Blue Key, RANGE HOLD).
5. Enter the frequency value of the input signal and retune the signal source to that frequency.
6. Select the desired measurement mode. (RANGE HOLD and DISABLE ERROR can be released at this time. RANGE HOLD must be released for Tuned RF Level.)

RF Frequency Error

FUNCTIONS

FREQ ERROR

DESCRIPTION

The Frequency Error function enables the Measuring Receiver to measure the difference (in kHz) between the RF input signal frequency and the frequency to which the instrument is tuned. This function can be used to observe frequency drift of input signals, or to compare input frequencies against a keyboard-entered reference.

Display resolution is controlled by Special Function 7. (Refer to *RF Frequency Resolution* on page 3-157.)

PROCEDURE

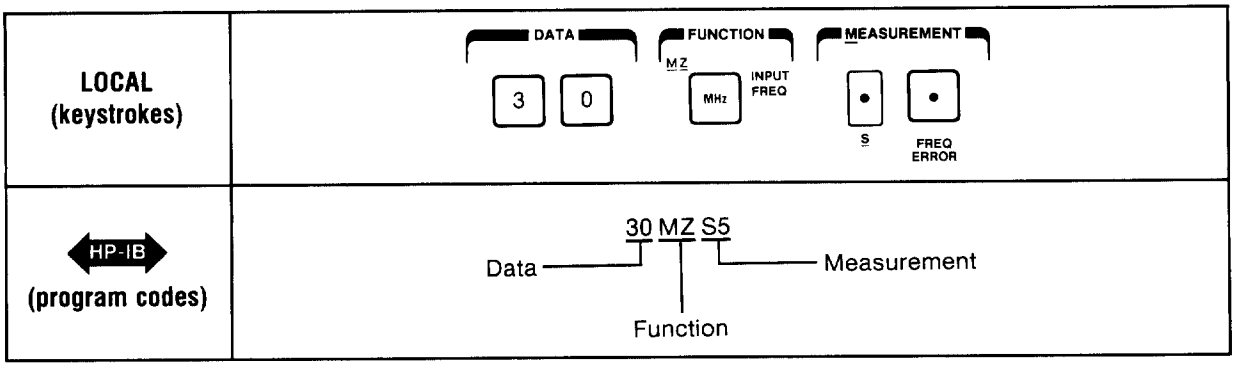
To make the RF frequency error measurement, connect the RF signal to the Measuring Receiver's RF INPUT.

If a frequency drift measurement is to be made, first allow the Measuring Receiver to automatically tune to the signal, then select the MHz key to prevent retuning. Select FREQ ERROR (Shift, FREQ) to display the frequency error. As the signal drifts the display indicates the magnitude and direction of the drift.

To make a frequency comparison, enter the reference frequency (in MHz) on the keyboard, then select MHz. Select FREQ ERROR to display the difference frequency. The number is negative if the signal frequency is lower than the reference, and positive if the signal frequency is higher than the reference. Valid frequency error measurements are made as long as the down-converted signal remains in the IF passband. (Refer to *RF Frequency Tuning* on page 3-141.)

EXAMPLE

To measure the error of an oscillator designed to operate at 30 MHz, connect the oscillator's output to the Measuring Receiver's RF INPUT connector and select the following keystrokes:



HP-IB PROGRAM CODES

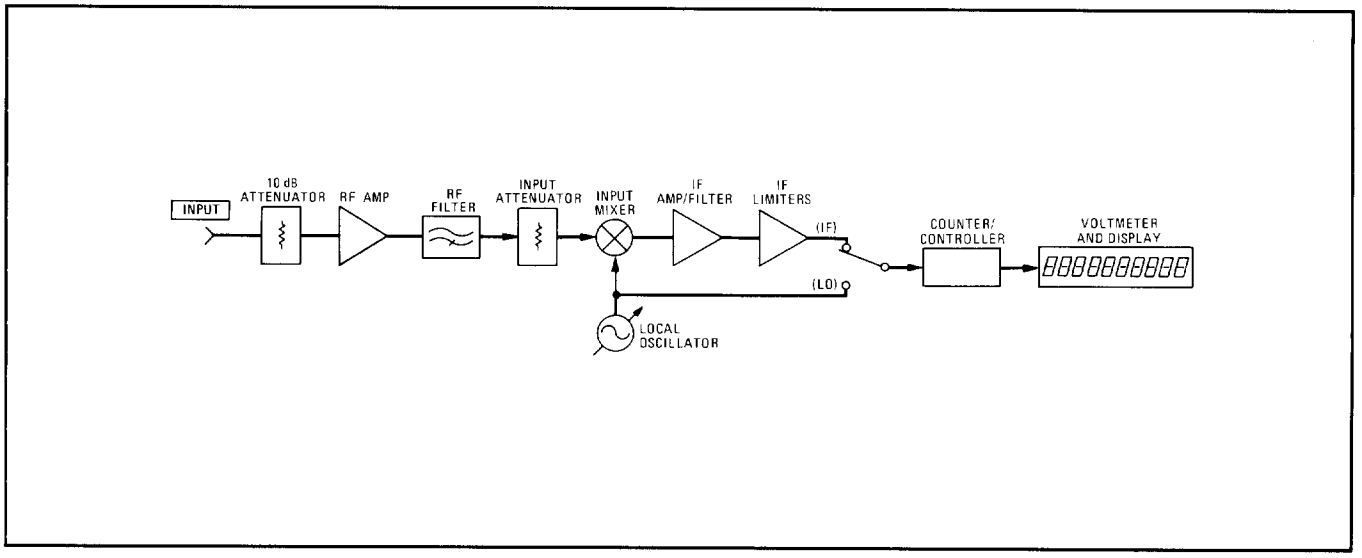
FREQ ERROR = S5
MHz = MZ

MEASUREMENT TECHNIQUE

When the Measuring Receiver is tuned, the IF signal is amplified and limited. If manually tuned, the RF input frequency is measured and compared to either the keyboard-entered frequency or to the frequency measured after the MHz key is pressed. The frequency difference is displayed as frequency error.

If the Measuring Receiver is automatically tuned, two methods of determining frequency error are used:

- When the input signal is greater than 2.5 MHz, the frequency of the actual IF signal is subtracted from the selected IF frequency (455 kHz or 1.5 MHz) to determine the frequency error.
- When the input signal is less than 2.5 MHz, the input signal is passed directly into the IF without down-conversion. When the signal is first located, the frequency is counted. When the FREQ ERROR key is selected, this first-counted frequency becomes the reference. Subsequent frequency counts are subtracted from this reference, and the results are displayed as frequency error.



RF Frequency Error Measurement Block Diagram

COMMENTS

Down-Converted Signals.

The down-converted RF input frequency must fall within the passband of the IF being used. For the 1.5 MHz IF, the passband is approximately 3 MHz wide. For the 455 kHz IF, the passband is approximately 200 kHz wide.

Input/Output Status.

When the instrument is measuring frequency error, the output signal available at MODULATION OUTPUT/AUDIO INPUT is the same as for the last modulation measurement (as indicated by the MODULATION OUTPUT annunciator).

Relative Measurements.

If frequency error is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Use Manual Tuning for Best Measurements.

The frequency error function can be used with the automatic tuning low-noise LO tune mode, but it is most valuable when used with manual tuning (normal or Track Mode). It is not recommended that frequency error be used when in automatic tuning track mode, since an inherent tuning offset exists in this mode.

Step Frequency Aids Multi-Channel Measurements.

Check channel accuracy on multi-channel transmitters using the frequency error function in conjunction with the kHz ↑ and kHz ↓ keys. Set the step frequency to the channel spacing to quickly determine the accuracy of evenly-spaced channels.

LO in Image Passband Distorts Measurements.

When tuning manually, it is possible to accidentally adjust the LO so that the input falls in the image passband; for example, when using the kHz ⇑ and kHz ⇓ keys. Frequency error measurements are inaccurate when the input image enters the IF passband. Refer to *RF Frequency Tuning* on page 3-141 for an illustration of the image passbands.

Changing Resolution.

Normally, the counter updates the display five times each second. For selection of other resolutions, use Special Function 7. (Refer to *RF Frequency Resolution* on page 3-157.) Counter accuracy is the reference accuracy ±3 counts.

Input/Output Status.

When the Frequency Error function is selected, MODULATION OUTPUT/AUDIO INPUT continues to output the last-selected modulation signal, filtered and/or de-emphasized (except PRE DISPLAY) as previously selected. The calibration of this output depends on the input signal level and should be assumed only when all errors are enabled (Special Function 8.8).

Parts Per Million Display.

To display frequency error in parts per million (ppm), first display the frequency error, then enter 1/10 the reference frequency (in MHz) as a ratio reference, and select RATIO. The display shows the frequency error in parts per million.

IF Frequency

FUNCTIONS

Special Function 34 (IF Frequency)

DESCRIPTION

The Measuring Receiver makes tuned (down-converted, heterodyned) measurements on its RF input signal using one of two IF frequencies. Three combinations of tuning and IF selection are used:

1. When RF input signals less than 2.5 MHz are measured, the RF input signal passes directly into the IF without down-conversion; that is, the RF input frequency and the IF frequency are the same. (Tuned measurements can be manually extended below 2.5 MHz. Refer to *RF Frequency Tuning* on page 3-141.)
2. When RF input signals greater than 2.5 MHz, but less than 10 MHz are measured, the signal is down-converted to a 455 kHz IF. (The 455 kHz IF is also selected when making the Tuned RF Level measurements; irrespective of RF frequency.)
3. When RF input signals greater than 10 MHz are measured, the signal is down-converted to a 1.5 MHz IF. (Note that special Function 3 can be used to select the 455 kHz IF. Refer to *Filters, RF and IF* on page 3-259.)

Special Function 34.0 enables the Measuring Receiver to measure and display the IF frequency for the signal being measured.

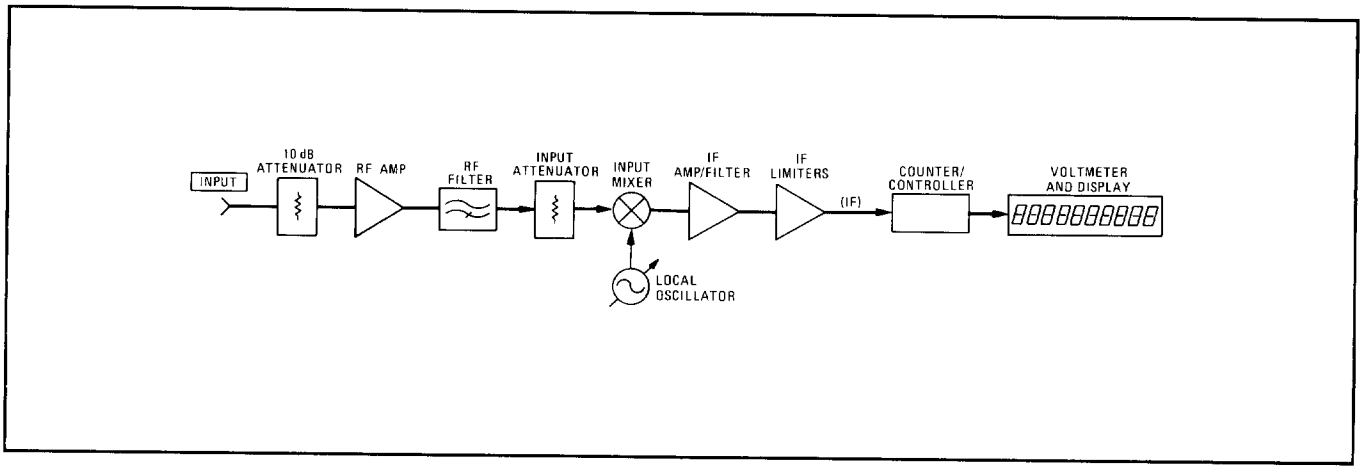
PROCEDURE

To measure the IF frequency, key in 34.0 SPCL.

MEASUREMENT TECHNIQUE

The IF signal, generated when the Local Oscillator and the RF input signal mix, is amplified by the IF Amplifier and FM Limiters and then counted. The IF frequency is displayed when Special Function 34 is used. When measuring RF input frequencies greater than 2.5 MHz, the Measuring Receiver uses either the 455 kHz or 1.5 MHz IF. For RF input frequencies less than 2.5 MHz, down-conversion is not normally used and the RF input signal passes directly into the IF.

BLOCK DIAGRAM



IF Frequency Measurement Block Diagram

COMMENTS

Input/Output Status.

When the instrument is measuring IF frequency, the signal at MODULATION OUTPUT/AUDIO INPUT remains unchanged.

Relative Measurements.

If IF frequency is to be displayed relative to a reference, enter the ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Frequency Resolution.

Normally, the counter updates the display five times each second. For selection of other resolutions, use Special Function 7. (Refer to *RF Frequency Resolution* on page 3-157.) Counter accuracy is the reference accuracy ±3 counts.

IF Filter Selection.

IF filter selection is dependent on the selected IF Frequency. (Refer to *Filters, RF and IF* on page 3-259.)

When using the 455 kHz IF on input signals with frequencies greater than 300 MHz, incidental AM (that is, AM due to FM) increases substantially.

RF Input Frequency Calculation.

The Measuring Receiver determines the frequency of the RF input signal by counting the frequencies of both the IF and LO and calculating their difference.

IF Frequency Accuracy.

The IF frequency need not be exactly its nominal value in order to guarantee accurate modulation measurements. Unless specifically overridden by Special Function 8 or DISABLE ERROR (Blue Key, RANGE HOLD), Error Messages safeguard the measurements. (Refer to *Error Message Disable Control* on page 3-267 and *RF Frequency Tuning* on page 3-141.)

LO Frequency

FUNCTIONS

Special Function 33 (LO Frequency)

DESCRIPTION

Special Function 33.0 enables the Measuring Receiver to display the local oscillator (LO) frequency.

PROCEDURE

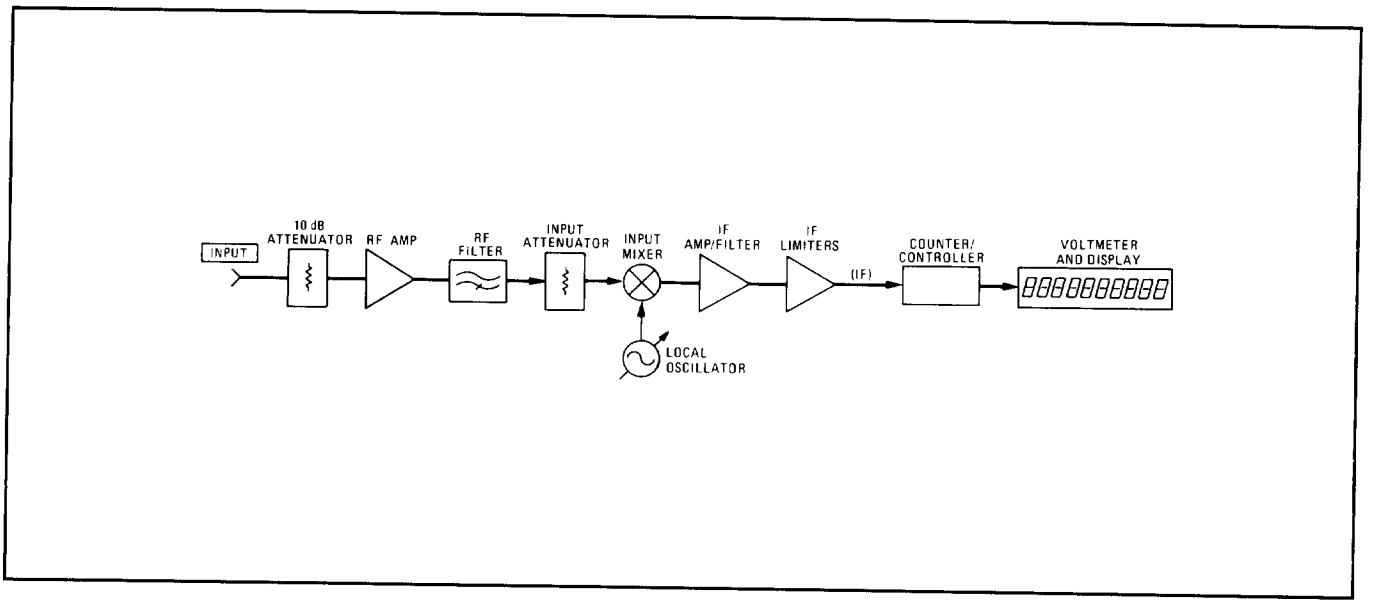
To measure the LO frequency, key in 33.0 SPCL.

MEASUREMENT TECHNIQUE

The LO frequency is essentially measured directly by the counter. The frequency that the LO is tuned to depends on (1) whether automatic tuning or manual tuning is being used, (2) whether the RF input signal is being down-converted, and (3) which IF is being used. The following table summarizes LO tuning. (Refer to *RF Frequency Tuning* on page 3-141 for more information.)

Tuning Mode	Down Conversion	Selected IF	Approximate LO Frequency
Automatic	Yes	1.5 MHz	Input + IF
	Yes	455 kHz	Input + IF
	No	1.5 MHz	101.5 MHz
Manual	Yes	1.5 MHz	Keyed In + IF
	Yes	455 kHz	Keyed In + IF
	No	1.5 MHz	101.5 MHz

BLOCK DIAGRAM



LO Frequency Measurement BLOCK DIAGRAM

COMMENTS

Input/Output Status.

When the instrument is measuring the LO frequency, the signal at MODULATION OUTPUT/ AUDIO INPUT remains unchanged.

Relative Measurements.

If the LO frequency is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Display Resolution.

Normally, the counter updates the display five times each second. For selection of other resolutions, use Special Function 7. (Refer to *RF Frequency Resolution* on page 3-157.) Counter accuracy is the reference accuracy ±3 counts.

LO Does Not Phase Lock to INPUT.

In general, LO tuning is never exact but is close enough to give calibrated measurements. The LO does not phase lock to the RF input signal.

LO Frequency for INPUT Less Than 2.5 MHz.

When the RF input signal is less than 2.5 MHz, the LO frequency is set to 101.5 MHz. This frequency is arbitrary. The LO must remain on to allow the RF input signal to pass through the input mixer. Note that 101.5 MHz is the frequency the LO is set to for a 100 MHz RF input signal with an IF of 1.5 MHz.

LO Input and LO Output (Option 003)

CAUTION

Do not apply greater than 40 Vdc or +5 dBm of RF power into the LO INPUT or damage to the instrument may result. Do not apply dc voltage or RF power into the LO OUTPUT or damage to the instrument may result.

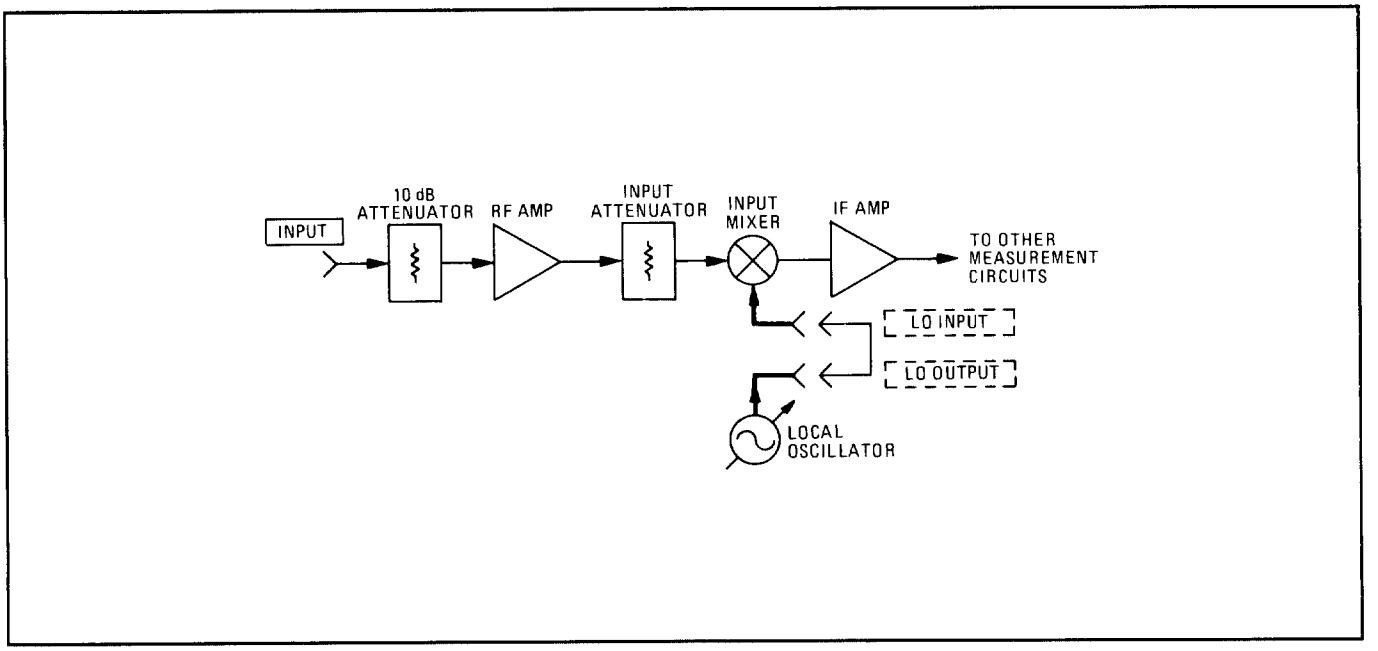
DESCRIPTION

In Measuring Receivers with Option 003, the internal local oscillator (LO) signal is routed through the rear-panel LO OUTPUT and LO INPUT connectors. The range of the LO signal is 1.27 MHz to 1301.5 MHz, at approximately 0 dBm. Both connectors are 50Ω, ac-coupled, Type-N connectors.

NOTE

The rear-panel LO OUTPUT must be connected to the rear-panel LO INPUT for normal Measuring Receiver operation that uses the internal local oscillator.

BLOCK DIAGRAM



LO Input and LO Output Block Diagram

PROCEDURE

To use LO OUTPUT as a signal source:

1. Select an IF frequency of either 1.5 MHz or 455 kHz using Special Function 3. (If the IF frequency is not specified, the Measuring Receiver will assume the 1.5 MHz IF for keyboard-entered frequencies greater than 10 MHz and the 455 kHz IF for frequencies less than 10 MHz but greater than 2.5 MHz.)
2. Subtract the IF frequency from the frequency desired at LO OUTPUT, and enter the result, in MHz, via the numeric keys; then press the MHz key. (To tune the LO below 2.96 MHz, use the procedure as described, but select the 455 kHz IF using Special Function code 3.1, and disable Error 01 using Special Function code 8.1.)
3. Connect the LO OUTPUT to the desired input.

The LO frequency can be monitored using Special Function 33. (Refer to *LO Frequency* on page 3-153.)

To use an external source as the LO INPUT:

1. Select an IF frequency (1.5 MHz or 455 kHz) using Special Function 3.
2. Press the MHz key to enter manual tune mode (to prevent the internal LO from continuously tuning).
3. Add the IF frequency to the frequency to which the Measuring Receiver is to be tuned, and set the external LO to that frequency.
4. Adjust the external LO to 0 dBm and connect it to the LO INPUT.

COMMENTS

Using the LO OUTPUT.

LO tuning is not exact. The instrument tunes the LO only close enough to make calibrated measurements.

Using the LO INPUT.

To tune to inputs below 2.5 MHz with an external LO, select the 1.5 MHz IF, but set the LO to approximately 100 MHz. LO signal is required for the Input Mixer to function even when down-conversion is not desired.

Invalid Frequency Measurements (RF and LO).

When an external LO is used, measurements made using the FREQ or FREQ ERROR keys are invalid. To determine input frequency, subtract the IF frequency (34.0 SPCL) from the LO frequency used.

The LO frequency function (33.0 SPCL) continues to measure the internal LO.

FM Transients Using an External LO.

When using an external LO, rapid changes in LO frequency within the IF passband cause FM transients. Several seconds are then required before accurate measurements are possible. To avoid the problem, turn off the external LO when switching its frequency.

RF Frequency Resolution

FUNCTIONS

Special Function 7 (RF Frequency Resolution)

DESCRIPTION

When making RF measurements, the frequency resolution can be manually set using Special Function 7.

When RF frequency measurements are made, the Measuring Receiver normally updates the display five times each second. The instrument automatically selects 10 Hz resolution for frequencies below approximately 2.5 MHz; 100 Hz resolution for frequencies from approximately 2.5 to approximately 320 MHz; and 1000 Hz resolution for frequencies greater than approximately 320 MHz. Use the numeric keyboard and the SPCL key to set the frequency resolution to either 1000, 100, or 10 Hz. (A resolution of 0.1 Hz or 1 Hz can be selected for RF frequency measurements.)

Special Function 7 sets the measurement resolution for RF Input Frequency, RF Frequency Error, IF Frequency, and LO Frequency Measurements.

PROCEDURE

To set the frequency resolution to a selected range or to re-enter the automatic selection mode, key in the corresponding Special Function code, then SPCL: (Note that with finer resolution, measurement time increases.)

7.0 Automatic selection.

7.1 Resolution of 10 Hz.

7.2 Resolution of 100 Hz.

7.3 Resolution of 1 kHz.

7.4 [1] (Applies to RF Frequency measurements only; other measurements treat 7.4 as 7.1.) Resolution of 0.1 Hz for input signals less than 10.1 MHz; resolution of 1 Hz for signals from 10.1 MHz through 1300 MHz. (When measuring frequencies as high as 1300 MHz, measurement time with this resolution is approximately 20 seconds.)

COMMENTS

Change Resolution Any Time.

The Measuring Receiver need not be making RF frequency measurements in order to change resolution modes; however, the resolution mode only affects RF frequency-related measurements. Counter accuracy is the reference accuracy +3 counts.

RF Frequency Measurements Greater Than 20 GHz

When making RF frequency measurements greater than 20 GHz, 7.1 SPCL selects 100 Hz resolution.

[1] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

Modulation Measurements Contents

AM

AM 3-161
- How to measure AM depth.

AM ALC Response Time 3-165
- How to optimize AM ALC response time vs. modulation rate.
- How to turn ALC off.

AM Calibration 3-167
- How to verify AM calibration.

AM Output 3-173
- How to use the rear-panel AM OUTPUT to obtain demodulated AM.

FM

FM 3-177
- How to measure FM deviation.

FM Calibration 3-181
- How to verify FM calibration.

FM De-Emphasis 3-187
- How to equalize pre-emphasized FM signals.

FM Output 3-191
- How to use the rear-panel FM OUTPUT to obtain demodulated FM.

Tone-Burst Receiver 3-193
- How to set up the instrument to output demodulated squelch-tone bursts.

ΦM

ΦM 3-197
- How to measure ΦM deviation.

AUDIO DETECTORS

Audio Detectors 3-201
- How to select the peak, average, and rms audio detectors.

Audio Detector Response 3-205
- How to trade off readability of noisy signals for measurement time.

GENERAL MODULATION MEASUREMENT FUNCTIONS

Audio Filters 3-207
- How to select the high-pass and low-pass noise filters which filter the demodulated signal.

Audio Range 3-211
- How to vary the display resolution and MODULATION OUTPUT sensitivity.

Modulation Output/Audio Input 3-215
- How to use the MODULATION OUTPUT/AUDIO INPUT to obtain the demodulated, audio signal.
- How to use the MODULATION OUTPUT/AUDIO INPUT to input an external audio signal for audio analysis.

Residual Noise Effects 3-219
- How to account for noise to make the most accurate peak-modulation measurements.

AM

FUNCTIONS

AM, Special Function 2 (Audio Range)

DESCRIPTION

Selecting AM enables the Measuring Receiver to measure the AM depth of the tuned RF input signal. (Selecting Special Function 2 sets measurement limits on the range of AM depth at the same time a specific display resolution is set.)

AM measurements are specified for rates from 20 Hz to 10 kHz for carrier frequencies 10 MHz and below (or whenever the 455 kHz IF is used) and from 20 Hz to 100 kHz for carrier frequencies from 10 to 1300 MHz (1.5 MHz IF only). The corresponding 3 dB audio bandwidths are approximately 0.5 Hz to 15 kHz for carriers 10 MHz and below (or with the 455 kHz IF) and approximately 0.5 Hz to 260 kHz for carriers from 10 to 1300 MHz (1.5 MHz IF only). (Special Function 6.1 will modify the lower frequency.) Modulation depths to 99% can be measured.

The demodulated signal's frequency and distortion can also be measured. (Refer to *Audio Measurements* section which starts on page 3-225.)

PROCEDURE

To make an AM measurement, first tune the instrument to the input signal by selecting AUTOMATIC OPERATION. Select AM.

Select an audio detector: PEAK+, PEAK−, PEAK±/2, AVG, or RMS. The RMS detector (Blue Key, AVG) is less accurate than the other detectors in measuring AM, has a reduced bandwidth, and is typically only used for audio distortion measurements.

The following table lists the different measurement range limits that can be selected with Special Function 2:

Modulation Range Peak± (%)	Detector Selected	Special Function Code	Program Code (HP-IB)	Display Resolution (%)	MODULATION OUTPUT Sensitivity (Vac/% AM)
Automatic Selection		2.0 SPCL	2.0SP	Automatic Selection	
≤4	RMS	2.4 SPCL	2.4SP	0.001	0.1
≤40	Pk, Avg	2.4 SPCL	2.4SP	0.01	0.1
≤40	Pk, Avg, RMS	2.1 SPCL	2.1SP	0.01	0.1
≤100	Pk, Avg, RMS	2.2 SPCL or 2.3 SPCL	2.2SP or 2.3SP	0.1	0.01

To filter the demodulated signal, select the desired filter. (Refer to *Filters, Audio* for more information about filters.)

EXAMPLE

To measure the positive peak AM depth of a signal in a 50 Hz to 15 kHz demodulated signal bandwidth:

LOCAL (keystrokes)	MEASUREMENT: AM ● DETECTOR: PEAK + ● FILTERS: 50 Hz ● 15 kHz ●
HP-IB (program codes)	M1 D1 H1L2 — Measurement, Detector, Filters

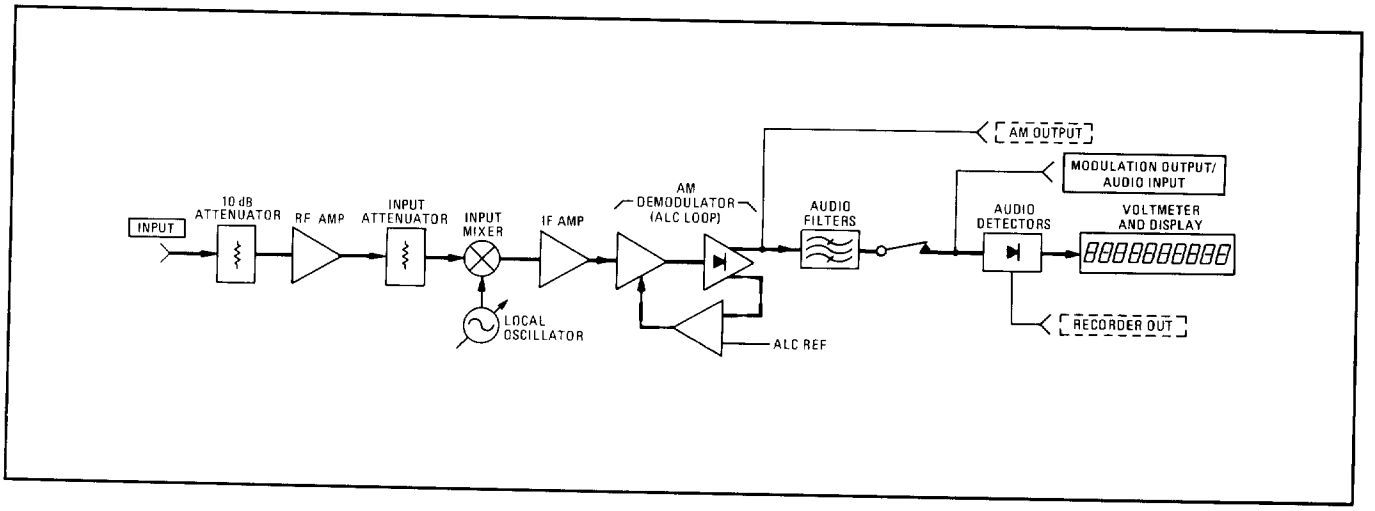
HP-IB PROGRAM CODES

All HP-IB codes for setting a limit or a specific display resolution for modulation-depth measurements are provided in "Procedures".

AM = M1
SPCL = SP

MEASUREMENT TECHNIQUE

The AM Demodulator measures AM as a ratio of the demodulated audio signal level to the average tuned carrier level. An automatic level control (ALC) loop within the AM Demodulator holds the carrier level constant so that the percent AM is proportional to the peak amplitude of the demodulated audio output. This audio output is then filtered, audio detected, and displayed as % AM. The demodulated AM is available at MODULATION OUTPUT/AUDIO INPUT (unless AUDIO INPUT is selected).



AM Measurement Block Diagram

COMMENTS

Input/Output Status.

The demodulated AM is present at MODULATION OUTPUT/AUDIO INPUT (unless AUDIO INPUT has been selected). The demodulated AM is usually present at the rear-panel AM OUTPUT connector. (Refer to *AM Output* on page 3-173.)

Peak±/2 Detector.

The PEAK+ detector always detects the peak of the carrier envelope while the PEAK− detector always detects the trough. The PEAK±/2 detector sums the peak and the trough readings and divides the total by two to provide an average of the two peak values. (Do not confuse this "average" value with the detected average value.)

Automatic Range Selection.

The routine which automatically selects the modulation range contains a region of overlap between 35 and 40% AM (peak detected). When using the average or RMS detectors, ranging occurs at readings lower than these. In general, if the modulation is reduced from above 40% into the overlap region, only 0.1% resolution is ordinarily displayed although 0.01% resolution is available. To display the increased resolution, press the AM key a second time. Audio Range has more detailed information on the modulation ranges that can be set.

Automatic Filter Selection.

When operating above 2.5 MHz, while using the 455 kHz IF, the upper limit of the demodulated signals modulation rate is that of the >20 kHz LP Filter. The 15 kHz LP Filter is automatically selected when operating below 10 MHz or whenever the 455 kHz IF is selected. However, this filter may be overridden by selecting another LP Filter. The lower limit of the modulation rate is determined by the ALC response time selected. (Refer to *AM ALC Response Time* on page 3-165.)

Inverted Output Signal.

The signal at the rear-panel AM Output is inverted relative to the Modulation Output signal.

Potential Inaccuracies.

AM conditions that cause the carrier signal to disappear (such as 100% AM or pulse modulation) will cause inaccuracies in measurement of FM, RM, or input frequency, or they could cause Error 05 (FM squelched) to be displayed when these measurements are selected.

Increased Accuracy.

Accuracy of AM readings may be improved by calibrating the AM measurement (refer to *AM Calibration* on page 3-167) and by taking into account the effects of residual noise (refer to *Residual Noise Effects* on page 3-219).

Relative AM Depth Measurements.

If AM depth is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

AM ALC Response Time

FUNCTIONS

Special Function 6 (Automatic Level Control)

DESCRIPTION

The Measuring Receiver normally uses a slow-responding AM automatic level control (ALC) circuit, allowing AM rates as low as 20 Hz to pass unaffected by the leveling loop. (Refer to the figure in *AM*, "Measurement Technique.")

Select a fast ALC response time to speed up the measurement settling time required for varying carrier levels. The faster ALC response time degrades AM accuracy at rates less than 1 kHz.

The ALC can be disabled. This feature, used in conjunction with the rear-panel AM Output connector, is useful for measuring AM at very low modulation rates. Disabling the ALC also permits measuring absolute changes in depth without regard to changes in carrier level (a feature that is useful in characterizing amplitude modulators).

PROCEDURE

The instrument normally operates with a slow AM ALC response time. To change the response time, or to disable the ALC, enter the corresponding Special Function code, then select SPCL.

AM ALC Response	Special Function Code	Program Code HP-IB
Slow ALC (AM rates >20 Hz)	6.0 SPCL	6.0SP
Fast ALC (AM rates >1 kHz	6.1 SPCL	6.1SP
ALC off	6.2 SPCL	6.2SP

HP-IB PROGRAM CODES

For HP-IB codes, refer to "PROCEDURE".

COMMENTS

Default Condition.

When the instrument is first turned on, or when Automatic Operation or Instrument Preset is selected, the slow ALC response is selected.

IF Level Dependency.

The displayed modulation depth and the sensitivity of the Modulation Output connector for AM demodulation are incorrect when the ALC is disabled unless the IF level is 100%. (Refer to *IF Level* on page 3-109.)

AM Calibration

FUNCTIONS

CALIBRATE, SAVE CAL, % CAL FACTOR, Special Functions 13 (AM Calibration) and 16 (AM Calibration Factors).

DESCRIPTION

The accuracy of the Measuring Receiver's AM demodulator can be checked with the internal AM calibrator. The calibration process generates a calibration factor to compensate for the AM measurement error (within the accuracy limits of the AM Calibrator). Using the SAVE CAL key or Special Function 16, the calibration factor can then be enabled to automatically correct the measured AM error in subsequent measurements. With the calibration factor enabled, AM measurements can be made with an accuracy typically better than 0.5%. The calibration factor can be enabled, disabled, or displayed at any time.

Other instruments in the HP 8901 and 8902 RF signal analyzer family can be calibrated or cross checked using Special Function 13.

PROCEDURE

Self-calibration

To determine the measurement error of the Measuring Receiver's AM demodulation circuits, first allow at least a half-hour continuous operation before calibration, then perform the following steps:

1. Connect the CALIBRATION AM/FM OUTPUT to the RF INPUT with a 50Ω cable (or a sensor module with an internal switch such as the HP 11722A) and select AM.
2. Select CALIBRATE. After several seconds, the AM calibration factor is displayed in % and stored (but not enabled unless already enabled).

The instrument displays 100.00% if no error is measured. A display of 100.17% means the AM demodulator in the Measuring Receiver is reading 0.17% high. As long as the CALIBRATE key light is on and the cable is connected, calibration repeats and the AM calibration factor is updated approximately every 17 seconds. To turn off the calibrator, select CALIBRATE or any Measurement key.

NOTE

For optimum accuracy, the instrument should be continuously operating for at least one half hour before calibration is performed. In addition, the first two AM Calibration Factors received after instrument power-up should not be used even if the instrument is already warm, since the circuits in the audio chain may not be fully settled.

Correcting Measurements with the AM Calibration Factor. Once a calibration factor has been determined, the instrument retains that value in its non-volatile memory. This factor may be enabled to automatically correct AM measurements. The calibration factor can also be disabled or displayed.

Selecting % CAL FACTOR or 16.2 SPCL displays the calibration factor being used.

Enter the appropriate front-panel key or Special Function code to manipulate the AM Calibration Factor as described in the following table:

Action: AM Calibration Factor	Measurement Mode	Front-Panel Key or Special Function Code	Program Code HP-IB
Disable	Any	16.0 SPCL	16.0SP
Enable	AM (From CALIBRATE mode)	(Blue Key) SAVE CAL	SC
	Any	16.1 SPCL	16.1SP
Display	AM	(Blue Key) % CAL FACTOR*	CF
	Any	16.2 SPCL	16.2SP

* The % CAL FACTOR key displays the status of the calibration factor: The factor is enabled if the value of the calibration factor is displayed, with 0.01% resolution. The factor is disabled if 100% is displayed. (Note the resolution of 1%. A display of 100.00% would be a true, calibration factor reading.)

Calibrating or Cross Checking Another HP 8901 or 8902 RF Signal Analyzer

To compute an AM calibration factor for another RF signal analyzer that has no internal calibrator, or that has an internal calibrator that is to be cross checked, use the Measuring Receiver and its calibrator as follows:

1. Connect the Measuring Receiver's CALIBRATION AM/FM OUTPUT to the RF input of the other RF signal analyzer.
2. Select 13.0 SPCL for the Measuring Receiver. Record the value that appears on the display. This is the computed, calibrated, peak AM depth (excluding noise).
3. Select 13.1 SPCL for both instruments. Record the value that appears on the display of the RF signal analyzer. (If display jitter makes readings difficult, select 5.1 SPCL.) The displayed value is the weighted, peak, residual AM depth of the calibrator's unmodulated output as demodulated by the RF signal analyzer.
4. Select 13.2 SPCL for both instruments. Record the value that appears on the display of the RF signal analyzer. This value is the demodulated, positive, peak AM depth of the calibrator's modulated output. (If display jitter makes readings difficult, select 5.1 SPCL.)
5. On the RF signal analyzer, select PEAK−. Note the value displayed on the RF signal analyzer. If the difference between the results of steps 4 and 5 is three counts or less in the least significant digit, an average between the two need not be computed; use the result from step 4. If the difference between the two results is greater than three counts in the least significant digit, compute the average as follows:

$$(13.2\ result) = \frac{(result\ of\ step\ 4) + 2(result\ of\ step\ 5)}{3}$$

6. Compute the AM calibration factor of the RF signal analyzer as follows:

$$AM\ Calibration\ Factor\ (\%) = 100 \times \frac{(13.2\ result) - (13.1\ result)}{(13.0\ result)}$$

7. To use this AM calibration factor to correct AM measurements made with the RF signal analyzer, enter the value as a ratio reference and use the Ratio function in the RF signal analyzer.

The Special Function codes are summarized in the table below:

Function	Special Function Code	Program Code HP-IB
Display computed peak AM	13.0 SPCL	13.0SP
Display demodulated peak residual AM	13.1 SPCL	13.1SP
Display demodulated peak AM	13.2 SPCL	13.2 SP

HP-IB PROGRAM CODES

HP-IB codes for enabling, disabling, or displaying the internal AM calibration factor are provided in "Procedures". The HP-IB codes for the AM Calibrator Special Function used to calibrate another RF signal analyzer are also provided as part of "Procedures".

AM = M1
CALIBRATE off = C0
CALIBRATE on = C1
SPCL = SP

INDICATIONS

Self-Calibration

When the CALIBRATE key is pressed, approximately 17 seconds pass during which the instrument configures itself and tunes to the calibrator's signal. The display indicates four dashes (----) and lights the % annunciator. Once the AM Calibration Factor has been computed, it is displayed. Subsequent updates occur approximately every 17 seconds.

Correcting Measurements with the AM Calibration Factor (Self-Calibrated).

When the calibration factor is enabled, the AM depth measurement is always a corrected measurement.

If % CAL FACTOR (Blue Key, MHz) is selected, and the AM calibration factor is enabled, the AM calibration factor is displayed. If % CAL FACTOR (Blue Key, MHz) is selected, and the AM calibration factor is disabled, 100% is displayed. (Note the resolution of 1%.)

Calibrating Another RF Signal Analyzer.

The Measuring Receiver displays the computed AM depth (Special Function 13.0), but shows two dashes (--) throughout the rest of the procedure.

MEASUREMENT TECHNIQUE

When AM and then CALIBRATE are selected, the FM Calibrator sends an unmodulated 10.1 MHz carrier to the AM Calibrator.

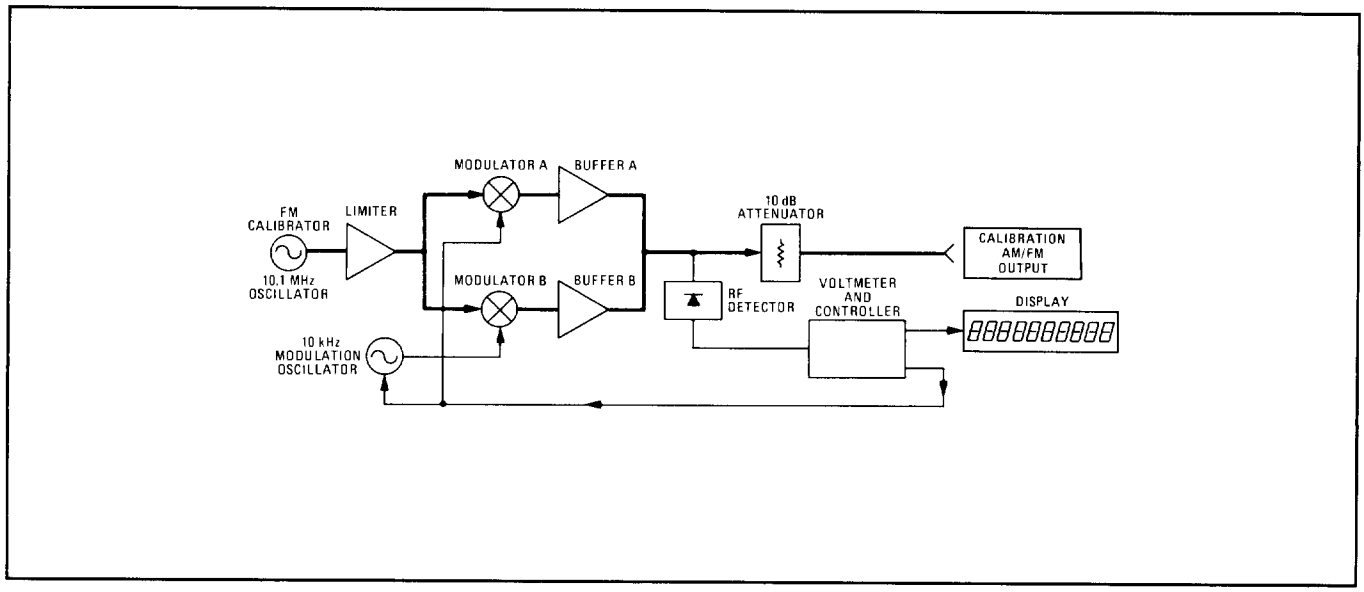
The AM Calibrator contains two identical modulators in parallel whose outputs are summed. When the calibration operation is initiated, each modulator is turned on and each individual output level is measured, via an on-board detector, to compute AM depth.

While one of the modulators is on, the residual AM of the calibrator (very low) and the AM demodulator (more significant) are characterized and weighted (refer to *Residual Noise Effects* on page 3-219). Next, one modulator is left on and the other is toggled on and off at a 10 kHz rate. Since the RF signal is switched between full on and half on, the resultant carrier modulation is very near 33.33%. (The exact depth is derived from the measurements that characterize the individual modulators.) This modulation is then measured by the AM demodulator. (Both peak detectors are used, and their average is computed.)

The Measuring Receiver compares the modulation depth (static measurements) with the demodulated AM (toggled measurements) and computes its accuracy error as follows:

$$AM\ Calibration\ Factor\ (\%) = \frac{Demodulated\ AM - Demodulated\ Residual\ AM}{Computed\ AM} \times 100$$

All segments of the calibration are carefully monitored. If any segment is out of limits, the calibration is aborted and Error 08 is displayed.



Simplified Block Diagram of the AM Calibrator

COMMENTS

Default Calibration Factor

If the instrument's non-volatile memory is erased, 100.00% is used as the default calibration factor.

Updating the AM Calibration Factor

Whenever AM calibration is performed, the instrument updates the stored AM calibration factor.

Special Function Cancellation

Performing Calibration cancels most special functions.

When Using the AM Calibrator to Calibrate Other Signal Analyzers

The modulation waveform of the AM Calibrator is a rounded squarewave. An RF signal analyzer, which uses it as a calibration standard, must have demodulation and audio-processing circuits which preserve the full fidelity of the waveform.

Automatic AM Ranging

When used to calibrate an RF signal analyzer, Special Functions 13.1 and 13.2 set the AM modulation range to that of 0 to 100% (Special Function 2.1). Upon exiting the AM Calibrator Special Function, the audio ranging is not returned to automatic but remains fixed (thus leaving the SPCL light on). Key in 2.0 SPCL to return the audio ranging to automatic.

AM Output

CAUTION

Do not apply greater than 10 Vpk (ac+dc) into the rear-panel AM OUTPUT connector or damage to the instrument may result.

DESCRIPTION

The rear-panel AM OUTPUT (dc coupled, 10 kΩ output impedance) provides an auxiliary output for the AM demodulated from the RF input signal. This output enables monitoring of AM during display of other measurements (such as FM, ΦM, or audio signals).

The output can also be used in conjunction with Special Function 6.2 (described in *AM ALC Response Time* on page 3-165) to measure AM depth at low modulation rates.

The output signal comprises both a dc voltage (related to the detected IF level) and an ac voltage (bandwidth 16 kHz, one pole proportional to the AM depth). The dc component contains an offset voltage (Voff) which must be subtracted out. The relationship between % AM and the signal levels at AM OUTPUT is:

$$\% AM = \frac{Vpk}{|Vdc - V_{off}|} \times 100\%$$

where: Vpk is the peak of the ac component,
Vdc is the total dc component, and
V_{off} is the dc offset voltage.

When the AM ALC is on, the dc level at AM OUTPUT is held constant, thus,

$$\% AM = K \times Vpk,$$

where:

$$K = \frac{100\%}{Vdc - V_{off}}$$

When the AM ALC is turned off (Special Function 6.2), the dc voltage at AM OUTPUT varies with the signal level (although the offset remains constant), and the full formula must be used for each measurement.

PROCEDURE

To measure AM depth via AM OUTPUT, first determine the offset voltage:

Select AUTOMATIC OPERATION to clear any Special Functions in effect, then connect a dc voltmeter to the AM OUTPUT connector and remove any signal at RF INPUT. Press MHz to fix the tuning, and read the offset voltage on the voltmeter.

Disable the AM ALC loop (6.2 SPCL) and apply the carrier to the RF INPUT. Measure the dc and peak ac signals at AM OUTPUT. Use the first equation in "DESCRIPTION" to compute % AM.

EXAMPLE

To measure AM depth at AM OUTPUT with the AM ALC turned off, measure V_{off} first:

Remove any signal at the RF INPUT and connect a dc voltmeter to AM OUTPUT.

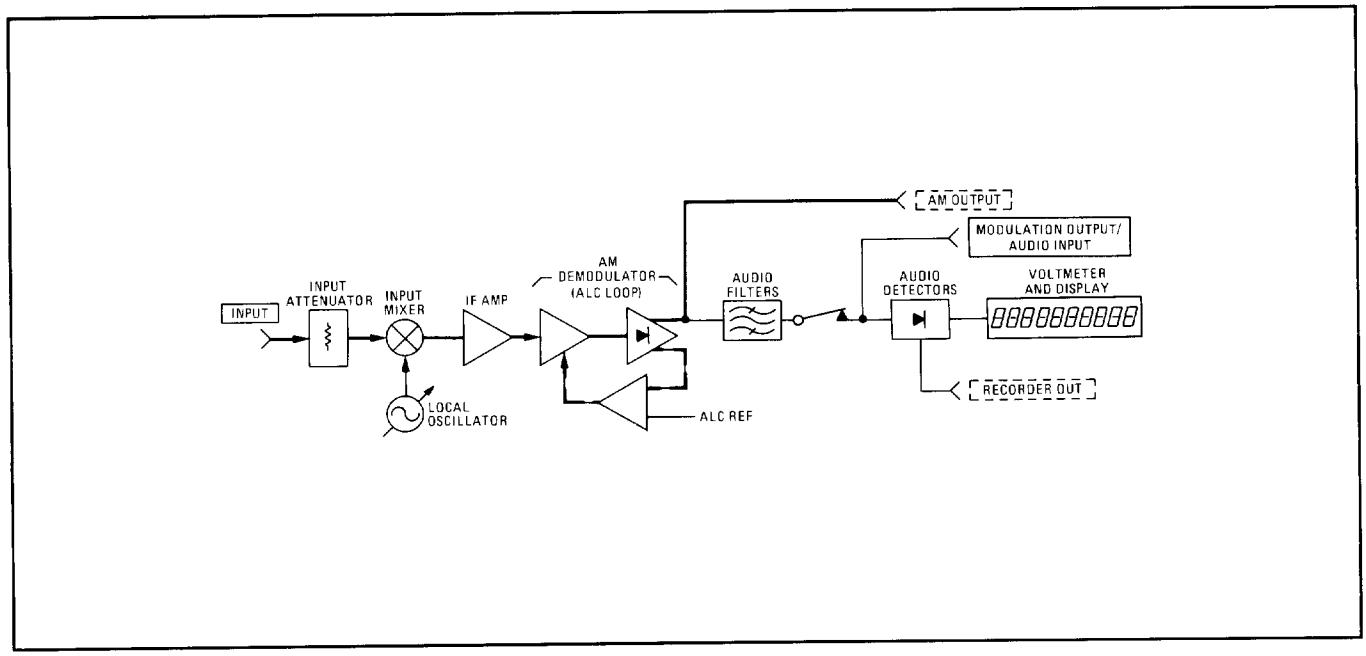
LOCAL (keystrokes)	AUTOMATIC OPERATION; MZ; MHz; INPUT FREQ
HP-IB (program codes)	AUMZ

For this example, assume the voltmeter reads an offset voltage of −0.36 Vdc. Connect an AM signal to the RF INPUT and tune the Measuring Receiver. Disable the AM ALC by selecting 6.2 SPCL.

Measure the dc voltage at AM OUTPUT. (When low AM rates are used, it is easiest to measure the dc voltage at AM OUTPUT before the modulation is applied.) For this example, assume the voltmeter reads −0.46 Vdc. Measure the peak ac voltage at AM OUTPUT (for low rates an oscilloscope may be necessary). For this example, assume 0.02 Vpk was measured on an oscilloscope. The % AM is:

$$\%\ AM = \frac{Vpk \times 100\%}{|Vdc - off|} = \frac{0.02 \times 100\%}{|(-0.46) - (-0.36)|} = 20\%\ AM$$

BLOCK DIAGRAM



AM Output Block Diagram

COMMENTS

Inherent IF Component

AM OUTPUT contains a significant IF component which is greatest when operating at a carrier frequency of 150 kHz.

RF Peak Detector Measurements of AM Output

The accuracy of measurements made on the AM OUTPUT signal could be degraded if RF level measurements are made using the RF peak detector (Special Function 35.0).

FM

FUNCTIONS

FM, Special Function 2 (Audio Range)

DESCRIPTION

The Measuring Receiver can measure the FM deviation of the tuned input signal. (Special Function 2 enables the instrument to set limits on the range of FM deviation that can be measured.)

FM Measurements are specified for rates from 20 Hz to 10 kHz for carrier frequencies 10 MHz and below (or whenever the 455 kHz IF is used) and from 20 Hz to 200 kHz for carrier frequencies from 10 to 1300 MHz (1.5 MHz IF only). The corresponding 3 dB audio bandwidths are approximately 0.5 Hz to 15 kHz for carriers 10 MHz and below (or with the 455 kHz IF) and approximately 0.2 Hz to 260 kHz for carriers from 10 to 1300 MHz (1.5 MHz IF only). Peak deviations up to 40 kHz can be measured on carriers below 10 MHz, and peak deviations up to 400 kHz can be measured on carriers above 10 MHz.

The demodulated signal's frequency and distortion can also be measured. (Refer to *Audio Measurements* on page 3-225.)

PROCEDURE

To make an FM measurement, first tune the instrument to the input signal by selecting Automatic Operation. Press the FM key.

Select an audio detector: PEAK+, PEAK−, PEAK±/2, AVG, or RMS. (The RMS detector, selected by pressing the Blue Key and AVG key, is accurate in measuring FM, has a reduced bandwidth, and is usually only used for less audio distortion measurements.)

The following table lists the different measurement range limits that can be selected with Special Function 2

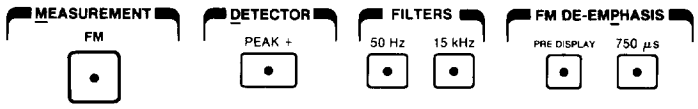
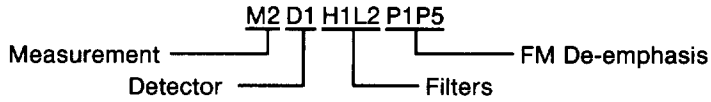
Modulation Range (Peak±kHz dev.)	Detector Selected	Special Function Code	Program Code HP-IB	Display Resolution (Hz)	MODULATION OUTPUT Sensitivity (Vac/% Hz)
Automatic Selection		2.0 SPCL	2.0SP	Automatic Selection	
≤0.04	RMS	2.4 SPCL[1]	2.4SP	0.01	100
≤0.4	RMS Pk, Avg Pk, Avg, RMS	2.4 SPCL 2.4 SPCL[1] 2.1 SPCL[1]	2.4SP 2.4SP 2.1SP	0.1	10
≤4	Pk, Avg Pk, Avg, RMS Pk, Avg, RMS	2.4 SPCL 2.1 SPCL 2.2 SPCL[1]	2.4SP 2.1SP 2.2SP	1	1
≤40	Pk, Avg, RMS	2.2 SPCL 2.3 SPCL[1]	2.2SP 2.3SP	10	0.1
≤400	Pk, Avg, RMS	2.3 SPCL	2.3SP	100	0.01

[1] With 750 μs de-emphasis, pre-display only.

To filter the demodulated signal, press the appropriate filter keys. (Refer to *Filters, Audio* on page 3-207 for more information about filters.) If de-emphasis equalization is desired, select the appropriate time constant and display placement. (Refer to *FM De-emphasis* on page 3-187 for more information about filters.)

EXAMPLE

To measure the positive peak deviation of a signal in a 50 Hz to 15 kHz post-detection bandwidth and to place a 750 μs time constant de-emphasis before the display:

LOCAL (keystrokes)	
HP-IB (program codes)	

HP-IB PROGRAM CODES

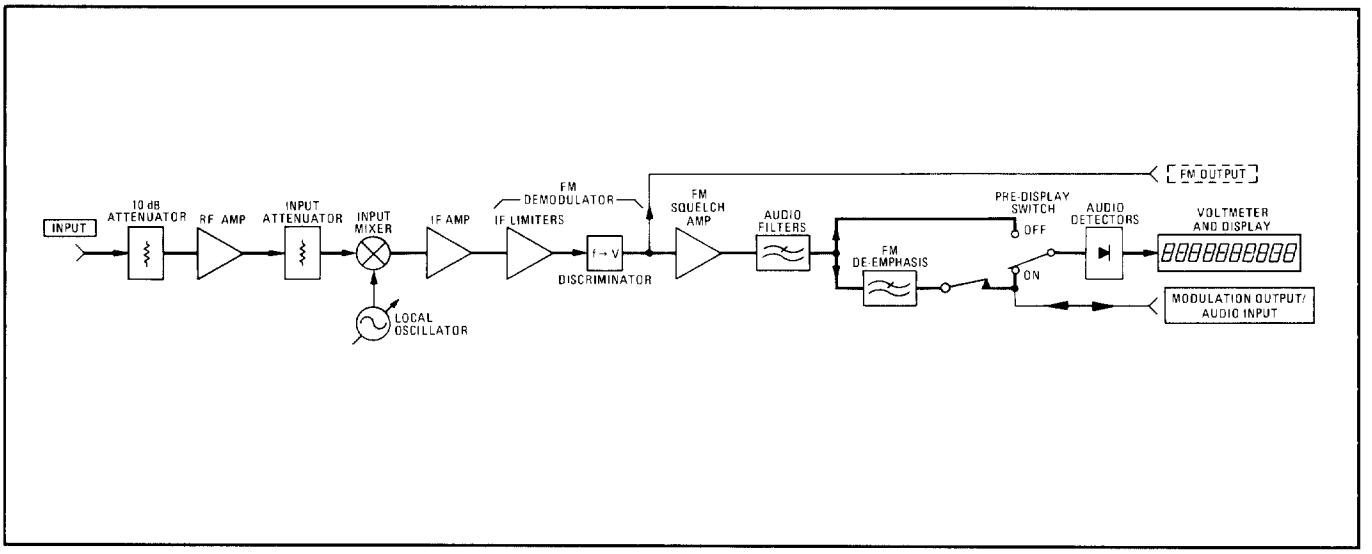
All HP-IB codes for setting range limits for FM measurements are provided in "Procedures".

FM = M2
SPCL = SP

MEASUREMENT TECHNIQUE

The FM on the IF is demodulated by a frequency discriminator. The amplitude of the discriminator's output is proportional to the frequency deviation. The demodulated signal is filtered, audio detected, and displayed as kHz deviation.

FM de-emphasis equalization can be inserted ahead of the audio detectors and display circuitry by selecting PRE DISPLAY. The demodulated FM signal always passes through the FM de-emphasis "network" before it appears at the output of MODULATION OUTPUT/AUDIO INPUT.



FM Measurement Block Diagram

COMMENTS

Input/Output Status.

The demodulated FM is present at MODULATION OUTPUT/AUDIO INPUT (unless AUDIO INPUT has been selected). The demodulated FM is usually present at the rear-panel FM OUTPUT connector. If the RF input signal drops too low for accurate FM demodulation, the FM measurement is automatically squelched (muted, turned off) except for the FM OUTPUT. (Refer to *FM Output* on page 3-191.)

Relative FM Deviation Measurements.

If FM deviation is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Peak±/2 Detector.

The PEAK+ detector always detects the upward carrier frequency excursion while the PEAK− detector always detects the downward carrier frequency excursion. The PEAK±/2 detector sums the upward and downward frequency-excursion readings and divides the total by two to provide an average of the two peak values. (Do not confuse this "average" value with the detected average value.)

Inverted Output Signals.

When operating with carrier frequencies below 2.5 MHz, the output signal at MODULATION OUTPUT/AUDIO INPUT is inverted unless the 455 kHz IF is selected. When operating with carrier frequencies above 2.5 MHz or when using the 455 kHz IF, the signal at FM OUTPUT is inverted.

Automatic Range Selection.

The routine which automatically selects the modulation range contains regions of overlap between the following displayed peak deviations:

0.35 and 0.4 kHz (750 μs de-emphasis, pre-display only), 3.5 and 4 kHz, and 35 and 40 kHz.

When using the average or RMS detector, ranging will occur at readings lower than these. In general, if the modulation is reduced from a higher range into an overlap region, the range does not change. To range the display for increased resolution, press the FM key a second time. To set the instrument to a selected modulation range, refer to Audio Range.

Default Condition.

When the Measuring Receiver is first powered up, demodulated FM, with a sensitivity of 0.01 Vpk/MHz (400 kHz peak deviation range), is available at MODULATION OUTPUT/AUDIO INPUT. The instrument does not autorange to more sensitive ranges because the Frequency Measurement mode has been automatically selected, which automatically disables Error 04 (audio circuits overdriven). When Error 04 is disabled, the instrument only autoranges to less sensitive audio ranges.

Increased Accuracy.

Accuracy of FM readings may be improved by using the FM Calibrator (refer to *FM Calibration* on page 3-181) and by taking into account the effects of residual noise (refer to *Residual Noise Effects* on page 3-219).

Automatic Squelching.

If the RF input signal drops too low for accurate FM demodulation, the FM measurement is automatically squelched (muted, turned off). In the 8902A Measuring Receiver, RF gain can be inserted into the RF signal path or IF gain can be inserted into the IF path to raise the signal to the level required for measurement.

Potential Inaccuracies.

AM conditions that cause the carrier signal to disappear (such as 100% AM or pulse modulation) will cause inaccuracies in measurement of FM, ΦM, or input frequency, or they could cause Error 05 (FM squelched) to be displayed when these measurements are selected.

Considerations When Using the RMS Detector

During FM measurements if the RMS detector is selected (Blue Key, AVG), FM de-emphasis pre-display is automatically selected. Pre-display must turn on at this time due to circuit configuration of the Measuring Receiver. When pre-display is selected this way, it will not turn off automatically when another detector is selected. Turn off pre-display (after selecting another detector) by pressing the PRE DISPLAY key (HP-IB code: P0). Measurements could be affected by this pre-display selection.

FM Calibration

FUNCTIONS

CALIBRATE, SAVE CAL, Function 12 (FM Calibration), Special Function 17 (FM Calibration Factor)

DESCRIPTION

The accuracy of the Measuring Receiver's FM demodulator can be checked with the internal FM calibrator. The calibration process generates a calibration factor to compensate for the FM measurement error (within the accuracy limits of the FM Calibrator). The calibration factor can then be enabled to automatically correct the measured FM error in subsequent measurements using the SAVE CAL key or Special Function 17. With the calibration factor enabled, FM measurements can be made with an accuracy typically better than 0.5%. The calibration factor can be enabled, disabled, or displayed at any time.

Other instruments in the HP 8901 and 8902 RF signal analyzer family can be calibrated or cross checked with the Measuring Receiver's FM calibrator using Special Function 12.

PROCEDURE

Self-Calibration.

To determine the measurement error of the Measuring Receiver's FM demodulation circuits, first allow at least a half-hour continuous operation before calibration, then perform the following steps:

1. Connect the CALIBRATION AM/FM OUTPUT to the RF INPUT with a 50Ω cable (or a sensor module with an internal switch such as the HP 11722A) and select FM.
2. Press the CALIBRATE key. After several seconds, the FM calibration factor is displayed in % and stored (but not enabled unless already enabled).

The instrument displays 100.00% if no error is measured. A display of 100.17% means the FM demodulator in the Measuring Receiver is reading 0.17% high. As long as the CALIBRATE key light is on and the cable is connected, calibration repeats and the FM calibration factor is updated approximately every 17 seconds. To turn off the calibrator, select CALIBRATE or any Measurement key.

NOTE

For optimum accuracy, the instrument should be continuously operating for at least one half hour before calibration is performed. In addition, the first two FM Calibration Factors received after instrument power-up should not be used even if the instrument is already warm, since the circuits in the audio chain may not be fully settled.

Correcting Measurements with the FM Calibration Factor.

Once a calibration factor has been determined, the instrument retains that value in its non-volatile memory. This factor can be enabled to automatically correct FM measurements. The calibration factor can also be disabled or displayed.

Selecting % CAL FACTOR (Blue Key, MHz) or 16.2 SPCL displays the Calibration Factor being used.

Enter the appropriate front-panel key or special function code to manipulate the FM Calibration Factor as described in the following table:

Action: FM Calibration Factor	Measurement Mode	Front-Panel Key or Special Function Code	Program Code HP-IB
Disable	Any	17.0 SPCL	17.0SP
Enable	FM (From CALIBRATE mode)	(Blue Key) SAVE CAL	SC
	Any	17.1 SPCL	17.1SP
Display	FM	(Blue Key) % CAL FACTOR*	CF
	Any	17.2 SPCL	17.2SP

Calibrating or Cross Checking Another HP 8901 or 8902 RF Signal Analyzer.

To compute an FM calibration factor for another RF signal analyzer that has no internal calibrator, or that has an internal calibrator that is to be cross checked, use the Measuring Receiver and its calibrator as follows:

1. Connect the Measuring Receiver's CALIBRATION AM/FM OUTPUT to the RF input of the other RF signal analyzer.
2. Key in 12.0 SPCL into the Measuring Receiver. Record the value that appears in the display. This is the computed, calibrated, peak FM deviation (excluding noise).
3. Key in 12.1 SPCL into both instruments. Record the value that appears on the display of the RF signal analyzer. (If display jitter makes readings difficult, key in 5.1 SPCL.) The displayed value is the weighted, peak, residual FM deviation of the calibrator's unmodulated output as demodulated by the RF signal analyzer.
4. Key in 12.2 SPCL for both instruments. Record the value that appears on the display of the RF signal analyzer. (If display jitter makes readings difficult, select 5.1 SPCL.) The displayed value is the demodulated, positive, peak FM deviation of the calibrator's modulated output (including noise).
5. On the RF signal analyzer, select PEAK−. Note the value displayed on the RF signal analyzer. If the difference between the results of steps 4 and 5 is three counts or less in the least significant digit, an average between the two need not be computed; use the result from step 4. If the difference between the two readings is greater than three counts in the least significant digit, compute the average as follows:

$$(12.2\ result) = \frac{(result\ of\ step\ 4) + (result\ of\ step\ 5)}{2}$$

6. Compute the FM calibration factor of the RF signal analyzer as follows:

$$FM\ Calibration\ Factor\ (\%) = 100 \times \frac{(12.2\ result) - (12.1\ result)}{(12.0\ result)}$$

7. To use this FM calibration factor to correct FM measurements made with the RF signal analyzer, enter the value as a ratio reference and use the Ratio function in the RF signal analyzer.

The Special Function codes are summarized in the table below:

Function	Special Function Code	Program Code HP-IB
Display computed peak FM	12.0 SPCL	12.0SP
Display demodulated peak residual FM	12.1 SPCL	12.1SP
Display demodulated peak FM	12.2 SPCL	12.2 SP

HP-IB PROGRAM CODES

HP-IB codes for enabling, disabling, or displaying the internal FM calibration factor are provided in "Procedures". The HP-IB codes for the FM Calibrator Special Function used to calibrate another RF signal analyzer are also provided as part of "Procedures".

FM = M2
CALIBRATE on = C1
CALIBRATE off = C0
SPCL = SP

INDICATIONS

Self-Calibration.

When the CALIBRATE key is pressed, approximately 17 seconds pass during which the instrument configures itself and tunes to the calibrator's signal. The display indicates four dashes (----) and lights the % annunciator. Once the FM Calibration Factor has been computed, it is displayed. Subsequent updates occur approximately every 17 seconds.

Correcting Measurements with the FM Calibration Factor (Self-Calibrated).

When the calibration factor is enabled, the FM deviation measurement is always a corrected measurement.

If % CAL FACTOR is selected, and the FM calibration factor is enabled, the FM calibration factor is displayed. If % CAL FACTOR is selected, and the FM calibration factor is disabled, 100% is displayed. (Note the resolution of 1%.)

Calibrating Another RF Signal Analyzer.

The Measuring Receiver displays the computed FM deviation (Special Function 12.0), but shows two dashes (--) throughout the rest of the procedure.

MEASUREMENT TECHNIQUE

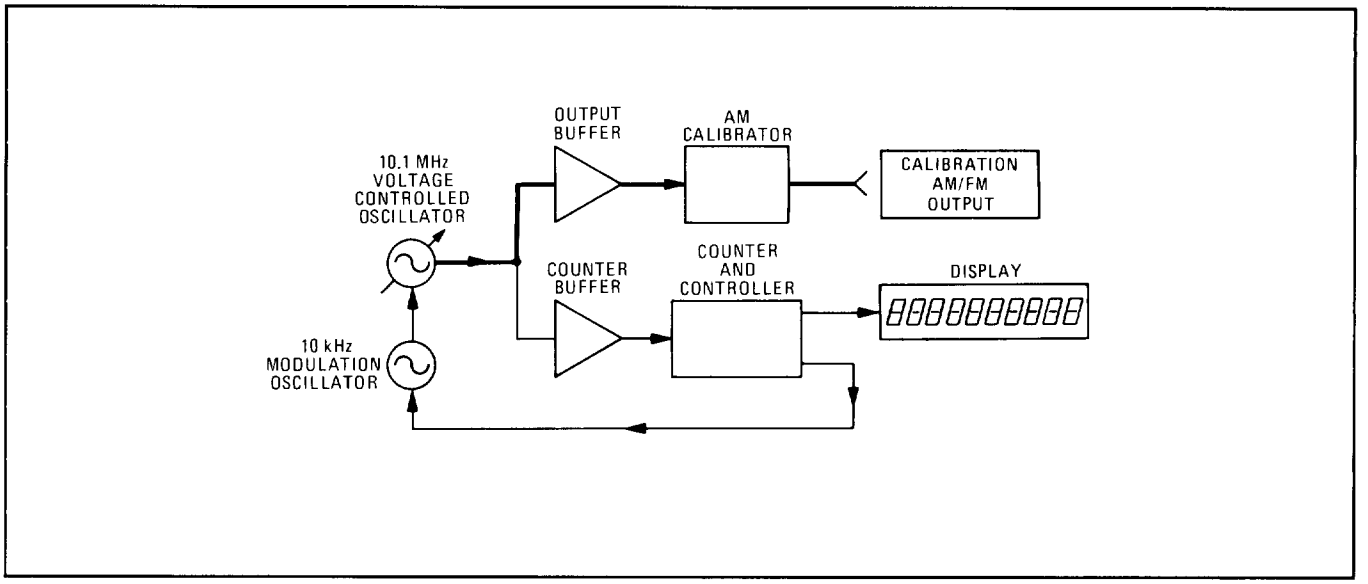
When FM is selected and CALIBRATE is selected, a 10.1 MHz voltage controlled oscillator (VCO) within the calibrator is driven to one end of its nominal tuning range. The frequency of the VCO is counted, and the oscillator is driven to the opposite end of its tuning range where it is counted again. The peak FM deviation is computed from these measurements.

While the VCO is at one end of its range, the residual FM of the calibrator (very low) and the FM Demodulator (more significant) are characterized and weighted. (Refer to *Residual Noise Effects* on page 3-219.) The VCO is frequency modulated by a 10 kHz modulation oscillator, and the FM demodulator makes another FM measurement. (Both peak detectors are used and the average is computed.)

The Measuring Receiver compares the deviation (static measurements) with the demodulated FM (toggled measurements) and computes its accuracy error as follows:

$$FM\ Calibration\ Factor\ (\%) = \frac{Demodulated\ FM - Demodulated\ Residual\ FM}{Computed\ FM} \times 100$$

All segments of the calibration are carefully monitored. If any segment is out of limits, the calibration is aborted and Error 08 is displayed.



Simplified Block Diagram of the FM Calibrator

COMMENTS

Default Calibration Factor.

If the instrument's non-volatile memory is erased, 100.00% is used as the default calibration factor.

Updating the FM Calibration Factor.

Whenever FM calibration is performed, the instrument updates the stored FM calibration factor.

Special Function Cancellation.

Performing calibration cancels most Special Functions.

When Using the FM Calibrator to Calibrate Other Signal Analyzers.

The modulation waveform of the FM Calibrator is a rounded trapezoid. An signal analyzer, which uses it as a calibration standard, must have demodulation and audio processing circuits which preserve the full fidelity of the waveform.

Automatic FM Ranging.

When used to calibrate an RF signal analyzer, Special Functions 12.1 and 12.2 set the FM deviation range to that of 0 to 40 kHz (Special Function 2.2). Upon exiting the FM Calibrator Special Function, the audio ranging is not returned to automatic but remains fixed (thus leaving the SPCL light on). Key in 2.0 SPCL to return the audio ranging to automatic.

FM De-emphasis

FUNCTIONS

Pre-Display, 25μs, 50μs, 75μs. 750μs

DESCRIPTION

The de-emphasis networks equalize the pre-emphasis often encoded on broadcast FM signals. This type of equalization provides a simple means of reducing audible noise on FM communication systems. Pre-emphasis gives a 6 dB per octave, high-frequency boost to the baseband audio before modulating the carrier. De-emphasis reverses the boost after demodulation at the receiver. The 3 dB corner of the pre-emphasis or de-emphasis network is usually expressed as a time constant. The relationship between the time constant, τ_o, and the 3dB corner frequency, f_o, is $f_o = \frac{1}{2}\ \pi\tau_o$.

The 3dB corner frequencies of the de-emphasis equalizers (typically accurate to ±3%)are listed in the following table:

FM De-emphasis

Time Constant (μs)	3 dB Frequency (Hz)
25	6366
50	3183
75	2122
750	212.2

PROCEDURE

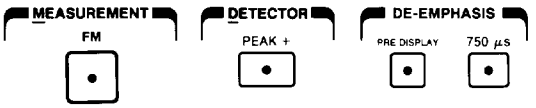
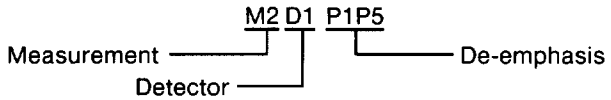
To add de-emphasis to the demodulated FM, select the key corresponding to the desired time constant. (Unless AUDIO INPUT has been selected, the de-emphasized FM is available at the MODULATION OUTPUT/AUDIO INPUT.) To also display the de-emphasized FM, select PRE DISPLAY.

HP-IB

In local operation, to turn off one of the de-emphasis functions, press the lighted key a second time. In remote operation, turn the equalizers off with code PO. (HP-IB code PO also turns off the PRE DISPLAY function.)

EXAMPLE

To measure the positive peak FM deviation of a carrier with 750 μs de-emphasis inserted before the deviation measurement:

LOCAL (keystrokes)	
HP-IB (program codes)	

HP-IB PROGRAM CODES

FM De-emphasis		
Time Constant (μs)	**PRE DISPLAY On**	**PRE DISPLAY Off**
Filters off	P0P1	P0
25	P1P2	P0P2
50	P1P3	P0P3
75	P1P4	P0P4
750	P1P5	P0P5

COMMENTS

Input/Output Status.

When selected, the de-emphasis networks are inserted in the audio signal path following the audio filters. They will affect the output signal at MODULATION OUTPUT/AUDIO INPUT and can be placed before the audio detector and display. (Refer to the block diagram in FM.) De-emphasis has no affect on the rear panel FM Output.

When Measuring Low Deviation FM

When 750 μs de-emphasis is selected, FM sensitivity at the MODULATION OUTPUT/AUDIO INPUT is increased by a factor of ten. The range of deviation measurements is restricted to 40 kHz peak deviation or less after de-emphasis. The display resolution, however, remains the same as without de-emphasis unless the pre-display mode has been selected at which time the display resolution increases ten times. This feature provides greater resolution for measuring low deviation FM.

HP-IB. Automatic Selection of Pre-Display.

When the true rms detector is selected, the pre-display mode for FM de-emphasis is automatically enabled. This is true whether FM has been selected or not. (Selection of the FM de-emphasis time constant, however, remains unaffected.) The pre-display mode remains enabled until deliberately disabled. This idiosyncrasy is important to remember when programming the instrument via HP-IB.

Considerations When Using the RMS Detector

During FM measurements if the RMS detector is selected (Blue Key, AVG), FM de-emphasis pre-display is automatically selected. Pre-display must turn on at this time due to circuit configuration of the Measuring Receiver. When pre-display is selected this way, it will not turn off automatically when another detector is selected. Turn off pre-display (after selecting another detector) by pressing the PRE DISPLAY key (HP-IB code: P0). Measurements could be affected by this pre-display selection.

FM Output

CAUTION

Do not apply greater than 10 Vpk (ac + dc) into the rear-panel FM OUTPUT connector or damage to the instrument may result.

DESCRIPTION

The rear-panel FM OUTPUT (dc-coupled, 10 kΩ output impedance) provides an auxiliary output for the FM demodulated from the RF input signal. This output enables monitoring of FM during display of other measurements (such as AM, ΦM, or audio signals) or when the modulation rate is very low.

The output signal comprises both a dc voltage, related to the counted IF frequency, and an ac voltage (bandwidth 16 kHz, one pole) proportional to the FM deviation.

With the input signal centered in the IF, the nominal dc offset voltage at FM OUTPUT is approximately 0.8 Vdc for the 1.5 MHz IF and −5.6 Vdc for the 455 kHz IF. The FM sensitivity is typically 6 V/MHz or 6 mV/kHz. The dc voltage at FM OUTPUT can be calculated as follows:

$$Vdc = V_{off} - \frac{(K)\ (FREQ\ ERROR)}{1000}$$

where: Vdc=representation of the dc voltage at FM OUTPUT volts,
V_{off}=representation of the dc offset voltage for the IF used volts,
K=the FM sensitivity in mV/kHz, or V/MHz, and
FREQ ERROR=the kHz error displayed when FREQ ERROR is selected.

Measure V_{off} when the frequency error is 0 kHz. The sensitivity can be measured using the following procedure:

PROCEDURE

To determine the sensitivity of the FM OUTPUT, apply an unmodulated 2 MHz carrier at the RF INPUT. (Select 3.2 SPCL, which uses the 1.5 MHz IF described in *Filters, RF and IF* on page 3-259). Measure the dc voltage at the output with a dc voltmeter. Move the carrier to 1 MHz and again note the dc voltage. The FM sensitivity (K in V/MHz or mV/kHz) is:

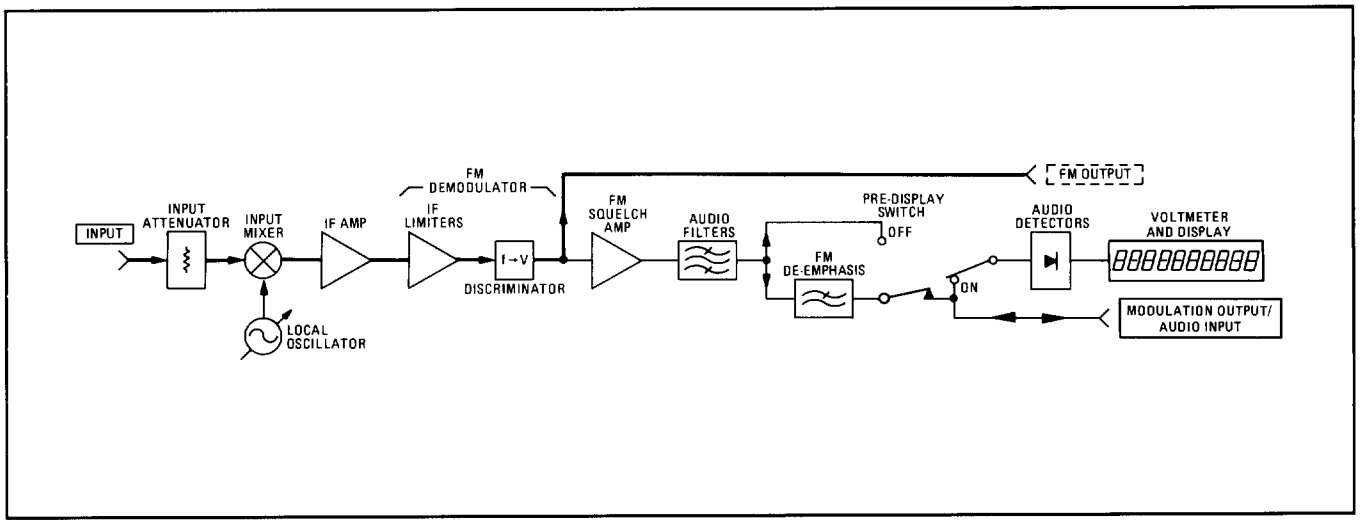
$$K = (Vdc\ \pm 2\ MHz) - (Vdc\ \pm 1\ MHz)$$

EXAMPLE

A 2 MHz unmodulated signal is applied to the RF INPUT. A dc voltmeter connected to FM OUTPUT measures +3.89 Vdc. When the carrier is set to 1 MHz, −2.272 Vdc is measured. The FM sensitivity is:

$$(3.890) - (-2.272) = 6.162\ V/MHz\ or\ 6.162\ mV/kHz$$

BLOCK DIAGRAM



FM Output Block Diagram

COMMENTS

Inherent IF Component.

FM OUTPUT is unsquelched and also contains a significant component at twice the IF frequency which is greatest when operating at a carrier frequency of 150 kHz.

Inverted AC Output Component.

Note that the sense of the ac output component (corresponding to the demodulated FM) is inverted for carriers above 2.5 MHz.

Accuracy of Output During RF Level Measurements.

When RF Level measurements (Special Function 35) are made, automatic selection of RF input attenuation and gain overrides any manual settings that might have been selected with Special Function 1. The selected attenuation could degrade the accuracy of measurements made on the FM OUTPUT signal.

Tone-Burst Receiver

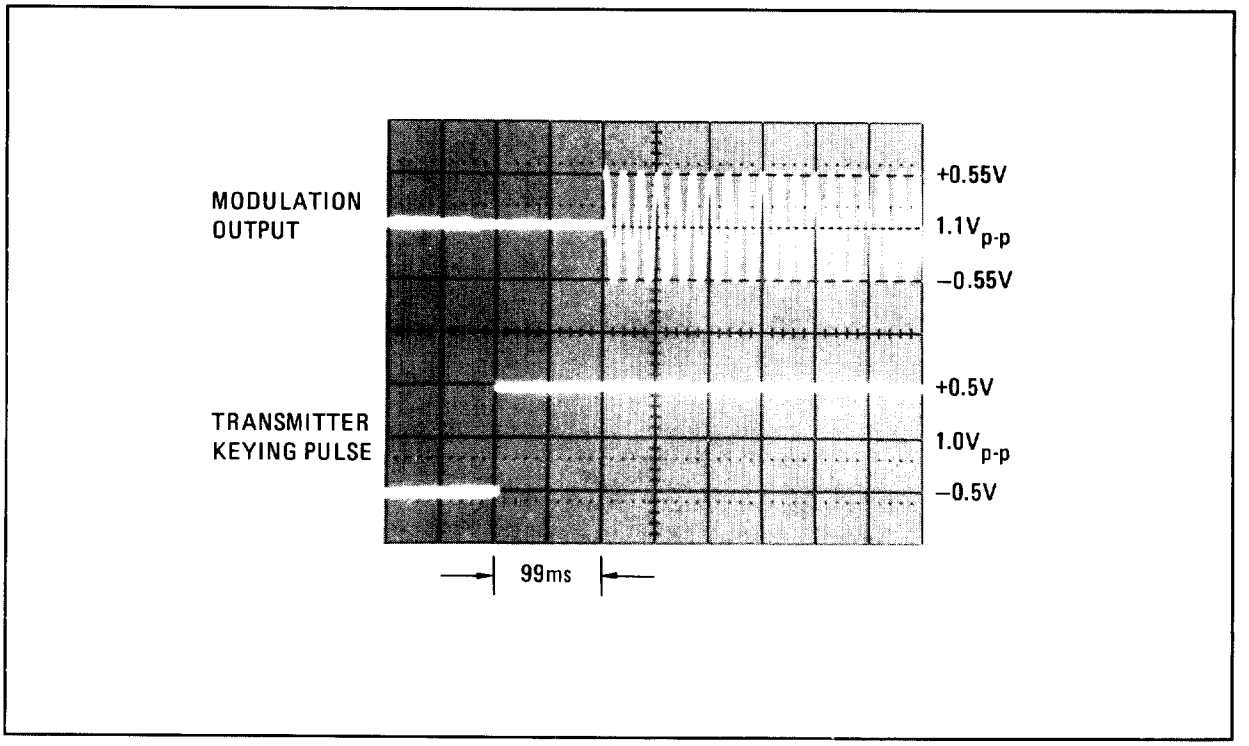
FUNCTIONS

Special Function 18 (Tone-Burst Receiver)

DESCRIPTION

In some FM applications (mobile radio testing, for example), after a transmitter is keyed, it issues squelch tones for a brief interval. Often, it is necessary to measure the frequency of the squelch tones. This measurement is made difficult by the noise in the demodulated audio during the short delay between the keying of the transmitter and the appearance of the audio tones.

Special Function 18 enables the Measuring Receiver to be configured as a tone-burst receiver. This function inserts a user-selectable delay between the instant the instrument senses an RF signal at its RF INPUT and the time when it turns on the output of MODULATION OUTPUT/AUDIO INPUT. When an external counter is connected to this output, the squelch tone will reach the counter only when a valid measurement can be made. The time delay is selectable from 1 through 99 milliseconds. The following photo illustrates a 99 ms delay between transmitter keying (lower trace).



Oscilloscope Photo Depicting a 99 ms Delay Between Transmitter Keying Pulse (Lower Trace) and Activation of MODULATION OUTPUT/AUDIO INPUT

PROCEDURE

In order to successfully measure tone bursts, tune and range the Measuring Receiver:

1. Select FM.
2. Select an audio detector and if desired, audio filters and FM de-emphasis.
3. Key on the transmitter and allow the Measuring Receiver to range and tune automatically.
4. Select RANGE HOLD to hold all ranges and tuning.
5. Select the time delay to be inserted between the moment the transmitter is keyed and the time MODULATION OUTPUT/AUDIO INPUT is to be turned on. This delay becomes the Special Function suffix. (If 18.0 SPCL is selected, the Measuring Receiver executes a 99 ms delay.)
6. Enter the Special Function code 18.NN (where NN is the selected delay in milliseconds), then select SPCL. (If 18.5 is entered, a 5 ms delay is executed. For a 50 ms delay, enter 18.50.)

The Measuring Receiver is now initiated to receive tone bursts. To exit this mode, select any key except the Blue Key, S (shift), or LOCAL Key, or numeric keys.

PROGRAM CODES

The Special Function code suffix is derived from the time delay as described in "PROCEDURE".

SPCL = SP

INDICATIONS

As the numeric code is entered, it appears on the front panel display. When the SPCL key is pressed, 18.NN is displayed (NN is the delay in milliseconds). If no RF is at the RF INPUT connector, two dashes (--) are displayed.

COMMENTS

Suggested Use of Maximum Delay.

When using the Tone Burst Receiver Special Function, use the 99 ms delay for best results. Shorter delays require very careful setup since, with no input, the high-gain IF Amplifier and Limiters "tune" the noise to an average frequency often slightly different than the nominal IF. When RF first enters the instrument, the IF shifts abruptly to the nominal frequency. This shift creates an FM transient which settles out after a short period and thus is not apparent with longer delays. With short delays the transients can be avoided by carefully tuning the instrument so that the IF frequency when the transmitter is on is close to, or equal to the average IF frequency when the transmitter is off.

HP-IB.

This function is best used when operating via HP-IB since the external counter connected to the output of MODULATION OUTPUT/AUDIO INPUT may need to acquire several sets of data in rapid succession (when counting multiple tones, for example).

Selective Range Holding.

Ranges can be held for this function using the individual Special Functions for each parameter instead of using the Range Hold key.

Default Condition.

Special Function code 18.0 provides a 99 ms delay.

Tone Burst Frequency Cannot Be Measured.

The audio frequency measurement mode cannot be used to measure the frequency of the tone burst.

ΦM But Not AM.

This feature works also with the ΦM measurement mode but not AM.

ΦM

FUNCTIONS

ΦM, Special Function 2 (Audio Range)

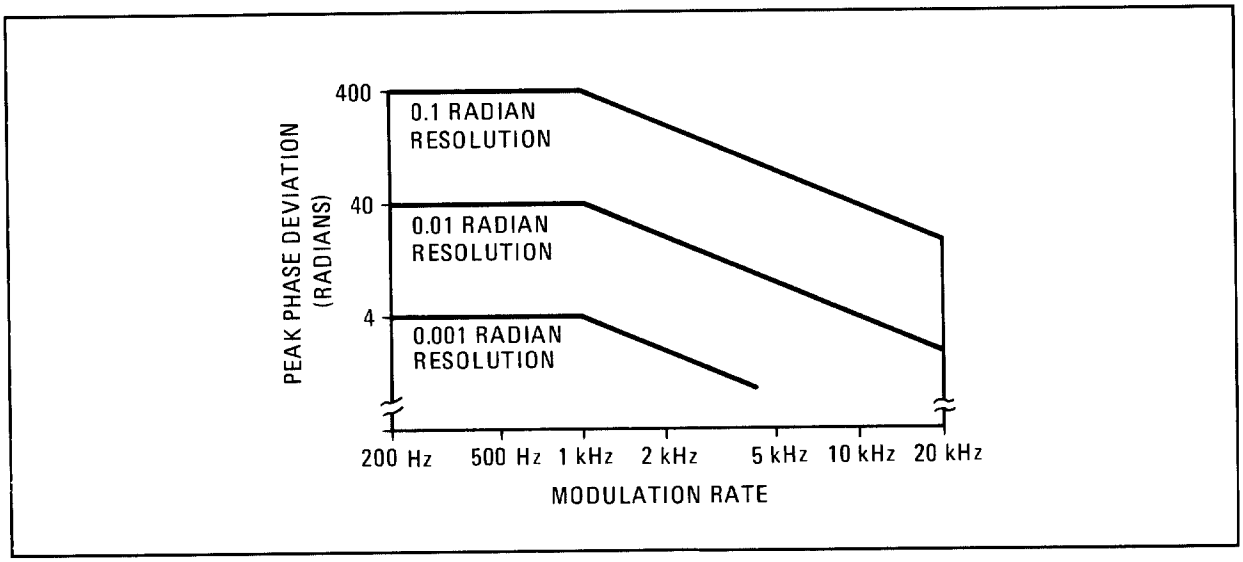
DESCRIPTION

The ΦM key enables the Measuring Receiver to measure the phase deviation of the tuned input signal. The demodulated ΦM is present at MODULATION OUTPUT/AUDIO INPUT.

The ΦM measurement is specified only for RF carriers from 10 to 1300 MHz; however, ΦM measurements can be performed on carriers from 150 kHz to 10 MHz.

The ΦM measurement is only specified for modulation rates from 200 Hz to 20 kHz; however, the low frequency 3 dB limit is typically 7 Hz.

The following figure shows the display resolution for different combinations of peak phase deviation and modulation rate.



PROCEDURE

To make a ΦM measurement, first tune the instrument to the input signal by selecting AUTOMATIC OPERATION. Select ΦM.

Select an audio detector: PEAK+, PEAK−, PEAK ± /2, AVG, or RMS. (The RMS detector, selected by pressing the Blue Key and the RMS key, is less accurate in measuring ΦM and is typically only used for audio distortion measurements.)

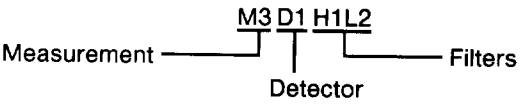
The following table lists the different measurement range limits that can be selected with Special Function 2:

Modulation Range (Peak±rad. dev.)	Detector Selected	Special Function Code	Program Code HP-IB	Display Resolution (radians)	MODULATION OUTPUT Sensitivity (mVac/radian)
Automatic Selection		2.0 SPCL	2.0SP	Automatic Selection	
≤0.4	RMS	2.4 SPCL	2.4SP	0.0001	10
≤4	Pk, Avg	2.4 SPCL	2.4SP	0.001	1
≤4	Pk, Avg, RMS	2.1 SPCL	2.1SP	0.001	1
≤40	Pk, Avg, RMS	2.2 SPCL	2.2SP	0.01	0.1
≤400	Pk, Avg, RMS	2.3 SPCL	2.3SP	0.1	0.01

To filter the demodulated signal, select the appropriate filter keys. (Refer to *Audio Filters* on page 3-207 for more information about filters.)

EXAMPLE

To measure the positive-peak phase deviation of a signal in a 50 Hz to 15 kHz post-detection bandwidth:

LOCAL (keystrokes)	
HP-IB (program codes)	

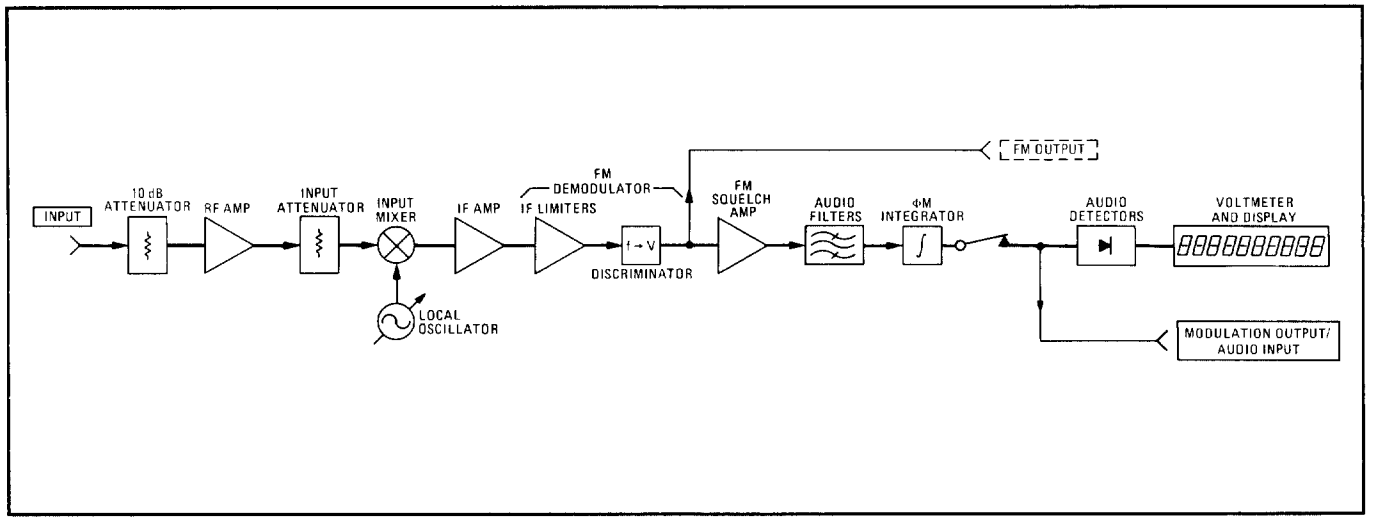
HP-IB PROGRAM CODE

All HP-IB codes for setting range limits for ΦM measurements are provided in "Procedures".

ΦM = M3

MEASUREMENT TECHNIQUE

The ΦM on the IF is first demodulated by a frequency discriminator. The amplitude of the discriminator's output is proportional to the frequency deviation. The demodulated signal is filtered and passed through an integrator, which extracts the phase information. The integrator's output is detected and displayed as phase deviation in radians. The integrator's output is made available at the MODULATION OUTPUT/AUDIO INPUT.



ΦM Measurement Block Diagram

COMMENTS

Frequency and Distortion Measurements.

The demodulated signal's frequency and distortion can also be measured. (Refer to *Audio Measurements* which begins on page 3-225.)

Relative Measurements.

If ΦM deviation is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

Peak Detector. The PEAK+ detector always detects the upward carrier phase excursion while the PEAK− detector always detects the downward carrier phase excursion. The PEAK±/2 detector sums the upward and downward phase-excursion readings and divides the total by two to provide an average of the two peak values. (Do not confuse this "average" value with the detected average value.)

Inverted Output Signals.

When operating with carrier frequencies below 2.5 MHz, the output signal at MODULATION OUTPUT/AUDIO INPUT is inverted unless the 455 kHz IF is selected. When operating with carrier frequencies above 2.5 MHz or when using the 455 kHz IF, the upper limit of the modulation rate is that of the >20 kHz LP FILTER.

Automatic Range Selection.

The routine which automatically selects the modulation range contains regions of overlap between the following displayed peak deviations:

0.35 and .4 radians, 3.5 and 4 radians, and 35 and 40 radians.

When using the average or RMS detector, ranging will occur at readings lower than these. In general, if the modulation is reduced from a higher range into an overlap region, the range does not change. To range the display for increased resolution, press the ΦM key a second time. To set the instrument to a selected modulation range, refer to *Audio Range* on page 3-211.

Potential Inaccuracies.

AM depths approaching 100% cause the carrier to nearly disappear and may cause inaccurate measurement of ΦM deviation or Error 05 (FM squelched).

Input/Output Status.

When ΦM is selected, the signal at the rear-panel FM OUTPUT still represents demodulated FM, not ΦM.

Increased Accuracy.

Accuracy of ΦM readings may be improved by taking into account the effects of residual noise. (Refer to *Residual Noise Effects* on page 3-219.)

Phase Deviation in Degrees.

To display phase deviation in degrees instead of radians, enter 1.745 as a ratio reference and select RATIO. (Refer to *Ratio* on page 3-245.)

Pulsed Phase Modulation.

Pulsed phase modulation, such as phase shift keying, cannot be accurately demodulated or measured by the Measuring Receiver.

Recommended Filter Selection.

Because of the high sensitivity of the ΦM measurement to low-frequency audio (microphonics, hum, etc.), use of the 50 Hz or 300 Hz low-pass filter is recommended. (Neither is switched in automatically.)

Audio Detectors

FUNCTIONS

PEAK+, PEAK−, PEAK±/2, PEAK HOLD, AVG, RMS.

DESCRIPTION

The Measuring Receiver provides three types of audio detectors: peak responding, average responding (rms calibrated), and true rms. These three detectors provide six modes of audio measurements:

- Positive Peak (PEAK+)
- Negative Peak (PEAK−)
- Average of Positive and Negative Peaks (PEAK+/2 mode)
- Positive or Negative Peak Hold (PEAK HOLD)
- Average (AVG:RMS Calibrated)
- True RMS (RMS)

The two peak detector keys, when pressed individually, select whether the positive peak or the negative peak of the demodulated signal is measured. When the two peak detector keys are pressed simultaneously (the PEAK±/2 mode), the positive and negative peaks are averaged according to the following equation:

$$Peak\ Average = \frac{(Peak+) + (Peak-)}{2}$$

Peak Hold detection is used in conjunction with positive or negative audio peak detector modes. This mode enables the instrument to hold and display indefinitely, the largest peak detected. This feature is useful for capturing the peak maximum of a modulation transient.

Average detection selects an average-responding detector that is calibrated to read the rms value of a sinewave.

True RMS detection selects a true rms detector to measure audio signals. Also, noise and residual measurements are best measured with the true rms detector. This detector is automatically selected and is the only one used with the external audio voltage measurement (Special Function 30), audio distortion measurement and the SINAD measurement (Special Function 29). Selection of this detector also affects the FM pre-display de-emphasis. (Refer to "COMMENTS".)

Once selected, a detector remains unchanged and is automatically activated each time modulation measurements are made until another detector is selected (except for the true rms detector as discussed in the previous paragraph). (However, once it is automatically selected, the true rms detector remains active.)

PROCEDURE

When a modulation measurement is selected, a detector is automatically activated.

To obtain a peak detector, select either PEAK+ or PEAK−. Press both keys simultaneously to enable the peak-average (PEAK±/2) mode.

Peak hold is used only with the peak detectors. Selecting PEAK HOLD initiates the peak hold mode. To initiate another peak hold, press that key again. The display is now updated with the new peak. The peak hold feature does not operate in the peak-average mode.

To obtain the average-responding, rms-calibrated detector, select AVG.

To initiate the true rms measurement, select RMS (Blue Key, AVG). The true rms detector is selected automatically for the external audio level measurement (Special Function 30), audio distortion measurement, and SINAD measurement (Special Function 29).

HP-IB PROGRAM CODES

Function	Program Code HP-IB
PEAK+	D1
PEAK−	D2
PEAK HOLD	D3
AVG	D4
RMS	D8
PEAK±/2	D9

COMMENTS

Input/Output Status.

The signal at MODULATION OUTPUT/AUDIO INPUT, AM OUTPUT, or FM OUTPUT is not affected by the DETECTOR keys.

True RMS Detector.

Only the true rms detector can be used for external audio level (Special Function 30) and for audio distortion measurement, and SINAD (Special Function 29.)

HP-IB Automatic Selection of Pre-Display.

When the true rms detector is selected, the pre-display mode for FM de-emphasis is automatically enabled. This is true whether FM has been selected or not. (Selection of the FM de-emphasis time constant, however, remains unaffected.) The pre-display mode remains enabled until deliberately disabled. This idiosyncrasy is important to remember when programming the instrument via HP-IB.

Peak Detector's Response Time.

A slower response time for the audio peak detectors can be selected with Special Function 5.1. (Refer to *Audio Detector Response* on page 3-205.)

Peak Hold Mode.

When the peak hold mode is selected, the limited rise time of the peak detector circuitry can cause a slight measurement error for narrow, one-time modulation transients. To prevent this error, repeat the peak-generating process several times while leaving the peak hold mode active.

If PEAK HOLD is selected while the average or true rms detector mode is active, the detector will switch to the peak detector mode previously selected. If PEAK HOLD is selected while the peak-average (PEAK±/2) mode is active, the detector reverts to PEAK+ with PEAK HOLD.

HP-IB

In remote operation, new peak-hold cycles can only be initiated by code D3. Thus, if the instrument is in HP-IB Hold mode (code T1), issue code D3 to initiate a peak-hold cycle. Although the display cannot be updated when in HP-IB Hold, the peak is captured, stored and updated. Upon leaving HP-IB hold via the triggering codes (T2 or T3), the data output represents the greatest peak captured since the peak-hold cycle was initiated.

Audio Detector Response

FUNCTIONS

Special Function 5 (Audio Detector Response)

DESCRIPTION

When making modulation measurements, both the audio peak detector response (for peak measurements including SINAD)[1] and the digital averaging response (for rms measurements) are usually fast. A slower response time (narrower detection bandwidth) can be enabled using Special Function 5.1.

The slow response time improves measurement readability on unstable or noisy signals whenever display jitter is excessive.

PROCEDURE

The Measuring Receiver is normally set for fast response. To change from fast to slow or vice versa, enter the corresponding Special Function code, then select SPCL.

Audio Detector Response	Special Function Code	Program Code HP-IB
Fast	5.0 SPCL	5.0SP
Slow	5.1 SPCL	5.1SP

COMMENTS

Default Condition

When the instrument is first turned on or when Automatic Operation or Instrument Preset is selected, the response time returns to fast.

[1] The slow response time for SINAD is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

Audio Filters

FUNCTIONS

HP FILTER, LP FILTER

DESCRIPTION

High-pass and low-pass filters can be inserted in the path of the demodulated signal.

The filters are used for such tasks as rejecting interfering audio signals such as line hum and sub-carriers. They also provide pre-defined bandwidths for residual noise measurements.

PROCEDURE

Insert the desired demodulated signal filter by selecting the appropriate keys. Only one high-pass and one low-pass filter can be inserted at once.

To remove a filter, select the key again.

To select a different filter, press the key corresponding to the desired filter.

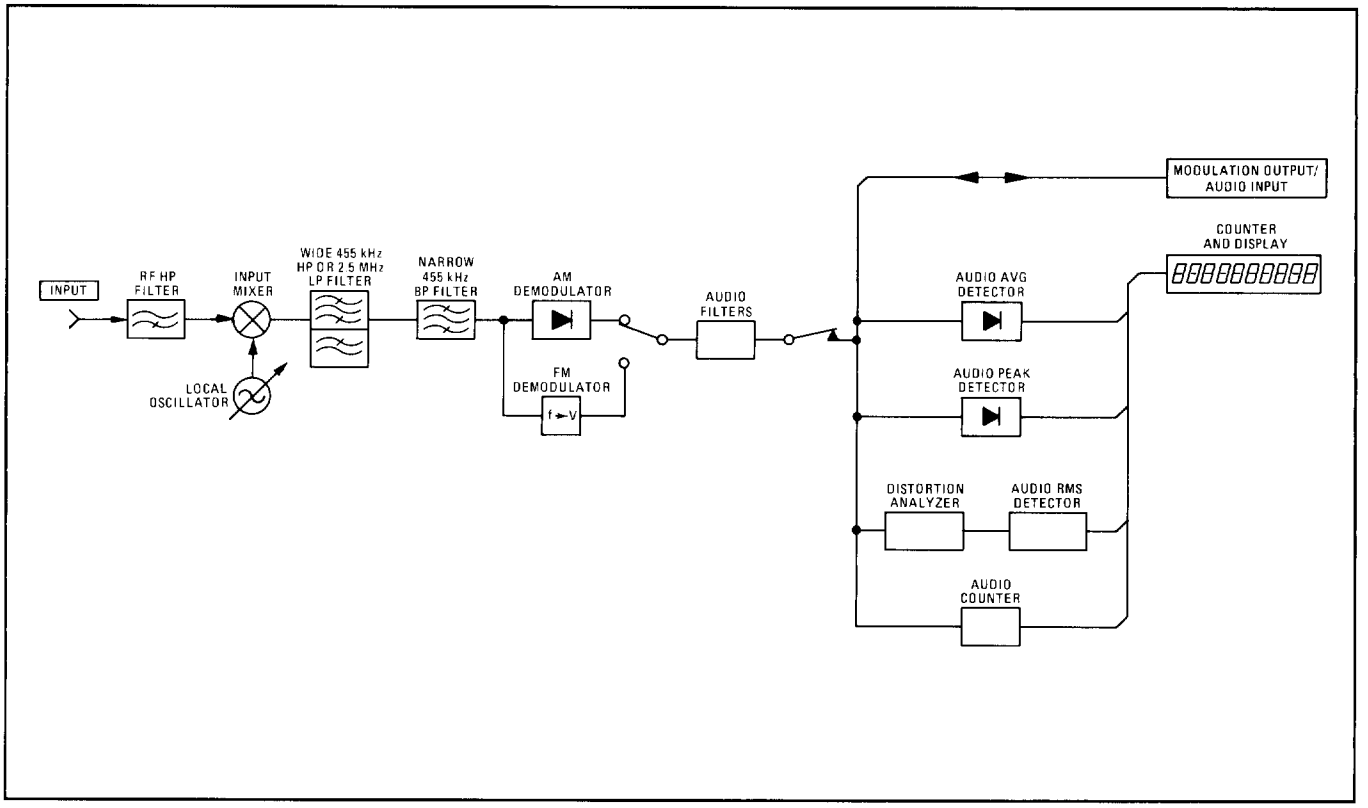
HP-IB codes for the various filter keys (listed in the following table) only insert the filters. To remove a high-pass or low-pass filter via HP-IB, use code H0 or L0 (respectively), or select another filter.

HP-IB PROGRAM CODES

HP FILTER	Program Code HP-IB
ALL OFF	H0
50 Hz	H1
300 Hz	H2

LP FILTER	Program Code HP-IB
ALL OFF	L0
3 kHz	L1
15 kHz	L2
>20 kHz	L3

BLOCK DIAGRAM



Audio Filters Block Diagram

COMMENTS

Filter Selection Affects Modulation Output.

The selected filters are always in the path of the demodulated signal independent of the selection of a modulation measurement. Thus, unless turned off, the output of MODULATION OUTPUT/AUDIO INPUT is filtered. In addition, the selected filters remain in effect when switching between modulation measurements.

Automatic Filter Selection.

Under certain conditions, filters are inserted automatically. When the 455 kHz IF is used, or when the RF input is less than 2.5 MHz, the 15 kHz low-pass filter is inserted unless another low-pass filter has been selected. (The ALL OFF >200 kHz low-pass filtering cannot be selected.) The 15 kHz low-pass filter selected when operating with the 455 kHz IF is automatically turned off when the 1.5 MHz IF is selected.

Bandwidth Limitations.

With no filters selected, the post-demodulation bandwidth is from less than 20 Hz to greater than 200 kHz. (These frequencies refer to the limits over which measurement accuracy is specified, not the 3 dB bandwidth.) However, the IF circuits and demodulators impose more severe bandwidth

limits. Refer to each specific measurement in these Detailed Operating Instructions for bandwidth limitations.

Filter Characteristics.

The individual filter characteristics are given below. The 3 dB bandwidth is specified in the filter's designation and is typically accurate to ±3%.

High-Pass Filters:

50 Hz High Pass: Two-pole Butterworth, 1% flat to <200 Hz

300 Hz High Pass: Two-pole Butterworth, 1% flat to <1 kHz

Low-Pass Filters:

3 kHz Low Pass: Five-pole Butterworth, 1% flat to >1 kHz

15 kHz Low Pass: Five-pole Chebyshev, 1% flat to >10 kHz

>20 kHz Low Pass: Nine-pole Bessel, 1% flat to >10 kHz. (When used with square wave modulation, this filter typically overshoots <1%. This filter's 3 dB point is typically 110 kHz.)

Filter Selection Does Not Affect Some Measurements.

External Audio level, distortion, and SINAD measurements are unaffected by the audio filters.

Recommended Filter Selection.

Because of the high sensitivity of the ΦM measurement to low-frequency audio (microphonics, hum, etc.), use of the 50 Hz or 300 Hz low-pass filter is recommended. (Neither is switched in automatically.)

Audio Range

FUNCTIONS

Special Function 2 (Audio Range)

DESCRIPTION

The Measuring Receiver is usually set to automatically select the audio range appropriate for the desired measurement. To set the audio range manually, use Special Function 2.

PROCEDURE

To set the audio range or to re-enter the automatic selection mode, select the corresponding Special Function code.

Modulation Range Peak± (%)	Detector Selected	Special Function Code	Program Code HP-IB	Display Resolution (%)	MODULATION OUTPUT Sensitivity (Vac/% AM)
Automatic Selection		2.0 SPCL	2.0SP	Automatic Selection	
≤4	RMS	2.4 SPCL	2.4SP	0.001	0.1
≤40	Pk, Avg	2.4 SPCL	2.4SP	0.01	0.1
≤40	Pk, Avg, RMS	2.1 SPCL	2.1SP	0.01	0.1
≤100	Pk, Avg, RMS	2.2 SPCL or 2.3 SPCL	2.2SP or 2.3SP	0.1	0.01

Audio Range Available for FM

Modulation Range (Peak±kHz dev.)	Detector Selected	Special Function Code	Program Code HP-IB	Display Resolution (Hz)	MODULATION OUTPUT Sensitivity (Vac/% Hz)
Automatic Selection		2.0 SPCL	2.0SP	Automatic Selection	
≤0.04	RMS	2.4 SPCL[1]	2.4SP	0.01	100
≤0.4	RMS Pk, Avg Pk, Avg, RMS	2.4 SPCL 2.4 SPCL[1] 2.1 SPCL[1]	2.4SP 2.4SP 2.1SP	0.1	10
≤4	Pk, Avg Pk, Avg, RMS Pk, Avg, RMS	2.4 SPCL 2.1 SPCL 2.2 SPCL[1]	2.4SP 2.1SP 2.2SP	1	1
≤40	Pk, Avg, RMS	2.2 SPCL 2.3 SPCL[1]	2.2SP 2.3SP	10	0.1
≤400	Pk, Avg, RMS	2.3 SPCL	2.3SP	100	0.01

[1] With 750 μs de-emphasis, pre-display only.

Audio Range Available for ΦM

Modulation Range (Peak±rad. dev.)	Detector Selected	Special Function Code	Program Code HP-IB	Display Resolution (radians)	MODULATION OUTPUT Sensitivity (mVac/radian)
Automatic Selection		2.0 SPCL	2.0SP	Automatic Selection	
≤0.4	RMS	2.4 SPCL	2.4SP	0.0001	10
≤4	Pk, Avg	2.4 SPCL	2.4SP	0.001	1
≤4	Pk, Avg, RMS	2.1 SPCL	2.1SP	0.001	1
≤40	Pk, Avg, RMS	2.2 SPCL	2.2SP	0.01	0.1
≤400	Pk, Avg, RMS	2.3 SPCL	2.3SP	0.1	0.01

COMMENTS

Audio Range Effect on Distortion Measurements

The selected Audio Range has no effect on audio distortion or SINAD measurements.

When the audio range selected is too high for the level of the audio signal, the signal-to-noise ratio will be low (no error is generated). (The output of MODULATION OUTPUT/AUDIO INPUT tracks the displayed values.) When the audio range is too low for the audio signal level, Error 04 is generated. (The output of the MODULATION OUTPUT/AUDIO INPUT will probably be clipped.) Depending on the audio filtering and detector in use, Error 04 may not be generated at exactly the nominal values listed in the tables above.

Disabling Error 04 Inhibits Audio Autoranging

When Error 04 is disabled (refer to *Error Message Disable Control* on page 3-267), the Measuring Receiver automatically ranges to a less sensitive range when the signal level requires, but it does not range back when the audio level is reduced. This feature is used most often when modulation varies widely with time (such as off-the-air demodulation of a broadcast signal).

Modulation Output/Audio Input

FUNCTIONS

AUDIO INPUT

CAUTION

Do not apply greater than 10 Vdc or greater than +30 dBm (1 watt) into MODULATION OUTPUT/AUDIO INPUT or damage to the instrument may result.

NOTE

For optimum signal flatness, cables attached to MODULATION OUTPUT/AUDIO INPUT (when used as an output) should be terminated in 600Ω.

DESCRIPTION

Modulation Output.

MODULATION OUTPUT/AUDIO INPUT provides a calibrated output for signals demodulated by the Measuring Receiver. The output signal available at the connector usually corresponds to the current modulation measurement. (The output is dc coupled and has a 600Ω output impedance into a BNC female connector.)

Audio Input.

The input at MODULATION OUTPUT/AUDIO INPUT also provides external access to the audio measurement circuits. The input impedance at the connector is 100 kΩ.

Effects on Modulation Output/Audio Input During Measurements.

Measurements have a direct effect on MODULATION OUTPUT/AUDIO INPUT. The following table lists the functioning of the MODULATION OUTPUT/AUDIO INPUT for each measurement. (Measurements not listed have no effect.)

Measurement	Measuring Receiver's Response
AM	Selects the demodulated AM signal (unless AUDIO INPUT is selected).
AUDIO DISTN	Measures signal available at MODULATION OUTPUT/AUDIO INPUT (depends on AUDIO INPUT key selection).
AUDIO FREQ	Measures signal available at MODULATION OUTPUT/AUDIO INPUT (depends on AUDIO INPUT key selection).
AUTOMATIC OPERATION	Selects the last-selected modulation measurement.
FM	Selects the demodulated FM signal (unless AUDIO INPUT is selected).
FREQ	Selects the last-selected modulation measurement.
FREQ ERROR	Selects the last-selected modulation measurement.
INSTR PRESET	Refer to **Instrument Preset**
ϕM	Selects the demodulated FM signal (unless AUDIO INPUT is selected).
RF POWER	Blanks output; turns off all Modulation Output, Audio Input keylights.
TUNED RF LEVEL	Blanks output; turns off all Modulation Output, Audio Input keylights.
29.0 SPCL (SINAD)	Selects the last-selected modulation measurement.
30.0 SPCL (Ext. Audio RMS Level)	Selects AUDIO INPUT.
33.0 SPCL (LO Frequency)	Selects the last-selected modulation measurement.
34.0 SPCL (IF Frequency)	Selects the last-selected modulation measurement.
35.0 SPCL (RF Level)	Blanks output; turns off all Modulation Output, Audio Input keylights.
36.0 SPCL (Peak Tuned RF Level)	Blanks output; turns off all Modulation Output, Audio Input keylights.
HP and LP Filters, and FM De-emphasis affect the output, but not the input of MODULATION OUTPUT/AUDIO INPUT. (See the Modulation Output/Audio Input Block Diagram in this instruction.)	

Display Resolution vs. Modulation Output Sensitivity

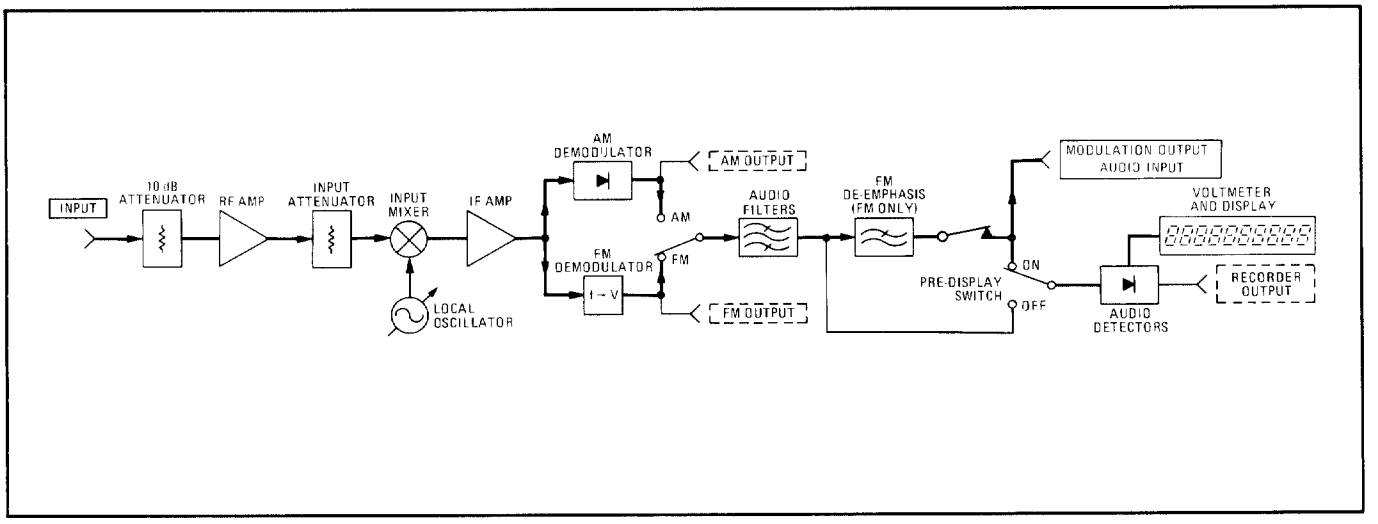
In Automatic Operation, when the Modulation Output/Audio Input feature is used, the output autoranges. Autoranging usually occurs between 3.5 and 4 Vpk, open circuit. Many variables, however, affect the autorange limits and hence the displayed measurement resolution. The variables include: type of modulation, audio detector, audio filtering, and FM de-emphasis. Special Function 2 permits manual setting of the audio range.

The following table examines this relationship. (Refer to *Audio Range* on page 3-211 for more information on modulation ranges.)

AM		FM		ϕM	
Display Resolution (%)	**Modulation Output Sensitivity (Vac/%)**	**Display Resolution (Hz)**	**Modulation Output Sensitivity (mVac/Hz)**	**Display Resolution (radians)**	**Modulation Output Sensitivity (mVac/radian)**
0.001	0.1	0.01*	100	0.0001	10
		0.1	10	0.001	1
0.01	0.1	1	1		
		10	0.1	0.01	0.1
0.1	0.01	100	0.01	0.1	0.01

*Available only with 750 μs de-emphasis, pre-display.

BLOCK DIAGRAM



Modulation Output/Audio Input Block Diagram

COMMENTS

Functions That Override Audio Input.

The Audio Input function is overridden by all measurements except audio frequency, distortion, SINAD, and external level.

Errors Disable Output Signal.

Errors 01 through 03, 05, 10, and HP-IB Error 96 (corresponds to a display of two dashes) turn off the signal at MODULATION OUTPUT/AUDIO INPUT.

Default Condition.

When the Measuring Receiver is first powered up, the demodulated output signal at MODULATION OUTPUT/AUDIO INPUT is FM. The sensitivity is 0.01 mV/Hz (the least-sensitive range) and will not autorange to more sensitive ranges. This is because at power up, FREQ is selected. Thus Error 04 (audio circuits overdriven) is automatically disabled. When Error 04 is disabled, only autoranging to less-sensitive audio ranges is allowed.

Safeguarding Output Signal.

When Errors 01 through 04 are always enabled via Special Function 8.8, the output signal at MODULATION OUTPUT/AUDIO INPUT is entirely safeguarded. Under this condition the instrument operates as a calibrated receiver and an error is displayed whenever the signal at MODULATION OUTPUT/AUDIO INPUT is uncalibrated. (Refer to *Error Message Disable Control* on page 3-267.)

Filters Affect Output Signal.

The audio high-pass and low-pass filters and FM de-emphasis affect the output but not the input of the MODULATION OUTPUT/AUDIO INPUT.

Residual Noise Effects

DESCRIPTION

To make the most accurate peak-modulation measurements, it is necessary to measure and correct the effects of residual noise, that is, noise not on the baseband signal, but modulating the RF carrier. The following procedure describes the measurement technique.

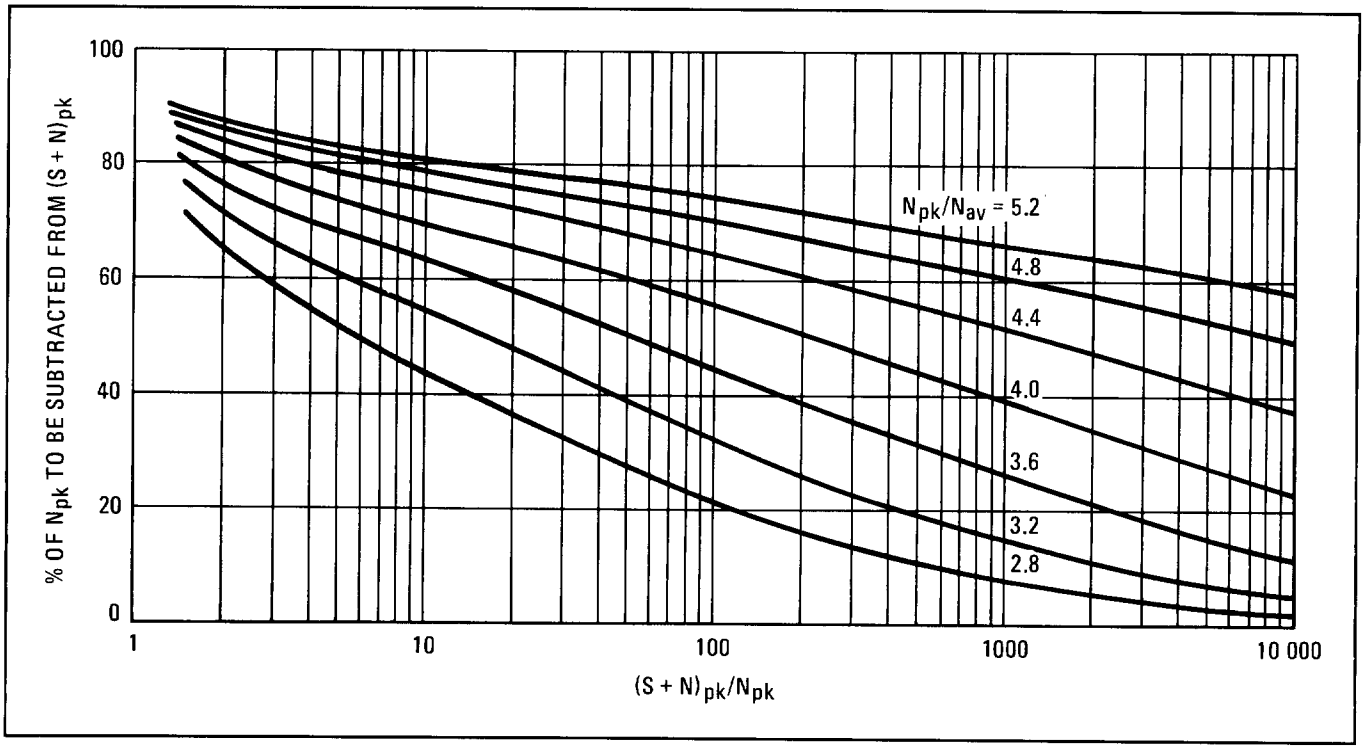
PROCEDURE

The following procedure enables the user to correct for the effects of residual noise on peak-modulation measurements.

NOTE

This procedure applies to sinewave modulation only.

1. Set up and make a normal peak-modulation measurement. The displayed measurement result will include the signal plus its noise, $(S + N)_{pk}$.
2. Press the Range Hold key to prevent autoranging. If filtering and/or de-emphasis was used in step 1, make all the following measurements with the same settings.
3. Remove the modulation from the signal and measure the remaining peak-residual noise, N_{pk}, on the carrier.
4. Select AVG. Measure the average residual noise, N_{av}.
5. Compute
$$\frac{(S+N)_{pk}}{N_{pk}} \text{ and } \frac{N_{pk}}{N_{av}}$$
6. Use the following nomograph to determine the percent, $N\%$, of the peak-residual noise level, N_{pk}, to be subtracted from the original, peak-signal-plus-noise measurement, $(S + N)_{pk}$.
7. Compute the corrected, peak modulation
$$S_{pk} = (S + N)_{pk} - N_{pk}(N\%)$$
where $N\%$ is expressed as a ratio (rather than in %).



Nomograph for Calculating Percentage of N_{pk} to be Subtracted from $(S + N)_{pk}$ to obtain S_{pk} (Sinewave Modulation Only)

EXAMPLE

An RF signal is applied to the Measuring Receiver. The modulation rate is 1 kHz and the peak modulation is to be measured in a 15 kHz post-detection bandwidth. To measure the peak AM depth and correct for the effects of residual noise on the modulation:

1. Measure the peak modulation depth, $(S + N)_{pk}$:

LOCAL (keystrokes)	AUTOMATIC OPERATION; MEASUREMENT: AM; DETECTOR: PEAK +; FILTER: 15 kHz
HP-IB (program codes)	AU M1 D1 L2 — Measurement, Detector, Filter

For the purposes of subsequent calculations, assume the displayed AM is 30.80%.

2. Disable auto-ranging by pressing the RANGE HOLD key:

LOCAL (keystrokes)	RANGE HOLD •
HP-IB **(program codes)**	G1 Range Hold

3. On the RF signal source, swith the AM off. Measure the residual AM, N_pk, on the CW signal. For the purposes of subsequent calculations, assume 0.07% is read on the Measuring Receiver's display.

4. Measure the average residual modulation:

LOCAL (keystrokes)	DETECTOR RMS CAL AVG •
HP-IB **(program codes)**	D4 Detector

For the purposes of subsequent calculations, assume the displayed average residual AM is 0.02%.

5. Compute:

$$\frac{N_{pk}}{N_{av}} = \frac{0.07\%}{0.02\%} = 3.5\%$$

6. Compute:

$$\frac{(S+N)_{pk}}{N_{pk}} = \frac{30.80\%}{0.07\%} = 440$$

7. Use the nomograph to find N%. (For the purposes of these calculations, assume N% is 26%.) Compute:

$$S_{pk} = (S+N)_{pk} - (N_{pk})(N\%) = 30.80\% - (0.07\%)(0.26) = 30.78\%.$$

NOTE

This correction factor of <0.1% of the peak reading is typical of a modulation measurement of a quality modulation source measured with the 15 kHz low-pass filter.

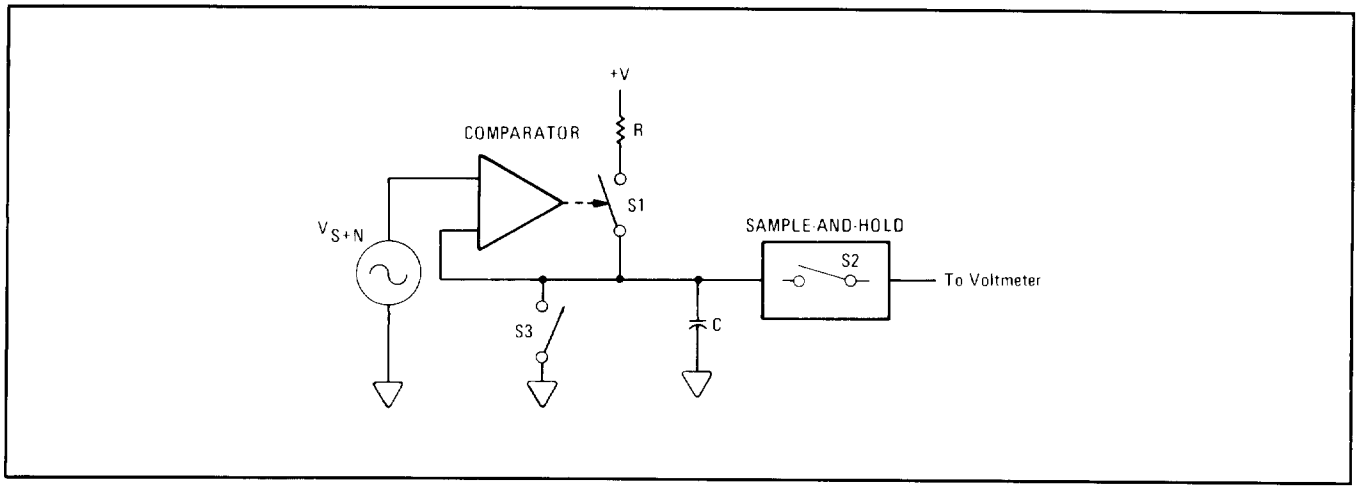
THEORY

Residual noise is the short-term amplitude or phase (and thus frequency) instability inherent in any CW signal source. In a measurement system composed of a signal source and the Measuring Receiver, residual noise is contributed by both instruments. When modulation is measured with the Measuring Receiver, both the intended and residual combined are measured. To precisely determine the modulation index due to the baseband signal alone, the effects of residual noise must be factored out of the measurement results.

Two noise components are commonly encountered in modulation measurements: periodic (often line-related) and gaussian (random). Periodic noise and the baseband signal behave identically. The Measuring Receiver measures the arithmetic sum of the peak or average levels of the two signals (according to the detector selected). To determine the modulation index due to the baseband signal alone, switch the modulation off, measure the peak-residual noise on the same range as before, and subtract the result from the original displayed modulation. The effects of random noise on the measurement system are not as straight forward. True random noise, when viewed in the frequency domain, is a continuous spectrum of frequencies at various amplitudes. The frequency of the noise spectrum is limited only by the bandwidths of the observing and/or generating devices. In the time domain, noise of this kind appears as random amplitude spikes (or fuzz) riding on top of the recovered baseband signal. The amplitude of these spikes is limited by the slow rate of the measuring and/or generating devices. Peak detecting these spikes exaggerates the amount of energy present in the noise spectrum so noise measurements are typically made with average-responding detectors and with limited bandwidths.

The measurement problem arises because modulation index is typically expressed as a peak level. To account for residual noise in these peak measurements, the actual effects of the noise on the Measuring Receiver's peak detector must be determined.

A simplified diagram of the Measuring Receiver's peak detector is shown in the following figure. Whenever the signal-plus-noise voltage into the comparator exceeds the voltage stored on the output capacitor, C, the comparator closes switch S1. The capacitor is then charged via the path from +V through resistor R. When the voltage across the capacitor exceeds the voltage of the incoming signal, the comparator opens the switch again. This process continues until the voltage on the capacitor is transferred to the voltmeter through the sample-and-hold switch, S2. C is then discharged by S3. When very narrow noise spikes are imposed on the comparator's input, the charging circuit's RC time constant will not allow the capacitor to fully charge before the noise peak has passed.



Simplified Diagram of the Measuring Receiver's Peak Detector

When noise alone is imposed on the detector, it is very probable that, as C begins to charge, a noise spike will exceed the voltage across the peak detector capacitor. However, as the voltage across the capacitor more nearly approaches the peak-noise level, this probability decreases. Thus the peak detector, over a significantly long time, can faithfully measure fairly high peak-noise levels.

When noise is riding on a sinewave, only the signal-plus-noise peaks exceeding the sinusoid's peak level can add charge to the peak detector capacitor. Statistically, there is less chance that the composite input signal will exceed the voltage across the capacitor (already charged to the peak of the sinewave) when measuring a sinewave than when measuring only noise. Thus, the contribution of noise on the measured peak-modulation level decreases as the signal-to-noise ratio increases.[2] To simply measure the peak-residual noise present when the modulation is removed and subtract the result directly from the peak reading of the combined input, over-compensates the effects of the noise.

The effects of residual noise on the peak detector depend on the signal-to-noise ratio, the statistics of the noise spikes, and the response time of the specific peak detector. These effects are quantified by taking the ratio of the peak noise reading to the average noise reading. The average noise level is a truer measure of the actual amount of noise energy present, while the peak reading characterizes the peak detector and the statistics of the noise spikes.

COMMENTS

Noise Must Be Gaussian.

The primary restriction placed on this method of accounting for residual noise is that the noise must be gaussian (that is, statistically random). Periodic noise (for example, line-related noise) has repeating peaks and thus does not fall within the statistical model used to derive the nomograph given in the procedure.

A noise-peak-to-noise-average ratio (N_{pk}/N_{av}) greater than 4.4 is a strong indication of a periodic component in the residual noise.

Use Range Hold During Measurement.

Both the modulation and the noise measurements used with the nomograph should be made on the same modulation range and with the same peak-detector time-constant. Use the Range Hold key while the instrument is measuring the modulated carrier, then measure the residual noise.

Select the Highest of Successive Readings.

When characterizing the effects of residual noise on peak ΦM measurements using the 3 kHz low-pass filter, readings may jump considerably. Use the highest of 10 successive readings for all peak measurements in the computations. (Simply select PEAK HOLD and note the reading after 2 seconds.)

No Residual Noise in Calibration.

The residual noise contributions of the AM and FM calibrators and the Measuring Receiver are accounted for in the calibration procedures. It is not necessary to factor residual noise corrections into the calibration procedures described in this manual. (Refer to AM Calibration and FM Calibration.)

Considerations When Using the RMS Detector

During FM measurements if the RMS detector is selected (Blue Key, AVG), FM de-emphasis pre-display is automatically selected. Pre-display must turn on at this time due to circuit configuration of the Measuring Receiver. When pre-display is selected this way, it will not turn off automatically when another detector is selected. Turn off pre-display (after selecting another detector) by pressing the PRE DISPLAY key (HP-IB code: P0). Measurements could be affected by this pre-display selection.

[2] Rice, S.O., "Statistical Properties of a Sine Wave Plus Random Noise", Bell System Technical Journal, 27, No.1, (January, 1948), pp. 109-157.

Audio Measurements Contents

AUDIO MEASUREMENTS

Audio Frequency 3-227
- How to count the demodulated audio frequency.
- How to count an external audio frequency.

Audio Distortion and Level 3-229
- How to measure audio distortion (only at 400 Hz or 1 kHz) on either an internally demodulated or an external audio input.
- How to measure the level of external audio input.

SINAD 3-233
- How to measure SINAD (only at 400 Hz or 1 kHz) on either an internally demodulated or an external audio input.

Audio Frequency

FUNCTIONS

AUDIO FREQ, AUDIO INPUT

DESCRIPTION

Audio Frequency counting can be performed on either demodulated internal signals or external audio signals as determined by the AUDIO INPUT key.

PROCEDURE

To count the frequency of the audio signal demodulated from the RF signal at the INPUT connector, select AUDIO FREQ (Shift, AM).

To count the frequency of an external audio signal at the MODULATION OUTPUT/AUDIO INPUT connector, follow the above procedure, and then select AUDIO INPUT. The measurement range is 20 Hz to 250 kHz. The input signal should not exceed 4 Vrms. The input impedance is approximately 100 kΩ.

HP-IB PROGRAM CODES

AUDIO FREQ = S1
AUDIO INPUT = A1

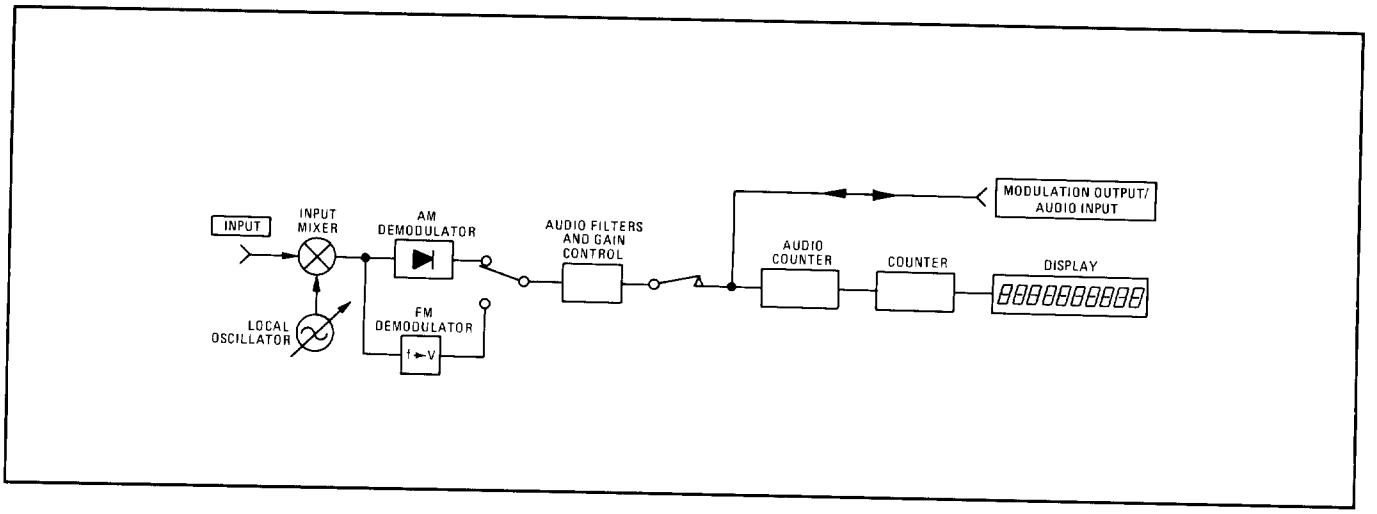
MEASUREMENT TECHNIQUE

The audio frequency is measured by a reciprocal-type counter. The input can be either the demodulated RF at the INPUT or an external audio input at the MODULATION OUTPUT/AUDIO INPUT. The Measuring Receiver gates its internal 10 MHz time base reference with the audio input signal for at least 100 ms. The frequency is then determined by the following equation:

$$audio\ frequency = \frac{(number\ of\ cycles\ of\ audio\ signal) \times 10\ MHz}{number\ of\ time\ base\ reference\ pulses}$$

The combination of minimum count time of 100 ms and the 10 MHz time base reference assures six-digit resolution.

The function of MODULATION OUTPUT/AUDIO INPUT connector is controlled by the AUDIO INPUT key. The connector has an input impedance of approximately 100 kΩ.



Audio Frequency Block Diagram

COMMENTS

Relative Measurements

If audio frequency is to be displayed relative to a reference, enter the value as a ratio reference using the Ratio function. (Refer to *Ratio* on page 3-145.)

Finer Resolution for Frequencies from 100 to 250 kHz [1]

Special Function 32.1 enables a resolution of 0.1 Hz for frequencies 100 to 250 kHz. For dB measurements, this special function enables a resolution of 0.001 dB instead of the normally displayed resolution of 0.01 dB. The selection of Special Function 32.0 or 32.1 is maintained through instrument power down.

32.0 Audio frequency is displayed with the normal resolution of 1 Hz for frequencies from 100 to 250 kHz.

32.1 Audio frequency is displayed with a resolution of 0.1 Hz for frequencies from 100 to 250 kHz.

32.2 Displays 0 if the normal measurement resolution is enabled (32.0 SPCL) and displays 1 if a finer resolution is enabled (32.1 SPCL).

[1] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

Audio Frequency

FUNCTIONS

AUDIO FREQ, AUDIO INPUT

DESCRIPTION

Audio Frequency counting can be performed on either demodulated internal signals or external audio signals as determined by the AUDIO INPUT key.

PROCEDURE

To count the frequency of the audio signal demodulated from the RF signal at the INPUT connector, select AUDIO FREQ (Shift, AM).

To count the frequency of an external audio signal at the MODULATION OUTPUT/AUDIO INPUT connector, follow the above procedure, and then select AUDIO INPUT. The measurement range is 20 Hz to 250 kHz. The input signal should not exceed 4 Vrms. The input impedance is approximately 100 kΩ.

HP-IB PROGRAM CODES

AUDIO FREQ = S1
AUDIO INPUT = A1

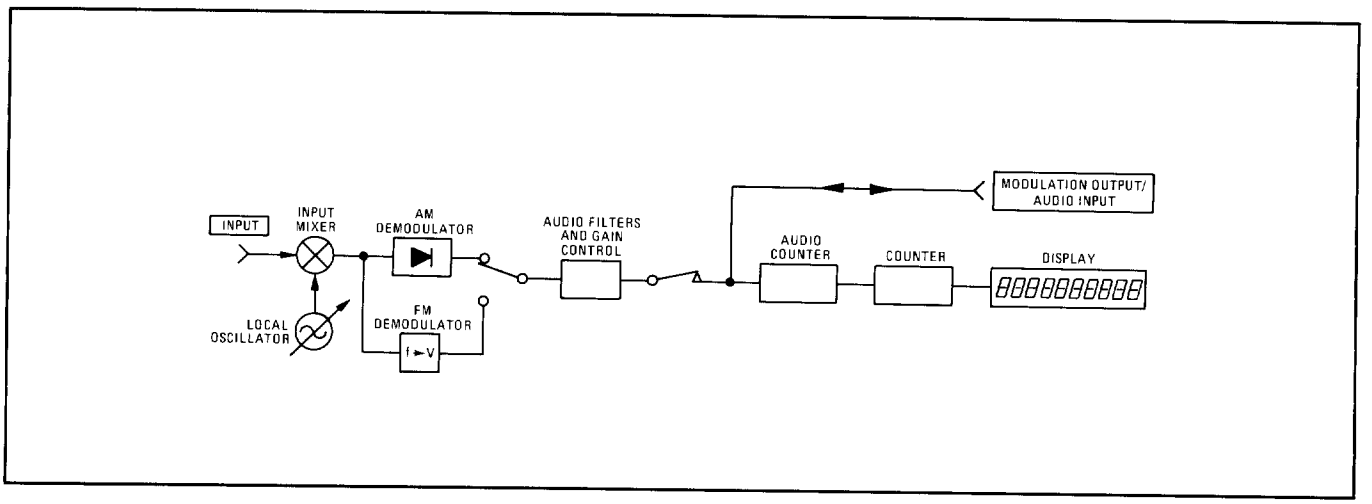
MEASUREMENT TECHNIQUE

The audio frequency is measured by a reciprocal-type counter. The input can be either the demodulated RF at the INPUT or an external audio input at the MODULATION OUTPUT/AUDIO INPUT. The Measuring Receiver gates its internal 10 MHz time base reference with the audio input signal for at least 100 ms. The frequency is then determined by the following equation:

$$audio\ frequency = \frac{(number\ of\ cycles\ of\ audio\ signal) \times 10\ MHz}{number\ of\ time\ base\ reference\ pulses}$$

The combination of minimum count time of 100 ms and the 10 MHz time base reference assures six-digit resolution.

The function of MODULATION OUTPUT/AUDIO INPUT connector is controlled by the AUDIO INPUT key. The connector has an input impedance of approximately 100 kΩ.



Audio Frequency Block Diagram

COMMENTS

Relative Measurements

If audio frequency is to be displayed relative to a reference, enter the value as a ratio reference using the Ratio function. (Refer to *Ratio* on page 3-145.)

Finer Resolution for Frequencies from 100 to 250 kHz [1]

Special Function 32.1 enables a resolution of 0.1 Hz for frequencies 100 to 250 kHz. For dB measurements, this special function enables a resolution of 0.001 dB instead of the normally displayed resolution of 0.01 dB. The selection of Special Function 32.0 or 32.1 is maintained through instrument power down.

32.0 Audio frequency is displayed with the normal resolution of 1 Hz for frequencies from 100 to 250 kHz.

32.1 Audio frequency is displayed with a resolution of 0.1 Hz for frequencies from 100 to 250 kHz.

32.2 Displays 0 if the normal measurement resolution is enabled (32.0 SPCL) and displays 1 if a finer resolution is enabled (32.1 SPCL).

[1] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

Audio Distortion and Level

FUNCTIONS

AUDIO DISTN, 1 kHz DISTN, 400 Hz DISTN, RMS, AUDIO INPUT, Special Function 30 (External Audio RMS Level)

DESCRIPTION

Measure distortion on either internally demodulated audio signals or externally input signals with fundamental frequencies of 1 kHz or 400 Hz. (The fundamental frequency must be within ±5% of the nominal 1 kHz or 400 Hz for accurate measurements.) Once selected, the measurement frequency remains unchanged and is automatically activated each time the audio distortion (or SINAD) measurement is selected.

Special Function 30.0 enables the instrument to measure the true rms level of an external signal applied to the MODULATION OUTPUT/AUDIO INPUT connector. (The connector is automatically switched to function as an input upon selection of Special Function 30.0. The true rms level of the internal demodulated audio cannot be measured.) Connector input impedance is nominally 100 kΩ. The maximum measurable input level is 4 Vrms.

PROCEDURE

To measure distortion on the demodulated audio signal, select AUDIO DISTN (Shift, FM).

To measure distortion on an external audio signal applied to the MODULATION OUTPUT/AUDIO INPUT, select AUDIO DISTN (Shift, FM) and AUDIO INPUT. (Only the true rms detector can be used for these measurements.)

To change the measurement bandwidth of the internally demodulated audio signal, Select the desired filter keys. (Refer to *Audio Filters* on page 3-207.)

If measurements are to be made on a 1 kHz audio signal, select 1 kHz DISTN (Blue Key, PEAK+). If measurements are to be made on a 400 Hz audio signal, select 400 Hz DISTN (Blue Key, PEAK−).

To measure the true rms level of an audio signal applied to the MODULATION OUTPUT/AUDIO INPUT, select 30.0 SPCL.

HP-IB PROGRAM CODES

AUDIO DISTN=S2
AUDIO INPUT = A1
MODULATION OUTPUT = A0
1 kHz DISTN = D5
400 Hz DISTN = D6
LIN results = LN
LOG results = LG
mV units = MV
uV units = UV
VOLTS units = VL
SPCL = SP

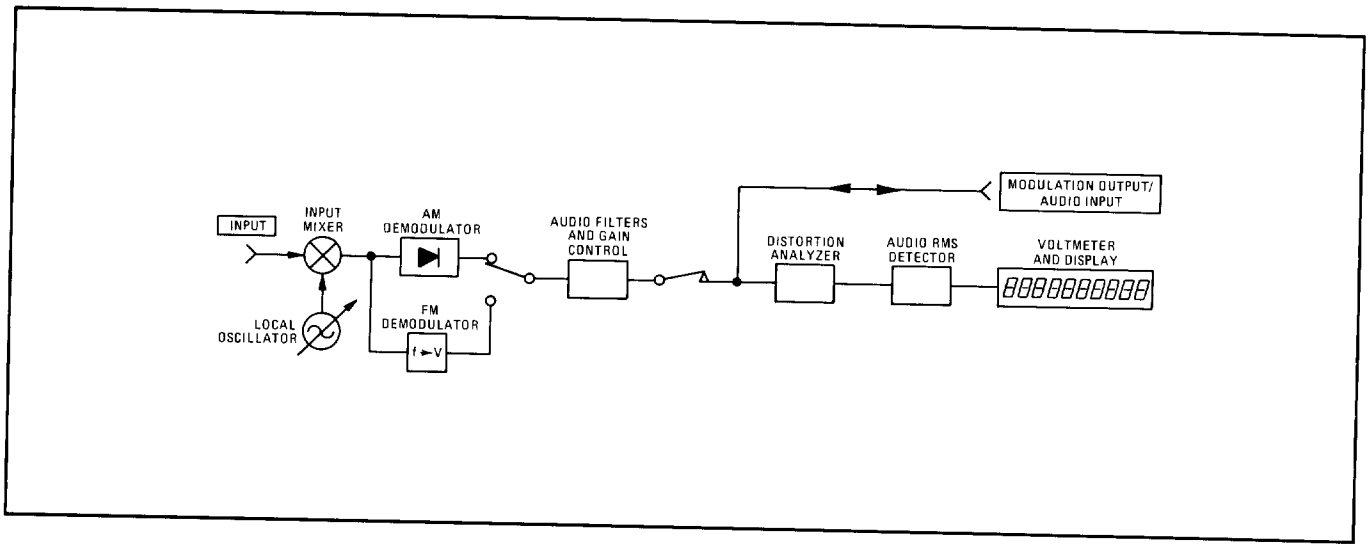
MEASUREMENT TECHNIQUE

To measure audio distortion, the instrument compares the input signal level measurement made with a true rms detector to the same measurement made with the fundamental component removed. Total harmonic distortion is then calculated as the ratio of the signal with its fundamental removed to the unfiltered signal.

The broadband audio signal is first measured with a true rms detector; then the audio signal path is switched through a notch filter set to the fundamental frequency (1 kHz or 400 Hz). The notch filter has approximately 55 dB rejection at the notch frequency with 10% total bandwidth. The distortion is computed as the ratio of the signal from the output of the notch filter to the signal without filtering.

The function of the MODULATION OUTPUT/AUDIO INPUT is controlled by the AUDIO INPUT key. The connector has an impedance of approximately 100 kΩ when used as an input and 600Ω when used as an output.

The true rms level (from 0V to 4V) of any external audio signal (from 20 Hz to 40 kHz) can be measured using the same rms detector. (In this mode, the MODULATION OUTPUT/AUDIO INPUT connector always functions as an input.)



Auto Distortion and Level Block Diagram

COMMENTS

Audio Level Measurement in Watts

Selection of watts as the unit for audio level measurements results in an error.

Automatic Selection of RMS and PRE DISPLAY

Selection of an audio distortion or level measurement automatically selects the true rms audio detector and sets FM de-emphasis to the pre-display mode. (Refer to *FM De-emphasis* on page 3-187.)

The SINAD measurement mode (Special Function 29) is almost identical to the audio distortion measurement mode. SINAD, as measured by the instrument, is the reciprocal of distortion. (Refer to *SINAD* on page 3-233.)

Relative Measurements

If audio distortion or level are to be displayed relative to a reference, enter the value as a ratio reference by selecting RATIO. (Refer to *Ratio* on page 3-245.) The measured results can be displayed in either linear units (mV, %, etc.) or logarithmic units (dBV, dB, etc.) using the LOG/LIN key. The previously selected units are reinstated whenever an audio measurement is selected.

SINAD

FUNCTIONS

1 kHz DISTN, 400 Hz DISTN, Special Function 29 (SINAD)

DESCRIPTION

Special Function 29.0 enables the Measuring Receiver to make SINAD (Signal to Noise And Distortion) measurements. The SINAD measurement is identical to the audio distortion measurement; but the result is expressed differently. SINAD is often measured as part of receiver sensitivity testing.

SINAD can be measured on audio signals with fundamental frequencies of either 1 kHz or 400 Hz using the 1 kHz DISTN or 400 Hz DISTN keys respectively. The fundamental frequency must be within ±5% of the nominal 1 kHz or 400 Hz for accurate measurements. Once selected, the measurement frequency remains unchanged and is automatically activated each time the SINAD (or audio distortion) measurement is selected.

SINAD can also be measured on an external audio signal applied to the MODULATION OUTPUT/AUDIO INPUT connector using the AUDIO INPUT key. When external audio is not selected, the instrument measures the SINAD on the internal demodulated audio.

PROCEDURE

To measure SINAD on the demodulated audio signal, select 29.0 SPCL.

To measure SINAD on an external audio signal applied to the MODULATION OUTPUT/AUDIO INPUT, select 29.0 SPCL and AUDIO INPUT. (Only the true rms detector can be used for this measurement.)

To change the measurement bandwidth of the internally demodulated audio signal, select the desired filter keys. (Refer to *Audio Filters* on page 3-207.)

If measurements are to be made on a 1 kHz signal, select 1 kHz DISTN (Blue Key, PEAK+). If measurements are to be made on a 400 Hz audio signal, select 400 Hz DISTN (Blue Key, PEAK−).

The measured results can be displayed in either linear units (%) or logarithmic units (dB) using the LOG/LIN key. The previously selected units are reinstated whenever an audio measurement is selected.

HP-IB PROGRAM CODES

AUDIO INPUT = A1
MODULATION OUTPUT = A0
1 kHz DISTN = D5
400 Hz DISTN = D6
LIN results = LN
LOG results = LG
SPCL = SP

MEASUREMENT TECHNIQUE

To measure SINAD, the instrument compares the input signal level measured by a true rms detector to the same measurement with the fundamental component removed. SINAD is then calculated as

the ratio of the unfiltered signal to the signal with its fundamental removed. Refer to the measurement technique discussions in *Audio Distortion and Level* on page 3-229.

COMMENTS

Relative Measurements.

If SINAD is to be displayed relative to a reference, enter the value as a ratio reference using the RATIO key. (Refer to *Ratio* on page 3-245.)

SINAD Response Time.

A slower response time can be selected with Special Function 5.1.[2] The slow response time improves measurement readability on unstable or noisy signals whenever display jitter is excessive.

[2] The slow response time for SINAD is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

Additional Capabilities Contents

FUNCTIONS THAT CAN BE USED WITH MANY MEASUREMENTS

Automatic Operation 3-237
- How to cancel special functions or automatically tune the instrument.

Instrument Preset 3-239
- How to preset the instrument to its default state.
- What the default conditions are.

Range Hold 3-243
- How to freeze current measurement ranges.

Ratio and Log/Lin 3-245
- How to scale a measurement result to a reference in % or dB.

Limit 3-249
- How to set limits on measurements being made.
- How overlimiting is displayed (front panel and HP-IB).

Store/Recall 3-253
- How to access the instrument's 8 storage registers.

FUNCTIONS THAT INCREASE MEASUREMENT CAPABILITIES

Frequency Offset Control 3-255
- How to extend the frequency range of the instrument into the microwave region using an external down-converter.

Filters, RF and IF 3-259
- How to insert the RF high-pass filter in the RF signal path to eliminate interfering, low-frequency signals.
- How to select the frequency and bandwidth of the IF filters.

IF Gain 3-263
- How to select IF gain to improve measurement sensitivity.

RF Input Attenuation and Gain 3-265
- How to select RF input attenuation or amplification to eliminate input overload or to improve measurement sensitivity.

Error Message Disable Control 3-267
- How to disable or enable combinations of Errors 01 through 04 to extend the instrument's usable measurement range.

Automatic Operation

FUNCTIONS

AUTOMATIC OPERATION

DESCRIPTION

The Automatic Operation function fulfills two major functions: (1) To configure the Measuring Receiver to automatically tune to the largest detectable RF input signal and to make the selected measurement. (2) To cancel most special functions.

Specifically, Automatic Operation sets special functions with prefixes 1 through 10 to their 0-suffix state, cancels many special functions with prefixes greater than 10, and overrides all service special functions (prefixes 0, 40, or greater). (Refer to *Special Functions* on page 3-271 for details on special functions 1 through 39. Refer to Section 8 of the Service Manual for details on Service Special Functions.) Automatic Operation also cancels some front-panel settings (TRACK MODE, RANGE HOLD, and DISABLE ERROR.

Those features that are not affected by Automatic Operation include HP or LP FILTERs, FM DE-EMPHASIS, MEASUREMENT, CALIBRATION, DETECTOR, DISPLAY, and RATIO. RF level- and modulation-related calibration factors remain intact. Limit settings (Special Function 14) and Frequency Offset Control (Special Function 27) are also not affected.

PROCEDURE

To enter the Automatic Operation mode, select Automatic Operation. The instrument will immediately re-tune to the input signal and make the measurement selected.

HP-IB PROGRAM CODE

AUTOMATIC OPERATION = AU

COMMENTS

Input/Output Status

MODULATION OUTPUT/AUDIO INPUT is blanked temporarily during the automatic tuning process initiated by selecting Automatic Operation.

The Value of the Automatic Operation Capability

Automatic Operation is the easiest way to make measurements in applications where only a single carrier is present at the RF INPUT. The instrument configures itself to meet the needs of most measurement situations, and all error messages signaling inaccurate measurements are enabled.

Range Hold is Opposite to Automatic Operation

The converse of the Automatic Operation mode is the Range Hold function.

Restrictions on Entering Automatic Operation

The instrument cannot enter the Automatic Tuning mode when making any tuned RF level measurements.

Instrument Preset

FUNCTIONS

Includes all Power-Up and Default Conditions and HP-IB Clear

DESCRIPTION

When first turned on (during power-up), the Measuring Receiver passes through a sequence of internal checks before it is ready to make measurements. The results of these checks are indicated internally as a service aid. (Refer to Section 8.) The running of the power-up sequence is indicated to the user by lighting all front-panel indicators (burned-out LEDs are evident at this time). After approximately 10 seconds, this sequence is completed.

When the Instrument Preset key is pressed, the instrument configures itself the same as during power-up, but bypasses the internal checks.

The Measuring Receiver contains a battery back-up to its internal memory, which makes part of the memory non-volatile after the power has been switched off (powered-down)–even if the power cord is unplugged.

Information retained after power-down:

- The 8 instrument states stored in the Store/Recall registers.
- For RF Power:
  a. One set of zero and calibration (SAVE CAL) data.
  b. One table of 16 frequency/calibration factor pairs and the reference calibration factor used with RF power sensors.
  c. One table of 22 frequency/calibration factor pairs and the reference calibration factor used with microwave power sensors in the Frequency Offset mode.
  d. The state of Special Function 32.0 or 32.1 (dB and frequency resolution).
- For Tuned RF Level:
  a. Four calibration factors.
  b. The frequency at which the calibration factors are valid.
  c. The state of the RF High-Pass Filter, Wide IF Filters, and Narrow IF Filters at the time of calibration (Special Function 3).
  d. The state of Special Function 1.0 or 1.9 (RF input attenuator and gain).
  e. The state of Special Function 32.0 or 32.1 (dB and frequency resolution).
- For AM and FM:
  An AM calibration factor and an FM calibration factor (both in disabled mode).

Default conditions after power-up or instrument preset:

If no signal is present at the INPUT connector and no HP-IB controller is connected, the measurement conditions and front-panel annunciators are as follows:

Measurement Conditions

Tuning	Automatic Signal Search
Measurement Mode:	Frequency
Modulation Output/Audio Input:	Blanked
Calibration Mode:	Off
HP-IB:	(See "COMMENTS".)
Special Functions:	(See below.)

If a suitable signal is present at the INPUT connector and no HP-IB controller is connected, the measurement conditions, front-panel annunciators, and Special Functions are as follows:

Measurement Conditions

Tuning:	Automatic, Low-Noise
Measurement Mode:	Frequency
IF Frequency:	Automatic Selection
Modulation Output/Audio Input:	Output FM
High-Pass Filter:	All Off
Low-Pass Filter:	All Off (15 kHz if input<10 MHz)
Calibration Mode:	Off
HP-IB:	(See "COMMENTS".)
Special Functions:	(See below.)

Special Functions

1-10:	suffix is set to 0
11 Previous Ratio:	off
Ratio Reference:	100%
14 Limit:	off
Upper Limit:	1300
Lower Limit:	0.150
Upper/Lower Limit Code:	0.005 (FREQ)
16 AM Calibration Factors:	100% or previous power-down value
17 FM Calibration Factors:	100% or previous power-down value
22 Service Request:	suffix set to 2
Status Byte:	cleared
25 External Attenuation:	0 dB
26 Set Reference:	0 dBm
27 Frequency Offset Control:	0 MHz
37 Calibration Factors, RF Power:	[both calibration factor tables from previous power-down]
Mode:	Automatic Cal Factor Mode
38, 39 Calibration Factors, Tuned RF Level:	4 calibration factors and RF and IF filters from previous power-down

PROCEDURE

To cause the instrument to run through its internal checks and reset the instrument to its default state, turn the instrument off, then on again.

To reset the Measuring Receiver to its default state but bypass the internal power-up checks, select INSTR PRESET (Blue Key, AUTOMATIC OPERATION), or issue a device clear command from an HP-IB controller.

To initiate the internal power-up checks, select 40.0 SPCL.

HP-IB PROGRAM CODES

INSTR PRESET (Device Clear) = IP
SPCL = SP

The instrument can also be preset using the device clear bus command. (Refer to the *Remote* section on page 3-25.)

COMMENTS

Setting the Instrument to a Known State.

The Instrument Preset feature is a very simple means of setting the instrument to a known state when writing test procedures involving the Measuring Receiver.

Losing Instrument States with a New Controller Assembly.

After plugging in a new controller Assembly, some or all of the instrument states stored through power-down may be non-existent. If this information is lost:

a. The Recall function reverts to the Instrument Preset state.

b. The RF Power measurement will: (1) display Error 15, (2) light the UNCAL and RECAL annunciators, and (3) use the default zero and calibration factors. (The RF power calibration factors must be re-entered.)

c. The calibration factors for Tuned RF Level will be displayed as 0.0% (using Special Function 38).

d. AM and FM calibration factors will be 100% when enabled (using Special Function 16 or 17).

Instrument Preset Clears Pending Require Service Messages.

When the instrument is preset, any pending Require Service Message is cleared. (For more details, refer to Receiving the Clear Message, in Remote Operation.)

CLEAR Key.

The HP-IB Clear message should not be confused with the front-panel CLEAR key or its CL HP-IB code. The HP-IB Clear message presets the instrument. The CLEAR key clears the display and returns the instrument to its previous state.

Alternative to Turning the Instrument Off and then On.

Use special function 40.0 to cause the Measuring Receiver to pass through its internal checks. (Special function 40.0 is not accessible from the HP-IB.)

Range Hold

FUNCTIONS

RANGE HOLD

DESCRIPTION

The Range Hold function freezes the current ranges being used by the Measuring Receiver. This function, the converse of Automatic Operation, disables automatic tuning and sets Special Functions prefixed 1, 2, 3, 7, 9, and 10 to the current range settings. The following functions are not affected by Range Hold: High-pass and Low-pass Filters, FM De-emphasis, Measurement, Detectors, and Display. Special Functions prefixed 1 through 10 that are already manually set are unaffected. The table below summarizes the effect of the Range Hold feature:

Special Function Prefix	Measurement Function	Effect of RANGE HOLD on Functions
1	RF Input Attenuation and Gain	Holds setting
2	Audio Range	Holds setting
3	RF and IF Filters	Holds setting
4	Tuned RF Level Display Averaging	No effect
5	Audio Detector Response	No effect
6	AM ALC Response	No effect
7	RF Frequency Resolution	Holds setting
8	Error Message Disable	No effect
9	IF Gain	Holds setting
10	RF Power Range	Holds setting
	AUTO TUNING	Selects Manual Tuning

PROCEDURE

To hold instrument settings in a specific measurement state, set the Measuring Receiver as desired, then select RANGE HOLD.

To exit the Range Hold mode, select RANGE HOLD a second time or select AUTOMATIC OPERATION.

HP-IB PROGRAM CODE

Automatic Ranging = G0
RANGE HOLD = G1

COMMENTS

Altering Held Functions.

Once settings are held with the Range Hold function, they can be altered by manually entering the desired setting. For example, the Range Hold function places the instrument in the manual tune mode; select AUTO TUNING (Blue Key, TRACK MODE) to re-enter the automatic tuning mode. Similarly, Special Functions can be used to set other functions or selectively return them to automatic operation.

Ratio and Log/Lin

FUNCTIONS

RATIO, PREVIOUS RATIO, LOG/LIN, Special Function 11 (Previous Ratio)

DESCRIPTION

The Ratio and Previous Ratio functions permit any measurement result to be scaled to a reference. The reference may be either a measurement result or a keyboard entry. Special Function 11.2 displays the current ratio reference.

The LOG/LIN key enables measurement results to be displayed in linear or logarithmic units, both absolute and relative. Examples of absolute units are kHz and mV (linear), or dBm (logarithmic). Examples of relative units are % and dB. For purposes of discussion, basic measurement units, such as % for AM or distortion, dB for SINAD, etc., (though actually relative units), are treated as absolute units. When the instrument displays % and dB as relative units (that is, when the ratio function is used), annunciator REL is added to the display.

All modulation and all frequency measurement results cannot be displayed with absolute, logarithmic units even though they can be displayed in relative, logarithmic units. (The LOG/LIN key is ignored.)

The Ratio function can be used with the following measurements:

AM
FM
ΦM
RF POWER
FREQ
AUDIO FREQ
AUDIO DISTN
IF LEVEL
TUNED RF LEVEL
FREQ ERROR
SINAD (29.0 SPCL)
Ext Audio RMS Level (30.0 SPCL)
LO Frequency (33.0 SPCL)
IF Frequency (34.0 SPCL)
RF Level (35.0 SPCL)
Peak Tuned RF Level (36.0 SPCL)

The Ratio function is exited when:

- the RATIO key is pressed a second time,
- a new measurement is selected, or
- other measurement units are selected.

PROCEDURE

Select LOG/LIN anytime during a measurement to change the display between linear and logarithmic units, where permitted, for both absolute and relative (Ratio) displays.

To use the Ratio function:

1. Select the desired Measurement mode. Measurements possible with the ratio function are listed in "DESCRIPTION."

2. Set the display to the desired reference value, either
   - adjust the signal parameter being measured for a display equal to the desired reference, or
   - enter the reference on the numeric keys. (If the reference value is to be negative, select minus; that is, the Blue Key, then the decimal key.)
3. Select RATIO. The display will show the measurement result relative to the reference.

To use the Previous Ratio function to restore a previously-entered ratio reference:

1. Select the desired Measurement mode.
2. Select PREVIOUS RATIO (Blue Key, RATIO). The display will show the measurement result relative to the original ratio reference. (The Measuring Receiver uses the previous ratio reference regardless of what Measurement the instrument was in when the ratio reference was entered and regardless of the current Measurement mode.)

To display the ratio (or previous ratio) reference, key in 11.2 SPCL.

EXAMPLES

Assume 35.35 kHz FM deviation is displayed. Enter this value as the ratio reference for subsequent measurements:

LOCAL (keystrokes)	DISPLAY RATIO •
HP-IB **(program codes)**	R1 Display

The displayed measurement result is 100% REL if linear units are selected or 0 dB REL if logarithmic units are selected. (The display will normally vary about these nominal values due to noise and the typical one-count uncertainty in the measured result.)

If it is desired to scale FM measurement results relative to 50 kHz, set the Measurement mode to FM:

LOCAL (keystrokes)	DATA 5 0 DISPLAY RATIO •
HP-IB **(program codes)**	50 R1 Data — Display

If, as in the previous example, 35.35 kHz FM deviation was measured, the displayed measurement result will be 70.7% REL if linear units are selected or −3.01 dB REL if logarithmic units are selected.

HP-IB PROGRAM CODES

LOG display = LG
LIN display = LN
PREVIOUS RATIO = R2
RATIO off = R0
RATIO on = R1
SPCL = SP

MEASUREMENT TECHNIQUE

In the Ratio mode, measurements are made in the same way as when not in the Ratio mode; however, before the result is displayed, the internal controller converts it to ratio. The following equations are used for computing ratio:

(M/R) (100%) = % ratio for all measurements,

(20) log (M/R) = dB ratio for the following measurements:[1] AM FM, ΦM, AUDIO DISTN, IF LEVEL, SINAD (29.0 SPCL), Ext Audio RMS Level, and (10) log (M/R) = dB ratio for the following measurements:[2] FREQ, AUDIO FREQ, FREQ ERROR, LO Frequency (33.0 SPCL), IF Frequency (34.0 SPCL),

where M is the (undisplayed) measurement result and R is the ratio reference.

COMMENTS

Input/Output Status.

The output signal at MODULATION OUTPUT/AUDIO INPUT is unaffected by the Ratio function.

Displaying the Reference.

When using a currently-displayed measurement result as the ratio reference, that result actually becomes the reference. The only way to read this reference then is to display it via Special Function 11.2.

Display Flicker.

Since displayed measurement results are computed from the actual physical measurements, least-significant digit flicker in the physical measurement can often lead to larger apparent flicker in the displayed result. For example, an AM measurement varying between 50.0% and 50.1% will vary between 100.0% and 100.2% REL with a ratio reference of 50 (or between 0.00 and 0.02 dB after switching to logarithmic units).

dB Ratio.

When using dB ratio; any ratio reference or measurement result that causes ratio M/R (refer to previous equations) to equal 0, results in a display of Error 11 since the log of 0 is undefined.

---

[1] When uV, mV, or V units are used, this equation provides the ratio result for RF POWER, TUNED RF LEVEL, and RF LEVEL (35.0 SPCL) measurements.

[2] When watts units are used, this equation provides the ratio result for RF POWER, TUNED RF LEVEL, and RF LEVEL (35.0 SPCL) measurements.

Finer Resolution for dB Measurements [3]

Special Function 32.1 enables a resolution of 0.001 dB. For audio frequency measurements, this special function enables a resolution of 0.1 Hz for frequencies from 100 to 250 kHz instead of the normally displayed resolution of 1 Hz. The selection of Special Function 32.0 or 32.1 is maintained through instrument power down.

32.0 Power is displayed with the normal measurement resolution of 0.01 dB.

32.1 Power is displayed with a measurement resolution of 0.001 dB.

32.2 Displays 0 if the normal measurement resolution is enabled (32.0 SPCL) and displays 1 if a finer resolution is enabled (32.1).

Use SET REF for Relative Tuned RF Level Measurements.

The SET REF key should be used to make scaled measurements in the Tuned RF Level Measurement mode. (Refer to *Attenuator Measurements* on page 3-115).

Modulation Flatness.

When used in conjunction with track mode tuning, the Ratio function makes checking modulation flatness with respect to RF frequency very convenient. (Refer to *RF Frequency Tuning* on page 3-141 for a discussion of track mode tuning.)

Setting Measurement Limits.

The ratio reference can also be entered as a limit reference. (Refer to *Limit* on page 3-249.)

Common Ratio Measurements.

The following list provides some useful references for common ratio measurements:

- To display broadcast FM deviation relative to the common standard of 75 kHz, use 75 and linear units.
- To display ΦM in degrees, enter a value of 1.745 and select linear units.
- To display AM as dB down from the carrier, enter a value of 200 and select logarithmic units.
- To display rms calibrated average as true average, enter a value of 111.07 and select linear units.
- To display rms calibrated average as peak, enter a value of 70.7 and select linear units.

[3] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

Limit

FUNCTIONS

RATIO, Special Function 14 (Limit)

DESCRIPTION

Using Special Function 14 and the RATIO key, lower and upper measurement limits can be entered into the Measuring Receiver. Subsequent out-of-limit measurements will then cause the LIMIT annunciator to light.

When the Limit feature is enabled, the Measuring Receiver can be configured to issue an HP-IB service request upon reaching a lower or upper limit (Refer to the *Remote* section in this manual on page 3-27.) The LIMIT light turns off five measurement cycles after the condition causing limiting is cleared.

Only one lower and one upper limit can be set. Once a limit has been set, it can be used only for that Measurement mode. (However, one limit can be used for one Measurement mode, and the other limit for another Measurement mode.) If, after setting limits, another Measurement mode is selected, the Limit feature is deactivated, but it is restored automatically when the former Measurement mode is re-entered.

Both limit references can be displayed, cleared, and restored; the status of the Limit function can be displayed; and the Measurement modes for which the limits were set can be displayed.

PROCEDURE

To establish a ratio reference and set it as a limit:

First enter the desired limit reference as a ratio reference and then set the lower or upper limit to that ratio reference:

1. Select the Measurement mode for which the limit is to be used.
2. Key in the reference value followed by the RATIO key (Do not use a terminator. The units will stay as currently displayed.) To change the sign of the reference, use the minus (−) key (Blue Key and the decimal point key.)

To set the limits:

3. Set the lower limit (14.1 SPCL) or the upper limit (14.2 SPCL) to the ratio reference.
4. To display the measurement result in absolute units, select RATIO again.

The Special Function codes pertaining to the Limit function are listed in the following table:

	Action	Special Function Code	Program Code HP-IB
Limit	Clear limits; turn off LIMIT annunciator.	14.0 SPCL	14.0SP
	Set lower limit to RATIO reference.	14.1 SPCL	14.1SP
	Set upper limit to RATIO reference.	14.2 SPCL	14.2SP
	Restore lower limit.	14.3 SPCL	14.3SP
	Restore upper limit.	14.4 SPCL	14.4SP
	Display lower limit.	14.5 SPCL	14.5SP
	Display upper limit.	14.6 SPCL	14.6SP
	Display selected, lower limit measurement code.	14.7 SPCL	14.7SP
	Display selected, upper limit measurement code.	14.8 SPCL	14.8SP
	Display limit status in the format Lower.Upper; where 0=disabled and 1=enabled.	14.9 SPCL	14.9SP

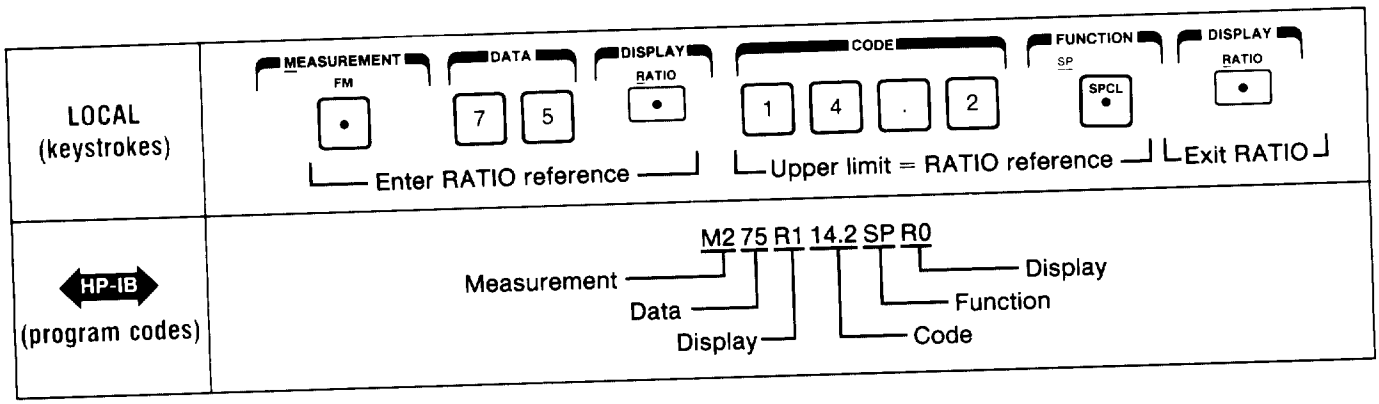
To display the limited measurement mode:

To determine the Measurement mode in which a lower or upper limit is in effect, select 14.7 SPCL or 14.8 SPCL (respectively). The displayed code represents the measurement in which the limit is in effect. These codes are indexed in the following table:

Display	Measurement	Display	Measurement
0.000	AM	0.011	AUDIO FREQ (external)
0.001	FM	2.003	RF LEVEL (35.0 SPCL)
0.002	ϕM	2.004	PEAK TUNED RF LEVEL (36.0 SPCL)
0.003	RF POWER	2.009	AUDIO DISTN (internal)
0.004	TUNED RF LEVEL	2.010	LO FREQUENCY (33.0 SPCL)
0.005	FREQ	2.011	AUDIO DISTN (external)
0.006	FREQ ERROR	4.009	SINAD (internal)
0.008	IF LEVEL	4.011	SINAD (external)
0.009	AUDIO FREQ (internal)	6.011	EXT AUDIO RMS LEVEL (30.0 SPCL)
0.010	IF FREQUENCY (34.0 SPCL)		

EXAMPLE

To set an upper limit of 75 kHz FM deviation:



Read the FM deviation in kHz with an upper limit set at 75 kHz.

HP-IB PROGRAM CODES

The codes for performing the various limit operations are provided in "Procedures".

RATIO off = R0
RATIO on = R1

COMMENTS

Relative Limits Not Possible.

The test for out-of-limit results is performed on the actual measurement results, not upon the displayed number. Thus, if the Ratio feature is enabled simultaneously with the Limit feature, the limit test is still based on the measurement result, not the computed ratio. Limits cannot be set in terms of relative measurement results.

Importance of Key Sequence.

If Special Function 14.1 or 14.2 is initiated with no previous numeric value, the ratio reference becomes the entered value. The desired limit must be entered before the Special Function numeric code.

Store/Recall

FUNCTIONS

STORE, RECALL

DESCRIPTION

The Measuring Receiver can store a complete instrument state (including all front-panel functions and most Special Functions) in any of its eight storage registers. The stored data is retained in non-volatile memory when the instrument is off even when the power cord is removed. Any of these stored states can then be re-initiated.

PROCEDURE

To store the current instrument state, select STORE (Blue Key, 7). Then key in a register number (1 through 8).

To recall a previously-stored instrument state, select RECALL (Blue Key, 8). Then key in the desired register number (1 through 8).

HP-IB PROGRAM CODES

RECALL = RC
STORE = TR

COMMENTS

Regarding storage of RF power calibration factors:

- The current reference calibration factor and the frequency/calibration-factor pair can be stored.
- Manual calibration factors can be stored.
- The table of calibration factors cannot be stored with this function, but two tables of calibration factors can be separately stored in the instrument's non-volatile memory. (Refer to *RF Power* under "Comments" on page 3-83.)

Frequency Offset Control

FUNCTIONS

Special Function 27 (Frequency Offset Control)

DESCRIPTION

Using an external mixer and local oscillator (LO) to down-convert the input signal, the frequency range of the Measuring Receiver can be extended into the microwave region. The Frequency Offset mode allows the Measuring Receiver to keep track of the frequencies involved in the down-conversion so the user can be freed from this task. This feature operates for frequencies up to 42 GHz.

The full complement of instrument measurements can be made on the down-converted microwave signal (with the same signal restrictions that apply in the normal frequency range). For best measurement accuracy, the external LO should be a source free from microphonics, residual FM, and drift since these signal impurities translate directly on to the down-converted signal. Use of a synthesized signal source is recommended. Examples of suitable signal sources are the HP 8340A, 8672A, and 8673A.

The RF Power measurement mode uses a separate table of frequencies and calibration factors in the Frequency Offset mode. Frequency entries can range from 0 to 110 GHz. (Refer to *RF Power* on page 3-75 for a procedure for entering calibration factors.)

A rear-panel FREQ OFST TTL OUT connector can indicate to external circuits whether the Measuring Receiver is in the Frequency Offset mode and whether the LO is above or below 18 GHz. Use this feature to control external RF switches to route or bypass the input signal between external mixers.

Use Special Function 27 to enter and exit the Frequency Offset mode and to enter and display the LO frequency.

PROCEDURE

To down-convert a microwave input signal into the range of the Measuring Receiver, set an external microwave signal source to a level suitable as an LO for the external mixer. Set the frequency of the external LO source to within 1300 MHz of the microwave input signal. Connect the external LO source to the L port of the external mixer. Connect the microwave input signal to the appropriate input port of the external mixer. Connect the output port of the mixer to the RF INPUT connector or to the input of a sensor module connected to the Measuring Receiver.

Key in 27.3 SPCL then select the LO frequency (in MHz) and select MHz to enter the Frequency Offset mode.

The following table summarizes the various Frequency Offset Control special functions:

Action Regarding Frequency Offset Control	Special Function Code	Program Code HP-IB
Exit Frequency Offset Mode	27.0 SPCL	27.0SP
Re-enter Frequency Offset Mode	27.1 SPCL	27.1SP
Display the External LO Frequency	27.2 SPCL	27.2SP
Enter and Enable the LO Frequency*	27.3 SPCL	27.3SP
*After Special Function 27.3 is entered, enter the frequency of the LO (in MHz) Frequencies from 0 to 40700 MHz can be entered.		

Having entered the appropriate LO frequency, either manually tune to the microwave input frequency by pressing the appropriate numeric keys followed by the MHz key or let the Measuring Receiver automatically tune to the input signal.

Perform instrument measurements as usual. Select DISPLAY FREQ (Blue Key, kHz ↑) to display the microwave input frequency.

HP-IB PROGRAM CODES

All HP-IB codes for manipulating the frequency offset control using Special Function 27 are provided in "Procedures".

DISPLAY FREQ = FR
MHz = MZ

MEASUREMENT TECHNIQUE

The external LO mixes with the microwave input signal to create a difference frequency which is the input to the Measuring Receiver. The frequency of the microwave input signal must be within 1300 MHz of the external LO to be within the measurement range of the Measuring Receiver. The LO frequency is manually entered by the operator using Special Function 27.3. The Measuring Receiver, thereafter, uses that LO frequency to compute the microwave input signal frequency regardless of the actual frequency of the LO.

If tuning is in the automatic mode, the Measuring Receiver computes and displays the microwave input frequency as

(frequency of LO) − (frequency at INPUT).

If tuning is manual, the Measuring Receiver computes and displays the microwave input frequency as:

(frequency of LO) ± (frequency of INPUT).

The difference is computed when the manually-entered frequency is less than the LO frequency. The sum is computed when the frequency is greater. The sense (+ or −) of the math operation remains the same regardless of the actual microwave input frequency, even if automatic tuning is selected.

The displayed frequency is always based on the frequency actually at the Measuring Receiver's input and not the manually-entered input frequency, which serves only to set the Measuring Receiver's internal LO. Manually entering a new microwave input frequency, entering a new LO frequency, or initiating automatic tune always retunes the Measuring Receiver.

When the manually entered LO frequency is displayed (Special Function 27.2), a minus (−) sign preceeding the frequency indicates that the math operation is a sum.

COMMENTS

Range Limitations.

If the entered LO frequency and microwave input frequency differ by more than 1300 MHz (or less than 0.15 MHz), an out-of-range error is displayed (Error 10). (Even though the Measuring Receiver appears to measure signals over the range 0 to 110 GHz, the instrument itself can tune to and measure signals only over the range of 0.15 to 1300 MHz. An exception to this is the RF Power measurement.)

Default Condition.

At power-up, the math operation (described under "MEASUREMENT TECHNIQUE") is a difference.

Peak+ and Peak– Functions Reversed.

When FM or ΦM measurements are made, the Peak+ and Peak– functions are reversed whenever the external LO frequency is less than the microwave input frequency.

HP-IB: Service Request Mask.

Using Special Function 22 (bit weight 16), the Measuring Receiver can be unmasked to output a Service Request whenever the Frequency Offset mode changes state (that is, entered or exited) or when the instrument is manually retuned. (Refer to the *Remote* section on page 3-27.)

FREQ OFFSET TTL OUT.

When the Measuring Receiver is in the Frequency Offset mode, the rear-panel FREQ OFFSET TTL OUT connector outputs a voltage which is dependent upon the state of the Frequency Offset mode and the entered external LO frequency. The state of the output is shown in the following table:

State of Frequency Offset Mode	Entered LO Frequency (GHz)	Nominal Voltage at FREQ OFFSET TTL OUT
Out	Any	0
In	0	0
In	>0 but ≤ 18	+5
In	>18 but ≤ 40.7	+3

Filters, RF and IF

FUNCTIONS

Special Function 3 (RF and IF Filters)

DESCRIPTION

RF Filter.

To eliminate unwanted low-frequency signals in the RF signal path, an RF filter can be inserted. Special Function 3 manually selects the 5.25 MHz High-Pass Filter. Since the IF generally responds to signals below 2.5 MHz, the filter eliminates any low frequencies that might be present on the input. (For input signals between 150 kHz to 10 MHz, the filter should be switched out.)

IF Filters.

The Measuring Receiver down-converts (heterodynes) the RF input to the IF. The IF is usually centered at 1.5 MHz for input signals 10 to 1300 MHz. (An IF of 455 kHz can be manually selected.) For signals between 2.5 MHz and 10 MHz, the IF is 455 kHz. Below 2.5 MHz, the signal is passed directly into the IF without down-conversion (unless the 455 kHz IF has been manually selected). IF filters determine the frequency response of each IF.

When the 1.5 MHz IF is selected, the IF frequency response is determined by the 2.5 MHz Low-Pass (LP) Filter.

When the 455 kHz IF is selected, the Wide 455 kHz Bandpass (BP) Filter determines the IF frequency response, unless a tuned RF level measurement is made which inserts the Narrow 455 kHz BP Filter in series with the other selected IF filter.

Various combinations of these filters can be manually inserted using Special Function 3. (Special Function 3 will override automatic filter selection for Tuned RF level measurements.)

PROCEDURE

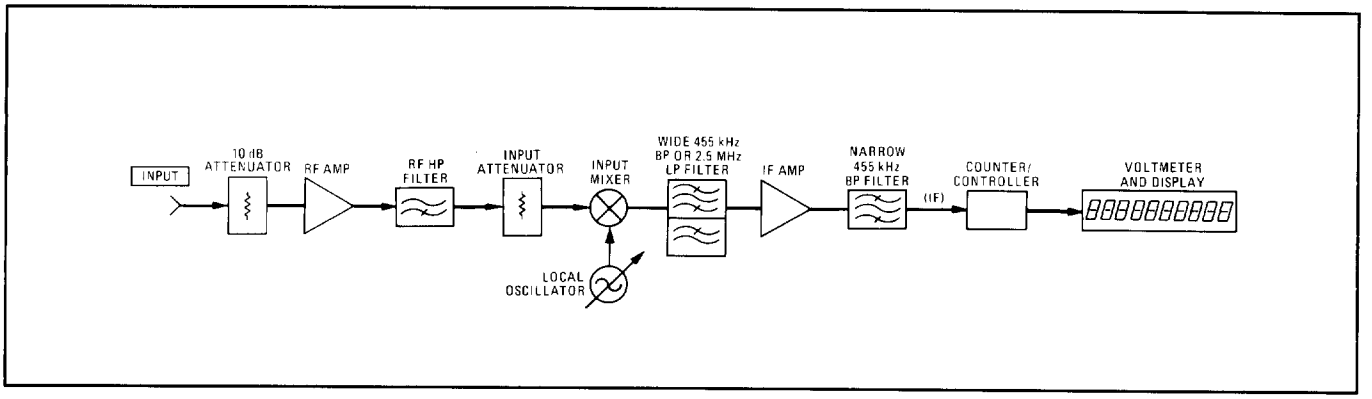
To select a desired combination of RF and IF filters, or to re-enter the automatic selection mode, key in the corresponding Special Function code, then press the SPCL key :

Special Function Code	Program Code HP-IB	IF Frequency	Wide IF Filter	Narrow IF Filter (30 kHz BW)	RF High-Pass Filter (5.25 MHz)
3.0 SPCL	3.0SP	Automatic Selection			OUT
3.1 SPCL	3.1SP	455 kHz	200 kHz BW	OUT	OUT
3.2 SPCL	3.2SP	1.5 MHz	2.5 MHz Low-Pass	OUT	OUT
3.3 SPCL	3.3SP	455 kHz	200 kHz BW	OUT	IN
3.4 SPCL	3.4SP	1.5 MHz	2.5 MHz Low-Pass	OUT	IN
3.5 SPCL	3.5SP	455 kHz	200 kHz BW	IN	OUT
3.6 SPCL	3.6SP	455 kHz	2.5 MHz Low-Pass	IN	OUT
3.7 SPCL	3.7SP	455 kHz	200 kHz BW	IN	IN
3.8 SPCL	3.8SP	455 kHz	2.5 MHz Low-Pass	IN	IN

HP-IB PROGRAM CODES

The HP-IB codes for selecting various combinations of RF and IF filters are provided in "PROCEDURE".

BLOCK DIAGRAM



Block Diagram of RF and IF Filters

COMMENTS

Default Condition.

When the instrument is first powered up or when Automatic Operation or Instrument Preset is selected, RF and IF Filters are placed in the automatic selection mode.

Automatic Retuning.

When a new IF is selected, the instrument immediately retunes.

Increased Sensitivity and Selectivity.

Many measurements can typically be made on very low-level signals. Using the narrow bandwidth of the 455 kHz IF for signal frequencies less than 2.5 MHz (but in the manual down-convert mode) or greater than 10 MHz increases the sensitivity and selectivity of the Measuring Receiver. (There are, however, restrictions on modulation, and measurement accuracy may decrease.) Manual deletion of RF input attenuation or insertion of gain also increases sensitivity. (Refer to *RF Input Attenuation and Gain* on page 3-265.)

IF Gain

FUNCTIONS

Special Function 9 (IF Gain)

DESCRIPTION

For Tuned RF Level measurements, the Measuring Receiver uses a programmable IF amplifier. The amplifier has precise 10 dB gain steps ranging from 0 to 60 dB. The amplifier is automatically inserted and programmed in the Tuned IF Level measurement mode for either the IF Synchronous or IF Average detector. For other measurements, the IF amplifier is bypassed.

Special Function 9 permits manual section of the IF amplifier and can be used with tuned measurements other than tuned RF level.

PROCEDURE

To manually set the IF gain, or to re-enter the automatic selection mode, key in the corresponding Special Function code followed by SPCL.

IF Gain (dB)	Special Function Code	Program Code HP-IB
Automatic Selection	9.0 SPCL	9.0SP
0	9.1 SPCL	9.1SP
10	9.2 SPCL	9.2SP
20	9.3 SPCL	9.3SP
30	9.4 SPCL	9.4SP
40	9.5 SPCL	9.5SP
50	9.6 SPCL	9.6SP
60	9.7 SPCL	9.7SP

HP-IB PROGRAM CODES

All HP-IB codes for selecting IF gain ranges are provided in "PROCEDURE".

COMMENTS

Default Condition.

When the instrument is first powered up, or when Automatic Operation or Instrument Preset is selected, the IF Gain function is placed in the automatic selection mode. (The gain will usually change when a different IF detector is selected.)

Multiple Uses of IF Amplifier.

The design of the programmable IF amplifier is optimized for the Tuned RF Level measurement mode which uses the 455 kHz IF. The amplifier, although not specified, can be used for all tuned measurements and IF frequencies to improve measurement sensitivity. (Refer to the block diagram in *Tuned RF Level* on page 3-103 to aid in visualizing the function of the IF amplifier.)

Measurement Degradation.

Increasing the IF gain for measurements other than Tuned RF Level would degrade performance. Degradation is most evident at high modulation rates, high IF gain, or IF frequencies other than 455 kHz.

IF Gain Change.

The IF gain will generally change when a different IF detector is selected.

RF Input Attenuation and Gain

FUNCTIONS

Special Function 1 (RF Input Attenuation and Gain)

DESCRIPTION

The RF input attenuation and gain is usually automatically selected but can be manually set by keyboard entry using Special Function 1.

PROCEDURE

To set the input attenuation/gain to a selected range, or to enter an automatic selection mode, key in the corresponding special function code, then select SPCL:

RF Input Attenuation		Special Function Code	Program Code HP-IB
RF Gain	RF Attenuation		
Automatic Selection	Automatic Selection	1.0 SPCL	1.0SP
0 dB	0 dB	1.1 SPCL	1.1SP
	10 dB	1.2 SPCL	1.2SP
	20 dB	1.3 SPCL	1.3SP
	30 dB	1.4 SPCL	1.4SP
	40 dB	1.5 SPCL	1.5SP
	50 dB	1.6 SPCL	1.6SP
24 dB	0 dB	1.7 SPCL	1.7SP
24 dB	10 dB	1.8 SPCL	1.8SP
Automatic Selection	Automatic Selection with 10 dB attenuation always inserted*	1.9 SPCL	1.9SP
* For Tuned RF Level Measurements only.			

COMMENTS

Default Condition.

When the Measuring Receiver is first powered up, or when Automatic Operation or Instrument Preset is selected, the RF input attenuation/gain is placed in the automatic selection mode (Special Function 1.0).

Error 02, 03.

If the RF input attenuation/gain is manually set to a range that causes the input signal level to overdrive the input mixer, Error 02 is displayed. If the RF input attenuation/gain is manually set so the signal level reaching the IF circuits is too low for accurate measurements, Error 03 is displayed.

Manual Settings Not Allowed with RF Level Measurements.

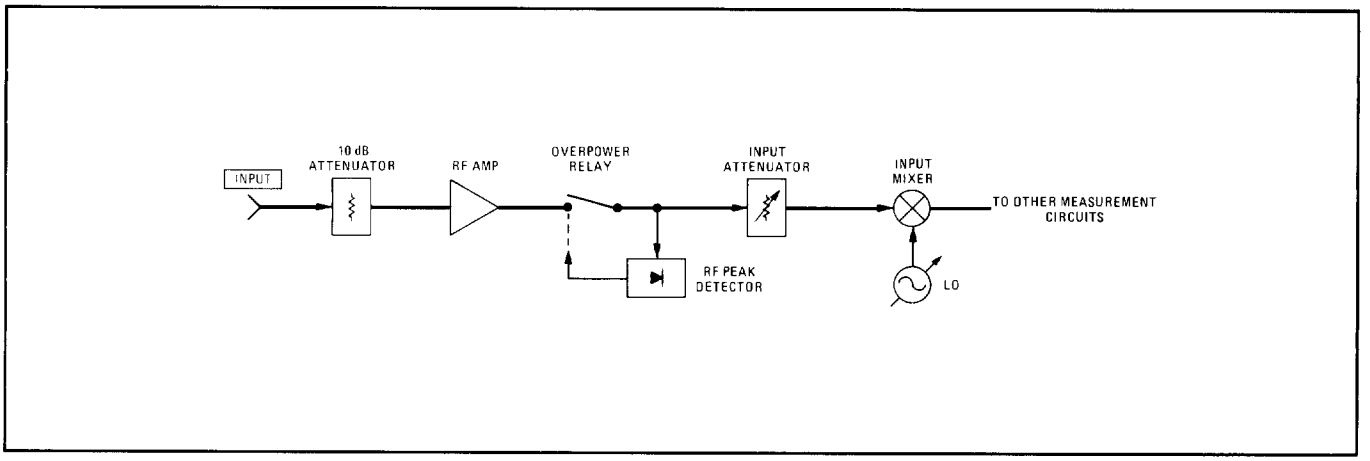
Manual setting of RF input attenuation/gain is overridden when RF Level measurements are selected.

Special Function 1.9.

When Special Function 1.9 (the alternate automatic selection) has been selected, the displayed special function suffix in the Special Display will differ from that suffix displayed in the Special Special Display. (Refer to *Special Functions* on page 3-272 for a description of these two types of display.) When the Special Display is initiated, 9 will be the first suffix. When the Special Special Display is initiated, the automatically-selected suffix will be displayed.

Increase Measurement Ability on Low Level Signals.

Use input gain (Special Functions 1.6 and 1.7 that insert the RF Amp) in conjunction with IF gain (Special Function 9) to make general, unspecified RF and audio measurements on low-level signals. Only use input gain for input signal frequencies greater than 1 MHz. The RF and IF Amplifiers could also contribute distortion and noise to the measurements. (Refer to *IF Gain* on page 3-263.)



Block Diagram of RF Input Attenuation and Gain

Error Message Disable Control

FUNCTIONS

DISABLE ERROR, Special Function 8 (Error Message Disable and Enable)

DESCRIPTION

Error Messages are one means the Measuring Receiver uses to safeguard measurement integrity. When the instrument senses a potential error-causing situation, an Error Message code is displayed to alert the user of the condition. The Error Message code indexes an Error Message, which describes the current errors. (Refer to *Error Message Summary* on page 3-285.)

When the Measuring Receiver is in its Automatic Operation mode, Error Messages are selectively enabled, depending on the measurement being made, to assure the broadest range of calibrated measurements. Some Error Messages, however, can be selectively disabled or enabled using Special Function 8. Disable Error performs the same function as Special Function 8.7 (Errors 01, 02, 03, and 04 disabled).

Most combinations of Errors 01 through 04 can be disabled or enabled by the operator to customize the behavior of the instrument to meet a particular set of measurement requirements. Special Function 8.8 (Errors 01 through 04 enabled) sets up the Measuring Receiver as a calibrated receiver. (Refer to "COMMENTS" for further elaboration.)

The following table lists the Error Messages conveyed by Errors 01 through 04:

Error	Error Message
01	Signal out of IF range
02	Input circuits overdriven
03	Input circuits underdriven
04	Audio circuits overdriven

The following table lists the errors that are automatically disabled in each Measurement mode:

Measurement Selected	Errors Disabled When in Automatic Selection Mode (Special Function 8.0)
AM	None
FM	None
ϕM	None
RF POWER	01, 04
FREQ	02, 03, 04
AUDIO FREQ	None
AUDIO DISTN	None
IF LEVEL	01, 02, 03, 04
TUNED RF LEVEL	02, 03, 04
FREQ ERROR	01, 02, 03, 04
SINAD (Special Function 29.0)	None
EXT AUDIO RMS LEVEL (Speical Function 30.0)	None
LO FREQUENCY (Special Function 33.0)	01, 02, 03, 04
IF FREQUENCY (Special Funciton 34.0)	01, 02, 03, 04
RF LEVEL (Special Function 35.0)	01, 04
PEAK TUNED RF LEVEL (Special Function 36.0)	02, 03, 04

PROCEDURES

To disable Errors 01, 02, 03, and 04, select DISABLE ERROR (Blue Key, RANGE HOLD). This key selection enables 8.7 SPCL.

To selectively enable or disable combinations of Errors 01 through 04, enter the Special Function code that corresponds to the condition desired, then select SPCL. The codes for the various conditions are listed in the following table:

Error Condition	Special Function Code	Program Code HP-IB
Automatic Selection	8.0 SPCL	8.0SP
01 disabled	8.1 SPCL	8.1SP
02 and 03 disabled	8.2 SPCL	8.2SP
01, 02, and 03 disabled	8.3 SPCL	8.3SP
04 disabled	8.4 SPCL	8.4SP
01 and 04 disabled	8.5 SPCL	8.5SP
02, 03, and 04 disabled	8.6 SPCL	8.6SP
01, 02, 03, and 04 disabled	8.7 SPCL	8.7SP
01, 02, 03, and 04 enabled	8.8 SPCL	8.8SP

HP-IB PROGRAM CODES

The HP-IB program codes for selectively disabling combinations of Errors 01 through 04 are provided in "PROCEDURE".

DISABLE ERROR = B1
Clear DISABLE ERROR function = B0

COMMENTS

Input/Output Status

When Error Messages are disabled, the accuracy of the displayed measurement and the fidelity of the signal at the output of the MODULATION OUTPUT/AUDIO INPUT are not safeguarded. When all the errors are enabled, displayed results are calibrated and the output of MODULATION OUTPUT/AUDIO INPUT is entirely safeguarded.

Disable Error 04 Inhibits Audio Autoranging

When Error 04 is disabled, the Measuring Receiver automatically ranges to a less sensitive range when the signal level requires, but it does not range back when the audio level is reduced. Thus, if a transitory peak audio signal is detected, the Measuring Receiver will up-range the audio range to accommodate the peak but will not down-range after it has passed. Audio autoranging is then prevented from interfering with other measurements such as input frequency. (Refer to *Audio Range* on page 3-211.)

Special Function 8 Overrides Automatic Selection

Note that Special Functions 8.1 through 8.8 override the automatic selection for all measurement modes. Thus, error messages that may be appropriately disabled for one measurement mode (such as frequency) may be inappropriate for another measurement mode (such as AM).

Limits to Disabling Error Messages

Disabling some error messages (such as Error 04) often give rise to other error messages that cannot be disabled (such as Error 07).

Safeguarding the Signal Fidelity at the Modulation Output

Special Function 8.8 is sometimes referred to as the "calibrated receiver" mode of operation. It assures that the output from MODULATION OUTPUT/AUDIO INPUT is safeguarded for most measurements. Some tuned, non-modulation measurement modes (such as frequency) do not completely safeguard the signal fidelity at this output since accurate demodulation is not the primary goal of that measurement mode.

Identify Currently Disabled Error Messages

Use the Special Display and the Special Special Display to identify currently disabled error messages. (Refer to *Special Functions* on page 3-272.)

Special Functions

FUNCTIONS

All Special Functions prefixed 1 to 39

DESCRIPTION

General Information.

Special functions enable extended use of the instrument beyond the control normally available from dedicated front-panel keys. The special functions are best used after a thorough understanding of the instrument is grasped.

Special functions are accessed via keyboard entry of the appropriate numeric code terminated by the SPCL key. (Refer to "Procedures".) The codes comprise a prefix, decimal, and suffix. Special functions are disabled in different ways, depending on the function. Refer to the following comprehensive table for actions which clear or disable any special function. Special functions are grouped by their prefixes into three categories as follows:

Prefix 0

Prefix 0 is the Direct Control Special Function intended for use in servicing the Measuring Receiver (discussed in detail in Section 8). All instrument error messages and safeguards are inactive. If the Direct Control Special Function is entered inadvertently, press AUTOMATIC OPERATION.

Prefixes 1 to 39

Prefixes 1 to 39 are the User Special Functions that are used during normal instrument operation when a special configuration, a special measurement, or special information is required. All error messages and most safeguards remain in effect unless the operator disables them. These special functions are described in the table in this instruction.

Prefixes 40 to 99

Prefixes 40 to 99 are the Service Special Functions used to assist in troubleshooting an instrument fault (discussed in detail in Section 8). The functions available include special internal measurements, software control, and special service tests and configurations. Most instrument safeguards are relinquished. If a Service Special Function is entered inadvertently, press AUTOMATIC OPERATION. Repair personnel can gain arbitrary control of the instrument as an aid in troubleshooting.

Viewing Special Function States

In addition to completing the entry of special function codes, the SPCL key enables viewing of some special function settings. The operator-requested settings of Special Functions prefixed 1 through 10 can be viewed by pressing the SPCL key once (following no numeric entry). This display is called the Special Display. If some of these Special Functions are in automatic modes (generally the 0-suffix setting), the actual instrument settings of these functions can be displayed by pressing the SPCL key a second time while the Special Display is still active. This display is called the Special Special Display. Both displays can be disabled by pressing any key except the Blue Key, LOCAL, or S (shift) key. (While either display is active, pressing the SPCL key selects the other display.)

A summary of User Special Functions is provided at the end of this instruction. Also included in this instruction are procedures for initiating special functions and for obtaining the Special Display and the Special Special Display.

PROCEDURES

Entering Special Functions.

To use a special function, key in the corresponding code, then select SPCL.

Special Display.

To display the user-requested modes of special functions prefixed 1 through 10, select SPCL alone one time. The digit position (noted beneath the display) corresponds to the special function prefix, and the number displayed in that position corresponds to the special function suffix.

Special Special Display.

To determine the actual instrument settings corresponding to special functions prefixed 1 through 10, press the SPCL key alone once while the Special Display is active. (If the Special Display is not active, press the SPCL key twice to get this display.) The digit position corresponds to the special function prefix, and the number displayed in that digit corresponds to the special function suffix.

HP-IB PROGRAM CODES

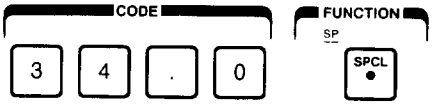
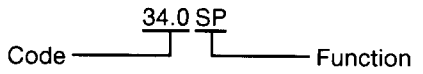
All special function codes are formed by the special function number followed by the code "SP". For example, the code for Special Function 7.3 is "7.3SP".

For special function codes with zero as a suffix, force a single space if the zero is to be ommitted. For example, "10.0SP" could be "10. SP"

EXAMPLES

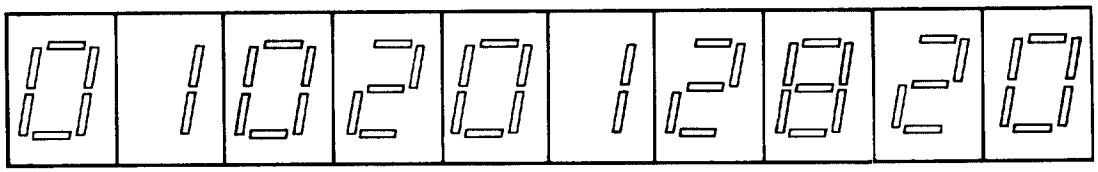
Entering Special Functions.

To display the frequency of the signal in the IF (Special Function 34):

LOCAL (keystrokes)	
HP-IB (program codes)	

Viewing the Special Display.

When SPCL is pressed alone once, the following display might result:

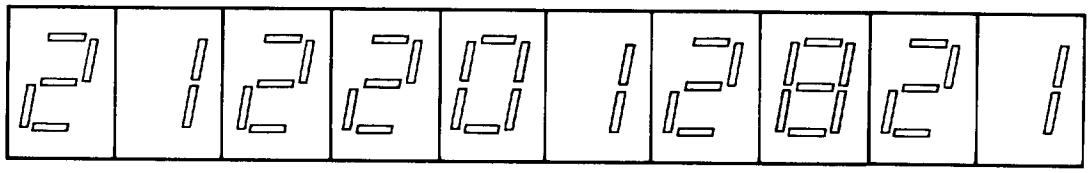


This display is interpreted as follows:

Special Function		User-Requested Setting
Code	Name	
1.0	RF Input Attenuation and Gain	Automatic Selection
2.1	Audio Range	40% AM; 4 kHz FM; 4 radians ϕM
3.0	RF and IF Filters	Automatic Selection (RF High-Pass Filter Out)
4.2	Tuned RF Level Detector Selection and Display Averaging	If Synchronous Detector with 1 Second Averaging Time
5.0	Audio Detector Response	Fast Response
6.1	Automatic Level Control	Fast Response
7.2	RF Frequency Resolution	100 Hz
8.8	Error Message Disable	All Errors Enabled
9.2	IF Gain	10 dB IF Gain
10.0	RF Power Range	Automatic Selection

Special Special Display.

When SPCL is pressed again, the following display might result: (The user-selected Special Functions shown in the previous example are repeated in the Special Special Display. The Special Functions that were left in the automatic selection mode will display the suffix that was automatically selected.)



The display is interpreted as follows:

Special Function		Actual Instrument Setting
Code	Name	
1.2	RF Input Attenuation and Gain	10 dB Attenuation
2.1	Audio Range	40% AM; 4 kHz FM; 4 radians ϕM
3.2	RF and IF Filters	1.5 MHz IF Frequency; 2.5 MHz IF Bandwidth; Narrow Filter Out; RF High-Pass Filter Out
4.2	Tuned RF Level Detector Selection and Display Averaging	If Synchronous Detector with 1 Second Averaging Time
5.0	Audio Detector Response	Fast Response
6.1	Automatic Level Control	Fast Response
7.2	RF Frequency Resolution	100 Hz
8.8	Error Message Disable	All Errors Enabled
9.2	IF Gain	10 dB IF Gain
10.1	RF Power Range	Range #1

COMMENTS

Omit Zero Suffixes.

If a special function has a suffix of zero, the zero need not be entered. For example, 10.0 SPCL equals 10.SPCL. (However, 22.2 SPCL does not equal 22.20 SPCL nor does 18.1 SPCL equal 18.10 SPCL.) If entering a special function code evokes Error 21 (invalid key sequence), the special function requested has not been executed.

HP-IB.

Force a single space in "10. SP" if the zero is to be omitted.

CLEAR Key.

If an error is made while keying in the special function code, select CLEAR and re-enter the code.

Incongruity Between Special and Special Special Display.

In most cases, the user-selected special function suffix appears in both the Special Display and the Special Special Display. However, Special Functions 1.9 and 4.4 are user-selected, automatic-selection modes, and might display a different suffix in the Special Special Display.

DETAILED DESCRIPTIONS OF ALL SPECIAL FUNCTIONS

1. RF Input Attenuation and Gain. Use this special function to select RF input attenuation or amplification to eliminate input overload or to improve measurement sensitivity. For more details about this function, refer to *RF Input Attenuation and Gain* on page 3-265.

1.0 Automatic selection
1.1 Attenuation of 0 dB
1.2 Attenuation of 10 dB
1.3 Attenuation of 20 dB
1.4 Attenuation of 30 dB
1.5 Attenuation of 40 dB
1.6 Attenuation of 50 dB
1.7 Gain of 24 dB
1.8 Gain of 14 dB (24 dB gain with 10 dB attenuation)
1.9 Automatic selection with 10 dB attenuation always inserted (usually only used in Tuned RF Level measurements)

2. Audio Range Selection. Use this special function to set the display resolution for modulation measurements. The Measuring Receiver's display resolution is dependent on the modulation being measured and the detector being used. For example, in FM measurements, Special Function 2.4 can only display 0.01 Hz resolution when the deviation being measured is less than 0.04 peak kHz and when the RMS detector is selected. Because this special function is so complex, it is not described in detail here. Refer to *Audio Range* on page 3-211, for detailed tables for this function.

3. RF and IF Filters. Use this special function to change the Measuring Receiver's RF and IF filters. (Refer to *Filters, RF and IF* on page 3-259 for information about the usefulness of changing these filters.)

Special Function Code	Program Code HP-IB	IF Frequency	Wide IF Filter	Narrow IF Filter (30 kHz BW)	RF High-Pass Filter (5.25 MHz)
3.0 SPCL	3.0SP	Automatic Selection			OUT
3.1 SPCL	3.1SP	455 kHz	200 kHz BW	OUT	OUT
3.2 SPCL	3.2SP	1.5 MHz	2.5 MHz Low-Pass	OUT	OUT
3.3 SPCL	3.3SP	455 kHz	200 kHz BW	OUT	IN
3.4 SPCL	3.4SP	1.5 MHz	2.5 MHz Low-Pass	OUT	IN
3.5 SPCL	3.5SP	455 kHz	200 kHz BW	IN	OUT
3.6 SPCL	3.6SP	455 kHz	2.5 MHz Low-Pass	IN	OUT
3.7 SPCL	3.7SP	455 kHz	200 kHz BW	IN	IN
3.8 SPCL	3.8SP	455 kHz	2.5 MHz Low-Pass	IN	IN

4. Tuned RF Level Synchronous and Average Detector and Display Averaging. Tuned RF level measurements can be made with one of two internal detectors: a narrow-band tracking IF synchronous detector or a wider-band IF average detector. The IF synchronous detector is more sensitive than the IF average detector but the IF average detector is more tolerant of signal drift and residual FM than the average detector. When measuring noisy signals, use the IF average detector (4.4 SPCL). The IF synchronous detector (4.0 SPCL) is automatically selected on power-up.

Measurement averaging time is automatically selected by the Measuring Receiver during the Tuned RF Level measurement when 4.0 SPCL or 4.4 SPCL is selected. The Measuring Receiver chooses these times based on the requirements of its internal circuitry. However, experienced operators may want to increase or decrease the measurement time using Special Function 4.

4.0 Synchronous detector; averaging time is automatic.

4.1 Synchronous detector; averaging time is 10s.

4.2 Synchronous detector; averaging time is 1s.

4.3 Synchronous detector; averaging time is 0.1s.

4.4 Average detector; averaging time is automatic.

4.5 Average detector; averaging time is 10s.

4.6 Average detector; averaging time is 1s.

4.7 Average detector; averaging time is 0.1s.

5. Audio Detector Response. Use this special function to help stabilize measurements on unstable or noisy signals when making modulation or SINAD measurements.[1]

5.0 Fast response time.

5.1 Slow response time.

6. Automatic Level Control. Use this special function to speed up the ALC response time or to disable the ALC. (The faster ALC response time degrades AM accuracy at rates less than 1 kHz.) Disabling the ALC, in conjunction with the rear-panel AM Output connector, can be used to measure AM at very low modulation rates. Disabling the ALC also permits measurement of absolute changes in AM depth without regard to changes in carrier level.

6.0 Slow ALC (for AM rates greater than 20 Hz).

6.1 Fast ALC (for AM rates greater than 1 kHz).

6.2 ALC off.

[1] The slow response time for SINAD is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

7. RF Frequency Resolution. Use this special function to manually set the display resolution during frequency measurements (including RF, IF, and LO frequencies). Note that with finer resolution, measurement time increases .

7.0 Automatic selection.

7.1 Resolution of 10 Hz.

7.2 Resolution of 100 Hz. (When using an external LO value greater than 20 GHz, 7.1 SPCL selects 100 Hz resolution.)

7.3 Resolution of 1 kHz.

7.4 [2] (Applies to RF Frequency measurements only; other measurements treat 7.4 as 7.1.) Resolution of 0.1 Hz for input signals less than 10.1 MHz; resolution of 1 Hz for signals from 10.1 MHz through 1300 MHz. (When measuring frequencies as high as 1300 MHz, measurement time with this resolution is approximately 20 seconds.)

8.Error Message Disable Control. Most combinations of Errors 01 through 04 can be disabled or enabled to customize the behaviour of the instrument to meet a particular set of measurement requirements. When the Measuring Receiver uses automatic selection of error messages, these messages are selectively enabled, depending on the measurement being made, to assure the broadest range of calibrated measurements. *Error Message Disable Control* on page 3-267 has a table that lists the errors that are automatically disabled during each measurement.

8.0 Automatic selection of disabled error messages.

8.1 Disables Error 01.

8.2 Disables Errors 02 and 03.

8.3 Disables Errors 01, 02, and 03.

8.4 Disables Error 04.

8.5 Disables Errors 01 and 04.

8.6 Disables Errors 02, 03, and 04.

8.7 Disables Errors 01, 02, 03, and 04. Performs the same function as DISABLE ERROR (Blue Key, RANGE HOLD).

8.8 Enables Errors 01, 02, 03, and 04. This ensures that the output from MODULATION OUTPUT is safeguarded for most measurements. Some tuned, non-modulation measurement modes (such as frequency) do not completely safeguard the signal fidelity at this output since accurate demodulation is not the primary goal of that measurement mode.

9. IF Gain. Use this special function to insert gain into the Measuring Receiver's circuitry. The amplifier used has precise 10 dB gain steps ranging from 0 to 60 dB. (Refer to *IF Gain* on page 3-263 for more information about this function.)

9.0 Automatic Selection of gain for Tuned RF Level measurements.

9.1 Gain of 0 dB inserted.

9.2 Gain of 10 dB inserted.

9.3 Gain of 20 dB inserted.

9.4 Gain of 30 dB inserted.

9.5 Gain of 40 dB inserted.

9.6 Gain of 50 dB inserted.

9.7 Gain of 60 dB inserted.

[2] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

10. RF Power Range. Use this special function to manually select one of the five internal power ranges. In most applications, the Measuring Receiver will automatically select the appropriate power range. The following table lists the power ranges and their associated special function codes.

10.0 Automatic selection.

10.1 Range #1 (most sensitive range).

10.2 Range #2.

10.3 Range #3.

10.4 Range #4.

10.5 Range #5 (least sensitive range).

11.2. Previous Ratio. Use this special function to display the reference set with the RATIO key.

12. FM Calibration for Another Instrument in the HP 8902 and HP 8902 RF Signal Analyzer Family. Use this special function to compute an FM calibration factor for another RF signal analyzer that has no internal calibrator, or that has an internal calibrator that is to be cross checked. (For a complete procedure for FM calibration, refer to *FM Calibration* on page 3-181.)

12.0 Display the computed peak FM.

12.1 Display the demodulated peak residual FM.

12.2 Display the demodulated peak FM.

13. AM Calibration for Another Instrument in the HP 8902 and HP 8902 RF Signal Analyzer Family. Use this special function to compute an AM calibration factor for another RF signal analyzer that has no internal calibrator, or that has an internal calibrator that is to be cross checked. (For a complete procedure for AM calibration, refer to *AM Calibration* on page 3-167.)

13.0 Display the computed peak AM.

13.1 Display the demodulated peak residual AM.

13.2 Display the demodulated peak AM.

14. Measurement Limits. Use this special function in conjunction with the RATIO key to set lower and upper measurement limits. (For a complete procedure on setting measurement limits, refer to *Limit* on page 3-249.)

14.0 Clear limits; turn off LIMIT annunciator.

14.1 Set a lower limit to the Ratio reference.

14.2 Set an upper limit to the Ratio reference.

14.3 Restore the lower limit.

14.4 Restore the upper limit.

14.5 Display the lower limit.

14.6 Display the upper limit.

14.7 Display the code for the measurement the lower limit applies to.

14.8 Display the code for the measurement the upper limit applies to.

14.9 Display the limit status in the format "Lower.Upper" where 0=disabled and 1=enabled.

15. Time Base Check. Use this special function to check the status of the time base being used by the Measuring Receiver. (More information about the time base is on page 3-3.)

15.0 Display whether the internal, Option 002 time base oven is warm enough to create a stable source; 0 = warm. Error 12 is displayed if the time base is cold.

15.1 Display whether the internal or external time base is being used; 0 = internal and 1 = external.

16. AM Calibration Factor. This special function enables you to disable, enable, or display the current AM calibration factor. Front-panel keys SAVE CAL (Blue Key, CALIBRATE) and % CAL FACTOR (Blue Key, MHz) can also be used to enable and display the calibration factor. (For a complete procedure for AM calibration, refer to *AM Calibration* on page 3-167.)

16.0 Disable the AM calibration factor.

16.1 Enable the AM calibration factor.

16.2 Display the AM calibration factor. (Displays 0 if not enabled.)

17. FM Calibration Factor. This special function enables you to disable, enable, or display the current FM calibration factor. Front-panel keys SAVE CAL (Blue Key, CALIBRATE) and % CAL FACTOR (Blue Key, MHz) can also be used to enable and display the calibration factor. (For a complete procedure for FM calibration, refer to *FM Calibration* on page 3-181.)

17.0 Disable the FM calibration factor.

17.1 Enable the FM calibration factor.

17.2 Display the FM calibration factor. (Displays 0 if not enabled.)

18.NN Tone Burst Receiver. Use this special function to measure the frequency of squelch tones. A time delay of NN ms is inserted between detection of a carrier and unsquelching of the output at the MODULATION OUTPUT connector. The range of NN is 1 to 99 ms. If NN is 0, the delay is 99 ms. (Refer to *Tone Burst Receiver* on page 3-193 for more information about this function.)

21. HP-IB Address. Use this special function to display the HP-IB address in the form:
AAAAAAA.TLS., where:
AAAAAAA is the address in binary,
T = 1 = talk only,
L = 1 = listen only, and
S = 1 = requesting service.

22. Service Request. Use this special function to set up a service request mask. A value of NN from 0 to 63 sums the weighted conditions below to set up a service request mask. The summed, weighted conditions are displayed when NN is 64. Refer to page 3-30 for more information about this service request mask.

1 Data ready
2 HP-IB error (cannot be disabled)
4 Instrument error
8 Limit exceeded
16 Frequency Offset mode state change
32 RECAL or UNCAL
64 read back SRQ mask

23. External LO (Option 030 Only). Use this special function when making Selective Power Measurements using an external LO. (Refer to *Selective Power Measurements* on page 3-119 for more information about this measurement.)

23.0 Return the LO to internal.

23.1 Set the LO to external.

23.2 Display the status of the LO (0=Internal, 1=External).

24. Selective Power Measurement (Option 030 Only). Use this special function when measuring adjacent channel power or single-sideband noise. (Refer to *Selective Power Measurements* on page 3-119 for more information about this measurement.)

24.0 Sets the Measuring Receiver to the Selective Power Measurement Mode.

24.1 Selects the wide-bandwidth IF filter for adjacent-channel or cellular radio power measurements; displays the IF level (in volts).

24.2 Establishes the level measured with 24.1 SPCL as the 0 dB reference.

24.3 Selects a narrower bandwidth IF filter than 24.1 SPCL for adjacent-channel power measurements; displays the IF level (in volts).

24.4 Establishes the level measured with 24.3 SPCL as the 0 dB reference.

24.5 Selects a very narrow bandwidth IF filter (2.5 kHz) for the single-sideband noise measurement; displays the IF level (in volts).

24.6 Establishes the level measured with 24.5 SPCL as the 0 dB reference.

24.7 Displays the noise measurement as normalized to a 1 Hz bandwidth.

24.8 Enables setting of the value of the noise measurement bandwidth.

24.9 Displays the value of the noise measurement bandwidth.

25. Current Value of External Attenuation. Use this special function in conjunction with dB EXT ATTEN (Blue Key, LOG/LIN) to scale level measurements to correctly indicate the power at the input of an external attenuator or amplifier connected to the Measuring Receiver. (For informatin on setting the value of external attenuation or gain, refer to *External Attenuation* on page 3-131.)

25.2 Display the current offset in dB. (Amplification is shown as a negative attenuation value.)

26. Relative Tuned RF Level Measurement. Use this special function in conjunction with SET REF (Blue Key, ZERO) to make relative Tuned RF Level measurements. (Refer to *Attenuator Measurements* on page 3-115 for more information about this function.)

SET REF Enter the relative Tuned RF Level measurement mode and set the input signal level as 0 dB.

26.0 Exit the relative Tuned RF Level measurement mode and enter the absolute Tuned RF Level measurement mode.

26.1 Re-enter the relative measurement mode using the previous reference set with SET REF.

27. Frequency Offset Control. Use this special function when making measurements on down-converted input signals. (The Measuring Receiver can measure frequencies to 42 GHz when an external mixer and LO are used to down-convert the input signal. Refer to *Frequency Offset Control* on page 3-255 for requirements of the local oscillator and mixer.) The Frequency Offset Control special function allows the Measuring Receiver to keep track of the frequencies involved in the down-conversion.

27.0 Exit the Frequency Offset Mode.

27.1 Enter the Frequency Offset Mode.

27.2 Display the external LO frequency.

27.3 Prepare to enter and enable the LO frequency. After entering 27.3 SPCL, enter the frequency of the LO (in MHz). Frequencies from 0 to 40700 MHz can be entered.

29.0 SINAD Measurement. Use this special function to make SINAD (Signal to Noise And Distortion) measurements on either internally demodulated signals or externally applied audio signals.

30.0 External Audio RMS Level Measurement. Use this special function to measure the true rms level of an audio signal applied to the Measuring Receiver's AUDIO INPUT connector.

31. Tuned RF Level Noise Correction. [3] Use this special function in conjunction with the IF Average Detector (Special Functions 4.4 through 4.7) when making Tuned RF Level measurements on low-level signals. The selection of Special Function 31 is maintained through instrument power down (the Measuring Receiver being turned off and then on).

The Tuned RF Level measurement calibrates three RF input attenuation ranges to achieve accurate low-level measurements. (The *Operating Information Pull-Out Card* illustrates these.) When Special Function 31.1 is enabled, the normal Tuned RF Level measurement procedure is followed (that is, stepping down in level and pressing the CALIBRATE key whenever the RECAL annunciator is displayed). However, when the Measuring Receiver calibrates the third RF range, it causes the sensor module to switch out the signal from the device-under-test momentarily (placing 50Ω at the output). Then the HP 8902A measures the noise between the RF input and the IF Average Detector circuitry. In subsequent measurements (in this third range), the Measuring Receiver subtracts the measured noise from the total signal-plus-noise to display the measured signal level.

31.0 Turn off noise correction.

31.1 Turn on noise correction.

31.2 Display 0 if noise correction is off and display 1 if it is on.

[3] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

COMMENTS ABOUT SPECIAL FUNCTION 31:

NOTE

Special Function 31.1 (for noise correction) should be entered once before making level measurements. To clear Special Function 31.1 you MUST enter 31.0 SPCL.

Special Function 31 can be especially useful when making measurements on down-converted signals.

Special Functions 31.0 and 31.1 can be toggled once the Tuned RF Level calibration has been done with 31.1 enabled. That is, the signal can be measured alternately with the noise added to the signal and without the noise.

The Measuring Receiver uses a default noise value (that might be invalid) in its measurement response if Special Function 31.1 is enabled after (instead of before) completing the Tuned RF Level calibration sequence. (The default noise value is the last value that was measured. This value is saved through Instrument Preset and power down.)

CAUTION

Do not use 31.1 SPCL when making any uncalibrated, or relative signal level measurement in Tuned RF Level mode without a power sensor. The Sensor Module must be used when making Tuned RF Level range-to-range calibrations with the AVG Detector.

32. dB and Frequency Resolution. [4] During RF Power and Tuned RF Level measurements, and measurements that use the Ratio function, use this special function to display dB measurements with resolution in 0.001 dB instead of the normally displayed resolution of 0.01 dB. During audio measurements, use this special function to display 0.1 Hz resolution from 100 to 250 kHz. The selection of Special Function 32.0 or 32.1 is maintained through instrument power down (the Measuring Receiver being turned off and then on). (Note that Special Functions 32.1 and 32.9 can be enabled simultaneously.)

32.0 Power is displayed with normal measurement resolution of 0.01 dB.

Audio frequency is displayed with the normal resolution of 1 Hz for frequencies from 100 to 250 kHz.

32.1 Power is displayed with measurement resolution of 0.001 dB.

Audio frequency is displayed with a resolution of 0.1 Hz for frequencies from 100 to 250 kHz.

32.2 Displays 0 if the normal measurement resolution is enabled (32.0 SPCL) and displays 1 if a finer resolution is enabled (32.1 SPCL).

32.9 Tuned RF Level Measurements Using Track-Mode Tuning. [5] Use this special function when making level measurements on low-level signals (greater than 40 MHz into the HP 8902A) that tend to drift. The track mode tuning is available only with the IF average detector (Special Functions 4.4 through 4.7) which can measure levels to −110 dBm). (Note that Special Functions 32.1 and 32.9 can be enabled simultaneously.)

To select track-mode tuning for a low-level Tuned RF Level measurement:

a. Instrument Preset the HP 8902A (blue key, green key).

b. If using a down converter to measure microwave signals, key in 27.3 SPCL. Key in the external L.O. frequency. Make sure that the L.O. frequency results in an IF frequency to the HP 8902A of greater than 40 MHz when mixed with the RF signal.

c. Set the RF signal to a level greater than -10 dBm.

d. Allow the HP 8902A to tune to the signal. (Wait for a frequency display.)

e. Select 32.9 SPCL. (This is the same as entering 4.4 SPCL, 8.1 SPCL, Log units, Track Mode and 27.3 SPCL.) The light in the TRACK MODE key should be on at this point.

f. Press the MHz key to enter the manual tune mode.

g. Select Tuned RF Level (yellow shift key, RF Power key).

h. If using an HP 11722A or HP 11792A sensor module, press the CALIBRATE key to make an absolute level measurement or set a relative reference by pressing the blue key and the ZERO key.

i. Step the signal level down in amplitude and press the CALIBRATE key whenever the RECAL annunciator is displayed.

COMMENTS ABOUT SPECIAL FUNCTION 32.9:

If the signal appears to be lost, set the signal level of the device-under-test to greater than −90 dBm. Then select Blue Key, CLEAR (HP-IB code: BC). This key sequence forces a retune of the VCO during Tuned RF Level measurements and should recapture the signal if it has not drifted more that 5 MHz. Once the signal has been recaptured, step the signal down for low-level measurements.

If the signal frequency into the HP 8902A drifts past one of the following frequency boundaries, the Measuring Receiver will lose the signal and the measurement process must be restarted.

40 MHz, 80 MHz, 160 MHz, 320 MHz, and 640 MHz.

33.0 LO Frequency Measurement. Use this special function to display the LO frequency for the signal being measured.

34.0 IF Frequency Measurement. Use this special function to display the IF frequency for the signal being measured. Special Function 3 enables you to manually select the IF for frequencies above 10 MHz. (Refer to *Filters, RF and IF* on page 3-259.)

35.0 RF Level Measurement. Enables the Measuring Receiver to measure the peak RF power. This measurement is selected when RF POWER is selected and no power sensor is connected to the SENSOR input.

36.0. Peak Tuned RF Level Measurement. This measurement is not as accurate or sensitive as the Tuned RF Level Measurement. Use the Peak Tuned RF Level measurement to measure the level of frequencies that are drifting or to determine flatness as a function of carrier frequency.

37. RF Power Calibration Factors. Use this special function to manipulate RF Power calibration factors. An extensive table in *RF Power* on page 3-78 summarizes each of these special functions. Two tables are available with the same special function. The table being used is determined by the status of Frequency Offset Mode (Special Function 27).

37.0 Use automatic calibration factors.

37.1 Use manual calibration factors.

37.2 Display calibration factor status (0=automatic, 1=manual).

37.3 Enter calibration factor.

37.4 Display table size.

37.5 Prepare to recall the reference calibration factor.

37.6 Prepare to recall the next frequency/calibration factor pair.

37.9 Clear the table.

38. Display Tuned RF Level Calibration Factors. Use this special function to display calibration factors used in Tuned RF Level measurements. This function is useful (when used with Special Function 39) in making repetitive Tuned RF Level measurements at many different frequencies. Measurement time is decreased when it is not necessary to perform calibration. For more details about this function, refer to *Tuned RF Level* on page 3-99. (Note: If the number of test frequencies is less than or equal to eight, consider using the storage registers to save the calibration data. For details about storing measurement settings, refer to *Store/Recall* on page 3-253.)

To display and then re-use Tuned RF Level calibration factors, perform calibration at the frequency of interest, read the calibration factors using Special Function 38, then re-enter the calibration factors before making measurements at the previously measured frequency using Special Function 39.

38.1 Display the calibration factor for Range #1.

38.2 Display the calibration factor for Range #2.

38.3 Display the calibration factor for Range #3.

38.4 [6] Display the SET REF reference calibration value. (This cal factor is displayed with a maximum of eight digits and a resolution of 0.01%.)

39. Enter Tuned RF Level Calibration Factors. Use this special function to enter calibration factors used in Tuned RF Level measurements. This function is useful (when used with Special Function 38) in making repetitive Tuned RF Level measurements at many different frequencies. Measurement time is decreased when it is not necessary to perform calibration. For more details about this function, refer to *Tuned RF Level* on page 3-99. (Note: If the number of test frequencies is less than or equal to eight, consider using the storage registers to save the calibration data. For details about storing instrument settings, refer to *Store/Recall* on page 3-253.)

To display and then re-use Tuned RF Level calibration factors, perform calibration at the frequency of interest; read the calibration factors using Special Function 38; then re-enter the calibration factors before making measurements at the previously measured frequency using Special Function 39. (Before using Special Function 39, ensure that the instrument is tuned to the input signal.)

39.1 Enter the calibration factor for Range #1.

39.2 Enter the calibration factor for Range #2.

39.3 Enter the calibration factor for Range #3.

39.4 [7] Enter the SET REF reference calibration value.

39.9 Clear all calibration factors.

[6] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

[7] This special function is not available with firmware date codes 234.1985 and below. (To display the firmware date code, select 42.0 SPCL.) To order a ROM set that contains this special function, contact the nearest HP sales office.

ERROR MESSAGE SUMMARY

DESCRIPTION

Error Messages are one means the Measuring Receiver uses to safeguard measurement integrity. When the instrument senses a potential error-causing situation, an Error Message code is displayed to alert the user of the condition. The Error Message code indexes an Error Message which describes the current error. Error Messages indicate operating problems, incorrect keyboard entries, or service-related problems. The error message is usually cleared when the error condition is removed.

Two types of error message display formats are used:

Error NN: The numerical value (NN) of the error message is displayed and

– – No detectable signal falls within the IF passband. Either no signal is at the input, or the instrument cannot tune to find the applied signal. (For example, it might be manually tuned far enough away from an input signal that no power is detected in the IF.) This display is output to the HP-IB as Error 96 using the HP-IB output format described in "HP-IB Output Format".

– – – – A signal has been detected but, for various reasons, a measurement result is not yet available. The instrument might be still completing the measurement requested, or in some cases, unable to complete a measurement because of manual settings of special functions. (For example, when frequency measurements are made on a low-level input signal with high AM depth, or when the RF input attenuation or gain is improperly set.) This display is never output to the HP-IB and typically indicates a transitory state in instrument operation.

– – – – – – The IF synchronous detector circuitry is searching for the IF signal. This error message can only be displayed when the IF synchronous detector is used in the Tuned RF Level measurement mode. (Refer to *Tuned RF Level* on page 3-95.) This display is never output to the HP-IB and typically indicates a transitory state in instrument operation.

Error messages are grouped by error code as follows:

Errors 01 through 19 and 90 through 99.

These messages are Operating Errors which indicate a condition has not been met to assure a calibrated measurement. Operating Errors can usually be cleared by readjustment of front-panel controls (usually, the easiest way is to select AUTOMATIC OPERATION). The DISABLE ERROR key or Special Function 8 can be used to selectively disable Errors 01 through 04. (Refer to *Error Message Disable Control* on page 3-267.)

Errors 20 through 29.

These messages are Entry Errors which indicate an invalid key sequence or keyboard entry. These errors require that a new keyboard entry or function selection be made. Some of these error displays time out after a few seconds and then allow the display to return to the current measurement.

Errors 30 through 39.

These messages are Tuned RF Level Calibration Errors which indicate a condition that has not been met to assure calibration. The error can usually be cleared by readjusting the input signal, or by setting Special Functions 1 and 9 to automatic selection.

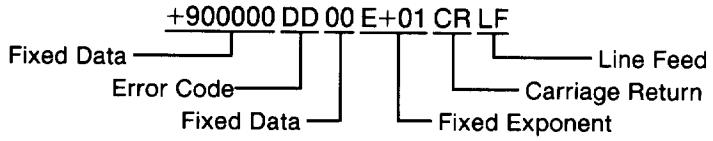
Errors 40 through 89.

These messages are Service Errors generated to provide service-related information. They must be enabled to be displayed since they are not displayed in normal instrument operation. Service Error Messages are discussed in Section 8 of the Service Manual.

HP-IB

HP-IB Output Format

The HP-IB output format for errors is shown below:



For example, Error 02 is output to the HP-IB as +9000000200E+01CRLF. Once an error has been input to the computing controller, the error code is simply derived by subtracting 9×10^{10} from the input number, then dividing the result by 1000.

Error Messages

The following table describes all Operating Errors and includes the error code, message, and the action typically required to remove the error-causing condition. The COMMENTS column that follows provides additional information and references pertaining to particular error messages.

Operating Errors		
Error Code	Message	Corrective Action
01	IF frequency error.	Retune to signal at input.
02	Input level too high.	Increase RF input attenuation.
03	Input Level too low.	Decrease RF input attenuation.
04	Audio circuits overdriven.	Increase audio range.
05	FM spuelched.	Reduce signal level varations (AM) at RF INPUT.
06	RF input overload.	Reduce RF signal level at RF INPUT, then press any key.
07	Voltmeter and display overload.	Increase audio range.
08	Calibrator error.	Connect CALIBRATION AM/FM OUTPUT to RF INPUT or turn off calibrator.
09	Option not installed.	Select another instrument function.
10	Input frequency out of range.	Adjust input frequency to within specified limits.
11	Calculated value out of range.	Conversion from % to dB is not possible. Press LOG/LIN for linear display.
12	Time Base oven cold (Option 002).	For highest accuracy, wait until oven is warm. (Refer to Special Function 15.)
13	Power sensor not connected.	Press RF POWER. RF level measurement is initiated if the power sensor is not connected.
14	Power sensor cannot zero.	Assure zero power at SENSOR input.
15	Calibration factor error.	Input calibration factors.
16	Audio circuits underdriven.	Increase external audio input level.
17	Selective power measurement (option series 030)	Release RANGE HOLD, adjust input level or re-reference measurement.
18	RF Power will not calibrate.	Assure 0 dBm at SENSOR input.
19	Tuned RF Level circuits underdriven.	Press Automatic Operation.
96	(HP–IB only) No input signal sensed by instrument.	Increase signal level at RF INPUT or retune.

COMMENTS

Error 01

With the 1.5 MHz IF, the IF frequency must be 1.5 MHz ±50 kHz.

With the 455 kHz IF, the IF frequency must be 455 kHz ±2.5 kHz. (±5 kHz in Tuned RF level.)

Refer to RF Frequency Tuning. Error 01 disables MODULATION OUTPUT/AUDIO INPUT.

Error 02

Refer to RF Input Attenuation and Gain for nominal input levels. Error 02 disables MODULATION OUTPUT/AUDIO INPUT.

Error 03

Refer to RF Input Attenuation and Gain for nominal input levels. Error 03 disables MODULATION OUTPUT/AUDIO INPUT.

Error 06

Maximum allowable input level is 7 Vrms (1W peak).

Error 07

If displayed during modulation measurements, increase audio range. If displayed during level measurements, increase RF input attenuation or increase RF power range.

Error 08

If the connection from CALIBRATION AM/FM OUTPUT to RF INPUT is intact, this error may indicate calibrator malfunction.

Error 09

Error 09 display times out. If the option is installed, Error 09 displayed may indicate an option malfunction.

Error 10

Error 10 turns off MODULATION OUTPUT/AUDIO INPUT.

Error 11

In dB RATIO, Error 11 is displayed when measurement result is 0 or negative. (The argument of the log function must be greater than 0.)

Error 12

Error 12 is enabled by Special Function 15.

Error 13

Error 13 usually only occurs when the power sensor is disconnected during an RF power measurement.

Error 14

Error 14 will not occur when using a sensor module (such as the HP 11722A) or a power sensor with an RF switch controlled by voltages accessed from the rear panel. (Refer to *Remote Control RF Switch* on page 3-133.)

Error 15

Refer to *RF Power* on page 3-78 for entry and edit information concerning calibration factors.

Error 17

Several conditions can cause this error:

- IF level too high for available range. Either Range Hold was selected or one of the measurement ranges (Special Functions 1 through 10) was user selected. Select AUTOMATIC OPERATION and try the measurement again.
- IF level too low when making a reference measurement. The reference is below 1.25V. Increase the source level to between 1.25V and 2.5V.
- Either a ratio measurement was attempted with an inadequate reference measurement or the reference was not measured before the ratio measurement was attempted. Take a reference measurement with the reference level between 1.25V and 2.5V.

Error 96

Error 96 corresponds to a display of two dashes (- -). Error 96 can occur when no signal is applied or when Error 03 is disabled and the instrument is manually tuned where no signal is found. Error 96 (- -) turns off MODULATION OUTPUT/AUDIO INPUT.

Entry Errors		
Errors	**Message**	**Corrective Action**
20	Entered value out of range.	Re-enter new value.
21	Invalid key sequence.	Check for compatibility of functions selected
22	Invalid Special Function prefix.	Re-enter correct Special Function Code.
23	Invalid Special Function suffix.	Re-enter correct Special Function Code.
24	Invalid HP-IB code.	Re-enter correct HP-IB code.
25	Special Functions selected not compatible with selected measurement.	Press AUTOMATIC OPERATION
26	End of RF POWER calibration factor table reached.	Check number of entries.

Error 20

When this error occurs during single-sideband noise measurements, the bandwidth entry was out-of-range. Usually it is unnecessary to enter a bandwidth for noise measurements. This bandwidth is established at the factory.

Error 24

Error 24 always causes the issuance of a Require Service message on the HP-IB.

Entry Errors		
Errors	**Message**	**Corrective Action**
30	Manual input attenuation or gain selection.	Change RF input attenuation and gain.
31	Requires new power reference.	Calibrate RF Power before attempting calibration of Tuned RF Level.
32	Calibration not possible.	Move input Signal level into avalid calibration range.
33	Power sensor reference error.	Maintain consistency in frequency and level at SENSOR during calibration.
34	Signal lost during calibration.	Maintain frequency stability at RF INPUT during calibration.
35	Level error during calibration.	Maintain signal stability at RF INPUT during calibration.

Entry Errors		
Errors	**Message**	**Corrective Action**
40-89	Serivce-related errors.	Refer to service section of HP 8902A instrument manual.

Errors 40 through 89

Service errors are normally disabled.

Table of Contents

Introduction 4–1
Equipment Required 4–1
Performance Test Record 4–1
Calibration Cycle 4–1
Abbreviated Performance Testing 4–1
Performance Test 1—AM 4–2
Performance Test 2—FM 4–8
Performance Test 3—ΦM 4–14
Performance Test 4—Audio Filters 4–18
Performance Test 5—Audio Measurements 4–20
Performance Test 6—Power Reference (Using Reference Comparison) 4–25
Performance Test 7—Power Reference (Using DC Substitution) 4–26
Performance Test 8—Power Meter 4–29
Performance Test 9—SWR 4–31
Performance Test 10—Tuned RF Level (Using a Step Attenuator) 4–35
Performance Test 11—Tuned RF Level (Using a Piston Attenuator) 4–39
Performance Test 12—High-Selectivity Filters (Options 032 and 033) 4–43
Performance Test 13—High-Selectivity Gain (Option Series 030) 4–48
Performance Test 14—Tuned RF Level 4–50
Table 4–1. Performance Test Record 4–51

Section 4
PERFORMANCE TESTS

4–1. INTRODUCTION

The procedures in this section test the instrument's electrical performance using the specifications of Table 1–1 as performance standards. All tests are performed without accessing the interior of the instrument. A simpler operational test is available in Section 3, *Operation*, under the title *Basic Functional Checks*.

NOTE

Unless otherwise noted, no warm-up period is required for the following tests.

Line voltage must be within +5% and −10% of nominal if the results of the performance tests are to be considered valid.

4–2. EQUIPMENT REQUIRED

Equipment required for the performance tests is listed in Table 1–3, *Recommended Test Equipment*. Any equipment that satisfies the critical specifications provided in the table may be substituted for the recommended model(s).

4–3. PERFORMANCE TEST RECORD

Results of the performance tests may be tabulated on the *Performance Test Record* at the end of the procedures. The *Performance Test Record* lists all of the tested specifications and their acceptable limits. The results, recorded at incoming inspection, can be used for comparison in periodic maintenance and troubleshooting and after repairs or adjustments.

4–4. CALIBRATION CYCLE

This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked using the following performance tests at least once every year.

4–5. ABBREVIATED PERFORMANCE TESTING

No abbreviation of performance testing is recommended.

Performance Test 1—AM

Specification

Characteristic	Performance Limits	Conditions
AMPLITUDE MODULATION		
Rates	20 Hz to 10 kHz 20 Hz to 100 kHz	150 kHz to 10 MHz carrier 10 to 1300 MHz carrier
Depth	To 99%	
Accuracy[1,2,3,4]	±2% of reading ±1 digit ±3% of reading ±1 digit ±1% of reading ±1 digit ±3% of reading ±1 digit	150 kHz to 10 MHz carrier; 50 Hz to 10 kHz rates; 5 to 99% depth 150 kHz to 10 MHz carrier; 20 Hz to 10 kHz rates; to 99% depth 10 to 1300 MHz carrier; 50 Hz to 50 kHz rates; 5 to 99% depth 10 to 1300 MHz carrier; 20 Hz to 100 kHz rates; 5 to 99% depth
Flatness[5,6]	±0.3% of reading ±1 digit	10 to 1300 MHz carrier; 90 Hz to 10 kHz rates; 20 to 80% depth
Demodulated Output Distortion	<0.3% THD <0.6% THD	<50% depth <95% depth
Residual AM	<0.01% rms	50 Hz to 3 kHz bandwidth
FREQUENCY MODULATION		
AM Rejection[2]	<20 Hz peak deviation	50% AM depth; 400 Hz and 1 kHz rates; 50 Hz to 3 kHz bandwidth
PHASE MODULATION		
AM Rejection[2]	<0.03 rad peak deviation	50% AM depth; 1 kHz rate; 50 Hz to 3 kHz bandwidth

(1) But not to exceed 50 kHz rates with rms detector.
(2) Peak residuals must be accounted for in peak readings. (Refer to *Residual Noise Effects* in *Detailed Operating Instructions* in Section 3.)
(3) For peak measurements only, AM accuracy may be affected by distortion generated by the Measuring Receiver. In the worst case, this can decrease accuracy by 0.1% of reading for each 0.1% of distortion.
(4) For rms detector, add ±3% of reading.
(5) Flatness is the variation in indicated AM depth for constant depth on input signal.
(6) For optimum flatness, cables should be terminated with their characteristic impedance.

Description

AM accuracy is measured with the internal AM Calibrator, which produces approximately 33% AM at a 10 kHz rate. A low-residual AM source is connected to the input and the internal residual AM is measured. A source, which can produce wide-band, linear AM, is modulated at various AM rates and depths to measure distortion, flatness, and incidental FM and ΦM. A special AM/FM test source is required for these tests to assure that the AM source has adequate bandwidth, low distortion, low residual AM, and low incidental FM and ΦM.

Equipment

AM/FM Test Source ..... HP 11715A
Audio Analyzer ..... HP 8903B
Audio Synthesizer ..... HP 3336C

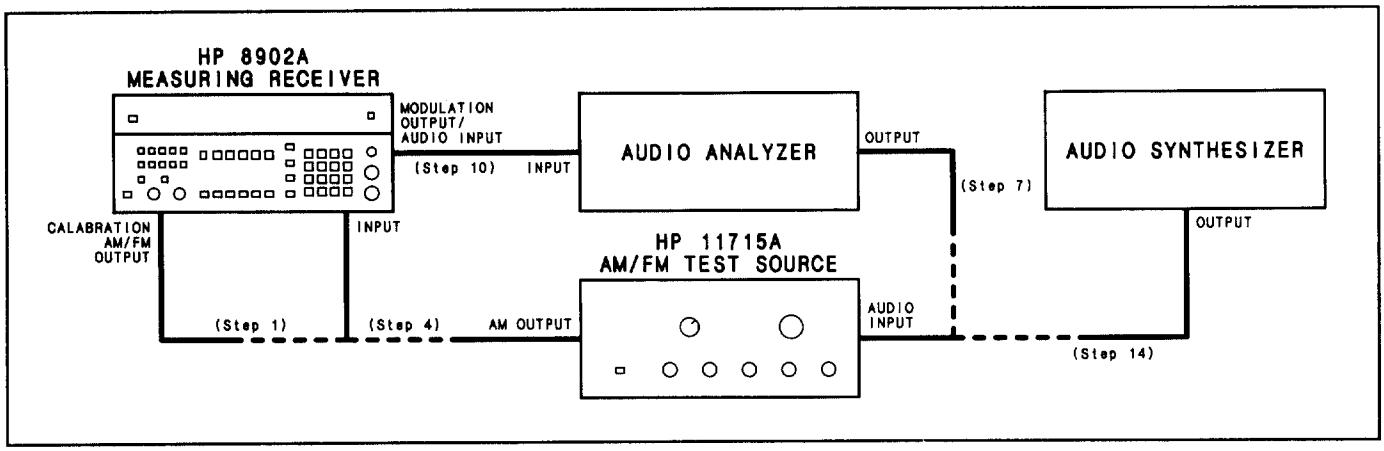


Figure 4—1. AM Performance Test Setup

NOTE

In the following procedure the RF modulation source can be connected either to a sensor module (which is connected to the Measuring Receiver) or directly to the Measuring Receiver's INPUT connector. The procedure is written for the latter case.

Procedure

AM Accuracy at 10 kHz Rate

1. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Connect the Measuring Receiver's CALIBRATION AM/FM OUTPUT to its INPUT.

NOTE

For greatest accuracy, allow the Measuring Receiver to warm up for at least one-half hour.

2. On the Measuring Receiver, press AM and then press CALIBRATE. Allow at least two readings (approximately 40 seconds) to pass. The display should read between 99 and 101%.

AM Calibration Factor 40% AM Range: 99 _____ 101%

3. Key in 2.2 SPCL to set the AM range to 100% AM. Allow at least two readings to pass. The display should read between 99 and 101%. Record this value for future reference.

AM Calibration Factor 100% AM Range: 99 _____ 101%

Residual AM

4. On the AM/FM test source, set the test mode switch to AM. Connect the test source AM output to the Measuring Receiver's INPUT. (See Figure 4–1. Nothing should be connected to the test source's audio input.)
5. On the Measuring Receiver, press FREQ and TRACK MODE. Tune the AM/FM test source's carrier frequency to approximately 12.5 MHz. Press TRACK MODE again to turn it off.
6. On the Measuring Receiver, press AM. Key in 2.0 SPCL to set the modulation range to automatic. Set the other controls as follows:

HP FILTER ..... 50 Hz
LP FILTER ..... 3 kHz
DETECTOR ..... AVG

The display should show 0.01% or less.

Residual AM: _____ 0.01%

AM Distortion

7. Set the audio analyzer's oscillator to 20 kHz. Connect its output to the audio input of the AM/FM test source. (See Figure 4–1.)

NOTE

For this test, if the audio analyzer has floating input and output connectors, the low connector should be grounded. Connections should be made to the high input or high output connector.

8. Set the Measuring Receiver controls as follows:

HP FILTER ..... ALL OFF
LP FILTER ..... ALL OFF
DETECTOR ..... PEAK+

9. Adjust the audio analyzer's oscillator level for a Measuring Receiver display of 50% AM.

10. Connect the audio analyzer's input to the Measuring Receiver's MODULATION OUTPUT/AUDIO INPUT. (See Figure 4–1.) Set the audio analyzer to measure the distortion on the 20 kHz signal at the MODULATION OUTPUT/AUDIO INPUT with 80 kHz of low-pass filtering (on the audio analyzer). The distortion should be 0.3% or less (−50 dB or less).

AM Distortion at 20 kHz Rate; 50% AM: _____ 0.3%

11. Increase the audio analyzer's oscillator level until the Measuring Receiver reads 95% AM. Measure the distortion. The distortion should be 0.6% or less (−44 dB or less).

AM Distortion at 20 kHz Rate; 95% AM: _____ 0.6%

12. Set the audio analyzer's oscillator frequency to 20 Hz. Readjust the level, if necessary, for a Measuring Receiver display of 95% AM. Measure the distortion. The distortion should be 0.6% or less.

AM Distortion at 20 Hz Rate; 95% AM: _____ 0.6%

13. Decrease the audio analyzer's oscillator level until the Measuring Receiver reads 50% AM. Measure the distortion. The distortion should be 0.3% or less.

AM Distortion at 20 Hz Rate; 50% AM: _____ 0.3%

AM Flatness

14. Set the audio synthesizer to 1 kHz at +1 dBm. Connect its output to the audio input of the AM/FM test source. (See Figure 4–1.) Fine adjust the audio synthesizer level for a Measuring Receiver display of 80% AM.

NOTE

Flatness of the audio synthesizer is critical for this test. If the audio synthesizer has leveling capability, switch it on.

15. On the Measuring Receiver, press AVG. Set RATIO on (with LOG/LIN set for a linear display). Set the audio synthesizer frequency as listed in the following table. For each setting, note the Measuring Receiver's display. The difference in readings between any two frequencies should be less than 0.8% REL.

NOTE

±0.3% of reading is equivalent to a difference of 0.6% between any pair of readings. ±1 digit at a nominal reading of 80.0 is about ±0.1% of the reading in the RATIO mode or ±0.2% for any pair of readings. The total limit is then 0.8%.

Audio Synthesizer Frequency (Hz)	Displayed AM (% REL)
1 000	_____
10 000	_____
150	_____
90	_____

AM Flatness (Maximum Difference): _____ 0.8% REL

AM Accuracy

16. On the Measuring Receiver, press RATIO to turn it off. Press PEAK+. Key in 5.1 SPCL to set the audio detector time constant to slow.
17. Set the audio synthesizer frequency to 10 kHz. Set the audio synthesizer level for a display as close as possible to 80.0% on the Measuring Receiver. Record the display reading below.

≈80.0% reading: _____ % AM

18. On the Measuring Receiver, key in the reading recorded in step 17 divided by the AM calibration factor recorded in step 3 then press RATIO. For example, if the AM Calibration Factor from step 3 is 100. 4% and the reading from step 17 is 80.15%, you would key in 79.83 (that is , 80.15/1.004), then press the RATIO key.

Audio Synthesizer Frequency (Hz)	AM Limits (% REL)		
	Lower	Actual	Upper
50 000	98.9	_____	101.1
100 000	96.9	_____	103.1
50	98.9	_____	101.1
20	96.9	_____	103.1

NOTE

±1 digit at a nominal reading of 80.0 is about ±0.1% of the reading in the RATIO mode.

19. On the Measuring Receiver, key in 3.1 SPCL to set the IF to 455 kHz. Set the audio synthesizer to the frequencies in the following table. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (Hz)	AM Limits (% REL)		
	Lower	Actual	Upper
20	96.9	_____	103.1
50	97.9	_____	102.1
10 000	97.9	_____	102.1

AM Rejection

20. On the Measuring Receiver, press RATIO to turn it off. Set the HP FILTER to 50 Hz and the LP FILTER to 3 kHz.
21. Set the audio synthesizer frequency to 1 kHz. Set its level for a Measuring Receiver display of 50% AM.
22. On the Measuring Receiver, press FM. Momentarily disconnect the audio input to the AM/FM test source and note the residual FM displayed on the Measuring Receiver.

Residual FM; 455 kHz IF: _____ Hz

23. Reconnect the audio input of the AM/FM test source. Note the Measuring Receiver's displayed FM. The displayed FM minus one-half the residual FM noted in step 22 should be 20 Hz peak or less.

AM Rejection (with FM); 455 kHz IF: _____ 20 Hz

24. On the Measuring Receiver, key in 3.0 SPCL to set the IF back to 1.5 MHz. Repeat steps 22 and 23.

Residual FM; 1.5 MHz IF: _____ Hz
AM Rejection (with FM); 1.5 MHz IF: _____ 20 Hz

25. On the Measuring Receiver, press ΦM. Momentarily disconnect the audio input to the AM/FM test source and note the residual ΦM displayed on the Measuring Receiver.

Residual ΦM; 1.5 MHz IF: _____ rad

26. Reconnect the audio input of the AM/FM test source. Note the Measuring Receiver's displayed ΦM. The displayed ΦM minus one-half the residual ΦM noted in step 25 should be 0.030 rad peak or less.

AM Rejection (with ΦM); 1.5 MHz IF: _____ 0.030 rad

Performance Test 2—FM

Specification

Characteristic	Performance Limits	Conditions
FREQUENCY MODULATION		
Rates[5]	20 Hz to 10 kHz	150 kHz to 10 MHz carrier
	20 Hz to 200 kHz	10 to 1300 MHz carrier
	20 Hz to 20 kHz	10 to 1300 MHz carrier; 750 μs de-emphasis
Deviations[5]	40 kHz peak maximum	150 Hz to 10 MHz carrier
	400 kHz peak maximum	10 to 1300 MHz carrier
	40 kHz peak maximum	10 to 1300 MHz carrier; 750 μs de-emphasis
Accuracy[1,2,3,5]	±2% of reading ±1 digit	250 kHz to 10 MHz carrier; 20 Hz to 10 kHz rates; <40 kHz peak deviation
	±1% of reading ±1 digit	10 to 1300 MHz carrier; 50 Hz to 100 kHz rates; <400 kHz peak deviation; <40 kHz peak deviation with 750 μs de-emphasis
	±5% of reading ±1 digit	10 to 1300 MHz carrier; 20 Hz to 200 kHz rates; <400 kHz deviation; <40 kHz peak deviation with 750 μs de-emphasis
Demodulated Output Distortion[4,5]	<0.1% THD	400 kHz to 10 MHz carrier; 20 Hz to 10 kHz rates; <10 kHz peak deviation
	<0.1% THD	10 to 1300 MHz carrier; 20 Hz to 100 kHz rates; <100 kHz peak deviation; <40 kHz peak deviation with 750 μs de-emphasis
Residual FM	<8 Hz rms at 1300 MHz decreasing linearly with frequency to <1 Hz rms for 100 MHz and below	50 Hz to 3 kHz bandwidth

(1) But not to exceed 50 kHz rates with rms detector.
(2) Peak residuals must be accounted for in peak readings. (Refer to *Residual Noise Effects* in *Detailed Operating Instructions* in Section 3.)
(3) For rms detector, add ±3% of reading.
(4) With 750 μs de-emphasis and pre-display "off", distortion is not specified for modulation outputs >4V peak. This can occur near maximum deviation for a measurement range at rates <2 kHz.
(5) But not to exceed 20 kHz rates and 40 kHz peak deviation with 750 μs de-emphasis.

Characteristic	Performance Limits	Conditions
AMPLITUDE MODULATION		
FM Rejection[2]	<0.2% AM	250 kHz to 10 MHz carrier; <5 kHz peak deviation; 400 and 1000 Hz rates; 50 Hz to 3 kHz bandwidth
	<0.2% AM	10 to 1300 MHz carrier; <50 kHz peak deviation; 400 Hz and 1 kHz rates; 50 Hz to 3 kHz bandwidth

[2] Peak residuals must be accounted for in peak readings. (Refer to *Residual Noise Effects* in *Detailed Operating Instructions* in Section 3.)

Description

FM is measured with a very low-noise oscillator at the Measuring Receiver's input. The resulting measured FM is the residual FM of the Measuring Receiver's internal local oscillator. FM accuracy is measured with the internal FM Calibrator, which produces approximately 34 kHz peak deviation at a 10 kHz rate. A source, which can produce wide-band, linear FM, is modulated at various FM rates and deviations to measure distortion, flatness, and incidental AM. A special AM/FM test source is required for these tests to assure that the FM source has adequate bandwidth, low distortion, low residual FM, and low incidental AM.

Equipment

AM/FM Test Source ..... HP 11715A
Audio Analyzer ..... HP 8903B
Audio Synthesizer ..... HP 3336C

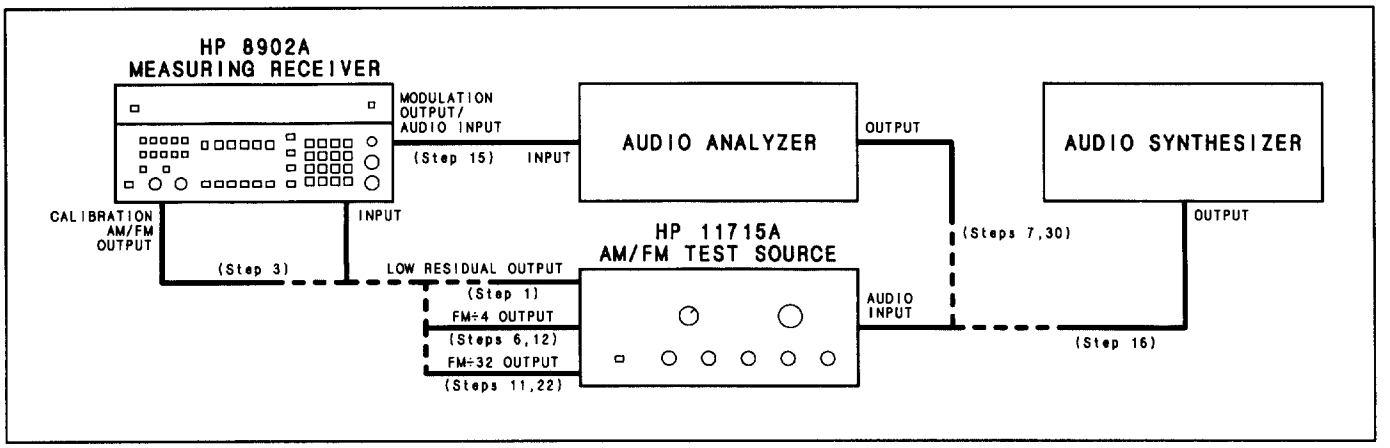


Figure 4—2. FM Performance Test Setup

NOTE

In the following procedure the RF modulation source can be connected either to a sensor module (which is connected to the Measuring Receiver) or directly to the Measuring Receiver's INPUT connector. The procedure is written for the latter case.

Procedure

Residual FM

1. On the AM/FM test source, set the test mode to residual FM. Connect its low-residual (560 MHz) output to the Measuring Receiver's INPUT. (See Figure 4–2.)
2. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Set the other controls as follows:

MEASUREMENT ..... FM
HP FILTER ..... 50 Hz
LP FILTER ..... 3 kHz
DETECTOR ..... AVG

The display should read 4 Hz or less.

Residual FM at 560 MHz; 50 Hz to 3 kHz bandwidth: _____ 4 Hz

NOTE

The equation for determining the residual FM limits is:

residual FM in Hz = 5.83 × carrier frequency in GHz + 0.42 Hz.

For a carrier of 560 MHz, the residual FM limit is 3.7 Hz. Allowing for one digit of uncertainty gives a limit of approximately 4 Hz.

FM Accuracy at 10 kHz Rate

3. Connect the Measuring Receiver's CALIBRATE AM/FM OUTPUT to the INPUT. (See Figure 4–2.)

NOTE

For greatest accuracy, allow the Measuring Receiver to warm up for at least one-half hour.

4. On the Measuring Receiver, press CALIBRATE. Allow at least two readings (approximately 40 seconds) to pass. The display should read between 99 and 101%. Record this value for future reference.

FM Calibration Factor; 40 kHz Modulation Range: 99 _____ 101%

5. On the Measuring Receiver, key in 2.3 SPCL to set the modulation range to 400 kHz. Allow at least two readings to pass. The display should read between 99 and 101%.

FM Calibration Factor; 400 kHz Modulation Range: 99 _____ 101%

6. On the AM/FM test source, set the test mode to FM. Connect its FM÷4 output to the Measuring Receiver's INPUT. (See Figure 4–2.)
7. Set the audio analyzer's oscillator to 10 kHz at 1V. Connect its output to the audio input of the AM/FM test source. (See Figure 4–2.)

NOTE

For this test, if the audio analyzer has floating input and output connectors, the low connector should be grounded. Connections should be made to the high input or high output connector.

8. On the Measuring Receiver, press FREQ and TRACK MODE. Tune the AM/FM test source's carrier frequency to approximately 100 MHz. Press TRACK MODE again to turn it off.
9. On the Measuring Receiver, press FM. Set LP FILTER to 15 kHz and DETECTOR to AVG. Key in 2.0 SPCL to set the modulation range to automatic.
10. Adjust the audio analyzer's oscillator level for a Measuring Receiver display of 20 kHz average deviation. On the Measuring Receiver, set RATIO on (with LOG/LIN set for a linear display).
11. Connect the FM÷32 output of the AM/FM test source to the Measuring Receiver's INPUT without disturbing the AM/FM test source's controls. (See Figure 4–2.) Multiply the displayed ratio on the Measuring Receiver by the calibration factor of step 4. (For example, if the display reads 12.52% REL and the calibration factor of step 4 is 100.4%, the result is 12.52 × 100.4 = 12.57% REL.) The result should be between 12.35 and 12.65% REL.

FM Accuracy; 4 kHz Modulation Range: 12.35 _____ 12.65% REL

FM Distortion, Accuracy, and Rejection—1.5 MHz IF

12. Connect the FM÷4 output of the AM/FM test source to the Measuring Receiver's INPUT. (See Figure 4–2.)
13. On the Measuring Receiver, set all LP FILTERs to off, DETECTOR to PEAK+, and RATIO off.
14. Set the audio analyzer's oscillator frequency to 100 kHz. Set the level for a Measuring Receiver display of 100 kHz peak deviation.
15. Connect the audio analyzer's input to the Measuring Receiver's MODULATION OUTPUT/AUDIO INPUT. (See Figure 4–2.) Set the audio analyzer to measure the distortion on the 100 kHz signal at the MODULATION OUTPUT/AUDIO INPUT (all audio analyzer filters should be off). The distortion should be 0.1% or less (−60 dB or less).

FM Distortion at 100 kHz Rate; 100 kHz Peak Deviation: _____ 0.1%

16. Set the audio synthesizer to 10 kHz at +5 dBm. Connect its output to the audio input of the AM/FM test source. (See Figure 4–2.) Fine adjust the level for a Measuring Receiver display of 100 kHz times the calibration factor of step 5. (For example, if the calibration factor of step 5 is 100.4%, set the level for a display of 100.4 kHz.)

NOTE

Flatness of the audio synthesizer is critical for this test. If the audio synthesizer has leveling capability, switch it on.

17. Set the audio synthesizer to the frequencies in the following table. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (Hz)	FM Limits (kHz)		
	Lower	Actual	Upper
50 000	98.9	_____	101.1
100 000	94.9	_____	105.1
50	98.9	_____	101.1
20	94.9	_____	105.1

18. On the Measuring Receiver, set HP FILTER to 50 Hz and LP FILTER to 3 kHz.
19. Set the audio synthesizer frequency to 1 kHz. Set the level for a Measuring Receiver display of 50 kHz peak deviation.
20. On the Measuring Receiver, press AM. Momentarily disconnect the audio input to the AM/FM test source and note the residual AM displayed on the Measuring Receiver.

Residual AM: _____ %

21. Reconnect the audio input of the AM/FM test source. Note the AM displayed on the Measuring Receiver. The displayed AM minus one-half the residual AM noted in step 20 should be 0.2% or less.

FM Rejection at 1 kHz Rate; 50 kHz Peak Deviation: _____ 0.2%

FM Distortion, Accuracy, and Rejection—455 kHz IF

22. Connect the FM÷32 output of the AM/FM test source to the Measuring Receiver's INPUT. (See Figure 4–2.)
23. On the Measuring Receiver, key in 3.1 SPCL to set the IF to 455 kHz. Press FM.
24. Set the audio synthesizer level for a Measuring Receiver display of 5 kHz peak deviation.
25. On the Measuring Receiver, press AM. Momentarily disconnect the audio input to the AM/FM test source and note the residual AM displayed on the Measuring Receiver.

Residual AM: _____ %

26. Reconnect the audio input of the AM/FM test source. Note the AM displayed on the Measuring Receiver. The displayed AM minus one-half the residual AM noted in step 25 should be 0.2% or less.

FM Rejection at 1 kHz Rate; 5 kHz Peak Deviation: _____ 0.2%

27. On the Measuring Receiver, press FM. Set all HP FILTERs to off and LP FILTER to >20 kHz.

28. Set the audio synthesizer level for a Measuring Receiver display of 10 kHz peak deviation times the calibration factor of step 4. (For example, if the calibration factor of step 4 is 100.4%, set the level for a display of 10.04 kHz.)

29. Set the audio synthesizer to the frequencies shown in the following table. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (Hz)	FM Limits (kHz)		
	Lower	Actual	Upper
10 000	9.79	_____	10.21
20	9.79	_____	10.21

30. Set the audio analyzer's oscillator to 10 kHz at 4V. Connect its output to the audio input of the AM/FM test source. (See Figure 4–2.) Fine adjust the oscillator level for a Measuring Receiver display of 10 kHz peak deviation.

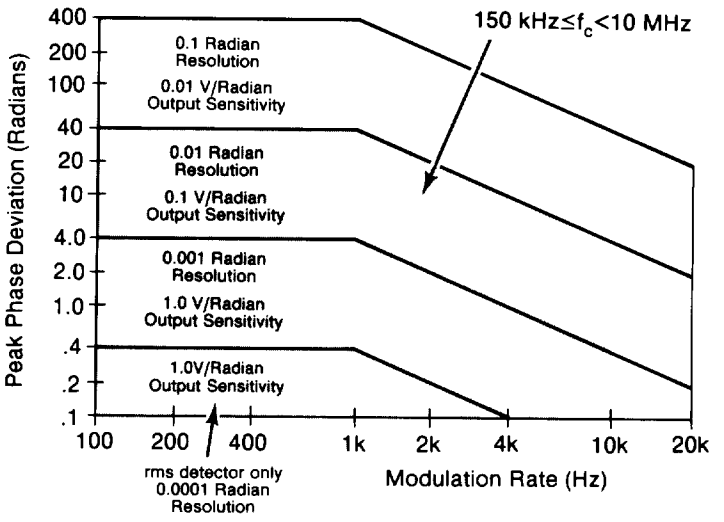
31. Set the audio analyzer to measure the distortion on the 10 kHz signal at the MODULATION OUTPUT/AUDIO INPUT of the Measuring Receiver. Set the distortion analyzer's low-pass filter to 30 kHz and the high-pass filter to 400 Hz. The distortion should be less than 0.1% (−60 dB or less).

FM Distortion at 10 kHz; 10 kHz Peak Deviation: _____ 0.1%

Performance Test 3—ΦM

Specification

Characteristic	Performance Limits	Conditions
PHASE MODULATION		
Rates	200 Hz to 10 kHz 200 Hz to 20 kHz	150 kHz to 10 MHz carrier 10 to 1300 MHz carrier
Accuracy(1,2)	±4% of reading ±1 digit ±3% of reading ±1 digit	150 kHz to 10 MHz carrier 10 to 1300 MHz carrier
Demodulated Output Distortion	<0.1% THD	



Phase Modulation Deviation and Maximum Resolution

(1) Peak residuals must be accounted for in peak readings. (Refer to *Residual Noise Effects* in *Detailed Operating Instructions* in Section 3.)

(2) For rms detector, add ±3% of reading.

Description

A signal with a known amount of phase modulation is generated by frequency modulating a carrier at a known peak deviation (as measured by the previously-calibrated Measuring Receiver) and rate. The relationship between the peak phase deviation and peak frequency deviation is:

$$\text{peak phase deviation} = \frac{\text{peak frequency deviation}}{\text{modulation rate}}.$$

The measured deviation is compared with the calculated deviation for several combinations of FM deviation and rate. The distortion is also measured. A special AM/FM test source is required for these tests to assure that the FM source has adequate bandwidth, low-distortion, and low residual FM.

EQUIPMENT

AM/FM Test Source ..... HP 11715A
Audio Analyzer ..... HP 8903B
Audio Synthesizer ..... HP 3336C

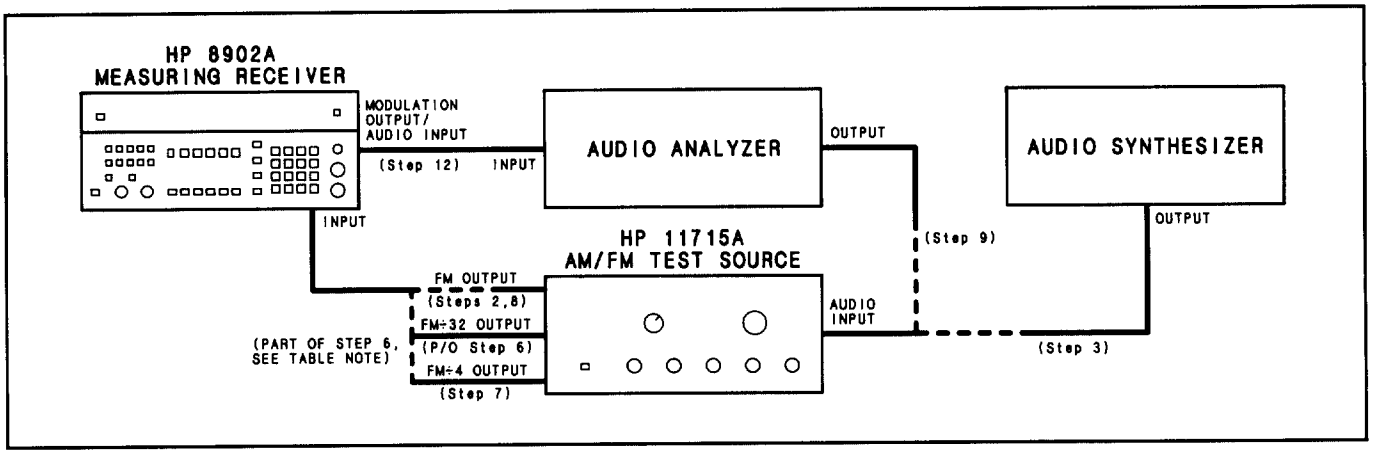


Figure 4–3. *ΦM Performance Test Setup*

NOTE

In the following procedure the RF modulation source can be connected either to a sensor module (which is connected to the Measuring Receiver) or directly to the Measuring Receiver's INPUT connector. The procedure is written for the latter case.

PROCEDURE

ΦM Accuracy

1. Perform *Performance Test 2—FM.*
2. On the AM/FM test source, set the test mode to FM. Connect its FM output to the Measuring Receiver's INPUT. (See Figure 4-3.)
3. Set the audio synthesizer to 200 Hz at −10 dBm. Connect its output to the audio input of the AM/FM test source. (See Figure 4-3.)
4. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press FREQ and TRACK MODE. Tune the AM/FM test source's carrier frequency to approximately 400 MHz. Press TRACK MODE again to turn it off.
5. On the Measuring Receiver, set the controls as follows:

MEASUREMENT ..... FM
LP FILTER ..... >20 kHz
DETECTOR ..... AVG

6. Set the audio synthesizer frequency as shown in the following table. Set the Measuring Receiver High Pass Filter as shown in the table. Set the audio synthesizer level to give the FM deviation shown in the table (as read on the Measuring Receiver). After setting each FM deviation, press ΦM. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (Hz)	High Pass Filter	Average FM Deviation (kHz)	ΦM Limits (rad)		
			Lower	Actual	Upper
200	50	50	242.4	_____	257.6
1 000	200	250	242.4	_____	257.6
20 000	300	250	12.0	_____	13.0
20 000	300	4*	0.193	_____	0.207

* Connect the FM÷32 output of the AM/FM test source to the Measuring Receiver's INPUT to make this measurement. (See Figure 4-3.) Press AUTOMATIC OPERATION, then MHz to retune the Measuring Receiver. If the resolution is not 0.001 rad, press ΦM again.

7. On the Measuring Receiver, key in 3.1 SPCL to set the IF to 455 kHz. Press FM. On the AM/FM test source, connect the FM÷4 output. (See Figure 4-3.) Set the audio synthesizer frequency as shown in the following table. Set the Measuring Receiver High Pass Filter as shown in the table. Set the audio synthesizer level to give the FM deviation shown in the table. After setting each FM deviation, press ΦM. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (Hz)	High Pass Filter	Average FM Deviation (kHz)	ΦM Limits (rad)		
			Lower	Actual	Upper
10 000	300	25	2.39	_____	2.61
10 000	300	2.5	0.239	_____	0.261
1 000	300	25	24.0	_____	26.0
200	50	5	24.0	_____	26.0

ΦM Distortion

8. Connect the FM output of the AM/FM test source to the Measuring Receiver's INPUT. (See Figure 4-3.) Press AUTOMATIC OPERATION on the Measuring Receiver.
9. Set the audio analyzer's oscillator to 1 kHz. Connect its output to the audio input of the AM/FM test source. (See Figure 4-3.)

NOTE

For this test, if the audio analyzer has floating input and output connectors, the low connector should be grounded. Connections should be made to the high input or high output connector.

10. On the Measuring Receiver, press ΦM. Set DETECTOR to PEAK+. Set HP FILTER to 300 Hz. Set LP FILTER to 15 kHz.
11. Adjust the audio analyzer's oscillator level to give a display of 400 rad peak deviation.

12. Connect the audio analyzer's input to the Measuring Receiver's MODULATION OUTPUT/AUDIO INPUT. (See Figure 4–3.) Set the audio analyzer to measure the distortion on the 1 kHz signal at the MODULATION OUTPUT/AUDIO INPUT. Set the high-pass filter on the audio analyzer to 400 Hz. The distortion should be 0.1% (–60 dB) or less.

ΦM Distortion at 1 kHz Rate; 400 rad Peak Deviation; 1.5 MHz IF: _____ 0.1%

13. Reduce the audio analyzer's oscillator level to give a display of 40 rad peak deviation.

14. On the Measuring Receiver, key in 3.1 SPCL. The distortion measured on the audio analyzer should be 0.1% or less.

ΦM Distortion at 1 kHz Rate; 40 rad Peak Deviation; 455 kHz IF: _____ 0.1%

Performance Test 4—Audio Filters

Specification

Characteristic	Performance Limits	Conditions
AUDIO FILTERS		
50 Hz High-Pass (2 Pole)		
3 dB Cutoff Frequency	50 Hz nominal	
Flatness	<1%	>200 Hz rates
300 Hz High-Pass (2 Pole)		
3 dB Cutoff Frequency	300 Hz nominal	
Flatness	<1%	>1 kHz rates
3 kHz Low-Pass (5 Pole)		
3 dB Cutoff Frequency	3 kHz nominal	
Flatness	<1%	<1 kHz rates
15 kHz Low-Pass (5 Pole)		
3 dB Cutoff Frequency	15 kHz nominal	
Flatness	<1%	<10 kHz rates
>20 kHz Low-Pass (9 Pole Bessel)[1]		
Flatness	< 1%	<10 kHz rates

[1] The >20 kHz low-pass filter is intended for minimum overshoot squarewave modulation.

Description

A signal is frequency modulated by a source which is known to have FM which is flat with rate. The flatness of the demodulated signal is then measured for various modulation filters.

NOTE

Flatness of the audio synthesizer is critical for this test. If the audio synthesizer has leveling capability, switch it on.

Equipment

AM/FM Test Source ..... HP 11715A
Audio Synthesizer ..... HP 3336C

Procedure

NOTE

In the following procedure the RF modulation source can be connected either to a sensor module (which is connected to the Measuring Receiver) or directly to the Measuring Receiver's INPUT connector. The procedure is written for the latter case.

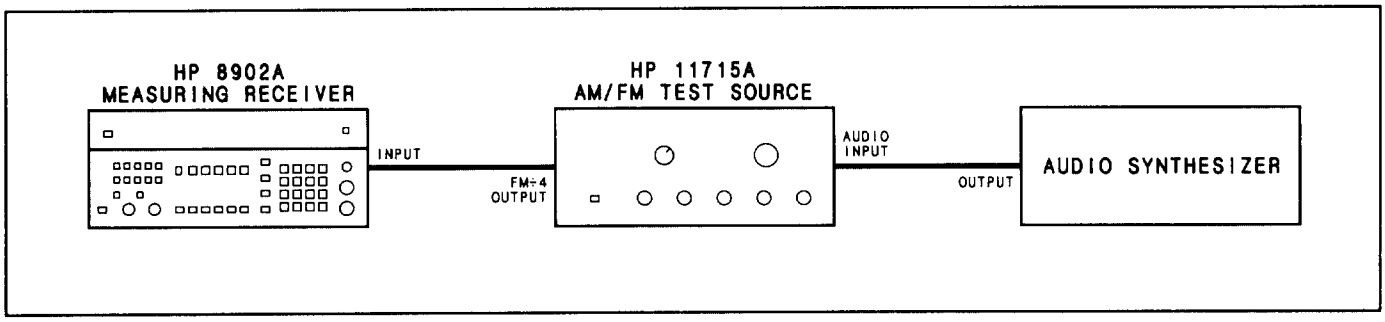


Figure 4–4. *Audio Filters Performance Test Setup*

1. Connect the equipment as shown in Figure 4–4.
2. On the AM/FM test source, set the test mode to FM.
3. Set the audio synthesizer to 200 Hz at +6 dBm.
4. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press FREQ and TRACK MODE. Tune the AM/FM test source's carrier frequency to approximately 100 MHz. Press TRACK MODE again to turn it off.
5. On the Measuring Receiver, press MHz to center the instrument's tuning. Set the other controls as follows:

   MEASUREMENT ..... FM
   DETECTOR ..... AVG

6. Set the audio synthesizer level to give a display of approximately 25 kHz average deviation.
7. Set the audio synthesizer frequency to the frequencies shown in the following table. For each setting, set RATIO on the Measuring Receiver to off, set all HP or LP FILTERs to off, then set RATIO to on (with LOG/LIN set for a linear display), and insert the filter indicated. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (Hz)	Filter	Ratio Limits (% REL)		
		Lower	Actual	Upper
200	50 Hz HP FILTER	98.99	_____	101.01
2 000	50 Hz HP FILTER	98.99	_____	101.01
1 000	300 Hz HP FILTER	98.99	_____	101.01
10 000	300 Hz HP FILTER	98.99	_____	101.01
1 000	3 kHz LP FILTER	98.99	_____	101.01
100	3 kHz LP FILTER	98.99	_____	101.01
10 000	15 kHz LP FILTER	98.99	_____	101.01
1 000	15 kHz LP FILTER	98.99	_____	101.01
10 000	>20 kHz LP FILTER	98.99	_____	101.01
1 000	>20 kHz LP FILTER	98.99	_____	101.01

Performance Test 5—Audio Measurements

Specification

Characteristic	Performance Limits	Conditions
AUDIO FREQUENCY COUNTER		
Frequency Range	20 Hz to 250 kHz	
Accuracy[1]	reference accuracy ±3 digits	>1 kHz rate; >10% AM, >1.5 kHz FM, or >1.5 rad ΦM; >100 mVrms external
	reference accuracy ±0.02 Hz	<1 kHz rate; >10% AM, >1.5 kHz FM, or >1.5 rad ΦM; >100 mVrms external
	reference accuracy ±0.2 Hz	<3 kHz rate; 1.5 to 10% AM, 0.15 to 1.5 kHz FM, or 0.15 to 1.5 rad ΦM; 3 kHz low-pass filter
AUDIO DISTORTION		
Frequency Range	400 or 1000 Hz ±5%	
Residual Noise and Distortion[1]	<0.3% (−50.4 dB)	20 Hz to 50 kHz bandwidth; <40°C
Accuracy	±1 dB of reading	
Sensitivity	1.5% peak AM 150 Hz peak FM 0.6 rad peak ΦM 0.1 to 3 Vrms	modulation modulation modulation external
AUDIO RMS LEVEL		
Frequency Range	50 Hz to 40 kHz	
Voltage Range	0.1 to 3 Vrms	
Accuracy	±4%	

[1] For demodulated signals, the residual noise generated by the Measuring Receiver must be accounted for in distortion measurements (that is, residual AM, FM, or ΦM).

Description

All audio measurements are made on external audio signals. Level accuracy is measured by comparing the voltage reading on the Measuring Receiver with the output from a more accurately set audio oscillator. Residual distortion and noise is measured by making a distortion measurement on a

low-distortion oscillator. Measurements must be made at several frequencies within the notch filter range to verify proper nulling of the fundamental. Distortion accuracy is measured by summing a low-distortion output from one oscillator with the output of an oscillator which is set to generate a second through fifth harmonic of known magnitude. The audio counter is checked by counting the signal from a audio frequency synthesizer set to both high and low levels.

EQUIPMENT

Audio Analyzer ..... HP 8903B
Audio Synthesizer ..... HP 3336C

PROCEDURE

Audio RMS Accuracy

1. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 30.0 SPCL to set the Measuring Receiver to measure external audio rms level.
2. Set the Audio Analyzer output to 50 Hz at 3 V amplitude. (Key in 10.0 SPCL on the HP 8903B to display the output settings.)
3. Connect the Audio Analyzer High Output to the Measuring Receiver's Modulation Output/Audio Input connector. Set the Audio Analyzer Output Float/GND switch to GND.
4. Set the Audio Analyzer to the frequencies shown in the following table. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Analyzer Frequency (Hz)	Level Limits (Vrms)		
	Lower	Actual	Upper
50	2.88	_____	3.12
500	2.88	_____	3.12
5 000	2.88	_____	3.12
40 000	2.88	_____	3.12

5. Set the Audio Analyzer level to 100 mV. Set the Audio Analyzer to the frequencies shown in the following table. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Analyzer Frequency (Hz)	Level Limits (mVrms)		
	Lower	Actual	Upper
40 000	96	_____	104
5 000	96	_____	104
500	96	_____	104
50	96	_____	104

Audio Counter Range and Sensitivity

6. On the Measuring Receiver, press S (shift) then AUDIO FREQ. Disconnect the Audio Analyzer from the Measuring Receiver's Audio Input. Connect the Audio Synthesizer output to the Measuring Receiver's Audio Input.

7. Set the Audio Analyzer to the frequencies and levels shown in the following table. For each setting, the Measuring Receiver's display should read within the limits indicated in the table.

Audio Synthesizer		Frequency Limits (kHz)		
Frequency (Hz)	Level (dBm)	Lower	Acutal	Upper
20	+8	0.01998	_____	0.02002
20	−13.0	0.01998	_____	0.02002
1 000	−13.0	0.99997	_____	1.00003
1 000	+8	0.99997	_____	1.00003
250 000	+8	249.997	_____	250.003
250 000	−13.0	249.997	_____	250.003

Residual Noise and Distortion

8. Set the audio synthesizer to 380 Hz at −13 dBm (100 mV at the audio input).

9. On the Measuring Receiver, press S (shift) then AUDIO DISTN. Press the blue key then press 400 Hz DISTN (the PEAK- key).

10. Slowly step the audio synthesizer up in frequency to 420 Hz using 2 Hz steps or finer. Note the highest distortion reading displayed on the Measuring Receiver. The highest reading should not exceed 0.3%.

Maximum Residual Distortion; 400 Hz Input at 100 mV: _____ 0.3%

11. Increase the audio synthesizer level to +16.5 dBm. Slowly step the audio synthesizer down in frequency to 380 Hz using 2 Hz steps or finer. Note the highest distortion reading displayed on the Measuring Receiver. The highest reading should not exceed 0.3%.

Maximum Residual Distortion; 400 Hz Input at 3V: _____ 0.3%

12. Set the audio synthesizer frequency to 950 Hz.

13. On the Measuring Receiver, press the blue key then press 1 kHz DISTN (the PEAK+ key).

14. Slowly step the audio synthesizer up in frequency to 1050 Hz using 5 Hz steps or finer. Note the highest distortion reading displayed on the Measuring Receiver. The highest reading should not exceed 0.3%.

Maximum Residual Distortion; 1 kHz Input at 3V: _____ 0.3%

15. Decrease the audio synthesizer level to −13 dBm. Slowly step the audio synthesizer down in frequency to 950 Hz using 5 Hz steps or finer. Note the highest distortion reading displayed on the Measuring Receiver. The highest reading should not exceed 0.3%.

Maximum Residual Distortion; 1 kHz Input at 100 mV: _____ 0.3%

Distortion Accuracy

16. On the audio analyzer, set its output float switch to the float position. Set the audio analyzer's oscillator to 1 kHz at 1V.
17. Set the audio synthesizer to 2 kHz at a level as low as possible without switching the instrument off (but less than −50 dBm). Connect the audio analyzer and audio synthesizer as shown in Figure 4-5. Note that the audio synthesizer is connected to the floating low output of the audio analyzer's output. (This has the effect of summing the two outputs.)

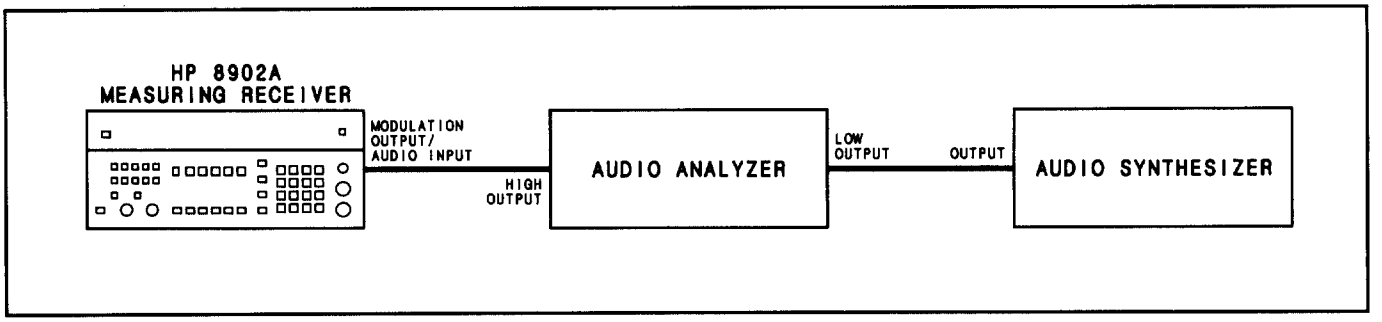


Figure 4-5. *Distortion Accuracy Performance Test Setup*

18. On the Measuring Receiver, key in 30.0 SPCL to set the Measuring Receiver to measure external audio rms level. (Note that the display reads approximately 1V.) Now set RATIO to on.
19. Set the audio analyzer's oscillator level to 0V or a level as low as possible without switching the instrument off (but at most 10 mV).
20. Increase the audio synthesizer's level until the Measuring Receiver's display reads between 99 and 101%.
21. Switch the audio synthesizer's level down exactly 40 dB. Set the audio analyzer's oscillator level back to 1V.
22. On the Measuring Receiver, press S (shift) then AUDIO DISTN.
23. Set the audio synthesizer's frequency as shown in the following table without changing the audio synthesizer's amplitude. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (kHz)	Distortion Limits (%)		
	Lower	Actual	Upper
2	0.89	_____	1.12
3	0.89	_____	1.12
4	0.89	_____	1.12
5	0.89	_____	1.12

24. Set the audio analyzer's oscillator frequency to 400 Hz without changing its level.
25. On the Measuring Receiver, press the blue key then press 400 Hz DISTN.
26. Set the audio synthesizer's frequency as shown in the following table without changing the audio synthesizer's amplitude. For each setting, the Measuring Receiver's display should read between the limits indicated in the table.

Audio Synthesizer Frequency (Hz)	Distortion Limits (%)		
	Lower	Actual	Upper
800	0.89	_____	1.12
1200	0.89	_____	1.12
1600	0.89	_____	1.12
2000	0.89	_____	1.12

Performance Test 6—Power Reference (Using Reference Comparison)

Specification

Characteristic	Performance Limits	Conditions
POWER REFERENCE		
Power Output	1 mW	
Power Output Accuracy	±1.2%	worst case; for 1 year; 0 to 55°C

Description

The power from an external 1 mW power reference is measured with a power sensor and the power meter of the Measuring Receiver. The same power meter and sensor are then used to measure the power from the Measuring Receiver's power reference.

NOTE

Due to accuracy limitations of this test method, the power level can only be verified to within ±1.9%. Greater accuracy can be obtained by using a recently calibrated external power reference or by following the procedure in Performance Test 7—Power Reference Accuracy (Using DC Substitution).

Equipment

Power Reference ..... HP 435A Opt K05
Sensor Module ..... HP 11722A

Procedure

1. Connect the input of the sensor module (or a compatible power sensor connected to the Measuring Receiver's SENSOR input) to the output of the external power reference.
2. On the Measuring Receiver, press RF POWER. Press RATIO and check that LOG/LIN is in the linear mode. (The display should read between 99.9 and 100.1% REL.)
3. Connect the power sensor/input switch to the CALIBRATION RF POWER OUTPUT connector of the Measuring Receiver. The display should read 98.1 and 101.9% REL.

RF Power Reference Accuracy: 98.1 _____ 101.9% REL

Performance Test 7—Power Reference (Using DC Substitution)

SPECIFICATION

Characteristic	Performance Limits	Conditions
POWER REFERENCE		
Power Output	1 mW	
Power Output Accuracy	±1.2%	worst case; for 1 year; 0 to 55°C

DESCRIPTION

The power from the power reference oscillator is measured by a method known as dc substitution. In this method a power-sensing thermistor is placed in one arm of a self-balancing, dc resistance bridge. With no power applied, the dc voltage supplying the top of the bridge is automatically adjusted until the thermistor heats to the temperature that produces the resistance required to bring the bridge into balance. When RF power is applied to the thermistor, the thermistor heats up and momentarily unbalances the bridge. The self-balancing circuits then readjust the supply voltage to the bridge to re-balance it. A second bridge, which senses only the ambient temperature, is employed to compensate for measurement drift. Careful measurement of the bridge dc voltages provides a way to determine the amount of RF power applied to the thermistor to a higher degree of accuracy than can be obtained by direct reading of the power meter.

NOTE

The power level can be measured to an accuracy of ±1.2% by this procedure. A simpler, but less accurate method for measuring the power reference can be found in the preceeding Performance Test 6—Power Reference (Using Reference Comparison).

EQUIPMENT

Digital Voltmeter ..... HP 3455A
Power Meter ..... HP 432A
Thermistor Mount ..... HP 478A Opt H75 *

NOTE

** Must be calibrated at the National Bureau of Standards (NBS) to obtain the accuracy for this test. See Table 1-2 for critical specifications.*

PROCEDURE

1. With the HP 432A Power Meter switched off and the thermistor interconnect cable connected to it but not to the thermistor mount, measure the resistance between the center conductor of the rear-panel VRF connector and pin 1 (the first pin to the right of the key slot) on the thermistor end of the interconnect cable. Record the value of the mount resistance for future reference. (It should be approximately 200Ω.)

Mount Resistance (R): _____ Ω

2. Connect the equipment as shown in Figure 4–6. The input of the digital voltmeter should be floating. The positive input of the voltmeter should be connected to the rear-panel VCOMP connector of the HP 432A Power Meter, the negative input to the VRF connector. Switch the equipment on and let it warm up for at least 30 minutes.

NOTE

From this point on do not handle the HP 478A in order to maintain its thermal stability.

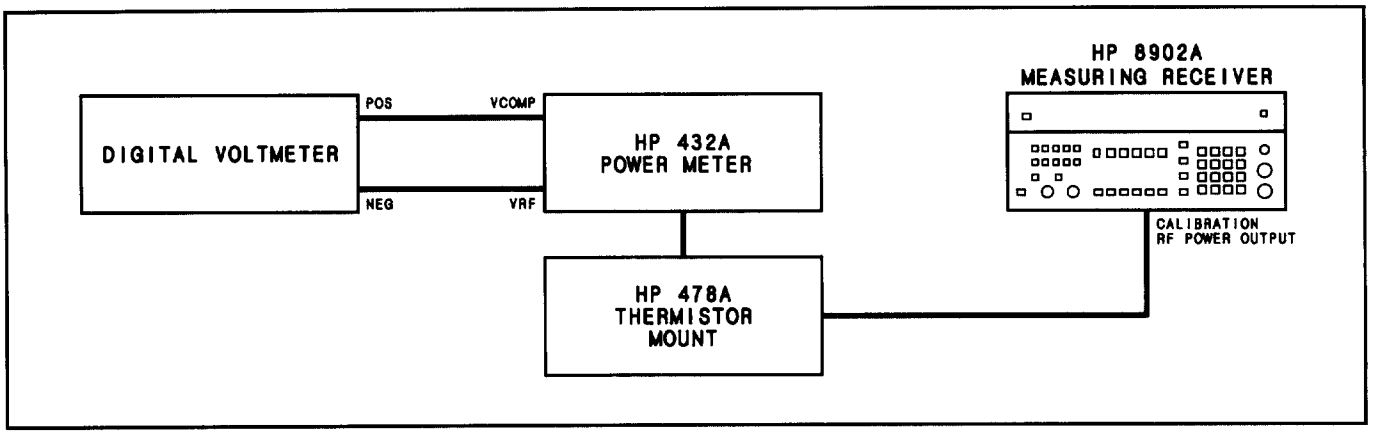


Figure 4–6. *Power Reference Performance Test Setup*

3. On the Measuring Receiver, key in 45.0 SPCL to switch the power reference off.
4. Set the HP 432A Power Meter RANGE to COARSE ZERO and adjust the front-panel COARSE ZERO to obtain a zero meter indication.
5. Fine zero the HP 432A Power Meter on the most sensitive range, then set the RANGE switch to 1 mW (0 dBm).
6. Observe the voltage reading on the voltmeter. If the reading is greater than 400 μV, press and hold the FINE ZERO switch on the HP 432A Power Meter and adjust COARSE ZERO so that the voltmeter reads less than 200 μV then release the FINE ZERO switch. Record the voltmeter reading for future reference.

$V_{COMP} - V_{RF}$ with No Power (V_0): _____ Vdc

NOTE

Steps 6, 7, and 8 should be performed as quickly as possible to minimize drift.

7. On the Measuring Receiver, key in 45.16 SPCL. Record the voltmeter reading.

$V_{COMP} - V_{RF}$ with 1 mW (V_1): _____ Vdc

8. Connect the voltmeter to read V_{COMP} (with respect to chassis ground) on the HP 432A Power Meter. (The voltmeter's negative input should connect to chassis ground.) Record the voltmeter reading.

V_{COMP} with 1 mW: _____ Vdc

9. Compute the power (P in watts) from the equation

$$P = \frac{2V_{COMP}(V_1 - V_0) + V_0^2 - V_1^2}{4RH}$$

where H is the effective efficiency of the thermistor mount at 50 MHz as read from its label and R is the resistance measured in step 1. The computed power should be between 0.988 and 1.012 mW.

RF Power Reference Power: 0.988 _____ 1.012 mW

Performance Test 8—Power Meter

SPECIFICATION

Characteristic	Performance Limits	Conditions
RF POWER		
RF Range Linearity[1]	±0.02 dB ±0.03 dB	RF ranges 2 to 5 RF range 1
RF Range-to-Range Change Error[1]	±0.02 dB/RF range change from reference range	
Zero Set[2]	±0.5% of full scale ±1 count	on lowest range

[1] Using Recorder Output. Using front-panel display, add ±1 count of least-significant digit.
[2] Decrease by a factor of ten for each higher range.

DESCRIPTION

A power meter range calibrator is used to check the range-to-range error, in-range linearity, and zeroing integrity of the power meter circuits. RF power ranging is simulated by a precision voltage divider in the range calibrator.

EQUIPMENT

Range Calibrator ..... HP 11683A

PROCEDURE

Zero Set

1. Connect the power meter output of the range calibrator to the Measuring Receiver's SENSOR input.
2. On the range calibrator, set the function to standby, polarity to normal, and range to 1 mW.
3. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press RF POWER. Press ZERO and wait for the instrument to zero.

NOTE

If Error 15 is displayed, press 100 then the blue key then the % CAL FACTOR key (the MHz key) to enter a dummy calibration factor of 100%.

4. On the Measuring Receiver, key in the special functions indicated in the following table. For each setting the Measuring Receiver's display should read as indicated in the table. (Take the average of several readings. Ignore the RECAL and UNCAL annunciators.)

Serial Prefix 2305A to 2449A

Special Function	Power Reading	
	Actual	Maximum
10.1	_____	0.00 μW ± 0.06
10.2	_____	0.0 μW ± 0.1
10.3	_____	0.000 mW ± 1 count
10.4	_____	0.00 mW ± 1 count
10.5	_____	0.0 mW ± 1 count

Serial Prefix 2451A and above:

Special Function	Power Reading	
	Actual	Maximum
10.1	_____	0.000 μW ± 0.051
10.2	_____	0.00 μW ± 0.06
10.3	_____	0.0 μW ± 0.2
10.4	_____	0.000 mW ± 1 count
10.5	_____	0.00 mW ± 1 count

Range-to-Range Error

5. On the range calibrator, set the function to calibrate.
6. On the Measuring Receiver, key in 10.0 SPCL to set the power meter ranging to automatic. Press CALIBRATE then press the blue key then press SAVE CAL (again, the CALIBRATE key). This normalizes the power reading to 1 mW. (The CALIBRATE key light should be on.)
7. On the Measuring Receiver, key in the Special Functions listed in the following table. For each setting, set the range calibrator to the range indicated in the table. The reading on the Measuring Receiver should be within the limits shown.

Special Function	Range Calibrator Range	Power Reading Limits		
		Lower	Actual	Upper
10.1	10 μW	9.90 μW	_____	10.10 μW
10.2	100 μW	99.4 μW	_____	100.6 μW
10.4	10 mW	9.94 mW	_____	10.06 mW
10.5	100 mW	99.0 mW	_____	101.0 mW

Accuracy within a Range

8. Set the range calibrator's range to 1 mW.
9. On the Measuring Receiver, key in 10.3 SPCL. Set the range calibrator's range to 100 μW. The Measuring Receiver's display should read between 0.099 and 0.101 mW (0.100 mW ±0.5% ±1 digit, then rounded to the nearest 0.001 mW).

Accuracy within a Range: 0.099 _____ 0.101 mW

Performance Test 9—SWR

Specification

Characteristic	Performance Limits	Conditions
RF POWER		
Input SWR	<1.15	using HP 11722A Sensor Module
TUNED RF LEVEL		
Input SWR	<1.18	at RF input; RF range 1 and 2
	<1.40	at RF input; RF range 3
	<1.33	at HP 11722A input; RF range 1 and 2
	<1.50	at HP 11722A input; RF range 3
	<1.33	at HP 11722A input; RF range 3 with Special Function 1.9 (10 dB RF and RF amplifier inserted)

Description

Input SWR is determined by measuring return loss. Measurements are made directly at the Measuring Receiver's input connector and (if available) at the input of a power sensor or sensor module connected to the Measuring Receiver. In either case, the input under test is driven by a signal generator through an SWR bridge. The reflected power is measured by a spectrum analyzer. A reference line is first established by disconnecting the output of the SWR bridge to create a high-reflection, open circuit. Since SWR for the tuned RF level measurement mode is specified only for input levels below 0 dBm, a spectrum analyzer is required to detect the much lower level of the reflected signal.

Equipment

Attenuator, 6 dB ..... HP 8491A Option 006
RF Spectrum Analyzer ..... HP 8559A/182T
Sensor Module ..... HP 11722A
Signal Generator ..... HP 8640B Option 002
SWR Bridge ..... Wiltron 60NF50

NOTE

The log display accuracy of the spectrum analyzer may be inadequate for this test. If any data points in the following procedure appear to be near or out of limits, check the amplitude calibration of the spectrum analyzer as described in its manual and use the data obtained there to correct the results in this procedure.

If a tracking generator that is compatible with the RF spectrum analyzer is substituted for the signal generator, a swept measurement can be made.

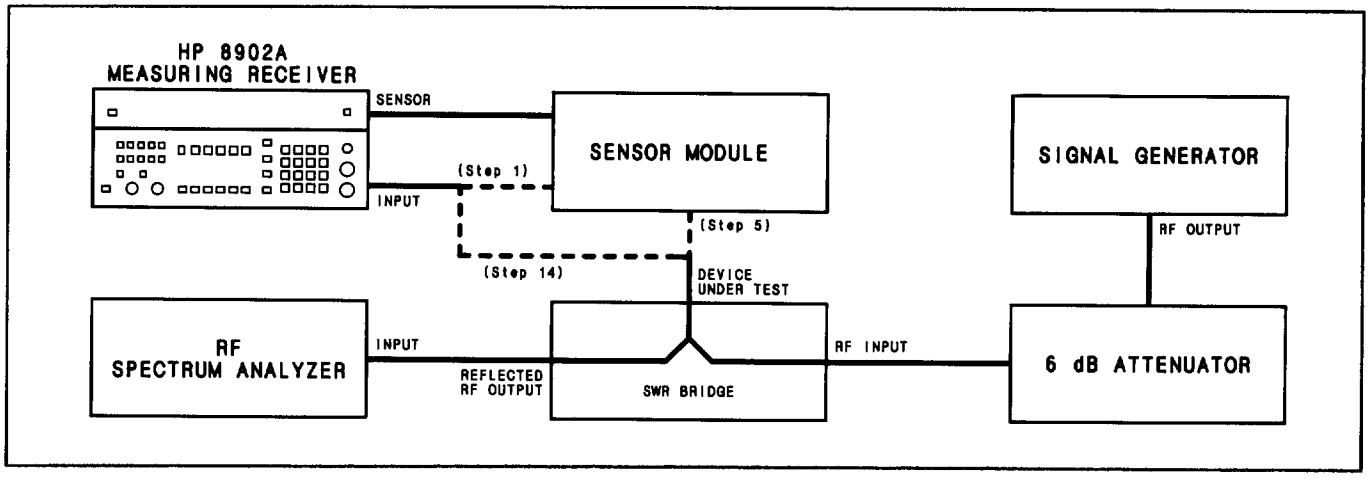


Figure 4–7. SWR Performance Test Setup

PROCEDURE

Sensor Module's Power Sensor SWR

NOTE

If a sensor module is not available, perform steps 1 through 4 except set the signal generator to –27 dBm. On the Measuring Receiver, press FREQ and key in 1.0 MHz. Then continue on at step 14.

1. Connect the equipment as shown in Figure 4–7. Connect the 6 dB attenuator directly to the RF input of the SWR bridge. Do not connect anything to the device-under-test input of the SWR bridge at this time.
2. Set the signal generator level to +3 dBm CW.
3. Set the spectrum analyzer to sweep 0 to 1 GHz. Set the display for 10 dB per vertical division.
4. With the sensor module disconnected from the SWR bridge, tune the signal generator from 0.1 to 1300 MHz and note the level of the signal. Adjust the spectrum analyzer's reference level, as needed, to set the average level of the signal to a convenient graticule reference. Resweep the signal generator and note the reference on the display.

NOTE

If the signal generator or spectrum analyzer is incapable of complete coverage of the frequency range, use whatever range is available. If the spectrum analyzer has variable persistence or storage capability, use it to store the reference line.

5. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press RF POWER. Connect the sensor module to the SWR bridge. (See Figure 4–7.)

6. Resweep the signal generator and observe the level of the signal on the spectrum analyzer. At all frequencies between 2.5 and 1300 MHz the signal should be 23 dB below the reference signal. (Repeat the above steps and adjust the spectrum analyzer sweep, as required, to gather data for the highest and lowest frequencies.)

Worst Case Return Loss for RF Power Measurement: _____ −23 dB

Sensor Module's Thru-Path SWR

7. On the Measuring Receiver, press FREQ. Key in 1.6 SPCL and 1.0 MHz to set the input attenuation to 50 dB (range 1) and manual tune the instrument.

NOTE

In the steps that follow, ignore error messages in the Measuring Receiver's display. The messages indicate that the instrument is not tuned to the input signal. Also ignore any spurious signals on the spectrum analyzer display. The signals originate with the Measuring Receiver's local oscillator.

8. If necessary, re-establish the reference on the spectrum analyzer (with the sensor module disconnected from the SWR bridge). Then with the sensor module connected to the SWR bridge, resweep the signal generator. At all frequencies between 2.5 and 1300 MHz, the signal should be 17 dB below the reference signal.

Worst Case Return Loss for Tuned RF Level Measurement;
External Sensor Module; Range 1: _____ −17 dB

9. On the Measuring Receiver, key in 1.2 SPCL to set the input attenuation to 10 dB (range 2). Repeat step 8.

Worst Case Return Loss for Tuned RF Level Measurement;
External Sensor Module; Range 2: _____ −17 dB

10. Set the signal generator level to −27 dBm.

11. With the sensor module disconnected from the SWR bridge, sweep the signal generator as before and establish a convenient reference on the spectrum analyzer's display.

12. Reconnect the sensor module to the SWR bridge. On the Measuring Receiver, key in 1.7 SPCL to set the input gain to 24 dB. Resweep the signal generator. At all frequencies between 2.5 and 1300 MHz, the signal should be 14 dB below the reference signal.

Worst Case Return Loss for Tuned RF Level Measurement;
External Sensor Module; Range 3: _____ −14 dB

13. On the Measuring Receiver, key in 1.8 SPCL to set the input gain to 14 dB. Resweep the signal generator. At all frequencies between 2.5 and 1300 MHz, the signal should be 17 dB below the reference signal.

Worst Case Return Loss for Tuned RF Level Measurement;
External Sensor; 14 dB Gain Range: _____ −17 dB

Measuring Receiver Input SWR

14. Disconnect the sensor module from the SWR bridge and the Measuring Receiver's input. Connect the SWR bridge's RF input directly to the Measuring Receiver's INPUT connector. (See Figure 4–7.)

15. On the Measuring Receiver, key in 1.7 SPCL. Resweep the signal generator. At all frequencies between 2.5 and 1300 MHz, the signal should be 16 dB below the reference signal.

Worst Case Return Loss for Tuned RF Level Measurement;
Measuring Receiver Input; Range 3: _____ −16 dB

16. Set the signal generator level to +3 dBm.

17. Remove the SWR bridge from the Measuring Receiver's input. Sweep the signal generator as before and establish a convenient reference on the spectrum analyzer's display.

18. Reconnect the SWR bridge to the Measuring Receiver's INPUT connector. On the Measuring Receiver, key in 1.2 SPCL. Resweep the signal generator. At all frequencies between 2.5 and 1300 MHz, the signal should be 22 dB below the reference signal.

Worst Case Return Loss for Tuned RF Level Measurement;
Measuring Receiver Input; Range 2: _____ −22 dB

19. On the Measuring Receiver, key in 1.6 SPCL. Repeat step 18.

Worst Case Return Loss for Tuned RF Level Measurement;
Measuring Receiver Input; Range 1: _____ −22 dB

Performance Test 10—Tuned RF Level (Using a Step Attenuator)

Specification

Characteristic	Performance Limits	Conditions
TUNED RF LEVEL		
Frequency Range	2.5 to 1300 MHz	
Power Range	0 to −127 dBm 0 to −100 dBm	using IF synchronous detector using IF average detector
Relative Measurement Accuracy(1)	detector linearity + IF range-to-range error + RF range-to-range error + frequency drift error + noise error ±1 digit	
Detector Linearity	±0.02 dB ±0.04 dB	IF synchronous detector IF average detector
IF Range-to-Range Error(2)	±0.02 dB/IF range change ±0.05 dB/IF range change	IF ranges 1 to 5 IF range 6 to 7
RF Range-to-Range Error	±0.04 dB/RF range change ±0.06 dB/RF range change	tuned RF level RF power to tuned RF level
Frequency Drift Error	±0.05 dB/kHz frequency drift from center of IF	
Noise Error(3)	±0.18 dB	

(1) Accuracy is specified only at constant temperature and after RF range calibration is completed. Accuracy is affected by the residual FM of the source under test. If the peak residual FM deviation is greater than 50 Hz, measured over a 30s period in a 3 kHz bandwidth, tuned RF level measurements should be made using the IF average detector (30 kHz bandwidth) by using Special Function 4.4.

(2) IF ranges 6 and 7 are used in automatic operation only for tuned RF level measurements below approximately −110 dBm for the IF synchronous detector, and below approximately −85 dBm for the IF average detector.

(3) Using the IF synchronous detector and for levels ¡−120 dBm, or for levels ¡−110 dBm if Special Function 1.9 is implemented.

Description

This test checks the relative accuracy of the tuned RF level measurement mode for both the IF synchronous and IF average detectors. The linearity of the detectors (including the linearity of the internal dc voltmeter) is checked first. Linearity is measured by feeding a 50 MHz signal through a calibrated step attenuator into the Measuring Receiver. The instruments are set to produce a signal that is near the upper measurement limit of the detector, a level reference is set, and the range settings held. The attenuation is then increased by 10 dB and the drop in displayed level is compared against the increase in attenuation.

IF gain step accuracy is measured by setting the instruments to produce a signal level that is in the overlap region of adjacent IF gain steps. The change in the displayed level for each gain change (after correcting for the detector linearity error) is the IF gain step error.

Frequency drift error is measured for each detector by noting the change in level as the signal frequency is fine tuned slightly.

NOTE

The output level accuracy of the signal generator is of secondary importance. The test may be performed at other frequencies where the step attenuator or a piston attenuator is accurately calibrated.

An alternate procedure which uses a piston attenuator over a wide attenuation range is found in Performance Test 11—Tuned RF Level (Using a Piston Attenuator).

Equipment

Attenuator, Step 10 dB ..... HP 355D Option J25
Signal Generator ..... HP 8640B

Procedure

NOTE

In the following procedure the signal generator can be connected either to a sensor module (which is connected to the Measuring Receiver) or directly to the Measuring Receiver's INPUT connector. The procedure is written for the latter case.

Ignore the UNCAL and RECAL annunciators and error messages as they appear in the display.

Detector Linearity

1. Set the signal generator to 50 MHz CW at +3 dBm. Allow the equipment to warm up at least one-half hour.
2. Set the 10 dB step attenuator to 10 dB and connect it directly to the Measuring Receiver's INPUT connector. Connect the signal generator's output to the attenuator.
3. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Allow the Measuring Receiver to find the input signal and measure its frequency, then press the MHz key.
4. Set the signal generator level to −7 dBm.
5. On the Measuring Receiver, key in the following:
   a. Key in S (shift) TUNED RF LEVEL.
   b. Key in 4.6 SPCL to select the IF average detector with a measurement averaging time of 1s.
   c. Key in 1.2 SPCL to set the input attenuation to 10 dB.
   d. Key in 9.2 SPCL to set the IF gain to 10 dB.
   e. Key in 49. S (Shift) 1 SPCL to display the voltage into the IF Average Detector. (Pressing S and 1 will cause "b" to appear in the display.) Adjust the signal generator level for a reading of approximately 3.0 (3 Vdc).
   f. Press CLEAR.

g. Press the blue key then press SET REF (the ZERO key) to enter the tuned RF attenuator measurement mode. (The display should read, on the average, between 99.99 and 100.01%. If it does not, press the blue key and SET REF again.)

6. Set the step attenuator to 20 dB. Divide the result in the Measuring Receiver's display (expressed as a ratio rather than percent or dB) by the attenuator's calibration factor for the 10 to 20 dB steps where the factor is expressed as a ratio (rather than dB). The computed result should be between 0.9931 and 1.0069 (±0.04 dB).
   For example, if the attenuator's calibration for the 10 dB step is −9.990 dB and for the 20 dB step is −20.015 dB, the difference is −10.025 dB. To express the dB difference as a ratio, compute $10^{(-10.025/20)} = 0.3153$. If the display reads 31.48% (that is, a ratio of 0.3148), the computed result is 0.3148/0.3153 = 0.9984.

IF Average Detector Linearity: 0.9954 _____ 1.0046

7. Set the attenuator back to 10 dB. Set the signal generator's level to −33 dBm.
8. On the Measuring Receiver, key in the following:
   a. Key in 4.2 SPCL to select the IF synchronous detector with a measurement averaging time of 1s.
   b. Key in 50.6 SPCL to display the voltage into the IF Synchronous Detector. If necessary, fine adjust the signal generator level for a reading of approximately 3.0 (3 Vdc).
   c. Press CLEAR.
   d. Press the blue key and SET REF. (The display should read, on the average, between 99.99 and 100.01%. If it does not, press the blue key and SET REF again.)
9. Set the step attenuator to 20 dB. Divide the result in the Measuring Receiver's display by the attenuator's calibration factor for the 10 to 20 dB steps (as was done in step 6). Record the computed result for future reference. The computed result should be between 0.9977 and 1.0023 (±0.02 dB).

IF Synchronous Detector Linearity: 0.9977 _____ 1.0023

IF Range-to-Range Accuracy

10. Set the step attenuator back to 10 dB.
11. On the Measuring Receiver, key in 9.1 SPCL to set the IF gain to 0 dB.
12. On the step attenuator, step up the attenuation in 10 dB steps as indicated in the following table. For each attenuator setting perform the following:
    a. Press the blue key then SET REF to establish a level reference.
    b. Key in the Special Function listed in the table.
    c. Note the average value of several readings and record the result in the table.
    d. Multiply the result recorded in step c by the result of step 9 and record the computed result for future reference. The computed result should be within the limits indicated in the table.

#	Attenuation of Step Attenuator (dB)	Special Function	Displayed Result (%)	Limits of Computed Result (%)		
				Lower	Actual	Upper
1	10	9.2	_____	99.77	_____	100.23
2	20	9.3	_____	99.77	_____	100.23
3	30	9.4	_____	99.77	_____	100.23
4	40	9.5*	_____	99.77	_____	100.23
5	50	9.6	_____	99.43	_____	100.58
6	60	9.7	_____	99.43	_____	100.58
* Key in 4.1 SPCL at this point.						

Frequency Drift Error

13. Set the step attenuator to 10 dB.
14. On the Measuring Receiver, key in 4.2 SPCL. Key in 9.2 SPCL. Press the blue shift key and the SET REF key. Fine tune the signal generator slowly up and down over a 10 kHz range, or until Error 01 appears, stopping at frequent intervals to note the display. Note the maximum and minimum value on the Measuring Receiver's display. The difference between the maximum and minimum values should be less than 12.20

IF Synchronous Detector Frequency Drift Error: _____ 12.2%

Performance Test 11—Tuned RF Level (Using a Piston Attenuator)

Specification

Characteristic	Performance Limits	Conditions
TUNED RF LEVEL		
Frequency Range	2.5 to 1300 MHz	
Power Range	0 to −127 dBm 0 to −100 dBm	using IF synchronous detector using IF average detector
Relative Measurement Accuracy(1)	detector linearity + IF range-to-range error + RF range-to-range error + frequency drift error + noise error ±1 digit	
Detector Linearity	±0.02 dB ±0.04 dB	IF synchronous detector IF average detector
IF Range-to-Range Error(2)	±0.02 dB/IF range change ±0.05 dB/IF range change	IF ranges 1 to 5 IF range 6 to 7
RF Range-to-Range Error	±0.04 dB/RF range change ±0.06 dB/RF range change	tuned RF level RF power to tuned RF level
Frequency Drift Error	±0.05 dB/kHz frequency drift from center of IF	
Noise Error(3)	±0.18 dB	

(1) Accuracy is specified only at constant temperature and after RF range calibration is completed. Accuracy is affected by the residual FM of the source under test. If the peak residual FM deviation is greater than 50 Hz, measured over a 30s period in a 3 kHz bandwidth, tuned RF level measurements should be made using the IF average detector (30 kHz bandwidth) by using Special Function 4.4.

(2) IF ranges 6 and 7 are used in automatic operation only for tuned RF level measurements below approximately −110 dBm for the IF synchronous detector, and below approximately −85 dBm for the IF average detector.

(3) Using the IF synchronous detector and for levels ¡−120 dBm, or for levels ¡−110 dBm if Special Function 1.9 is implemented.

Description

This test checks the relative accuracy of the tuned RF level measurement mode for both the IF synchronous and IF average detectors. The linearity of the detectors (including the linearity of the internal dc voltmeter) is checked first. Linearity is measured by feeding a 30 MHz signal through a calibrated piston attenuator into the Measuring Receiver. The instruments are set to produce a signal that is near the upper measurement limit of the detector, a level reference is set, and the range settings held. The attenuation is then increased by 10 dB and the drop in displayed level is compared against the increase in attenuation.

IF gain step accuracy is measured by increasing the attenuation of the piston attenuator in 10 dB steps and comparing the displayed reading with the increase in attenuation.

Frequency drift error is measured for each detector by noting the change in level as the signal frequency is fine tuned slightly.

NOTE

The output level accuracy of the signal generator is of secondary importance. The test may be performed at other frequencies where the piston attenuator is accurately calibrated.

An alternate procedure which uses a calibrated 10 dB step attenuator in place of the piston attenuator is found in Performance Test 10—Tuned RF Level (Using a Step Attenuator).

Equipment

Attenuator, 3 dB (2 required) ..... HP 8491A Option 03
Attenuator, Piston ..... Eaton Type 32
Signal Generator ..... HP 8640B

Procedure

NOTE

In the following procedure an external sensor module is not used. If a sensor module is connected to the Measuring Receiver, disconnect it. Use short interconnect cables to prevent leakage from the input of the attenuator to the input of the Measuring Receiver. Triple-shielded coaxial cable is recommended.

Detector Linearity

1. Set the signal generator to 30 MHz CW at +10 dBm. Allow the equipment to warm up at least one-half hour.
2. Set the piston attenuator to 10 dB. Connect one fixed 3 dB attenuator directly to the piston attenuator's input and connect the other end of the 3 dB attenuator through a short, well-shielded cable to the signal generator's output connector.
3. Connect the other fixed 3 dB attenuator directly to the piston attenuator's output and connect the other end of the 3 dB attenuator to the Measuring Receiver's INPUT.
4. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Allow the Measuring Receiver to find the input signal and measure its frequency, then press MHz.

NOTE

In the following steps, ignore the RECAL and UNCAL annunciators and error messages.

5. On the Measuring Receiver, key in the following:
   a. Key in S (shift) TUNED RF LEVEL.
   b. Key in 4.6 SPCL to select the IF average detector with a measurement averaging time of 1s.

c. Key in 1.2 SPCL to set the input attenuation to 10 dB.

d. Key in 9.3 SPCL to set the IF gain to 20 dB.

6. On the Measuring Receiver, key in 49. S (shift) 1 SPCL to set the instrument to measure and display the voltage from the IF Average Detector. (Pressing S and 1 will cause "b" to appear in the display.) Adjust the signal generator level for a reading of approximately 3.0 (3 Vdc).

NOTE

The piston attenuator is assumed to have 30 dB insertion loss at the 10 dB attenuation setting (20 dB residual insertion loss plus the added 10 dB). The two 3 dB attenuators add another 6 dB. If the piston attenuator has a residual insertion loss other than 20 dB, adjust the signal generator level as needed to obtain the 3 Vdc reading.

7. Press CLEAR to re-enter tuned RF level. Press the blue key then press SET REF (the ZERO key) to set the displayed reading as a reference. (The display should read between 99.99 and 100.01%. If it does not, press the blue key and SET REF again.)

NOTE

If calibration data is supplied with the piston attenuator, use the data in all subsequent measurements to correct for the attenuator error.

8. Set the piston attenuator to 20 dB. The display should read between 31.48 and 31.77% (that is, −10±0.04 dB expressed in %).

IF Average Detector Linearity: 31.48 _____ 31.77%

9. Set the piston attenuator back to 10 dB.

10. On the Measuring Receiver, key in 4.2 SPCL to select the IF synchronous detector with a measurement averaging time of 1s. Key in 9.1 SPCL to set the IF gain to 0 dB.

11. On the Measuring Receiver, key in 50.6 SPCL to set the instrument to measure and display the voltage from the IF synchronous detector. Lower the signal generator level for a reading of approximately 3.0.

12. Press CLEAR. Press the blue key and SET REF. (The display should read between 99.99 and 100.01%. If it does not, press the blue key and SET REF again.)

13. Set the piston attenuator to 20 dB. The display should read between 31.55 and 31.70% (that is, −10±0.02 dB).

IF Synchronous Detector Linearity: 31.55 _____ 31.70%

IF Range-to-Range Accuracy

14. Set the piston attenuator back to 10 dB.

15. Set the piston attenuator as indicated in the following table. For each step, key in the special function indicated in the table. For each step the display should read within the limits indicated in the table.

Special Function	Attenuation of Piston Attenuator (dB)	Limits of Displayed Result (%)		
		Lower	Actual	Upper
9.1	10		Ref	
9.2	20	31.55	_____	31.70
9.3	30	9.954	_____	10.046
9.4	40	3.141	_____	3.184
9.5	50	0.9908	_____	1.0093
9.6	60	0.3115	_____	0.3210
9.7	70	0.09795	_____	0.10209

Frequency Drift Error

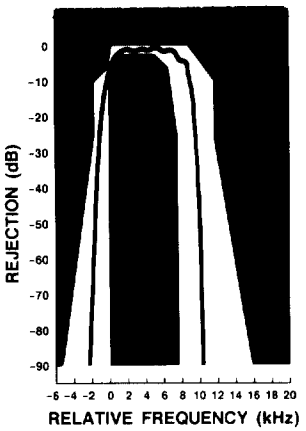
16. On the Measuring Receiver, key in 9.1 SPCL.
17. Set the piston attenuator to approximately 10 dB.
18. On the Measuring Receiver, press the blue shift key and the SET REF key. Fine tune the signal generator slowly up and down over a 10 kHz range, or until an Error 01 appears, stopping at frequent intervals to note the display. Note the maximum and minimum value on the Measuring Receiver's display. The difference between the maximum and minimum values should be less than 12.20% (1.0 dB).

IF Synchronous Detector Frequency Drift Error: _____ 12.20%

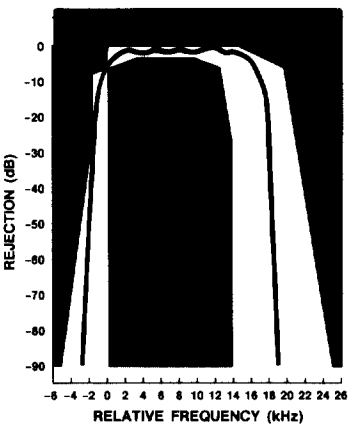
Performance Test 12—High-Selectivity Filters (Options 032 and 033)

Specification

SELECTIVE POWER: Filter Shape



12.5 kHz Filter Shape (Option 032)



25 kHz Filter Shape (Option 033)

Description

The accuracy of the high-selectivity filters is tested by feeding a 455 kHz CW signal directly into the IF via the front-panel input connector. As the frequency of the input is changed, the shape of the IF is determined.

NOTE

This procedure tests only instruments with the 12.5 kHz Adjacent Channel Filter (Option 032) or 25 kHz Adjacent Channel Filter (Option 033) or both. Depending on the combination of these filters with the other available filter options (Options 035 and 037), either filter can be defined as the "wide" or "narrow" filter with regards to Special Function 24, which is used in the procedure. Follow the procedure or procedures which apply to the instrument's particular option combination.

Equipment

Signal Generator ..... HP 8640B or HP 3336C

Procedure

NOTE

In the following procedure the signal generator can be connected either to a sensor module (which is connected to the Measuring Receiver) or directly to the Measuring Receiver's INPUT connector. The procedure is written for the latter case.

Initial Setup

1. Set the signal generator to 455.0 kHz CW at +3 dBm. Connect the signal generator's output to the Measuring Receiver's INPUT. Allow the equipment to warm up at least one-half hour.

"Wide" Filter Test—Option Combination 032 and 037

2. On the Measuring Receiver, key in the following:
   a. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
   b. Key in 100 MHz to inhibit automatic tuning.
   c. Key in 24.0 SPCL to initialize the high-selectivity level measurement.
   d. Key in 3.1 SPCL to remove the RF input high-pass filter.
   e. Key in 24.1 SPCL to read the IF level.
3. Slowly tune the frequency of the signal generator up and down until the peak reading is found.
4. On the Measuring Receiver, key in 24.1 SPCL and 24.2 SPCL to establish and display the current IF level as a level reference. (The display should read 0 dB.)
5. Tune the signal generator down until the first minimum is found. The display should read −2 dB or higher (that is, between −2 and 0 dB).

   12.5 kHz Filter: Loss at First Minimum: −2 dB _____

6. Tune the signal generator down until the display reads −6.00 dB. Record the signal generator's frequency.

   12.5 kHz Filter: Lower 6 dB Frequency: _____ kHz

7. Tune the signal generator down 1.6 kHz. The display should read −30 dB or less (that is, more negative).

   12.5 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner: _____ −30 dB

8. Tune the signal generator down another 3 kHz. The display should read −80 dB or less.

   12.5 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner: _____ −80 dB

9. Tune the signal generator up until the display reads 0 dB, then continue on until the display reads −6.00 dB. Record the signal generator's frequency.

   12.5 kHz Filter: Upper 6 dB Frequency: _____ kHz

10. Subtract the reading of step 9 from the reading of step 6. The difference should be between 6.4 and 10.4 kHz.

    12.5 kHz Filter: 6 dB Bandwidth: 6.4 _____ 10.4 kHz

11. Tune the signal generator up 12 kHz above the frequency recorded in step 6. The display should read −30 dB or less.

12.5 kHz Filter: Loss at 12 kHz Above Lower 6 dB Corner: _____ −30 dB

12. Tune the signal generator up another 3 kHz. The display should read −80 dB or less.

12.5 kHz Filter: Loss at 15 kHz Above Lower 6 dB Corner: _____ −80 dB

"Wide" Filter Test—Option Combination 032 and 033 or 033 and 037

13. Perform step 1, then on the Measuring Receiver, key in the following:
    a. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
    b. Key in 100 MHz to inhibit automatic tuning.
    c. Key in 24.0 SPCL to initialize the high-selectivity level measurement.
    d. Key in 3.1 SPCL to remove the RF input high-pass filter.
    e. Key in 24.1 SPCL to read the IF level.
14. Slowly tune the frequency of the signal generator up and down until the peak reading is found.
15. On the Measuring Receiver, key in 24.1 SPCL and 24.2 SPCL to establish and display the current IF level as a level reference. (The display should read 0 dB.)
16. Tune the signal generator down until the first minimum is found. The display should read −2 dB or higher (that is, between −2 and 0 dB).

25 kHz Filter: Loss at First Minimum: −2 dB _____

17. Tune the signal generator down until the display reads −6.00 dB. Record the signal generator's frequency.

25 kHz Filter: Lower 6 dB Frequency: _____ kHz

18. Tune the signal generator down 1.6 kHz. The display should read −30 dB or less (that is, more negative).

25 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner: _____ −30 dB

19. Tune the signal generator down another 3 kHz. The display should read −80 dB or less.

25 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner: _____ −80 dB

20. Tune the signal generator up until the display reads 0 dB, then continue on until the display reads −6.00 dB. Record the signal generator's frequency.

25 kHz Filter: Upper 6 dB Frequency: _____ kHz

21. Subtract the reading of step 20 from the reading of step 17. The difference should be between 12.4 and 16.9 kHz.

25 kHz Filter: 6 dB Bandwidth: 12.4 _____ 16.9 kHz

22. Tune the signal generator up 18.5 kHz above the frequency recorded in step 17. The display should read −30 dB or less.

25 kHz Filter: Loss at 18.5 kHz Above Lower 6 dB Corner: _____ −30 dB

23. Tune the signal generator up another 3 kHz. The display should read −80 dB or less.

25 kHz Filter: Loss at 21.5 kHz Above Lower 6 dB Corner: _____ −80 dB

"Narrow" Filter Test—Option Combination 032 and 033 or 032 and 035

24. Perform step 1, then on the Measuring Receiver, key in the following:
    a. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
    b. Key in 100 MHz to inhibit automatic tuning.
    c. Key in 24.0 SPCL to initialize the high-selectivity level measurement.
    d. Key in 3.1 SPCL to remove the RF input high-pass filter.
    e. Key in 24.3 SPCL to read the IF level.
25. Slowly tune the frequency of the signal generator up and down until the peak reading is found.
26. On the Measuring Receiver, key in 24.3 SPCL and 24.4 SPCL to establish and display the current IF level as a level reference. (The display should read 0 dB.)
27. Tune the signal generator down until the first minimum is found. The display should read −2 dB or higher (that is, between −2 and 0 dB).

12.5 kHz Filter: Loss at First Minimum: −2 dB _____

28. Tune the signal generator down until the display reads −6.00 dB. Record the signal generator's frequency.

12.5 kHz Filter: Lower 6 dB Frequency: _____ kHz

29. Tune the signal generator down 1.6 kHz. The display should read −30 dB or less (that is, more negative).

12.5 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner: _____ −30 dB

30. Tune the signal generator down another 3 kHz. The display should read −80 dB or less.

12.5 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner: _____ −80 dB

31. Tune the signal generator up until the display reads 0 dB, then continue on until the display reads −6.00 dB. Record the signal generator's frequency.

12.5 kHz Filter: Upper 6 dB Frequency: _____ kHz

32. Subtract the reading of step 31 from the reading of step 28. The difference should be between 6.4 and 10.4 kHz.

12.5 kHz Filter: 6 dB Bandwidth: 6.4 _____ 10.4 kHz

33. Tune the signal generator up 12 kHz above the frequency recorded in step 28. The display should read −30 dB or less.

12.5 kHz Filter: Loss at 12 kHz Above Lower 6 dB Corner: _____ −30 dB

34. Tune the signal generator up another 3 kHz. The display should read −80 dB or less.

12.5 kHz Filter: Loss at 15 kHz Above Lower 6 dB Corner: _____ −80 dB

"Narrow" Filter Test—Option Combination 033 and 035

35. Perform step 1, then on the Measuring Receiver, key in the following:
    a. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
    b. Key in 100 MHz to inhibit automatic tuning.
    c. Key in 24.0 SPCL to initialize the high-selectivity level measurement.
    d. Key in 3.1 SPCL to remove the RF input high-pass filter.
    e. Key in 24.3 SPCL to read the IF level.
36. Slowly tune the frequency of the signal generator up and down until the peak reading is found.
37. On the Measuring Receiver, key in 24.3 SPCL and 24.4 SPCL to establish and display the current IF level as a level reference. (The display should read 0 dB.)
38. Tune the signal generator down until the first minimum is found. The display should read −2 dB or higher (that is, between −2 and 0 dB).

    25 kHz Filter: Loss at First Minimum: −2 dB _____

39. Tune the signal generator down until the display reads −6.00 dB. Record the signal generator's frequency.

    25 kHz Filter: Lower 6 dB Frequency: _____ kHz

40. Tune the signal generator down 1.6 kHz. The display should read −30 dB or less (that is, more negative).

    25 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner: _____ −30 dB

41. Tune the signal generator down another 3 kHz. The display should read −80 dB or less.

    25 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner: _____ −80 dB

42. Tune the signal generator up until the display reads 0 dB, then continue on until the display reads −6.00 dB. Record the signal generator's frequency.

    25 kHz Filter: Upper 6 dB Frequency: _____ kHz

43. Subtract the reading of step 42 from the reading of step 39. The difference should be between 12.4 and 16.9 kHz.

    25 kHz Filter: 6 dB Bandwidth: 12.4 _____ 16.9 kHz

44. Tune the signal generator up 18.5 kHz above the frequency recorded in step 39. The display should read −30 dB or less.

    25 kHz Filter: Loss at 18.5 kHz Above Lower 6 dB Corner: _____ −30 dB

45. Tune the signal generator up another 3 kHz. The display should read −80 dB or less.

    25 kHz Filter: Loss at 21.5 kHz Above Lower 6 dB Corner: _____ −80 dB

Performance Test 13

HIGH-SELECTIVITY GAIN (OPTION SERIES 030)

Specification

Characteristic	Performance Limits	Conditions
SELECTIVE POWER		
Frequency Range	10 to 1300 MHz	
Carrier Power Range	+30 to −20 dBm +30 to −10 dBm	12.5, 25, and 30 kHz filters carrier noise filter
Relative Measurement Accuracy	±0.5 dB ±0.5 dB	levels > −95 dBc; 12.5, 25, and 30 kHz filters levels > −129 dBc/Hz; carrier noise filter

Description

This test checks the relative accuracy of the selective power measurement mode. The linearity of the IF rms detector (including the linearity of the internal dc voltmeter) is checked first. Linearity is measured by feeding a 455 kHz signal directly into the IF via the front-panel connector. The level is set to produce a signal that is near the upper measurement limit of the detector, a level reference is set, and the range settings held. The signal level is then decreased by precisely 5 dB, and the drop in displayed level is compared against the decrease in level.

IF gain step accuracy is measured by increasing the attenuation of the attenuator in 5 dB steps and comparing the displayed reading with the increase in attenuation.

Equipment

Signal Generator ..... HP 3336C

Procedure

NOTE

In the following procedure the signal generator can be connected either to a sensor module (which is connected to the Modulation Analyzer) or directly to the Modulation Analyzer's INPUT connector. The procedure is written for the latter case.

Detector Linearity

1. Set the signal generator to 455 kHz CW at +3 dBm. Connect the signal generator's output to the Modulation Analyzer's INPUT. Allow the equipment to warm up at least one-half hour.

2. On the Modulation Analyzer, key in the following:
   a. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
   b. Key in 100 MHz to inhibit automatic tuning.
   c. Key in 24.0 SPCL to initialize the high-selectivity level measurement.
   d. Key in 3.1 SPCL to remove the RF input high-pass filter.
   e. Key in 24.1 SPCL to read the IF level.
   f. Key in 49.C SPCL (C is yellow shift key and digit 2) to select and display the output of the IF rms detector and to inhibit IF ranging.
3. Adjust the level of the signal generator for a displayed reading of 2.500.
4. Decrease the signal generator level by exactly 5 dB. Divide the displayed reading by 1.406 and record the result.

IF RMS Detector Linearity: _____

IF Gain Accuracy

5. On the Modulation Analyzer, key in 0.390 SPCL, 0.3 S (Shift) 4 S 4 SPCL, and 0.3 S 30 SPCL to set the IF gain to 0 dB. Key in 49.C SPCL.
6. Increase the signal generator level for a displayed reading of 1.000.
7. Decrease the signal generator level by the exact amount indicated in the following table. For each setting, key in the Special Function(s) indicated, then key in 49.C SPCL. Multiply the displayed result by the result of step 4. The computed result should be between 0.944 and 1.059 (that is, ±0.5 dB).

Decrease in Signal Generator Level (dB)	Special Function	Displayed Level	Limits of Computed Result		
			Lower	Actual	Upper
5	0.3 S 4 S 3	_____	0.944	_____	1.059
5	0.3 S 4 S 1	_____	0.944	_____	1.059
5	0.3 S 4 7	_____	0.944	_____	1.059
5	0.3 S 4 S 4, 0.391	_____	0.944	_____	1.059
0	0.392	_____	0.944	_____	1.059
0	0.394	_____	0.944	_____	1.059
0	0.390, 0.3 S 31	_____	0.944	_____	1.059

Performance Test 14

TUNED RF LEVEL

Specification

Characteristic	Performance Limits	Conditions
TUNED RF LEVEL		
Relative Accuracy	±0.015 dB +0.010 dB/10 dB ±0.015 dB + 0.050 dB/10 dB	0.000 dBm to −100.000 dBm −100.001 dBm to −127.000 dBm

Description

This test checks the relative accuracy of the HP 8902A Option 050 Tuned RF Level measurement mode for the IF synchronous detector using the HP 11812A.

NOTE

The output level accuracy of the signal generator is of secondary importance.

Equipment

Signal Generator ..... HP 8640B
Step Attenuator ..... HP 11812A

Procedure

NOTE

In the following procedure make direct connections between test equipment, avoiding cables and adapters, where possible. Turn on all equipment and allow it to warm up for 30 minutes before performing this test.

Tuned RF Level Accuracy with Step Attenuator

1. Connect the equipment as shown in Figure 4-1.
2. Setup:
   a. Set the signal generator output to 30 MHz at +20 dBm CW.
   b. Set the Step Attenuator to 0 dB.
3. Procedure:
   a. On the Measuring Receiver press INSTR PRESET (blue key then green key).
   b. Wait for the Measuring Receiver to display 30 MHz. Then Press the MHz key to manual tune the Measuring Receiver.
   c. Press S (Yellow key), TUNED RF LEVEL. Wait for a measurment to be displayed.
   d. Key in 39.9 SPCL to clear any previous calibration factors for the Tuned RF Level measurment.

e. Key in 32.1 SPCL and 4.1 SPCL to enable 0.001 dB resolution and 10 second averaging.
f. Press the LOG/LIN key for a log display in dB.
g. Wait for a measurement to be displayed.
h. Press SET REF (blue key and zero key) to establish the current level as a reference.
i. The Measuring Receiver display should now be 0.000 dB ±0.003 dB.

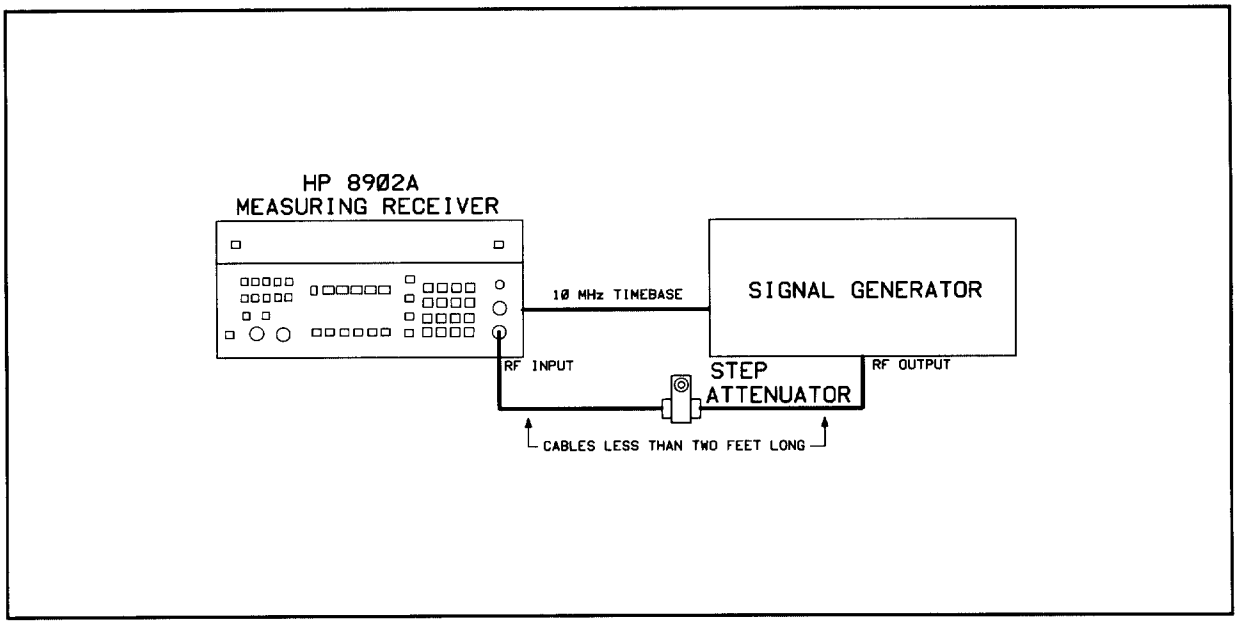


Figure 4-8. *Tuned RF Level Performance Test Setup*

4. Measure 0 dBm to −50 dBm Error:
   a. Set the Step Attenuator as indicated in the following table and record the Measuring Receiver readings in the column labeled "HP 8902A Reading (dB)". (Take the average of three readings.)
   b. Record the Step Attenuator calibrated value for each setting in the column labeled "Step Attenuator Value (dB)".
   c. Determine the Measuring Receiver error as indicated in the column labeled "Calculated Error". Record the error in this column.
   d. When the RECAL annunciator lights, press CALIBRATE and wait for the calibration to be made. (Recalibration will take approximately 1 minute.)

Step Attenuator Setting (dB)	Step Attenuator Value (dB)	HP 8902A Reading (dB)	Lower Limit	Calculated Error	Upper Limit
0	A1= 0.000 dB	A= _____	−0.015 dB	A1−|A| _____	0.015 dB
10	B1= _____	B= _____	−0.025 dB	B1−|B| _____	0.025 dB
20	C1= _____	C= _____	−0.035 dB	C1−|C| _____	0.035 dB
30	D1= _____	D= _____	−0.045 dB	D1−|D| _____	0.045 dB
40	E1= _____	E= _____	−0.055 dB	E1−|E| _____	0.055 dB
50	F1= _____	F= _____	−0.065 dB	F1−|F| _____	0.065 dB
0	G1= 0.000 dB	G= _____	−0.015 dB	G1−|G| _____	0.015 dB

5. Measure −50 dBm to −100 dBm Error:

   a. Reduce the signal generator level by 50 dB.

   b. Wait for a measurment to be displayed.

   c. On the Measuring Receiver, press the blue key and SET REF to establish a new ratio reference.

   d. Repeat step 4 using the following table.

Step Attenuator Setting (dB)	Step Attenuator Value (dB)	HP 8902A Reading (dB)	Lower Limit	Calculated Error	Upper Limit
0	A1= 0.000 dB	A= _____	−0.015 dB	A1−|A| _____	0.015 dB
10	B1= _____	B= _____	−0.025 dB	B1−|B| _____	0.025 dB
20	C1= _____	C= _____	−0.035 dB	C1−|C| _____	0.035 dB
30	D1= _____	D= _____	−0.045 dB	D1−|D| _____	0.045 dB
40	E1= _____	E= _____	−0.055 dB	E1−|E| _____	0.055 dB
50	F1= _____	F= _____	−0.065 dB	F1−|F| _____	0.065 dB
0	G1= 0.000 dB	G= _____	−0.015 dB	G1−|G| _____	0.015 dB

6. Measure −100 dBm to −120 dBm Error:

   a. Reduce the signal generator level by 50 dB.

   b. Wait for a measurment to be displayed.

   c. On the Measuring Receiver, press the blue key and SET REF to establish a new ratio reference.

   d. If the Measuring Receiver does not display 0.000 dB ±0.003, press blue key and SET REF again.

   e. Repeat step 4 using the following table.

Step Attenuator Setting (dB)	Step Attenuator Value (dB)	HP 8902A Reading (dB)	Lower Limit	Calculated Error	Upper Limit
0	A1= 0.000 dB	A= _____	−0.015 dB	A1−|A| _____	0.015 dB
10	B1= _____	B= _____	−0.065 dB	B1−|B| _____	0.065 dB
20	C1= _____	C= _____	−0.115 dB	C1−|C| _____	0.115 dB
0	D1= 0.000 dB	D= _____	−0.015 dB	D1−|D| _____	0.015 dB

Table 4–1. Performance Test Record (1 of 7)

Hewlett-Packard Company
Model 8902A
Measuring Receiver

Tested By _____

Serial Number _____ **Date** _____

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
1	**AM PERFORMANCE TEST**			
	AM Accuracy at 10 kHz Rate			
	AM Calibration Factor 40% AM Range	99%	_____	101%
	AM Calibration Factor 100% AM Range	99%	_____	101%
	Residual AM		_____	0.01%
	AM Distortion			
	20 kHz Rate; 50% AM		_____	0.3%
	20 kHz Rate; 95% AM		_____	0.6%
	20 Hz Rate; 95% AM		_____	0.6%
	20 Hz Rate; 50% AM		_____	0.3%
	AM Flatness			
	AM Flatness (Maximum Difference)		_____	0.8% REL
	AM Accuracy			
	1.5 MHz IF; 50 kHz Rate	98.9% REL	_____	101.1% REL
	1.5 MHz IF; 100 kHz Rate	96.9% REL	_____	103.1% REL
	1.5 MHz IF; 50 Hz Rate	98.9% REL	_____	101.1% REL
	1.5 MHz IF; 20 Hz Rate	96.9% REL	_____	103.1% REL
	455 kHz IF; 20 Hz Rate	96.9% REL	_____	103.1% REL
	455 kHz IF; 50 Hz Rate	97.9% REL	_____	102.1% REL
	455 kHz IF; 10 kHz Rate	97.9% REL	_____	102.1% REL
	AM Rejection			
	With FM; 455 kHz IF		_____	20 Hz
	With FM; 1.5 MHz IF		_____	20 Hz
	With ΦM; 1.5 MHz IF		_____	0.030 rad
2	**FM PERFORMANCE TEST**			
	Residual FM			
	Residual FM at 560 MHz; 50 Hz to 3 kHz bandwidth		_____	4 Hz
	FM Accuracy at 10 kHz Rate			
	FM Calibration Factor; 40 kHz Modulation Range	99%	_____	101%
	FM Calibration Factor; 400 kHz Modulation Range	99%	_____	101%
	FM Accuracy; 4 kHz Modulation Range	12.35% REL	_____	12.65% REL

Table 4–1. Performance Test Record (2 of 7)

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
2	**FM PERFORMANCE TEST (cont'd)**			
	FM Distortion, Accuracy, and Rejection—1.5 MHz IF			
	FM Distortion at 100 kHz Rate; 100 kHz Peak Deviation		_____	0.1%
	FM Accuracy at 50 kHz Rate	98.9 kHz	_____	101.1 kHz
	FM Accuracy at 100 kHz Rate	94.9 kHz	_____	105.1 kHz
	FM Accuracy at 50 Hz Rate	98.9 kHz	_____	101.1 kHz
	FM Accuracy at 20 Hz Rate	94.9 kHz	_____	105.1 kHz
	FM Rejection at 1 kHz Rate; 50 kHz Peak Deviation		_____	0.2%
	FM Distortion, Accuracy, and Rejection—455 kHz IF			
	FM Rejection at 1 kHz Rate; 5 kHz Peak Deviation		_____	0.2%
	FM Accuracy at 10 kHz Rate	9.79 kHz	_____	10.21 kHz
	FM Accuracy at 20 Hz Rate	9.79 kHz	_____	10.21 kHz
	FM Distortion at 10 kHz; 10 kHz Peak Deviation		_____	0.1%
3	**ΦM PERFORMANCE TEST**			
	ΦM Accuracy			
	Modulation Rate (Hz) / *Average FM Deviation (kHz)*			
	200 / 50	242.4 rad	_____	257.6 rad
	1 000 / 250	242.4 rad	_____	257.6 rad
	20 000 / 250	12.0 rad	_____	13.0 rad
	20 000 / 4	0.193 rad	_____	0.207 rad
	10 000 / 25	2.39 rad	_____	2.61 rad
	10 000 / 2.5	0.239 rad	_____	0.261 rad
	1 000 / 25	24.0 rad	_____	26.0 rad
	200 / 5	24.0 rad	_____	26.0 rad
	ΦM Distortion			
	1 kHz Rate; 400 rad Peak Deviation; 1.5 MHz IF		_____	0.1%
	1 kHz Rate; 40 rad Peak Deviation; 455 kHz IF		_____	0.1%
4	**AUDIO FILTERS PERFORMANCE TEST**			
	Rate (Hz) / *Filter*			
	200 / 50 Hz HP FILTER	98.99% REL	_____	101.01% REL
	2 000 / 50 Hz HP FILTER	98.99% REL	_____	101.01% REL
	1 000 / 300 Hz HP FILTER	98.99% REL	_____	101.01% REL
	10 000 / 300 Hz HP FILTER	98.99% REL	_____	101.01% REL
	1 000 / 3 kHz LP FILTER	98.99% REL	_____	101.01% REL
	100 / 3 kHz LP FILTER	98.99% REL	_____	101.01% REL
	10 000 / 15 kHz LP FILTER	98.99% REL	_____	101.01% REL
	1 000 / 15 kHz LP FILTER	98.99% REL	_____	101.01% REL
	10 000 / ¿20 kHz LP FILTER	98.99% REL	_____	101.01% REL
	1 000 / ¿20 kHz LP FILTER	98.99% REL	_____	101.01% REL

Table 4–1. Performance Test Record (3 of 7)

Test No.	Test Description		Results Minimum	Results Actual	Results Maximum
5	**AUDIO MEASUREMENTS PERFORMANCE TEST**				
	Audio RMS Accuracy				
	50 Hz Rate		2.88 Vrms	_____	3.12 Vrms
	500 Hz Rate		2.88 Vrms	_____	3.12 Vrms
	5 kHz Rate		2.88 Vrms	_____	3.12 Vrms
	40 kHz Rate		2.88 Vrms	_____	3.12 Vrms
	40 kHz Rate		96 mVrms	_____	104 mVrms
	5 kHz Rate		96 mVrms	_____	104 mVrms
	500 Hz Rate		96 mVrms	_____	104 mVrms
	50 Hz Rate		96 mVrms	_____	104 mVrms
	Audio Counter Range and Sensitivity				
	Rate (Hz)	*RF Level (dBm, V)*			
	20	+16.5, 3	0.01998 kHz	_____	0.02002 kHz
	20	−13.0, 0.1	0.01998 kHz	_____	0.02002 kHz
	1 000	−13.0, 0.1	0.99997 kHz	_____	1.00003 kHz
	1 000	+16.5, 3	0.99997 kHz	_____	1.00003 kHz
	250 000	+16.5, 3	249.997 kHz	_____	250.003 kHz
	250 000	−13.0, 0.1	249.997 kHz	_____	250.003 kHz
	Residual Noise and Distortion				
	400 Hz Input at 100 mV			_____	0.3%
	400 Hz Input at 3V			_____	0.3%
	1 kHz Input at 3V			_____	0.3%
	1 kHz Input at 100 mV			_____	0.3%
	Distortion Accuracy				
	1 kHz Rate; 2nd harmonic		0.89%	_____	1.12%
	1 kHz Rate; 3rd harmonic		0.89%	_____	1.12%
	1 kHz Rate; 4th harmonic		0.89%	_____	1.12%
	1 kHz Rate; 5th harmonic		0.89%	_____	1.12%
	400 Hz Rate; 2nd harmonic		0.89%	_____	1.12%
	400 Hz Rate; 3rd harmonic		0.89%	_____	1.12%
	400 Hz Rate; 4th harmonic		0.89%	_____	1.12%
	400 Hz Rate; 5th harmonic		0.89%	_____	1.12%
6	**POWER REFERENCE PERFORMANCE TEST (USING REFERENCE COMPARISON)**				
	RF Power Reference Accuracy		98.1% REL	_____	101.9% REL
7	**POWER REFERENCE PERFORMANCE TEST (USING DC SUBSTITUTION)**				
	RF Power Reference Power		0.988 mW	_____	1.012 mW

Table 4–1. Performance Test Record (4 of 7)

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
8	**POWER METER PERFORMANCE TEST**			
	Serial Prefix 2305A to 2449A			
	Zero Set			
	Special Function 10.1		_____	0.06 μW
	Special Function 10.2		_____	0.1 μW
	Special Function 10.3		_____	0.001 μW
	Special Function 10.4		_____	0.01 mW
	Special Function 10.5		_____	0.1 mW
	Serial Prefix 2451A and above			
	Zero Set			
	Special Function 10.1		_____	0.051 0.051 μW
	Special Function 10.2		_____	0.06 .06 μW
	Special Function 10.3		_____	0.2 0.2 μW
	Special Function 10.4		_____	0.001 mW
	Special Function 10.5		_____	0.01 mW
	Range-to-Range Error			
	Special Function 10.1; 10 μW Range	9.90 μW	_____	10.10 μW
	Special Function 10.2; 100 μW Range	99.4 μW	_____	100.6 μW
	Special Function 10.4; 10 mW Range	9.94 mW	_____	10.06 mW
	Special Function 10.5; 100 mW Range	99.0 mW	_____	101.0 mW
	Accuracy within a Range	0.099 mW	_____	0.101 mW
9	**SWR PERFORMANCE TEST**			
	Sensor Module's Power Sensor SWR			
	Worst Case Return Loss for RF Power Measurement		_____	−23 dB
	Sensor Module's Thru-Path SWR			
	Worst Case Return Loss for Tuned RF Level Measurement			
	External Sensor Module; Range 1		_____	−17 dB
	External Sensor Module; Range 2		_____	−17 dB
	External Sensor Module; Range 3		_____	−14 dB
	External Sensor; 14 dB Gain Range		_____	−17 dB
	Measuring Receiver Input SWR			
	Worst Case Return Loss for Tuned RF Level Measurement			
	Measuring Receiver Input; Range 3		_____	−16 dB
	Measuring Receiver Input; Range 2		_____	−22 dB
	Measuring Receiver Input; Range 1		_____	−22 dB

Table 4–1. Performance Test Record (5 of 7)

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
10	**TUNED RF LEVEL PERFORMANCE TEST (USING A STEP ATTENUATOR)**			
	Detector Linearity			
	IF Average Detector Linearity	0.9931	_____	1.0069
	IF Synchronous Detector Linearity	0.9977	_____	1.0023
	IF Range-to-Range Accuracy			
	Special Function 9.2	99.77%	_____	100.23%
	Special Function 9.3	99.77%	_____	100.23%
	Special Function 9.4	99.77%	_____	100.23%
	Special Function 9.5	99.77%	_____	100.23%
	Special Function 9.6	99.43%	_____	100.58%
	Special Function 9.7	99.43%	_____	100.58%
	Frequency Drift Error			
	IF Synchronous Detector Frequency Drift Error		_____	12.2%
11	**TUNED RF LEVEL PERFORMANCE TEST (USING A PISTON ATTENUATOR)**			
	Detector Linearity			
	IF Average Detector Linearity	31.55%	_____	31.70%
	IF Synchronous Detector Linearity	31.59%	_____	31.66%
	IF Range-to-Range Accuracy			
	Special Function 9.2	31.55%	_____	31.70%
	Special Function 9.3	9.954%	_____	10.046%
	Special Function 9.4	3.141%	_____	3.184%
	Special Function 9.5	0.9908%	_____	1.0093%
	Special Function 9.6	0.3115%	_____	0.3210%
	Special Function 9.7	0.09795%	_____	0.10209%
	Frequency Drift Error			
	IF Synchronous Detector Frequency Drift Error		_____	12.2%
12	**HIGH-SELECTIVITY FILTERS PERFORMANCE TEST (OPTIONS 032 AND 033)**			
	"Wide" Filter Test—Option Combination 032 and 037			
	12.5 kHz Filter: Loss at First Minimum	−2 dB	_____	
	12.5 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner		_____	−30 dB
	12.5 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner		_____	−80 dB
	12.5 kHz Filter: 6 dB Bandwidth	6.4 kHz	_____	10.4 kHz
	12.5 kHz Filter: Loss at 12 kHz Above Lower 6 dB Corner		_____	−30 dB
	12.5 kHz Filter: Loss at 15 kHz Above Lower 6 dB Corner		_____	−80 dB

Table 4–1. Performance Test Record (6 of 7)

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
12	**HIGH-SELECTIVITY FILTERS PERFORMANCE TEST (OPTIONS 032 AND 033) (cont'd)**			
	"Wide" Filter Test—Option Combination 032 and 033 or 033 and 037			
	25 kHz Filter: Loss at First Minimum	−2 dB	_____	
	25 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner		_____	−30 dB
	25 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner		_____	−80 dB
	25 kHz Filter: 6 dB Bandwidth	12.4 kHz	_____	16.9 kHz
	25 kHz Filter: Loss at 18.5 kHz Above Lower 6 dB Corner		_____	−30 dB
	25 kHz Filter: Loss at 21.5 kHz Above Lower 6 dB Corner		_____	−80 dB
	"Narrow" Filter Test—Option Combination 032 and 033 or 032 and 035			
	12.5 kHz Filter: Loss at First Minimum	−2 dB	_____	
	12.5 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner		_____	−30 dB
	12.5 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner		_____	−80 dB
	12.5 kHz Filter: 6 dB Bandwidth	6 .4 kHz	_____	10.4 kHz
	12.5 kHz Filter: Loss at 12 kHz Above Lower 6 dB Corner		_____	−30 dB
	12.5 kHz Filter: Loss at 15 kHz Above Lower 6 dB Corner		_____	−80 dB
	"Narrow" Filter Test—Option Combination 033 and 035			
	25 kHz Filter: Loss at First Minimum	−2 dB	_____	
	25 kHz Filter: Loss at 1.6 kHz Below Lower 6 dB Corner		_____	−30 dB
	25 kHz Filter: Loss at 4.6 kHz Below Lower 6 dB Corner		_____	−80 dB
	25 kHz Filter: 6 dB Bandwidth	12.4 kHz	_____	16.9 kHz
	25 kHz Filter: Loss at 18.5 kHz Above Lower 6 dB Corner		_____	−30 dB
	25 kHz Filter: Loss at 21.5 kHz Above Lower 6 dB Corner		_____	−80 dB
13	**HIGH-SELECTIVITY GAIN PERFORMANCE TEST (OPTION SERIES 030)**			
	IF Gain Accuracy			
	Special Function 0.3 S 4 S 3	0.944	_____	1.059
	Special Function 0.3 S 4 S 1	0.944	_____	1.059
	Special Function 0.3 S 4 7	0.944	_____	1.059
	Special Functions 0.3 S 4 S 4, 0.391	0.944	_____	1.059
	Special Function 0.392	0.944	_____	1.059
	Special Function 0.394	0.944	_____	1.059
	Special Functions 0.390, 0.3 S 31	0.944	_____	1.059

Table 4–1. Performance Test Record (7 of 7)

Hewlett-Packard Company
HP 8902A Option 050 **Tested By** _____

Serial Number _____ **Date** _____

Test No.	Test Description	Results		
		Minimum	Actual	Maximum
14	**TUNED RF LEVEL PERFORMANCE TEST (OPTION 050)**			
	Relative Accuracy Error with HP 11812A			
	Attenuator Setting (−0 dBm to −50 dBm)			
	0 dB	−0.015 dB	_____	0.015 dB
	10 dB	−0.025 dB	_____	0.025 dB
	20 dB	−0.035 dB	_____	0.035 dB
	30 dB	−0.045 dB	_____	0.045 dB
	40 dB	−0.055 dB	_____	0.055 dB
	50 dB	−0.065 dB	_____	0.065 dB
	0 dB	−0.015 dB	_____	0.015 dB
	Attenuator Setting (−50 dBm to −100 dBm)			
	0 dB	−0.015 dB	_____	0.015 dB
	10 dB	−0.025 dB	_____	0.025 dB
	20 dB	−0.035 dB	_____	0.035 dB
	30 dB	−0.045 dB	_____	0.045 dB
	40 dB	−0.055 dB	_____	0.055 dB
	50 dB	−0.065 dB	_____	0.065 dB
	0 dB	−0.015 dB	_____	0.015 dB
	Attenuator Setting (−100 dBm to −120 dBm)			
	0 dB	−0.015 dB	_____	0.015 dB
	10 dB	−0.065 dB	_____	0.065 dB
	20 dB	−0.115 dB	_____	0.115 dB
	0 dB	−0.015 dB	_____	0.015 dB

Table of Contents

Page

Introduction 5–1
Safety Considerations 5–1
Equipment Required 5–2
Factory-Selected Components 5–2
Post-Repair Tests, Adjustments, and Checks 5–2
Related Adjustments 5–2
Adjustment 1—Power Supply 5–5
Adjustment 2—Internal Reference Frequency 5–6
Adjustment 3—RF Peak Detector Offset and Gain 5–7
Adjustment 4—Sampler Efficiency and Offset 5–8
Adjustment 5—LO Doubler Output Power and Balance 5–10
Adjustment 6—Voltmeter Offset and Sensitivity 5–12
Adjustment 7—15 kHz and >20 kHz Low-Pass Filter Gain 5–14
Adjustment 8—ALC Reference 5–15
Adjustment 9—FM Calibrator 5–16
Adjustment 10—FM Sensitivity 5–17
Adjustment 11—FM Flatness 5–18
Adjustment 12—FM Distortion and Incidental AM—1.5 MHz IF 5–20
Adjustment 13—ΦM Sensitivity 5–22
Adjustment 14—AM Calibrator 5–24
Adjustment 15—AM Sensitivity 5–25
Adjustment 16—FM Distortion and Incidental AM—455 kHz IF 5–26
Adjustment 17—Track-Tune Mode Offset 5–28
Adjustment 18—Power Reference (Using Reference Comparison) 5–29
Adjustment 19—Power Reference (Using DC Substitution) 5–31
Adjustment 20—Power Meter 5–34
Adjustment 21—Audio True RMS Detector and Notch Filter Gain 5–36
Adjustment 22—Battery Backup 5–38
Adjustment 23—Narrow 455 kHz IF Filter 5–39
Adjustment 24—IF Synchronous Detector 5–43

Section 5
ADJUSTMENTS

5–1. INTRODUCTION

This section contains adjustments and checks that assure peak performance of the Measuring Receiver. The instrument should be readjusted after repair or failure to pass a performance test. Allow a 30 minute warm-up prior to performing the adjustments. Removing the top cover is the only disassembly required for most adjustments.

To determine which performance tests and adjustments to perform after a repair, refer to paragraph 5–5, *Post-Repair Tests, Adjustments, and Checks.*

5–2. SAFETY CONSIDERATIONS

This section contains information, cautions, and warnings which must be followed for your protection and to avoid damage to the equipment.

WARNING

Adjustments described in this section are performed with power supplied to the instrument and with protective covers removed. Maintenance should be performed only by service trained personnel who are aware of the hazard involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

Removal of the Measuring Receiver's bottom cover is not necessary to perform these adjustments. However, if the bottom cover is removed, hazardous voltage (≈120 Vac) is accessible.

A pin-to-pin voltage difference of 55 Vdc may be found on many of the Measuring Receiver's circuit board connectors. Be careful while working on the circuit boards with power supplied to the instrument.

If a circuit board is placed on an extender board, the possibility of coming in contact with 55 Vdc is greatly increased. Be careful while working on the circuit boards with power supplied. Work with one hand. Do not touch the extender board.

5–3. EQUIPMENT REQUIRED

Each adjustment procedure contains a list of required test equipment. The test equipment is identified by callouts in the test setup diagrams where included.

If substitutions must be made for the specified test equipment, refer to Table 1–3 in the *Operating Manual* for the minimum specifications. It is important that the test equipment meet the critical specifications listed in the table if the Measuring Receiver is to meet its performance requirements.

5-4. FACTORY-SELECTED COMPONENTS

Factory-selected components are identified on the schematics and parts list by an asterisk (*) which follows the reference designator. The normal value or range of the components is shown. The *Manual Changes* sheets will provide updated information pertaining to the selected components. Table 5-1 lists the reference designator, the criterion used for selecting a particular value, the normal value range, and the service sheet where the component part is shown.

5-5. POST-REPAIR TESTS, ADJUSTMENTS, AND CHECKS

Table 5-2 lists the performance tests, adjustments, and checks needed to calibrate or verify calibration of a repaired assembly. The tests, adjustments, and checks are classified by assembly repaired.

The table is also useful as a cross reference between performance tests and assemblies when the failure is a specification that is slightly out of limits.

For all repairs, perform the *Basic Functional Checks* in Section 3, *Adjustment 1—Power Supply* (but only adjust the +15V supply if it is out of limits), and the *Adjustment 2—Internal Reference Frequency*. The *Basic Functional Checks* utilize automatic tuning and measurement which exercises nearly every circuit in the instrument (except the Remote Interface Assembly).

5-6. RELATED ADJUSTMENTS

The procedures in this section can be done in any order, but it is advisable to check the power supply voltages and time base reference first.

Table 5-1. Factory Selected Components

Reference Designator	Service Sheet	Range of Values	Basis of Selection
A6C43 A6C51 A6L8	8	290 pF to 330 pF 300 pF to 600 pF 68 μH to 80 μH	If AM flatness peaks at 20 Hz and rolls off at 50 kHz, change A6L8 to 80 μH and A6C43 to 290 pF. If AM flatness peaks at 50 kHz and is correct at 20 Hz, lower A6C51. Lowering A6C51 by 100 pF will decrease peaking about 0.3%.
A19C43 A19R63 A19R72 A19R74	17	4.7 pF to 15 pF 38.1 to 110Ω 121 to 619Ω 121 to 619Ω	See *Adjustment 5—LO Doubler Output Power and Balance.*
A23C45 A23R55	18	1.8 pF to 2.7 pF 750 to 1780Ω	See *Adjustment 4—Sampler Offset and Efficiency.*
A32R5 A32R2 A32VR2	3 3 3	7100 to 7500Ω 1.47 kΩ 8.2V	See *Adjustment 18 or 19—Power Reference.*
A51R24 A51R32	29	19.6 k to 38.3 kΩ 9.09 k to 11 kΩ	See *Adjustment 9— FM Calibrator.*
A54R24	7	75 to 4640Ω	See *Adjustment 24—IF Synchronous Detector.*
A54R25	7	5.6 M to 6.81 MΩ	If the instrument fails Test 2 of the IF Synchronous Detector Test (Special Function 53) and indicates Fault 8 (VCO slow sweep too fast or too slow), the VCO sweep rate can be increased by decreasing A54R25 to 5.6 MΩ (HP part number 0683-5655).

Table 5–2. Post-Repair Tests, Adjustments, and Checks (1 of 2)

Assembly Repaired	Test, Adjustment, or Check
A1 Keyboard and Display Assembly	Power-Up Checks Service Special Functions (Use 60.0 SPCL, Key Scan, and exercise all keys.)
A2 Audio Filter Assembly	Performance Test 1—AM Adjustment 7—15 kHz and >20 kHz Low-Pass Filter Gain Adjustment 15—AM Sensitivity
A3 Audio De-emphasis and Output Assembly	Performance Test 2—FM (FM Distortion—1.5 MHz IF only) Performance Test 3—ΦM Performance Test 4—Audio Filters Adjustment 13—ΦM Sensitivity
A4 FM Demodulator Assembly	Performance Test 2—FM Adjustment 10—FM Sensitivity Adjustment 11—FM Flatness
A5 Voltmeter Assembly	Adjustment 6—Voltmeter Offset and Sensitivity Service Special Functions (Use 49.N and 50.N SPCL, Display Internal Voltages, and check for reasonable readings.)
A6 AM Demodulator Assembly	Performance Test 1—AM Adjustment 8—ALC Reference Adjustment 12—FM Distortion and Incidental AM—1.5 MHz IF Adjustment 15—AM Sensitivity
A10 Power Supply Regulators Assembly	Adjustment 1—Power Supply
A11 Counter Assembly	Adjustment 2—Internal Reference Frequency Power-up Checks
A13 Controller Assembly	Adjustment 22—Battery Backup Power-Up Checks
A14 Remote Interface Assembly	HP-IB Functional Checks Power-Up Checks
A15 RF Input Control Assembly	
A16 RF Detector Assembly	Adjustment 3—RF Peak Detector Offset and Gain
A17 Input Mixer Assembly A18 IF Amplifier Assembly	Adjustment 12—FM Distortion and Incidental AM—1.5 MHz IF Adjustment 16—FM Distortion and Incidental AM—455 kHz IF
A19 LO Divider Assembly	Adjustment 5—LO Doubler Output Power and Balance (Doubler repairs only) Power-Up Checks
A20 LO Control Assembly	Performance Test 2—FM (Residual FM only) Power-Up Checks
A21 Low Frequency VCXO Filter Assembly	Power-Up Checks
A22 Low Frequency VCXO Assembly	Performance Test 2—FM (Residual FM only) Power-Up Checks
A23 Sampler Assembly	Performance Test 2—FM (Residual FM only) Adjustment 4—Sampler Efficiency and Offset Power-Up Checks
A24 High Frequency VCO Assembly	Performance Test 2—FM (Residual FM only) Power-Up Checks

Table 5—2. Post-Repair Tests, Adjustments, and Checks (2 of 2)

Assembly Repaired	Test, Adjustment, or Check
A25 Audio Motherboard Assembly A26 Power Supply Motherboard Assembly A27 Digital Motherboard Assembly A28 RF Mother Board Assembly A29 Series Regulator Heat Sink Assembly A30 Line Power Module	Power-Up Checks
A31 Remote Interface Connector Assembly	HP-IB Functional Checks
A32 Power Reference Oscillator Assembly	Performance Test 6 or 7—Power Reference Adjustment 18 or 19—Power Reference
A50 AM Calibrator Assembly	Performance Test 1—AM (AM Accuracy at 10 kHz only) Adjustment 14—AM Calibrator
A51 FM Calibrator Assembly	Performance Test 2—FM (FM Accuracy at 10 kHz only) Adjustment 9—FM Calibrator
A52 Audio Counter/Distortion Analyzer Assembly	Performance Test 5—Audio Measurements Adjustment 21—Audio True RMS Detector and Notch Filter Gain
A53 RF Power Assembly	Performance Test 8—Power Meter Adjustment 20—Power Meter Adjustment
A54 IF Synchronous Detector Assembly	Performance Test 10 or 11—Tuned RF Level Adjustment 24—IF Synchronous Detector Service Special Functions (Use Special Function 53.)
A55 IF Amplifier/Filter Assembly	Performance Test 10 or 11—Tuned RF Level Adjustment 23—Narrow 455 kHz IF Filter
A70 Amplifier/Switch Interconnect Assembly	
A71 IF Amplifier/Detector Assembly	Performance Test 13—High-Selectivity Gain
A72 IF Channel/Filter Assembly	Performance Test 12—High-Selectivity Filters Performance Test 13—High-Selectivity Gain
AT1 Input Attenuator AT2 10 dB Attenuator S1, S2 RF Switch U1 RF Amplifier U2 Limiter	Performance Test 9—SWR Performance Test 10 or 11—Tuned RF Level
Y1 Crystal Oscillator	Adjustment 2—Internal Reference Frequency

Adjustment 1—Power Supply

REFERENCE

Service Sheets 31 and 32.

DESCRIPTION

The +15V supply is adjusted, and the other supplies, which are dependent upon it, are checked.

EQUIPMENT

Digital Voltmeter ..... HP 3455A

PROCEDURE

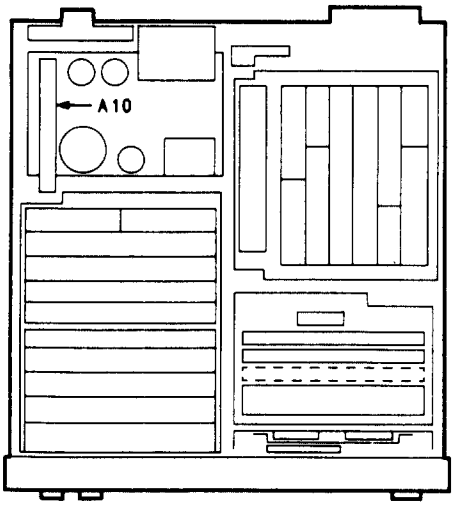
1. Set the voltmeter to measure +15 Vdc. Connect its input to A10TP3 (+15V SW).
2. Adjust A10R24 (+15V) for +14.99 to +15.01 Vdc at A10TP3.
3. Check the other supplies with the voltmeter as indicated in the following table.

2305A TO 2616A

Supply	Test Point	Voltage Limits (Vdc)	
		Minimum	Maximum
−15V	A10TP4	−15.2	−14.8
+5V	A10TP5	+4.9	+5.2
−5V	A10TP6	−5.2	−4.9
+40V	A10TP7	+40.5	+42.5

2618A AND ABOVE

Supply	Test Point	Voltage Limits (Vdc)	
		Minimum	Maximum
−15V	A10TP4	−15.2	−14.8
+5V	A10TP5	+5.1	+5.35
−5V	A10TP6	−5.4	−5.1
+40V	A10TP7	+40.5	+42.5



Adjustment 2—Internal Reference Frequency

Reference

Service Sheets 22 and 31.

Description

An oscilloscope, triggered by an external reference, is used to monitor the internal reference frequency. The internal reference frequency is adjusted for a stationary waveform on the oscilloscope.

Equipment

Frequency Standard ..... House Standard
Oscilloscope ..... HP 1740A

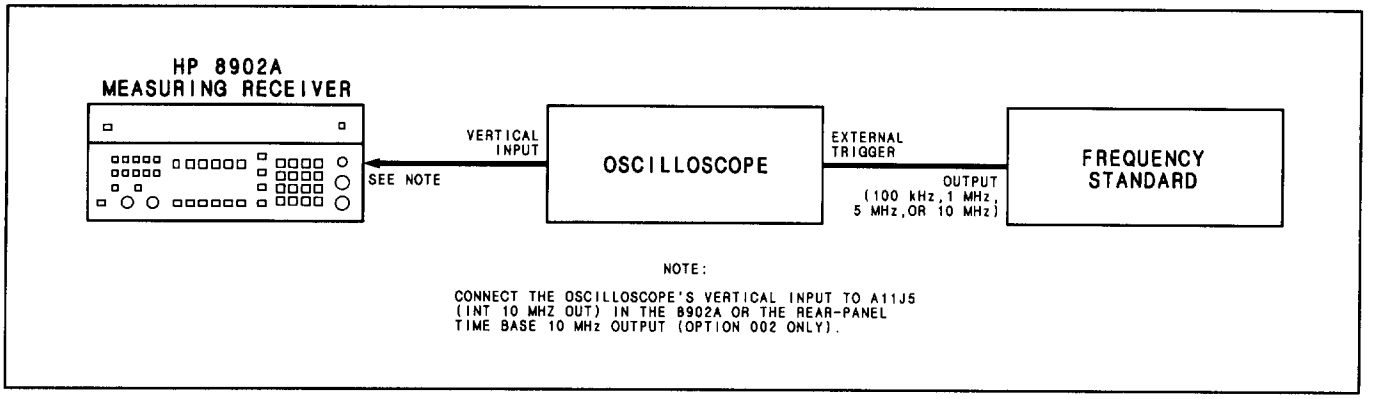
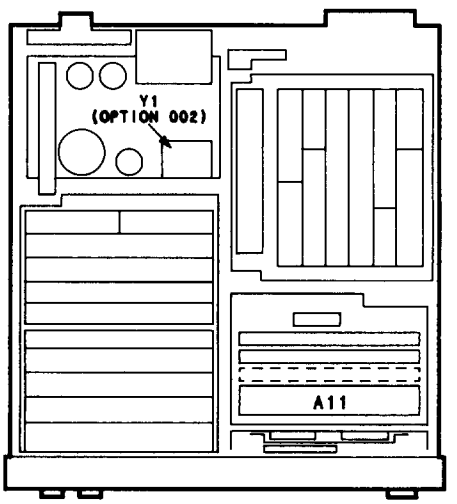


Figure 5–1. Internal Reference Frequency Adjustment Test Setup

Procedure

1. Connect the equipment as shown in Figure 5–1. Allow the equipment to warm up for 15 minutes. For Option 002, a warm-up of the Measuring Receiver of several days with covers on is recommended.
2. Set the oscilloscope's vertical sensitivity to view the Measuring Receiver's time base output. Set its horizontal scale for 10 μs per division. Set the oscilloscope to trigger externally.
3. Adjust A11C14 (10 MHZ REF) or, for Option 002, Y1 (COARSE and FINE) for a stationary waveform. If adjusting A11C14, use a totally non-metalic adjustment tool.



NOTE

Movement of the waveform to the right at a rate of one division per second means that the Measuring Receiver's time base is low by 0.1 ppm.

If the frequency of the internal reference is quite far off, the oscilloscope display may be difficult to interpret. In that case, connect the frequency standard directly to the Measuring Receiver's INPUT, press FREQ, and adjust the internal reference frequency for a display equal to the standard's frequency, then begin again at step 2.

Adjustment 3—RF Peak Detector Offset and Gain

Reference

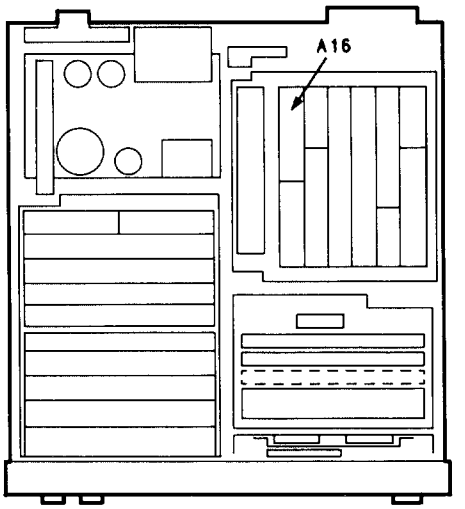
Service Sheet 4.

Description

With no RF input, the output from the RF peak detector is adjusted for 0 Vdc while monitoring it with the internal voltmeter. The internal 1 mW power reference is then connected to the instrument's input and the RF peak detector gain is adjusted for a reading equivalent to 1 mW.

Procedure

1. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 35.0 SPCL to measure RF level with the RF peak detector set to high gain. Key in 49.31 SPCL to set the voltmeter to measure and display the output of the RF peak detector.
2. Adjust A16R27 (DET OFS) for displayed readings that fall between 0.0000 and 0.0006. (The slight positive offset prevents negative readings which generate an error message in log mode.)
3. Connect CALIBRATION RF POWER OUTPUT to INPUT.
4. Key in 45.16 SPCL to turn on the RF power calibrator. Key in 49.31 SPCL. The display should read between 0.1800 and 0.2500. If it does not, proceed as follows.
   a. Turn the instrument off. Remove both cables from the A16 RF Detector Assembly and extend the assembly.
   b. Connect CALIBRATION RF POWER OUTPUT to A16J1 (RF IN). Connect AT1J1 (RF IN) to A16J2 (RF OUT) either by extending the the existing cable or by replacing it with a short jumper cable.
   c. Turn the instrument on. Key in 35.0 SPCL. Key in 45.16 SPCL. Key in 49.31 SPCL.
   d. Adjust A16R33 (DET GAIN) for a display between 0.2000 and 0.2300. (The nominal reading would be 0.2150.)
   e. Re-install the A16 assembly and repeat steps 1 to 4.



Adjustment 4—Sampler Efficiency and Offset

Reference

Service Sheet 18.

Description

Using the track-tune mode, the two signals into the sampler are configured so that the low-frequency VCXO is at a set frequency and the high-frequency VCO tracks the RF input signal. The output of the sampler is observed on an oscilloscope. The RF input is tuned to locate a zero-beat frequency at the sampler output then tuned for a 1 MHz beat. The sampler offset and efficiency (or frequency response) are then adjusted so that the dc offset is 50 mV and the amplitude of the 1 MHz waveform is the same as the zero beat.

NOTE

Improper adjustment of efficiency may result in the loop easily breaking or not attaining phase lock.

Equipment

Oscilloscope ..... HP 1740A
Signal Source ..... HP 8640B or HP 3336C

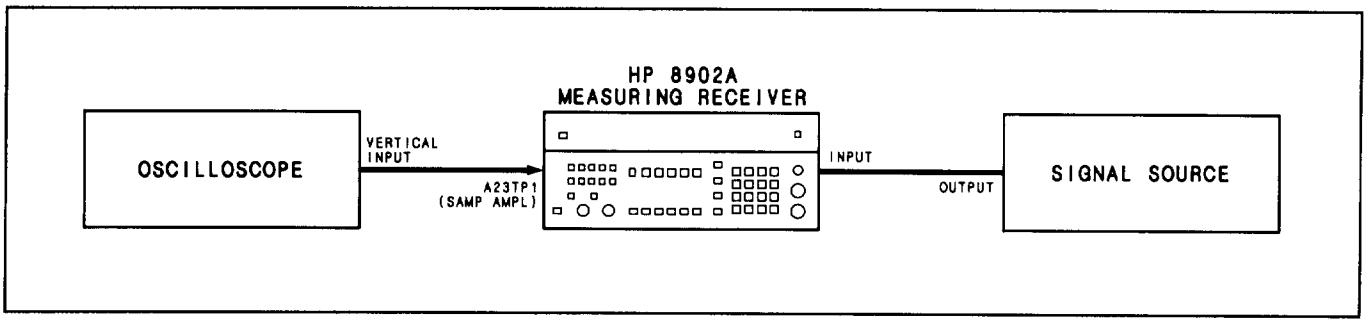


Figure 5–2. *Sampler Efficiency and Offset Adjustment Test Setup*

Procedure

1. Set the signal source to 18 MHz CW at 0 dBm.
2. Connect the equipment as shown in Figure 5–2. (The oscilloscope input should be ac coupled. The signal source can be connected either to a sensor module or directly the the Measuring Receiver's INPUT.)
3. Set the oscilloscope's vertical sensitivity to 0.2 V/division and horizontal scale for 10 μs/division.
4. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press TRACK MODE. If the instrument fails to tune to the 18 MHz signal, key in 18 MHz then press TRACK MODE.

5. Fine tune the signal source up slowly until a zero beat signal appears on the oscilloscope. Then increase the signal source frequency by 1 kHz. Note the frequency of the signal source. Note the peak-to-peak amplitude on the oscilloscope.

Signal Source Frequency: _____ MHz
Waveform Amplitude: _____ mVpp

6. Tune the signal source up by 30.0 kHz. This tunes the high-frequency VCO up 32 × 30 kHz ≈ 1 MHz since the LO frequency is the HF VCO frequency divided by 32 on this band.

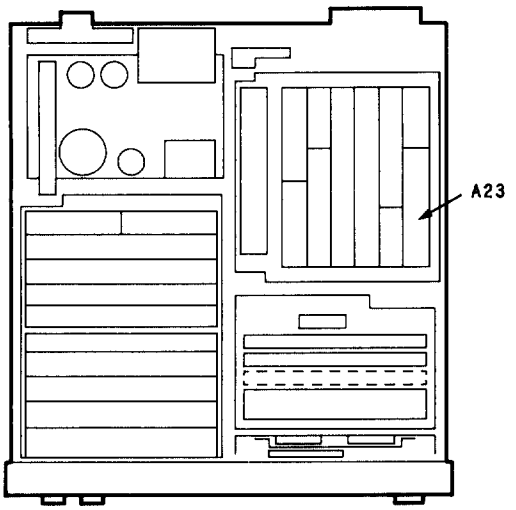
7. Adjust A23R34 (OFS) such that when the input coupling of the oscilloscope is changed from ac to dc the waveform shifts upward 50 mV. Adjust A23R34 only when the input coupling is set to dc.

8. Adjust A23R54 (EFF) for the same peak-to-peak amplitude on the oscilloscope as noted in step 5. If the adjustment has not enough range:

   a. Set A23R54 fully ccw and repeat steps 5 to 7.

   b. The signal amplitude step 5. If it is not, replace A23R55 by higher values of resistance as listed in the following table. If this still does not have enough effect, replace A23C45 with 2.7 pF (HP Part Number 0160-4619).

   c. Adjust A23R54 for the same amplitude as noted in step 5.



9. Repeat step 7.

10. Key in 54.0 SPCL to run the LO tuning test. The display should show 0.

Part Numbers for A23R55

Resistance (Ω)	HP Part Number
511	0757-0416
750	0757-0420
1000	0757-0280
1210	0757-0274
1470	0757-1094
1780	0757-0278

Adjustment 5—LO Doubler Output Power and Balance

Reference

Service Sheet 17.

Description

The power from the LO is monitored with a power meter while the LO is stepped through its doubler band. The bias and coupling components are changed as necessary to obtain the required power output. The LO is then monitored on a spectrum analyzer as the LO is swept slowly over its doubler band. The doubler balance is adjusted for minimum ½ and ³⁄₂ harmonics of the doubled frequency.

NOTE

Excessive subharmonics can cause the LO to tune to a wrong frequency when automatically tuning.

Equipment

Sensor Module ..... HP 11722A
RF Spectrum Analyzer ..... HP 8559A/182T

Procedure

NOTE

In the following procedure, a power meter and power sensor combination can be substituted for the sensor module. The Measuring Receiver can then be left in the frequency measurement mode.

1. Connect the sensor module to the Measuring Receiver's SENSOR and INPUT connectors.
2. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
3. Zero and calibrate the sensor module using the RF power calibrator in the Measuring Receiver. Set LOG/LIN to read in dBm.
4. Connect the sensor module's input directly to A19J3 (LO OUT), or for Option 003, the rear-panel LO OUTPUT connector.
5. On the Measuring Receiver, press FREQ. Key in 650 MHz to set the LO to the bottom of its doubler band.
6. Step the LO frequency up in 50 000 kHz steps. (Key in 50 000 ↑ kHz for the first step, then ↑ kHz thereafter.) For each step, press FREQ to tune the LO, then press RF POWER and note the power reading. Do this until Error 20 or Error 15 is displayed. (The LO has reached the top of its range or the frequency is beyond the range of the caibration factors of the sensor module.) The power readings should be between +1.4 and +3.0 dBm. If the power readings are within range, continue with step 7. If the power readings are out of range, change the components on A19 according to the following guidelines.
   a. To increase the power throughout the entire doubler band, decrease the value of A19R63. (Use values within the range 38.1 to 110Ω.)

b. To eliminate low-frequency roll-off, increase the value of A10C43. Do not use a value of C43 that is larger than necessary or the effectiveness of the high-pass filter is reduced. (Use values within the range 4.7 to 15 pF.)

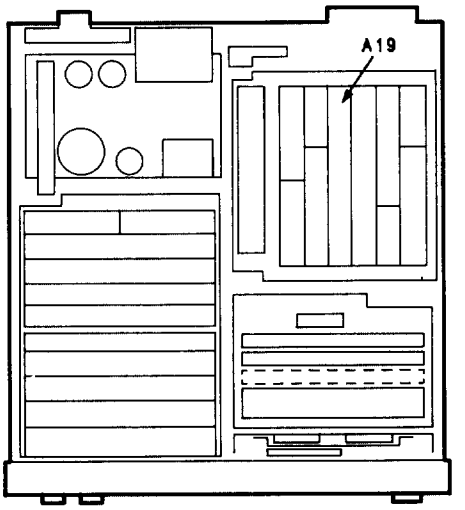
c. To eliminate high-frequency roll-off, increase the values of both A19R72 and R74 equally. (Use values within the range 121 to 619Ω.)

d. The effect of changing these components is interactive, therefore, whenever a component is changed, the power must be rechecked over the entire doubler band.

7. Set the spectrum analyzer to view a +10 dBm signal with a 0 to 2 GHz span width and log display. Connect its RF input to A19J3 (LO OUT), or for Option 003, the rear-panel LO OUTPUT connector.

8. On the Measuring Receiver, press the blue key then press INSTR PRESET. Key in 55.0 SPCL to cause the LO to sweep slowly over its doubler range.

9. Adjust A19R41 (DBLR BAL) for the minimum level of the ½ and ³⁄₂ harmonics of the doubled signal over the swept range. The ½ and ³⁄₂ harmonics should be more than 30 dB below the doubled signal. The doubled signal sweeps from approximately 600 to 1300 MHz with a level of approximately +2 dBm.



NOTE

To ease adjustment, note the frequency of the fundamental where harmonics are worst, manually tune to that frequency (use the frequency increment keys to assist in fine tuning), make the adjustment, then key in 55.0 SPCL and recheck the entire range. The sweep can be halted at any time by pressing the SPCL key.

Adjustment 6—Voltmeter Offset and Sensitivity

Reference

Service Sheets 14 and 15.

Description

The dc offsets of the audio peak and average detectors are first adjusted. The voltmeter sensitivity is then adjusted while comparing the displayed reading to the level read by an external dc voltmeter. The sensitivity of the average detector is adjusted while comparing the average mode to the peak mode when detecting a sinusoidal signal.

Equipment

Audio Oscillator ..... HP 8903B
Digital Voltmeter ..... HP 3455A

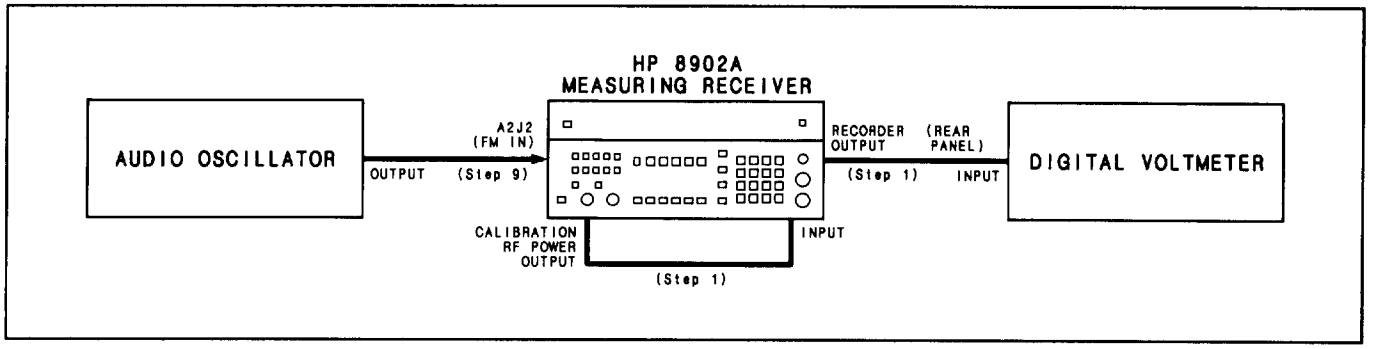
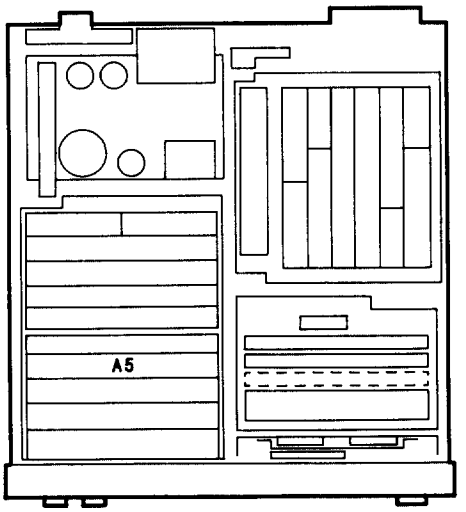


Figure 5–3. Voltmeter Offset and Sensitivity Adjustment Test Setup

Procedure

1. Connect the equipment as shown in Figure 5–3. Do not connect the audio oscillator to the Measuring Receiver at this time. (The Measuring Receiver's INPUT can be connected either directly to the CALIBRATION RF POWER OUTPUT or through a sensor module.)
2. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 45.16 SPCL to turn on the RF power calibrator. (This provides a signal for the Measuring Receiver to tune to.)
3. On the Measuring Receiver, set HP FILTER to 300 Hz and LP FILTER to 3 kHz. Key in 2.3 SPCL to set the audio gain to minimum. Key in 0.110 SPCL to set the audio input and audio overvoltage detector to no input and no reset. Key in 49. S (shift) 0 SPCL to set the voltmeter to measure and display the audio peak detector output.
4. Adjust A5R38 (PK DET OFS) for a display between 0.0003 and 0.0007.
5. Key in 49.9 SPCL to set the voltmeter to measure and display the average detector output.
6. Set A5R2 (RECT OFS) fully ccw to shut off A5U3.
7. Adjust A5R18 (AVG OFS) for a display between −0.0001 and +0.0001.



8. Set A5R2 (RECT OFS) fully cw then slowy ccw until the display reads between 0.0004 and 0.0006.
9. Set the audio oscillator for 2 kHz at 1 Vrms. Connect its output to A2J2 (FM IN) of the Measuring Receiver as shown in Figure 5-3.
10. On the Measuring Receiver, press FM. Key in 49.0 S (shift) 0 SPCL to connect the output from the audio peak detector to the RECORDER OUTPUT.
11. Adjust the audio oscillator level until the external voltmeter reads between +1.999 and +2.001 Vdc.
12. Adjust A5R73 (VM SENS) for a display on the Measuring Receiver between 199.9 and 200.1, or if the level has drifted slightly, until the four digits of the display agree with the first four digits of the voltmeter reading to within ±1 digit.
13. On the Measuring Receiver, key in 49.09 spcl.
14. Adjust A5R23 (AVG SENS) for a display on the Measuring Receiver between 141.3 and 141.5, or if the level has drifted slightly, until the four digits of the display equals the voltmeter reading to within ±1 digit.
15. On the Measuring Receiver, press PEAK+. Note the display. Press PEAK−. The two readings of the display should agree to within ±1 digit.
16. Perform *Adjustment 10—FM Sensitivity, Adjustment 13—ΦM Sensitivity,* and *Adjustment 15—AM Sensitivity.*

Adjustment 7—15 kHz and >20 kHz Low-Pass Filter Gain

Reference

Service Sheet 12.

Description

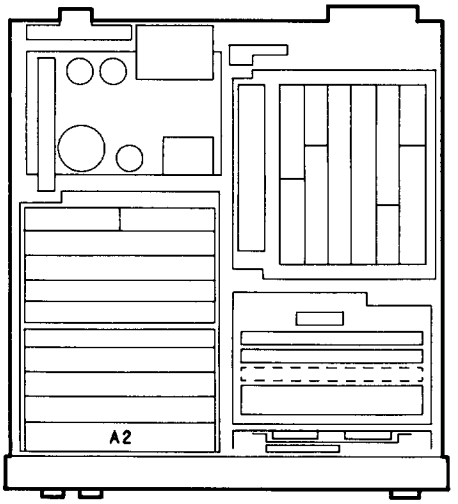
A signal generator is amplitude modulated at a 1 kHz rate. The signal is demodulated by the Measuring Receiver with no low-pass, audio filtering. Using the ratio feature, the demodulated signal is referenced to 100%. The low-pass filtering is then set to >20 kHz and 15 kHz, then the filter gain of each is adjusted for a reading of 100%.

Equipment

Signal Generator ..... HP 8640B

Procedure

1. Set the signal generator to 11 MHz at 0 dBm with 30% AM at a 1 kHz rate. Connect its RF output to the Measuring Receiver's INPUT. (The signal source can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press AM. Set DETECTOR to AVG.
3. Set RATIO on (with LOG/LIN set for a linear display). The display should show between 99.95 and 100.05% REL.
4. Set LP FILTER to >20 kHz. Adjust A2R44 (>20 kHz LPF GAIN) for a display of 99.95 to 100.05% REL.
5. Set LP FILTER to 15 kHz. Adjust A2R40 (15 kHz LPF GAIN) for a display of 99.95 to 100.05% REL.



Adjustment 8—ALC Reference

Reference

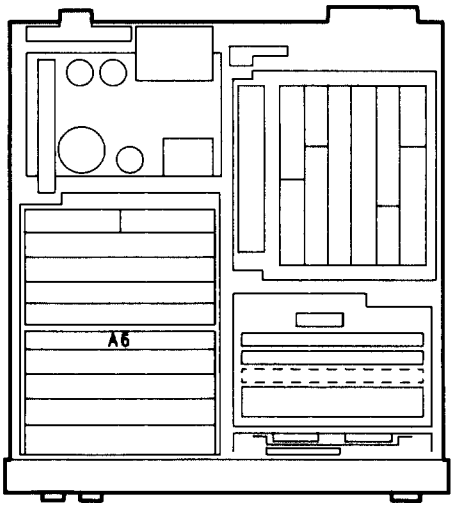
Service Sheet 8.

Description

The ALC reference voltage is adjusted while monitoring it with the internal voltmeter.

Procedure

1. Connect the CALIBRATION RF POWER OUTPUT to the INPUT. (The CALIBRATION RF POWER OUTPUT can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 45.16 SPCL to turn on the RF power calibrator. (This provides a signal for the Measuring Receiver's input.) Key in 49. S (Shift) 1 SPCL to connect the internal voltmeter to a node which represents the average IF level which the ALC loop forces to equal the ALC reference.
3. Adjust A6R65 (ALC REF) for a display between 2.0970 to 2.1030.



Adjustment 9—FM Calibrator

REFERENCE

Service Sheet 29.

DESCRIPTION

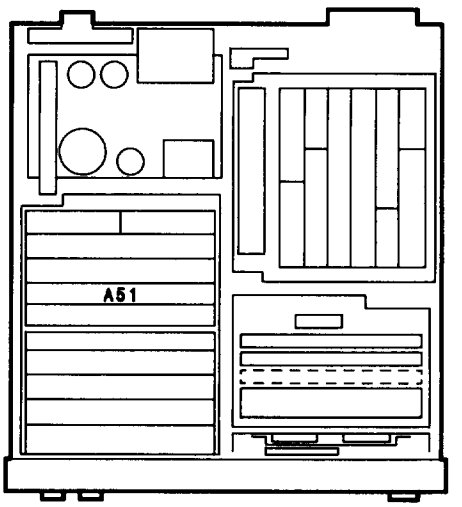
The FM calibrator is set to CW and its frequency is adjusted while being monitored by the internal counter. The calibrator is then set to modulate, and the symmetry is adjusted as the demodulated signal is measured with the peak+ and peak− detectors. The computed peak deviation is checked and if out of limits, a resistor is changed to bring the deviation within the proper limits.

NOTE

This calibration adjustment is not critical. Built-in safeguards minimize the possibility of erroneous calibration. If conditions exist that are out of calibration, the Measuring Receiver displays an error message.

PROCEDURE

1. Connect CALIBRATION AM/FM OUTPUT to INPUT. (The CALIBRATION AM/FM OUTPUT can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. Key 12.1 SPCL and 46.3 SPCL. This sets the FM calibrator to CW and connects the internal counter to measure the calibrator's frequency.
3. Using a non-metalic tool, adjust A51C20 (FREQ) for a display between 1009000 and 1011000. If the frequency cannot be adjusted high enough, change A51R32 to 11 kΩ (HP part number 0757-0443).
4. Key in 12.2 SPCL then 5.1 SPCL. This sets the instrument to display the demodulated FM from the calibrator and sets the peak detector time constant to slow.
5. Alternately set the DETECTOR to PEAK+ and PEAK− and note the display for each setting. Adjust A51R12 (TRAPEZOID SYMM) until the readings are the same for both detectors within ±0.010 kHz.
6. Key in 12.0 SPCL to set the instrument to display the computed FM deviation from the FM calibrator. The display should read between 30 and 38 kHz. If the peak deviation exceeds these limits, alter the value of A51R24. Increasing the value of A51R24 by 10% will decrease the peak deviation by approximately 2.5 kHz. Use resistors indicated in the following table.



Part Numbers for A51R24

Resistance (kΩ)	HP Part Number
26.1	0698-3159
28.7	0698-3449
31.6	0698-5446
34.8	0757-0123
38.3	0698-3161

Adjustment 10—FM Sensitivity

Reference

Service Sheet 11.

Description

The FM sensitivity is adjusted for a calibration factor of 100% while the Measuring Receiver measures the output of its FM calibrator.

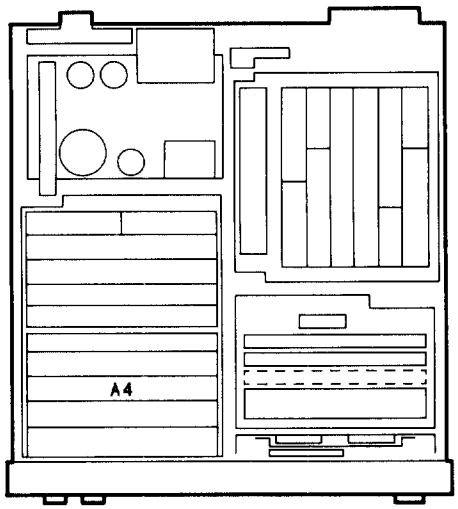
Procedure

1. Perform *Adjustment 9—FM Calibrator.*
2. Connect the CALIBRATION AM/FM OUTPUT to the INPUT. (The CALIBRATION AM/FM OUTPUT can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)

NOTE

For best accuracy, allow the Measuring Receiver to warm up for at least one-half hour.

3. Press FM then CALIBRATE. Allow at least two readings (approximately 40 seconds) to pass, then adjust A4R50 (FM SENS) for a display of 99.95 to 100.05%.



Adjustment 11—FM Flatness

Reference

Service Sheet 11.

Description

The AM/FM test source is frequency modulated at a 1 kHz rate with 400 kHz peak deviation. The demodulated FM is used as a reference. The modulation rate is increased to 150 kHz and the FM flatness is adjusted to bring the display back to the reference. The AM/FM test source is required to assure that the FM source has adequate bandwidth.

Equipment

AM/FM Test Source ..... HP 11715A
Audio Synthesizer ..... HP 3336C

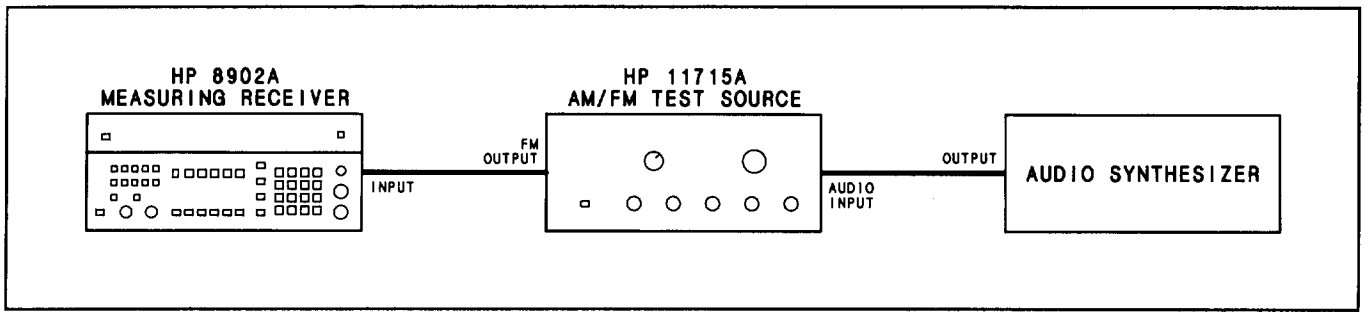
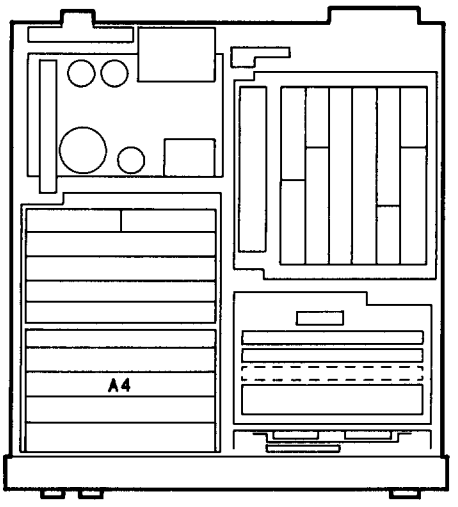


Figure 5–4. FM Flatness Adjustment Test Setup

Procedure

1. Connect the equipment as shown in Figure 5–4 using a short cable, approximately 0.3 meters (1 foot), to connect the audio synthesizer. (The AM/FM test source can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. With the leveling on, set the audio synthesizer to 1 kHz at +5 dBm. On the AM/FM test source, set the test mode to FM.
3. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
4. Tune the AM/FM test source's carrier frequency to approximately 400 MHz.
5. On the Measuring Receiver, press MHz to center its tuning. Press FM. Set DETECTOR to AVG. Adjust the audio synthesizer level for a display of approximately 280 kHz average deviation. Set RATIO on (with LOG/LIN set for a linear display).



6. Set the audio synthesizer frequency to 150 kHz without changing the level. Adjust A4R85 (FM FLATNESS) for a reading of 99.9 to 100.1% REL on the Measuring Receiver.

NOTE

If flatness does not adjust properly, try performing Adjustment 12—FM Distortion and Incidental AM—1.5 MHz IF.

Adjustment 12—FM Distortion and Incidental AM—1.5 MHz IF

Reference

Service Sheet 5.

Description

The AM/FM test source is frequency modulated at a 100 kHz rate with 400 kHz peak deviation. The peak deviation is measured with both the positive and negative peak detectors when the Measuring Receiver is tuned first to the signal and then to its image. The IF is adjusted so that the difference between the detector readings is the same for both signals. This method permits proper adjustment of distortion even in the presence of a small amount of distortion from the FM source. The incidental AM is measured on an FM signal modulated at a 1 kHz rate and 50 kHz peak deviation. The instrument is adjusted for minimum AM.

Equipment

AM/FM Test Source ..... HP 11715A
Audio Analyzer ..... HP 8903B

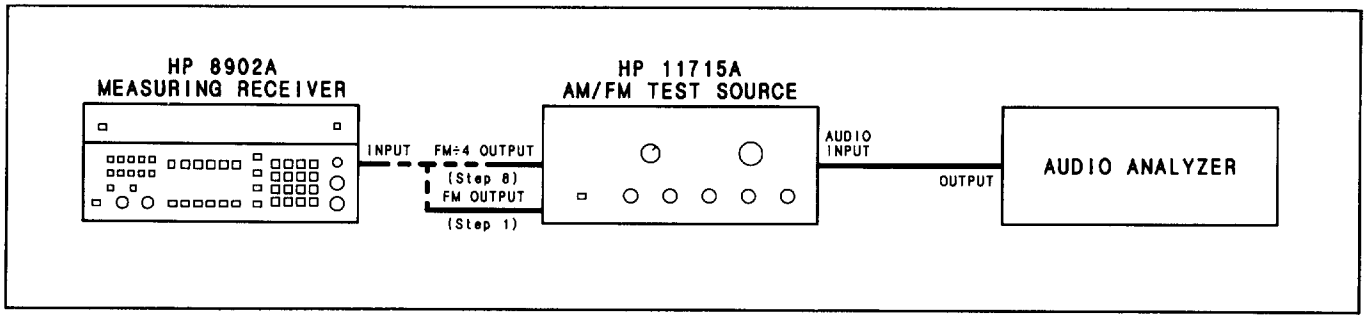


Figure 5–5. FM Distortion and Incidental AM—1.5 MHz Adjustment IF Test Setup

Procedure

1. Connect the equipment as shown in Figure 5–5. (The AM/FM test source output can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. Set the audio analyzer's oscillator to 100 kHz at 4V. On the AM/FM test source, set the test mode to FM.
3. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Set the HP FILTER to 50 Hz.
4. Tune the AM/FM test source's carrier frequency to approximately 400 MHz.
5. On the Measuring Receiver, press MHz to center its tuning. Press FM. Adjust the audio analyzer's oscillator level for a display of 400 kHz peak deviation on the Measuring Receiver.
6. On the Measuring Receiver, switch the DETECTOR between PEAK+ and PEAK– and note the difference between the two readings. Adjust A18R23 (FM DISTN 1.5 MHZ IF) for equal readings between PEAK+ and PEAK–.
7. On the Measuring Receiver, key in 3000 ⇓ kHz to tune the Measuring Receiver to the signal image. Again switch between PEAK+ and PEAK–. The difference between the two readings should be less than 1.6 kHz. If it is not, adjust A18R23 again to diminish the difference by one half. Now note the reading for PEAK+ (PK1+) and PEAK– (PK1–). Press ⇑ kHz. Note the reading for PEAK+ (PK2+) and PEAK– (PK2–). The instrument is adjusted properly when

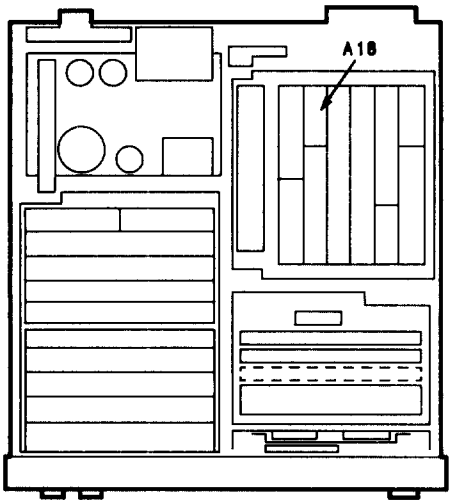
|(PK1+ − PK1−) + (PK2+ − PK2−)| < 1.6 kHz.

(Ideally, PK1+ should equal PK2−, and PK1− should equal PK2+.)

8. Connect the FM÷4 output of the AM/FM test source to the Measuring Receiver's INPUT.
9. On the Measuring Receiver, set LP FILTER to 3 kHz. Press AUTOMATIC OPERATION.
10. Set the audio analyzer's oscillator frequency to 1 kHz and level for a display of 50 kHz deviation on the Measuring Receiver.
11. On the Measuring Receiver, press AM. Adjust A18R19 (INC AM 1.5 MHZ IF) for a minimum display (but less than 0.2%).

NOTE

The specification for incidental AM requires that 0.5 times the residual AM be subtracted out. The residual FM can be measured by momentarily disconnecting the audio input to the AM/FM test source and noting the displayed AM. Subtracting 0.5 times the displayed AM from the AM measurement in step 11 gives the actual incidental AM.



Adjustment 13—ΦM SENSITIVITY

Reference

Service Sheet 13.

Description

The AM/FM test source is frequency modulated with a sinusoidal signal at a 1 kHz rate and with 100 kHz peak deviation. This is equivalent to 100 rad peak deviation since

$$\text{phase deviation} = \frac{\text{frequency deviation}}{\text{modulation rate}}.$$

The ΦM sensitivity is adjusted for a reading of 100 rad.

Equipment

AM/FM Test Source ..... HP 11715A
Audio Synthesizer ..... HP 3336C

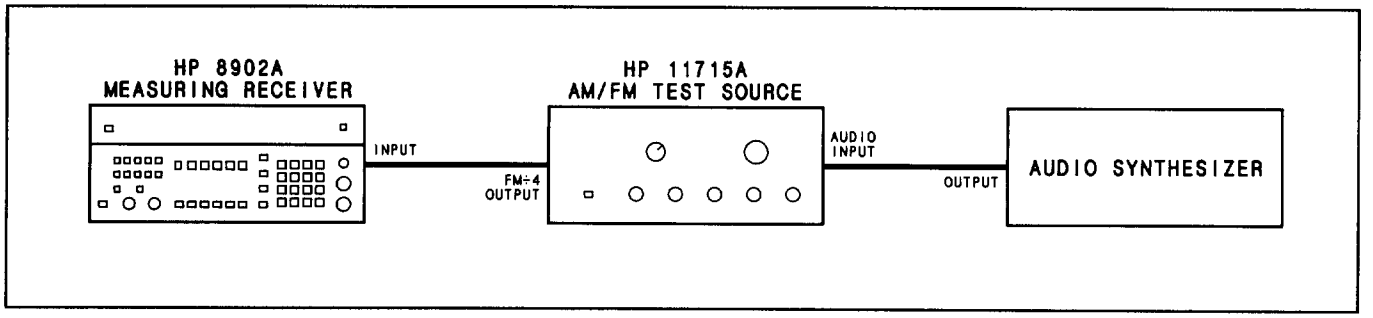
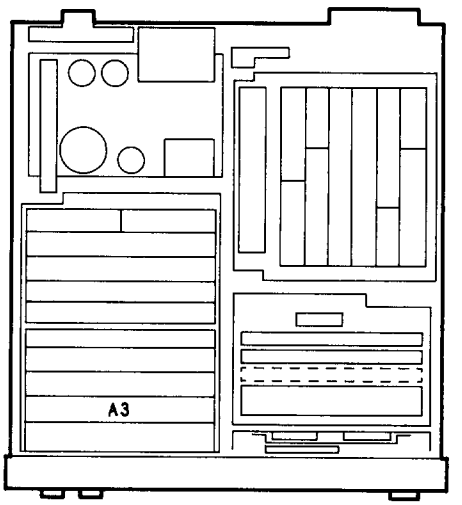


Figure 5–6. ΦM Sensitivity Adjustment Test Setup

Procedure

1. Connect the equipment as shown in Figure 5–6. (The AM/FM test source output can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. Set the audio synthesizer to 1 kHz at +4 dBm. On the AM/FM test source, set the test mode to FM.
3. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Set HP FILTER to 300 Hz and LP FILTER to 3 kHz.
4. Tune the AM/FM test source's carrier frequency to approximately 100 MHz.
5. On the Measuring Receiver, press the MHz key to center its tuning. Press FM. Adjust the audio synthesizer for a display of 100 kHz on the Measuring Receiver.



6. On the Measuring Receiver, press ΦM. Adjust A3R27 (ΦM SENS) for a display of the same numerical value as the display in kHz of step 5 ±0.2 rad.

NOTE

If a test oscillator is used in place of the audio synthesizer, the modulation rate must be measured with a counter (or simply key in S (Shift) AUDIO FREQ). The adjustment is then made to give a display equal to the ratio (frequency deviation)/(modulation rate).

Adjustment 14—AM Calibrator

Reference

Service Sheet 30.

Description

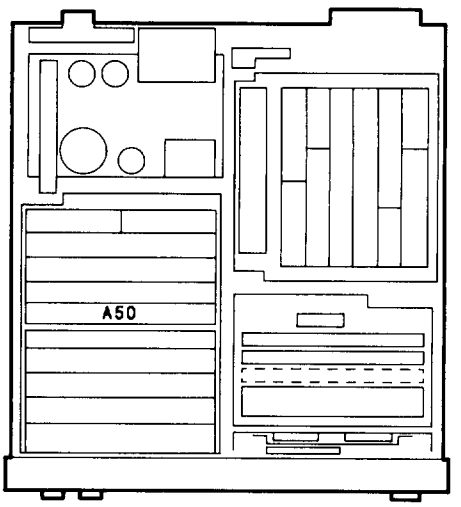
The Measuring Receiver is set to read %AM as computed from internal measurements. The AM depth is adjusted for 33.33%. The AM is then demodulated and the symmetry is adjusted as the signal is measured with the peak+ and peak− detectors.

NOTE

This calibration adjustment is not critical. Built-in safeguards minimize the possibility of erroneous calibration. If conditions exist that are out of calibration, the Measuring Receiver displays an error message.

Procedure

1. Connect CALIBRATION AM/FM OUTPUT to INPUT. (The CALIBRATION AM/FM OUTPUT can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. Key in 13.0 SPCL. This sets the instrument to display the AM computed from internal measurements.
3. Adjust A50R45 ("A" LVL) for a display of 33.330 to 33.336%.
4. Key in 49.5 SPCL. This Connects the internal voltmeter to measure the output level from the AM calibrator. The display should read between 1.8 and 2.2.
5. Key in 13.2 SPCL then 5.1 SPCL. This sets the instrument to display the demodulated AM from the calibrator and sets the peak detector time constant to slow.
6. Alternately set the DETECTOR to PEAK+ and PEAK− and note the display for each setting. Adjust A50R39 (SYMM) until the readings are the same for both detectors within ±0.015%.



Adjustment 15—AM Sensitivity

REFERENCE

Service Sheet 12.

DESCRIPTION

The AM sensitivity is adjusted for a calibration factor of 100% while the Measuring Receiver measures the output of its AM calibrator.

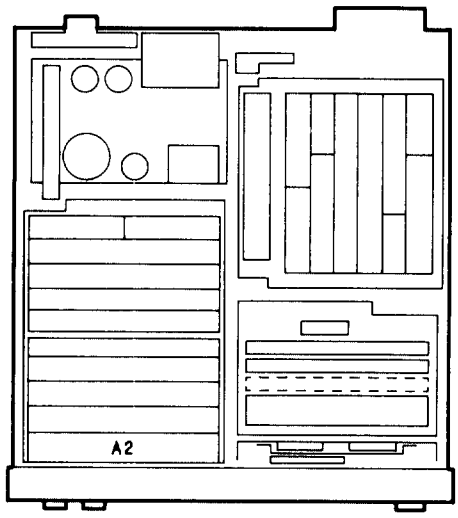
PROCEDURE

1. Perform *Adjustment 14—AM Calibrator.*
2. Connect the CALIBRATION AM/FM OUTPUT to the INPUT. (The CALIBRATION AM/FM OUTPUT can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)

NOTE

For best accuracy, allow the Measuring Receiver to warm up for at least one-half hour.

3. Press AM then CALIBRATE. Allow at least two readings (approximately 40 seconds) to pass, then adjust A2R6 (AM SENS) for a display of 99.95 to 100.05%.



Adjustment 16—FM Distortion and Incidental AM—455 kHz IF

Reference

Service Sheets 5 and 8.

Description

The signal generator is set to 2.45 MHz and frequency modulated at a 1 kHz rate with 10 kHz peak deviation. The incidental AM on the signal is measured and the instrument is adjusted for minimum AM. At 2.45 MHz the signal is not down converted by the Measuring Receiver but goes directly into the IF. The adjustment alters the rolloff characteristic of a 2.5 MHz IF low-pass filter, which is the principal source of the incidental AM.

For the 455 kHz IF, the AM/FM test source is frequency modulated at a 10 kHz rate with 10 kHz peak deviation. The demodulated FM is measured with a distortion analyzer and FM distortion is adjusted for a minimum. The incidental AM is measured with FM set for a 1 kHz rate and 5 kHz peak deviation. The instrument is adjusted for minimum AM.

Equipment

AM/FM Test Source	HP 11715A
Audio Analyzer	HP 8903B
Signal Generator	HP 8640B

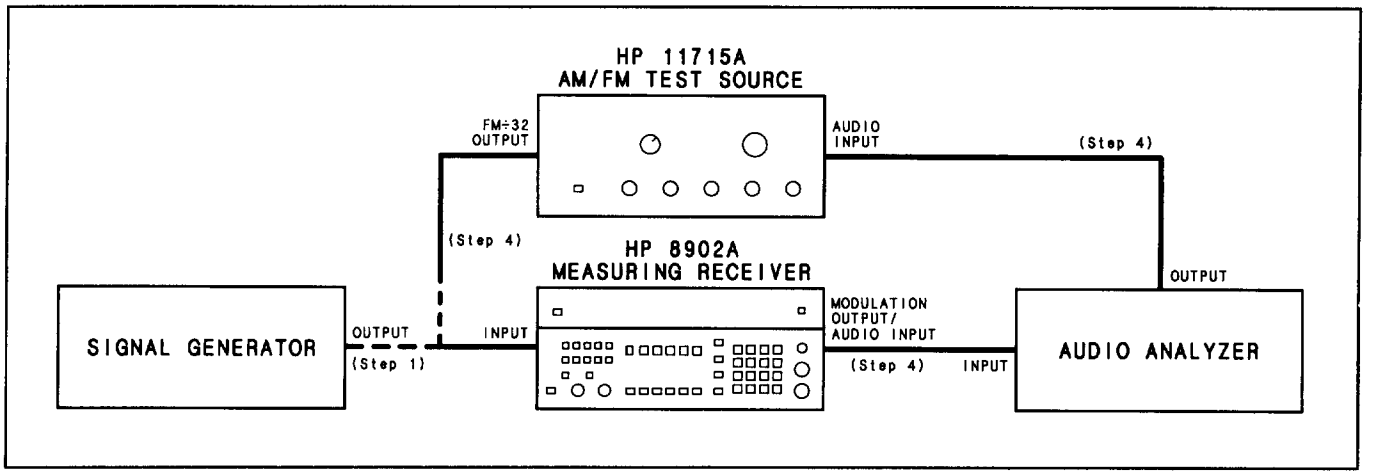


Figure 5–7. FM Distortion and Incidental AM—455 kHz IF Adjustment Test Setup

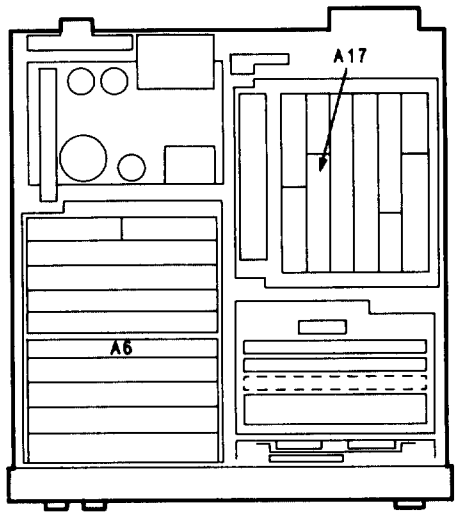
Procedure

NOTE

In the following procedure the RF modulation source can be connected either to a sensor module (which is connected to the Measuring Receiver) or directly to the Measuring Receiver's INPUT connector. The procedure is written for the latter case.

1. Set the signal generator to 2.45 MHz at 0 dBm with 10 kHz peak FM deviation at a 1 kHz rate. Connect its RF output to the Measuring Receiver's INPUT as shown in Figure 5–7.
2. On the Measuring Receiver, press the blue key and then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 34.0 SPCL to measure the IF

frequency. The IF should be approximately 2.45 MHz. If it reads approximately 0.455 MHz, tune the frequency down slightly until a reading of 2.45 MHz is obtained.



3. On the Measuring Receiver, press AM. Set HP FILTER to 50 Hz, LP FILTER to 3 kHz, and DETECTOR to AVG. Adjust A6C8 (IF FLATNESS) for a minimum display (but less than 0.2%).
4. Disconnect the signal generator and connect the remaining equipment as shown in Figure 5-7.
5. Set the audio analyzer's oscillator to 10 kHz at 4V. On the AM/FM test source, set the test mode to FM.
6. On the Measuring Receiver, press FREQ. Tune the AM/FM test source's carrier frequency to approximately 12.5 MHz.
7. On the Measuring Receiver, key in 3.1 SPCL to set the IF to 455 kHz, press FM, and set LP FILTER to >20 kHz and DETECTOR to PEAK+.
8. Adjust the audio analyzer's oscillator level for a Measuring Receiver display of 10 kHz peak deviation.
9. Set the distortion analyzer (in the audio analyzer) to measure the distortion on the 10 kHz signal at the MODULATION OUTPUT/AUDIO INPUT with 30 kHz of low-pass filtering on the distortion analyzer.
10. Adjust A17L11 (FM DISTN 455 KHZ IF) for minimum distortion but less than 0.1% (less than −60 dB).
11. On the Measuring Receiver, set LP FILTER to 3 kHz.
12. Set the audio analyzer's oscillator frequency to 1 kHz and level for 5 kHz peak deviation on the Measuring Receiver.
13. On the Measuring Receiver, press AM. Adjust A17L8 (INC AM 455 KHZ IF) for a minimum display (but less than 0.2%).

NOTE

The specification for incidental AM requires that 0.5 times the residual AM be subtracted out. The residual AM can be measured by momentarily disconnecting the audio input to the AM/FM test source and noting the displayed AM on the Measuring Receiver. Subtracting 0.5 times the displayed AM from the AM measured in step 14 gives the actual incidental AM.

14. If a significant adjustment was made in either step 10 or step 13, repeat steps 5 through 14.

Adjustment 17—Track-Tune Mode Offset

REFERENCE

Service Sheet 20.

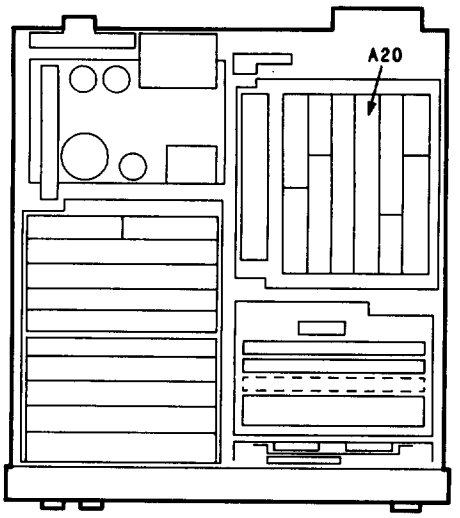
DESCRIPTION *(2305A TO 2529A)*

The Measuring Receiver is tuned to a signal and put in the track-tune mode. The frequency of the IF is measured and the offset is adjusted to bring the frequency to within ±20 kHz of 1.5 MHz.

DESCRIPTION *(2530A AND ABOVE)*

The Measuring Receiver is tuned to a signal and put in the track-tune mode with a 455 kHz IF. The frequency of the IF is measured and the offset is adjusted to bring the frequency to within ±500 Hz of 455 kHz.

PROCEDURE *(2305A TO 2529A)*



1. Connect the CALIBRATION RF POWER OUTPUT to the INPUT. (The CALIBRATION RF POWER OUTPUT can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 45.16 SPCL to turn on the RF power calibrator. (This provides a signal for the Measuring Receiver's input.)
3. Key in 34.0 SPCL to set the instrument to measure the IF frequency. Press TRACK MODE.
4. Adjust A20R1 (TRK OFS) for a display between 1.480 and 1.520 MHz.

PROCEDURE *(2530A AND ABOVE)*

1. Connect the CALIBRATION RF POWER OUTPUT to the INPUT. (The CALIBRATION RF POWER OUTPUT can be connected either to a sensor module or directly to the Measuring Receiver's INPUT.)
2. Press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 45.16 SPCL to turn on the RF power calibrator. (This provides a signal for the Measuring Receiver's input.)
3. Press MHz. Press TRACK MODE. Key in 0.072 SPCL. (This puts the Measuring Receiver in the 455 kHz IF, manual track-tune mode.) Key in 46.1 SPCL to set the instrument to measure the IF frequency.
4. Adjust A20R1 (TRK OFS) for a display between 45450 and 45550.

Adjustment 18—Power Reference (Using Reference Comparison)

Reference

Service Sheet 3.

Description

The frequency of the internal power reference is checked and adjusted, if necessary, to 50 MHz. The power from an external 1 mW power reference is measured with a power sensor and the power meter of the Measuring Receiver. The same power sensor and power meter are then used to measure the power from the Measuring Receiver's power reference. The Measuring Receiver's power reference is adjusted to give the same reading as for the external power reference.

NOTE

After adjustment, the accuracy of the Measuring Receiver's power reference will be ±1.2%. Greater accuracy can be obtained by using a recently calibrated external power reference or by following the procedure in Adjustment 19—Power Reference (Using DC Substitution).

Equipment

Power Reference	HP 435A Opt K05
Sensor Module	HP 11722A

Procedure

1. Connect the sensor module's cables to the SENSOR and INPUT of the Measuring Receiver. Connect the sensor module's input to the CALIRATION RF POWER OUTPUT. (If a sensor module is not available, connect the Measuring Receiver's INPUT directly to the CALIBRATION RF POWER OUTPUT.)
2. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 45.16 SPCL to turn on the RF power calibrator. Press TRACK MODE. The Measuring Receiver's display should read between 49.5 and 50.5 MHz.
3. If the frequency of the RF power calibrator is not within the proper limits, remove the thumb screw retaining the A32 Power Reference Oscillator and slide the assembly out. Adjust A32L1 for a frequency reading between 49.5 and 50.5 MHz. (The adjustment is accessed through a hole on the back side of the assembly.)

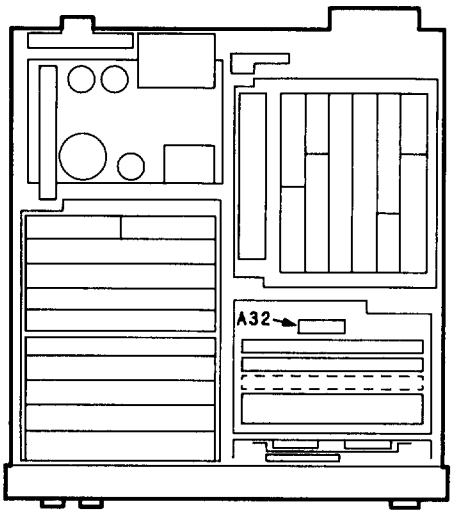
CAUTION

After removing the RF power calibrator assembly, take care that the power supply terminals do not short against the metal chassis parts.

NOTE

If the frequency of the power reference is already within the proper limits, do not attempt to adjust the frequency to exactly 50 MHz. To do so may unnecessarily affect the level.

4. Reinstall the A32 assembly. (The thumb screw need only be finger tight.)
5. Connect the input of the sensor module (or a compatible power sensor connected to the Measuring Receiver's SENSOR input) to the output of the external power reference.
6. On the Measuring Receiver, press ZERO and wait for the power sensor to zero.
7. On the Measuring Receiver, press RF POWER. Press RATIO and check that LOG/LIN is in the linear mode. (The display should read between 99.9 and 100.1% REL.)
8. Connect the sensor module to the CALIBRATION RF POWER OUTPUT of the Measuring Receiver. Press ZERO and allow the instrument to zero. Adjust A32R4 (LEVEL ADJ) for a reading between 99.9 and 100.1% REL. If the adjustment runs out of range, replace A32R5 with 7500Ω and readjust A32R4.



Adjustment 19—Power Reference (Using DC Substitution)

Reference

Service Sheet 3.

Description

The frequency of the internal power reference is checked and adjusted, if necessary, to 50 MHz. The power from the power reference oscillator is measured by a method known as dc substitution. In this method a power-sensing thermistor is placed in one arm of a self-balancing, dc resistance bridge. With no power applied, the dc voltage supplying the top of the bridge is automatically adjusted until the thermistor heats to the temperature that produces the resistance required to bring the bridge into balance. When RF power is applied to the thermistor, the thermistor heats up and momentarily unbalances the bridge. The self-balancing circuits then readjust the supply voltage to the bridge to rebalance it. A second bridge, which senses only the ambient temperature, is employed to compensate for measurement drift. Careful measurement of the bridge dc voltages provides a way to determine the amount of RF power applied to the thermistor to a higher degree of accuracy than can be obtained by direct reading of the power meter.

NOTE

After adjustment, the accuracy of the Measuring Receiver's power reference will be ±0.7%. A simpler, but less accurate method for adjusting the power reference can be found in Adjustment 18—Power Reference (Using Reference Comparison).

Equipment

Digital Voltmeter	HP 3455A
Power Meter	HP 432A
Thermistor Mount	HP 478A Opt H75

Procedure

1. On the Measuring Receiver, connect the CALIBRATION RF POWER OUTPUT to the INPUT. (If a sensor module is being used, connect its input to the CALIBRATION RF POWER OUTPUT.)
2. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 45.16 SPCL to turn on the RF power calibrator. Press TRACK MODE. The Measuring Receiver's display should read between 49.5 and 50.5 MHz.
3. If the frequency of the RF power calibrator is not within the proper limits, remove the thumb screw retaining the A32 Power Reference Oscillator and slide the assembly out. Adjust A32L1 for a frequency reading between 49.5 and 50.5 MHz. (The adjustment is accessed through a hole on the back side of the assembly.)

CAUTION

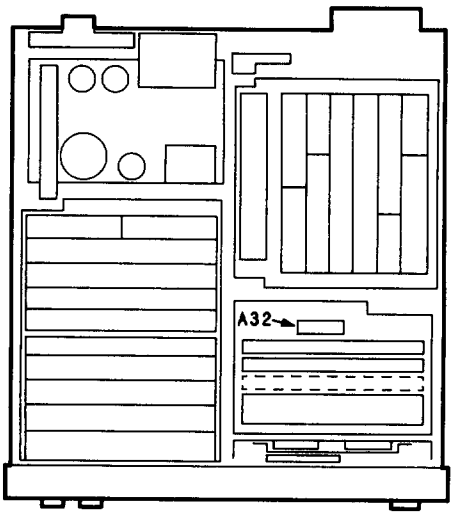
After removing the RF power calibrator assembly, take care that the power supply terminals do not short against the metal chassis parts.

NOTE

If the frequency of the power reference is already within the proper limits, do not attempt to adjust the frequency to exactly 50 MHz. To do so may unnecessarily affect the level.

4. Reinstall the A32 assembly. (The thumb screw need only be finger tight.)
5. With the HP 432A Power Meter switched off and the thermistor interconnect cable connected to it but not to the thermistor mount, measure the resistance between the center conductor of the rear-panel VRF connector and pin 1 (the first pin to the right of the key slot) on the thermistor end of the interconnect cable. Record the value of the mount resistance for future reference. (It should be approximately 200Ω.)

   Mount Resistance (R): _____ Ω
6. Connect the equipment as shown in Figure 5–8. The input of the digital voltmeter should be floating. The positive input of the voltmeter should be connected to the rear-panel VCOMP connector of the HP 432A Power Meter, the negative input to the VRF connector. Switch the equipment on and let it warm up for at least 30 minutes.



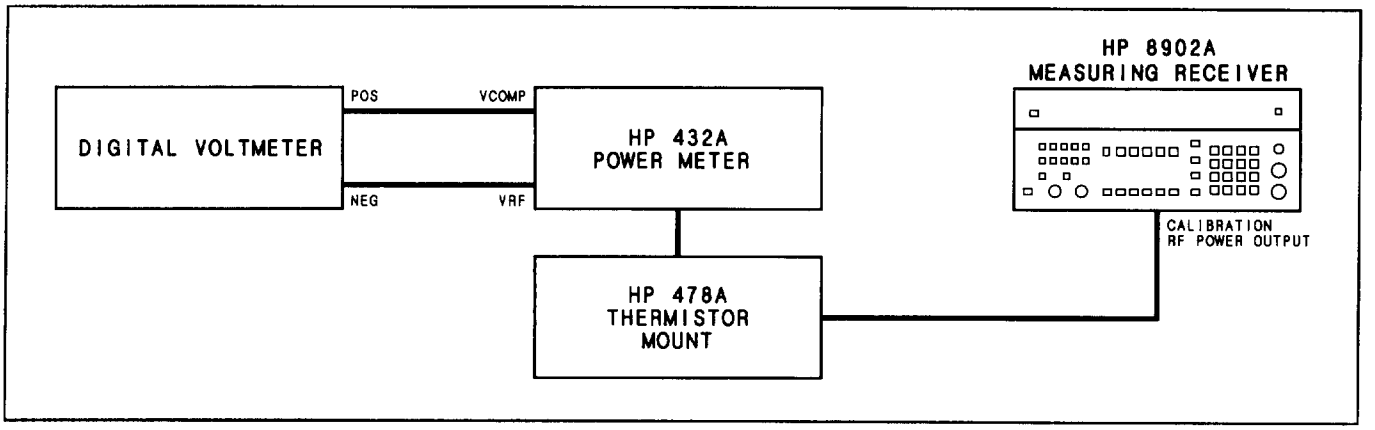


Figure 5–8. *Power Reference Adjustment Test Setup*

7. On the Measuring Receiver, key in 45.0 SPCL to switch the power reference off.
8. Set the HP 432A Power Meter RANGE to COARSE ZERO and adjust the front-panel COARSE ZERO to obtain a zero meter indication.
9. Fine zero the HP 432A Power Meter on the most sensitive range, then set the RANGE switch to 1 mW (0 dBm).

10. Observe the voltage reading on the voltmeter. If the reading is greater than 400 μV, press and hold the FINE ZERO switch on the HP 432A Power Meter and adjust COARSE ZERO so that the voltmeter reads less than 200 μV then release the FINE ZERO switch. Record the voltmeter reading.

$V_{COMP} - V_{RF}$ with No Power (V_0): _____ Vdc

11. Connect the voltmeter to read V_{COMP} (with respect to chassis ground) on the HP 432A Power Meter. (The voltmeter's negative input should connect to chassis ground.)

12. On the Measuring Receiver, key in 45.16 SPCL. Record the voltmeter reading.

V_{COMP} with 1 mW: _____ Vdc

13. Reconnect the voltmeter leads as shown in Figure 5–8 (where VRF is connected to the negative input of the voltmeter).

14. The voltmeter is now set up to measure V_1 which represents the reference output level. Compute the desired value of V_1 (for 1 mW) from the equation

$$V_1 = V_{COMP} - \sqrt{(V_{COMP} - V_0)^2 - 0.004RH}$$

where H is the effective efficiency of the thermistor mount at 50 MHz as read from the mount's label.

Desired V_1: _____ Vdc

15. Adjust A32R4 (LEVEL ADJ) until the voltmeter reading is the same as V_1 computed in step 14. If the adjustment runs out of range, replace A32R5 with 7100Ω and readjust A32R4.

Adjustment 20—Power Meter

Reference

Service Sheet 1.

Description

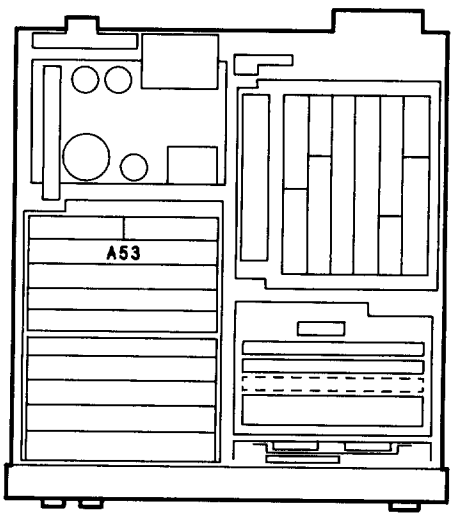
The frequency of the 220 Hz multivibrator is adjusted for a maximum power reading of a nominal input signal. This occurs when the phase shift through the ac amplifier chain of the power meter is zero. Two linearity adjustments are then made on the two highest power ranges using a power meter range calibrator.

Equipment

Extender Cable ..... HP 08901-60179
Range Calibrator ..... HP 11683A

Procedure

1. Connect the power meter output of the range calibrator to the Measuring Receiver's SENSOR input.
2. On the range calibrator, set the function to calibrate, polarity to normal, and range to 1 mW.
3. On the Measuring Receiver, press RF POWER. Adjust A53R40 (FREQ) for a maximum reading on the Measuring Receiver's display (approximately 1 mW).
4. On the Measuring Receiver, press S (Shift) AUDIO FREQ. Set AUDIO INPUT to read external.
5. On the Measuring Receiver, connect the MODULATION OUTPUT/AUDIO INPUT to A53TP4 (MLTVIB). The Measuring Receiver's display should read between 204 and 236 Hz.
6. Remove the cable from A53TP4.
7. On the range calibrator, set the function to standby.
8. On the Measuring Receiver, press RF POWER. Press ZERO and wait for the instrument to zero.
9. On the range calibrator, set the function to calibrate.



10. On the Measuring Receiver, press CALIBRATE then press the blue key then press SAVE CAL (again, the CALIBRATE key). This normalizes the power reading to 1 mW. (The CALIBRATE key light should be on.)
11. On the Measuring Receiver, key in 10.4 SPCL to set the power meter to range 4.
12. Set the range calibrator range to 10 mW. The Measuring Receiver's display should read between 9.99 and 10.01 mW. If it does not, perform the following steps.
    a. Switch the Measuring Receiver off and extend the A53 RF Power Assembly.
    b. Connect the extender cable to the RF Power Assembly. Connect the range calibrator to the sensor connector on the extender cable.
    c. Switch the Measuring Receiver back on. Repeat steps 7 to 12.
    d. Adjust A53R13 (RNG 4) for a Measuring Receiver display of 10.00 mW.

13. On the Measuring Receiver, key in 10.5 SPCL to set the power meter to range 5.
14. Set the range calibrator range to 100 mW. The Measuring Receiver's display should read between 99.9 and 100.1 mW. If it does not, perform the following steps.
    a. If the A53 RF Power Assembly is already extended, go to step e.
    b. Switch the Measuring Receiver off and extend the A53 RF Power Assembly.
    c. Connect the extender cable to the RF Power Assembly. Connect the range calibrator to the sensor connector on the extender cable.
    d. Switch the Measuring Receiver off and extend the A53 RF Power Assembly. (Reconnect the two cables on the top of the assembly.)
    e. Switch the Measuring Receiver back on. Repeat steps 7 to 14.
    d. Adjust A53R16 (RNG 5) for a Measuring Receiver display of 100.0 mW.

Adjustment 21—Audio True RMS Detector and Notch Filter Gain

Reference

Service Sheet 16.

Description

The offset of the audio true rms detector is first adjusted to read zero with no audio input, then a signal of known level is applied to the detector and the sensitivity of the detector is adjusted to read the correct level. The gain of the audio notch filter is adjusted for a reading of 100% with an input signal that is twice the frequency of the notch filter.

Equipment

Audio Oscillator ..... HP 8903B
Digital Voltmeter ..... HP 3455A

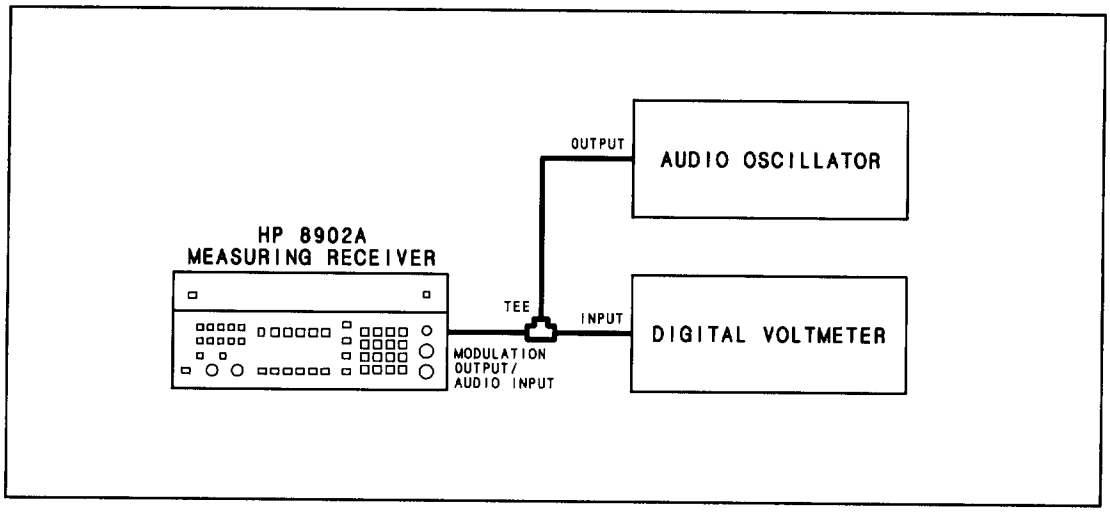
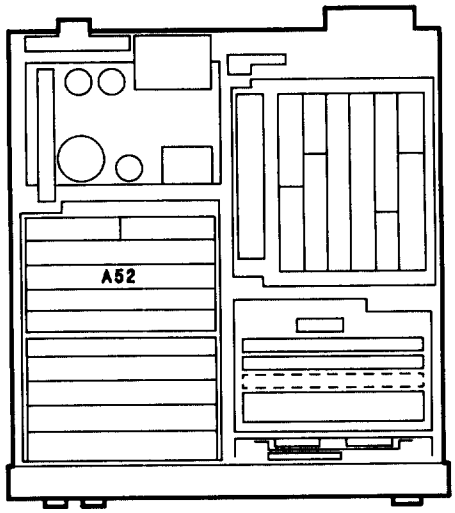


Figure 5–9. Audio True RMS Detector and Notch Filter Gain Adjustment Test Setup

Procedure

1. Remove any cable from the MODULATION OUTPUT/AUDIO INPUT connector of the Measuring Receiver.
2. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 30.0 SPCL to set the instrument to measure and display the voltage at the MODULATION OUTPUT/AUDIO INPUT connector with the audio true rms detector. Key in 49.7 SPCL to measure and display the output of the audio true rms detector. (The displayed voltage will be ten times the level displayed with Special Function 30.)
3. Adjust A52R47 (RMS OFS) for a reading on the Measuring Receiver's display between −0.0005 and 0.0005.
4. Key in 30.0 SPCL. The display should read 0.0000 V.
5. Connect the equipment as shown in Figure 5–9.
6. Set the audio oscillator for 3.9 Vrms into an open circuit at 2 kHz. Set the voltmeter to read ac volts.

7. Adjust A52R38 (RMS SENS) for a reading on the display of the Measuring Receiver that is the same as the reading on the voltmeter to the third decimal place. (The readings should be approximately 3.9 Vrms.)
8. Set the audio oscillator level to 100 mVrms.
9. On the Measuring Receiver, press S (Shift) AUDIO DISTN. Adjust A52R44 (NOTCH FLTR GAIN) for a display on the Measuring Receiver between 99.9 and 100.1%.
10. Set the audio oscillator frequency to 800 Hz.
11. On the Measuring Receiver, press the blue key then press 400 Hz DISTN (the PEAK– key). The Measuring Receiver's display should read greater than 98%.



Adjustment 22—Battery Backup

Reference

Service Sheet 24.

Description

The battery backup circuit switches the supply for the internal RAM to an internal battery when either the +12V or +5V supply drops. The two supplies are measured on the memory assembly and the voltage at which the backup switches is adjusted to a level based on the measured supply voltages.

Equipment

Digital Voltmeter ..... HP 3455A

Procedure

1. Connect the voltmeter to A13TP10 (+5V). Measure and record the dc voltage with respect to ground.

   Voltage at A13TP10 _____ Vdc

2. Connect the voltmeter to A13TP12 (+12V). Measure and record the dc voltage with respect to ground.

   Voltage at A13TP12 _____ Vdc

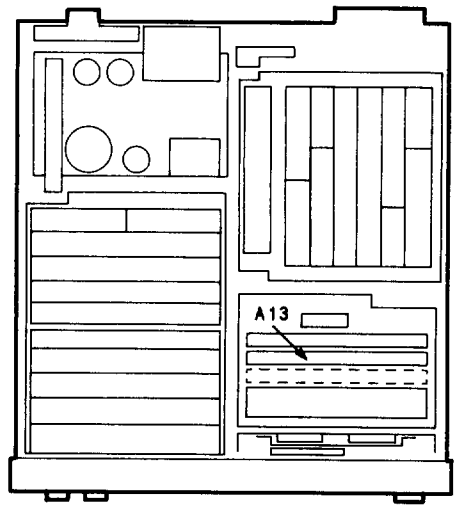
3. Make the following calculations.

   $\frac{2}{5}$ × Voltage at A13TP10 = _____ Vdc

   $\frac{1}{6}$ × Voltage at A13TP12 = _____ Vdc

4. Make the following calculalation.

   0.95 × Lowest Voltage of Step 3 = _____ Vdc



5. Connect the voltmeter to A13TP11 (VR). Adjust A13R12 (VR) until the voltmeter reads within ±0.05V of the voltage calculated in step 4.

Adjustment 23—Narrow 455 kHz IF Filter

REFERENCE

Service Sheet 6.

DESCRIPTION

An x-y plot of the frequency response of the narrow 455 kHz IF filter is obtained by sweeping the IF with a signal generator and looking at the response on an oscilloscope with its x axis driven by the sweep output of the signal generator. The filter's overall response is checked and adjustments are made only if the filter is out of limits. The overall IF gain is also adjusted.

Adjustment of the filter begins by adjusting overall flatness and slope. If the adjustment is inadequate, then the first stage of the filter is observed as succeeding stages are shorted out and adjustments made to the filter components to bring about responses of a particular given shape.

EQUIPMENT

Divider Probe, 10:1	HP 10040A
Oscilloscope	HP 1740A
Signal Generator	HP 3336C
Adjustment Tool	8710-0772

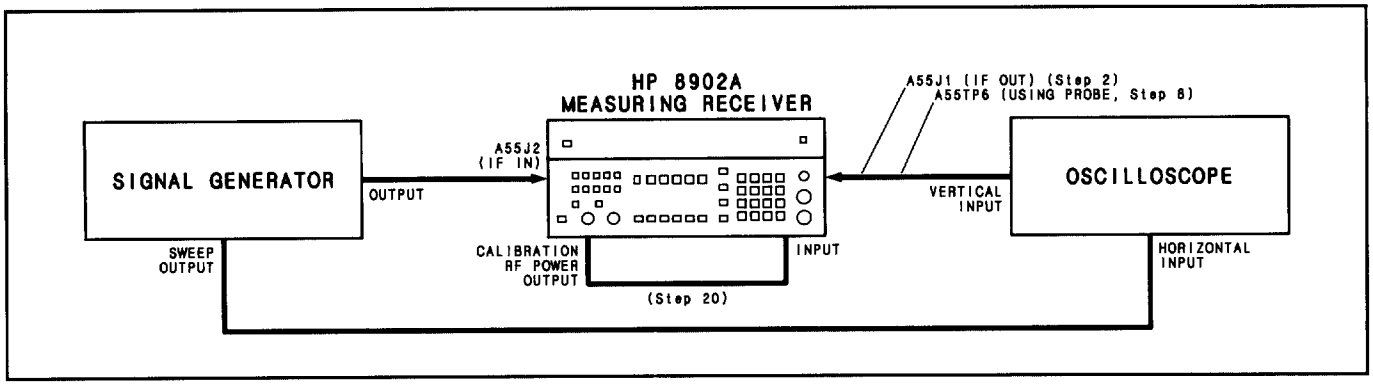
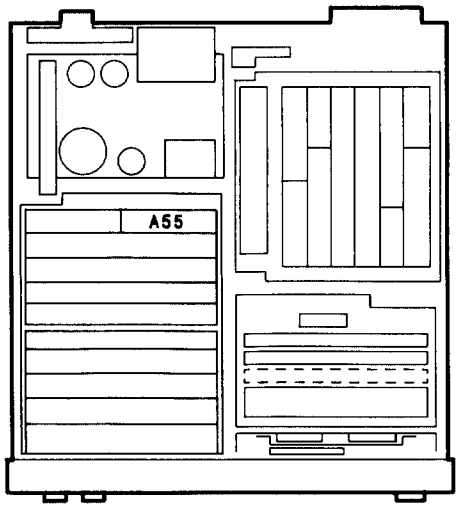


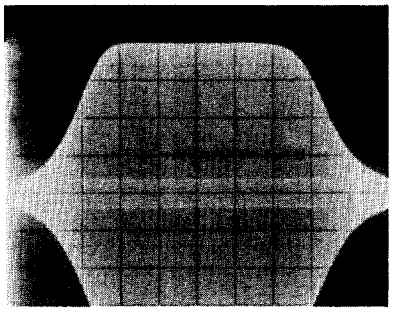
Figure 5-10. *Narrow 455 kHz IF Filter Adjustment Test Setup*

PROCEDURE

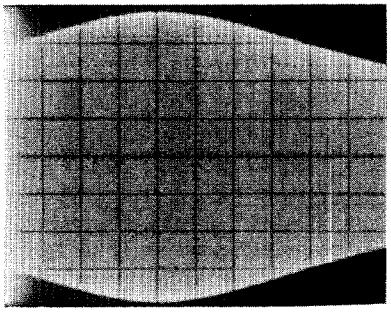
1. Perform *Adjustment 16—FM Distortion and Incidental AM—455 kHz IF.*
2. Connect the equipment as shown in Figure 5-10. (Connect the vertical input of the oscilloscope directly to A55J1 (IF OUT).)
3. Set the signal generator to 0 dBm and set its frequency to sweep from 430 to 480 kHz (that is, 455±25 kHz).
4. On the Measuring Receiver, press the blue key then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 0.2 S (Shift) 26 SPCL and 0.2 S 30 SPCL to set the gain of the IF amplifiers to 0 dB and to insert the narrow 455 kHz IF filter.



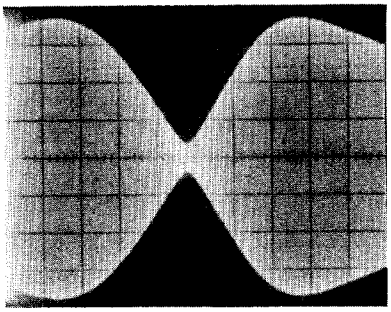
5. Adjust the oscilloscope so that the swept IF response spans exactly ten horizontal divisions and eight vertical divisions then readjust the vertical position to bring the top of the waveform to a convenient graticule. (Set the signal generator sweep rate as slow as possible while obtaining a flicker-free display.)
6. On the Measuring Receiver, adjust A55C24 (FLTR SLOPE) and A55R48 (FLTR FLAT) for the flattest response. The filter response should appear as in Figure 5–11a. Pass-band ripple should be less than 0.1 division (2.5%) overall over the two center horizontal divisions (±5 kHz centered about 455 kHz). The filter response should be down at least 1 division (25%) at ±3 horizontal divisions (±15 kHz) from the center. (Adjustment of A55C24 affects symmetry, A55R48 affects flatness and gain. Expand the vertical scale, if necessary, to see the passband ripple.)
7. If the filter response can be properly adjusted, continue on at step 19. Otherwise, turn the Measuring Receiver off. Remove the cables from the A55 IF Amplifier/Filter Assembly. Remove the shield cover from the assembly and extend the assembly.
8. Connect the equipment as shown in Figure 5–10. (Connect the vertical input of the oscilloscope to A55TP6 with a low-capacitance 10:1 divider probe.) Turn the Measuring Receiver back on.
9. On the Measuring Receiver, key in 0.2 S (Shift) 26 SPCL and 0.2 S 30 SPCL.
10. Short A55TP3 to A55TP2 (GND).
11. Increase the oscilloscope's vertical gain by a factor of ten. Adjust the positioning for a centered waveform.
12. Adjust A55L3 for a peak one division left of center (450 kHz). The response should appear as in Figure 5–11b.
13. Remove the short from A55TP3. Short A55TP5 to A55TP2. Adjust A55L4 for a dip 0.2 division left of center (454 kHz). The response should appear as in Figure 5–11c.
14. Remove the short from A55TP5. Short A55TP4 to A55TP2. Adjust A55L5 for a peak 0.2 division left of center. The response should appear as in Figure 5–11d.
15. Remove the short from A55TP4. Short A55TP1 to A55TP2. Adjust A55L6 for a dip 0.2 division left of center. The response should appear as in Figure 5–11e.
16. Remove the short from A55TP1. Adjust A55L7 for a dip 0.2 division left of center. The response should appear as in Figure 5–11f.
17. Turn the Measuring Receiver off. Re-install the shield cover on the A55 assembly and insert the assembly into its extrusion.
18. Reconnect the equipment as in step 2. Turn the Measuring Receiver back on. Repeat steps 4 through 7.
19. Disconnect the oscilloscope from A55J1 and the signal generator from A22J2. Reconnect the internal innerconnect cables to A55J1 and A55J2.
20. On the Measuring Receiver, connect CALIBRATION RF POWER OUTPUT to INPUT. See Figure 5–10.
21. On the Measuring Receiver, press the blue key then INSTR PRESET. Key in 45.16 SPCL to turn on the RF power calibrator. Let the Measuring Receiver tune, then key in 3.5 SPCL to select the narrow 455 kHz IF filter. Press MHz to manually tune the instrument to the input signal. Key in S (shift) IF LEVEL. The display should indicate approximately 100%.
22. Key in 6.2 SPCL to open the AM ALC loop to permit measurement of IF level. Key in 1.3 SPCL to insert 20 dB of RF attenuation. The display should read between 50 and 200%.



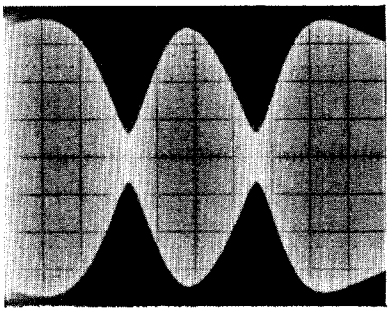
a. Oscilloscope Display for Step 6



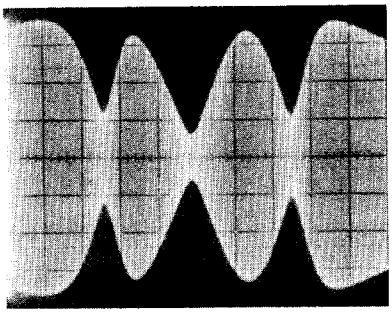
b. Oscilloscope Display for Step 12



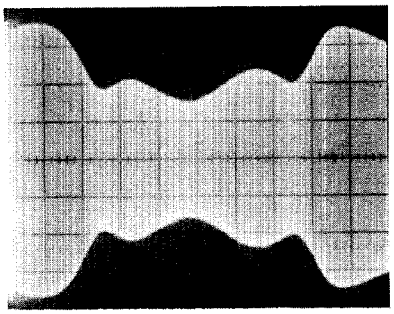
c. Oscilloscope Display for Step 13



d. Oscilloscope Display for Step 14



e. Oscilloscope Display for Step 15



f. Oscilloscope Display for Step 16

Figure 5–11. *Narrow 455 kHz IF Filter Adjustment Oscilloscope Displays*

23. Press RATIO and LOG/LIN to set a reference of 0 dB. Key in 3.1 SPCL to remove the narrow 455 kHz IF filter. Adjust A55R33 (AMPL GAIN) for a display of 0.00 dB REL.
24. Press RANGE HOLD. Connect the white/green/violet (957) cable that normally connects to A55J2 (IF IN) to A54J2 (IF IN). (This bypasses the A55 IF Amplifier/Filter Assembly and establishes an input reference for measuring the gain of the A55 assembly.)

25. Press RATIO twice to establish a new reference. Reconnect the white/green/violet cable back to A55J2 and reconnect the white/brown/green cable (915) back to A54J2.
26. Adjust A55R38 (IF GAIN) for a display of 0.00 dB REL.

Adjustment 24—IF Synchronous Detector

Reference

Service Sheet 7.

Description

The pretune frequency is adjusted for 457 kHz. The pretune voltage is removed, and the phase detector offset voltage is adjusted for no frequency drift. By means of comparing the peaks of the 455 kHz VCO drive signal to the zero crossings of the VCO drive to the synchronous detector, the relative phase shift is adjusted for 90°. The synchronous detector offset is adjusted for 0 Vdc with no input signal. A resistor in the gain-determining DAC of the phase lock loop is selected to give a pre-determined lock bandwidth.

Equipment

Divider Probe, 10:1 (2 required) ..... HP 10040A
Oscilloscope ..... HP 1740A
Gain/Phase Meter (Optional) ..... HP 3575A

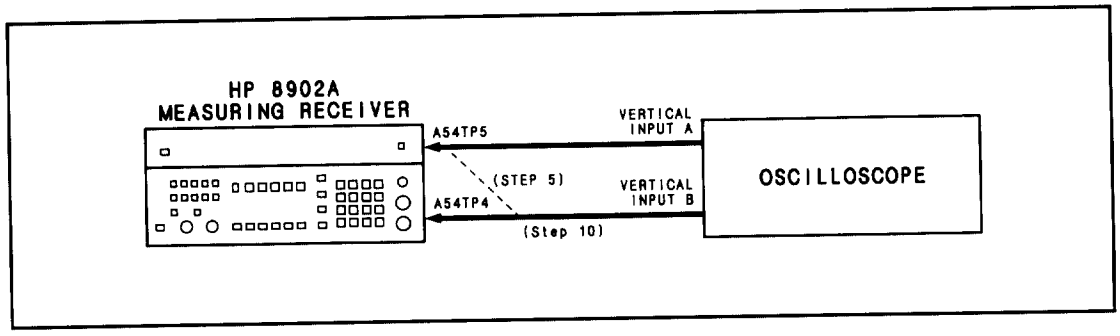
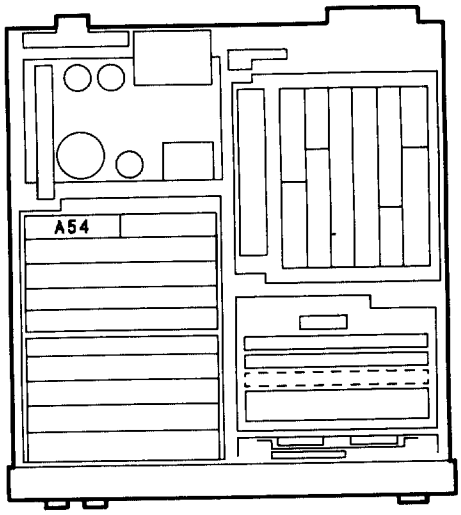


Figure 5–12. *IF Synchronous Detector Adjustment Test Setup*

Procedure



1. Turn the Measuring Receiver off. Extend the A54 IF Synchronous Detector Assembly. The cables need not be reconnected to the assembly.
2. Turn the instrument back on. Key in 48.7 SPCL to pretune the 455 kHz VCO to 457 kHz and display the VCO frequency. Adjust A54L3 for a display between 45650 and 45750 (that is, 457±0.5 kHz).
3. Key in 48.2 SPCL to read the VCO frequency (but with no pretune voltage applied). Note the frequency drift on display. If the frequency drifts up more than 10 counts (100 Hz) in one minute, adjust A54R17 (Φ DET OFS) clockwise approximately 1 turn (and vice versa for drift down).
4. Key in 48.7 SPCL and 48.2 SPCL again and repeat step 3 until the frequency drift is within limits.

NOTE

If using the optional Gain/Phase Meter, perform optional steps 5a–7a instead of steps 5–11. Continue with step 12.

5. Connect both channels of an oscilloscope through two 10:1 divider probes to A54TP5. See Figure 5–12. Set the coupling of both channels to ac. Set both channels to 10 mV per vertical division (combined with the probes the total vertical sensitivity will be 100 mV per division). Set the triggering to channel A. Set the sweep time to 20 ns per division (use a magnifier if needed).
6. On the Measuring Receiver, key in 48.7 SPCL.
7. On the oscilloscope, adjust the horizontal position to locate the zero crossing of channel A. Set the input switch for channel A to ground. Adjust the vertical position of channel A to center the trace of channel A. Set the input switch for channel A to ac.
8. Set the input switch for channel B to ground. Adjust the vertical position of channel B to center the trace of channel B. Set the input switch for channel B to ac.
9. Note the time difference of the zero-crossing of the two traces. This difference represents the phase error of the two channels. (By momentarily grounding one of the input switches, note which channel leads.)
10. Move the probe of channel B to A54TP4. Adjust the vertical position of channel B to bring the trace of channel B on the display.
11. Adjust A54L4 to center the peak of channel B directly over the zero crossing of channel A plus the error noted in step 9. The centering must be within ±0.5 horizontal division (that is, ±10 ns or ±1.7°). See Figure 5–12. (Momentarily ground the input switch of channel A to check the zero crossing of channel A.)
12. On the Measuring Receiver, key in 48.1 SPCL to display the synchronous detector offset voltage. Adjust A54R76 (SYCH DET OFS) for a reading between −0.0010 and 0.0010.
13. If the A54U7 Loop Bandwidth Control DAC has been replaced, perform the following procedure.
    a. Turn the Measuring Receiver off. Unplug the A54 IF Synchronous Detector Assembly.
    b. Measure the resistance between pins 1 and 16 of A54U7.
    c. Calculate the resistance (in ohms) of A54R24 by the formula

$$R24 = 2150 \times \left(\frac{\text{resistance of step b}}{7736} - 1 \right).$$

    d. Replace A54R24, if necessary, with a resistor of a value within ±10% of the resistance calculated in step c.

Optional Steps

5a. On the Gain/Phase Meter set channel A and B input range switches to "2–20V".
Set the Frequency Range switch to "100–1M".
Set the Phase Reference switch to "A".
Set the Amplitude B/Phase switch to "Phase".
6a. Connect channel A, through a 1:1 probe, to A54TP5.
Connect Channel B, through a 1:1 probe, to A54TP4.
7a. Adjust A54L4 for a 90.0°±0.5°phase difference reading. (Continue with step 12.)

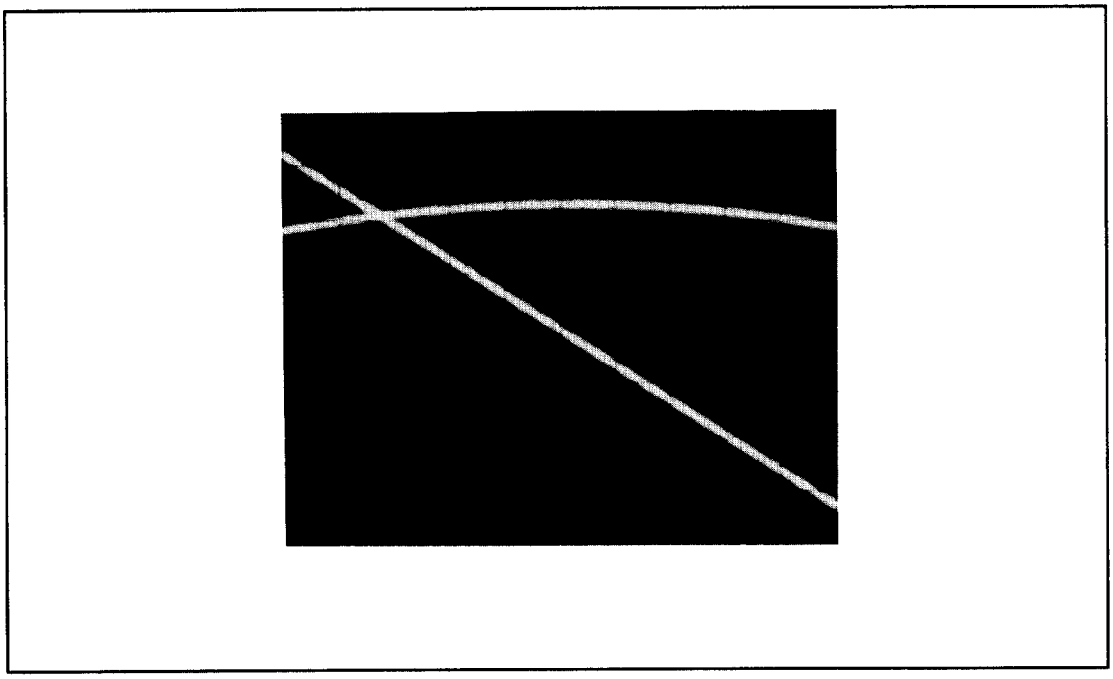


Figure 5–13. *IF Synchronous Detector Adjustment Waveform*

INDEX

%

% CAL FACTOR,
    in AM measurements, 3-167
    RF power calibration, 3-75

– –

– –, 3-105, 3-116, 3-101, 3-194, 3-285, 3-288
– – – –, 3-105, 3-116, 3-101, 3-285
– – – – – –, 3-105, 3-116, 3-101, 3-285

0

0.001 dB resolution, 3-281
0.1 Hz resolution, 3-281

1

1 mW power reference oscillator, 3-75
1 kHz DISTN, 3-229, 3-233
1.5 MHz IF frequency, 3-151
1.5 MHz IF detector, 3-259
10 MHz time base, 3-3

4

400 Hz DISTN, 3-233, 3-229
455 kHz IF detector, 3-259
455 kHz IF frequency, 3-151

5

50 MHz reference calibration factor, 3-75

7

750 us de-emphasis, 3-188

A

absolute tuned RF level measurements, 3-95
accounting for external attenuation, 3-131
accuracy, in RF power measurements, 3-75
adjacent-channel power measurements, 3-122, 3-119
agile frequency sources, measuring, 3-139, 3-145
AM, 3-161
    affected by IF level, 3-109
    ALC response time, 3-165
    as dB down from the carrier, 3-248
    calibration, 3-167
    increasing accuracy of measurements, 3-163
    OUTPUT, 3-163, 3-173
attenuation, external; compensating for, 3-131
attenuation, selecting, 3-265
attenuator measurements, 3-115
audio detector, 3-201
    response, 3-276
    response time, 3-205
AUDIO DISTN, 3-229
audio filters, 3-207
AUDIO FREQ, 3-227
AUDIO INPUT, 3-215, 3-227, 3-229
audio level measurements, 3-229
audio range selection, 3-275
audio range, 3-211
AUTO TUNING, 3-141
automatic cal factors, 3-75
automatic level control, 3-276
AUTOMATIC OPERATION, 3-237
automatic tuning, 3-141
average tuned RF level measurements, 3-95

C

CALIBRATE,
    In AM measurements, 3-167
    In FM measurements, 3-181
    RF power calibration, 3-75
    Tuned RF level calibration, 3-95
calibration factors, AM, 3-279
calibration factors, FM, 3-279
calibration factors, RF power, 3-75, 3-78, 3-283
    Automatic, 3-75
    example HP-IB program for entering, 3-85
    frequency-dependent, 3-75
    Manual, 3-83, 3-84, 3-106
    resolution, 3-83
    tuned RF level, 3-99, 3-283
calibration,
    AM, 3-167,3-278
    FM, 3-181,3-278
    RF power, 3-75
cellular radio measurements, 3-119
channel accuracy, checking, 3-149
CLEAR, 3-241, 3-26
    used with HP-IB, 3-18, 3-22
comparing frequencies, 3-147
compensating for external attenuation, 3-131

D

dB and frequency resolution, 3-281
dB EXT ATTEN, 3-131
de-emphasis, 3-187
DETECTOR, 3-201
detector response time, 3-205
DISABLE ERROR, 3-267
display averaging, tuned RF level, 3-107
DISPLAY FREQ INCR, 3-141
DISPLAY FREQ, RF power calibration, 3-75
down converter, using the 8902 as, 3-130
down-converting a microwave signal, 3-255
drifting signals, measuring, 3-147

E

entering RF power calibration factors, 3-76
error 02, 3-265
error 03, 3-265
error 04, 3-213, 3-269
error 05, 3-200
error 06, 3-90
error 07, 3-269
error 11, 3-248
error 17, 3-288
error 24, 3-14
error message disable control, 3-267, 3-277
error message summary, 3-285
external attenuation (dB), 3-131, 3-280
external audio rms level measurement, 3-281, 3-229
external LO, using an, 3-255
external LO, 3-279

F

filters, RF and IF, 3-259
filters, audio, 3-207
firmware date codes 234.1985 and below, 3-82, 3-99, 3-100
3-105,3-106, 3-157, 3-205, 3-228, 3-234,
3-276, 3-281, 3-282, 3-283,
flatness, measuring, 3-143
flatness, modulation; checking, 3-248
FM calibration, 3-181
FM DE-EMPHASIS, 3-187
FM OUTPUT, 3-191
FM, 3-177
FM, deviation relative to 75 kHz, 3-248
FREQ ERROR, 3-147
FREQ ERROR, parts per million display, 3-149
FREQ OFST TTL OUT, 3-255, 3-257
FREQ, 3-137
frequency agile sources, measuring, 3-139, 3-145
frequency dependent calibration factors in RF power, 3-75
frequency offset control, 3-255, 3-280
frequency resolution, 3-157
frequency tuning, 3-141
fuses, 3-2

G

gain, external; compensating for, 3-131
gain, IF, 3-263
gain, selecting, 3-265

H

high-selectivity power measurements, 3-119
HP FILTER, 3-207
HP-IB address, 3-279
HP-IB,
8901A/02A code differences, 3-46
8902 automatically selects pre-display, 3-202
abort, 3-33
address, 3-34
alpha characters, 3-13
ASCII characters not used, 3-14
capabilities, 3-19, 3-21, 3-22
CLEAR key, 3-22
clear, 3-239, 3-25
code sequence, 3-16
codes, 3-38, 3-39
commas, 3-13
data output, 3-18
device clear, 3-25
example program for RF power cal factor entry, 3-85
example, 3-17
invalid characters, 3-14
local, 3-26
measurement example, 3-17
pass control, 3-33
peak hold cycles, 3-203
remote, 3-26
RF power calibration, 3-83
service request, 3-27
spaces, 3-13
SRQ mask, 3-31
SRQ, 3-27
status byte, 3-32
syntax, numeric, 3-16
syntax, programming, 3-15
take control, 3-33
trigger codes, 3-17
trigger, 3-22
turning off functions, 3-14
using the tone-burst receiver, 3-194

I

IF average detector, 3-96
IF detector selection, 3-99
IF filters, 3-259
IF frequency, 3-151, 3-282
IF gain, 3-263, 3-277
IF LEVEL, 3-109
IF LEVEL, affects AM accuracy, 3-109
IF OUTPUT, 3-129
IF OUTPUT, used to check for spurious signals, 3-130
IF synchronous detector, 3-96
image frequencies, 3-144
impedance, source, 3-83
increment steps, 3-142, 3-143
input attenuation and gain, 3-265
INPUT FREQ, 3-141
INSTR PRESET, 3-239
internal checks, 3-239
internal voltmeter; used to make measurements, 3-91

K

kHz⇑, kHz⇓, 3-141

L

level measurements, scaling, 3-131
level, relative measurements, 3-95, 3-115
limit, 3-249, 3-278

LO frequency, 3-153, 3-282
LO INPUT and LO OUTPUT, 3-155
local lockout, 3-26
LOG/LIN, 3-245
losing instrument states, 3-241
low-level power measurements, 3-95
low-level signals, increasing sensitivity on, 3-266
low-noise LO frequency tuning, 3-141
LP FILTER, 3-207

M

manual calibration factors for RF power, 3-83
manual tuning, 3-141
measurement codes used in limits, 3-250
MODULATION OUTPUT, 3-215
modulation range, 3-211
multi-channel transmitters, checking channel accuracy, 3-149
multiple signal sources, measuring, 3-139, 3-145

N

noise correction for tuned RF level measurements, 3-106
noise effects, residual, 3-219
noise measurements, single-sideband, 3-119
normalizing noise measurements, 3-119

O

offset in input attenuation, compensating for, 3-131
offsetting the LO, for selective power measurements, 3-119
option 003, 3-155
option 030, 3-119, 3-279, 3-280

P

parts per million display; frequency error measurments, 3-149
peak detectors,
    in AM measurements, 3-163
    in FM measurements, 3-180
peak tuned RF level, 3-113, 3-282
phase lock, LO does not, 3-154
phase modulation, 3-197
    in degrees, 3-200
    recommended filter selection, 3-200
phase shift keying, 3-200
power measurements, low-level, 3-95
power measurements, RF, 3-75
power measurements, adjacent channel, 3-119
power sensor,
    changing, 3-83
    in RF power measurements, 3-75
    user-built, 3-133
power-up and default conditions, 3-239
power, relative measurements, 3-95, 3-115
pre-emphasis equalization, 3-187
PREVIOUS RATIO, 3-245, 3-278
program, example for entering RF power cal factors, 3-85
pull-out cards, 3-2
pulsed phase modulation, 3-200

R

RANGE HOLD, 3-243
range, audio, 3-211
range, modulation, 3-211
ratio measurements, common, 3-248
RATIO, with tuned RF level measurements, 3-117
RATIO, 3-245, 3-249
recalibrating RF power, reasons, 3-82
RECALL, 3-253
RECAL,
    in RF power measurements, 3-82
    in tuned RF level measurements, 3-95
receiver, setting up the 8902 as, 3-269
recorder output, for RF power measurements, 3-91
relative tuned RF level measurements, 3-95, 3-115
remote control RF switch, 3-133
residual noise effects, 3-219
resolution, finer for audio frequency measurements, 3-228
resolution, finer for dB measurements, 3-105
resolution,
    frequency, 3-157
    RF power calibration factor, 3-83
RF and IF filters, 3-275
RF filters, 3-259
RF frequency error, 3-147
RF frequency resolution, 3-157, 3-277
RF frequency tuning, 3-141
RF input attenuation and gain, 3-265, 3-275
RF input frequency, 3-137
RF level measurements, 3-89
RF level, 3-282
RF power range, 3-278
RF POWER, 3-75
    calibration, 3-75
    reasons to recalibrate, 3-82
    using the internal voltmeter with, 3-91
RF POWER, when initiates RF level measurements, 3-89
rms calibrated average as peak, 3-248
rms calibrated average as true average, 3-248
RMS, 3-229
RMS detector, considerations when using, 3-180

S

SAVE CAL,
    in AM calibration, 3-167
    in FM calibration, 3-181
    RF power calibration, 3-75, 3-84
selective power measurements, 3-119, 3-280
selectivity of tuned RF level measurements, 3-96
selectivity, increasing, 3-259
sensitivity,
    increasing, 3-259
    increasing for frequency measurements, 3-138
    increasing on low-level signals, 3-266
    of tuned RF level measurements, 3-96
sensor module, 3-96
    in RF power measurements, 3-75
    user-built, 3-133
sensor, power, in RF power measurements, 3-75
service request, 3-279, 3-27
SET REF, 3-115
    Used in tuned RF level measurements, 3-95, 3-98, 3-280
SINAD, 3-233, 3-280
single-sideband noise measurements, 3-119
source impedance, 3-83
special display, 3-272
special, special display, 3-272

Special Functions, 3-271
01, 3-265, 3-275
02, 3-211, 3-275
03, 3-259, 3-275
04, 3-95, 3-95, 3-99, 3-276
05, 3-205, 3-276
06, 3-165, 3-276
07, 3-157, 3-277
08, 3-267, 3-277
09, 3-259, 3-277
10, 3-278
11, 3-245
11.2, 3-278
12, 3-181, 3-278
13, 3-167, 3-278
14, 3-249, 3-278
16, 3-167, 3-279
17, 3-181, 3-279
18, 3-193, 3-279
21, 3-279
22, 3-279, 3-30
23, 3-123, 3-119, 3-279
24, 3-123, 3-119, 3-280
25, 3-131, 3-280
26, 3-115, 3-280
27, 3-255, 3-280
29, 3-233, 3-280
30, 3-229
31, 3-281
32, 3-281
32.9, 3-105
33, 3-153, 3-282
34, 3-151, 3-282
35, 3-89, 3-282
36, 3-113, 3-282
37, 3-75, 3-78, 3-283
38, 3-95, 3-99, 3-283
39, 3-95, 3-99, 3-283
special special display, 3-272
spurious signals, check for using the IF output, 3-130
squelch tone measurement, 3-193
squelching, automatic if the input signal drops, 3-180
SRQ, 3-27
status bit, 3-33
stepping frequency, 3-142, 3-143
STORE, 3-253
switch, remote control RF, 3-133
synchronous tuned RF level measurements, 3-95

T

table of calibration factors, 3-75
table of calibration factors, storing, 3-83
time base, 3-3
tone-burst receiver, the 8902 as, 3-193
tone-burst receiver mode, 3-279
track mode tuning for tuned RF level measurements, 3-282
TRACK MODE, 3-141
track-mode tuning in tuned RF level measurements, 3-105
tuned RF level detector selection, 3-96, 3-99, 3-276
tuned RF level noise correction, 3-281
tuned RF level, peak, 3-113
TUNED RF LEVEL, 3-95
Display averaging, 3-107
Measurements using ratio, 3-117
tuning, frequency, 3-141

U

UNCAL, in tuned RF level measurements, 3-97, 3-107
user-built sensor module, 3-133

V

voltmeter, internal; used to make measurements, 3-91

Z

ZERO, RF power calibration, 3-75

Section 6
REPLACEABLE PARTS

6-1. INTRODUCTION TO THIS SECTION

This section contains information for ordering parts. Table 6-1 lists reference designations, and Table 6-2 lists abbreviations that are used in the Replaceable Parts List. Table 6-3 lists all replaceable parts in the instrument. Table 6-4 contains the names and addresses that correspond to the manufacturer's code numbers listed in Table 6-3. Also included in this section are photographs and drawings to aid in identifying and ordering chassis mounted parts and mechanical parts.

6-2. REFERENCE DESIGNATIONS AND ABBREVIATIONS USED IN THIS MANUAL

Table 6-1 lists the reference designation letters for electrical parts in the instrument. The letter designations found in Table 6-1 are coupled with numeric designations to provide a unique reference designation for each part in the instrument. For example A16R1 is the reference designation of a particular resistor R1 on assembly A16.

Table 6-2 lists abbreviations used in the parts list and on schematics.

6-3. REPLACEABLE PARTS LIST

Table 6-3 is a list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components with reference designations in alphanumeric order.

b. Chassis-Mounted parts with reference designations in alphanumeric order.

c. Mechanical parts with reference designations in alphanumeric order.

For your convenience, the Replaceable Parts List is paginated so that each assembly listing can be removed from Section 6 and collated into Section 8 with its corresponding service information.

Ordering Parts.

Instrument Serial Numbers.

Attached to the rear of the instrument is a serial-number plate. The first four digits and the letter are the instrument serial-number prefix. The last five digits (serial-number suffix) are unique to each instrument. When parts in the instrument are changed, the serial-number prefix of the instrument may also change. This means that sometimes a part will be listed more than once in the the replaceable parts list along with a serial-number prefix or range of serial-number prefixes. Find the serial-number prefix on the serial plate of your instrument and order the part listed under the corresponding prefix in the table. If no serial prefix information is listed, the part is compatible in instruments of all serial numbers.

How to Order

To order a part in the Replaceable Parts List, call or write the nearest Hewlett-Packard Sales Office. Have the following information ready to speed the ordering process:

1. The Hewlett-Packard part number with the check digit. (The check digit will ensure accurate and timely processing of your order.)
2. The quantity required.
3. An approved purchase order number. (Sometimes required.)

NOTE

Within the USA, it is better to order directly from the HP Parts Center in Mountain View California. Ask your nearest HP office for information and forms for the "Direct Order System".

Replaceable Parts List Updating (Manual Updates)

A "MANUAL UPDATES" packet is shipped with the manual, when necessary, to provide the most current information available at the time of shipment. These packets consist of replacement and addition pages which should be incorporated into the manual to bring it up to date.

Hewlett-Packard offers a Documentation Update Service that will provide you with further updates as they become available. If you operate or service instruments of different serial prefixes, we strongly recommend that you join this service immediately to ensure that you manual is kept current. For more information, refer to the Documentation Update Service reply card included in this manal, or call: Technical Writing Department (509) 922-4001,

or write:

Hewlett-Packard Company
Technical Writing Department
24001 E. Mission - TAF C-34
Spokane, WA 99220

6-4. MECHANICAL AND CHASSIS PART LOCATIONS AND REFERENCE DESIGNATIONS

Most mechanical parts are identified in Figures 6-1 to 6-9. These figures are located at the end of this section. Major mechanical parts have reference designations that begin with the letters MP. To find the part number and description of a mechanical part, find the part in one of the photographs or drawings, and then look up the reference designation in Table 6-3. Mechanical hardware, such as screws, are listed under the part which they attach. For example, the screws that attach the fan (B1) to the rear panel are listed under B1.

6-5. RECOMMENDED SPARES LIST

Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard has prepared a "Recommended Spares" list for this instrument. The contents of the list are based on failure reports and repair data. Quantities given are for one year of parts support. You can request a complimentary copy of the "Recommended Spares" list from your nearest Hewlett-Packard office.

When stocking parts to support more than one instrument or to support a variety of Hewlett-Packard instruments, it may be more economical to work from one consolidated list rather than simply adding together stocking quantities from the individual instrument lists. Hewlett-Packard will prepare consolidated "Recommended Spares" lists for any number or combination of instruments. Contact your nearest Hewlett-Packard office for details.

Table 6–1. *Reference Designations*

REFERENCE DESIGNATIONS

A . . . . . assembly
AT . . . . . attenuator; isolator; termination
B . . . . . fan; motor
BT . . . . . battery
C . . . . . capacitor
CP . . . . . coupler
CR . . . . . diode; diode thyristor; varactor
DC . . . . . directional coupler
DL . . . . . delay line
DS . . . . . annunciator; signaling device (audible or visual); lamp; LED
E . . . . . miscellaneous electrical part
F . . . . . fuse
FL . . . . . filter
H . . . . . hardware
HY . . . . . circulator
J . . . . . electrical connector (stationary portion); jack
K . . . . . relay
L . . . . . coil; inductor
M . . . . . meter
MP . . . . . miscellaneous mechanical part
P . . . . . electrical connector (movable portion); plug
Q . . . . . transistor; SCR; triode thyristor; FET
R . . . . . resistor
RT . . . . . thermistor
S . . . . . switch
T . . . . . transformer
TB . . . . . terminal board
TC . . . . . thermocouple
TP . . . . . test point
U . . . . . integrated circuit; microcircuit
V . . . . . electron tube
VR . . . . . voltage regulator; breakdown diode
W . . . . . cable; transmission path; wire
X . . . . . socket
Y . . . . . crystal unit (piezo-electric or quartz)
Z . . . . . tuned cavity; tuned circuit

Table 6–2. *Abbreviations (1 of 2)*

ABBREVIATIONS

A . . . . . ampere
ac . . . . . alternating current
ACCESS . . . . . accessory
ADJ . . . . . adjustment
A/D . . . . . analog-to-digital
AF . . . . . audio frequency
AFC . . . . . automatic frequency control
AGC . . . . . automatic gain control
AL . . . . . aluminum
ALC . . . . . automatic level control
AM . . . . amplitude modulation
AMPL . . . . . amplifier
APC . . . . . automatic phase control
ASSY . . . . . assembly
AUX . . . . . auxiliary
avg . . . . . average
AWG . . . . . American wire gauge
BAL . . . . . balance
BCD . . . . . binary coded decimal
BD . . . . . board
BECU . . . . . beryllium copper
BFO . . . . . beat frequency oscillator
BH . . . . . binder head
BKDN . . . . . breakdown
BP . . . . . bandpass
BPF . . . . . bandpass filter
BRS . . . . . brass
BWO . . . . . backware-wave oscillator
CAL . . . . . calibrate
ccw . . . . . counter-clockwise
CER . . . . . ceramic
CHAN . . . . . channel
cm . . . . . centimeter
CMO . . . . . cabinet mount only
COAX . . . . . coaxial
COEF . . . . . coefficient
COM . . . . . common
COMP . . . . . composition
COMPL . . . . . complete
CONN . . . . . connector
CP . . . . . cadmium plate
CRT . . . . . cathode-ray tube
CTL . . . . . complementary transistor logic
CW . . . . . continuous wave
cw . . . . . clockwise
cm . . . . . centimeter
D/A . . . . . digital-to-analog
dB . . . . . decibel
dBm . . . . . decibel referred to 1 mW
dc . . . . . direct current
deg . . . . . degree (temperature interval or difference)
...° . . . . . degree (plane angle)
°C . . . . . degree Celsius (centigrade)
°F . . . . . degree Fahrenheit
°K . . . . . degree Kelvin
DEPC . . . . . deposited carbon
DET . . . . . detector
diam . . . . . diameter
DIA . . . . . diameter (used in parts list)
DIFF AMPL . . . . . differential amplifier
div . . . . . division
DPDT . . . . . double-pole, double-throw
DR . . . . . drive
DSB . . . . . double sideband
DTL . . . . . diode transistor logic
DVM . . . . . digital voltmeter
ECL . . . . . emitter coupled logic
EMF . . . . . electromotive force
EDP . . . . . electronic data processing
ELECT . . . . . electrolytic
ENCAP . . . . . encapsulated
EXT . . . . . external
F . . . . . farad
FET . . . . field-effect transistor
F/F . . . . . flip-flop
FH . . . . . flat head
FIL H . . . . . fillister head
FM . . . . frequency modulation
FP . . . . . front panel
FREQ . . . . . frequency
FXD . . . . . fixed
g . . . . . gram
GE . . . . . germanium
GHz . . . . . gigahertz
GL . . . . . glass
GRD . . . . . ground(ed)
H . . . . . henry
h . . . . . hour
HET . . . . . heterodyne
HEX . . . . . hexagonal
HD . . . . . head
HDW . . . . . hardware
HF . . . . . high frequency
HG . . . . . mercury
HI . . . . . high
HP . . . . . Hewlett-Packard
HPF . . . . . high pass filter
HR . . . . . hour (used in parts list)
HV . . . . . high voltage
Hz . . . . . Hertz
IC . . . . . integrated circuit
ID . . . . . inside diameter
IF . . . . . intermediate frequency
IMPG . . . . . impregnated
in . . . . . incandescent
INCL . . . . . include(s)
INP . . . . . input
INS . . . . . insulation
INT . . . . . internal
kg . . . . . kilogram
kHz . . . . . kilohertz
k . . . . . kilohm
kV . . . . . kilovolt
lb . . . . . pound
LC . . . . . inductance-capacitance
LED . . . . . light-emitting diode
LF . . . . . low frequency
LG . . . . . long
LH . . . . . left hand
LIM . . . . . limit
LIN . . . . . linear taper (used in parts list)
LK WASH . . . . . lock washer
LO . . . . . low; local oscillator
LOG . . . . . logarithmic taper (used in parts list)
log . . . . . logarithm(ic)
LPF . . . . . low pass filter
LV . . . . . low voltage
m . . . . . meter (distance)
mA . . . . . milliampere
MAX . . . . . maximum
M . . . . . megohm
MEG . . . . . meg (10^6) (used in parts list)
MET FLM . . . . . metal film
MET OX . . . . . metallic oxide
MF . . . . . medium frequency; microfarad (used in parts list)
MFR . . . . . manufacturer
mg . . . . . milligram
MHz . . . . . megahertz
mH . . . . . millihenry
mho . . . . . mho
min . . . . . minute (time)
...' . . . . . minute (plane angle)
MINAT . . . . . miniature
mm . . . . . millimeter

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6–2. *Abbreviations (2 of 2)*

MOD .... modulator
MOM ..... momentary
MOS ..... metal-oxide semiconductor
ms ..... millisecond
MTG ..... mounting
MTR ..... meter (indicating device)
mV ..... millivolt
mVac ..... millivolt, ac
mVdc ..... millivolt, dc
mVpk ..... millivolt, peak
mVp-p ..... millivolt, peak-to-peak
mVrms ..... millivolt, rms
mW ..... milliwatt
MUX ..... multiplex
MY ..... mylar
μA ..... microampere
μF ..... microfarad
μH ..... microhenry
μmho ..... micromho
μs ..... microsecond
μV ..... microvolt
μVac ..... microvolt, ac
μVdc ..... microvolt, dc
μVpk ..... microvolt, peak
μVp-p ..... microvolt, peak-to-peak
μVrms ..... microvolt, rms
μW ..... microwatt
nA ..... nanoampere
NC ..... no connection
N/C ..... normally closed
NE ..... neon
NEG ..... negative
nF ..... nanofarad
NI PL ..... nickel plate
N/O ..... normally open
NOM ..... nominal
NORM ..... normal
NPN ..... negative-positive-negative
NPO ..... negative-positive zero (zero temperature coefficient)
NRFR ..... not recommended for field replacement
NSR ..... not separately replaceable
ns ..... nanosecond
nW ..... nanowatt
OBD .... order by description
OD ..... outside diameter
OH ..... oval head
OP AMPL ..... operational amplifier
OPT ..... option
OSC ..... oscillator
OX ..... oxide
oz ..... ounce
Ω ..... ohm
P ..... peak (used in parts list)
PAM ..... pulse-amplitude modulation
PC ..... printed circuit
PCM .... pulse-code modulation; pulse-count modulation
PDM ..... pulse-duration modulation
pF ..... picofarad
PH BRZ .... phosphor bronze
PHL ..... Phillips
PIN ..... positive-intrinsic-negative
PIV ..... peak inverse voltage
pk ..... peak
PL ..... phase lock
PLO .... phase lock oscillator
PM ..... phase modulation
PNP ..... positive-negative-positive
P/O ..... part of
POLY ..... polystyrene
PORC ..... porcelain
POS ..... positive; position(s) (used in parts list)
POSN ..... position
POT ..... potentiometer
p-p ..... peak-to-peak
PP ..... peak-to-peak (used in parts list)
PPM ..... pulse-position modulation
PREAMPL ..... preamplifier
PRF ..... pulse-repetition frequency
PRR .... pulse repetition rate
ps ..... picosecond
PT ..... point
PTM ..... pulse-time modulation
PWM ..... pulse-width modulation
PWV ..... peak working voltage
RC ..... resistance-capacitance
RECT ..... rectifier
REF ..... reference
REG ..... regulated
REPL ..... replaceable
RF ..... radio frequency
RFI ..... radio frequency interference
RH ... round head; right hand
RLC ..... resistance-inductance-capacitance
RMO ..... rack mount only
rms ..... root-mean-square
RND ..... round
ROM ..... read-only memory
R&P ..... rack and panel
RWV ..... reverse working voltage
S ..... scattering parameter
s ..... second (time)
..." ..... second (plane angle)
S-B ..... slow-blow (fuse) (used in parts list)
SCR ..... silicon controlled rectifier; screw
SE ..... selenium
SECT ..... sections
SEMICON .... semiconductor
SHF .... superhigh frequency
SI ..... silicon
SIL ..... silver
SL ..... slide
SNR .... signal-to-noise ratio
SPDT ..... single-pole, double-throw
SPG ..... spring
SR ..... split ring
SPST ..... single-pole, single-throw
SS ..... Service Sheet
SSB ..... single sideband
SST ..... stainless steel
STL ..... steel
SQ ..... square
SWR .... standing-wave ratio
SYNC ..... synchronize
T ..... timed (slow-blow fuse)
TA ..... tantalum
TC ..... temperature compensating
TD ..... time delay
TERM ..... terminal
TFT ..... thin-film transistor
TGL ..... toggle
THD ..... thread
THRU ..... through
TI ..... titanium
TOL ..... tolerance
TRIM ..... trimmer
TSTR ..... transistor
TTL ..... transistor-transistor logic
TV ..... television
TVI .... television interference
TWT ..... traveling wave tube
U ..... micro (10^{-6}) (used in parts list)
UF ..... microfarad (used in parts list)
UHF ..... ultrahigh frequency
UNDEF ..... undefined
UNREG ..... unregulated
V ..... volt
VA ..... voltampere
Vac ..... volts, ac
VAR ..... variable
VCO ..... voltage-controlled oscillator
Vdc ..... volts, dc
VDCW ..... volts, dc, working (used in parts list)
V(F) ..... volts, filtered
VFO ..... variable-frequency oscillator
VHF ..... very-high frequency
Vpk ..... volts, peak
Vp-p ..... volts, peak-to-peak
Vrms ..... volts, rms
VSWR ..... voltage standing wave ratio
VTO ..... voltage-tune oscillator
VTVM ..... vacuum-tube voltmeter
V(X) ..... volts, switched
W ..... watt
W/ ..... with
WIV ..... working inverse voltage
WW ..... wirewound
W/O ..... without
YIG ..... yttrium-iron-garnet
Z_o ..... characteristic impedance

NOTE

All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A1						
A1	08901-60143	0	1	KEYBOARD AND DISPLAY ASSEMBLY	28480	08901-60143
A1C1	0180-0228	6	5	CAPACITOR-FXD 22UF +-10% 15VDC TA	56289	150D226X9015B2
A1C2	0160-2291	5	1	CAPACITOR-FXD .18UF +-10% 80VDC POLYE	28480	0160-2291
A1C3	0160-0576	5	87	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C8	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C9	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C10	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C12	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C13	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C15	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C16	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C17	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C18	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1C19	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A1CR1	1901-1098	1	87	DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A1CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A1CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A1CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A1DS1	1990-0759	6	4	LED-LIGHT BAR MODULE LUM-INT = 3MCD	28480	HLMP-2620
	1200-1303	5	4	SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-1303
A1DS2	1990-0759	6		LED-LIGHT BAR MODULE LUM-INT = 3MCD	28480	HLMP-2620
	1200-1303	5		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-1303
A1DS3	1990-1273	1	28	LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS4	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS5	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS6	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS7	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS8	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS9	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS10	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS11	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS12	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS13	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS14	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS15	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS16	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS17	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS18	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS19	1990-0759	6		LED-LIGHT BAR MODULE LUM-INT = 3MCD	28480	HLMP-2620
	1200-1303	5		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-1303
A1DS20				NOT ASSIGNED		
A1DS21	1990-0759	6		LED-LIGHT BAR MODULE LUM-INT = 3MCD	28480	HLMP-2620
	1200-1303	5		SOCKET-IC 16-CONT DIP DIP-SLDR	28480	1200-1303
A1DS22	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS23	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613

†Refer to Section 7 for update information

*Factory Selected Component (Refer to Section 5)

Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A1DS24	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS25	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS26	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS27	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS28	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS29	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS30	1990-0699	3	2	LED-LIGHT BAR-RED MODULE LUM-INT = 7MCD	28480	1LM1-2350
	1200-0901	7	2	SOCKET-STRP 8-CONT W-WRAP	28480	1200-0901
2305A TO 2914A						
A1DS31†	1990-0670	0	5	LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0670
A1DS32†	1990-0670	0		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0670
A1DS33†	1990-0670	0		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0670
A1DS34†	1990-0670	0		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0670
A1DS35†	1990-0670	0		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0670
A1DS36†	1990-0678	8	2	LED-LAMP-GRN LUM-INT = 800UCD IF = 30MA-MA	28480	1990-0678
A1DS37†	1990-0950	3	5	LED-LAMP-RED LUM-INT = 1MCD IF = 13MA-MAX	28480	1990-0950
2920A AND ABOVE						
A1DS31†	1990-0487	7	5	LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0487
A1DS32†	1990-0487	7		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0487
A1DS33†	1990-0487	7		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0487
A1DS34†	1990-0487	7		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0487
A1DS35†	1990-0487	7		LED-LAMP-YLW LUM-INT = 1MCD IF = 20MA-MAX	28480	1990-0487
A1DS36†	1990-0835	9	2	LED-LAMP-GRN LUM-INT = 6MCD IF = 30MA-MAX	28480	HLMP-1523
A1DS37†	1990-1273	1	5	LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS38	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	28480	1990-1273
A1DS39	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	28480	1990-1273
A1DS40	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	28480	1990-1273
A1DS41	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	28480	1990-1273
2305A TO 2914A						
A1DS42†	1990-0950	3		LED-LAMP-RED LUM-INT = 1MCD IF = 13MA-MAX	28480	1990-0950
A1DS43†	1990-0950	3		LED-LAMP-RED LUM-INT = 1MCD IF = 13MA = MAX	28480	1990-0950
A1DS44†	1990-0950	3		LED-LAMP-RED LUM-INT = 1MCD IF = 13MA = MAX	28480	1990-0950
A1DS45†	1990-0678	8		LED-LAMP-GRN LUM-INT = 800UCD IF = 30MA-MAX	28480	1990-0678
2920A AND ABOVE						
A1DS42†	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS43†	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS44†	1990-1273	1		LED-LAMP-RED LUM-INT = 8.6MCD BVR = 5V	01542	QLMP-1613
A1DS45†	1990-0835	9		LED-LAMP-GRN LUM-INT = 6MCD IF = 30MA = MAX	28480	HLMP-1523
A1DS46	1990-0699	3		LED-LIGHT BAR-RED MODULE LUM-INT = 7MCD	28480	1LM1-2350
	1200-0901	7		SOCKET-STRP 8-CONT W-WRAP	28480	1200-0901
A1J1	1251-5169	6	5	CONNECTOR 6-PIN M POST TYPE	28480	1251-5169
A1J2	1200-0507	9	2	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A1MP1	5041-0252	7	12	KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP2	5041-0943	3	1	KEY CAP HALF LOCAL	28480	5041-0943
A1MP3	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP4	5041-0319	7	5	KEY CAP-HALF GRAY-LIT	28480	5041-0319
A1MP5	5041-0484	7	1	KEY CAP HALF YELLOW LED	28480	5041-0484
A1MP6	5041-0351	7	1	KAY CAP QUARTER	28480	5041-0351
A1MP7	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP8	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP9	5041-0319	7		KEY CAP-HALF GRAY-LIT	28480	5041-0319
A1MP10	5041-0386	8	5	KEY CAP FULL BK-LIT	28480	5041-0386
A1MP11	5041-0508	6	1	KEY CAP/HALF GR	28480	5041-0508
A1MP12	5041-0286	7	2	KEY CAP LT PIPE	28480	5041-0286
A1MP13	5041-0286	7		KEY CAP LT PIPE	28480	5041-0286
A1MP14	5041-0451	8	1	KEY CAP LT P/BLUE	28480	5041-0451
A1MP15	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP16	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP17	5041-0319	7		KEY CAP-HALF GRAY-LIT	28480	5041-0319
A1MP18	5041-0386	8		KEY CAP FULL BK-LIT	28480	5041-0386
A1MP19	5041-0835	2	1	KEY CAP/FULL 7 LT GY	28480	5041-0835
A1MP20	5041-0832	9	1	KEY CAP/FULL 4 LT GY	28480	5041-0832
A1MP21	5041-0829	4	1	KEY CAP/FULL 1 LT GY	28480	5041-0829
A1MP22	5041-0838	5	1	KEY CAP/FULL 0 LT GY	28480	5041-0838
A1MP23	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP24	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP25	5041-0319	7		KEY CAP-HALF GRAY-LIT	28480	5041-0319
A1MP26	5041-0386	8		KEY CAP FULL BK-LIT	28480	5041-0386
A1MP27	5041-0836	3	1	KEY CAP/FULL 8 LT GY	28480	5041-0836
A1MP28	5041-0833	0	1	KEY CAP/FULL 5 LT GY	28480	5041-0833
A1MP29	5041-0830	7	1	KEY CAP/FULL 2 LT GY	28480	5041-0830
A1MP30	5041-0839	6	1	KEY CAP/FULL GY DOT	28480	5041-0839
A1MP31	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP32	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP33	5041-0319	7		KEY CAP-HALF GRAY-LIT	28480	5041-0319
A1MP34	5041-0386	8		KEY CAP FULL BK-LIT	28480	5041-0386
A1MP35	5041-0837	4	1	KEY CAP/FULL 9 LT GY	28480	5041-0837
A1MP36	5041-0834	1	1	KEY CAP/FULL 6 LT GY	28480	5041-0834
A1MP37	5041-0831	8	1	KEY CAP/FULL 3 LT GY	28480	5041-0831
A1MP38	5041-1672	7	1	KEY CAP/FULL CLEAR	28480	5041-1672
A1MP39	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP40	5041-0252	7		KEY CAP QUARTER GY-LIT	28480	5041-0252
A1MP41	5041-0310	8	1	KEY CAP HALF GY	28480	5041-0310
A1MP42	5041-0386	8		KEY CAP FULL BK-LIT	28480	5041-0386
A1MP43	5041-2753	7	1	KEY CAP-FULL MHZ	28480	5041-2753
A1MP44	5041-2750	4	1	KEY CAP-FULL KHZ UP	28480	5041-2750
A1MP45	5041-2751	5	1	KEY CAP-FULL KHZ DN	28480	5041-2751
A1MP46	5041-2752	6	1	KEY CAP-FULL SPCL	28480	5041-2752
A1R1	1810-0279	5	1	NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A1R2	1810-0207	9	1	NETWORK-RES 8-SIP22.0K OHM X 7	01121	208A223
A1R3	0757-0199	3	10	RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A1R4	0757-0123	3	2	RESISTOR 34.8K 1% .125W F TC = 0 + -100	28480	0757-0123
A1R5	0757-0461	2	4	RESISTOR 68.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6812-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A1R6	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A1R7	0698-0082	7	18	RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A1R8	0698-3453	2	1	RESISTOR 196K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1963-F
A1R9	0757-0461	2		RESISTOR 68.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6812-F
A1R10	0757-0461	2		RESISTOR 68.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6812-F
A1R11	0757-0447	4	5	RESISTOR 16.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1622-F
A1R12	1810-0402	6	10	NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R13	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R14	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R15	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R16	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R17	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R18	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R19	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R20	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R21	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R22	1810-0370	7	7	NETWORK-RES 8-SIP220.0 OHM X 7	01121	208A221
A1R23	1810-0370	7		NETWORK-RES 8-SIP220.0 OHM X 7	01121	208A221
A1R24	1810-0370	7		NETWORK-RES 8-SIP220.0 OHM X 7	01121	208A221
A1R25	1810-0370	7		NETWORK-RES 8-SIP220.0 OHM X 7	01121	208A221
A1R26	1810-0370	7		NETWORK-RES 8-SIP220.0 OHM X 7	01121	208A221
A1R27	1810-0370	7		NETWORK-RES 8-SIP220.0 OHM X 7	01121	208A221
A1R28	0698-3438	3	10	RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A1R29-R32				NOT ASSIGNED		
A1R33	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A1R34	1810-0370	7		NETWORK-RES 8-SIP220.0 OHM X 7	01121	208A221
A1S1	5060-9436	7	46	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S2	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S10	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S13	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S14	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S15	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S16	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S17	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S18	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S19	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S20	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A1S21	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S22	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S23	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S24	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S25	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S26	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S27	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S28	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S29	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S30	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S31	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S32	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S33	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S34	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S35	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S36	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S37	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S38	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S39	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S40	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S41	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S42	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S43	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S44	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S45	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1S46	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1TP1	1251-0600	0	118	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A1U1	1820-1729	3	20	IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U2	1820-2075	4	5	IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A1U3	1990-0574	3	10	DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8	10	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U4	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U5	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U6	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U7	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U8	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U9	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U10	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A1U11	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U12	1990-0574	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7651
	1200-0803	8		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0803
A1U13	1826-0412	1	3	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A1U14	1820-1144	6	2	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A1U15	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A1U16	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U17	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A1U18	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A1U19	1820-1427	8	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N
A1U20	1820-1198	0	10	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A1U21	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A1U22	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U23	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U24	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U25	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U26	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U27	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U28	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U29	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U30	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U31	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U32	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U33	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U34	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U35	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U36	1820-1216	3	16	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U37	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U38	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U39	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U40	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U41	1820-2075	4		IC TRANSCEIVER TTL LS BUS OCTL	28480	1820-2075
A1W1	8150-0447	6	1	WIRE 24AWG BK 300V PVC 7X32 80C	28480	8150-0447
	0362-0227	1	1	CONNECTOR-SGL CONT SKT 1.14-MM-BSC-SZ	28480	0362-0227
A1W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA.	28480	8190-0005
A1W3	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA.	28480	8190-0005
A1W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA.	28480	8190-0005
A1W5	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA. 2	8480 8	190-0005

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A2						
A2	08901-60008	6	1	AUDIO FILTERS ASSEMBLY	28480	08901-60008
A2C1	0180-1746	5	35	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A2C2	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A2C3	0160-4650	4	2	CAPACITOR-FXD 1380PF +-1% 500VDC MICA	28480	0160-4650
A2C4	0160-4650	4		CAPACITOR-FXD 1380PF +-1% 500VDC MICA	28480	0160-4650
A2C5	0160-2055	9	28	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A2C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A2C7	0160-4648	0	2	CAPACITOR-FXD 1650PF +-1% 500VDC MICA	28480	0160-4648
A2C8	0160-4648	0		CAPACITOR-FXD 1650PF +-1% 500VDC MICA	28480	0160-4648
A2C9	0160-0134	1	2	CAPACITOR-FXD 220PF +-5% 300VDC MICA	28480	0160-0134
A2C10	0160-4649	1	1	CAPACITOR-FXD 214PF +-1% 500VDC MICA	28480	0160-4649
A2C11	0180-1714	7	2	CAPACITOR-FXD 330UF+-10% 6VDC TA	56289	150D337X9006S2
A2C12	0140-0229	3	1	CAPACITOR-FXD 380PF +-1% 300VDC MICA	72136	DM15F381F0300WV1C
A2C13	0180-2206	4	5	CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A2C14	0140-0196	3	2	CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J0300WV1CR
A2C15	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A2C16	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A2C17	0140-0194	1	1	CAPACITOR-FXD 110PF +-5% 300VDC MICA	72136	DM15F111J0300WV1CR
A2C18				NOT ASSIGNED		
A2C19	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A2C20	0180-2141	6	2	CAPACITOR-FXD 3.3UF+-10% 50VDC TA	56289	150D335X9050B2
A2C21	0160-4084	8	34	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A2C22				NOT ASSIGNED		
A2C23	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A2C24				NOT ASSIGNED		
A2C25	0180-1714	7		CAPACITOR-FXD 330UF+-10% 6VDC TA	56289	150D337X9006S2
A2C26	0160-4849	3	1	CAPACITOR-FXD 9100PF +-1% 100VDC	28480	0160-4849
A2C27	0160-2302	9	3	CAPACITOR-FXD 4000PF +-1% 100VDC MICA	28480	0160-2302
A2C28				NOT ASSIGNED		
A2C29△	0160-6606	4	1	CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-6606
A2C30	0140-0154	3	1	CAPACITOR-FXD 1300PF +-5% 500VDC MICA	72136	DM20F132J0500WV1CR
A2C31	0160-4759	4	1	CAPACITOR-FXD 6800PF +-1% 200VDC	28480	0160-4759
A2C32	0160-3538	5	1	CAPACITOR-FXD 750PF +-5% 100VDC MICA	28480	0160-3538
A2C33	0160-3536	3	1	CAPACITOR-FXD 620PF +-5% 100VDC MICA	28480	0160-3536
A2C34	0140-0198	5	4	CAPACITOR-FXD 200PF +-5% 300VDC MICA	72136	DM15F201J0300WV1CR
A2C35				NOT ASSIGNED		
A2C36	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A2C37	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A2C38	0160-3068	6	1	CAPACITOR-FXD 1500PF +-5% 300VDC MICA	28480	0160-3068
A2CR1	1901-0040	1	34	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2J1	1250-1220	0	35	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4	40	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9	41	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A2J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) △ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A2L1	9140-0137	1	6	INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q = 60	28480	9140-0137
A2L2	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q = 60	28480	9140-0137
A2L3	9140-0293	0	2	INDUCTOR RF-CH-MLD 906UH 2% .2DX.45LG	28480	9140-0293
A2L4	9140-0293	0		INDUCTOR RF-CH-MLD 906UH 2% .2DX.45LG	28480	9140-0293
A2L5	9100-1653	4	1	INDUCTOR RF-CH-MLD 910UH 5% .2DX.45LG	28480	9100-1653
A2L6	9140-0291	8	1	INDUCTOR RF-CH-MLD 824UH 2% .2DX.45LG	28480	9140-0291
A2L7	9100-1645	4	1	INDUCTOR RF-CH-MLD 390UH 5% .2DX.45LG	28480	9100-1645
A2L8	9140-0292	9	1	INDUCTOR RF-CH-MLD 375UH 2% .2DX.45LG	28480	9140-0292
A2L9	9140-0280	5	1	INDUCTOR 13MH 2% .25DX.7LG	28480	9140-0280
A2L10	9100-1660	3	1	INDUCTOR RF-CH-MLD 2MH 5% .23DX.57LG	28480	9100-1660
A2L11	9140-0281	6	1	INDUCTOR 16MH 2% .25DX.7LG	28480	9140-0281
A2L12	9100-1654	5	1	INDUCTOR RF-CH-MLD 1.1MH 5% .23DX.57LG	28480	9100-1654
A2L13	9100-1651	2	1	INDUCTOR RF-CH-MLD 750UH 5% .2DX.45LG	28480	9100-1651
A2L14	9100-1648	7	1	INDUCTOR RF-CH-MLD 560UH 5% .2DX.45LG	28480	9100-1648
A2MP1	08901-00022	8	1	COVER AUD FILTER	28480	08901-00022
	2360-0113	2	36	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A2MP2	08901-00014	8	1	ENCL SHLD DIVDR	28480	08901-00014
A2MP3	08901-00015	9	1	COVER ENCL SHLD	28480	08901-00015
A2MP4	08901-00050	2	1	SPACER #1	28480	08901-00050
A2MP5	08901-00051	3	1	SPACER #2	28480	08901-00051
A2MP6	08901-00052	4	1	SPACER #3	28480	08901-00052
A2MP7	08901-00053	5	1	SPACER #4	28480	08901-00053
A2Q1	1854-0295	7	4	TRANSISTOR-DUAL NPN PD = 400MW	28480	1854-0295
A2Q2	1854-0071	7	31	TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A2Q3	1853-0007	7	21	TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A2Q4	1854-0477	7	14	TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A2Q5	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A2Q6	1853-0012	4	3	TRANSISTOR PNP 2N2904A SI TO-39 PD = 600MW	01295	2N2904A
A2Q7	1854-0013	7	1	TRANSISTOR NPN 2N2218A SI TO-5 PD = 800MW	04713	2N2218A
2305A TO 2449A						
A2R1	0757-0442	9	77	RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A2R2	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
2451A AND ABOVE						
A2R1	0757-0290	5		RESISTOR 6.19K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-61
A2R2	0757-0290	5		RESISTOR 6.19K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-61F
A2R3	0699-0140	0	2	RESISTOR 524 .1% .1W F TC = 0 + -15	28480	0699-0140
A2R4	0699-0139	7	2	RESISTOR 660 .1% .1W F TC = 0 + -15	28480	0699-0139
A2R5	0698-8556	6	2	RESISTOR 1.62K .1% .125W F TC = 0 + -10	28480	0698-8556
A2R6	2100-3052	4	1	RESISTOR-TRMR 50 10% C SIDE-ADJ 17-TRN	02111	43P500
A2R7	0699-0140	0		RESISTOR 524 .1% .1W F TC = 0 + -15	28480	0699-0140
A2R8	0699-0144	4	2	RESISTOR 10K .01% .1W F TC = 0 + -5	28480	0699-0144
A2R9	0699-0145	5	4	RESISTOR 1.1174K .01% .1W F TC = 0 + -5	28480	0699-0145
A2R10	0698-3451	0	4	RESISTOR 133K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1333-F
A2R11	0698-7219	6	2	RESISTOR 196 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-196R-F
A2R12	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A2R13	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A2R14	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A2R15	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A2R16	0698-3457	6	2	RESISTOR 316K 1% .125W F TC = 0 + -100	28480	0698-3457
A2R17	0698-7260	7	17	RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A2R18				NOT ASSIGNED		
A2R19	0698-8823	0	1	RESISTOR 8.25 1% .125W F TC = 0 + -100	28480	0698-8823
A2R20	0698-3451	0		RESISTOR 133K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1333-F
A2R21				NOT ASSIGNED		
A2R22	0698-6414	1	5	RESISTOR 1K .1% .1W F TC = 0 + -5	28480	0698-6414
A2R23	0699-0176	2	1	RESISTOR 415 .1% .1W F TC = 0 + -15	28480	0699-0176
A2R24	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A2R25				NOT ASSIGNED		
A2R26	0757-0280	3	101	RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A2R27	0698-8475	8	7	RESISTOR 1.799K .1% .1W F TC = 0 + -5	28480	0698-8475
A2R28	0698-3430	5	10	RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A2R29	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A2R30	0698-8556	6		RESISTOR 1.62K .1% .125W F TC = 0 + -10	28480	0698-8556
A2R31	0699-0161	5	1	RESISTOR 580 .1% .1W F TC = 0 + -15	28480	0699-0161
A2R32	0699-0143	3	2	RESISTOR 825 .1% .1W F TC = 0 + -15	28480	0699-0143
A2R33	0757-0394	0	17	RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A2R34	0757-0180	2	1	RESISTOR 31.6 1% .125W F TC = 0 + -100	28480	0757-0180
A2R35	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A2R36	0698-8475	8		RESISTOR 1.799K .1% .1W F TC = 0 + -5	28480	0698-8475
A2R37	0699-0144	4		RESISTOR 10K .01% .1W F TC = 0 + -5	28480	0699-0144
A2R38	0699-0145	5		RESISTOR 1.1174K .01% .1W F TC = 0 + -5	28480	0699-0145
A2R39	0757-0400	9	3	RESISTOR 90.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-90R9-F
A2R40	2100-0552	3	3	RESISTOR-TRMR 50 10% C SIDE-ADJ 1-TRN	28480	2100-0552
A2R41	0699-0159	1	1	RESISTOR 860 .1% .1W F TC = 0 + -15	28480	0699-0159
A2R42	0698-8475	8		RESISTOR 1.799K .1% .1W F TC = 0 + -5	28480	0698-8475
A2R43	0698-3434	9	2	RESISTOR 34.8 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-34R8-F
A2R44	2100-0552	3		RESISTOR-TRMR 50 10% C SIDE-ADJ 1-TRN	28480	2100-0552
A2R45	0699-0160	4	1	RESISTOR 940 .1% .1W F TC = 0 + -15	28480	0699-0160
A2R46	0698-3136	8	4	RESISTOR 17.8K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1782-F
A2R47	0698-3243	8	2	RESISTOR 178K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1783-F
A2R48	0698-6414	1		RESISTOR 1K .1% .1W F TC = 0 + -5	28480	0698-6414
A2R49	0699-0144	4		RESISTOR 10K .01% .1W F TC = 0 + -100	28480	0699-0144
A2R50	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
2305A TO 2644A						
A2R51	0757-0399	5	2	RESISTOR 82.5 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-82R5-F
2703A AND ABOVE						
A2R51	0757-0399	0	1	RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-101-F
A2RT1	0837-0027	6	2	THERMISTOR DISC 30-OHM TC = -3.9%/C-DEG	28480	0837-0027
A2RT2	0839-0011	2	1	THERMISTOR DISC 100-OHM TC = -3.8%/C-DEG	28480	0839-0011
A2RT3	0837-0027	6		THERMISTOR DISC 30-OHM TC = -3.9%/C-DEG	28480	0837-0027

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A2TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
2305A TO 2449A						
A2U1	1826-0582	6	7	IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A2U2	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
2451A AND ABOVE						
A2U1	1826-0606	5		ANALOG SWITCH 4 SPST 16-CER DIP	17856	DG201BK
A2U2	1826-0606	5		ANALOG SWITCH 4 SPST 16-CER DIP	17856	DG201BK
A2U3	1826-0413	2	5	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	34371	HA2-2605-5
2305A TO 2449A						
A2U4	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
2451A AND ABOVE						
A2U4	1826-0606	5		ANALOG SWITCH 4 SPST 16-CER DIP	17856	DG201BK
A2U5	1826-0109	3	1	IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A2W1	08901-20096	8	1	CABLE SEMI RIGID AM	28480	08901-20096
A2W2	08901-20095	7	1	CABLE SEMI RIGID FM	28480	08901-20095

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3						
A3	08901-60009	7	1	AUDIO DE-EMPHASIS AND OUTPUT ASSEMBLY	28480	08901-60009
A3C1	0180-0058	0	9	CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A3C2	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A3C3	0180-2929	8	9	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
2305A TO 2515A						
A3C4	0160-3858	2	2	CAPACITOR-FXD .039UF +-2% 200VDC	28480	0160-3858
2519A AND ABOVE						
A3C4	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC MPC	28480	0160-5340
A3C5	0160-4613	9	2	CAPACITOR-FXD .1UF +-1% 50VDC POLYSTY	28480	0160-4613
2305A TO 2515A						
A3C6	0160-3858	2		CAPACITOR-FXD .039UF +-2% 200VDC	28480	0160-3858
2519A AND ABOVE						
A3C6	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC MPC	28480	0160-5340
A3C7	0160-4613	9		CAPACITOR-FXD .1UF +-1% 50VDC POLYSTY	28480	0160-4613
A3C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C10	0160-3879	7	93	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C18	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C22	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C23	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C24△	0160-6606	4		CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-6606
A3C25	0160-4317	0	1	CAPACITOR-FXD 1200PF +-1% 100VDC MICA	28480	0160-4317
A3C26	0140-0213	5	2	CAPACITOR-FXD 2000PF +-1% 300VDC MICA	72136	DM19F202F0300WV1CR
A3C27	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C28	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C29	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C30	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C31	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C32	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C33	0140-0213	5		CAPACITOR-FXD 2000PF +-1% 300VDC MICA	72136	DM19F202F0300WV1CR

†Refer to Section 7 for update information. *Factory selected Component (Refer to Section 5) △ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3C34Δ	0160-6606	4		CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-6606
A3C35				NOT ASSIGNED		
A3C36	0140-0196	3		CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J0300WV1CR
A3C37	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A3C38				NOT ASSIGNED		
A3C39	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C40	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C42	0160-2204	0	3	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A3C43	0160-2201	7	1	CAPACITOR-FXD 51PF +-5% 300VDC MICA	28480	0160-2201
A3C44	0180-0291	3	9	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A3C45				NOT ASSIGNED		
A3C46				NOT ASSIGNED		
2305A TO 2515A						
A3C47	0160-3165	4	1	CAPACITOR-FXD .047UF +-2% 50VDC POLYE	28480	0160-3165
A3C48	0160-2302	9		CAPACITOR-FXD 4000PF +-1% 100VDC MICA	28480	0160-2302
2519A AND ABOVE						
A3C47	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC MPC	28480	0160-5340
A3C48	0160-4217	9		CAPACITOR-FXD 3900PF +-1% 500VDC MICA	28480	0160-4217
A3C49	0160-5201	3	2	CAPACITOR-FXD .01UF +-1% 200VDC	28480	0160-5201
A3C50	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C51	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C52	0160-5201	3		CAPACITOR-FXD .01UF +-1% 200VDC	28480	0160-5201
2305A TO 2515A						
A3C53	0160-2302	9		CAPACITOR-FXD 4000PF +-1% 100VDC MICA	28480	0160-2302
2519A AND ABOVE						
A3C53	0160-4217	9		CAPACITOR-FXD 3900PF +-1% 500VDC MICA	28480	0160-4217
A3C54				NOT ASSIGNED		
A3C55	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C56	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C57	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C58	0180-0116	1	5	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A3C59	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C60	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C61	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C62	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C63				NOT ASSIGNED		
A3C64	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A3C65	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A3C66				NOT ASSIGNED		
A3C67				NOT ASSIGNED		
A3C68	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2

[Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3C69	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A3C70	0160-0134	1		CAPACITOR-FXD 220PF +-5% 300VDC MICA	28480	0160-0134
A3C71				NOT ASSIGNED		
A3C72	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A3C73	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C74	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C75	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A3C76	0180-0197	8	55	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3C77	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A3CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR3	1901-1098	1		DIODE-SWITCHING IN4150 50V 200MA 4NS	9N171	1N4150
A3CR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR8				NOT ASSIGNED		
A3CR9	1901-1098	1		DIODE-SWITCHING 1N4150 200MA 4NS	9N171	1N4150
A3L1	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q=60	28480	9140-0137
A3L2	9100-1633	0	1	INDUCTOR RF-CH-MLD 68UH 5% .166DX.385LG	28480	9100-1633
A3L3	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q=60	28480	9140-0137
A3MP1	08901-00021	7	1	COVER AUD DE-EMP	28480	08901-00021
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A3Q1	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
2305A TO 2515A						
A3R1	0698-7353	9	1	RESISTOR 19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1902
2519A AND ABOVE						
A3R1	0698-6942	0		RESISTOR 25K .1% .125W F TC=0+-50	24546	C4-1/8-T0-2502-F
A3R2	0698-5091	8	1	RESISTOR 45K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4502-F
A3R3	0757-0349	5	1	RESISTOR 22.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2262-F
2305A TO 2515A						
A3R4	0698-6343	5	2	RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
2519A AND ABOVE						
A3R4	0698-8191	5		RESISTOR 12.5K .1% .125W F TC=0+-25	24546	C4-1/8-T0-1252-F
A3R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R6				NOT ASSIGNED		
A3R7	0698-0085	0	16	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A3R8	0698-3159	5	3	RESISTOR 26.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2612-F
A3R9	0698-3161	9	4	RESISTOR 38.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3832-F
A3R10				NOT ASSIGNED		
A3R11	0757-0441	8	11	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R12	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A3R13	0757-0438	3	40	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R14	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3R15				NOT ASSIGNED		
A3R16	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A3R17	0757-0465	6	30	RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A3R18	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A3R19	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A3R20	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A3R21	0683-2265	1	3	RESISTOR 22M 5% .25W FC TC = -900/ + 1200	01121	CB2265
A3R22	0757-0279	0	19	RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A3R23	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A3R24				NOT ASSIGNED		
A3R25	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A3R26	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A3R27	2100-3273	1	2	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	28480	2100-3273
A3R28	0698-3156	2	7	RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1472-F
2305A TO 2515A						
A3R29	0698-8046	9	1	RESISTOR 16K .1% .125W F TC = 0 + -25	19701	MF4C1/8-T9-1602
2519A AND ABOVE						
A3R29	0698-6942	0		RESISTOR 25K .1% .125W F TC = 0 + -50	24546	C4-1/8-T0-250
A3R30	0698-7264	1	1	RESISTOR 14.7K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1472-F
A3R31	0698-8191	5	1	RESISTOR 12.5K .1% .125W F TC = 0 + -25	19701	MF4C1/8-T9-1252-B
A3R32	0698-7643	0	2	RESISTOR 6.25K .1% .125W F TC = 0 + -25	19701	MF4C1/8-T9-6251-B
A3R33	0699-0069	2	2	RESISTOR 2.15M 1% .125W F TC = 0 + -100	28480	0699-0069
A3R34	0698-8642	1	1	RESISTOR 56.2K .1% .125W F TC = 0 + -25	28480	0698-8642
A3R35	0698-8731	9	12	RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
2305A TO 2515A						
A3R36	0698-6614	3	1	RESISTOR 7.5K .1% .125W F TC = 0 + -25	28480	0698-6614
2519A AND ABOVE						
A3R36	0698-8307	5		RESISTOR 7.4K .25% .125W F TC = 0 + -50	28480	0698-8307
A3R37	0698-7643	0		RESISTOR 6.25K .1% .125W F TC = 0 + -25	19701	MF4C1/8-T9-6251-B
A3R38	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A3R39	0698-7251	6	6	RESISTOR 4.22K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-4221-F
A3R40	0698-7224	3	2	RESISTOR 316 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-316R-F
A3R41	0698-3157	3	10	RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A3R42				NOT ASSIGNED		
A3R43	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A3R44	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A3R45	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A3R46	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A3R47	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A3R48	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A3R49	0698-3159	5		RESISTOR 26.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2612-F
A3R50	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3R51 Δ	0698-6414	5		RESISTOR 1K .1% .1W F TC = 0 + -5	28480	0698-6414
A3R52	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A3R53	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A3R54	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A3R55 Δ	0698-6414	5		RESISTOR 1K .1% .1W F TC = 0 + -5	28480	0698-6414
A3R56	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A3R57	0757-0439	4	8	RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A3R58				NOT ASSIGNED		
A3R59	0757-0401	0	51	RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A3R60	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A3R61	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A3R62	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A3R63	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A3R64	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A3R65	0698-7272	1	1	RESISTOR 31.6K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-3162-F
A3TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3U1	1826-0413	2		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	34371	HA2-2605-5
A3U2	1826-0413	2		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	34371	HA2-2605-5
A3U3	1826-0413	2		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	34371	HA2-2605-5
A3U4	1826-0753	3	5	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A3U5	1826-0371	1	6	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A3U6	1826-0059	2	10	IC OP AMP GP TO-99 PKG	01295	LM201AL
A3U7	1826-0783	9	6	IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A3U8	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A3U9	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A3U10	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A3U11	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
2305A TO 2449A						
A3U12	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A3U13	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A3U14	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A3U15	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
2451A AND ABOVE						
A3U12	1826-0606	5		ANALOG SWITCH 4 SPST 16-CER DIP	17856	DG201BK
A3U13	1826-0606	5		ANALOG SWITCH 4 SPST 16-CER DIP	17856	DG201BK
A3U14	1826-0606	5		ANALOG SWITCH 4 SPST 16-CER DIP	17856	DG201BK
A3U15	1826-0606	5		ANALOG SWITCH 4 SPST 16-CER DIP	17856	DG201BK
A3U16	1820-1195	7	13	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A3U17	1820-1418	7	1	IC DCDR TTL LS BCD-TO-DEC 4-TO-10-LINE	01295	SN74LS42N
A3U18	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A3U19	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A3U20	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A3U21	1820-1272	1	1	IC BFR TTL LS NOR QUAD 2-INP	01295	SN74LS33N
A3U22	1820-1112	8	5	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A3U23	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A3VR1	1902-0041	4	10	DIODE-ZNR 5.11V 5% DO-35 PD = .4W	28480	1902-0041
A3VR2	1902-0048	1	2	DIODE-ZNR 6.81V 5% DO-35 PD = .4W	28480	1902-0048
A3VR3	1902-0048	1		DIODE-ZNR 6.81V 5% DO-35 PD = .4W	28480	1902-0048
A3VR4	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD = .4W	28480	1902-0041
A3VR5	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD = .4W	28480	1902-0041

†Refer to Section 7 for update information. *Factory Selected Component (Refer to section 5.) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A4						
A4	08901-60184	9	1	FM DEMODULATOR ASSEMBLY	28480	08901-60184
A4C1	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A4C2	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A4C3	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C4	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C5	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C6	0160-4492	2	3	CAPACITOR-FXD 18PF +-5% 200VDC CER 0+-30	28480	0160-4492
A4C7	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A4C8	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A4C9	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A4C10	0160-4492	2		CAPACITOR-FXD 18PF +-5% 200VDC CER 0+-30	28480	0160-4492
A4C11	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C12	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C13	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A4C14	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A4C15	0160-4806	2	1	CAPACITOR-FXD 39PF +-5% 100VDC CER 0+-30	28480	0160-4806
A4C16	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C17	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C18	0160-4832	4	32	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C19	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C20	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C21	0180-0094	4	9	CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A4C22	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C23	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A4C24	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A4C25	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A4C26	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A4C27	0160-5699	3	3	CAPACITOR-FXD 20PF +-5% 100VDC CER 0+-30	28480	0160-5699
A4C28	0160-5699	3		CAPACITOR-FXD 20PF +-5% 100VDC CER 0+-30	28480	0160-5699
A4C29	0160-0162	5	1	CAPACITOR-FXD .022UF +-10% 200VDC POLYE	28480	0160-0162
A4C30	0160-0153	4	3	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A4C31	0160-4805	1	2	CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C32	0160-4808	4	1	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A4C33	0160-5491	3	1	CAPACITOR-FXD 240PF +-5% 100VDC CER	28480	0160-5491
A4C34				NOT ASSIGNED		
A4C35	0160-4799	2	1	CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A4C36	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A4C37	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C38	0160-4801	7	3	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A4C39	0160-3501	2	5	CAPACITOR-FXD 4UF +-10% 50VDC MET-POLYC	28480	0160-3501
A4C40				NOT ASSIGNED		
A4C41	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C42	0160-4812	0	5	CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A4C43	0160-4791	4	2	CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A4C44	0160-4795	8	2	CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
A4C45	0160-5719	8	1	CAPACITOR-FXD 620PF +-5% 100VDC CER	28480	0160-5719

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A4C46	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C47	0160-4822	2	6	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A4C48	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A4C49	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C50	0160-4819	7	2	CAPACITOR-FXD 2200PF +-5% 100VDC CER	28480	0160-4819
A4C51	0160-4819	7		CAPACITOR-FXD 2200PF +-5% 100VDC CER	28480	0160-4819
A4CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4CR6	08901-80037	3	4	MATCH DIODE SET	28480	08901-80037
A4CR7	08901-80037	3		MATCH DIODE SET	28480	08901-80037
A4CR8	08901-80037	3		MATCH DIODE SET	28480	08901-80037
A4CR9	08901-80037	3		MATCH DIODE SET	28480	08901-80037
A4CR10	1901-0518	8	32	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR11	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR12	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR13	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR14	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4CR15	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4CR16	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A4DS1	1990-0325	2	2	LED-LAMP LUM-INT = 800UCD IF = 50MA-MAX	28480	5082-4403
A4DS2	1990-0325	2		LED-LAMP LUM-INT = 800UCD IF = 50MA-MAX	28480	5082-4403
A4J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A4J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A4J3	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A4L1	9140-0098	3	2	INDUCTOR RF-CH-MLD 2.2UH 10%	28480	9140-0098
A4L2	9140-0098	3		INDUCTOR RF-CH-MLD 2.2UH 10%	28480	9140-0098
A4L3	9100-2272	5	2	INDUCTOR RF-CH-MLD 47UH 10% .105DX.26LG	28480	9100-2272
A4L4	9100-2272	5		INDUCTOR RF-CH-MLD 47UH 10% .105DX.26LG	28480	9100-2272
A4MP1	08901-00020	6	1	COVER FM D MOD	28480	08901-00020
	2190-0008	3	19	WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A4Q1	1854-0210	6	4	TRANSISTOR NPN 2N2222 SI TO-18 PD = 500MW	04713	2N2222
A4Q2	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q3	1853-0020	4	23	TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A4Q4	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A4Q5	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A4Q6	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A4Q7	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A4Q8	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A4Q9	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q10	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A4Q11	1858-0032	8	5	TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A4Q12	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A4Q13	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A4Q14	1854-0210	6		TRANSISTOR NPN 2N2222 SI TO-18 PD = 500MW	04713	2N2222
A4Q15	1854-0210	6		TRANSISTOR NPN 2N2222 SI TO-18 PD = 500MW	04713	2N2222
A4Q16	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q17	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A4Q18	1854-0295	7		TRANSISTOR-DUAL NPN PD = 400MW	28480	1854-0295
A4Q19	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A4Q20	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q21	1855-0020	8	4	TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	28480	1855-0020
A4Q22	1855-0049	1	2	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0049
A4Q23	1854-0637	1	6	TRANSISTOR NPN 2N2219A SI TO-5 PD = 800MW	01295	2N2219A
	1200-0173	5	19	INSULATOR-XSTR DAP-GL	28480	1200-0173
A4Q24	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q25	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A4Q26	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD = 800MW	01295	2N2219A
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A4Q27	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q28	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD = 800MW	01295	2N2219A
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
	1205-0361	3	2	HEAT SINK SGL TO-5/TO-39-CS	13103	2226C
A4Q29	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q30	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A4Q31	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q32	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A4Q33	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD = 800MW	01295	2N2219A
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
	1205-0361	3		HEAT SINK SGL TO-5/TO-39-CS	13103	2226C
A4Q34	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q35	1855-0020	8		TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	28480	1855-0020
A4R1	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A4R2	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A4R3	0698-3155	1	22	RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R4	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A4R5	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A4R6	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A4R7	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R8	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R9	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R10	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R11	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R12	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R13	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A4R14	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A4R15	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R16	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 7) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A4R17	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R18	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A4R19	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R20	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R21	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R22	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R23	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R24	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A4R25	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R26	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R27	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R28	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A4R29	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R30	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R31	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R32	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R33	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R34	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R35	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R36	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R37	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A4R38	0698-0084	9	21	RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A4R39	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A4R40	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A4R41	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R42	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A4R43				NOT ASSIGNED		
A4R44				NOT ASSIGNED		
A4R45	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A4R46	0698-3160	8	7	RESISTOR 31.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3162-F
A4R47	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A4R48	0757-0403	2	5	RESISTOR 121 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-121R-F
A4R49	0698-8833	2	1	RESISTOR 10K .1% .125W F TC = 0 + -10	28480	0698-8833
A4R50	2100-3273	1		RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	28480	2100-3273
A4R51	0698-3904	8	1	RESISTOR 14.7K .1% .1W F TC = 0 + -10	28480	0698-3904
A4R52	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A4R53	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A4R54	0698-3441	8	13	RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A4R55	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A4R56	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A4R57	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A4R58	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A4R59	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A4R60	0757-0400	9		RESISTOR 90.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-90R9-F
A4R61	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A4R62	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A4R63	0757-0346	2	16	RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A4R64	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A4R65	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A4R66	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A4R67	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A4R68	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A4R69	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A4R70	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R71	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A4R72	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R73	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R74	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A4R75	0698-8821	8	2	RESISTOR 5.62 1% .125W F TC = 0 + -100	28480	0698-8821
A4R76	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R77	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A4R78	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A4R79	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R80	0698-3432	7	5	RESISTOR 26.1 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-26R1-F
A4R81	0698-3432	7		RESISTOR 26.1 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-26R1-F
A4R82	0698-3160	8		RESISTOR 31.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3162-F
A4R83	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A4R84	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A4R85	2100-3352	7	2	RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	28480	2100-3352
A4R86	0698-3454	3	5	RESISTOR 215K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2153-F
A4R87	0698-0083	8	14	RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A4R88	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A4R89	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A4R90	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R91	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A4R92	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A4R93	0698-8549	7	3	RESISTOR 2.1K .5% .1W F TC = 0 + -5	28480	0698-8549
A4R94	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R95	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A4R96	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R97	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A4R98	0757-0395	1	2	RESISTOR 56.2 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-56R2-F
A4R99	0699-0139	7		RESISTOR 660 .1% .1W F TC = 0 + -15	28480	0699-0139
A4R100	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R101	0698-8827	4	11	RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A4R102	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A4R103	0698-3160	8		RESISTOR 31.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3162-F
A4R104	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A4R105	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A4R106	0698-3446	3	7	RESISTOR 383 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-383R-F
A4TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4VR1	1902-0680	7	9	DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A5						
2305A TO 2528A						
A5	08902-60005	4	1	VOLTMETER ASSEMBLY	28480	08902-60005
2530A AND ABOVE						
A5	08902-60101	1	1	VOLTMETER ASSEMBLY	28480	08902-60101
A5C1	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A5C2	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A5C3	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A5C4	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A5C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C7	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A5C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C9	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A5C10	0180-0374	3	6	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A5C11	0160-4387	4	3	CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A5C12	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A5C13	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C14	0180-1704	5	1	CAPACITOR-FXD 47UF+-10% 6VDC TA	56289	150D476X9006B2
A5C15	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A5C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A5C17	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A5C18	0160-3501	2		CAPACITOR-FXD 4UF +-10% 50VDC MET-POLYC	28480	0160-3501
A5C19	0160-0970	3	1	CAPACITOR-FXD .47UF +-10% 80VDC POLYE	28480	0160-0970
A5C20	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C21	0160-3878	6	44	CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A5C22	0160-3402	2	4	CAPACITOR-FXD 1UF +-5% 50VDC MET-POLYC	28480	0160-3402
A5C23	0160-3501	2		CAPACITOR-FXD 4UF +-10% 50VDC MET-POLYC	28480	0160-3501
A5C24	0160-3501	2		CAPACITOR-FXD 4UF +-10% 50VDC MET-POLYC	28480	0160-3501
A5C25	0160-3402	2		CAPACITOR-FXD 1UF +-5% 50VDC MET-POLYC	28480	0160-3402
A5C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C27	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C28	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C29	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A5C30	0160-4807	3	4	CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A5C31	0160-4397	6	1	CAPACITOR-FXD .1UF +-1% 100VDC POLYSTY	28480	0160-4397
A5C32	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C33	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A5C34	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C35	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A5CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A5CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A5CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A5CR5	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A5CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR8	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A5CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR11	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A5CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR14	1901-0880	7		DIODE-GEN PRP 125MA D0-35	28480	1901-0880
A5CR15	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A5CR16	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A5L1	9140-0210	1	9	INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A5MP1	08901-00019	3	1	COVER VOLT MTR	28480	08901-00019
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A5Q1	1854-0810	2	18	TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A5Q2	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A5Q3	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A5Q4	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A5Q5	1855-0414	4	3	TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A5Q6	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A5Q7	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A5R1	1810-0126	1	1	NETWORK-RES 14-DIP10.0K OHM X 13	11236	760-1-R10K
A5R2	2100-3358	3	2	RESISTOR-TRMR 1M 20% C SIDE-ADJ 1-TRN	28480	2100-3358
A5R3	0698-8549	7		RESISTOR 2.1K .5% .1W F TC = 0 + -5	28480	0698-8549
2305A TO 2449A						
A5R4	0699-0074	9	2	RESISTOR 14.7M 1% .125W F TC = 0 + -150	28480	0699-0074
2451A AND ABOVE						
A5R4	0699-0073	8		RESISTOR 10M 1% .125W F TC = 0 + -150	28480	0699-0073
A5R5	0757-0288	1	3	RESISTOR 9.09K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-9091-F
A5R6	0698-8549	7		RESISTOR 2.1K .5% .1W F TC = 0 + -5	28480	0698-8549
A5R7	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A5R8	0698-8731	9		RESISTOR 4.8K .1% .1W F TC = 0 + -15	28480	0698-8731
A5R9	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A5R10	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R11	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A5R12	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A5R13	0698-3154	0	12	RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A5R14	0698-3132	4	11	RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
2305A TO 2449A						
A5R15	0699-0074	9		RESISTOR 14.7M 1% .125W F TC = 0 + -150	28480	0699-0074
2451A AND ABOVE						
A5R15	0699-0073	8		RESISTOR 10M 1% .125W F TC = 0 + -150	28480	0699-0073

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A5R16	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R17	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A5R18	2100-3358	3		RESISTOR-TRMR 1M 20% C SIDE-ADJ 1-TRN	28480	2100-3358
A5R19	0757-0461	2		RESISTOR 68.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6812-F
A5R20	0698-3150	6	7	RESISTOR 2.37K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2371-F
A5R21	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A5R22	0699-0222	9	1	RESISTOR 10.5K .1% .1W F TC = 0 + -15	28480	0699-0222
A5R23	2100-3351	6	1	RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A5R24	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A5R25	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A5R26	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A5R27	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A5R28	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R29	0757-0458	7	8	RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5112-F
A5R30	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A5R31	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A5R32	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R33	0698-6286	5	1	RESISTOR 100M 10% .25W FC TC = -900/ + 1200	01121	CB1071
A5R34	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A5R35	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A5R36	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A5R37	0757-0458	7		RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5112-F
A5R38	2100-3353	8	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	28480	2100-3353
2306A TO 2449A						
A5R39	0698-3457	6		RESISTOR 316K 1% .125W F TC = 0 + -100	28480	0698-3457
2451A AND ABOVE						
A5R39	0698-3454	3		RESISTOR 215K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2153-F
A5R40	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A5R41	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A5R42	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A5R43	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R44	0757-0420	3	9	RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A5R45	0698-3152	8	8	RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A5R46	0698-6360	6	3	RESISTOR 10K .1% .125W F TC = 0 + -25	28480	0698-6360
A5R47	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A5R48	0698-6360	6		RESISTOR 10K .1% .125W F TC = 0 + -25	28480	0698-6360
A5R49	0699-0847	4	3	RESISTOR 1.96K .1% .125W F TC = 0 + -50	28480	0699-0847
A5R50	0699-0847	4		RESISTOR 1.96K .1% .125W F TC = 0 + -50	28480	0699-0847
A5R51	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A5R52	0698-6631	4	1	RESISTOR 2.5K .1% .125W F TC = 0 + -25	28480	0698-6631
A5R53	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A5R54	0698-3156	2		RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1472-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A5R55	0698-6362	8	1	RESISTOR 1K .1% .125W F TC = 0 + -25	28480	0698-6362
A5R56	0699-0847	4		RESISTOR 1.96K .1% .125W F TC = 0 + -50	28480	0699-0847
A5R57	0757-0467	8	4	RESISTOR 121K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1213-F
A5R58	0757-0463	4	3	RESISTOR 82.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8252-F
A5R59	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A5R60	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A5R61	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A5R62	0757-0467	8		RESISTOR 121K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1213-F
A5R63	0698-3243	8		RESISTOR 178K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1783-F
A5R64	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A5R65	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A5R66	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R67	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R68	0698-3443	0	9	RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A5R69	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A5R70	0757-0419	0	7	RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
A5R71	0757-0405	4	4	RESISTOR 162 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-162R-F
A5R72	0757-0419	0		RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
A5R73	2100-3103	6	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	02111	43P103
A5R74	0699-0239	8	1	RESISTOR 59K .1% .1W F TC = 0 + -15	28480	0699-0239
A5R75	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A5R76	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A5R77	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A5R78	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A5R79	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A5R80	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A5R81	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A5TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5U1	1826-1048	7	1	IC OP AMP PRCN 8-DIP-C PKG	28480	1826-1048
A5U2	1826-0969	3	1	RMS/DC 10-METAL BPLR	28480	1826-0969
A5U3	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A5U4	1826-0098	9	3	IC COMPARATOR PRCN TO-99 PKG	27014	LM211H
A5U5	1826-0098	9		IC COMPARATOR PRCN TO-99 PKG	27014	LM211H
A5U6	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A5U7	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A5U8	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A5U9	1826-0180	0	2	IC TIMER TTL MONO/ASTBL	01295	NE555P
A5U10	1826-0605	4	3	IC MULTIPLXR 8-CHAN-ANLG 16-DIP-C PKG	17856	DG508BK
A5U11	1826-0605	4		IC MULTIPLXR 8-CHAN-ANLG 16-DIP-C PKG	17856	DG508BK
A5U12	1826-0605	4		IC MULTIPLXR 8-CHAN-ANLG 16-DIP-C PKG	17856	DG508BK
A5U13	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A5U14	1820-1211	8	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86N
A5U15	1820-1411	0	13	IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A5U16	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A5U17	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A5U18	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A5VR1	1902-0946	8	1	DIODE-ZNR 3.3V 5% DO-35 PD = .4W TC = -.039%	28480	1902-0946
A5VR2	1902-3082	9	1	DIODE-ZNR 4.64V 5% DO-35 PD = .4W	28480	1902-3082
A5VR3	1902-3024	9	1	DIODE-ZNR 2.87V 5% DO-7 PD = .4W TC = -.07%	28480	1902-3024
A5VR4	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827
A5W1				NOT ASSIGNED		
2305A TO 2627A						
A5W2				NOT ASSIGNED		
2625A AND ABOVE						
A5W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A6						
A6	08901-60186	1	1	AM DEMODULATOR ASSEMBLY	28480	08901-60186
A6C1	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A6C2	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A6C3	0160-2208	4	1	CAPACITOR-FXD 330 +-5% 300VDC MICA	28480	0160-2208
A6C4	0160-2660	2	1	CAPACITOR-FXD 20PF +-2% 500VDC CER 0+-30	28480	0160-2660
A6C5	0160-4635	5	1	CAPACITOR-FXD 212PF +-1% 100VDC MICA	28480	0160-4635
A6C6	0160-4795	8		CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
A6C7	0160-4807	3		CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A6C8	0121-0105	4	3	CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	304324 9/35PF N650
A6C9	0160-4833	5	7	CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A6C10				NOT ASSIGNED		
A6C11	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A6C12				NOT ASSIGNED		
A6C13				NOT ASSIGNED		
A6C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C15	0160-4835	7	19	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A6C16	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A6C17	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C18	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A6C19	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A6C20	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A6C21	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A6C22	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A6C23	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A6C24	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A6C25	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A6C26	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C27				NOT ASSIGNED		
A6C28				NOT ASSIGNED		
A6C29	0160-4807	3		CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A6C30	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A6C31	0160-3501	2		CAPACITOR-FXD 4UF +-10% 50VDC MET-POLYC	28480	0160-3501
A6C32	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A6C33				NOT ASSIGNED		
A6C34	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A6C35				NOT ASSIGNED		
A6C36	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A6C37	0160-5528	7	1	CAPACITOR-FXD .22UF +-5% 100VDC	28480	0160-5528
A6C38	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A6C39	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A6C40	0160-3539	6	1	CAPACITOR-FXD 820PF +-5% 100VDC MICA	28480	0160-3539
A6C41	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A6C42	0160-4807	3		CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A6C43*	0160-2208	4	1	CAPACITOR-FXD 330PF +-5% 300VDC MICA	28480	0160-2208

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A6C44	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A6C45	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A6C46	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A6C47	0180-2929	8		CAPACITOR-FXD 68UF +-10% 10VDC TA	28480	0180-2929
A6C48				NOT ASSIGNED		
A6C49				NOT ASSIGNED		
A6C50	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
2305A TO 2338A						
*A6C51**	0160-0340	1	1	CAPACITOR-FXD 600PF +-1% 300VDC MICA	28480	0160-0340
2339A AND 2340A						
*A6C51**	0160-4678	6		CAPACITOR-FXD 560PF +-1% 100VDC MICA	28480	0160-4678
2341A AND 2342A						
*A6C51**	0160-0340	1	1	CAPACITOR-FXD 600PF +-1% 300VDC MICA	28480	0160-0340
2343A AND ABOVE						
*A6C51**	0160-4678	6		CAPACITOR-FXD 560PF +-1% 100VDC MICA	28480	0160-4678
A6C52	0180-2613	7	1	CAPACITOR-FXD 390UF +-10% 6VDC TA	56289	150D397X9006R2-DJB
A6C53	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A6C54	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A6C55	0160-5469	5	27	CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A6C56	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A6C57	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A6C58	0160-4825	5	4	CAPACITOR-FXD 560PF +-5% 100VDC CER	28480	0160-4825
A6C59	0160-4825	5		CAPACITOR-FXD 560PF +-5% 100VDC CER	28480	0160-4825
A6C60	0160-4810	8	1	CAPACITOR-FXD 330PF +-5% 100VDC CER	28480	0160-4810
A6C61	0180-0197	8		CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A6C62	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A6C63	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A6C64	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A6C65	0180-0376	5	2	CAPACITOR-FXD .47UF +-10% 35VDC TA	56289	150D474X9035A2
A6C66	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A6C67	0160-5714	3	1	CAPACITOR-FXD .68UF +-10% 100VDC CER	28480	0160-5714
A6C68	0160-4789	0	1	CAPACITOR-FXD 15PF +-5% 100VDC CER 0 +-30	28480	0160-4789
A6C69	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A6C70	0160-4509	2	1	CAPACITOR-FXD .033UF +-5% 50VDC	28480	0160-4509
A6CR1-CR4				NOT ASSIGNED		
A6CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A6CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A6CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A6CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A6CR9	1901-0539	3	5	DIODE-SM SIG SCHOTTKY	28480	1901-0539
A6CR10	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A6CR11				NOT ASSIGNED		
A6CR12				NOT ASSIGNED		
A6CR13	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A6CR14	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518

†Refer to Section 7 for update information. *Factory selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A6CR15	08901-80024	8	2	DET DIODES-MATCH	28480	08901-80024
A6CR16	08901-80024	8		DET DIODES-MATCH	28480	08901-80024
A6CR17	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A6CR18	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A6CR19	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A6CR20	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A6CR21	1901-0539	3		DIODE-SM SIG SCHOTTKY	28480	1901-0539
A6CR22	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A6J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A6J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A6J3	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A6J4	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A6L1	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A6L2	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A6L3	9140-0271	4	1	INDUCTOR RF-CH-MLD 13.3UH 2%	28480	9140-0271
A6L4	9140-0272	5	1	INDUCTOR RF-CH-MLD 32UH 2% .166DX.385LG	28480	9140-0272
A6L5	9140-0273	6	1	INDUCTOR RF-CH-MLD 47.6UH 2%	28480	9140-0273
A6L6				NOT ASSIGNED		
A6L7	9100-1652	3	1	INDUCTOR RF-CH-MLD 820UH 5% .2DX.45LG	28480	9100-1652
A6L8*	9100-1633	0	1	INDUCTOR RF-CH-MLD 68UH 5% .166DX.385LG	28480	9100-1633
A6L9	9100-1666	9	1	INDUCTOR RF-CH-MLD 3.6MH 5% .23DX.57LG	28480	9100-1666
A6L10	9140-0131	5	4	INDUCTOR RF-CH-MLD 10MH 5% .25DX.75LG	28480	9140-0131
A6MP1	08901-00109	2	1	COVER AM DEMOD	28480	08901-00109
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A6Q1	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A6Q2	1858-0010	2	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	04713	MPQ2906
A6Q3				NOT ASSIGNED		
A6Q4	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A6Q5	1854-0404	0	13	TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
2305A TO 2449A						
A6Q6	1855-0420	2	8	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
2451A AND ABOVE						
A6Q6	1855-0265	3		TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	17856	VCR2N
A6Q7	1855-0421	3	1	TRANSISTOR J-FET 2N5114 P-CHAN D-MODE	17856	2N5114
A6Q8	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A6Q9	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A6Q10	1853-0281	9	8	TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A6Q11	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251

†Refer to section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A6Q12	1854-0215	1	1	TRANSISTOR NPN SI PD = 350MW FT = 300MHZ	04713	2N3904
A6Q13	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A6Q14	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD = 800MW	01295	2N2219A
A6Q15	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A6Q16	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A6Q17	1855-0597	4		TRANSISTOR J-FET P-CHAN D-MODETO-92 SI	28480	1855-0597
A6Q18	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A6Q19	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A6Q20	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A6Q21	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A6Q22-Q28				NOT ASSIGNED		
A6Q29	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A6Q30	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A6Q31	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A6R1	0757-1108	6	1	RESISTOR 300 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-301-F
A6R2	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A6R3	0698-3446	3		RESISTOR 383 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-383R-F
A6R4	0698-3447	4	6	RESISTOR 422 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-422R-F
A6R5	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R6	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A6R7	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A6R8	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A6R9	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R10	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A6R11				NOT ASSIGNED		
A6R12				NOT ASSIGNED		
A6R13	0698-3160	8		RESISTOR 31.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3162-F
A6R14	0757-0458	7		RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5112-F
A6R15	0757-0458	7		RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5112-F
A6R16	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R17	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A6R18	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A6R19	0698-3445	2	9	RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A6R20	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A6R21	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R22	0698-3150	6		RESISTOR 2.37K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2371-F
A6R23	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A6R24	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A6R25	0698-3445	2		RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A6R26	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A6R27	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A6R28	0757-0458	7		RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5112-F
A6R29	0757-0458	7		RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5112-F
A6R30	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A6R31	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A6R32	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A6R33	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A6R34	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A6R35	0757-0338	2	4	RESISTOR 1K 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-1001-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A6R36	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R37	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R38	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A6R39	0757-0443	0	3	RESISTOR 11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1102-F
A6R40				NOT ASSIGNED		
A6R41	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A6R42	0757-0338	2		RESISTOR 1K 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-1001-F
A6R43				NOT ASSIGNED		
A6R44	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R45				NOT ASSIGNED		
A6R46	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A6R47				NOT ASSIGNED		
A6R48				NOT ASSIGNED		
A6R49	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R50	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A6R51	0698-4488	5	1	RESISTOR 26.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2672-F
A6R52	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-3481-F
A6R53				NOT ASSIGNED		
A6R54	0698-4472	7	1	RESISTOR 7.68K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7681-F
A6R55	0698-3150	6		RESISTOR 2.37K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2371-F
A6R56	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R57	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A6R58	0698-3432	7		RESISTOR 26.1 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-26R1-F
A6R59				NOT ASSIGNED		
A6R60	0699-0148	8	2	RESISTOR 31.6K .1% .1W F TC = 0 + -15	28480	0699-0148
A6R61	0757-0200	7	5	RESISTOR 5.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5621-F
A6R62	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A6R63	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A6R64	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R65	2100-3207	1	2	RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN	28480	2100-3207
A6R66	0698-8955	9	1	RESISTOR 13.5K .1% .1W F TC = 0 + -10	28480	0698-8955
A6R67	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A6R68	0757-0419	0		RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
A6R69	0699-0149	9	1	RESISTOR 28.7K .1% .1W F TC = 0 + -15	28480	0699-0149
A6R70	0698-3447	4		RESISTOR 422 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-422R-F
A6R71	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A6R72	0699-0096	5	2	RESISTOR 12K .1% .1W F TC = 0 + -10	28480	0699-0096
A6R73	0698-4454	5	3	RESISTOR 523 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-523R-F
A6R74	0698-4454	5		RESISTOR 523 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-523R-F
A6R75	0690-8191	5		RESISTOR 12.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1252-F
A6R76	0698-4454	5		RESISTOR 523 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-523R-F
A6R77	0757-0444	1	4	RESISTOR 12.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1212-F
A6R78	0757-0443	0		RESISTOR 11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1102-F
A6R79	0699-0148	8		RESISTOR 31.6K .1% .1W F TC = 0 + -15	28480	0699-0148
A6R80	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A6R81	0698-4626	3	1	RESISTOR 1.47K 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-1471-F
A6R82	0698-3440	7	7	RESISTOR 196 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-196R-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A6R83-R86				NOT ASSIGNED		
A6R87	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R88	0699-0143	3		RESISTOR 825 .1% .1W F TC = 0 + -15	28480	0699-0143
A6R89	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R90	0757-0447	4		RESISTOR 16.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1622-F
A6R91	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R92	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A6R93	0698-3440	7		RESISTOR 196 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-196R-F
A6R94	0757-0338	2		RESISTOR 1K 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-1001-F
A6R95	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A6R96	0698-8979	7	1	RESISTOR 11.6K 1% .125W F TC = 0 + -100	28480	0698-8979
A6R97	0698-3153	9	7	RESISTOR 3.83K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3831-F
A6R98	0757-0440	7	6	RESISTOR 7.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7501-F
A6R99	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R100	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A6R101	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A6R102	0698-3432	7		RESISTOR 26.1 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-26R1-F
A6R103	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A6R104	0698-3454	3		RESISTOR 215K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2153-F
A6R105	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A6R106				NOT ASSIGNED		
A6R107	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A6R108	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A6R109	0698-8825	2	1	RESISTOR 681K 1% .125W F TC = 0 + -100	28480	0698-8825
A6R110	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A6R111				NOT ASSIGNED		
A6R112	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A6R113	0683-2265	1		RESISTOR 22M 5% .25W FC TC = -900/ + 1200	01121	CB2265
A6R114	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A6R115	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R116				NOT ASSIGNED		
A6R117	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A6R118	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A6R119	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A6R120	0757-0317	7	2	RESISTOR 1.33K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1331-F
A6R121	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A6R122	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A6R123				NOT ASSIGNED		
A6R124	0698-3440	7		RESISTOR 196 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-196R-F
A6R125	0683-2265	1		RESISTOR 22M 5% .25W FC TC = -900/ + 1200	01121	CB2265
A6R126	0698-3440	7		RESISTOR 196 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-196R-F
A6R127				NOT ASSIGNED		
A6R128	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A6R129	0698-3454	3		RESISTOR 215K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2153-F
A6TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A6U1	1826-0035	4	2	IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM308AH
A6U2	1826-0989	7	4	IC OP AMP GP 8-DIP-C PKG	27014	LM307J
A6U3	1826-0035	4		IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM308AH
A6U4	1826-0716	8	1	IC OP AMP LOW-NOISE DUAL 8-DIP-C PKG	18324	NE5532AFE
A6U5	1826-0606	5	10	IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A6U6	1826-0102	6	1	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LM312H
A6U7	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P PKG	27014	LM311N
A6U8	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A6U9	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A6U10	1820-1197	9	5	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A6VR2	1902-0072	1	1	DIODE-ZNR 7.87V 2% DO-35 PD = .4W	28480	1902-0072
A6VR3	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827
A6VR4	1902-3059	0	5	DIODE-ZNR 3.83V 5% DO-35 PD = .4W	28480	1902-3059

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A10						
2305A TO 2619A						
A10	08901-60141	8	1	POWER SUPPLY REGULATORS ASSEMBLY	28480	08901-60141
2522A AND ABOVE						
A10	08901-60269	1		POWER SUPPLY REGULATORS ASSEMBLY	28480	08901-60269
A10C1	0180-0229	7	6	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A10C2	0160-4831	3	2	CAPACITOR-FXD 4700PF +-10% 100VDC CER	28480	0160-4831
A10C3	0160-4831	3		CAPACITOR-FXD 4700PF +-10% 100VDC CER	28480	0160-4831
A10C4	0160-5098	6	4	CAPACITOR-FXD .22UF +-10% 50VDC CER	16299	CAC05X7R224J050A
A10C5	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A10C6	0180-1794	3		CAPACITOR-FXD 22UF+-10% 35VDC TA	56289	150D226X9035R2
A10C7	0180-1794	3		CAPACITOR-FXD 22UF+-10% 35VDC TA	56289	150D226X9035R2
A10C8	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A10C9	0180-1794	3	1	CAPACITOR-FXD 22UF+-10% 35VDC TA	56289	150D226X9035R2
2305A TO 2717A						
A10C10	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
2742A AND ABOVE						
A10C10	0180-0097	7		CAPACITOR-FXD 47UF+-10% 35VDC TA	56289	150D476X903552
A10C11	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A10C12	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A10C13	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A10C14	0160-4830	2	2	CAPACITOR-FXD 2200PF +-10% 100VDC CER	28480	0160-4830
A10C15	0160-4830	2		CAPACITOR-FXD 2200PF +-10% 100VDC CER	28480	0160-4830
A10C16	0180-2141	6		CAPACITOR-FXD 3.3UF+-10% 50VDC TA	56289	150D335X9050B2
A10C17	0160-5098	6		CAPACITOR-FXD .22UF +-10% 50VDC CER	16299	CAC05X7R224J050A
A10C18	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A10C19	0160-5098	6		CAPACITOR-FXD .22UF +-10% 50VDC CER	16299	CAC05X7R224J050A
A10C20	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A10CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR5	1901-0028	5	7	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR6	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR9	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR10	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR11	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR12	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR13	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10CR14	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A10CR15	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A10CR16	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A10DS1	1990-0485	5	5	LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	5082-4984
A10DS2	1990-0485	5		LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	5082-4984
A10DS3	1990-0485	5		LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	5082-4984
A10DS4	1990-0485	5		LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	5082-4984
A10DS5	1990-0485	5		LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	5082-4984
A10F1	2110-0083	6	3	FUSE 2.5A 250V NTD 1.25X.25 UL	28480	2110-0083
A10F2	2110-0036	9	1	FUSE 8A 125V NTD 1.25X.25 UL	75915	312008
A10F3	2110-0083	6		FUSE 2.5A 250V NTD 1.25X.25 UL	28480	2110-0083
A10F4	2110-0083	6		FUSE 2.5A 250V NTD 1.25X.25 UL	28480	2110-0083
	2110-0643	4		FUSEHOLDER-CLIP TYPE 15A 250 V	28480	2110-0643
A10J1	1251-5635	1	1	CONNECTOR 12-PIN M POST TYPE	28480	1251-5635
A10MP1	5001-0178	2	2	BRACKET-ANGLE	28480	5001-0178
	2190-0007	2	3	WASHER-LK INTL T NO. 6 .141-IN-ID	28480	2190-0007
	2360-0191	6	3	SCREW-MACH 6-32 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A10MP2	5001-0178	2		BRACKET-ANGLE	28480	5001-0178
	2190-0007	2		WASHER-LK INTL T NO. 6 .141-IN-ID	28480	2190-0007
	2360-0191	6		SCREW-MACH 6-32 .188-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A10Q1	1884-0005	0	1	THYRISTOR-SCR VRRM = 50	04713	MCR649P-2
	0340-0875	9	1	INSULATOR-XSTR THRM-CNDCT	28480	0340-0875
	2190-0004	9	11	WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
	2200-0141	8	11	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	2200-0141
A10Q2	1854-0798	5	1	TRANSISTOR NPN SI DARL PD = 1W	04713	MPS-U45
	2190-0004	9		WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
	08901-00137	6	1	HEAT SINK, PC	28480	08901-00137
	2200-0141	8		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	2200-0141
A10Q3	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A10Q4	1884-0273	4	3	THYRISTOR-SCR 2N4101 TO-66	3L585	2N4101
	0340-0681	5	4	INSULATOR-XSTR THRM-CNDCT GRA	28480	0340-0681
	2190-0004	9		WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
	2200-0141	8		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	2200-0141
A10Q5	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A10Q6	1884-0273	4		THYRISTOR-SCR 2N4101 TO-66	3L585	2N4101
	0340-0681	5		INSULATOR-XSTR THRM-CNDCT GRA	28480	0340-0681
	2190-0004	9		WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
	2200-0141	8		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	2200-0141
A10Q7	1884-0273	4		THYRISTOR-SCR 2N4101 TO-66	3L585	2N4101
	0340-0681	5		INSULATOR-XSTR THRM-CNDCT GRA	28480	0340-0681
	2190-0004	9		WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
	2200-0141	8		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	2200-0141
A10Q8	1884-0073	2	1	THYRISTOR-SCR TO-5 VRRM = 100	28480	1884-0073
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A10Q9	1854-0474	4	3	TRANSISTOR NPN SI PD = 310MW FT = 100MHZ	04713	2N5551
A10Q10	1858-0008	8	2	TRANSISTOR ARRAY 14-PIN PLSTC DIP	04713	MHQ6001
A10Q11	1858-0008	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	04713	MHQ6001
A10Q12	1853-0414	0	1	TRANSISTOR PNP 2N6423 SI TO-66 PD = 35W	04713	2N6423
	0340-0681	5		INSULATOR-XSTR THRM-CNDCT GRA	28480	0340-0681
	2190-0004	9		WASHER-LK INTL T NO. 4 .115-IN-ID	28480	2190-0004
	2200-0141	8		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	28480	2200-0141

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A10Q13	1854-0474	4		TRANSISTOR NPN SI PD = 310MW FT = 100MHZ	04713	2N5551
A10Q14	1854-0474	4		TRANSISTOR NPN SI PD = 310MW FT = 100MHZ	04713	2N5551
A10R1	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A10R2	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A10R3	0811-3290	7	1	RESISTOR .1 5% 2W PW TC = 0 + -800	28480	0811-3290
A10R4	0811-3293	0	2	RESISTOR .18 5% 2W PW TC = 0 + -800	28480	0811-3293
A10R5	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A10R6	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A10R7	0757-0289	2	9	RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A10R8	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A10R9	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A10R10	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A10R11	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A10R12	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A10R13	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A10R14	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A10R15	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A10R16	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A10R17	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A10R18	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A10R19	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A10R20	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A10R21	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A10R22	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A10R23	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A10R24	2100-3350	5	2	RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	28480	2100-3350
A10R25	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A10R26	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A10R27	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A10R28	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A10R29	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A10R30	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A10R31	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A10R32	0698-3624	9	1	RESISTOR 150 5% 2W MO TC = 0 + -200	28480	0698-3624
A10R33	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A10R34	0698-3601	2	1	RESISTOR 10 5% 2W MO TC = 0 + -200	27167	FP42-2-T00-10R0-J
A10R35	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A10R36	0757-0444	1		RESISTOR 12.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1212-F
A10R37	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A10R38	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A10R39	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A10R40	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A10R41	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A10R42	0698-3136	8		RESISTOR 17.8K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1782-F
A10R43	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A10R44	0757-0402	1	8	RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A10R45	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A10R46	0757-0274	5	6	RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A10R47	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A10R48	0811-3293	0		RESISTOR .18 5% 2W PW TC = 0 + -800	28480	0811-3293
A10R49	8110-0180	0	1	RIBBON-RES .157-OHM/FT .0253X.0625	28480	8110-0180
2305A TO 2616A						
A10R50	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
2618A AND ABOVE						
A10R50	0698-5808	5		RESISTOR 4K 1% .125W F TC = 0 + -100	24546	C4-1/8-70-4001-F
A10R51	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
2305A TO 2523A						
A10R52	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
2528A AND ABOVE						
A10R52	0698-3156	2		RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1472-F
A10R53	0757-0444	1		RESISTOR 12.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1212-F
2305A TO 2616A						
A10R54	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
2618A AND ABOVE						
A10R54	0698-5808	5		RESISTOR 4K 1% .125W F TC = 1 + -100	24546	C4-1/8-TO-4001-F
A10R55	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A10R56	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A10R57	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A10R58	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A10R59	0698-3160	8		RESISTOR 31.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3162-F
A10R60	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A10R61	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A10R62	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A10TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A10U1	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A10U2	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A10VR1	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827
A10VR2	1902-0968	4	1	DIODE-ZNR 27V 5% DO-35 PD = .4W TC = + .095%	28480	1902-0968
A10VR3	1902-3214	9	2	DIODE-ZNR 16.2V 2% DO-35 PD = .4W	28480	1902-3214
A10VR4	1902-3214	9		DIODE-ZNR 16.2V 2% DO-35 PD = .4W	28480	1902-3214
A10VR5	1902-0960	6	2	DIODE-ZNR 12V 5% DO-35 PD = .4W TC = + .077%	28480	1902-0960
A10VR6	1902-0960	6		DIODE-ZNR 12V 5% DO-35 PD = .4W TC = + .077%	28480	1902-0960
A10VR7	1902-3333	3	1	DIODE-ZNR 46.4V 5% DO-35 PD = .4W	28480	1902-3333
A10VR8	1902-0952	6	2	DIODE-ZNR 5.6V 5% DO-35 PD = .4W TC = + .046%	28480	1902-0952
A10VR9	1902-0952	6		DIODE-ZNR 5.6V 5% DO-35 PD = .4W TC = + .046%	28480	1902-0952
A10VR10	1902-3301	5	1	DIODE-ZNR 34.8V 5% DO-35 PD = .4W	28480	1902-3301
A10VR11	1902-0943	5	3	DIODE-ZNR 2.4V 5% DO-35 PD = .4W TC = -.037%	28480	1902-0943

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A11						
2305A TO 2530A						
A11	08901-60093	9	1	COUNTER ASSEMBLY (EXCEPT OPTION 002)	28480	08901-60093
A11	08901-60018	8	1	COUNTER ASSEMBLY (OPTION 002 ONLY)	28480	08901-60018
2535A AND ABOVE						
A11	08902-60107	7	1	COUNTER ASSEMBLY (EXCEPT OPTION 002)	28480	08902-60107
A11	08902-60106	6	1	COUNTER ASSEMBLY (OPTION 002 ONLY)	28480	08902-60106
2305A TO 2530A						
A11C1	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
2535A AND ABOVE						
A11C1	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C2	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
2305A TO 2530A						
A11C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
2535A AND ABOVE						
A11C3	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C4	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C5	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C6	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C7	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A11C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A11C9	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
2305A TO 2530A						
A11C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C11	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C12	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C13	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
2535A AND ABOVE						
A11C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C12	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C13	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A11C14	0121-0105	4		CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	304324 9/35PF N650
2305A TO 2530A						
A11C15	0160-0161	4	2	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A11C16	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C17	0160-0572	1	10	CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A11C18	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C19	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C20	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A11C21	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
2535A AND ABOVE						
A11C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C17	0160-4819	7		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4819
A11C18	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C19	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C20	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A11C21	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C22	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
2305A TO 2530A						
A11C23	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A11C24	0160-0570	9	3	CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A11C25	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A11C26	0140-0198	5		CAPACITOR-FXD 200PF +-5% 300VDC MICA	72136	DM15F201J0300WV1
A11C27	0160-3875	3	5	CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A11C28	0140-0198	5		CAPACITOR-FXD 200PF +-5% 300VDC MICA	72136	DM15F201J0300
A11C29	0160-0939	4	1	CAPACITOR-FXD 430PF +-5% 300VDC MICA	28480	0160-0939
A11C30	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
2535A AND ABOVE						
A11C23	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C24	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A11C25	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11C26	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A11C27	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER	28480	0160-4787
A11C28	0160-4812	0		CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A11C29	0160-4808	4		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4808
A11C30	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A11CR1	1901-0179	7	18	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR2	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A11CR3	1901-0535	9	9	DIODE-SM SIG SCHOTTKY	28480	1901-0535
A11CR4	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A11CR5	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A11CR6	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A11DS1	1990-0647	1	1	LED-LAMP LUM-INT = 12MCD IF = 20MA-MAX	28480	5082-4558
A11J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A11J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A11J3	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A11J4	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A11J5	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A11J6	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
2305A TO 2530A						
A11L1				NOT ASSIGNED		
2535A AND ABOVE						
A11L1	9100-3922	4		INDUCTOR-FXD 120-1300HZ	28480	9100-3922
A11L2	9100-2248	5	1	INDUCTOR RF-CH-MLD 120NH 10% .105DX.26LG	28480	9100-2248
2305A TO 2530A						
A11MP1	08901-00033	1	1	COVER COUNTER	28480	08901-00033
2535A AND ABOVE						
A11MP1	08902-00028	5	1	COVER, COUNTER	28480	08902-00028
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A11MP2	08901-00063	7	1	LABEL I D (EXCEPT OPT. 002)	28480	08901-00063
A11Q1	1853-0015	7	2	TRANSISTOR PNP SI PD = 200MW FT = 500MHZ	28480	1853-0015
A11Q2	1853-0015	7		TRANSISTOR PNP SI PD = 200MW FT = 500MHZ	28480	1853-0015
A11Q3	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A11Q4	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A11Q5	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A11R1	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A11R2	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A11R3	0698-8812	7	2	RESISTOR 1 1% .125W F TC = 0 + -100	28480	0698-8812
A11R4	0698-8816	1	1	RESISTOR 2.15 1% .125W F TC = 0 + -100	28480	0698-8816
A11R5	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A11R6	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A11R7	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A11R8	0757-0463	4		RESISTOR 82.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8252-F
A11R9	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A11R10	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A11R11	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A11R12	1810-0204	6	1	NETWORK-RES 8-SIP1.0K OHM X 7	01121	208A102
A11R13	0757-0397	3	15	RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A11R14	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A11R15	0698-3445	2		RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A11R16	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1001-F
A11R17	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A11R18	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A11R19	0698-3153	9		RESISTOR 3.83K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3831-F
A11R20	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A11R21	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A11R22	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A11R23	0757-0398	4	3	RESISTOR 75 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-75R0-F
A11R24	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A11R25	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A11R26	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A11R27	0698-3429	2	13	RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A11R28	0698-3445	2		RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A11R29	0698-3445	2		RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A11R30	0757-0424	7	3	RESISTOR 1.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1101-F
A11R31	0757-1000	7	1	RESISTOR 51.1 1% .5W F TC = 0 + -100	28480	0757-1000
A11R32	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A11R33	0698-3432	7		RESISTOR 26.1 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-26R1-F
A11R34	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A11R35	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A11R36	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A11R37	1810-0206	8	8	NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A11R38	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A11R39	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A11TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A11TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A11U1	1820-0817	8	4	IC FF ECL D-M/S DUAL	04713	MC10131P
A11U2	1820-0803	2	1	IC GATE ECL OR-NOR TPL	04713	MC10105P
A11U3	1820-1425	6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A11U4	1820-1416	5	2	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A11U5	1820-1193	5	4	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A11U6	1820-0693	8	2	IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A11U7	1820-1217	4	1	IC MUXR/DATA-SEL TTL LS 8-TO-1-LINE	01295	SN74LS151N
A11U8	1820-1251	6	2	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS196N
A11U9	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A11U10	1820-1251	6		IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS196N
A11U11	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A11U12	1820-1199	1	5	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A11U13	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A11U14	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
	1200-0638	7	2	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A11U15	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A11U16	1820-0693	8		IC FF TTL S D-TYPE POS-EDGE-TRIG	01295	SN74S74N
A11U17	1820-1240	3	1	IC DCDR TTL S 3-TO-8-LINE 3-INP	01295	SN74S138N
A11U18	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A11U19	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A11U20	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A11U21	1820-0723	5	2	IC RCVR TTL LINE RCVR DUAL 2-INP	01295	SN75107AN
A11Y1	0410-0423	2	1	CRYSTAL-QUARTZ 10.000 MHZ (EXCEPT OPT. 002)	28480	0410-0423

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60244 – SERIAL PREFIX 2305A TO 2742A**					
A13	08901-60244	2	1	CONTROLLER ASSEMBLY	28480	08901-60244
A13BT1	1420-0322	2		BATTERY 2.8V .2A-HR LI/I PIN	28480	1420-0322
	08901-00195	6	1	BATTERY INSULATOR	28480	08901-00195
A13C1	0180-2111	0	3	CAPACITOR-FXD 33UF +-10% 35VDC TA	56289	150D336X9035SA
A13C2	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C3	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A13C4	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A13C5	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C6	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A13C7	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C8	0180-0100	3	2	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A13C9	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C11	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C12	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C13	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C17	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C18	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
2305A TO 2528A						
A13C19	0160-4814	2	3	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A13C20	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
2530A TO 2625A						
A13C19	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A13C20	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
2627A AND ABOVE						
A13C19				NOT ASSIGNED		
A13C20				NOT ASSIGNED		
A13C21Δ	0180-5098	6		CAPACITOR-FXD .22UF+-10% 50VDC TA	28480	0180-5098
A13C22				NOT ASSIGNED		
A13CR1	1901-0159	3	1	DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A13CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A13CR4	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A13CR5	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A13CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A13CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60244 – SERIAL PREFIX 2305A TO 2742A**					
A13DS1	1990-0534	5	4	LED-LAMP LUM-INT = 2.2MCD IF = 20MA-MAX	28480	5082-4555
A13DS2	1990-0534	5		LED-LAMP LUM-INT = 2.2MCD IF = 20MA-MAX	28480	5082-4555
A13DS3	1990-0534	5		LED-LAMP LUM-INT = 2.2MCD IF = 20MA-MAX	28480	5082-4555
A13DS4	1990-0534	5		LED-LAMP LUM-INT = 2.2MCD IF = 20MA-MAX	28480	5082-4555
2305A TO 2625A						
A13L1	9140-0238	3	1	INDUCTOR RF-CH-MLD 82UH 5% .166DX.385LG	28480	9140-0238
2627A AND ABOVE						
A13L1				NOT ASSIGNED		
A13MP1	4040-0749	4	2	EXTR-PC BD BRN POLYC .062-BD-THKNS	28480	4040-0749
	1480-0116	8	4	PIN-ROLL .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A13MP2	4040-0751	8	1	EXTR-PC BD ORN POLYC .062-BD-THKNS	28480	4040-0751
	1480-0116	8		PIN-ROLL .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A13Q1	1853-0393	4	1	TRANSISTOR PNP SI TO-18 PD = 500MW	28480	1853-0393
A13Q2	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A13Q3	1853-0459	3	8	TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459
A13R1	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A13R2	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A13R3	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A13R4	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A13R5	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A13R6	0698-3156	2		RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1472-F
A13R7	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A13R8	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A13R9	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R10	0757-0419	0		RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
2305A TO 2535A						
A13R11	0698-3454	3		RESISTOR 215K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2153-F
2540A AND ABOVE						
A13R11	0757-0458	7		RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-5112-F
A13R12	2100-2522	1	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	30983	ET50X103
A13R13	0698-6624	5	3	RESISTOR 2K .1% .125W F TC = 0 + -25	28480	0698-6624
A13R14	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A13R15	0698-6624	5		RESISTOR 2K .1% .125W F TC = 0 + -25	28480	0698-6624
A13R16	0698-6624	5		RESISTOR 2K .1% .125W F TC = 0 + -25	28480	0698-6624
A13R17	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R18	0698-6360	6		RESISTOR 10K .1% .125W F TC = 0 + -25	28480	0698-6360
A13R19	0698-6348	0	1	RESISTOR 3K .1% .125W F TC = 0 + -25	28480	0698-6348
A13R20	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R21	0757-0459	8	2	RESISTOR 56.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5622-F
A13R22	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A13R23	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A13R24	0698-3162	0	3	RESISTOR 46.4K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4642-F
A13R25	0698-3161	9		RESISTOR 38.3K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3832-F
A13R26	0757-0447	4		RESISTOR 16.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1622-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60244 – SERIAL PREFIX 2305A TO 2742A**					
A13R27	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R28	0757-0418	9	3	RESISTOR 619 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-619R-F
A13R29	1810-0229	5	1	NETWORK-RES 8-SIP330.0 OHM X 7	01121	208A331
A13R30	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP12	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP13	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP14	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13TP15	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A13U1	1818-1968	7	1	IC CMOS 16384 (16K) STAT RAM 250-NS 3-S	28480	1818-1968
	1200-0565	9	1	SOCKET-IC 24-CONT DIP-SLDR	28480	1200-0565
A13U2	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A13U3	1826-0759	9	1	IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
2305A TO 2331A						
A13U4	08902-80064	6	1	ROM #3	28480	08901-80064
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2337A TO 2449A						
A13U4	08902-80068	0		ROM #3	28480	08901-80068
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2451A TO 2515A						
A13U4	08902-80073	7		ROM #3	28480	08901-80073
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2519A TO 2535A						
A13U4	08902-80078	2		ROM #3	28480	08901-80078
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2535A TO 2606A						
A13U4	08902-80083	9		ROM #3	28480	08901-80083
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2616A TO 2631A						
A13U4	08902-80089	5		ROM #3	28480	08901-80089
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2644A TO 2706A						
A13U4	08902-80092	1		ROM #3	28480	08901-80092
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2717A AND ABOVE						
A13U4	08902-80107	8		ROM #3	28480	08901-80107
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60244 – SERIAL PREFIX 2305A TO 2742A**					
A13U5	1820-1281	2	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
A13U6	1826-0275	4	1	IC 78L12A V RGLTR TO-92	04713	MC78L12ACP
2305A TO 2331A						
A13U7	08901-80063	5	1	ROM #2	28480	08901-80063
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2337A TO 2449A						
A13U7	08901-80067	9		ROM #2	28480	08901-80067
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2451A TO 2515A						
A13U7	08901-80072	6		ROM #2	28480	08901-80072
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2519A TO 2530A						
A13U7	08901-80077	1		ROM #2	28480	08901-80077
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2535A TO 2606A						
A13U7	08901-80082	8		ROM #2	28480	08901-80082
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2616A TO 2625A						
A13U7	08901-80088	4		ROM #2	28480	08901-80088
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2644A TO 2706A						
A13U7	08901-80091	0		ROM #2	28480	08901-80091
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2717A AND ABOVE						
A13U7	08901-80106	7		ROM #2	28480	08901-80106
	1200-0553	5	3	SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
A13U8	1820-2027	6	1	IC-STATIC MEMORY INTERFACE	28480	1820-2027
	1200-0552	4	2	SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0552
A13U9	1820-1928	4	1	IC-F8-MPU; CLK FREQ = 2 MHZ	28480	1820-1928
	1200-0552	4		SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0552

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60244 – SERIAL PREFIX 2305A TO 2742A**					
2305A TO 2331A						
A13U10	08901-80062	4	1	ROM #1	28480	08901-80062
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2337A TO 2449A						
A13U10	08901-80066	8		ROM #1	28480	08901-80066
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2451A TO 2515A						
A13U10	08901-80071	5		ROM #1	28480	08901-80071
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2519A TO 2523A						
A13U10	08901-80076	0		ROM #1	28480	08901-80076
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2528A TO 2530A						
A13U10	08901-80084	0		ROM #1	28480	08901-80084
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2535A TO 2606A						
A13U10	08901-80081	7		ROM #1	28480	08901-80081
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2616A TO 2625A						
A13U10	08901-80087	3		ROM #1	28480	08901-80087
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2644A TO 2706A						
A13U10	08901-80090	9		ROM #1	28480	08901-80090
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
2717A AND ABOVE						
A13U10	08901-80105	6		ROM #1	28480	08901-80105
	1200-0553	5		SOCKET-IC 28-CONT DIP-SLDR	28480	1200-0553
A13U11	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A13U12	1820-1917	1	1	IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS240N
A13U13	1820-1287	8	1	IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS37N
A13VR1	1902-0777	3	1	DIODE-ZNR 1N825 6.2V 5% DO-7 PD = .4W	04713	1N825
A13W1	8159-0005	0	11	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A13W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60196 – SERIAL PREFIX 2745A AND ABOVE**					
A13	08901-60196	4	1	CONTROLLER ASSEMBLY	28480	08901-60196
A13BT1	1420-0322	2		BATTERY 2.8V .2A-HR LI/I PIN	28480	1420-0322
A13C1	0180-0116	1	1	CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A13C2	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C3	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A13C4				NOT ASSIGNED		
A13C5	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C6	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A13C7	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C8				NOT ASSIGNED		
A13C9				NOT ASSIGNED		
A13C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C12	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C13	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A13C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
Δ A13C17	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	28480	0180-0100
A13C18	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A13C19				NOT ASSIGNED		
A13C20				NOT ASSIGNED		
A13C21	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C22	0160-4814	2	1	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A13CR1	1901-0159	3	1	DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A13CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A13CR4	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A13CR5	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A13CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A13CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A13DS1	1990-1110	5	4	LED-LAMP LUM-INT = 1.51MCD IF = 20MA-MAX	28480	1990-1110
A13DS2	1990-1110	5		LED-LAMP LUM-INT = 1.5MCD IF = 20MA-MAX	28480	1901-1110
A13DS3	1990-1110	5		LED-LAMP LUM-INT = 1.5MCD IF = 20MA-MAX	28480	1990-1110
A13DS4	1990-1110	5		LED-LAMP LUM-INT = 1.5MCD IF = 20MA-MAX	28480	1990-1110
A13L1				NOT ASSIGNED		
A13MP1	4040-0749	4	2	EXTR-PC BD BRN POLYC .062-BD-THKNS	28480	4040-0749
	1480-0116	8	4	PIN-ROLL .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A13MP2	4040-0751	8	1	EXTR-PC BD ORN POLYC .062-BD-THKNS	28480	4040-0751
	1480-0116	8		PIN-ROLL .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A13Q1	1853-0393	4	1	TRANSISTOR PNP SI TO-18 PD = 500MW	28480	1853-0393
A13Q2	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A13Q3	1853-0459	3	8	TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60196 – SERIAL PREFIX 2745A AND ABOVE**					
A13R1	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A13R2	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A13R3				NOT ASSIGNED		
A13R4				NOT ASSIGNED		
A13R5				NOT ASSIGNED		
A13R6	0698-3156	2		RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1472-F
A13R7	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A13R8	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A13R9	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R10	0757-0419	0		RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
△A13R11	0698-3454	3		RESISTOR 215K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2153-F
A13R12	2100-2522	1	1	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	30983	ET50X103
A13R13	0698-6624	5	3	RESISTOR 2K .1% .125W F TC = 0 + -25	28480	0698-6624
A13R14	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A13R15	0698-6624	5		RESISTOR 2K .1% .125W F TC = 0 + -25	28480	0698-6624
A13R16	0698-6624	5		RESISTOR 2K .1% .125W F TC = 0 + -25	28480	0698-6624
A13R17	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R18	0698-6360	6		RESISTOR 10K .1% .125W F TC = 0 + -25	28480	0698-6360
A13R19	0698-6348	0	1	RESISTOR 3K .1% .125W F TC = 0 + -25	28480	0698-6348
A13R20	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R21	0757-0459	8	2	RESISTOR 56.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5622-F
A13R22	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A13R23	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A13R24	0698-3162	0	3	RESISTOR 46.4K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4642-F
A13R25	0698-3161	9		RESISTOR 38.3K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3832-F
A13R26	0757-0447	4		RESISTOR 16.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1622-F
A13R27	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R28	0757-0418	9	3	RESISTOR 619 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-619R-F
A13R29	1810-0229	5	1	NETWORK-RES 8-SIP330.0 OHM X 7	01121	208A331
A13R30	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A13R31	1810-0286	4	1	NETWORK-RES 16-DIP 10.0K OHM X 15	01121	316A103
A13TP16	1251-5730	7	1	CONNECTOR 15-PIN M POST TYPE	28480	1251-5730
A13U1	1LJ6-0001	2	1	IC CMOS 16384 (16K) STAT RAM 250-NS 3-S	28480	1LJ6-0001
	1200-0541	9	1	SOCKET-IC 24-CONT DIP-SLDR	28480	1200-0541
A13U2	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A13U3	1826-0759	9	1	IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A13U4				NOT ASSIGNED		
A13U5				NOT ASSIGNED		
A13U6	1826-0275	4	1	IC 78L12A V RGLTR TO-92	04713	MC78L12ACP
A13U7				NOT ASSIGNED		
A13U8	1820-2027	6	1	IC-STATIC MEMORY INTERFACE	28480	1820-2027
	1200-0654	4	2	SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0654
A13U9	1820-1928	4	1	IC-F8-MPU; CLK FREQ = 2 MHZ	28480	1820-1928
	1200-0654	4		SOCKET-IC 40-CONT DIP-SLDR	28480	1200-0654
A13U10				NOT ASSIGNED		
A13U11	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N

†Refer to Section 5 for update information. *Factory Selected Component (Refer to Section 5) △ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A13	**08901-60196 – SERIAL PREFIX 2745A AND ABOVE**					
A13U12	1820-1917	1	1	IC BFR TTL LS LINE DRVR OCTL	01295	SN74LS240N
A13U13	1820-1287	8	1	IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS37N
2314A TO 2950A						
A13U14△	08901-80111	4	1	ROM #1	28480	08901-80111
3001A TO 3024A						
A13U14	08901-80116	9	1	ROM #1	28480	08901-80116
3028A ONLY						
A13U14	08901-80117	0	1	ROM #1	28480	08901-80117
3104A AND ABOVE						
A13U14	08901-80121		1	ROM #1	28480	08901-80121
	1200-0567	1	1	SOCKET-IC 28-CONT DIP DIP-SLDR	28480	1200-0567
A13VR1	1902-0777	3	1	DIODE-ZNR 1N825 6.2V 5% DO-7 PD = .4W	04713	1N825
A13W1	8159-0005	0	11	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A13W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) △ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14						
2305A TO 2519A						
A14	08901-60223	7	1	REMOTE INTERFACE ASSEMBLY	28480	08901-60223
2522A AND ABOVE						
A14	08901-60268	0		REMOTE INTERFACE ASSEMBLY	28480	08901-60268
A14C1	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A14C2	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A14C3	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C4	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C5	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C6	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C7	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C8	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C9	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C12	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A14C13	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A14C17	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A14C18	0160-4833	5		CAPACITOR-FXD .022UF +-10% 100VDC CER	28480	0160-4833
A14CR1	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A14J1	1251-5649	7	1	CONNECTOR 20-PIN M POST TYPE	28480	1251-5649
	1251-4460	8	2	CLIP-CABLE PLUG RTNG-DUAL INLINE 16 CONT	28480	1251-4460
A14MP1	4040-0749	4		EXTR-PC BD BRN POLYC .062-BD-THKNS	28480	4040-0749
	1480-0116	8		PIN-ROLL .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A14MP2	4040-0752	9	1	EXTR-PC BD YEL POLYC .062-BD-THKNS	28480	4040-0752
	1480-0116	8		PIN-ROLL .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A14R1	0698-3438	3		RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A14R2	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A14R3	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A14R4	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
2522A TO 3001A						
A14R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
3018A AND ABOVE						
A14R5	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	28480	0698-0084

†Refer to Section 7 for update information.

*Factory Selected Component (Refer to Section 5)

Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14R6	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A14R7	1810-0136	3	1	NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0136
A14R8	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A14R9	0698-7224	3		RESISTOR 316 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-316R-F
2305A TO 2515A						
A14R10				NOT ASSIGNED		
2522A AND ABOVE						
A14R10	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-1002-F
A14S1	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC	28480	3101-1973
	1200-0485	2	1	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0485
A14TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A14U1	1820-1689	4	2	IC SER-XMTR/RCVR TTL QUAD	28480	1820-1689
A14U2	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A14U3	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A14U4	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A14U5	1820-1689	4		IC SER-XMTR/RCVR TTL QUAD	28480	1820-1689
A14U6	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A14U7	1820-1905	7	1	IC GATE TTL LS NOR DUAL 5-INP	07263	74LS260PC
2305A TO 2519A						
A14U8	1820-0706	4	1	IC COMPTR TTL MAGTD 5-BIT	07263	9324PC
2522A AND ABOVE						
A14U8	1820-2740	0		IC COMPTR TTL LS MAGTD 2-INP 8-BIT	01295	SN74LS688N
A14U9	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A14U10	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A14U11	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A14U12	1820-0621	2	1	IC BFR TTL NAND QUAD 2-INP	01295	SN7438N
A14U13	1820-2100	6	1	IC MICPROC-ACCESS NMOS DUAL 8-BIT	07263	3861EPC
	1200-0654	7	1	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A14U14				NOT ASSIGNED		
A14U15	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A14U16	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A14U17	08901-80004	4	1	PROM PROGRAMMED	28480	08901-80004
A14U18				NOT ASSIGNED		
A14U19	1820-0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A14U20	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A14U21	1820-1200	5	3	IC INV TTL LS HEX	01295	SN74LS05N
A14U22	1820-1200	5		IC INV TTL LS HEX	01295	SN74LS05N
A14VR1	1902-3182	0	1	DIODE-ZNR 12.1V 5% DO-35 PD = .4W	28480	1902-3182

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A15	**08902-60004 – SERIAL PREFIX 2305A TO 2702A**					
A15	08902-60004	3	1	RF INPUT CONTROL ASSEMBLY	28480	08902-60004
A15C1	0180-2208	6	1	CAPACITOR-FXD 220UF+-10% 10VDC TA	56289	150D227X9010S2
A15C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A15CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR9	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15CR10	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A15J1	1251-4582	5	2	CONNECTOR 10-PIN M POST TYPE	28480	1251-4582
A15J2	1200-0508	0	1	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0508
A15MP1	08902-00002	5	1	COVER RF INPUT	28480	08902-00002
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
A15Q1	1854-0668	8	4	TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0668
A15Q2	1854-0668	8		TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0668
A15Q3	1854-0668	8		TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0668
A15Q4	1854-0668	8		TRANSISTOR NPN SI TO-18 PD=500MW	28480	1854-0668
A15R1	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R3	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R4	0757-0467	8		RESISTOR 121K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A15R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R6	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R7	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R8	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R9	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R11	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A15R12	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A15R13	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A15R14	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A15R15	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A15U1	1820-0535	7	8	IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A15U2	1820-0535	7		IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A15U3	1820-0535	7		IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A15U4	1820-0535	7		IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A15U5	1820-0535	7		IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A15U6	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U7	1820-1441	6	1	IC ADDR TTL LS BIN FULL ADDR 4-BIT	01295	SN74LS283N
A15U8	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A15U9	1820-0629	0	1	IC FF TTL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A15U10	1820-1208	3	1	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A15U11	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A15	**08902-60065 – SERIAL PREFIX 2704A AND ABOVE**					
A15	08902-60065	6	1	RF INPUT CONTROL ASSEMBLY	28480	08902-60065
A15C1				NOT ASSIGNED		
A15C2	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A15C3	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A15C4	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A15C5	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A15C6	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A15C7	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A15C8	0160-4853	9		CAPACITOR-FXD 22PF +-2% 200VDC CER 0+-30	28480	0160-4853
A15C9	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	28480	150D105X9035A2
A15C10	0160-4853	9		CAPACITOR-FXD 22PF +-200VDC CER 0+-30	28480	0160-4853
A15C11	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A15CR1-10				NOT ASSIGNED		
A15J1	1251-4582	5	2	CONNECTOR 10-PIN M POST TYPE	28480	1251-4582
A15J2				NOT ASSIGNED		
A15J3	1251-4498	2		CONECTOR 7-PIN M POST TYPE	28480	1251-4498
A15L1				NOT ASSIGNED		
A15L2	9100-3922	4		INDUCTOR-FXD 120-1300HZ	28480	9100-3922
A15MP1	08902-00002	5		COVER RF INPUT	28480	08902-00002
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0008	3		WASHER-LK EXT T NO.6 .141-IN-ID	28480	2190-0008
A15Q1-4				NOT ASSIGNED		
A15R1				NOT ASSIGNED		
A15R2				NOT ASSIGNED		
A15R3	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A15R4	0757-0467	8		RESISTOR 121K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1213-F
A15R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A15R6	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A15R7-15				NOT ASSIGNED		
A15R16	0698-3449	6		RESISTOR 28.7K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2872-F
A15R17	1757-0459	8		RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-TO-5622-F
A15R18	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A15U1-5				NOT ASSIGNED		
A15U6	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A15U7	1820-1441	6		IC ADDR TTL LS BIN FULL ADDR 4-BIT	01295	SN74LS283N
A15U8	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A15U9	1820-0629	0		IC FF TLL S J-K NEG-EDGE-TRIG	01295	SN74S112N
A15U10	1820-1208	3		IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A15U11	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A15U12	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A15U13	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS09N
A15U14	1820-2111	9		IC DRVR TTL INV	01295	SN75R68N
A15U15	1820-1419	8		IC COMPTR TTL LS MACTD 4-BIT	01295	SN75LS85N
A15U16	1820-1445	0		IC LCH TTL LS 4-BIT	01295	SN74LS375N
A15U17	1820-1423	4		IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N

†Refer to Section 7 for update information. *Factory selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A16						
2305A TO 2540A						
A16	08902-60002	1	1	RF DETECTOR ASSEMBLY	28480	08902-60002
2546A AND ABOVE						
A16	08902-60041	8	1	RF DETECTOR ASSEMBLY	28480	08902-60041
A16C1	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C3	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C4	0160-5630	2	1	CAPACITOR-FXD .15UF +-10% 50VDC CER	28480	0160-5630
A16C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A16C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A16C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A16C9	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A16C10	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
2305A TO 2540A						
A16C11	0160-4768	5	3	CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4768
2546A AND ABOVE						
A16C11	0160-4543	4		CAPACITOR-FXD 470-F +-10% 100VDC CER	28480	0160-4543
A16C12	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A16C13	0160-4040	6	3	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A16C14	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A16C15	0160-4502	5	1	CAPACITOR-FXD 390PF +-5% 100VDC CER	28480	0160-4502
A16C16	0160-4768	5		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4768
A16C17	0180-2205	3	1	CAPACITOR-FXD .33UF+-10% 35VDC TA	56289	150D334X9035A2
A16C18	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A16C19	0160-4825	5		CAPACITOR-FXD 560PF +-5% 100VDC CER	28480	0160-4825
2305A TO 2337A						
A16C20	0160-3877	5	9	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
2338A TO 2340A						
A16C20	0160-4768	5		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4786
2341A ONLY						
A16C20	0160-3877	5	9	CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
2342A AND ABOVE						
A16C20	0160-4768	5		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4786

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A16C21	0160-4492	2		CAPACITOR-FXD 18PF +-5% 200VDC CER 0+-30	28480	0160-4492
A16C22	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C23	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C24	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C25	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A16C26	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A16C27	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A16C28	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C29	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16C30	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A16CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A16CR2	08901-80005	5		DIODES, MATCHED	28480	08901-80005
A16CR3	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A16CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A16CR5	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A16CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A16CR7	08901-80005	5		DIODES, MATCHED	28480	08901-80005
2305A TO 2540A						
A16J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A16J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
2546A AND ABOVE						
A16J1	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A16J2	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A16J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A16K1	0490-1185	3	1	RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-1185
A16K2	0490-1158	0	1	RELAY 2C 5VDC-COIL 1A 28VDC	28480	0490-1158
A16L1	9100-3922	4	45	INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16L5	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16L6	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16L7	9100-2258	7	1	INDUCTOR RF-CH-MLD 1.2UH 10% .105DX.26LG	28480	9100-2258
A16L8	9140-0142	8	1	INDUCTOR RF-CH-MLD 2.2UH 10% .105DX.26LG	28480	9140-0142
A16L9	9100-2257	6	1	INDUCTOR RF-CH-MLD 820NH 10% .105DX.26LG	28480	9100-2257
A16L10	9100-2261	2	1	INDUCTOR RF-CH-MLD 2.7UH 10% .105DX.26LG	28480	9100-2261

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A16L11	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16L12	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A16MP1	08902-00001	4	1	COVER RF DETECT	28480	08902-00001
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A16MP2	5001-0176	0	16	GROUND STRAP	28480	5001-0176
A16MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A16MP4	08662-00040	0	4	SHIELD COMP SMALL	28480	08662-00040
A16MP5	08662-00038	6	4	SHIELD CKT SM	28480	08662-00038
A16Q1	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A16Q2	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A16Q3	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A16R1	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A16R2	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A16R3	0699-1213	0	1	RESISTOR 61.59 1% .2W C TC = 0 + -200	28480	0699-1213
A16R4	0698-3615	8	1	RESISTOR 47 5% 2W MO TC = 0 + -200	27167	FP42-2-T00-47R0-J
A16R5	0698-7242	5		RESISTOR 1.78K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1781-F
A16R6	0757-0123	3		RESISTOR 34.8K 1% .125W F TC = 0 + -100	28480	0757-0123
A16R7	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A16R8	0698-3454	3		RESISTOR 215K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2153-F
A16R9	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
2306A TO 2522A						
A16R10	0698-8961	7	1	RESISTOR 909K 1% .125W F TC = 0 + -100	28480	0698-8961
2523A AND ABOVE						
A16R10	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
2305A TO 2436A						
A16R11	0698-3451	0		RESISTOR 133K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1333-F
2449A AND ABOVE						
A16R11	0757-0470	3		RESISTOR 162K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1623-F
A16R12	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A16R13	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A16R14	0757-0428	1	3	RESISTOR 1.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1621-F
2305A TO 2331A						
A16R15	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
2337A TO 2523A						
A16R15	0698-3151	7		RESISTOR 2.87K A% .125W F TC = 0 + -100 2	4546 C	4-1/8-T0-2871-F
2528A AND ABOVE						
A16R15	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A16R16	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A16R17	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A16R18	0699-0071	6	3	RESISTOR 4.64M 1% .125W F TC = 0 + -100	28480	0699-0071
A16R19	0699-0071	6		RESISTOR 4.64M 1% .125W F TC = 0 + -100	28480	0699-0071
A16R20	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A16R21	0757-0428	1		RESISTOR 1.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1621-F
A16R22	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A16R23	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A16R24	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A16R25	0698-3266	5	1	RESISTOR 237K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2373-F
A16R26	0699-0071	6		RESISTOR 4.64M 1% .125W F TC = 0 + -100	28480	0699-0071
A16R27	2100-3161	6	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	02111	43P203
A16R28	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A16R29	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A16R30	0698-3158	4	7	RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F *
A16R31	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A16R32△	0757-0180	2		RESISTOR 31.6 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3162-F
A16R33△	2100-2061	3	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	73138	82PR200
A16R34	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A16TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A16TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A16TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A16TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A16TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A16U1	1826-0740	8	2	IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A16U2	1826-0098	9		IC COMPARATOR PRCN TO-99 PKG	27014	LM211H
A16U3	1826-0191	3	3	IC COMPARATOR GP DUAL TO-100 PKG	27014	LM319H
A16U4	1826-1048	7	1	IC OP AMP PRCN 8-DIP-C PKG	28480	1826-1048
A16U5	1826-0740	8		IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A16U6	1820-0535	7		IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
2305A TO 2540A						
A16U7				NOT ASSIGNED		
2546A AND ABOVE						
A16U7	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A16W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A16W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) △ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A17	**08901-60145 – SERIAL PREFIX 2305A TO 2530A**					
A17	08901-60145	2	1	INPUT MIXER ASSEMBLY	28480	08901-60145
A17C1	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C2	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C3	0160-3873	1	4	CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A17C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A17C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C11	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C12	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C13	0160-4497	7	1	CAPACITOR-FXD 82PF +-5% 200VDC CER 0+-30	28480	0160-4497
A17C14	0160-4652	6	1	CAPACITOR-FXD 960PF +-1% 500VDC MICA	00853	RDM19F961F5C
A17C15	0160-4647	9	1	CAPACITOR-FXD 154PF +-1% 500VDC MICA	28480	0160-4647
A17C16	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C17	0160-4646	8	1	CAPACITOR-FXD 444PF +-1% 500VDC MICA	28480	0160-4646
A17C18	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C19	0160-4387	4		CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A17C20	0160-4641	3	1	CAPACITOR-FXD 3520PF +-1% 50VDC	28480	0160-4641
A17C21	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C22	0160-4651	5	1	CAPACITOR-FXD 817PF +-1% 500VDC MICA	00853	RDM19F(817)F5C
A17C23	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C24	0180-0376	5		CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A17C25	0160-4387	4		CAPACITOR-FXD 47PF +-5% 200VDC CER 0+-30	28480	0160-4387
A17C26	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A17C27	08901-00064	8	1	STRAP/CAPACITOR	28480	08901-00064
2305A TO 2326A *A17C28*				NOT ASSIGNED		
2328A TO 2530A *A17C28*	0160-5491	3		CAPACITOR-FXD 240PF +-5% 100VDC CER	28480	0160-5491
A17CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17DS1	1990-0524	3	1	LED-LAMP LUM-INT = 1MCD IF = 20MA-MAX BVR = 5V	28480	5082-4550
A17J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A17J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A17	**08901-60145 – SERIAL PREFIX 2305A TO 2530A**					
A17J3	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A17L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L5	9100-4434	5	1	INDUCTOR RF-CH-MLD 240UH 2% .166DX.385LG	28480	9100-4434
2305A TO 2326A						
A17L6	9140-0302	2		INDUCTOR RF-CH-MLD 21.9UH 2%	28480	9140-0302
2328A TO 2530A						
A17L6	9100-1621	6		INDUCTOR RF-CH-MLD 18UH 10% .166DX.385LG	28480	9100-1621
A17L7	9140-0131	5		INDUCTOR RF-CH-MLD 10MH 5% .25DX.75LG	28480	9140-0131
2305A TO 2403A						
A17L8	08901-80002	2	1	INDUCR VARIABLE	28480	08901-80002
2405A TO 2530A						
A17L8	9140-0840	3		COIL-VAR 6.1UH-19.1UH Q = 27 PC-MTG	28480	9140-0840
A17L9	9140-0131	5		INDUCTOR RF-CH-MLD 10MH 5% .25DX.75LG	28480	9140-0131
A17L10	9100-1626	1	1	INDUCTOR RF-CH-MLD 36UH 5% .166DX.385LG	28480	9100-1626
2305A TO 2403A						
A17L11	08901-80001	1	1	INDUCR VARIABLE	28480	08901-80001
2405A TO 2530A						
A17L11	9140-0841	4		COIL-VAR 18UH-56.3UH Q = 20 PC-MTG	28480	9140-0841
A17L12	9140-0303	3	1	INDUCTOR RF-CH-MLD 89.3UH 2%	28480	9140-0303
A17L13	9140-0131	5		INDUCTOR RF-CH-MLD 10MH 5% .25DX.75LG	28480	9140-0131
2305A TO 2326A						
A17L14				NOT ASSIGNED		
2328A TO 2530A						
A17L14	9100-1621	6		INDUCTOR RF-CH-MLD 18UH 10% .166DX.385LG	28480	9100-1621
A17MP1	08901-00030	8	1	COVER MIXER	28480	08901-00030
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
A17MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A17MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A17MP4	0363-0159	0	1	RFI STRIP-FINGERS BE-CU ZINC PLATED	28480	0363-0159

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A17	**08901-60145 – SERIAL PREFIX 2305A TO 2530A**					
2305A TO 2413A						
A17MP5	08662-00040	0		SHIELD COMP SMALL	28480	08662-00040
A17MP6	08662-00038	6		SHIELD CKT SM	28480	08662-00038
2414A TO 2530A						
A17MP5				NOT ASSIGNED		
A17MP6				NOT ASSIGNED		
A17Q1	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A17Q2	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A17Q3	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A17Q4	1854-0632	6	1	TRANSISTOR NPN SI PD = 180MW FT = 4GHZ	25403	BFR-91
A17Q5	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A17Q6	1854-0720	3	1	TRANSISTOR NPN SI PD = 500MW FT = 4GHZ	28480	1854-0720
A17Q7	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A17Q8	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A17R1	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A17R2	0757-0200	7		RESISTOR 5.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5621-F
A17R3	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A17R4	0698-8821	8		RESISTOR 5.62 1% .125W F TC = 0 + -100	28480	0698-8821
A17R5	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A17R6	0698-0087	2	1	RESISTOR 316 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-3160-F
A17R7	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A17R8	0699-0135	3	2	RESISTOR 71.2 1% .25W F TC = 0 + -100	28480	0699-0135
A17R9	0699-0135	3		RESISTOR 71.2 1% .25W F TC = 0 + -100	28480	0699-0135
A17R10	0698-7204	9	5	RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A17R11	0698-7220	9	4	RESISTOR 215 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-215R-F
A17R12	0698-7204	9		RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A17R13	0757-0467	8		RESISTOR 121K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1213-F
A17R14	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A17R15	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A17R16	0699-0392	4	1	RESISTOR 34.8 1% .125W F TC = 0 + -100	28480	0699-0392
A17R17	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A17R18	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A17R19	0698-7204	9		RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A17R20	0757-0799	9	1	RESISTOR 121 1% .5W F TC = 0 + -100	28480	0757-0799
A17R21	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A17R22	0698-7205	0	8	RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A17R23	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A17R24	0698-7216	3	3	RESISTOR 147 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-147R-F
A17R25	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A17R26	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A17R27	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A17R28	0757-0278	9	3	RESISTOR 1.78K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1781-F
A17R29	0757-0278	9		RESISTOR 1.78K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1781-F
A17R30	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A17	**08901-60145 – SERIAL PREFIX 2305A TO 2530A**					
A17R31	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A17R32	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A17R33	0757-0403	2		RESISTOR 121 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-121R-F
A17R34	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A17R35	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A17R36	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A17R37	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A17R38	0757-0403	2		RESISTOR 121 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-121R-F
A17R39	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A17R40	0757-0403	2		RESISTOR 121 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-121R-F
A17R41	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A17R42	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A17T1	08901-80031	7	1	TRANSFORMER ENCP	28480	08901-80031
A17U1	08901-67001	3	1	MIXER CIRCUIT	28480	08901-67001
	0340-0850	0	2	INSULATOR-XSTR TFE	28480	0340-0850
	1251-1556	7	24	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A17U2	1826-0412	1		IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A17	**08902-60104 – SERIAL PREFIX 2535A AND ABOVE**					
A17	08902-60104	4	1	INPUT MIXER ASSEMBLY	28480	08902-60104
A17C1	0160-3879	7	8	CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C2	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C3	0160-3873	1	1	CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A17C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C8	0180-0197	8	2	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A17C9	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A17C11	0160-5469	5	5	CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A17C12	0160-4835	7	5	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A17C13	0160-4812	0	1	CAPACITOR-FXD 220PF +-5% 100VDC CER	28480	0160-4812
A17C14	0160-4652	6	1	CAPACITOR-FXD 960PF +-1% 500VDC MICA	00853	RDM19F961F5C
A17C15	0160-4647	9	1	CAPACITOR-FXD 154PF +-1% 500VDC MICA	28480	0160-4647
A17C16	0180-2929	8	1	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A17C17	0160-4646	8	1	CAPACITOR-FXD 444PF +-1% 500VDC MICA	28480	0160-4646
A17C18	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A17C19	0160-4814	2	1	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A17C20	0160-4641	3	1	CAPACITOR-FXD 3520PF +-1% 50VDC	28480	0160-4641
A17C21	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A17C22	0160-4651	5	1	CAPACITOR-FXD 817PF +-1% 500VDC MICA	00853	RDM19F(817)F5C
A17C23	0160-0576	5	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A17C24	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A17C25	0160-4801	7	1	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A17C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A17C27	08901-00064	8	1	STRAP/CAPACITOR	28480	08901-00064
A17C28	0160-4512	7	2	CAPACITOR-FXD 120PF +-5% 200VDC CER	28480	0160-4512
A17C29	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A17C30	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A17C31	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A17C32	0160-4822	2	1	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A17C33	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A17C34	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A17C35	0160-4512	7		CAPACITOR-FXD 120PF +-5% 200VDC CER	28480	0160-4512
A17C36	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A17CR1Δ	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A17CR2Δ	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A17CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR6	1901-0518	8	2	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A17CR7	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A17	**08902-60104 – SERIAL PREFIX 2535A AND ABOVE**					
A17CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17CR9	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A17DS1	1990-0524	3	1	LED-LAMP LUM-INT = 1MCD IF = 20MA-MAX BVR = 5V	28480	5082-4550
A17E1	9170-0847	3	1	CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE
A17J1	1250-1425	7	2	CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A17J2	1250-1220	0	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4	2	WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9	2	NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A17J3	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A17J4	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A17L1	9100-3922	4	4	INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A17L5	9100-4434	5	1	INDUCTOR 240UH 2% .165DX.385LF Q = 65	28480	9100-4434
A17L6	9100-3313	7	1	INDUCTOR RF-CH-MLD 22UH 5% .166DX.385LG	28480	9100-3313
A17L7	9100-1625	0	1	INDUCTOR RF-CH-MLD 33UH 5% .166DX.385LG	28480	9100-1625
A17L8	9140-0840	3	1	COIL-VAR 18UH-56.3UH Q = 20 PC-MTG	28480	9140-0840
A17L10	9100-1626	1	1	INDUCTOR RF-CH-MLD 36UH 5% .166DX.385LG	28480	9100-1626
A17L11	9140-0841	4	1	COIL-VAR 6.1UH-19.1UH Q = 20 PC-MTG	28480	9140-0841
A17L12	9140-0303	3	2	INDUCTOR RF-CH-MLD 89.3UH 2%	28480	9140-0303
A17L14	9140-0454	5	1	INDUCTOR RF-CH-MLD 18UH 5% .166DX.385LG	28480	9140-0454
A17MP1	08902-00026	3	1	COVER-MIXER	28480	08902-00026
	2360-0113	2	1	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A17MP2	5001-0176	0	2	GROUND STRAP	28480	5001-0176
A17MP3	0363-0159	0	1	RFI STRIP-FINGERS BE-CU ZINC PLATED	28480	0363-0159
A17Q1	1853-0281	9	4	TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A17Q2	1853-0314	9	2	TRANSISTOR PNP 2N2905A SI TO-39 PD = 600MW	04713	2N2905A
A17Q3	1854-0404	0	1	TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A17Q4	1854-0632	6	1	TRANSISTOR NPN SI PD = 180MW FT = 4GHZ	25403	BFR-91
A17Q5	1853-0020	4	2	TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A17Q6	1854-0720	3	1	TRANSISTOR NPN SI PD = 500MW FT = 4GHZ	28480	1854-0720
A17Q7	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A17Q8	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A17Q9	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A17Q10	1853-0314	9		TRANSISTOR PNP 2N2905A SI TO-39 PD = 600MW	04713	2N2905A
A17Q11	1854-0610	0	1	TRANSISTOR NPN SI TO-46 FT = 800MHZ	28480	1854-0610
A17Q12	1858-0008	8	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	04713	MHQ6001
A17Q13	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A17R1	0757-0442	9	1	RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A17R2	0757-0200	7	1	RESISTOR 5.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5621-F
A17R3	0698-3154	0	5	RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A17R4	0698-8821	8	3	RESISTOR 5.62 1% .125W F TC = 0 + -100	28480	0698-8821
A17R5	0698-8821	8		RESISTOR 5.62 1% .125W F TC = 0 + -100	28480	0698-8821

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A17	**08902-60104 – SERIAL PREFIX 2535A AND ABOVE**					
A17R6	0698-0087	2	1	RESISTOR 316 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-3160-F
A17R7	0698-0085	0	2	RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A17R8	0699-0135	3	2	RESISTOR 71.2 1% .25W F TC = 0 + -100	28480	0699-0135
A17R9	0699-0135	3		RESISTOR 71.2 1% .25W F TC = 0 + -100	28480	0699-0135
A17R10	0698-7204	9	3	RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A17R11	0698-7220	9	1	RESISTOR 215 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-215R-F
A17R12	0698-7204	9		RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A17R13	0757-0421	4	1	RESISTOR 825 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-825R-F
A17R14	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A17R15	0757-0422	5	2	RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A17R16	0699-0392	4	1	RESISTOR 34.8 1% .125W F TC = 0 + -100	28480	0699-0392
A17R17	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A17R18	0757-0441	8	1	RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A17R19	0698-7204	9		RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A17R20	0757-0799	9	1	RESISTOR 121 1% .5W F TC = 0 + -100	28480	0757-0799
A17R21	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A17R22	0698-7205	0	3	RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A17R23	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A17R24	0698-7216	3	1	RESISTOR 147 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-147R-F
A17R25	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A17R26	0757-0274	5	1	RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A17R27	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A17R28	0757-0278	9	1	RESISTOR 1.78K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1781-F
A17R29	0757-0294	9	2	RESISTOR 17.8 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-17R8-F
A17R30	0698-3441	8	1	RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A17R31	0698-3431	6	1	RESISTOR 23.7 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-23R7-F
A17R32	0757-0418	9	3	RESISTOR 619 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-619R-F
A17R33	0698-3443	0	3	RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A17R34	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A17R35	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A17R36	0757-0294	9		RESISTOR 17.8 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-17R8-F
A17R37	0757-0394	0	2	RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A17R38	0757-0180	2	1	RESISTOR 31.6 1% .125W F TC = 0 + -100	28480	0757-0180
A17R39	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A17R40	0757-0418	9		RESISTOR 619 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-619R-F
A17R41	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A17R42	0757-0401	0	2	RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A17R43	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A17R44	0757-0418	9		RESISTOR 619 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-619R-F
A17R45	0698-4037	0	2	RESISTOR 46.4 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-46R4-F
A17R46	0698-8821	8		RESISTOR 5.62 1% .125W F TC = 0 + -100	28480	0698-8821
A17R47	0698-4037	0		RESISTOR 46.4 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-46R4-F
A17R48	0698-3438	3	1	RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A17R49	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A17R50	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A17T1	08901-80031	7	1	XFMR TORD14.OTRN	28480	08901-80031
A17U1	08901-67001	3	1	MIXER CIRCUIT	28480	08901-67001
	0340-1098	0	1	INSULATOR-XSTR TFE	28480	0340-1098
	1251-1556	7	12	CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A18						
A18	08901-60004	2	1	IF AMPLIFIER ASSEMBLY	28480	08901-60004
A18C1	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A18C2	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A18C3	0160-3459	9	45	CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A18C4	0180-2620	6	14	CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A18C5	0180-2619	3	7	CAPACITOR-FXD 22UF+-10% 15VDC TA	25088	D22GS1B15K
A18C6	0160-0156	7	1	CAPACITOR-FXD 3900PF +-10% 200VDC POLYE	28480	0160-0156
A18C7	0160-2257	3	1	CAPACITOR-FXD 10PF +-5% 500VDC CER 0+-60	28480	0160-2257
A18C8	0140-0198	5		CAPACITOR-FXD 200PF +-5% 300VDC MICA	72136	DM15F201J0300WV1CR
A18C9	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A18C10	0160-2242	6	2	CAPACITOR-FXD 2.4PF +-.25PF 500VDC CER	28480	0160-2242
A18C11	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A18C12	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A18C13Δ	0160-6623	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-6623
A18C14	0160-2266	4	1	CAPACITOR-FXD 24PF +-5% 500VDC CER 0+-30	28480	0160-2266
A18C15	0160-2199	2	10	CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A18C16	0160-2205	1	1	CAPACITOR-FXD 120PF +-5% 300VDC MICA	28480	0160-2205
A18C17	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A18C18	0160-2242	6		CAPACITOR-FXD 2.4PF +-.25PF 500VDC CER	28480	0160-2242
A18C19	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A18C20	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A18C21	0160-2265	3	1	CAPACITOR-FXD 22PF +-5% 500VDC CER 0+-30	28480	0160-2265
A18CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A18CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A18CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A18CR4	1901-0880	7		DIODE-GEN PRP 125MA D0-35	28480	1901-0880
A18CR5	1901-0880	7		DIODE-GEN PRP 125MA D0-35	28480	1901-0880
A18CR6	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A18CR7	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
2305A TO 2449A *A18E1* *2451A AND ABOVE*				NOT ASSIGNED		
A18E1	9170-0029	3		CORE-SHIELDING BEAD		
A18J1	1250-1205	1	6	CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1205
A18J2	1250-1205	1		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1205
A18L1	9100-1628	3	1	INDUCTOR RF-CH-MLD 43UH 5% .166DX.385LG	28480	9100-1628
A18L2	9140-0237	2	1	INDUCTOR RF-CH-MLD 200UH 5% .166DX.385LG	28480	9140-0237
A18MP1	08901-00029	5	1	COVER IF AMPLIFIER	28480	08901-00029
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A18Q1	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A18Q2	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A18Q3	1853-0018	0	1	TRANSISTOR PNP SI TO-72 PD = 200MW FT = 1GHZ	28480	1853-0018
A18Q4	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A18Q5	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A18Q6	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A18Q7	1854-0610	0	5	TRANSISTOR NPN SI TO-46 FT = 800MHZ	28480	1854-0610
A18R1	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A18R2	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A18R3	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A18R4	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A18R5	0757-0278	9		RESISTOR 1.78K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1781-F
A18R6	0698-3153	9		RESISTOR 3.83K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3831-F
A18R7	0698-3434	9		RESISTOR 34.8 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-34R8-F
A18R8	0757-0418	9		RESISTOR 619 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-619R-F
A18R9	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A18R10	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A18R11	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A18R12	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A18R13	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A18R14	0757-0338	2		RESISTOR 1K 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-1001-F
A18R15	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A18R16	0698-3446	3		RESISTOR 383 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-383R-F
A18R17	0698-3446	3		RESISTOR 383 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-383R-F
A18R18	0698-3445	2		RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A18R19	2100-0552	3		RESISTOR-TRMR 50 10% C SIDE-ADJ 1-TRN	28480	2100-0552
A18R20	0698-3150	6		RESISTOR 2.37K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2371-F
A18R21	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A18R22	0698-3440	7		RESISTOR 196 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-196R-F
A18R23	2100-3351	6		RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A18R24	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A18R25	0757-0402	1		RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A18R26	0757-0395	1		RESISTOR 56.2 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-56R2-F
A18R27	0757-0402	1		RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A18R28	0698-3151	7	6	RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2871-F
A18R29	0698-3447	4		RESISTOR 422 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-422R-F
A18R30	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A18R31	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A18R32	0698-3431	6	4	RESISTOR 23.7 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-23R7-F
A18R33	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08901-60024, 08901-60274 – SERIAL PREFIX 2305A TO 2717A**					
2305A TO 2618A						
A19	08901-60024	6	1	LO DIVIDER ASSEMBLY	28480	08901-60024
2621A AND ABOVE						
A19	08901-60274	8	1	LO DIVIDER ASSEMBLY	28480	08901-60274
A19C1	0160-0570	9		CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A19C2	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C3	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C4	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C5	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C6	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C7	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C8	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C9	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C10	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A19C11	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C12	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A19C13	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C14	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C15	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C16	0160-4830	2		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-4830
A19C17	0160-0576	5		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-0576
A19C18	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C19				NOT ASSIGNED		
A19C20				NOT ASSIGNED		
A19C21	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C22	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C23	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C24	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C25	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C26	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C27	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C28	0160-0572	1		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A19C29	0160-0690	4	2	CAPACITOR-FXD 1PF +-.5PF 100VDC CER	28480	0160-0690
A19C30	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C31	0160-0572	1		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A19C32	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C33	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C34	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C35	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C36	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C37	0160-0571	0	7	CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08901-60024, 08901-60274 – SERIAL PREFIX 2305A TO 2717A**					
2305A TO 2343A						
A19C38	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
2345A AND ABOVE						
A19C38	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A19C39	0160-0572	1		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A19C40	0160-4830	2		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-4830
A19C41	0160-4830	2		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-4830
A19C42	0160-0572	1		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A19C43*	0160-4491	1	1	CAPACITOR-FXD 8.2PF +-5% 200VDC CER	28480	0160-4491
A19C44	0160-3568	1	2	CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A19C45	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A19C46	0160-3568	1		CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A19C47	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C48	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C49	0160-0690	4		CAPACITOR-FXD 1PF +-.5PF 100VDC CER	28480	0160-0690
A19C50	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C51	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C52	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C53	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A19C54	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C55	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C56	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A19C57	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C58	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A19C59	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A19C60	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C61	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C62	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A19C63	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C64	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C65	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C66	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C67	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C68	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C69	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C70	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 50VDC CER	28480	0160-3878
A19CR1	1901-0033	2	8	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
2305A TO 2411A						
A19CR2	0122-0072	6	4	DIODE-VVC 2.2PF 5% C3/C25-MIN=4.5	04713	BB105B
A19CR3	0122-0072	6		DIODE-VVC 2.2PF 5% C3/C25-MIN=4.5	04713	BB105B
A19CR4	0122-0072	6		DIODE-VVC 2.2PF 5% C3/C25-MIN=4.5	04713	BB105B
A19CR5	0122-0072	6		DIODE-VVC 2.2PF 5% C3/C25-MIN=4.5	04713	BB105B
2412A AND ABOVE						
A19CR2	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161
A19CR3	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161
A19CR4	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161
A19CR5	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08901-60024, 08901-60274 – SERIAL PREFIX 2305A TO 2717A**					
A19CR6	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A19CR7	1901-1097	0	2	DIODE-PIN	28480	1901-1097
A19CR8	1901-1097	0		DIODE-PIN	28480	1901-1097
A19CR9	1901-0639	4	1	DIODE-PIN	28480	5082-3080
A19CR10	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A19E1	9170-0029	3	11	CORE-SHIELDING BEAD	28480	9170-0029
A19E2	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A19J1	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A19J2	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A19J3	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A19L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L5	9135-0068	6	2	INDUCTOR RF-CH-MLD 33NH 6% .102DX.26LG	28480	9135-0068
A19L6	9135-0073	3	3	INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A19L7	9135-0068	6		INDUCTOR RF-CH-MLD 33NH 6% .102DX.26LG	28480	9135-0068
A19L8	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A19L9				PART OF ETCHED CIRCUIT BOARD		
A19L10	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L11	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L12	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L13	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A19L14	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A19L15				PART OF ETCHED CIRCUIT BOARD		
2305A TO 2618A						
A19MP1	08901-00028	4	1	COVER LO DIVDER	28480	08901-00028
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2621A AND ABOVE						
A19MP1	08901-00166	1	1	COVER LO DIVIDER	28480	08901-00166
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A19MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A19MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A19MP4	08662-00041	1	1	SHIELD COMPONENT LGE	28480	08662-00041
A19MP5	08662-00039	7	1	SHIELD CKT LGE	28480	08662-00039

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08901-60024, 08901-60274 – SERIAL PREFIX 2305A TO 2717A**					
A19Q1	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A19Q2	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A19Q3	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A19Q4	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A19R1	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A19R2	0698-7227	6	9	RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R3	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R4	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R5	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R6	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R7	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R8	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R9	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R10	0698-3437	2	1	RESISTOR 133 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-133R-F
A19R11	0757-0402	1		RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A19R12	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R13	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R14	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R15	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R16	0757-0280	3		RESISTOR 1K 1% .5W .125W F TC = 0 + -100	28480	0757-0280
A19R17	0698-3151	7		RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	0698-3151
A19R18	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A19R19	0698-7201	6	1	RESISTOR 34.8 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-34R8-F
A19R20	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
2305A TO 2343A						
A19R21	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
2345A TO 2618A						
A19R21	0698-7214	1		RESISTOR 121 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-121R-F
2621A AND ABOVE						
A19R21	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-51.1R-F
A19R22	0757-0440	7		RESISTOR 7.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7501-F
A19R23	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A19R24	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A19R25	0698-3158	4		RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F
A19R26	1810-0203	5	3	NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
2305A TO 2343A						
A19R27	0698-7209	4		RESISTOR 75 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-75R0-F
2345A TO 2618A						
A19R27	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-51.1R-F
2621A AND ABOVE						
A19R27	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-2610-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08901-60024, 08901-60274 – SERIAL PREFIX 2305A TO 2717A**					
A19R28	1810-0203	5		NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A19R29	1810-0203	5		NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A19R30	0698-7205	0		RESISTOR 51.1 1% .05W F TC=0+-100	24546	C3-1/8-TO-51R1-F
A19R31	0698-7260	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A19R32	0698-7260	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A19R33	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-TO-751-F
A19R34	0757-0420	3		RESISTOR 750 1% .12W F TC=0+-100	24546	C4-1/8-TO-751-F
A19R35	0698-7195	7	2	RESISTOR 19.6 1% .05W F TC=0+-100	24546	C3-1/8-TO-19R6-F
A19R36	0757-0276	7		RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A19R37	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A19R38	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A19R39	0757-0276	7		RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A19R40	0698-7229	8	7	RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-TO-511R-F
A19R41	2100-2413	9	1	RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	30983	ET50X201
A19R42	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R43	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R44	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R45	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R46	0698-7229	8		RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-TO-511R-F
A19R47	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R48	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A19R49	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R50	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R51	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R52	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R53	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R54	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R55	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R56	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R57	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A19R58	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A19R59	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A19R60	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A19R61	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A19R62	0698-3158	4		RESISTOR 23.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2372-F
A19R63*	0757-0398	4	3	RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A19R64	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A19R65				NOT ASSIGNED		
A19R66	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A19R67	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R68	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R69	0698-3447	4		RESISTOR 422 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A19R70	0757-0397	3		RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A19R71	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A19R72*	0757-0422	5	11	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08901-60024, 08901-60274 – SERIAL PREFIX 2305A TO 2717A**					
A19R73				NOT ASSIGNED		
A19R74*	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R75	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R76	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A19R77	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A19R78	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A19R79	0757-0726	2	1	RESISTOR 511 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-511R-F
A19R80	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A19R81	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A19R82	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A19R83	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R84	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R85	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
2305A TO 2343A						
A19R86	0698-7209	4		RESISTOR 75 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-75R0-F
2345A AND ABOVE						
A19R86	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-51.1R-F
A19R87	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-51R1-F
A19R88	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A19R89	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A19R90	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A19R91	0698-7247	0	5	RESISTOR 2.87K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2871-F
A19R92	0698-3151	7		RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2871-F
A19R93	0698-7247	0		RESISTOR 2.87K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2871-F
A19R94	0698-7208	3	1	RESISTOR 68.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-68R1-F
A19R95	0698-7229	8		RESISTOR 511 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-511R-F
A19R96	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R97	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R98	0698-7229	8		RESISTOR 511 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-511R-F
A19R99	0698-3439	4	4	RESISTOR 178 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-178R-F
A19R100	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R101	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R102	0698-3439	4		RESISTOR 178 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-178R-F
A19R103	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A19R104	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A19R105	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A19R106	0698-7209	4		RESISTOR 75 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-75R0-F
A19R107	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R108	0698-7209	4		RESISTOR 75 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-75R0-F
A19R109	0698-7229	8		RESISTOR 511 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-511R-F
A19R110	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A10R111	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	28480	0698-3132
A19R112	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A19R113	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19R114	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19R115	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19R116	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08901-60024, 08901-60274 – SERIAL PREFIX 2305A TO 2717A**					
A19TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A19TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A19U1	1820-1225	4	1	IC FF ECL D-M/S DUAL	04713	MC10231P
A19U2	1826-0372	2	6	IC MISC 8-DIP-P PKG	28480	1826-0372
A19U3	1826-0013	8	2	IC OP AMP LOW-NOISE TO-99 PKG	06665	SSS741CJ
A19U4	08901-67002	4	1	FREQUENCY DUBLER	28480	08901-67002
	0340-0850	0		INSULATOR-XSTR TFE	28480	0340-0850
	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A19U5	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A19U6	1820-0817	8		IC FF ECL D-M/S DUAL	04713	MC10131P
A19U7	1820-1940	0	2	IC CNTR ECL BIN SYNCHRO POS-EDGE-TRIG	28480	1820-1940
A19U8	1820-1940	0		IC CNTR ECL BIN SYNCHRO POS-EDGE-TRIG	28480	1820-1940
A19U9	1820-0796	2	1	IC GATE ECL NOR QUAD 2-INP	04713	MC1662L
A19U10	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A19U11	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A19U12	1820-0817	8		IC FF ECL D-M/S DUAL	04713	MC10131P
A19U13	1820-1400	7	2	IC GATE ECL AND QUAD 2-INP	04713	MC10104P
A19U14	1820-1400	7		IC GATE ECL AND QUAD 2-INP	04713	MC10104P
A19U15	1820-0828	1	2	IC DCDR ECL BIN 3-TO-8-LINE 3-INP	04713	MC10162P
A19U16	1820-0802	1	2	IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A19U17	1820-0817	8		IC FF ECL D-M/S DUAL	04713	MC10131P
A19U18	1820-0828	1		IC DCDR ECL BIN 3-TO-8-LINE 3-INP	04713	MC10162P
A19U19	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A19U20	1820-1052	5	1	IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A19VR1	1902-0943	5		DIODE-ZNR 2.4V 5% DO-35 PD = .4W TC = -.037%	28480	1902-0943
A19VR2	1902-0049	2	3	DIODE-ZNR 6.19V 5% DO-35 PD = .4W	28480	1902-0049
A19VR3	1902-0049	2		DIODE-ZNR 6.19V 5% DO-35 PD = .4W	28480	1902-0049
A19VR4	1902-0049	2		DIODE-ZNR 6.19V 5% DO-35 PD = .4W	28480	1902-0049
A19W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A19W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A19W3				NOT ASSIGNED		
A19W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08902-60126 – SERIAL PREFIX 2742A AND ABOVE**					
A19	08902-60126	0	1	LO DIVIDER ASSEMBLY	28480	08902-60126
A19C1	0160-0570	9		CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A19C2	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C3	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C4	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C5	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C6	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C7	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C8	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C9	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C10	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A19C11	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C12	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A19C13	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C14	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C15	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C16	0160-4830	2		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-4830
A19C17	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A19C18	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C19				NOT ASSIGNED		
A19C20				NOT ASSIGNED		
A19C21	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C22	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C23	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C24	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C25	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C26	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C27	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C28				NOT ASSIGNED		
A19C29	0160-0690	4	2	CAPACITOR-FXD 1PF +-.5PF 100VDC CER	28480	0160-0690
A19C30	0160-4832	4		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-4832
A19C31	0160-0572	1		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A19C32	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C33	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C34	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A19C35	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C36	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C37	0160-0571	0	7	CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A19C38	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A19C39	0160-4830	2		CAPACITOR-FXD 2200PF +-10% 100VDC CER	28480	0160-4830
A19C40	0160-4830	2		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-4830
A19C41	0160-4830	2		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-4830
A19C42	0160-0572	1		CAPACITOR-FXD 2200PF +-20% 100VDC CER	28480	0160-0572
A19C43*	0160-4491	1	1	CAPACITOR-FXD 8.2PF +-5% 200VDC CER	28480	0160-4491

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08902-60126 – SERIAL PREFIX 2742A AND ABOVE**					
A19C44	0160-3568	1	2	CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A19C45	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A19C46	0160-3568	1		CAPACITOR-FXD 2.7PF +-5% 200VDC CER	51642	100-100-NP0-279J
A19C47	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C48	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C49	0160-0690	4		CAPACITOR-FXD 1PF +-.5PF 100VDC CER	28480	0160-0690
A19C50	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C51	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C52	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C53	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A19C54	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C55	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C56	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A19C57	0160-4822	2		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-4822
A19C58	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A19C59	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A19C60	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C61	0160-4835	7		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4835
A19C62	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A19C63	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A19C64	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A19C65	0160-0576	5		CAPACITOR-FXD .1UF +-10% 100VDC CER	28480	0160-0576
A19C66				NOT ASSIGNED		
A19C67	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A19C68				NOT ASSIGNED		
A19C69				NOT ASSIGNED		
A19C70				NOT ASSIGNED		
A19CR1	1901-0033	2	8	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A19CR2	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161
A19CR3	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161
A19CR4	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161
A19CR5	0122-0161	4		DIODE-VVC 2.2PR 7% BVR=30V	28480	0122-0161
A19CR6	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A19CR7	1901-1097	0	2	DIODE-PIN	28480	1901-1097
A19CR8	1901-1097	0		DIODE-PIN	28480	1901-1097
A19CR9	1901-0639	4	1	DIODE-PIN	28480	5082-3080
A19CR10	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A19E1	9170-0029	3	11	CORE-SHIELDING BEAD	28480	9170-0029
A19E2	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A19J1	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A19J2	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A19J3	1250-1425	7		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08902-60126 – SERIAL PREFIX 2742A AND ABOVE**					
A19L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L5	9135-0068	6	2	INDUCTOR RF-CH-MLD 33NH 6% .102DX.26LG	28480	9135-0068
A19L6	9135-0073	3	3	INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A19L7	9135-0068	6		INDUCTOR RF-CH-MLD 33NH 6% .102DX.26LG	28480	9135-0068
A19L8	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A19L9				PART OF ETCHED CIRCUIT BOARD		
A19L10	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L11	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L12	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A19L13	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A19L14	9135-0073	3		INDUCTOR RF-CH-MLD 51NH 6% .102DX.26LG	28480	9135-0073
A19L15				PART OF ETCHED CIRCUIT BOARD		
A19MP1	08901-00166	1	1	COVER LO DIVIDER	28480	08901-00166
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A19MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A19MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A19MP4	08662-00041	1	1	SHIELD COMPONENT LGE	28480	08662-00041
A19MP5	08662-00039	7	1	SHIELD CKT LGE	28480	08662-00039
A19Q1	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A19Q2	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A19Q3	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A19Q4	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A19R1	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A19R2	0698-7227	6	9	RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R3	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R4	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R5	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A19R6	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R7	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R8	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R9	0698-7232	3		RESISTOR 681 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-681R-F
A19R10	0698-3437	2	1	RESISTOR 133 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-133R-F
A19R11	0757-0402	1		RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A19R12	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R13	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R14	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R15	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R16	0757-0280	3		RESISTOR 1K 1% .5W .125W F TC = 0 + -100	28480	0757-0280
A19R17	0698-3151	7		RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	0698-3151
A19R18	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A19R19	0698-7201	6	1	RESISTOR 34.8 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-34R8-F
A19R20	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A19R21	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-51.1R-F
A19R22	0757-0440	7		RESISTOR 7.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7501-F
A19R23	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A19R24	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A19R25	0698-3158	4		RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08902-60126 – SERIAL PREFIX 2742A AND ABOVE**					
A19R26	1810-0203	5	3	NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A19R27	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19R28	1810-0203	5		NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A19R29	1810-0203	5		NETWORK-RES 8-SIP470.0 OHM X 7	01121	208A471
A19R30	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-51R1-F
A19R31	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A19R32	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
2305A TO 2751A						
A19R33	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-751-F
2834A AND ABOVE						
A19R33	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19R34	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C3-1/8-TO-751-F
A19R35	0698-7195	7	2	RESISTOR 19.6 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-19R6-F
A19R36	0757-0276	7		RESISTOR 61.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6192-F
A19R37	0757-0394	0		RESISTOR 51.1 1% .125W F TC + 0 + -100	24546	C4-1/8-TO-51R1-F
A19R38	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	0757-0394
A19R39	0757-0276	7		RESISTOR 61.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6192-F
A19R40	0757-0416	7		RESISTOR 511 1%.125W F TC = 0 + -100	24546	0757-0416
A19R41	2100-2413	9	1	RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	30983	ET50X201
A19R42	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R43	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R44	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R45	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R46	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-511R-F
A19R47	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R48	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	0757-0346
A19R49	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R50	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R51	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R52	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R53	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R54	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R55	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R56	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R57	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A19R58	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A19R59	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A19R60	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A19R61	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R62	0698-3158	4		RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F
A19R63*	0757-0398	4	3	RESISTOR 75 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-75R0-F
A19R64	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R65				NOT ASSIGNED		
A19R66	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A19R67	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R68	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08902-60126 – SERIAL PREFIX 2742A AND ABOVE**					
A19R69	0698-3447	4		RESISTOR 422 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-422R-F
A19R70	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R71	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A19R72*	0757-0422	5	11	RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R73				NOT ASSIGNED		
A19R74*	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A19R75	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R76	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A19R77	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A19R78	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A19R79	0757-0726	2	1	RESISTOR 511 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-511R-F
A19R80	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A19R81	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A19R82	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A19R83	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R84	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R85	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R86	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-51R1-F
A19R87	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-51R1-F
A19R88	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A19R89	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A19R90	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A19R91	0698-7247	0	5	RESISTOR 2.87K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2871-F
A19R92	0698-3151	7		RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2871-F
A19R93	0698-7247	0		RESISTOR 2.87K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2871-F
A19R94	0698-7208	3	1	RESISTOR 68.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-68R1-F
A19R95	0698-7229	8		RESISTOR 511 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-511R-F
A19R96	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R97	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A19R98	0698-7229	8		RESISTOR 511 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-511R-F
A19R99	0698-3439	4	4	RESISTOR 178 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-178R-F
A19R100	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R101	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R102	0698-3439	4		RESISTOR 178 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-178R-F
A19R103	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A19R104	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A19R105	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A19R106	0698-7209	4		RESISTOR 75 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-75R0-F
A19R107	0757-0397	3		RESISTOR 68.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-68R1-F
A19R108	0698-7209	4		RESISTOR 75 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-75R0-F
A19R109	0698-7229	8		RESISTOR 511 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-511R-F
A19R110	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A10R111	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	28480	0698-3132
A19R112	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A19R113	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19R114	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A19	**08902-60126 – SERIAL PREFIX 2742A AND ABOVE**					
A19R115	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19R116	0698-3132	4		RESISTOR 261 1% .126W F TC = 0 + -100	24546	C4-1/8-TO-2610-F
A19TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A19TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A19U1	1820-1225	4	1	IC FF ECL D-M/S DUAL	04713	MC10231P
A19U2	1826-0372	2	6	IC MISC 8-DIP-P PKG	28480	1826-0372
A19U3	1826-0013	8	2	IC OP AMP LOW-NOISE TO-99 PKG	06665	SSS741CJ
A19U4	08901-67002	4	1	FREQUENCY DUBLER	28480	08901-67002
	0340-1098	0		INSULATOR-XSTR TFE	28480	0340-1098
	1251-1556	7		CONNECTOR-SGL CONT SKT .018-IN-BSC-SZ	28480	1251-1556
A19U5	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A19U6	1820-0817	8		IC FF ECL D-M/S DUAL	04713	MC10131P
A19U7	1820-1940	0	2	IC CNTR ECL BIN SYNCHRO POS-EDGE-TRIG	28480	1820-1940
A19U8	1820-1940	0		IC CNTR ECL BIN SYNCHRO POS-EDGE-TRIG	28480	1820-1940
A19U9	1820-0796	2	1	IC GATE ECL NOR QUAD 2-INP	04713	MC1662L
A19U10	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A19U11	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A19U12	1820-0817	8		IC FF ECL D-M/S DUAL	04713	MC10131P
A19U13	1820-1400	7	2	IC GATE ECL AND QUAD 2-INP	04713	MC10104P
A19U14	1820-1400	7		IC GATE ECL AND QUAD 2-INP	04713	MC10104P
A19U15	1820-0828	1	2	IC DCDR ECL BIN 3-TO-8-LINE 3-INP	04713	MC10162P
A19U16	1820-0802	1	2	IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A19U17	1820-0817	8		IC FF ECL D-M/S DUAL	04713	MC10131P
A19U18	1820-0828	1		IC DCDR ECL BIN 3-TO-8-LINE 3-INP	04713	MC10162P
A19U19	1820-0802	1		IC GATE ECL NOR QUAD 2-INP	04713	MC10102P
A19U20	1820-1052	5	1	IC XLTR ECL ECL-TO-TTL QUAD 2-INP	04713	MC10125L
A19U21	1820-1225	4		IC FF ECL D-M/S DUAL	04713	MC10216P
A19VR1	1902-0943	5		DIODE-ZNR 2.4V 5% DO-35 PD = .4W TC = -.037%	28480	1902-0943
A19VR2	1902-0049	2	3	DIODE-ZNR 6.19V 5% DO-35 PD = .4W	28480	1902-0049
A19VR3	1902-0049	2		DIODE-ZNR 6.19V 5% DO-35 PD = .4W	28480	1902-0049
A19VR4	1902-0049	2		DIODE-ZNR 6.19V 5% DO-35 PD = .4W	28480	1902-0049
A19W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A19W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A19W3				NOT ASSIGNED		
A19W4	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60185 – SERIAL PREFIX 2305A TO 2530A**					
A20	08901-60185	0	1	LO CONTROL ASSEMBLY	28480	08901-60185
A20C1	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A20C2	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A20C3	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A20C4	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A20C5	0180-2853	7	2	CAPACITOR-FXD 10UF+-20% 100VDC TA	56289	109D106X0100C2
A20C6	0180-0490	4	1	CAPACITOR-FXD 68UF+-10% 6VDC TA	90201	TDC686K006WLF
A20C7	0160-2204	0		CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A20C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C9	0160-2204	0		CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A20C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C11	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C12	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A20C13	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A20C14	0160-0153	4		CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A20C15	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C16	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C17	0160-0161	4		CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A20C18	0180-2853	7		CAPACITOR-FXD 10UF+-20% 100VDC TA	56289	109D106X0100C2
A20C19	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C20	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A20C22	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A20C23	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A20CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR11	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR13	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR16	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR17	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR18	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR19	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR20	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR21	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR22	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR23	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A20CR24	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR25	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60185 – SERIAL PREFIX 2305A TO 2530A**					
A20CR26	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR27	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20E1	9170-0847	3		CORE SHIELDING BEAD	28480	9170-0847
A20MP1	08901-00104	7	1	COVER LO CONT BD	28480	08901-00104
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A20Q1	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A20Q2	1853-0034	0	8	TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A20Q3	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A20Q4	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A20Q5	1854-0247	9	8	TRANSISTOR NPN SI TO-39 PD = 1W FT = 800MHZ	28480	1854-0247
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A20Q6	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A20Q7	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A20Q8	1854-0023	9	4	TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0023
A20Q9	1854-0023	9		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0023
A20Q10	1855-0273	3	2	TRANSISTOR J-FET P-CHAN D-MODE TO-92 SI	28480	1855-0273
A20Q11	1855-0273	3		TRANSISTOR J-FET P-CHAN D-MODE TO-92 SI	28480	1855-0273
A20Q12	1854-0023	9		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0023
A20Q13	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A20Q14	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A20Q15	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A20Q16	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A20Q17				NOT ASSIGNED		
A20Q18	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A20Q19	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A20Q20	1854-0022	8	4	TRANSISTOR NPN SI TO-39 PD = 700MW	07263	S17843
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A20Q21	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A20Q22	1854-0022	8		TRANSISTOR NPN SI TO-39 PD = 700MW	07263	S17843
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A20Q23	1853-0012	4		TRANSISTOR PNP 2N2904A SI TO-39 PD = 600MW	01295	2N2904A
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A20Q24	1853-0594	7	1	TRANSISTOR-DUAL PNP 2N3808 TO-78	28480	1853-0594
A20Q25				NOT ASSIGNED		
A20Q26	1854-0022	8		TRANSISTOR NPN SI TO-39 PD = 700MW	07263	S17843
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A20Q27	1854-0022	8		TRANSISTOR NPN SI TO-39 PD = 700MW	07263	S17843
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A20Q28	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A20R1	2100-3274	2	2	RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	28480	2100-3274
A20R2	0698-7275	4	2	RESISTOR 42.2K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-4222-F
A20R3	0698-7243	6	2	RESISTOR 1.96K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1961-F
A20R4	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A20R5	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R6	0698-7258	3	3	RESISTOR 8.25K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-8251-F
A20R7	0698-7270	9	1	RESISTOR 26.1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2612-F
A20R8	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R9	0698-7212	9	16	RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A20R10	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A20R11	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60185 – SERIAL PREFIX 2305A TO 2530A**					
A20R12	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R13	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R14	0698-7279	8	1	RESISTOR 61.9K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-6192-F
A20R15	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R16				NOT ASSIGNED		
A20R17	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R18	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
2305A TO 2345A						
A20R19	0698-7267	4	1	RESISTOR 19.6K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1962-F
A20R20	0698-7259	4	3	RESISTOR 9.09K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-9091-F
A20R21	0698-7251	6		RESISTOR 4.22K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-4221-F
A20R22	0698-7240	3		RESISTOR 1.47K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1471-F
A20R23	0698-7220	9		RESISTOR 215 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-215R-F
A20R24	0757-0470	3	2	RESISTOR 162K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1623-F
A20R25	0698-7282	3	1	RESISTOR 82.5K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-8252-F
A20R26	0698-7274	3	1	RESISTOR 38.3K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-3832-F
2403A TO 2530A						
A20R19	0698-7279	8		RESISTOR 61.9K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-6192-F
A20R20	0698-7271	0		RESISTOR 28.7K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2872-F
A20R21	0698-7263	0		RESISTOR 13.3K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1332-F
A20R22	0698-7255	0		RESISTOR 6.19K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-6191-F
A20R23	0698-7246	9		RESISTOR 2.61K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2611-F
A20R24	0698-3260	9		RESISTOR 464K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4643-F
A20R25	0698-3266	5		RESISTOR 237K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-2373-F
A20R26	0698-7286	7		RESISTOR 121K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1213-F
A20R27	0698-7261	8	2	RESISTOR 11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1102-F
A20R28	0698-7253	8	5	RESISTOR 5.11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-5111-F
A20R29	0698-7216	3		RESISTOR 147 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-147R-F
A20R30	0698-7251	6		RESISTOR 4.22K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-4221-F
A20R31	0698-7259	4		RESISTOR 9.09K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-9091-F
A20R32	0698-7284	5	11	RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A20R33	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R34	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R35	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R36	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R37	0698-7288	9	5	RESISTOR 147K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1473-F
A20R38	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R39	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A20R40	0698-7243	6		RESISTOR 1.96K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1961-F
A20R41	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R42	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R43	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A20R44	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R45	0698-7288	9		RESISTOR 147K 1% .05W F TC = 0 + -100	24546*	C3-1/8-T0-1473-F
A20R46	0698-7275	4		RESISTOR 42.2K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-4222-F

†Refer to Section 7 for update information.

*Factory Selected Component (Refer to Section 5)

Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60185 – SERIAL PREFIX 2305A TO 2530A**					
A20R47	0757-0460	1	3	RESISTOR 61.9K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6192-F
A20R48	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R49	0698-7253	8		RESISTOR 5.11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-5111-F
A20R50	0757-0290	5	2	RESISTOR 6.19K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-6191-F
A20R51	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R52	0698-7258	3		RESISTOR 8.25K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-8251-F
A20R53	0698-7253	8		RESISTOR 5.11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-5111-F
A20R54				NOT ASSIGNED		
A20R55				NOT ASSIGNED		
A20R56	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R57	0757-0462	3	1	RESISTOR 75K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7502-F
A20R58	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A20R59	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R60	0698-7259	4		RESISTOR 9.09K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-9091-F
A20R61	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R62	0698-8744	4	1	RESISTOR 2K .05% .1W F TC = 0 + -15	28480	0698-8744
A20R63	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A20R64	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A20R65	0699-0381	1	2	RESISTOR 40K .1% .1W F TC = 0 + -15	28480	0699-0381
A20R66	0699-0381	1		RESISTOR 40K .1% .1W F TC = 0 + -15	28480	0699-0381
A20R67	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A20R68	0699-0118	2	3	RESISTOR 20K .1% .1W F TC = 0 + -5	28480	0699-0118
A20R69	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A20R70	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R71	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R72	0698-7257	2	2	RESISTOR 7.5K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-7501-F
A20R73	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R74	0757-0158	4	1	RESISTOR 619 1% .5W F TC = 0 + -100	28480	0757-0158
A20R75	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R76	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R77	0698-7218	5	1	RESISTOR 178 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-178R-F
A20R78	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R79	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R80	0698-7286	7	1	RESISTOR 121K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1213-F
A20R81	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A20R82	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A20R83	0698-7288	9		RESISTOR 147K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1473-F
A20R84	0698-7262	9	7	RESISTOR 12.1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1212-F
A20R85	0699-0069	2		RESISTOR 2.15M 1% .125W F TC = 0 + -100	28480	0699-0069
A20TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20U1	1826-0989	7	4	IC OP AMP GP 8-DIP-C PKG	27014	LM307J
A20U2	1820-1547	3	1	IC MULTIPLXR 8-CHAN-ANLG 16-DIP-C PKG	04713	MC14051BCL
A20U3	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A20U4	1826-0328	8	1	IC OP AMP GP DUAL 8-DIP-C PKG	07933	RV4558DE
A20U5	1826-0557	5	1	IC OP AMP GP QUAD 14-DIP-C PKG	27014	LM348J

†Refer to Section 7 for update information. *Factory Selected Component ‡Refer to Section 5 Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60185 – SERIAL PREFIX 2305A TO 2530A**					
A20U6	1820-1200	5		IC INV TTL LS HEX	01295	SN74LS05N
A20U7	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U8	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A20U9	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A20U10	1826-0188	8	2	IC CONV 8-B-D/A 16-DIP-C PKG	04713	MC1408L-8
A20U11	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A20U12	1826-0188	8		IC CONV 8-B-D/A 16-DIP-C PKG	04713	MC1408L-8
A20U13	08901-80075	9	2	OPTO-ISOLATOR LED-PCNDCT IF = 40MA-MAX	28480	08901-80075
A20U14	08901-80075	9		OPTO-ISOLATOR LED-PCNDCT IF = 40MA-MAX	28480	08901-80075
A20U15	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A20U16	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U17	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U18	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U19	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U20	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U21	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U22	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U23	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A20VR1	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD = .4W	28480	1902-0041
A20VR2	1902-0064	1	4	DIODE-ZNR 7.5V 5% DO-35 PD = .4W TC = +.05%	28480	1902-0064
A20VR3	1902-0064	1		DIODE-ZNR 7.5V 5% DO-35 PD = .4W TC = +.05%	28480	1902-0064
A20VR4	1902-0064	1		DIODE-ZNR 7.5V 5% DO-35 PD = .4W TC = +.05%	28480	1902-0064
A20VR5	1902-0064	1		DIODE-ZNR 7.5V 5% DO-35 PD = .4W TC = +.05%	28480	1902-0064

†Refer to Section 7 for update information *Factory selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60262 – SERIAL PREFIX 2535A AND ABOVE**					
A20	08901-60262	4	1	LO CONTROL ASSEMBLY	28480	08901-60262
A20C1	0160-4835	7	3	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A20C2	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A20C3	0180-1746	5	2	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A20C4	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A20C5	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A20C6	0180-0269	5	1	CAPACITOR-FXD 1UF+50-10% 150VDC AL	56289	30D105G150BA2
A20C7	0160-4801	7	2	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A20C8	0160-4832	4	8	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20C9	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A20C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20C12	0160-4807	3	1	CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A20C13	0180-0197	8	1	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A20C14	0160-4814	2	1	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A20C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20C17	0160-0161	4	1	CAPACITOR-FXD .01UF +-10% 200VDC POLYE	28480	0160-0161
A20C18	0160-3324	7	1	CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A20C19	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20C20	0180-1997	8	1	CAPACITOR-FXD 20UF+50-10% 150VDC AL	28480	0180-1997
A20C21	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20C22	0160-4822	2	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A20C23	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A20C24	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A20CR1	1901-1085	6	2	DIODE-SM SIG SCHOTTKY	28480	1901-1085
A20CR2	1901-1085	6		DIODE-SM SIG SCHOTTKY	28480	1901-1085
A20CR3				NOT ASSIGNED		
A20CR4				NOT ASSIGNED		
A20CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR9	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR10	1901-0518	8	6	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR11	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR12	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR13	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR14	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR15	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR16	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR17	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR18	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR19	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR20	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60262 – SERIAL PREFIX 2535A AND ABOVE**					
2305A TO 2745A						
A20CR21				NOT ASSIGNED		
2748A AND ABOVE						
A20CR21	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR22	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20CR23				NOT ASSIGNED		
A20CR24	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A20CR25	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A20DS1				NOT ASSIGNED		
A20DS2				NOT ASSIGNED		
A20DS3	1990-0717	6	2	LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	HLMP-1501
A20DS4	1990-0717	6		LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	HLMP-1501
A20L1	9100-3922	4	3	INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A20L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A20L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A20MP1	08901-00104	7	1	CVR LO CONT BD	28480	08901-00104
	2360-0113	2	2	SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A20Q1	1854-0477	7	5	TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A20Q2	1853-0034	0	3	TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A20Q3	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A20Q4	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A20Q5	1854-0378	7	1	TRANSISTOR NPN 2N5109 SI TO-39 PD = 800MW	3L585	2N5109
A20Q6	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A20Q7	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A20Q8	1853-0594	7	3	TRANSISTOR-DUAL PNP 2N3808 TO-78	28480	1853-0594
A20Q9	1855-0292	6	2	TRANSISTOR J-FET 2N5432 N-CHAN D-MODE	17856	2N5432
A20Q10	1855-0292	6		TRANSISTOR J-FET 2N5432 N-CHAN D-MODE	17856	2N5432
A20Q11	1855-0423	5	1	TRANSISTOR MOSFET N-CHAN E-MODE	17856	VN10KM
A20Q12	1854-0813	5	3	TRANSISTOR NPN 2N3501S SI TO-39 PD = 1W	28480	1854-0813
A20Q13	1853-0462	8	2	TRANSISTOR PNP 2N3635 SI TO-39 PD = 1W	28480	1853-0462
A20Q14				NOT ASSIGNED		
A20Q15				NOT ASSIGNED		
A20Q16	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A20Q17				NOT ASSIGNED		
A20Q18				NOT ASSIGEND		
A20Q19	1853-0594	7		TRANSISTOR-DUAL PNP 2N3808 TO-78	28480	1853-0594
A20Q20	1854-0474	4	3	TRANSISTOR NPN SI PD = 310MW FT = 100MHZ	04713	2N5551
A20Q21	1854-0474	4		TRANSISTOR NPN SI PD = 310MW FT = 100MHZ	04713	2N5551
A20Q22	1854-0813	5	3	TRANSISTOR NPN 2N3501S SI TO-39 PD = 1W	28480	1854-0813
A20Q23	1853-0462	8	2	TRANSISTOR PNP 2N3635 SI TO-39 PD = 1W	28480	1853-0462
A20Q24	1853-0594	7		TRANSISTOR-DUAL PNP 2N3808 TO-78	28480	1853-0594
A20Q25				NOT ASSIGNED		
A20Q26	1854-0813	5	3	TRANSISTOR NPN 2N3501S SI TO-39 PD = 1W	28480	1854-0813
A20Q27	1854-0474	4		TRANSISTOR NPN SI PD = 310MW FT = 100MHZ	04713	2N5551
A20Q28	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60262 – SERIAL PREFIX 2535A AND ABOVE**					
A20R1	2100-3161	6	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 17-TRN	02111	43P203
A20R2	0757-0463	4	1	RESISTOR 82.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8252-F
A20R3	0698-7284	5	2	RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A20R4	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A20R5	0698-7260	7	4	RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R6	0699-0381	1	1	RESISTOR 40K .1% .1W F TC = 0 + -15	28480	0699-0381
A20R7	0699-0122	8	2	RESISTOR 4.8K .1% .125W F TC = 0 + -25	28480	0699-0122
A20R8	0699-0122	8		RESISTOR 4.8K .1% .125W F TC = 0 + -25	28480	0699-0122
A20R9	0698-6360	6	1	RESISTOR 10K .1% .125W F TC = 0 + -25	28480	0698-6360
A20R10	0698-8049	2	1	RESISTOR 64K .1% .125W F TC = 0 + -25	19701	MF4C1/8-T9-6402-B
A20R11	0757-0289	2	3	RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A20R12	0698-3152	8	2	RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A20R13	0698-3154	0	4	RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A20R14	0698-8212	1	1	RESISTOR 6K .25% .125W F TC = 0 + -25	19701	MF4C1/4-T9-6001-C
A20R15	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R16	1810-0204	6	1	NETWORK-RES 8-SIP1.0K OHM X 7	01121	208A102
A20R17	0698-7244	7	4	RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A20R18	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A20R19	0698-7279	8	1	RESISTOR 61.9K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-6192-F
A20R20	0698-3449	6	1	RESISTOR 28.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2872-F
A20R21	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A20R22	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-6191-F
A20R23	0698-0085	0	2	RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A20R24	0698-3260	9	1	RESISTOR 464K 1% .125W F TC = 0 + -100	28480	0698-3260
A20R25	0698-3266	5	1	RESISTOR 237K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2373-F
A20R26	0698-7286	7	2	RESISTOR 121K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1213-F
A20R27				NOT ASSIGNED		
A20R28				NOT ASSIGNED		
A20R29	0698-3438	3	1	RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A20R30	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A20R31	0698-7259	4	2	RESISTOR 9.09K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-9091-F
2305A TO 2745A						
A20R32	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
2748A AND ABOVE						
A20R32	0698-7259	4		RESISTOR 9.09K 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-9091-F
A20R33	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A20R34	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
2305A TO 2745A						
A20R35	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
2748A AND ABOVE						
A20R35	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-3487-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60262 – SERIAL PREFIX 2535A AND ABOVE**					
A20R36	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A20R37	1810-0206	8	1	NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A20R38				NOT ASSIGNED		
A20R39				NOT ASSIGNED		
A20R40	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A20R41				NOT ASSIGNED		
A20R42	0757-0123	3	4	RESISTOR 34.8K 1% .125W F TC = 0 + -100	28480	0757-0123
A20R43	0698-7248	1	2	RESISTOR 3.16K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-3161-F
A20R44	0698-7260	7		RESISTOR 10K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1002-F
A20R45	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A20R46	0698-7276	5	1	RESISTOR 46.4K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-4642-F
A20R47	0698-3159	5		RESISTOR 26.1 1% .125W F TC = 0 + -100	28480	0698-3159
A20R48	0757-0123	3		RESISTOR 34.8K 1% .125W F TC = 0 + -100	28480	0757-0123
A20R49				NOT ASSIGNED		
A20R50				NOT ASSIGNED		
A20R51	0698-7261	8	1	RESISTOR 11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1102-F
A20R52	0698-7258	3	1	RESISTOR 8.25K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-8251-F
A20R53				NOT ASSIGNED		
A20R54				NOT ASSIGNED		
A20R55				NOT ASSIGNED		
A20R56	0698-7236	7	7	RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
2305A TO 2540A						
A20R57	0757-0123	3		RESISTOR 34.8K 1% .125W F TC = 0 + -100	28480	0757-0123
2546A AND ABOVE						
A20R57	0757-0458	7	R	ESISTOR 51.1K 1% .125W F TC = 0 + -100	28480	C4-1/8-TO-5112-F
A20R58	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A20R59	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R60	0698-7259	4		RESISTOR 9.09K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-9091-F
A20R61	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R60-R69				NOT ASSIGNED		
A20R70	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R71	0698-3439	4	1	RESISTOR 178 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-178R-F
A20R72	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R73	0698-0082	7	1	RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A20R74	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A20R75	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R76	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A20R77	0698-7286	7		RESISTOR 121K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1213-F
A20R78	0699-0069	2	1	RESISTOR 2.15M 1% .125W F TC = 0 + -100	28480	0699-0069
A20R79				NOT ASSIGNED		
A20R80				NOT ASSIGNED		
A20R81				NOT ASSIGNED		
A20R82	0698-7248	1		RESISTOR 3.16K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-3161-F

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A20	**08901-60262 – SERIAL PREFIX 2535A AND ABOVE**					
A20TP1	1251-0600	0	4	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A20U1	1826-0989	7	4	IC OP AMP GP 8-DIP-C PKG	27014	LM307J
A20U2	1826-0605	4	1	IC MULTIPLXR 8-CHAN-ANLG 16-DIP-C PKG	17856	DG508BK
A20U3	1820-1198	0	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A20U4	1826-0990	0	1	IC OP AMP GP DUAL 8-DIP-C PKG	04713	MC1458U
A20U5	1826-0716	8	1	IC OP AMP LOW-NOISE DUAL 8-DIP-C PKG	18324	NE5532AFE
A20U6	1820-1199	1	2	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A20U7	1820-1195	7	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A20U8	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A20U9	1820-1216	3	2	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A20U10	1826-0188	8	2	IC CONV 8-B-D/A 16-DIP-C PKG	04713	MC1408L-8
A20U11	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A20U12	1826-0188	8		IC CONV 8-B-D/A 16-DIP-C PKG	04713	MC1408L-8
A20U13	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A20U14	1826-0606	5	2	IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A20U15	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A20U16	1820-1411	0	7	IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U17	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U18	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U19	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U20	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U21	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U22	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A20U23	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A20VR1	1902-0955	9	1	DIODE-ZNR 7.5V 5% DO-35 PD = .4W TC = + .062%	28480	1902-0955
A20W1	8159-0005	0	1	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A21						
A21	08901-60025	7	1	LOW FREQUENCY VCXO FILTER ASSEMBLY	28480	08901-60025
A21C1	0160-2028	6	3	CAPACITOR-FXD 2700PF +-5% 500VDC MICA	28480	0160-2028
A21C2	0160-2534	9	2	CAPACITOR-FXD 300PF +-1% 300VDC MICA	28480	0160-2534
A21C3	0160-2028	6		CAPACITOR-FXD 2700PF +-5% 500VDC MICA	28480	0160-2028
A21C4	0160-2028	6		CAPACITOR-FXD 2700PF +-5% 500VDC MICA	28480	0160-2028
A21C5	0160-2534	9		CAPACITOR-FXD 300PF +-1% 300VDC MICA	28480	0160-2534
A21J1	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A21J2	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A21L1	9140-0112	2	5	INDUCTOR RF-CH-MLD 4.7UH 10%	28480	9140-0112
A21L2	9140-0112	2		INDUCTOR RF-CH-MLD 4.7UH 10%	28480	9140-0112
A21MP1	08901-00025	1	1	COVER VCOX FILTER	28480	08901-00025
A21MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A21MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A21MP4	08901-00044	4	1	GASKT-VCOX FILTER	28480	08901-00044

†Refer to Section 7 for update information

*Factory Selected Component (Refer to section 5)

Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A22						
A22	08901-60007	5	1	LOW FREQUENCY VCXO ASSEMBLY	28480	08901-60007
A22C1	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A22C2	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C3	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C4	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C5	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C6	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C7	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C9	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C10	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C11	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C12	0160-3456	6	2	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A22C13	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A22C14	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C15	0160-4678	6	1	CAPACITOR-FXD 560PF +-1% 100VDC MICA	28480	0160-4678
A22C16	0160-4679	7	1	CAPACITOR-FXD 270PF +-1% 300VDC MICA	28480	0160-4679
A22C17	0160-4456	8	1	CAPACITOR-FXD 750PF +-1% 300VDC MICA	28480	0160-4456
A22C18	0160-2328	9	1	CAPACITOR-FXD 200PF +-1% 300VDC MICA	28480	0160-2328
A22C19	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C20	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C21	0160-2032	2	1	CAPACITOR-FXD 510PF +-5% 500VDC MICA	28480	0160-2032
A22C22	0160-2030	0	1	CAPACITOR-FXD 1200PF +-5% 500VDC MICA	28480	0160-2030
A22C23	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C24	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C25	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A22C26	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C27	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A22C28	0160-4680	0	1	CAPACITOR-FXD 4000PF +-5% 100VDC MICA	28480	0160-4680
A22CR1	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A22CR2	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A22CR3	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A22CR4	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A22CR5	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A22CR6	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A22CR7	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A22CR8	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
2305A TO 2411A						
A22CR9	0122-0065	7	9	DIODE-VVC 29PF 3%	28480	0122-0065
A22CR10	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
A22CR11	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
A22CR12	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
2412A AND ABOVE						
A22CR9	0122-0162	5		DIODE VVC 29PF 10% BVR=30V		
A22CR10	0122-0162	5		DIODE VVC 29PF 10% BVR=30V		
A22CR11	0122-0162	5		DIODE VVC 29PF 10% BVR=30V		
A22CR12	0122-0162	5		DIODE VVC 29PF 10% BVR=30V		

[Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A22CR13	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A22CR14	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A22CR15	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A22CR16	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A22E1	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A22E2	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A22J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A22L1	9140-0112	2		INDUCTOR RF-CH-MLD 4.7UH 10%	28480	9140-0112
A22L2	9100-1616	9	3	INDUCTOR RF-CH-MLD 1.5UH 10%	28480	9100-1616
A22L3	9140-0325	9	1	INDUCTOR RF-CH-MLD 10UH 2% .312DX.969LG	06560	004414-012G
A22L4	9140-0112	2		INDUCTOR RF-CH-MLD 4.7UH 10%	28480	9140-0112
A22L5	9100-1615	8	1	INDUCTOR RF-CH-MLD 1.2UH 10%	28480	9100-1615
A22L6	9140-0324	8	1	INDUCTOR RF-CH-MLD 6.8UH 2% .312DX.969LG	06560	004414-010G
A22L7	9100-1616	9		INDUCTOR RF-CH-MLD 1.5UH 10%	28480	9100-1616
A22L8	9140-0180	4	1	INDUCTOR RF-CH-MLD 2.7UH 10%	28480	9140-0180
A22L9	9100-1616	9		INDUCTOR RF-CH-MLD 1.5UH 10%	28480	9100-1616
A22L10	9140-0112	2		INDUCTOR RF-CH-MLD 4.7UH 10%	28480	9140-0112
A22MP1	08901-00026	2	1	COVER LF VCXO	28480	08901-00026
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A22MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A22MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A22Q1	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A22Q2	1853-0012	4		TRANSISTOR PNP 2N2904A SI TO-39 PD = 600MW	01295	2N2904A
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A22Q3	1854-0610	0		TRANSISTOR NPN SI TO-46 FT = 800MHZ	28480	1854-0610
A22Q4	1854-0610	0		TRANSISTOR NPN SI TO-46 FT = 800MHZ	28480	1854-0610
A22Q5	1854-0247	9		TRANSISTOR NPN SI TO-39 PD = 1W FT = 800MHZ	28480	1854-0247
A22Q6	1854-0247	9		TRANSISTOR NPN SI TO-39 PD = 1W FT = 800MHZ	28480	1854-0247
A22Q7	1854-0610	0		TRANSISTOR NPN SI TO-46 FT = 800MHZ	28480	1854-0610
A22Q8	1854-0610	0		TRANSISTOR NPN SI TO-46 FT = 800MHZ	28480	1854-0610
A22Q9	1853-0001	1	1	TRANSISTOR PNP SI TO-39 PD = 600MW	28480	1853-0001
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A22R1	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A22R2	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A22R3	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A22R4	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A22R5	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A22R6	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A22R7	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A22R8	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A22R9	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A22R10	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A22R11	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A22R12	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A22R13	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A22R14	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A22R15	0698-8004	9	4	RESISTOR 200K .1% .1W F TC = 0 + -15	07716	MAR-1/10-T10-2003-B
A22R16	0698-8004	9		RESISTOR 200K .1% .1W F TC = 0 + -15	07716	MAR-1/10-T10-2003-B
A22R17	0698-3445	2		RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A22R18	0757-0398	4		RESISTOR 75 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-75R0-F
A22R19	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A22R20	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A22R21	0698-8004	9		RESISTOR 200K .1% .1W F TC = 0 + -15	07716	MAR-1/10-T10-2003-B
A22R22	0698-8004	9		RESISTOR 200K .1% .1W F TC = 0 + -15	07716	MAR-1/10-T10-2003-B
A22R23	0757-0400	9		RESISTOR 90.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-90R9-F
A22R24	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A22R25	0698-3430	5		RESISTOR 21.5 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-21R5-F
A22R26	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A22R27	0698-3435	0	1	RESISTOR 38.3 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-38R3-F
A22R28	0757-0421	4	5	RESISTOR 825 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-825R-F
A22R29	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A22R30	0698-3156	2		RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1472-F
A22R31	0698-3446	3		RESISTOR 383 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-383R-F
A22R32	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A22R33	0757-0403	2		RESISTOR 121 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-121R-F
A22R34	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A22R35	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A22R36	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A22R37	0757-0399	5		RESISTOR 82.5 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-82R5-F
A22R38	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A22R39	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A22T1	08660-60369	0	2	TRANSFORMER-RF GRN	28480	08660-60369
A22T2	08660-60369	0		TRANSFORMER-RF GRN	28480	08660-60369
A22TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A22TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
2305A TO 2546A						
A22Y1	0410-1181	1	1	CRYSTAL-QUARTZ 9.26 MHZ HC-42/U-HLDR	28480	0410-1181
	1200-0758	2	2	SOCKET-XTAL 2-CONT HC-25/U DIP-SLDR	28480	1200-0758
A22Y2	0410-1182	2	1	CRYSTAL-QUARTZ 11.26 MHZ HC-42/U-HLDR	28480	0410-1182
	1200-0758	2		SOCKET-XTAL 2-CONT HC-25/U DIP-SLDR	28480	1200-0758
2606A AND ABOVE						
A22Y1	0410-1615	6		CRYSTAL-QUARTZ RESONATOR 9.26 MHZ	28480	0410-1615
	1400-0973	7		CLIP CMPNT .139D .154 DIA STL	28480	1400-0973
A22Y2	0410-1616	7		CRYSTAL-QUARTZ RESONATOR 11.26 MHZ	28480	0410-1616
	1400-0973	7		CLIP CMPNT .139D .154 DIA STL	28480	1400-0973

†Refer to Section 7 for update information. *Factory selected component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A23						
A23	08901-60144	1	1	SAMPLER ASSEMBLY	28480	08901-60144
A23C1	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A23C2	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A23C3	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A23C4	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A23C5	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A23C6	0180-2617	1	7	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A23C7	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A23C8	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A23C9	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A23C10	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A23C11	0180-2618	2	1	CAPACITOR-FXD 33UF+-10% 10VDC TA	25088	D33GS1B10K
A23C12	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A23C13	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A23C14	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A23C15	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A23C16	0160-0570	9		CAPACITOR-FXD 220PF +-20% 100VDC CER	20932	5024EM100RD221M
A23C17	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A23C18	0160-3876	4	6	CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A23C19	0160-3876	4		CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A23C20	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A23C21	0160-3876	4		CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A23C22	0160-3876	4		CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A23C23	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A23C24	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A23C25	0160-3873	1		CAPACITOR-FXD 4.7PF +-.5PF 200VDC CER	28480	0160-3873
A23C26	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A23C27	0180-1745	4	1	CAPACITOR-FXD 1.5UF+-10% 20VDC TA	56289	150D155X9020A2
A23C28	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A23C29	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A23C30	0160-5699	3		CAPACITOR-FXD 20PF +-5% 100VDC CER 0+-30	28480	0160-5699
A23C31	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A23C32	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A23C33	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A23C34	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A23C35	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A23C36	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A23C37	0160-4653	7	1	CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A23C38	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A23C39	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A23C40	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A23C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A23C42	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A23C43	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A23C44	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A23C45*Δ	0160-3568	1	1	CAPACITOR-FXD 2.7PF +-.25PF 200VDC CER	28480	0160-3568
A23CR1	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23CR2	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23CR3	1901-0189	9		DIODE-STEP RECOVERY	28480	1901-0189
A23CR4	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A23CR5	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A23CR6	1906-0098	9	4	DIODE-MATCHED 1V	28480	1906-0098
A23CR7	1906-0098	9		DIODE-MATCHED 1V	28480	1906-0098
A23CR8	1906-0098	9		DIODE-MATCHED 1V	28480	1906-0098
A23CR9	1906-0098	9		DIODE-MATCHED 1V	28480	1906-0098
A23CR10	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23CR11	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23CR12	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23CR13	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23CR14	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A23CR15	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A23DS1	1990-0326	3	3	LED-LAMP LUM-INT = 300UCD IF = 50MA-MAX	28480	5082-4444
A23DS2	1990-0326	3		LED-LAMP LUM-INT = 300UCD IF = 50MA-MAX	28480	5082-4444
A23E1	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A23J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A23J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A23L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A23L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A23L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A23L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A23L5	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A23L6	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A23L7-L9				PART OF ETCHED CIRCUIT BOARD		
A23L10	9100-2250	9	2	INDUCTOR RF-CH-MLD 180NH 10% .105DX.26LG	28480	9100-2250
A23L11	9100-2250	9		INDUCTOR RF-CH-MLD 180NH 10% .105DX.26LG	28480	9100-2250
A23L12				PART OF ETCHED CIRCUIT BOARD		
A23L13				PART OF ETCHED CIRCUIT BOARD		
A23L14	9140-0144	0	3	INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A23L15	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A23L16	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A23MP1	08901-00024	0	1	COVER SAMP	28480	08901-00024
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A23MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A23MP3	5001-0176	0		GROUND STRAP	28480	5001-0176

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
2305A TO 2413A						
A23MP4	08662-00040	0		SHIELD COMP SMALL	28480	08662-00040
A23MP5	08662-00038	6		SHIELD CKT SM	28480	08662-00038
2414A AND ABOVE						
A23MP4				NOT ASSIGNED		
A23MP5				NOT ASSIGNED		
A23Q1	1854-0247	9		TRANSISTOR NPN SI TO-39 PD = 1W FT = 800MHZ	28480	1854-0247
A23Q2	1854-0247	9		TRANSISTOR NPN SI TO-39 PD = 1W FT = 800MHZ	28480	1854-0247
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A23Q3	1854-0023	9		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0023
A23Q4	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A23Q5	1854-0210	6		TRANSISTOR NPN 2N2222 SI TO-18 PD = 500MW	04713	2N2222
A23Q6	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
	1205-0037	0	1	HEAT SINK TO-18-CS	28480	1205-0037
A23Q7	1853-0038	4	1	TRANSISTOR PNP SI TO-39 PD = 1W FT = 100MHZ	28480	1853-0038
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A23Q8	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A23Q9	1855-0049	1		TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0049
A23Q10	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A23Q11	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A23Q12	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A23R1	0757-0288	1		RESISTOR 9.09K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-9091-F
A23R2	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A23R3	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A23R4	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A23R5	0757-0405	4		RESISTOR 162 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-162R-F
A23R6	0757-0421	4		RESISTOR 825 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-825R-F
A23R7	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A23R8	0698-3440	7		RESISTOR 196 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-196R-F
A23R9	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A23R10	0757-0405	4		RESISTOR 162 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-162R-F
A23R11	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A23R12	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A23R13	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A23R14	0698-3136	8		RESISTOR 17.8K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1782-F
A23R15	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A23R16	0698-3631	8	1	RESISTOR 330 5% 2W MO TC = 0 + -200	28480	0698-3631
A23R17	0698-3399	5	1	RESISTOR 133 1% .5W F TC = 0 + -100	28480	0698-3399
A23R18	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A23R19	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A23R20	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A23R21	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A23R22	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A23R23	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A23R24	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A23R25	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A23R26	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827

†Refer to Section 7 for update information

*Factory Selected Component (Refer to Section 5)

Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A23R27	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A23R28	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A23R29	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A23R30	0698-3151	7		RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2871-F
A23R31	0698-3151	7		RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2871-F
A23R32	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A23R33	2100-2633	5	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	30983	ET50X102
A23R34	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A23R35	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A23R36	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A23R37	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A23R38	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A23R39	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A23R40	0698-3162	0		RESISTOR 46.4K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4642-F
A23R41	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A23R42	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A23R43	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A23R44	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A23R45	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A23R46	0698-3260	9	3	RESISTOR 464K 1% .125W F TC = 0 + -100	28480	0698-3260
A23R47	0698-3260	9		RESISTOR 464K 1% .125W F TC = 0 + -100	28480	0698-3260
A23R48	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A23R49	0698-3260	9		RESISTOR 464K 1% .125W F TC = 0 + -100	28480	0698-3260
A23R50	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A23R51	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A23R52	0757-0421	4		RESISTOR 825 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-825R-F
A23R53	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A23R54	2100-2521	0	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	30983	ET50X202
A23R55*△	0757-0278	9	49	RESISTOR 1.78K 1% .125W F TC = 0 + -100	28480	0757-0278
A23R56	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A23R57	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A23R58	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A23R59	0757-0379	1	1	RESISTOR 12.1 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-12R1-F
A23R60	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A23R61	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A23R62	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A23R63	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A23T1	08901-80042	0	1	SAMPLER TRANS	28480	08901-80042
A23TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A23U1	1826-0138	8	3	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A23U2	1826-0413	2		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	34371	HA2-2605-5
A23VR1	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD = .4W	28480	1902-0041
A23VR2	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD = .4W	28480	1902-0041
A23VR3	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD = .4W	28480	1902-0041
A23VR4	1902-0554	4	2	DIODE-ZNR 10V 5% PD = 1W IR = 10UA	28480	1902-0554
A23VR5	1902-0554	4		DIODE-ZNR 10V 5% PD = 1W IR = 10UA	28480	1902-0554
A23W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to section 7 for update information *Factory Selected Component (Refer to Section 5) △ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A24						
A24	08901-60021	3	1	HIGH FREQUENCY VCO ASSEMBLY	28480	08901-60021
A24C1	0160-0571	0		CAPACITOR-FXD 470PF +-20% 100VDC CER	28480	0160-0571
A24C2	0160-3877	5		CAPACITOR-FXD 100PF +-20% 200VDC CER	28480	0160-3877
A24C3	0160-0575	4	12	CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A24C4	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C5	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C6	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A24C7	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A24C8	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A24C9	0160-0573	2	2	CAPACITOR-FXD 4700PF +-20% 100VDC CER	28480	0160-0573
A24C10	0160-3531	8		CAPACITOR-FXD 2UF +-5% 50VDC MET-POLYC	28480	0160-3531
A24C11	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A24C12Δ	0160-5951	0	1	CAPACITOR-FXD 390PF +-5% 50VDC CER 0+-30	28480	0160-5951
A24C13	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
	4330-0145	9	2	INSULATOR-BEAD GLASS	28480	4330-0145
A24C14	0160-5034	0	1	CAPACITOR-FXD 120PF +-2% 50VDC CER 0+-30	95275	VJ0805A121GH
A24C15	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C16				NOT ASSIGNED		
A24C17	0160-4304	5	1	CAPACITOR-FXD 10PF +-10% 100VDC CER	51959	0805C100K3T
A24C18	0160-4103	2	1	CAPACITOR-FXD 220PF +-5% 100VDC CER	72982	8121-M100-COG-221J
A24C19	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C20	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C21	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C22	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C23	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C24	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C25	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C26	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C27	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C28	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C29	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A24C30				NOT ASSIGNED		
A24C31	0160-3876	4		CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A24C32	0160-3875	3		CAPACITOR-FXD 22PF +-5% 200VDC CER 0+-30	28480	0160-3875
A24C33	0160-3876	4		CAPACITOR-FXD 47PF +-20% 200VDC CER	28480	0160-3876
A24C34	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A24C35	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A24C36	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A24CR1	1901-0880	7		DIODE-GEN PRP 125MA D0-35	28480	1901-0880
A24CR2	1901-0880	7		DIODE-GEN PRP 125MA D0-35	28480	1901-0880

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
2305A TO 2411A						
A24CR3	0122-0326	3	2	DIODE-VVC 43PF 5% C3/C25-MIN = 5 BVR = 30V	28480	0122-0326
A24CR4	0122-0326	3		DIODE-VVC 43PF 5% C3/C25-MIN = 5 BVR = 30V	28480	0122-0326
2412A AND ABOVE						
*A24CR3*Δ	0122-0173	8		DIODE VVC 29PF 7% BVR = 30V	28480	0122-0173
*A24CR4*Δ	0122-0173	8		DIODE VVC 29PF 7% BVR = 30V	28480	0122-0173
A24CR5	1901-0880	7		DIODE-GEN PRP 125MA D0-3528480 1901-0880		
A24CR6	1901-0880	7		DIODE-GEN PRP 125MA D0-35	28480	1901-0880
2305A TO 2411A						
A24E1-E4				NOT ASSIGNED		
2412A AND ABOVE						
A24E1	4330-0145	9		INSULATOR-BEAD GLASS	28480	4330-0145
A24E2	4330-0145	9		INSULATOR-BEAD GLASS	28480	4330-0145
A24E3	4330-0145	9		INSULATOR-BEAD GLASS	28480	4330-0145
A24E4	4330-0145	9		INSULATOR-BEAD GLASS	28480	4330-0145
A24J1	1250-1205	1		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1205
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A24J2	1250-1205	1		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1205
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A24L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A24L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A24L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A24L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A24L5	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A24L6	9100-2251	0	2	INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG	28480	9100-2251
A24L7	08901-00068	2	1	INDUCTOR	28480	08901-00068
A24L8	9100-2251	0		INDUCTOR RF-CH-MLD 220NH 10% .105DX.26LG	28480	9100-2251
A24L9				PART OF ETCHED CIRCUIT BOARD		
A24L10				PART OF ETCHED CIRCUIT BOARD		
A24MP1	08901-00023	9	1	COVER HF VCO	28480	08901-00023
A24MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A24MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A24MP4	08662-00040	0		SHLD COMP SMALL	28480	08662-00040
A24MP5	08662-00038	6		SHIELD CKT SM	28480	08662-00038
A24MP6	08901-00043	3	1	GASKT-HF VCO	28480	08901-00043
A24Q1	1854-0247	9		TRANSISTOR NPN SI TO-39 PD = 1W FT = 800MHZ	28480	1854-0247
	0340-0834	0	1	INSULATOR-XSTR POLYI	28480	0340-0834
A24Q2	1855-0020	8		TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	28480	1855-0020
A24Q3	1855-0020	8		TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	28480	1855-0020
A24Q4	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A24Q5	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A24Q6	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A24Q7	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404

†Refer to section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A24Q8	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A24R1	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A24R2	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A24R3	0698-3449	6	2	RESISTOR 28.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2872-F
A24R4	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A24R5	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A24R6	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A24R7	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A24R8	0757-0402	1		RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A24R9	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A24R10	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A24R11	0698-3151	7		RESISTOR 2.87K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2871-F
A24R12	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A24R13	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A24R14	0757-0405	4		RESISTOR 162 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-162R-F
A24R15	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A24R16				NOT ASSIGNED		
A24R17	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A24R18	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A24R19	0698-3405	4	1	RESISTOR 422 1% .5W F TC = 0 + -100	28480	0698-3405
A24R20	0698-7195	7		RESISTOR 19.6 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-19R6-F
A24R21	0757-0402	1		RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A24R22	0757-0402	1		RESISTOR 110 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-111-F
A24R23	0698-7219	6		RESISTOR 196 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-196R-F
A24R24	0698-7206	1	1	RESISTOR 56.2 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-56R2-F
A24R25	0698-7222	1	1	RESISTOR 261 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-261R-F
A24R26	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A24R27	0698-7199	1	1	RESISTOR 28.7 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-28R7-F
A24TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A24TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A24TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A24U1	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A24U2	1826-0372	2		IC MISC 8-DIP-P PKG	28480	1826-0372
A24U3	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A25						
2503A TO 2530A						
A25	08901-60137	2	1	AUDIO MOTHER BOARD ASSEMBLY	28480	08901-60137
2535A TO 2621A						
A25	08902-60103	3	1	AUDIO MOTHER BOARD ASSEMBLY	28480	08902-60103
2631A AND ABOVE						
A25	08902-60116	8	1	AUDIO MOTHERBOARD ASSEMBLY	28480	08902-60103
A25C1	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A25C2	0160-3466	8	1	CAPACITOR-FXD 100PF +-10% 1KVDC CER	28480	0160-3466
A25J1	1250-0836	2	1	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0836
A25J2	1251-8417	2	4	CONN-POST TYPE .100-PIN-SPCG 16-CONT	28480	1251-8417
A25J3	1251-8417	2		CONN-POST TYPE .100-PIN-SPCG 16-CONT	28480	1251-8417
A25J4	1251-5169	6		CONNECTOR 6-PIN M POST TYPE	28480	1251-5169
A25J5	1251-5643	1	1	CONNECTOR 4-PIN M POST TYPE	28480	1251-5643
A25R1	0698-3443	0		RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A25R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A25XA1				NOT ASSIGNED		
A25XA2	1251-2035	9	8	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A25XA3	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A25XA4	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A25XA5	1251-1365	6	6	CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A25XA6	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A25XA7	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A25XA8	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A25XA9-XA49				NOT ASSIGNED		
A25XA50	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A25XA51	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A25XA52	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A25XA53	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A26						
A26	08901-60142	9	1	POWER SUPPLY MOTHER BOARD ASSEMBLY	28480	08901-60142
A26C1	0160-0889	3	1	CAPACITOR-FXD .33UF +-10% 80VDC POLYE	28480	0160-0889
A26C2	0160-0168	1	1	CAPACITOR-FXD .1UF +-10% 200VDC POLYE	28480	0160-0168
A26C3	0180-3017	7	1	CAPACITOR-FXD .045F+75-10% 25VDC AL	28480	0180-3017
	2190-0034	5	10	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
	2680-0099	1	8	SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A26C4	0180-0480	2	1	CAPACITOR-FXD 4500UF+75-10% 25VDC AL	00853	500452U025AA2A
	2190-0034	5		WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
	2680-0099	1		SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A26C5	0160-4065	5	2	CAPACITOR-FXD .1UF +-20% 250VAC(RMS)	28480	0160-4065
A26C6	0180-3110	1	1	CAPACITOR-FXD .013F+75-10% 40VDC AL	28480	0180-3110
	2190-0034	5		WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
	2680-0099	1		SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A26C7	0180-0677	9	1	CAPACITOR-FXD 5800UF+75-10% 40VDC AL	28480	0180-0677
	2190-0034	5		WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
	2680-0099	1		SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A26C8	0180-1797	6	1	CAPACITOR-FXD 50UF+50-10% 150VDC AL	56289	39D506F150FJ4
A26C9	0180-2207	5	1	CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A26C10	0160-3968	5		CAPACITOR-FXD .47UF +-10% 250VAC (RMS)	28480	0160-3968
A26CR1	1901-0662	3	6	DIODE-PWR RECT 100V 6A	04713	MR751
A26CR2	1901-0662	3		DIODE-PWR RECT 100V 6A	04713	MR751
A26CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A26CR4	1901-0662	3		DIODE-PWR RECT 100V 6A	04713	MR751
A26CR5	1901-0662	3		DIODE-PWR RECT 100V 6A	04713	MR751
A26CR6	1901-0662	3		DIODE-PWR RECT 100V 6A	04713	MR751
A26CR7	1901-0662	3		DIODE-PWR RECT 100V 6A	04713	MR751
A26CR8	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A26F1	2110-0331	7	1	FUSE .3A 250V .25X.27	28480	2110-0331
	1251-8305	8	4	CABLE CLAMP-RECT CONN	28480	1251-8305
	1251-8308	1		CONNECTOR-SGL CONN SKT .054-IN-BSC-SZ	28480	1251-8308
A26J1	1251-3412	8	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-3412
A26J2	1252-1762	9		CONNECTOR 6-PIN HDR POST TYPE	28480	1252-1762
A26J3	1252-1762	9		CONNECTOR 6-PIN HDR POST TYPE	28480	1252-1762
A26J4				NOT ASSIGNED		
A26J5	1251-5636	2	1	CONNECTOR 11-PIN M POST TYPE	28480	1251-5636
A26J6	1251-8041	9	1	CONN-POST TYPE .156-PIN-SPCG 8-CONT	28480	1251-8041
A26K1	0490-0618	5	1	RELAY 2C 24VDC-COIL 5A 115VAC	28480	0490-0618
A26MP1	08901-20049	1	1	SHIELD/HI VOLTAGE	28480	08901-20049
	0361-0207	5	1	RIVET-BLIND DR-PIN RNDH .125DIA	00000	ORDER BY DESCRIPTION
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0119	8	1	SCREW-MACH 6-32 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0003	3	2	WASHER-FL NM NO. 6 .141-IN-ID .375-IN-OD	28480	3050-0003
	3050-0227	3	2	WASHER-FL MTLC NO. 6 .149-IN-ID	28480	3050-0227
	7120-4163	7	1	LABEL-WARNING .5-IN-WD 1-IN-LG AL	28480	7120-4163

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A26Q1	1884-0276	7	1	THYRISTOR-TRIAC TO-220AB	28480	1884-0276
	2190-0004	9		WASHER-LK INT LT NO.4 .115-IN-ID	00000	ORDER BY DESCRIPTION
	2200-0141	8		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A26R1	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A26R2	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A26R3	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A26R4	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A26R5	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A26R6	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A26VR1	1902-3381	1	2	DIODE-ZNR 68.1V 5% DO-7 PD = .4W TC = + .079%	28480	1902-3381
A26VR2	1902-3381	1		DIODE-ZNR 68.1V 5% DO-7 PD = .4W TC = + .079%	28480	1902-3381
A26XA1-XA9				NOT ASSIGNED		
A26XA10	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A27	**08901-60140 – SERIAL PREFIX 2305A TO 2530A**					
A27	08901-60140	7	1	DIGITAL MOTHER BOARD ASSEMBLY	28480	08901-60140
A27C1	0160-4801	7	28	CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C2	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C3	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C4	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C5	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C6	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C7	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C8	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C9	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C10	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C11	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C12	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C13	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C14	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C15	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C16	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C17	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
2314A TO 2628A *A27C18*	0160-4389	6		CAPACITOR-FXD 100PR +-5PF 200VDC CER	28480	0160-4389
2635A AND ABOVE *A27C18*				NOT ASSIGNED		
A27C19	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C20	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C21				NOT ASSIGNED		
A27C22				NOT ASSIGNED		
A27C23				NOT ASSIGNED		
A27C24				NOT ASSIGNED		
A27J1	1251-7998	3	2	CONN POST HDR 16	28480	1251-7998
A27J2	1251-7998	3		CONN POST HDR 16	28480	1251-7998
A27J3	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
	1251-4460	8		CLIP-CABLE PLUG RTNG-DUAL INLINE 16 CONT	28480	1251-4460
A27J4	1252-1762	9		CONNECTOR 6-PIN HDR POST TYPE	28480	1252-1792
A27XA1-XA10				NOT ASSIGNED		
A27XA11A	1251-1365	6	5	CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A27XA12A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A27XA12B	1251-2035	9	3	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A27XA13A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A27XA13B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A27XA14A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A27XA14B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A27	**08902-60102 – SERIAL PREFIX 2535A AND ABOVE**					
A27	08902-60102	2	1	DIGITAL MOTHER BOARD ASSEMBLY	28480	08902-60102
A27C1	0160-4801	7	28	CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C2	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C3	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C4	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C5	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C6	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C7	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C8	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
2305A TO 2625A *A27C9*	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
2627A AND ABOVE *A27C9*				NOT ASSIGNED		
A27C10	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C11	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C12	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C13	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C14	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C15	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C16	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C17	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C18	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C19	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27C20	0160-4801	7		CAPACITOR-FXD 100PF +-5PF 100VDC CER	28480	0160-4801
A27J1	1251-8417	3	2	CONN POST HDR 16	28480	1251-8417
A27J2	1251-8417	3		CONN POST HDR 16	28480	1251-8417
A27J3	1200-0507	9		SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
	1251-4460	8		CLIP-CABLE PLUG RTNG-DUAL INLINE 16 CONT	28480	1251-4460
A27J4	1252-1762	9		CONNECTOR 6-PIN HDR POST TYPE	28480	1252-1762
A27XA1-XA10				NOT ASSIGNED		
A27XA11A	1251-1365	6	5	CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A27XA12A	1251-2035	9	3	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A27XA12B	1251-2035	9	3	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A27XA13A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A27XA13B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A27XA14A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A27XA14B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A28						
A28	08902-60007	6	1	RF MOTHERBOARD ASSEMBLY	28480	08902-60007
A28C1	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A28C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A28C3	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A28C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A28C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A28C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A28C7	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A28J1	1251-4966	9	1	CONNECTOR 8-PIN M POST TYPE	28480	1251-4966
A28J2	1251-8417	2		CONN-POST TYPE .100-PIN-SPCG 16-CONT	28480	1251-8417
A28J3	1251-8417	2		CONN-POST TYPE .100-PIN-SPCG 16-CONT	28480	1251-8417
A28L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A28L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A28L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A28L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A28L5	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A28L6	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A28L7	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A28XA1-XA14				NOT ASSIGNED		
A28XA15	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A28XA16	1251-0472	4	7	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A28XA17	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A28XA18	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A28XA19	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A28XA20	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A28XA21	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A28XA22	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A28XA23	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A28XA24	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A29						
A29	08901-60181	6	1	SERIES REGULATOR HEAT SINK ASSEMBLY	28480	08901-60181
A29MP1	1400-0017	0	1	CLAMP-CABLE .312-DIA .375-WD NYL	28480	1400-0017
	2190-0006	1	1	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0127	8	1	SCREW-MACH 6-32 .875-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2420-0002	6	1	NUT-HEX-DBL-CHAM 6-32-THD .109-IN-THK	28480	2420-0002
	3050-0227	3		WASHER-FL MTLC NO. 6 .149-IN-ID	28480	3050-0227
A29MP2	08901-20218	6	1	HEATSINK	28480	08901-20218
	2200-0107	6	4	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A29Q1	1853-0344	5	1	TRANSISTOR PNP 2N5876 SI TO-3 PD = 150W	04713	2N5876
	0340-1119	6	4	INSULATOR-COVER NYLON	28480	0340-1119
	2360-0125	6	4	SCREW-MACH 6-32 .750-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	5001-5501	5	4	TRANS SPACER TO3	28480	5001-5501
A29Q2	1853-0411	7	1	TRANSISTOR PNP 2N6050 SI DARL TO-3	28480	1853-0411
	0340-1119	6		INSULATOR-COVER NYLON	28480	0340-1119
	2360-0125	6		SCREW-MACH 6-32 .750-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	5001-5501	5		TRANS SPACER TO3	28480	5001-5501
A29Q3	1854-0669	9	1	TRANSISTOR NPN 2N6057 SI TO-3 PD = 150W	04713	2N6057
	0340-1119	6		INSULATOR-COVER NYLON	28480	0340-1119
	2360-0125	6		SCREW-MACH 6-32 .750-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	5001-5501	5		TRANS SPACER TO3	28480	5001-5501
A29Q4	1854-0743	0	1	TRANSISTOR NPN 2N5878 SI TO-3 PD = 150W	01295	2N5878
	0340-1119	6		INSULATOR-COVER NYLON	28480	0340-1119
	2360-0125	6		SCREW-MACH 6-32 .750-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	5001-5501	5		TRANS SPACER TO3	28480	5001-5501
A29W1	08901-60233	9	1	HEATSINK CABLE 01B	28480	08901-60233

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A30						
A30	0960-0443	1	1	LINE MODULE-FILTERED	28480	0960-0443
A30C1	0160-4065	5		CAPACITOR-FXD .1UF +-20% 250VAC(RMS)	28480	0160-4065
A30TB1	5020-8122	2		LINE VOLTAGE SELECTOR CARD	28480	5020-8122

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A31						
A31	08901-60242	0	1	REMOTE INTERFACE CONNECTOR ASSEMBLY	28480	08901-60242
A31J1	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A31J2	1251-5240	4	1	CONNECTOR 20-PIN M POST TYPE	28480	1251-5240
A31MP1	0380-0644	4	2	STANDOFF-HEX .327-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	2190-0034	5		WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
A31MP2	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
	2190-0019	6	2	WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0019
	2200-0109	8	2	SCREW-MACH 4-40 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2260-0002	6	2	NUT-HEX-DBL-CHAM 4-40-THD .062-IN-THK	28480	2260-0002

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A32						
A32	08901-60227	1	1	POWER REFERENCE OSCILLATOR ASSEMBLY	28480	08901-60227
	08901-00194	5	1	P.C. SHIELD	28480	08901-00194
A32C1	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A32C2	0160-3036	8	2	CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
	2190-0009	4	2	WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
	2580-0002	4	2	NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A32C3	0160-3036	8		CAPACITOR-FDTHRU 5000PF +80 -20% 200V	28480	0160-3036
	2190-0009	4		WASHER-LK INTL T NO. 8 .168-IN-ID	28480	2190-0009
	2580-0002	4		NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
A32C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A32C5	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A32C6	0160-2027	5	1	CAPACITOR-FXD 300PF +-5% 500VDC MICA	28480	0160-2027
A32C7	0160-3070	0	1	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-3070
A32C8	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A32C9	0160-2255	1	1	CAPACITOR-FXD 8.2PF +-.25PF 500VDC CER	28480	0160-2255
	4330-0145	9		INSULATOR-BEAD GLASS	28480	4330-0145
A32C10	0160-3878	6		CAPACITOR-FXD 1000PF +-20% 100VDC CER	28480	0160-3878
A32C11	0160-0179	4	1	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-0179
A32C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A32C13	0160-4006	4	1	CAPACITOR-FXD 36PF +-5% 300VDC GL	28480	0160-4006
A32C14	0160-4007	5	1	CAPACITOR-FXD 200PF +-5% 300VDC GL	28480	0160-4007
A32CR1	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A32CR2	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A32CR3	0122-0299	9	1	DIODE-VVC 82PF 5% C2/C20-MIN=2 BVR=20V	28480	0122-0299
A32J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A32L1	08901-80043	1	1	COIL VARIABLE	28480	08901-80043
A32L2	9140-0144	0		INDUCTOR RF-CH-MLD 4.7UH 10% .105DX.26LG	28480	9140-0144
A32L3	08901-80044	2	1	COIL 3 1/2 TURNS	28480	08901-80044
A32MP1	08901-20232	4	1	OSC COVER	28480	08901-20232
A32Q1	1854-0247	9		TRANSISTOR NPN SI TO-39 PD=1W FT=800MHZ	28480	1854-0247
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A32Q2	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A32R1	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A32R2*	0757-1094	9	10	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A32R3	0811-3234	9	1	RESISTOR 10K 1% .05W PWW TC=0+-10	20940	140-1/20-1002-F
A32R4	2100-3154	7	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	02111	43P102
A32R5*	0811-3381	7	1	RESISTOR 7.1K 1% .05W PWW TC=0+-10	28480	0811-3381

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A32R6	0757-0440	7		RESISTOR 7.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7501-F
A32R7	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A32R8	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A32R9	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A32R10	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A32R11	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A32R12	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A32R14	0757-0398	4		RESISTOR 75 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-75R0-F
A32R15	0757-0317	7		RESISTOR 1.33K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1331-F
A32R16	0698-6364	0	1	RESISTOR 50 .1% .125W F TC = 0 + -25	28480	0698-6364
A32U1	1826-0013	8		IC OP AMP LOW-NOISE TO-99 PKG	06665	SSS741CJ
A32U2	1826-1227	8	1	IC OP AMP GP 8-DIP-C PKG	27014	LM301AJ
A32VR1	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827
A32VR2*	1902-0956	0	1	DIODE-ZNR 8.2V 5% DO-35 PD = .4W TC = + .065%	28480	1902-0956

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A50						
A50	08901-60220	4	1	AM CALIBRATOR ASSEMBLY	28480	08901-60220
A50C1	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C2	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A50C3	0180-0058	0		CAPACITOR-FXD 50UF+75-10% 25VDC AL	56289	30D506G025CC2
A50C4	0180-2617	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	25088	D6R8GS1B35K
A50C5	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C6	0180-2619	3		CAPACITOR-FXD 22UF+-10% 15VDC TA	25088	D22GS1B15K
A50C7	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C8	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C9	0160-0207	9	1	CAPACITOR-FXD .01UF +-5% 200VDC'POLYE	28480	0160-0207
A50C10	0180-2619	3		CAPACITOR-FXD 22UF+-10% 15VDC TA	25088	D22GS1B15K
A50C11	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C12	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C13	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C14	0180-2619	3		CAPACITOR-FXD 22UF+-10% 15VDC TA	25088	D22GS1B15K
A50C15	0180-2619	3		CAPACITOR-FXD 22UF+-10% 15VDC TA	25088	D22GS1B15K
A50C16	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A50C17	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C18	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C19	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C20	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C21				NOT ASSIGNED		
A50C22	0160-3454	4	1	CAPACITOR-FXD 220PF +-10% 1KVDC CER	28480	0160-3454
A50C23	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C24	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C25	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C26	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C27	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C28	0160-3691	1	1	CAPACITOR-FXD 75PF +-1% 100VDC MICA	28480	0160-3691
A50C29	0180-2619	3		CAPACITOR-FXD 22UF+-10% 15VDC TA	25088	D22GS1B15K
A50C30	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A50C31	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C32	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C33	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C34	0160-2414	4	1	CAPACITOR-FXD .022UF +-5% 200VDC POLYE	28480	0160-2414
A50C35	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C36	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C37	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C38	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C39	0180-2619	3		CAPACITOR-FXD 22UF+-10% 15VDC TA	25088	D22GS1B15K
A50C40	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C41	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C42	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A50C43	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C44	0160-0127	2	1	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A50C45	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084

†Refer to Section 7 for update information

*Factory Selected Component (Refer to Section 5)

Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A50C46	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C47	0160-0153	4		CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A50C48	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C49	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A50C50	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A50C51	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C52	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50C53	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A50C54	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A50CR1	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR2	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR3	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR4	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR5	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR6	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR7	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR8	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A50CR9	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A50CR10	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A50CR11	1901-0535	9		DIODE-SM SIG SCHOTTKY	28480	1901-0535
A50CR12	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A50E1	9170-0847	3	4	CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE
A50E2	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE
A50J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A50J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A50L1	9100-1635	2	9	INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A50L2	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A50L3	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A50L4	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A50L5	9100-1637	4	2	INDUCTOR RF-CH-MLD 120UH 5% .166DX.385LG	28480	9100-1637
A50L6	9100-1637	4		INDUCTOR RF-CH-MLD 120UH 5% .166DX.385LG	28480	9100-1637
A50L7	9100-3913	3	1	INDUCTOR RF-CH-MLD 3.3UH 5% .166DX.385LG	28480	9100-3913
A50L8	9140-0179	1	1	INDUCTOR RF-CH-MLD 22UH 10% .166DX.385LG	28480	9140-0179
A50MP1	08901-00129	6	1	COVER AM CAL	28480	08901-00129
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A50MP2	08901-00114	9	1	LABEL AM CAL	28480	08901-00114
A50Q1	1858-0032	8	1	TRANSISTOR ARRAY 14-PIN PLSTC DIP	28480	1858-0032
A50Q2	1854-0345	8	3	TRANSISTOR NPN 2N5179 SI TO-72 PD = 200MW	04713	2N5179
A50Q3	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD = 200MW	04713	2N5179
A50Q4	1854-0345	8		TRANSISTOR NPN 2N5179 SI TO-72 PD = 200MW	04713	2N5179
A50Q5	1854-0295	7		TRANSISTOR-DUAL NPN PD = 400MW	28480	1854-0295
A50Q6	1854-0019	3	2	TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0019

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A50Q7	1854-0019	3		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0019
A50Q8	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q9	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q10	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q11	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q12	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q13	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q14	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A50Q15	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q16	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A50Q17	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A50Q18	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q19	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A50Q20	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD = 500MW	04713	2N2222A
A50Q21	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50Q22	1853-0020	4		TRANSISTOR PNP SI PD = 300MW FT = 150MHZ	28480	1853-0020
A50Q23	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A50R1	0757-0346	2		RESISTOR 10 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-10R0-F
A50R2	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A50R3	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A50R4	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A50R5	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A50R6	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A50R7	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A50R8	0698-5466	1	1	RESISTOR 5.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5701-F
A50R9	0698-3153	9		RESISTOR 3.83K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3831-F
A50R10	0698-3150	6		RESISTOR 2.37K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2371-F
A50R11	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A50R12	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A50R13	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A50R14	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A50R15	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A50R16	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A50R17	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A50R18	0698-3158	4		RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F
A50R19	0698-3158	4		RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F
A50R20	0698-4439	6	2	RESISTOR 3.24K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3241-F
A50R21	0698-4439	6		RESISTOR 3.24K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3241-F
A50R22	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A50R23	0757-0447	4		RESISTOR 16.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1622-F
A50R24	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A50R25	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A50R26	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A50R27	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A50R28	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A50R29	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A50R30	0698-3431	6		RESISTOR 23.7 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-23R7-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A50R31	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A50R32	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A50R33	0698-3431	6		RESISTOR 23.7 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-23R7-F
A50R34	0698-3438	3		RESISTOR 147 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-147R-F
A50R35	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A50R36	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A50R37	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A50R38	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A50R39	2100-3207	1		RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN	28480	2100-3207
A50R40	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A50R41	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A50R42	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A50R43	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A50R44	0757-0421	4		RESISTOR 825 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-825R-F
A50R45	2100-3349	2	2	RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	28480	2100-3349
A50R46	0698-3442	9	4	RESISTOR 237 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-237R-F
A50R47	0698-3447	4		RESISTOR 422 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-422R-F
A50R48	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A50R49	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A50R50	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A50R51	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A50R52	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A50R53	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A50R54	0757-0419	0		RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
A50R55	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A50R56	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A50R57	0757-0419	0		RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
A50R58	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A50R59	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A50R60	0698-3153	9		RESISTOR 3.83K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3831-F
A50R61	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A50R62	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A50R63	0757-0440	7		RESISTOR 7.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7501-F
A50R64	0757-0440	7		RESISTOR 7.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-7501-F
A50R65	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A50R66	0698-4190	6	1	RESISTOR 50 .25% .125W F TC = 0 + -100	03888	PME55-1/8-T0-50R0-C
A50R67	0698-3488	3	1	RESISTOR 442 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-422R-F
A50R68	0757-0428	1		RESISTOR 1.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1621-F
A50R69	0698-6235	4	1	RESISTOR 96.25 .5% .125W F TC = 0 + -100	24546	C4-1/8-T0-96R25-D
A50R70	0757-0439	4		RESISTOR 6.81K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6811-F
A50R71	0698-7982	0	1	RESISTOR 71.16 .1% .25W F TC = 0 + -50	19701	MF52C1/4-T2-71R16-B
A50R72	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A50R73	0757-0419	0		RESISTOR 681 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-681R-F
A50R74	0698-3445	2		RESISTOR 348 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-348R-F
A50R75	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A50R76	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A50R77	0698-7981	9	1	RESISTOR 96.25 .1% .25W F TC = 0 + -50	19701	MF52C1/4-T2-96R25-B
A50R78	0757-0424	7		RESISTOR 1.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1101-F
A50R79	0698-3442	9		RESISTOR 237 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-237R-F
A50R80	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A50R81	0698-3442	9		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A50R82	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A50R83	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A50R84	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A50R85	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A50R86	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A50R87	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A50R88	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A50R89	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A50R90	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A50R91	0757-0402	1		RESISTOR 110 1% .125W F TC=0+-100	24546	C4-1/8-T0-111-F
A50R92	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A50R93	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A50R94	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A50R95	0757-0421	4		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A50R96	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A50R97	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A50R98	0698-3491	8	1	RESISTOR 1K .1% .125W F TC=0+-50	28480	0698-3491
A50R99	0698-3449	6		RESISTOR 28.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2872-F
A50R100	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A50R101	0698-4158	6	1	RESISTOR 100K .1% .125W F TC=0+-50	28480	0698-4158
A50R102	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A50R103	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A50R104	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A50R105	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A50R106	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A50R107	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A50R108	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A50R109	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A50TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A50TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A50TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A50U1	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A50U2	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A50U3	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A50U4	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A50U5	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A50U6	1826-0180	0		IC TIMER TTL MONO/ASTBL	01295	NE555P
A50U7	1820-1963	7	2	IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	3L585	CD4013BAE
A50U8	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A50U9	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A50U10	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A50VR1	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A50VR2	1902-3059	0		DIODE-ZNR 3.83V 5% DO-35 PD=.4W	28480	1902-3059
A50VR3	1902-3104	6	3	DIODE-ZNR 5.62V 5% DO-35 PD=.4W	28480	1902-3104

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A51						
A51	08901-60013	3	1	FM CALIBRATOR ASSEMBLY	28480	08901-60013
A51C1	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C2	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C3	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C4	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C5	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A51C6	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A51C7	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C8	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C9	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A51C10				NOT ASSIGNED		
A51C11	0160-2207	3	1	CAPACITOR-FXD 300PF +-5% 300VDC MICA	28480	0160-2207
A51C12	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A51C13	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A51C14	0160-4040	6		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4040
A51C15	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A51C16	0140-0205	5	1	CAPACITOR-FXD 62PF +-5% 300VDC MICA	72136	DM15E620J0300WV1CR
A51C17	0160-3535	2	1	CAPACITOR-FXD 560PF +-5% 300VDC MICA	28480	0160-3535
A51C18	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A51C19	0160-0574	3	2	CAPACITOR-FXD .022UF +-20% 100VDC CER	28480	0160-0574
A51C20	0121-0436	4	1	CAPACITOR-V TRMR-AIR 2.6-23.5PF 350V	74970	189-0509-125
A51C21	0160-0574	3		CAPACITOR-FXD .022UF +-20% 100VDC CER	28480	0160-0574
A51C22	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C23	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C24	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51C25	0160-3459	9		CAPACITOR-FXD .02UF +-20% 100VDC CER	28480	0160-3459
A51CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A51CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
2305A TO 2411A						
A51CR3	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
2412A AND ABOVE						
A51CR3	0122-0173	8		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	25403	BB809SELECTED
A51CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
2305A TO 2411A						
A51CR5	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
A51CR6	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
2412A AND ABOVE						
A51CR5	0122-0173	8		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	25403	BB809SELECTED
A51CR6	0122-0173	8		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR-30V	25403	0122-0173

†Refer to Section 7 for update information.

*Factory Selected Component (Refer to Section 5)

Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A51CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A51CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A51E1	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE
A51E2	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B PARYLENE
A51J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A51J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A51L1	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A51L2	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A51L3	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A51L4	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A51L5	9100-1635	2		INDUCTOR RF-CH-MLD 91UH 5% .166DX.385LG	28480	9100-1635
A51L6	9140-0310	2	1	INDUCTOR RF-CH-MLD 390NH 5% .105DX.26LG	28480	9140-0310
A51L7	9140-0309	9	1	INDUCTOR RF-CH-MLD 1.8UH 5% .105DX.26LG	28480	9140-0309
A51MP1	08901-00040	0	1	COVER-FM CAL	28480	08901-00040
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A51Q1	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A51Q2	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A51Q3	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A51Q4	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A51Q5	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A51Q6	1853-0034	0		TRANSISTOR PNP SI TO-18 PD = 360MW	28480	1853-0034
A51Q7	1854-0247	9		TRANSISTOR NPN SI TO-39 PD = 1W FT = 800MHZ	28480	1854-0247
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A51Q8	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A51Q9	1854-0295	7		TRANSISTOR-DUAL NPN PD = 400MW	28480	1854-0295
A51Q10	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A51Q11	1854-0071	7		TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A51Q12	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A51Q13	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360MW	04713	2N3251
A51R1	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A51R2	0757-0443	0		RESISTOR 11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1102-F
A51R3	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A51R4	0698-3153	9		RESISTOR 3.83K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3831-F
A51R5	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A51R6	0698-3447	4		RESISTOR 422 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-422R-F
A51R7	0698-6502	8	3	RESISTOR 3.32K .25% .125W F TC = 0 + -50	28480	0698-6502
A51R8	0698-6502	8		RESISTOR 3.32K .25% .125W F TC = 0 + -50	28480	0698-6502
A51R9	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A51R10	0698-3153	9		RESISTOR 3.83K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3831-F
A51R11	0698-8068	5	2	RESISTOR 4.99K .25% .125W F TC = 0 + -25	19701	MF4C1/8-T9-4991-C

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A51R12	2100-3349	2		RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	28480	2100-3349
A51R13	0698-8068	5		RESISTOR 4.99K .25% .125W F TC = 0 + -25	19701	MF4C1/8-T9-4991-C
A51R14	0698-8024	3	1	RESISTOR 3.09K .25% .125W F TC = 0 + -50	19701	MF4C1/8-T2-3091-C
A51R15	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A51R16	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A51R17	0698-3155	1		RESISTOR 4.64K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4641-F
A51R18	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A51R19	0757-0464	5	1	RESISTOR 90.9K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-9092-F
A51R20	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A51R21	0698-7215	2	1	RESISTOR 133 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-133R-F
A51R22	0698-7839	6	1	RESISTOR 222 .5% .125W F TC = 0 + -50	19701	MF4C1/8-T2-222R-D
A51R23	0698-5439	8	2	RESISTOR 1K .25% .125W F TC = 0 + -50	28480	0698-5439
A51R24*Δ	0698-3159	5	1	RESISTOR 26.1K 1% .125W F TC = 0 + -50	28480	0698-3159
A51R25				NOT ASSIGNED		
A51R26	0698-5439	8		RESISTOR 1K .25% .125W F TC = 0 + -50	28480	0698-5439
A51R27	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-3481-F
A51R28	0698-3440	7		RESISTOR 196 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-196R-F
A51R29	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A51R30	0698-3157	3		RESISTOR 19.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1962-F
A51R31	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A51R32*	0757-0288	1		RESISTOR 9.09K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-9091-F
A51R33	0757-0447	4		RESISTOR 16.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1622-F
A51R34*	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A51R35	0757-0401	0		RESISTOR 100 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-101-F
A51R36	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A51R37	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A51R38	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A51R39	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A51R40	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A51R41	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A51R42	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A51R43	0698-3132	4		RESISTOR 261 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2610-F
A51R44	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A51R45	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A51R46	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A51TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A51TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A51TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A51U1	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A51U2	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A51U3	1826-0059	2		IC OP AMP GP TO-99 PKG	01295	LM201AL
A51U4	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A51U5	1820-1963	7		IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	3L585	CD4013BAE

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A51U6	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A51U7	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A51U8	1820-1411	0		IC LCH TTL LS D-TYPE 4-BIT	01295	SN74LS75N
A51U9	1820-0723	5		IC RCVR TTL LINE RCVR DUAL 2-INP	01295	SN75107AN
A51VR1	1902-3059	0		DIODE-ZNR 3.83V 5% DO-35 PD = .4W	28480	1902-3059
A51VR2	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827
A51VR3	1902-3104	6		DIODE-ZNR 5.62V 5% DO-35 PD = .4W	28480	1902-3104
A51VR4	1902-3104	6		DIODE-ZNR 5.62V 5% DO-35 PD = .4W	28480	1902-3104
A51VR5	1902-3059	0		DIODE-ZNR 3.83V 5% DO-35 PD = .4W	28480	1902-3059
A51VR6	1902-3059	0		DIODE-ZNR 3.83V 5% DO-35 PD = .4W	28480	1902-3059

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A52						
A52	08901-60131	6	1	AUDIO COUNTER/DISTORTION ANALYZER ASSY	28480	08901-60131
A52C1	0180-2929	8		CAPACITOR-FXD 68UF +-10% 10VDC TA	28480	0180-2929
A52C2	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A52C3	0180-0291	3		CAPACITOR-FXD 1UF +-10% 35VDC TA	56289	150D105X9035A2
A52C4	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A52C5	0160-5098	6		CAPACITOR-FXD .22UF +-10% 50VDC CER	16299	CAC05X7R224J050A
A52C6	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A52C7	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A52C8	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A52C9	0160-4797	0	1	CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A52C10	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A52C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C12	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C13	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A52C14	0160-4267	9	6	CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-4267
A52C15	0160-5340	1	6	CAPACITOR-FXD .03UF +-1% 200VDC	28480	0160-5340
A52C16	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC	28480	0160-5340
A52C17	0160-4267	9		CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-4267
A52C18	0160-4768	5		CAPACITOR-FXD 470PF +-5% 100VDC CER	28480	0160-4768
A52C19	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C20	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C21	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C22	0160-4267	9		CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-4267
A52C23	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC	28480	0160-5340
A52C24	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC	28480	0160-5340
A52C25	0160-4267	9		CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-4267
A52C26	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A52C27	0160-4267	9		CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-4267
A52C28	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC	28480	0160-5340
A52C29	0160-5340	1		CAPACITOR-FXD .03UF +-1% 200VDC	28480	0160-5340
A52C30	0160-4267	9		CAPACITOR-FXD .02UF +-1% 200VDC	28480	0160-4267
A52C31	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A52C32	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A52C33	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C34	0160-3674	0	2	CAPACITOR-FXD .47UF +-5% 100VDC	28480	0160-3674
A52C35	0180-1746	5		CAPACITOR-FXD 15UF +-10% 20VDC TA	56289	150D156X9020B2
A52C36	0160-5036	2	3	CAPACITOR-FXD .27UF +-2% 100VDC	28480	0160-5036
A52C37	0160-5036	2		CAPACITOR-FXD .27UF +-2% 100VDC	28480	0160-5036
A52C38	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C39	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A52C40	0160-5036	2		CAPACITOR-FXD .27UF +-2% 100VDC	28480	0160-5036
A52C41	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A52C42	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A52C43	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A52C44	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A52C45	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A52C46	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A52C47	0160-4787	8	1	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A52CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A52CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A52CR3				NOT ASSIGNED		
A52CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A52CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A52CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A52CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A52CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A52J1	1250-1425	7	2	CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A52J2	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A52L1	9100-3562	8	1	INDUCTOR RF-CH-MLD 4.7UH 5% .166DX.385LG	28480	9100-3562
A52L2	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A52L3	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A52MP1	08901-00074	0	1	CVR AUDIO MEAS	28480	08901-00074
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
A52R1	0698-8822	9	2	RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A52R2	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A52R3	0699-0790	6	2	RESISTOR 100K .1% .1W F TC=0+-15	28480	0699-0790
A52R4	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A52R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A52R6	0699-0790	6		RESISTOR 100K .1% .1W F TC=0+-15	28480	0699-0790
A52R7	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A52R8	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A52R9	0699-0778	0	1	RESISTOR 3.717K .1% .1W F TC=0+-15	28480	0699-0778
A52R10	0699-0785	9	1	RESISTOR 24.14K .1% .1W F TC=0+-15	28480	0699-0785
A52R11	0699-0780	4	4	RESISTOR 4.64K .1% .1W F TC=0+-15	28480	0699-0780
A52R12	0699-0777	9	1	RESISTOR 3.622K .1% .1W F TC=0+-15	28480	0699-0777
A52R13	0699-0789	3	1	RESISTOR 72.42K .1% .1W F TC=0+-15	28480	0699-0789
A52R14	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A52R15				NOT ASSIGNED		
A52R16	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A52R17	0699-0782	6	1	RESISTOR 14.16K .1% .1W F TC=0+-15	28480	0699-0782
A52R18	0699-0780	4		RESISTOR 4.64K .1% .1W F TC=0+-15	28480	0699-0780
A52R19				NOT ASSIGNED		
A52R20	0699-0784	8	1	RESISTOR 17.55K .1% .1W F TC=0+-15	28480	0699-0784
A52R21				NOT ASSIGNED		
A52R22	0699-0776	8	1	RESISTOR 2.712K .1% .1W F TC=0+-15	28480	0699-0776
A52R23	0699-0780	4		RESISTOR 4.64K .1% .1W F TC=0+-15	28480	0699-0780
A52R24	0699-0788	2	1	RESISTOR 54.3K .1% .1W F TC=0+-15	28480	0699-0788
A52R25	0699-0787	1	1	RESISTOR 49.25K .1% .1W F TC=0+-15	28480	0699-0787
A52R26	0699-0786	0	1	RESISTOR 28.12K .1% .1W F TC=0+-15	28480	0699-0786
A52R27	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A52R28	0699-0791	7	1	RESISTOR 103.2K .1% .1W F TC=0+-15	28480	0699-0791
A52R29	0699-0057	8	3	RESISTOR 9K .1% .1W F TC=0+-5	28480	0699-0057
A52R30	0698-6414	1		RESISTOR 1K .1% .1W F TC=0+-5	28480	0698-6414

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A52R31	0699-0779	1	1	RESISTOR 4.523K .1% .1W F TC = 0 + -15	28480	0699-0779
A52R32	0699-0780	4		RESISTOR 4.64K .1% .1W F TC = 0 + -15	28480	0699-0780
A52R33	0698-6414	1		RESISTOR 1K .1% .1W F TC = 0 + -5	28480	0698-6414
A52R34	0699-0781	5	1	RESISTOR 7.18K .1% .1W F TC = 0 + -15	28480	0699-0781
A52R35	0699-0057	8		RESISTOR 9K .1% .1W F TC = 0 + -5	28480	0699-0057
A52R36	0699-0783	7	1	RESISTOR 14K .1% .1W F TC = 0 + -15	28480	0699-0783
A52R37	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A52R38	2100-3352	7		RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	28480	2100-3352
A52R39	0699-0057	8		RESISTOR 9K .1% .1W F TC = 0 + -5	28480	0699-0057
A52R40	0698-6414	1		RESISTOR 1K .1% .1W F TC = 0 + -5	28480	0698-6414
A52R41	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A52R42	0698-3158	4		RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F
A52R43	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A52R44	2100-3274	2		RESISTOR-TRMR 10K 10% C SIDE-ADJ 1-TRN	28480	2100-3274
A52R45	0698-8827	4		RESISTOR 1M 1% .125W F TC = 0 + -100	28480	0698-8827
A52R46	0757-0420	3		RESISTOR 750 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-751-F
A52R47	2100-3354	9	1	RESISTOR-TRMR 50K 10% C SIDE-ADJ 1-TRN	28480	2100-3354
A52R48	0757-0458	7		RESISTOR 51.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5112-F
A52R49	0698-3161	9		RESISTOR 38.3K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3832-F
2306A ONLY						
A52R50	0698-3161	9		RESISTOR 38.3K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3832-F
2326A AND ABOVE						
A2R50				NOT ASSIGNED		
A52R51	0698-3450	9	10	RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
A52R52	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A52R53	0698-3136	8		RESISTOR 17.8K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1782-F
A52R54	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A52R55	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A52R56	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A52R57	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A52R58	0757-0199	3		RESISTOR 21.5K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2152-F
A52R59	0757-0290	5		RESISTOR 6.19K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-6191-F
A52R60	0757-0418	9		RESISTOR 619 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-619R-F
A52TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A52TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A52TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A52TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A52TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A52U1	1826-0421	2	1	IC CONV RMS/DC 14-DIP-C PKG	24355	AD536AJ
A52U2	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A52U3	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A52U4	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A52U5	1826-1012	8		ANALOG SWITCH 4 SPST 16-PIN	17856	DG201BP
A52U6	1826-1012	8		ANALOG SWITCH 4 SPST 16-PIN	17856	DG201BP
A52U7	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A52U8	1820-2096	9	2	IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS393N
A52U9	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A52U10	1820-1417	6	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A52U11	1820-1445	0	1	IC LCH TTL LS 4-BIT	01295	SN74LS375N
A52U12	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A52U13	1826-0191	3		IC COMPARATOR GP DUAL TO-100 PKG	27014	LM319H
A52U14	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A52U15	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A52U16	1820-2096	9		IC CNTR TTL LS BIN DUAL 4-BIT	01295	SN74LS393N
A52U17	1826-0785	1	1	IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A52U18	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A52U19	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A52VR1	1902-0961	7	2	DIODE-ZNR 13V 5% DO-35 PD = .4W TC = +.082%	28480	1902-0961
A52VR2	1902-0961	7		DIODE-ZNR 13V 5% DO-35 PD = .4W TC = +.082%	28480	1902-0961
A52W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A52W2	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
2305A ONLY						
A52W3				NOT ASSIGNED		
2326A AND ABOVE						
A52W3	8159-0005	0		RESISTOR-ZERO OHMS 22AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A53						
A53	08901-60130	5	1	POWER METER ASSEMBLY	28480	08901-60130
A53C1	0180-2111	0		CAPACITOR-FXD 33UF+-10% 35VDC TA	56289	150D336X9035SA
A53C2	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A53C3	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A53C4	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A53C5	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A53C6	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A53C7	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A53C8	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C9	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C10	0160-4624	2	3	CAPACITOR-FXD 8200PF +-5% 50VDC CER	28480	0160-4624
A53C11	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C12	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C13	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A53C14	0160-2290	4	3	CAPACITOR-FXD .15UF +-10% 80VDC POLYE	28480	0160-2290
A53C15	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A53C16	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C17	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C18	0160-4624	2		CAPACITOR-FXD 8200PF +-5% 50VDC CER	28480	0160-4624
A53C19	0160-2290	4		CAPACITOR-FXD .15UF +-10% 80VDC POLYE	28480	0160-2290
A53C20	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A53C21	0160-4624	2		CAPACITOR-FXD 8200PF +-5% 50VDC CER	28480	0160-4624
A53C22	0160-2290	4		CAPACITOR-FXD .15UF +-10% 80VDC POLYE	28480	0160-2290
A53C23	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A53C24	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A53C25	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C26	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C27	0160-0157	8	1	CAPACITOR-FXD 4700PF +-10% 200VDC POLYE	28480	0160-0157
A53C28	0180-2111	0		CAPACITOR-FXD 33UF+-10% 35VDC TA	56289	150D336X9035SA
A53C29	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A53C30	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A53C31	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C32	0160-0575	4		CAPACITOR-FXD .047UF +-20% 50VDC CER	28480	0160-0575
A53C33	0160-5546	9	2	CAPACITOR-FXD .039UF +-5% 100VDC	28480	0160-5546
A53C34	0160-5546	9		CAPACITOR-FXD .039UF +-5% 100VDC	28480	0160-5546
A53C35	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A53C36	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C37	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C38	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C39	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C40	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C41	0160-5370	7	1	CAPACITOR-FXD 2.2UF +-5% 50VDC MET-POLYC	28480	0160-5370
A53C42	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C43	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C44	0160-3674	0		CAPACITOR-FXD .47UF +-5% 100VDC	28480	0160-3674
A53C45	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A53C46	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C47	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C48	0160-3324	7	1	CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A53C49	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A53C50	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A53C51	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53C52	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A53C53	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A53CR1	1901-0895	4	2	DIODE-SM SIG SCHOTTKY	28480	1901-0895
A53CR2	1901-0895	4		DIODE-SM SIG SCHOTTKY	28480	1901-0895
A53CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A53CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A53CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A53K1	0490-1063	6	2	RELAY-REED 2A 500MA 50VDC 5VDC-COIL 10VA	28480	0490-1063
A53K2	0490-1063	6		RELAY-REED 2A 500MA 50VDC 5VDC-COIL 10VA	28480	0490-1063
A53MP1	08901-00075	1	1	COVER, RF POWER	28480	08901-00075
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A53Q1				NOT ASSIGNED		
A53Q2	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A53Q3	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
	1200-0173	5		INSULATOR-XSTR DAP-GL	28480	1200-0173
A53Q4	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A53Q5	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A53Q6	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A53Q7	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A53Q8	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A53Q9	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A53Q10	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A53Q11	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A53Q12	1854-0810	2		TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A53Q13	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A53Q14	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A53Q15	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A53R1	0699-0075	0	1	RESISTOR 21.5M 1% .125W F TC=0+-150	28480	0699-0075
A53R2	0698-3450	9		RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A53R3	0698-3159	5		RESISTOR 26.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2612-F
A53R4	0698-3450	9		RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A53R5	0698-3156	2		RESISTOR 14.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1472-F
A53R6	0757-0459	8		RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
A53R7	0698-3431	6		RESISTOR 23.7 1% .125W F TC=0+-100	03888	PME55-1/8-T0-23R7-F
A53R8	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A53R9	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A53R10	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A53R11	0757-0463	4		RESISTOR 82.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8252-F
A53R12	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A53R13	2100-2655	1	2	RESISTOR-TRMR 100K 10% C TOP-ADJ 1-TRN	73138	82PR100K
A53R14	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A53R15	0698-3451	0		RESISTOR 133K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1333-F
A53R16	2100-2655	1		RESISTOR-TRMR 100K 10% C TOP-ADJ 1-TRN	73138	82PR100K

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A53R17	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A53R18	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A53R19	0811-3351	1	1	RESISTOR 11K .025% .05W PWW TC = 0 + -10	28480	0811-3351
A53R20	0811-3348	6	2	RESISTOR 111.11 .025% .05W PWW TC = 0 + -10	28480	0811-3348
A53R21	0698-3450	9		RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
A53R22	0757-0438	3		RESISTOR 5.11K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5111-F
A53R23	0698-3150	6		RESISTOR 2.37K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2371-F
A53R24	0811-3350	0	1	RESISTOR 10K .025% .05W PWW TC = 0 + -10	28480	0811-3350
A53R25	0811-3349	7	1	RESISTOR 1K .025% .05W PWW TC = 0 + -10	28480	0811-3349
A53R26	0811-3348	6		RESISTOR 111.11 .025% .05W PWW TC = 0 + -10	28480	0811-3348
A53R27	0757-0289	2		RESISTOR 13.3K 1% .125W F TC = 0 + -100	19701	MF4C1/8-T0-1332-F
A53R28	0698-3450	9		RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
A53R29	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A53R30	0698-3150	6		RESISTOR 2.37K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2371-F
A53R31	0698-3450	9		RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
A53R32	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A53R33	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A53R34	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A53R35	0757-0200	7		RESISTOR 5.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5621-F
A53R36	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A53R37	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A53R38	0757-0460	1		RESISTOR 61.9K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6192-F
A53R39	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A53R40	2100-2514	1	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	30983	ET50W203
A53R41	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A53R42	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A53R43	0757-0460	1		RESISTOR 61.9K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-6192-F
A53R44	0698-3154	0		RESISTOR 4.22K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4221-F
A53R45	0757-0200	7		RESISTOR 5.62K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-5621-F
A53R46	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A53R47	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A53R48	0757-0422	5		RESISTOR 909 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-909R-F
A53R49	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A53R50	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A53R51	0698-3446	3		RESISTOR 383 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-383R-F
A53R52	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A53R53	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A53R54	0698-3152	8		RESISTOR 3.48K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3481-F
A53R55	0698-3459	8	1	RESISTOR 383K 1% .125W F TC = 0 + -100	28480	0698-3459
A53R56	0698-8638	5	1	RESISTOR 3.16K .1% .125W F TC = 0 + -25	28480	0698-8638
A53R57	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A53R58	0698-3160	8		RESISTOR 31.6K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3162-F
A53R59	0698-0083	8		RESISTOR 1.96K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1961-F
A53R60	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A53R61	0698-3156	2		RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1472-F
A53R62	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A53R63	0757-0470	3		RESISTOR 162K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1623-F
A53R64	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F
A53R65	0811-1557	5	1	RESISTOR 15 5% 3W PW TC = 0 + -20	28480	0811-1557
A53R66	0698-3444	1		RESISTOR 316 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-316R-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A53R67	0699-0842	9	1	RESISTOR 6.19K .1% .125W F TC = 0 + -25	28480	0699-0842
A53R68	0698-3156	2		RESISTOR 14.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1472-F
A53R69	0698-3158	4		RESISTOR 23.7K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2372-F
A53R70	0698-3450	9		RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
A53R71	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A53R72	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A53R73	0698-3450	9		RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
A53R74	0698-3450	9		RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
A53R75	0698-3406	5	1	RESISTOR 1.33K 1% .5W F TC = 0 + -100	28480	0698-3406
A53R76	0698-3450	9		RESISTOR 42.2K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4222-F
2306A TO 2413A						
A53R77	0698-3391	7	1	RESISTOR 21.5 1% .5W F TC = 0 + -100	28480	0698-3391
2414A AND ABOVE						
A53R77	0698-3388	2		RESISTOR 14.7 1% .5W F TC = 0 + -100	28480	0698-3388
A53R78	0698-0085	0		RESISTOR 2.61K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2611-F
A53TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A53TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A53TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A53TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A53TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A53TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A53TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A53U1	1826-0092	3	1	IC OP AMP GP DUAL TO-99 PKG	28480	1826-0092
A53U2	1826-0990	0	1	IC OP AMP GP DUAL 8-DIP-C PKG	04713	MC1458U
A53U3	1826-0989	7	4	IC OP AMP GP 8-DIP-C PKG	27014	LM307J
A53U4	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A53U5	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A53U6	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A53U7	1826-0043	4		IC OP AMP GP TO-99 PKG	3L585	CA307T
A53U8	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A53U9	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A53U10	1820-1934	2	1	IC CONV 8-B-D/A 16-DIP-C PKG	06665	DAC-08EQ
A53U11	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A53U12	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A53U13	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A53U14	1820-0535	7		IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A53U15	1820-0535	7		IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A53U16	1820-1422	3	1	IC MV TTL LS MONOSTBL RETRIG	01295	SN74LS122N
A53U17	1826-1048	1		IC OP AMP PRCN 8-DIP-C PKG	06665	OP-07CZ
A53VR1	1902-3002	3	2	DIODE-ZNR 2.37V 5% DO-7 PD = .4W TC = -.074%	28480	1902-3002
A53VR2	1902-3002	3		DIODE-ZNR 2.37V 5% DO-7 PD = .4W TC = -.074%	28480	1902-3002
A53VR3	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827
A53VR4	1902-0947	9	1	DIODE-ZNR 3.6V 5% DO-35 PD = .4W TC = -.036%	28480	1902-0947
A53VR5	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD = .4W	24046	1N827

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A54						
2305A TO 2339A						
A54				THE RECOMMENDED REPLACEMENT FOR ALL INSTRUMENTS IS 08902-60031		
2340A AND ABOVE						
A54	08902-60031	6		IF SYNCHRONOUS DETECTOR ASSEMBLY	28480	08902-60031
A54C1	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C2	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C3	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
2305A TO 2412A						
A54C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
2413A AND ABOVE						
A54C4	0160-4084	8		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A54C5	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C7	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C8	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C9	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A54C10	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C11	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C12	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A54C13	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C14	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A54C15	0160-5339	8	2	CAPACITOR-FXD 8UF +-10% 50VDC MET-POLYC	28480	0160-5339
A54C16	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C17	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C18	0160-5339	8		CAPACITOR-FXD 8UF +-10% 50VDC MET-POLYC	28480	0160-5339
A54C19	0160-4389	6		CAPACITOR-FXD 100PF +-5PF 200VDC CER	28480	0160-4389
A54C20	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C21	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A54C22	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C23	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C24	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C25	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C26	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C27	0160-5757	4	1	CAPACITOR-FXD 96PF +-1% 100VDC CER	28480	0160-5757
A54C28	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C29	0160-5758	5	1	CAPACITOR-FXD 120PF +-1% 100VDC+100+-20	28480	0160-5758
A54C30	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A54C31	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C32	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C33	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C34	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A54C35	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C36	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A54C37	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C38	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C39	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C40	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A54C41	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C42	0160-3879	7		CAPACITOR-FXD .01UF +-20% 100VDC CER	28480	0160-3879
A54C43	0160-3402	2		CAPACITOR-FXD 1UF +-5% 50VDC MET-POLYC	28480	0160-3402
A54C44	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C45	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C46	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A54C47	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C48	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54C49	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A54CR1	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A54CR2	1901-0880	7		DIODE-GEN PRP 125MA D0-35	28480	1901-0880
A54CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
2305A TO 2411A						
A54CR4	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
A54CR5	0122-0065	7		DIODE-VVC 29PF 3%	28480	0122-0065
2412A AND ABOVE						
A54CR4	0122-0162	5		DIODE VVC 29PF 10% BVR=30V		
A54CR5	0122-0162	5		DIODE VVC 29PF 10% BVR=30V		
A54CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A54CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A54CR8	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A54CR9	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A54CR10	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A54CR11	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A54CR12	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A54DS1	1990-0719	8	1	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	HLMP-13015
A54DS2	1990-0326	3		LED-LAMP LUM-INT=300UCD IF=50MA-MAX	28480	5082-4444
A54E1	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A54E2				NOT ASSIGNED		
A54E3				NOT ASSIGNED		
A54E4	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A54E5	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A54E6	9170-0029	3		CORE-SHIELDING BEAD	28480	9170-0029
A54J1	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A54J2	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
A54L1	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q=60	28480	9140-0137
A54L2	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q=60	28480	9140-0137
A54L3	08902-80002	3	2	INDUCTOR 1MHY	28480	08902-80002
A54L4	08902-80002	3		INDUCTOR 1MHY	28480	08902-80002

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A54MP1	08902-00011	6	1	COVER-TRKG DTECT	28480	08902-00011
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A54MP2	5001-0176	0		GROUND STRAP	28480	5001-0176
A54MP3	5001-0176	0		GROUND STRAP	28480	5001-0176
A54Q1	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A54Q2	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A54Q3	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A54Q4	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A54Q5	1858-0049	7	1	TRANSISTOR ARRAY 16-PIN PLSTC DIP	28480	1858-0049
A54Q6	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A54Q7	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A54Q8	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A54Q9	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A54R1	0698-7204	9		RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A54R2	0698-7236	7		RESISTOR 1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1001-F
A54R3	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A54R4	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A54R5	0698-7247	0		RESISTOR 2.87K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2871-F
A54R6	0698-7223	2		RESISTOR 750 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-750R-F
A54R7	0698-7255	0	5	RESISTOR 6.19K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-6191-F
A54R8	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A54R9	0698-7245	8	5	RESISTOR 2.37K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2371-F
A54R10	0698-7229	8		RESISTOR 511 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-511R-F
A54R11	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A54R12	0698-7251	6		RESISTOR 4.22K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-4221-F
A54R13	0698-7216	3		RESISTOR 147 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-147R-F
A54R14	0698-7262	9		RESISTOR 12.1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1212-F
A54R15	0698-7255	0		RESISTOR 6.19K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-6191-F
A54R16	0698-8475	8		RESISTOR 1.799K .1% .1W F TC = 0 + -5	28480	0698-8475
A54R17	2100-3756	5	2	RESISTOR-TRMR 20 10% C SIDE-ADJ 17-TRN	28480	2100-3756
A54R18	0698-8475	8		RESISTOR 1.799K .1% .1W F TC = 0 + -5	28480	0698-8475
A54R19	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A54R20	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A54R21	0699-0068	1	1	RESISTOR 1.47M 1% .125W F TC = 0 + -100	28480	0699-0068
A54R22	0698-7268	5	5	RESISTOR 21.5K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2152-F
A54R23	0698-7245	8		RESISTOR 2.37K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2371-F
A54R24*	0698-7240	3	5	RESISTOR 1.47K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1471-F
A54R25*	0699-1502	0	1	RESISTOR 5.5M 1% .125W F TC = 0 + -150	28480	0699-1502
A54R26	0698-7268	5		RESISTOR 21.5K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2152-F
A54R27	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A54R28	0698-7262	9		RESISTOR 12.1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1212-F
A54R29	0699-0073	8	1	RESISTOR 10M 1% .125W F TC = 0 + -150	28480	0699-0073
A54R30	0698-7288	9		RESISTOR 147K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1473-F
A54R31	0698-7268	5		RESISTOR 21.5K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2152-F
A54R32	0698-7261	8		RESISTOR 11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1102-F
A54R33	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A54R34	0698-7247	0		RESISTOR 2.87K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2871-F
A54R35	0698-7258	3		RESISTOR 8.25K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-8251-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A54R36	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A54R37	0698-7262	9		RESISTOR 12.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1212-F
A54R38	0698-7247	0		RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A54R39	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A54R40	0698-7232	3		RESISTOR 681 1% .05W F TC=0+-100	24546	C3-1/8-TO-681R-F
A54R41	0698-7247	0		RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A54R42	0698-7247	0		RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A54R43	0698-7245	8		RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A54R44	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
A54R45	0698-7268	5		RESISTOR 21.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2152-F
A54R46	0699-0843	0	2	RESISTOR 2.87K .1% .125W F TC=0+-25	28480	0699-0843
A54R47	0698-7254	9	1	RESISTOR 5.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5621-F
A54R48	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-TO-422R-F
A54R49	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A54R50	0699-0843	0		RESISTOR 2.87K .1% .125W F TC=0+-25	28480	0699-0843
A54R51	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
A54R52	0698-7268	5		RESISTOR 21.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2152-F
A54R53	0698-7247	0		RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A54R54	0698-7245	8		RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A54R55	0698-7257	2		RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A54R56	0698-7262	9		RESISTOR 12.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1212-F
A54R57	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
A54R58	0698-7255	0		RESISTOR 6.19K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6191-F
A54R59	0698-7227	6		RESISTOR 422 1% .05W F TC=0+-100	24546	C3-1/8-TO-422R-F
A54R60	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A54R61	0698-7255	0		RESISTOR 6.19K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6191-F
A54R62	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A54R63	0698-7245	8		RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A54R64	0698-7229	8		RESISTOR 511 1% .05W F TC=0+-100	24546	C3-1/8-TO-511R-F
A54R65	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
A54R66	0698-7288	9		RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A54R67	0698-7249	2		RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A54R68	0698-7223	2	1	RESISTOR 287 1% .05W F TC=0+-100	24546	C3-1/8-TO-287R-F
A54R69	0698-3445	2		RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A54R70	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1001-F
A54R71	0698-7262	9		RESISTOR 12.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1212-F
A54R72	0698-7251	6		RESISTOR 4.22K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4221-F
A54R73	0698-7241	4	1	RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1621-F
A54R74	0698-8475	8		RESISTOR 1.799K .1% .1W F TC=0+-5	28480	0698-8475
A54R75	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A54R76	2100-3756	5		RESISTOR-TRMR 20 10% C SIDE-ADJ 17-TRN	28480	2100-3756
A54R77	0698-8475	8		RESISTOR 1.799K .1% .1W F TC=0+-5	28480	0698-8475
A54R78	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
A54R79	0698-7212	9		RESISTOR 100 1% .05W F TC=0+-100	24546	C3-1/8-TO-100R-F
A54R80	0699-0118	2		RESISTOR 20K .1% .1W F TC=0+-5	28480	0699-0118
A54R81	0699-0118	2		RESISTOR 20K .1% .1W F TC=0+-5	28480	0699-0118
A54R82	0698-7262	9		RESISTOR 12.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1212-F
A54R83	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A54R84	0698-8824	1	1	RESISTOR 562K 1% .125W F TC=0+-100	28480	0698-8824
A54R85	0698-8812	7		RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A54R86	0698-7247	0		RESISTOR 2.87K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2871-F
A54R87	0698-7244	7		RESISTOR 2.15K 1% .05W F TC=0+-100	24546	C3-1/8-TO-2151-F
A54TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A54TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A54TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A54TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A54U1	1826-1048	7	1	IC OP AMP PRCN 8-DIP-C PKG	28480	1826-1048
A54U2	1820-0427	6	2	IC MODULATOR TO-100 PKG	04713	MC1496G
A54U3	1820-0427	6		IC MODULATOR TO-100 PKG	04713	MC1496G
A54U4	1826-1048	7		IC OP AMP PRCN 8-DIP-C PKG	28480	1826-1048
A54U5	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-C	04713	MC34004BL
A54U6	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A54U7	1826-0752	2	1	IC CONV 12-B-D/A 16-DIP-C PKG	24355	AD7542BD
A54U8	1826-0191	3		IC COMPARATOR GP DUAL TO-100 PKG	27014	LM319H
A54U9	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A55						
2305A TO 2530A						
A55	08902-60003	2	1	IF AMPLIFIER/FILTER ASSEMBLY	28480	08902-60003
2535A AND ABOVE						
A55	08902-60105	5	1	IF AMPLIFIER/FILTER ASSEMBLY	28480	08902-60105
A55C1	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A55C2	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A55C3	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A55C4	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A55C5	0180-2929	8		CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A55C6	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A55C7	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C8	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
2305A TO 2530A						
A55C9				NOT ASSIGNED		
2535A AND ABOVE						
A55C9	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C10	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A55C11	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C12	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C13	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C14	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A55C15	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C16	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C17	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A55C18	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A55C19	0160-4386	3		CAPACITOR-FXD 33PF +-5% 200VDC CER 0+-30	28480	0160-4386
A55C20	0160-0576	5		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A55C21Δ	0160-5719	8	4	CAPACITOR-FXD 620PF +-5% 100VDC CER	28480	0160-5719
A55C22	0160-4896	0	1	CAPACITOR-FXD 47PF +-2% 200VDC CER 0+-30	28480	0160-4896
A55C23	0160-4825	5		CAPACITOR-FXD 560PF +-5% 100VDC CER	28480	0160-4825
A55C24	0121-0105	4		CAPACITOR-V TRMR-CER 9-35PF 200V PC-MTG	52763	304324 9/35PF N650
A55C25	0160-0573	2		CAPACITOR-FXD 4700PF +-20% 100VDC CER	28480	0160-0573
A55C26	0160-4887	9	1	CAPACITOR-FXD 25PF +-2% 200VDC CER 0+-30	28480	0160-4887
A55C27Δ	0160-5719	8	4	CAPACITOR-FXD 620PF +-5% 100VDC CER	28480	0160-5719
A55C28	0160-4781	2	1	CAPACITOR-FXD 27PF +-2% 200VDC CER 0+-30	28480	0160-4781

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A55C29Δ	0160-5719	8	4	CAPACITOR-FXD 620PF +-5% 100VDC CER	28480	0160-5719
A55C30	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C31	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C32	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55C33	0160-4782	3	1	CAPACITOR-FXD 33PF +-2% 200VDC CER 0+-30	28480	0160-4782
A55C34	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
2305A TO 2530A						
A55C35	0160-4383	0	1	CAPACITOR-FXD 6.8PF +-.5PF 200VDC CER	20932	5024E0200RD689D
2535A AND ABOVE						
A55C35				NOT ASSIGNED		
A55C36Δ	0160-5719	8	4	CAPACITOR-FXD 620PF +-5% 100VDC CER	28480	0160-5719
A55C37	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A55C38	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A55C39	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A55CR1	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A55CR2	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A55CR3	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A55CR4	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
2305A TO 2530A						
A55J1	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A55J2	1250-1220	0		CONNECTOR-RF SMC M PC 50-OHM	28480	1250-1220
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
2535A AND ABOVE						
A55J1	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50 OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A55J2	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50 OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A55L1	9100-1629	4	2	INDUCTOR RF-CH-MLD 47UH 5% .166DX.385LG	28480	9100-1629
A55L2	9100-1629	4		INDUCTOR RF-CH-MLD 47UH 5% .166DX.385LG	28480	9100-1629
A55L3	08902-80001	2	5	INDUCTOR 180UH	28480	08902-80001
A55L4	08902-80001	2		INDUCTOR 180UH	28480	08902-80001
A55L5	08902-80001	2		INDUCTOR 180UH	28480	08902-80001
A55L6	08902-80001	2		INDUCTOR 180UH	28480	08902-80001
A55L7	08902-80001	2		INDUCTOR 180UH	28480	08902-80001
A55MP1	08902-00014	9	1	COVER IF AMP FTR	28480	08902-00014
	2190-0008	3		WASHER-LK EXT T NO. 6 .141-IN-ID	28480	2190-0008
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A55MP2	08902-00012	7	1	SHIELD CAN	28480	08902-00012
A55MP3	2200-0171	4	2	SCREW-MACH 4-40 .750-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A55Q1	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A55Q2	1853-0430	0	4	TRANSISTOR PNP 2N4959 SI TO-72 PD = 200MW	04713	2N4959
2305A TO 2530A						
A55Q3	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
2535A AND ABOVE						
A55Q3	1855-0292	6		TRANSISTOR J-FET 2N5432 N-CHAN D-MODE	17856	2N5432
A55Q4	1853-0430	0		TRANSISTOR PNP 2N4959 SI TO-72 PD = 200MW	04713	2N4959
A55Q5	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A55Q6	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A55Q7	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A55Q8	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A55Q9	1853-0430	0		TRANSISTOR PNP 2N4959 SI TO-72 PD = 200MW	04713	2N4959
A55Q10	1853-0430	0		TRANSISTOR PNP 2N4959 SI TO-72 PD = 200MW	04713	2N4959
A55Q11	1854-0810	2		TRANSISTOR NPN SI PD = 625MW FT = 200MHZ	28480	1854-0810
A55R1	0699-0678	9	2	RESISTOR 900 .01% .1W F TC = 0 + -5	28480	0699-0678
A55R2	0699-0681	4	3	RESISTOR 100 .01% .1W F TC = 0 + -5	28480	0699-0681
A55R3	0698-7203	8	2	RESISTOR 42.2 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-42R2-F
A55R4	0698-4593	3	1	RESISTOR 464 1% .25W F TC = 0 + -100	24546	C5-1/4-TO-464R-F
A55R5	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-51R1-F
A55R6	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A55R7	0698-3442	9		RESISTOR 237 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-237R-F
A55R8	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A55R9	0699-0678	9		RESISTOR 900 .01% .1W F TC = 0 + -5	28480	0699-0678
A55R10	0699-0681	4		RESISTOR 100 .01% .1W F TC = 0 + -5	28480	0699-0681
A55R11	0698-7210	7	1	RESISTOR 82.5 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-82R5-F
A55R12	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A55R13	0698-7204	9		RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-46R4-F
A55R14	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A55R15	0698-7227	6		RESISTOR 422 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-422R-F
A55R16	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A55R17	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A55R18	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
2305A TO 2338A						
A55R19	0699-0679	0	1	RESISTOR 683.8 .01% .1W F TC = 0 + -5	28480	0699-0679
A55R20	0699-0680	3		RESISTOR 216.2 .01% .1W F TC = 0 + -5	28480	0699-0680
2339A AND 2340A						
A55R19	0698-1149	3		RESISTOR 683.7 + -0.01% .1W F TC = 0 + -5	28480	0698-1149
A55R20	0699-1150	6		RESISTOR 216.4 + -0.01% .1W F TC = 0 + -5	28480	0698-1150
2341A AND 2342A						
A55R19	0699-0679	0	1	RESISTOR 683.8 .01% .1W F TC = 0 + -5	28480	0699-0679
A55R20	0699-0680	3	1	RESISTOR 216.2 .01% .1W F TC = 0 + -5	28480	0699-0680
2343A AND ABOVE						
A55R19	0699-1149	3		RESISTOR 683.7 + -0.01% .1W F TC = 0 + -5	28480	0699-1149
A55R20	0699-1150	6		RESISTOR 216.4 + -0.01% .1W F TC = 0 + -5	28480	0698-1150

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A55R21	0699-0681	4		RESISTOR 100 .01% .1W F TC = 0 + -5	28480	0699-0681
A55R22	0698-7220	9		RESISTOR 215 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-215R-F
A55R23	0698-7214	1	1	RESISTOR 121 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-121R-F
A55R24	0698-7203	8		RESISTOR 42.2 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-42R2-F
A55R25	0698-7233	4	1	RESISTOR 750 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-750R-F
A55R26	0698-7253	8		RESISTOR 5.11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-5111-F
A55R27	0698-7244	7		RESISTOR 2.15K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-2151-F
A55R28	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A55R29	0757-0733	1	2	RESISTOR 1.1K 1% .25W F TC = 0 + -100	28480	0757-0733
A55R30	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A55R31	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A55R32	0698-7242	5		RESISTOR 1.78K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1781-F
A55R33	2100-0545	4	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3292X-1-102
A55R34	0698-7237	8	1	RESISTOR 1.1K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1101-F
A55R35	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A55R36	0698-7253	8		RESISTOR 5.11K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-5111-F
A55R37	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
A55R38	2100-3732	7	1	RESISTOR-TRMR 500 10% C SIDE-ADJ 17-TRN	28480	2100-3732
2305A TO 2530A						
A55R39	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
2535A AND ABOVE						
A55R39	0698-7225	4	1	RESISTOR 348 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-348R-F
A55R40	0698-7240	3		RESISTOR 1.47K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1471-F
A55R41	0757-0424	7		RESISTOR 1.1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1101-F
2305A TO 2530A						
A55R42	0698-7225	4	1	RESISTOR 348 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-348R-F
2535A AND ABOVE						
A55R42	0698-7233	4		RESISTOR 750 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-750R-F
A55R43	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A55R44	0698-7220	9		RESISTOR 215 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-215R-F
A55R45	0698-3429	2		RESISTOR 19.6 1% .125W F TC = 0 + -100	03888	PME55-1/8-T0-19R6-F
A55R46	0757-0733	1		RESISTOR 1.1K 1% .25W F TC = 0 + -100	28480	0757-0733
A55R47	0698-7255	0		RESISTOR 6.19K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-6191-F
A55R48	2100-3759	8	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 17-TRN	28480	2100-3759
A55R49	0698-7212	9		RESISTOR 100 1% .05W F TC = 0 + -100	24546	C3-1/8-TO-100R-F
A55R50	0698-7284	5		RESISTOR 100K 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-1003-F
2305A TO 2530A						
A55R51				NOT ASSIGNED		
2535A AND ABOVE						
A55R51	0698-7204	9		RESISTOR 46.4 1% .05W F TC = 0 + -100	24546	C3-1/8-T0-46R4-F

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A55TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A55U1	1826-1020	9	2	IC SWITCH ANLG 2 SPST 10 -METAL	17856	DG200ABA
A55U2	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A55U3	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A55U4	1826-1020	9		IC SWITCH ANLG 2 SPST 10 -METAL	17856	DG200ABA
A55U5	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A55U6	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A55U7	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A55W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A70	**08902-60006 – SERIAL PREFIX 2305A TO 2702A**					
A70	08902-60006	5	1	AMPLIFIER/SWITCH INTERCONNECT ASSY	28480	08902-60006
A70C1	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C2	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C3	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A70C4	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C6	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C7	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C8	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C9	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C10	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C11	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C12	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70DS1	1990-0718	7	1	LED-LAMP LUM-INT = 1MCD IF = 20MA-MAX BVR = 5V	28480	HLMP-1401
A70DS2	1990-0717	6	1	LED-LAMP LUM-INT = 800UCD IF = 30MA-MAX	28480	HLMP-1501
A70J1	1251-4582	5		CONNECTOR 10-PIN M POST TYPE	28480	1251-4582
A70J2				NOT ASSIGNED		
A70J3				NOT ASSIGNED		
A70L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L2	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L3	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A70L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L5	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L6	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L7	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L8	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L9	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L10	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70R1	0698-3439	4		RESISTOR 178 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-178R-F
A70R2	0698-3439	4		RESISTOR 178 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-178R-F
A70R3	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A70R4	0698-3162	0		RESISTOR 46.4K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4642-F
A70R5	0757-0442	9		RESISTOR 10K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1002-F
A70R6	0757-0416	7		RESISTOR 511 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-511R-F
A70U1	1826-0412	1		IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A70	**08902-60064 – SERIAL PREFIX 2704A AND ABOVE**					
A70	08902-60064	5		AMPLIFIER/SWITCH INTERCONNECT ASSY	28480	08902-60064
A70C1	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C2	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C3	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A70C4	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C6	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C7	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C8	0160-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A70C9	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C10	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C11	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70C12	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A70J1	1251-4582	5		CONNECTOR 10-PIN M POST TYPE	28480	1251-4582
A70J2				NOT ASSIGNED		
A70J3				NOT ASSIGNED		
A70J4	1251-4498	2		CONNECTOR 7-PIN M POST TYPE	28480	1251-4498
A70L1	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70L2				NOT ASSIGNED		
A70L3	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A70L4-9				NOT ASSIGNED		
A70L10	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A70R1				NOT ASSIGNED		
A70R2				NOT ASSIGNED		
A70R3	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A70R4	0698-3162	0		RESISTOR 46.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4642-F
A70R5	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A70R6	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A70U1	1826-0412	1		IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A70U2	1820-2111	9		IC DRVR TTL INV	01295	SN75468N

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A71						
A71	08902-60109	9	1	IF AMPLIFIER/DETECTOR ASSEMBLY (OPTION 030 ONLY)	28480	08902-60109
A71C1	0180-0116	1	4	CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A71C2	0180-0197	8	1	CAPACITOR-FXD 2.2UF +-10% 20VDC TA	56289	150D225X9020A2
A71C3	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A71C4	0160-4832	4	14	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C6	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C7	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C8	0160-4797	0	6	CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A71C9	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C10	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C12	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C13	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C15	0160-4797	0		CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A71C16	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C17	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C18	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C19	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C20	0160-4797	0		CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A71C21	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C22	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C23	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C24	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71C25	0160-4789	0	1	CAPACITOR-FXD 15PF +-5% 100VDC CER 0+-30	28480	0160-4789
A71C26	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C27	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A71C28	0160-5550	5	1	CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYC	28480	0160-5550
A71C29	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A71CR1	1901-0518	8	6	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A71CR2	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A71CR3	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A71CR4	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A71CR5	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A71FL1Δ	9135-0268	8		FILTER-CERAMIC BANDPASS; 455KHZ CENTER	28480	9135-0268
A71FL2Δ	9135-0267	7		FILTER-CERAMIC BANDPASS; 455KHZ CENTER	28480	9135-0267
A71J1	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A71J2	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A71L1	9100-1642	1	2	INDUCTOR RF-CH-MLD 270UH 5% .2DX.45LG	28480	9100-1642
A71L2	9100-1642	1		INDUCTOR RF-CH-MLD 270UH 5% .2DX.45LG	28480	9100-1642
A71MP1	08902-00034	3	1	BOARD COVER, IF AMP/DET	28480	08902-00034
A71Q1	1853-0459	3	7	TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459
A71Q2	1854-0404	0	9	TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A71Q3	1853-0459	3		TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459
A71Q4	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A71Q5	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A71Q6	1853-0459	3		TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459
A71Q7	1855-0235	7	1	TRANSISTOR J-FET N-CHAN D-MODE TO-52 SI	28480	1855-0235
A71Q8	1853-0459	3		TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459
A71Q9	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A71Q10	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A71Q11	1855-0420	2	3	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A71Q12	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A71Q13	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A71Q14	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A71R1	0699-0678	9	4	RESISTOR 900 .01% .1W F TC = 0 + -5	28480	0699-0678
A71R2	0699-0681	4	4	RESISTOR 100 .01% .1W F TC = 0 + -5	28480	0699-0681
A71R3	0698-3441	8	18	RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R4	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R5	0757-0274	5	14	RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A71R6	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R7	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A71R8	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A71R9	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A71R10	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R11	0699-0678	9		RESISTOR 900 .01% .1W F TC = 0 + -5	28480	0699-0678
A71R12	0699-0681	4		RESISTOR 100 .01% .1W F TC = 0 + -5	28480	0699-0681
A71R13	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R14	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R15	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A71R16	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R17	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A71R18	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A71R19	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A71R20	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R21	0699-0678	9		RESISTOR 900 .01% .1W F TC = 0 + -5	28480	0699-0678
A71R22	0699-0681	4		RESISTOR 100 .01% .1W F TC = 0 + -5	28480	0699-0681
A71R23	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A71R24	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R25	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A71R26	0757-0394	0		RESISTOR 51.1 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-51R1-F
A71R27	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A71R28	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A71R29	0698-6317	3	1	RESISTOR 500 .1% .125W F TC = 0 + -25	03888	PME55-1/8-T9-500R-B
A71R30	0699-0825	8	1	RESISTOR 281.2 .1% .125W F TC = 0 + -25	28480	0699-0825

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A71R31Δ	0699-1655	4		RESISTOR 158.1 .1% .125W F TC=0+-25	28480	0699-1655
A71R32Δ	0699-1637	2		RESISTOR 203.2 .1% .125W F TC=0+-25	28480	0699-1637
A71R33	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1211-F
A71R34	0757-0401	0	1	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A71R35	0698-3154	0	3	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A71R36	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A71R37	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A71R38	0698-3441	8		RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A71R39	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A71R40	0757-0465	6	5	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A71R41	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A71R42	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A71R43	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A71R44	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1211-F
A71R45	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A71R46	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A71R47	0698-0082	7		RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A71R48	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A71R49	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A71R50	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A71R51	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A71TP1	1251-0600	0	2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A71TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A71U1	1826-1020	9	5	ANALOG SWITCH 2 SPST 10-METAL	17856	DG200ABA
A71U2	1826-1020	9		ANALOG SWITCH 2 SPST 10-METAL	17856	DG200ABA
A71U3	1826-1020	9		ANALOG SWITCH 2 SPST 10-METAL	17856	DG200ABA
A71U4	1826-0606	5	1	IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A71U5	1826-1020	9		ANALOG SWITCH 2 SPST 10-METAL	17856	DG200ABA
A71U6Δ	1826-1314	4		RMS DC 14-CERDIP BPLR	28480	1826-1314
A71U7	1820-1195	7	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A71U8	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A72						
A72	08902-60108	8	1	IF CHANNEL FILTER ASSEMBLY (OPTION 030 ONLY) (DOES NOT INCLUDE FL1,FL2,R5,R6,R9&R10)	28480	08902-60108
A72C1	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A72C2	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A72C3	0180-2929	8	1	CAPACITOR-FXD 68UF+-10% 10VDC TA	28480	0180-2929
A72C4	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A72C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A72C6	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A72C7	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A72C8	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A72C9	0160-5469	5		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-5469
A72C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A72C11	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A72C12	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A72C13	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A72C14	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A72C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A72C16	0160-4797	0		CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A72C17	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A72C18	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A72C19	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A72C20	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A72C21	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A72C22Δ	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A72C23	0160-4797	0		CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A72C24	0160-4797	0		CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A72CR1	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A72CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A72CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A72CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A72CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A72CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A72CR7	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A72DS1	1990-0717	6	1	LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	HLMP-1501
A72E1	9170-0847	3	2	CORE-SHIELDING BEAD	02114	56-590-65/3B
A72E2	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				••••••••••••••••NOTE•••••••••••••••• FOR INFORMATION ABOUT SELECTING FILTERS FL1–FL2, SEE SERVICE SHEET 33, NOTE 2		
A72FL1	08901-80079	3		OPTION 032 12.5 KHZ FILTER WHEN FILTER OPTIONS INSTALLED ARE 032 AND 037.	28480	08901-80079
A72FL1	08901-80080	6		OPTION 033 25 KHZ FILTER WHEN FILTER OPTIONS INSTALLED ARE 033 AND 032 OR 033 AND 037	28480	08901-80080
A72FL1	08901-80085	1		OPTION 035 30 KHZ FILTER WHEN FILTER OPTIONS INSTALLED ARE 035 AND 032, 035 AND 033, OR 035, AND 037	28480	08901-80085
A72FL2	08901-80079	3		OPTION 032 12.5 KHZ FILTER WHEN FILTER OPTIONS INSTALLED ARE 032 AND 037.	28480	08901-80079
A72FL2	08901-80080	6		OPTION 033 25 KHZ FILTER WHEN FILTER OPTIONS INSTALLED ARE 033 AND 032 OR 033 AND 037	28480	08901-80080
A72FL2	08901-80086	2		OPTION 035 30 KHZ FILTER WHEN FILTER OPTIONS INSTALLED ARE 035 AND 032, 035 AND 033, OR 035, AND 037	28480	08901-80086
A72J1	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A72J2	1250-1425	7		CONNECTOR-RF SMC M SGL-HOLE-RR 50-OHM	28480	1250-1425
	2190-0124	4		WASHER-LK INTL T NO. 10 .195-IN-ID	28480	2190-0124
	2950-0078	9		NUT-HEX-DBL-CHAM 10-32-THD .067-IN-THK	28480	2950-0078
A72J3	1251-4700	9	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-4700
A72L1	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q = 60	28480	9140-0137
A72L2	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q = 60	28480	9140-0137
A72L3	9140-0137	1		INDUCTOR RF-CH-MLD 1MH 5% .2DX.45LG Q = 60	28480	9140-0137
A72MP1	08902-00033	2	1	BOARD COVER, IF CHAN FLTR	28480	08902-00033
A72Q1	1855-0421	3	1	TRANSISTOR J-FET 2N5114 P-CHAN D-MODE	17856	2N5114
A72Q2	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A72Q3	1854-0668	8	2	TRANSISTOR NPN SI TO-18 PD = 500MW	28480	1854-0668
A72Q4	1854-0668	8		TRANSISTOR NPN SI TO-18 PD = 500MW	28480	1854-0668
A72Q5	1853-0430	0	1	TRANSISTOR PNP 2N4959 SI TO-72 PD = 200MW	04713	2N4959
	9170-0847	3		CORE-SHIELDING BEAD	02114	56-590-65/3B
A72Q6	1854-0345	8	1	TRANSISTOR NPN 2N5179 SI TO-72 PD = 200MW	04713	2N5179
A72Q7	1853-0459	3		TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459
A72Q8	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A72Q9	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A72Q10	1853-0459	3		TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459
A72Q11	1854-0404	0		TRANSISTOR NPN SI TO-18 PD = 360MW	28480	1854-0404
A72Q12	1853-0459	3		TRANSISTOR PNP SI PD = 625MW FT = 200MHZ	28480	1853-0459

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A72R1	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A72R2	0757-0465	6		RESISTOR 100K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1003-F
A72R3	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A72R4	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A72R5*				NOT SEPARATELY REPLACEABLE P/O A72FL1 FACTORY SELECTED FOR FILTER OPTIONS		
A72R6*				NOT SEPARATELY REPLACEABLE P/O FL2 FACTORY SELECTED FOR FILTER OPTIONS		F
A72R7	0757-0400	9	3	RESISTOR 90.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-90R9-F
A72R8	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R9*				NOT SEPARATELY REPLACEABLE P/O FL1 FACTORY SELECTED FOR FILTER OPTIONS		F
A72R10*				NOT SEPARATELY REPLACEABLE P/O FL2 FACTORY SELECTED FOR FILTER OPTIONS		F
A72R11	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A72R12	0757-0405	4		RESISTOR 162 1% .125W F TC = O + -100	24546	C-4-1/8-TO-162R-F
A72R13	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R14	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A72R15	0757-0405	4		RESISTOR 162 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-162R-F
A72R16	0698-0082	7		RESISTOR 464 1% .1252 F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A72R17	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R18	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R19	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A72R20	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R21	0757-1094	9		RESISTOR 1.47K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1471-F
A72R22	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A72R23	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A72R24	0699-0678	9		RESISTOR 900 .01% .1W F TC = 0 + -5	28480	0699-0678
A72R25	0699-0681	4		RESISTOR 100 .01% .1W F TC = 0 + -5	28480	0699-0681
A72R26	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A72R27	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A72R28	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A72R29	0698-0082	7		RESISTOR 464 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-4640-F
A72R30	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A72R31	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A72R32	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A72R33	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A72R34	0757-0274	5		RESISTOR 1.21K 1% .125W F TC = 0 + -100	24546	C4-1/8-TO-1211-F
A72R35	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R36	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R37	0698-3443	0		RESISTOR 287 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-287R-F
A72R38	0757-0400	9		RESISTOR 90.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-90R9-F
A72R39	0757-0400	9		RESISTOR 90.9 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-90R9-F
A72R40	0757-0280	3	2	RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A72R41	0757-0280	3		RESISTOR 1K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-1001-F
A72R42	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A72R43	0698-0084	9		RESISTOR 2.15K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-2151-F
A72R44	0698-3441	8		RESISTOR 215 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-215R-F
A72T1	08901-80070	4	1	TRANSFORMER/FLTR	28480	08901-80070
A72U1	1826-0154	8		IC SWITCH ANLG DUAL TO-100 PKG	17856	DG200BA
A72U2	1820-0535	7	1	IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A72U3	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A72U4	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A72U5	1826-0989	7	4	IC OP AMP GP 8-DIP-C PKG	27014	LM307J

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2305A TO 2702A						
AT1	08902-60035	0	1	INPUT ATTENUATOR ASSY	28480	08902-60035
	2360-0115	4	1	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2704A ONLY						
AT1	08642-60962	7	1	INPUT ATTENUATOR 70dB	28480	08642-60692
2706A AND ABOVE						
AT1	08642-60291	5	1	INPUT ATTENUATOR 70dB	28480	08642-60291
AT1	08902-60044	1		INPUT ATTENUATOR ASSY, RESTORED (REQUIRES EXCHANGE)	28480	08902-60044
2305A TO 2702A						
AT2	11722-60005	3	1	10 DB ATTENUATOR	28480	11722-60005
2704A AND ABOVE						
AT2				REPLACED BY U3		
2305A TO 2339A						
B1	08901-60094	0	1	FAN ASSEMBLY, 115v-50/60HZ (EXCEPT OPTION 004)	28480	08901-60095
	86701-00017	3		SHIELDING DISK	28480	86701-00017
	1520-0067	4	5	SHOCK MOUNT .44-EFF-HGT .31-OD (FOR FAN IN REAR PANEL)	28480	1520-0067
	0400-0009	9		GROMMET-RND .125-IN-ID .25-IN-GRV-OD	28480	0400-0009
	1251-3201	3		CONNECTOR 3-PIN F POST TYPE	28480	1251-3201
	1251-4283	3		CONTACT-CONN U/W-POST-TYPE FEM CAP	28480	1251-4283
2340A ONLY						
B1	08901-60247	5		FAN ASSEMBLY 115V-50/60HZ (EXCEPT OPTION 004)	28480	08901-60247
	0624-0216	4		SCREW-TPG 8-32 .375-IN-LG PAN-HD-POZI	28480	0624-0216
	3160-0300	6		FINGERGUARD	28480	3160-0300
	86701-00017	3		SHIELDING DISK	28480	86701-00017
	1520-0067	4	5	SHOCK MOUNT .44-EFF-HGT .31-OD (FOR FAN IN REAR PANEL)	28480	1520-0067
2341A TO 2343A						
B1	08901-60094	0	1	FAN ASSEMBLY, 115V-50/60HZ (EXCEPT OPTION 004)	28480	08901-60095
	86701-00017	3		SHIELDING DISK	28480	86701-00017
	1520-0067	4	5	SHOCK MOUNT .44-EFF-HGT .31-OD (FOR FAN IN REAR PANEL)	28480	1520-0067
	0400-0009	9		GROMMET-RND .125-IN-ID .25-IN-GRV-OD	28480	0400-0009
	1251-3201	3		CONNECTOR 3-PIN F POST TYPE	28480	1251-3201
	1251-4283	3		CONTACT-CONN U/W-POST-TYPE FEM CAP	28480	1251-4283

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2345A AND ABOVE						
B1	08901-60306	7		FAN ASSEMBLY 115V-50/60HZ (EXCEPT OPTION 004)	28480	08901-60306
	0624-0216	4		SCREW-TPG 8-32 .375-IN-LG PAN-HD-POZI	28480	0624-0216
	3160-0300	6		FINGERGUARD	28480	3160-0300
	86701-00017	3		SHIELDING DISK	28480	86701-00017
	1520-0067	4	5	SHOCK MOUNT .44-EFF-HGT .31-OD (FOR FAN IN REAR PANEL)	28480	1520-0067
B1	08901-60307	8	1	FAN ASSEMBLY, 115V 48/480-HZ (OPTION 004 ONLY)	28480	08901-60307
	0400-0009	9		GROMMET-RND .125-IN-ID .25-IN-GRV-OD	28480	0400-0009
	1251-3201	3		CONNECTOR 3-PIN F POST TYPE	28480	1251-3201
	1251-3897	3	3	CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3897
	1520-0067	4		SHOCK MOUNT .44-EFF-HGT .31-OD	28480	1520-0067
	86701-00017	3		FAN SHIELD	28480	86701-00017
C10	0160-3968	5	1	CAPACITOR-FXD .47UF +-10PF 250VAC(RMS) (OPTION 004 ONLY)	28480	0160-3968
CR1	1906-0231	2	1	DIODE-CT-RECT 200V 15A	28480	1906-0231
	1200-0043	8	1	INSULATOR-XSTR ALUMINUM	28480	1200-0043
	2200-0107	6	6	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
F1	2110-0083	6	1	FUSE 2.5A 250V NTD 1.25X.25 UL (FOR 115V OPERATION)	28480	2110-0083
F1	2110-0043	8	1	FUSE 1.5A 250V NTD 1.25X.25 UL (FOR 230V OPERATION)	28480	2110-0043
J1	08662-60304	5	2	CONN ASSEMBLY RF INPUT (EXCEPT OPTION 001)	28480	08662-60304
	2190-0104	0	2	WASHER-LK INTL T 7/16 IN .439-IN-ID	28480	2190-0104
	2950-0132	6	2	NUT-HEX-DBL-CHAM 7/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	08731-210	2	2	LOCKING NUT	28480	08731-210
J2				MODULATION OUTPUT/AUDIO INPUT P/O W9 NSR (J2 APPEARS ON THE REAR PANEL OF OPTION 001 INSTRUMENTS)		
J3	1250-1811	5	6	ADAPTER-COAX STR F-N F-SMA CALIBRATION OUTPUT, AM/FM (EXCEPT OPTION 001) (INCLUDES ATTACHING HARDWARE)	28480	1250-1811
2305A TO 2328A						
J4	1250-1811	5		ADAPTER-COAX STR F-N F-SMA CALIBRATION OUTPUT, RF POWER (EXCEPT OPTION 001) (INCLUDES ATTACHING HARDWARE)	28480	1250-1811
2329A AND ABOVE						
J4	1250-1895	5		ADAPTER-COAX STR F-N F-SMA CALIBRATION OUTPUT, RF POWER (EXCEPT OPTION 001)	28480	1251-1895

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
J5	1250-0083	1	4	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM OUTPUT, AM	28480	1250-0083
	2190-0016	3	7	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8	7	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J6	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM OUTPUT, FM	28480	1250-0083
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J7	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM OUTPUT, RECORDER	28480	1250-0083
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J8				OUTPUT, IF P/O W26 NSR		
J9				TIME BASE 10 MHZ OUTPUT P/O W22 NSR (OPTION 002 ONLY)		
J10				TIME BASE 10 MHZ INPUT P/O W23 NSR (OPTION 002 ONLY)		
J11	1250-1811	5		ADAPTER-COAX STR F-N F-SMA AM/FM CAL OUTPUT, REAR (OPTION 001 ONLY) (INCLUDES ATTACHING HARDWARE)	28480	1250-1811
2305A TO 2328A						
J12	1250-1811	5		ADAPTER-COAX STR F-N F-SMA CALIBRATION OUTPUT, RF POWER (OPTION 001 ONLY) (INCLUDES ATTACHING HARDWARE)	28480	1250-1811
2329A AND ABOVE						
J12	1250-1895	5		ADAPTER-COAX STR F-N F-SMA CALIBRATION OUTPUT, RF POWER (OPTION 001 ONLY)	28480	1251-1895
J13	1250-1811	5		ADAPTER-COAX STR F-N F-SMA LO OUTPUT, REAR (OPTIONS 003 AND 030 ONLY) (INCLUDES ATTACHING HARDWARE)	28480	1250-1811
J14	1250-1811	5		ADAPTER-COAX STR F-N F-SMA LO INPUT, REAR (OPTIONS 003 AND 030 ONLY) (INCLUDES ATTACHING HARDWARE)	28480	1250-1811
J15	08662-60304	5		CONN ASSY RF INPUT, REAR (OPTION 001 ONLY)	28480	08662-60304
	2190-0104	0		WASHER-LK INTL T 7/16 IN .439-IN-ID	28480	2190-0104
	2950-0132	6		NUT-HEX-DBL-CHAM 7/16-28-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	08731-210	2		LOCKING NUT	28480	08731-210

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
J16	1510-0091	3	2	BINDING POST SGL SGL-TUR JGK RED "RF SWITCH 1"	28480	1510-0091
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J17	1510-0091	3	2	BINDING POST SGL SGL-TUR JGK RED "RF SWITCH 2"	28480	1510-0091
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8	1	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J18	1510-0091	3		BINDING POST SGL SGL-TUR JGK RED RF SWITCH GROUND	28480	1510-0091
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J19	1250-0083	1		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM FREQ OFFSET TTL OUT	28480	1250-0083
	2190-0016	3		WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2950-0001	8		NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
2305A TO 2505A						
MP1	5020-8805	8	1	FRONT FRAME	28480	5020-8805
	2360-0114	3	6	SCREW-MACH 6-32 .25-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP2	5020-8837	6	4	CORNER STRUT	28480	5020-8837
	2360-0115	4	28	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0119	8	1	SCREW-MACH 6-32 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2510-0192	6	16	SCREW-MACH 8-32 .25-IN-LG 100 DEG (MP2 TO MP1, MP16)	00000	ORDER BY DESCRIPTION
2515A AND ABOVE						
MP1	5021-5805	4	1	FRONT FRAME	28480	5021-5805
	2360-0114	3	6	SCREW-MACH 6-32 .25-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
MP2	5021-5837	2	4	CORNER STRUT	28480	5021-5837
	2360-0115	4	28	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0119	8	1	SCREW-MACH 6-32 .438-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	0515-1331	5	16	SCREW-METRIC SPECIALTY M4 X 0.7 THD;6 (MP2 TO MP1, MP16)	28480	0515-1331
MP3	5041-8802	9	1	TRIM, TOP	28480	5041-8802
MP4	5062-3704	4	2	STRAP HANDLE 18 IN.	28480	5062-3704
MP5	5062-3735	1	1	COVER-TOP ASSY	28480	5062-3735
	0510-0043	4	2	RETAINER-RING E-R EXT .141-IN-DIA STL	28480	0510-0043
	0510-1171	1	2	RETAINER-PUSH ON RND EXT .265-IN-DIA STL	28480	0510-1171
MP6	5062-3747	5	1	COV-BOTTOM ASSY	28480	5062-3747
	0510-0043	4		RETAINER-RING E-R EXT .141-IN-DIA STL	28480	0510-0043
	0510-1171	1		RETAINER-PUSH ON RND EXT .265-IN-DIA STL	28480	0510-1171
MP7	08902-00066	1	2	SIDE COVER	28480	08902-00066
MP8	08902-00065	0	1	WINDOW PANEL	28480	08902-00065
MP9	5041-8819	8	2	STRAP, HANDLE, CAP-FRONT	28480	5041-8819
	0515-1239	2		SCREW-MACH M3 X 0.8 12MM-LG	00000	ORDER BY DESCRIPTION
MP10	5041-8820	1	2	STRAP, HANDLE, CAP-REAR	28480	5041-8820
	0515-1239	2		SCREW-MACH M3 X 0.8 12MM-LG	00000	ORDER BY DESCRIPTION
MP11	5041-8801	8	4	FOOT(STANDARD)	28480	5041-8801
MP12	5001-0540	2	2	TRIM, SIDE	28480	5001-0540
MP13	1460-1345	5	2	TILT STAND SST	28480	1460-1345

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2305A TO 2912A						
MP14	08901-00097	7	1	FRONT PANEL (EXCEPT OPT 001)	28480	08901-00097
MP14	08901-00107	0	1	FRONT PANEL (OPT 001 ONLY)	28480	08901-00107
2914A TO 3018A						
MP14	08901-00200	4	1	FRONT PANEL (EXCEPT OPT 001)	28480	08901-00200
MP14	08901-00201	5	1	FRONT PANEL (OPT 001 ONLY)	28480	08901-00201
	0510-1148	2	3	RETAINER-PUSH ON KB-TO-SHFT EXT	28480	0510-1148
3024A AND ABOVE						
MP14	08901-00200	4	1	FRONT PANEL	28480	08901-00200
	6960-0150	3	3	HOLE PLUG .500D	28480	6960-0150
	6960-0148	9	1	HOLE PLUG .688D	28480	6960-0148
	6960-0154	7	1	HOLE PLUG .812D	28480	6960-0154
2305A TO 2912A						
MP15	08901-00100	3	1	FRONT SUB-PANEL	28480	08901-00100
	5040-6928	4		STRIP DIVIDER	28480	5040-6928
	2190-0003	8	11	WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0003
	2200-0149	6	11	SCREW-MACH 4-40 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0105	6	7	WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
2914A ONLY						
MP15	08901-00209	3	1	FRONT SUB-PANEL	28480	08901-00209
	5040-6928	4		STRIP DIVIDER	28480	5040-6928
	2190-0003	8	11	WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0003
	2200-0149	6	11	SCREW-MACH 4-40 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0105	6	7	WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
2920A AND ABOVE						
MP15†	08901-00209	3	1	FRONT SUB-PANEL	28480	08901-00209
	2190-0003	8	11	WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0003
	2200-0149	6	11	SCREW-MACH 4-40 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0105	6	7	WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
	0380-1230	6	4	SPACER-RND .45-IN-LG .147-IN-ID (SEE SECTION 7)	00000	ORDER BY DESCRIPTION
	5041-3616	3	11	LIGHT PIPE (SEE SECTION 7)	28480	5041-3616
2305A TO 2339A						
MP16	08901-20230	2	1	REAR PANEL	28480	08901-20230
2340A ONLY						
MP16	08901-20233	5		REAR PANEL	28480	08901-20233
2341A TO 2343A						
MP16	08901-20230	2	1	REAR PANEL	28480	08901-20230
2345A TO 2505A						
MP16	08901-20233	5		REAR PANEL	28480	08901-20233
2515A AND ABOVE						
MP16	08901-20272	2	1	REAR PANEL	28480	08901-20272

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2305A TO 2451A						
MP17	08901-00078	4	1	CENTER STRUT	28480	08901-00078
	0624-0100	5	111	SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL	28480	0624-0100
	2200-0107	6	8	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0116	5	4	SCREW-MACH 6-32 .312-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
	2360-0117	6	14	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2505A TO 2621A						
MP17	08901-00078	4	1	CENTER STRUT	28480	08901-00078
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
	2200-0107	6	8	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0116	5	4	SCREW-MACH 6-32 .312-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
	2360-0117	6	14	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2631A AND ABOVE						
MP17	08901-00171	8	1	CENTER STRUT	28480	08901-00171
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
	2200-0107	6	8	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0116	5	4	SCREW-MACH 6-32 .312-IN-LG 82 DEG	00000	ORDER BY DESCRIPTION
	2360-0117	6	14	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP18	5041-8821	2	4	FOOT, REAR	28480	5040-8821
	0515-1232	5		SCREW-MACH M3.5 X 0.6 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
2305A TO 2621A						
MP19	08901-00076	2	1	SUPPORT BRACKET AUD TOP	28480	08901-00076
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	08662-20028	6	10	HOLE PLUG	28480	08662-20028
2631A AND ABOVE						
MP19	08901-00169	4	1	SUPPORT BRACKET AUD TOP	28480	08901-00169
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	08662-20028	6	10	HOLE PLUG	28480	08662-20028
MP20	08901-00009	1	1	POWER SUPPLY SUPPORT BRACKET	28480	08901-00009
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0117	6		SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP20	08901-00108	1	1	POWER SUPPLY SUPPORT BRACKET (OPT 002 ONLY)	28480	08901-00108
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0117	6		SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP21	08901-00047	7	1	SUPPORT BRACKET DIGTL	28480	08901-00047
MP22	08901-20159	4	1	WIRE DUCT	28480	08901-20159
	2190-0006	1	4	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0197	2	4	SCREW-MACH 6-32 .375-IN-LG PAN-HD-POZI	28480	2360-0197
	3050-0227	3	4	WASHER-FL MTLC NO. 6 .149-IN-ID	28480	3050-0227

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2305A TO 2621A						
MP23	08901-00035	3	1	GASKET (BETWEEN EXTRUSION AND A27)	28480	08901-00035
2631A AND ABOVE						
MP23				NOT ASSIGNED		
2305A TO 2530A						
MP24	08901-00088	6	1	PC BD GUIDE	28480	08901-00088
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	08662-20028	6		HOLE PLUG	28480	08662-20028
2535A AND ABOVE						
MP24	08902-00023	0	1	PC BD GUIDE	28480	08902-00023
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	08662-20028	6		HOLE PLUG	28480	08662-20028
MP25	08901-80007	7	4	SHOCK MOUNT	28480	08901-80007
MP26				NOT ASSIGNED		
MP27	5061-2033	8	1	INFORMATION TRAY	28480	5061-2033
MP28	08901-00046	6	1	FAN COVER	28480	08901-00046
MP29	08902-00015	0	1	SPACER RF AMP (BETWEEN U1 AND A70)	28480	08902-00015
	2200-0105	4	4	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP30	08901-20160	7	1	WIRE DUCT COVER	28480	08901-20160
MP31	08901-00140	1	1	REAR WIRE DUCT SUPPORT	28480	08901-00140
2305A TO 2702A						
MP32	08902-00018	3	1	BRACKET, AMP (S1, S2)	28480	08902-00018
	2200-0151	0	4	SCREW-MACH 4-40 .75-IN-LG PAN-HD-POZI (ATTACH S1, S2 TO MP32)	00000	ORDER BY DESCRIPTION
	2190-0003	8		WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0003
	2200-0105	4	4	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI (ATTACH A70 TO MP32)	00000	ORDER BY DESCRIPTION
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI (ATTACH MP32 TO MP33 AND MP17)	00000	ORDER BY DESCRIPTION
2704A AND ABOVE						
MP32	08902-00062	7		DECK AMPLIFIER	28480	08902-00062
	2200-0151	0	4	SCREW-MACH 4-40 .75-IN-LG PAN-HD-POZI (ATTACH U3 TO MP32)	00000	ORDER BY DESCRIPTION
	2190-0003	8		WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0003
	2200-0105	4	2	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI (ATTACH A70 TO MP32)	00000	ORDER BY DESCRIPTION
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI (ATTACH MP32 TO MP33 AND MP17)	00000	ORDER BY DESCRIPTION
2305A TO 2702A						
MP33	08902-00016	1	1	DECK AMPLIFIER	28480	08902-00016
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2704A AND ABOVE						
MP33	08902-00063	8		BRACKET ATTENUATOR	28480	08902-00063
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI (ATTACH MP33 TO CHASSIS)	00000	ORDER BY DESCRIPTION

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2305A TO 2530A						
MP34	1600-0692	1	3	STAMPING-BE-CU CLIP WINDOW RETAINING	28480	1600-0692
2535A AND ABOVE						
MP34				NOT ASSIGNED		
MP35	08902-00019	4	1	ATTENUATOR MOUNTING BRACKET	28480	08902-00019
	2200-0105	4		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP36	08901-00086	4	1	SHOCK MOUNT BRACKET, FRONT	28480	08901-00086
	0400-0010	2	4	GROMMET-RND .25-IN-ID .375-IN-GRV-OD	28480	0400-0010
	2190-0017	4	4	WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
	2580-0002	4	2	NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
MP37	08901-00079	5	1	SHOCK MOUNT BRACKET, REAR	28480	08901-00079
	0400-0010	2		GROMMET-RND .25-IN-ID .375-IN-GRV-OD	28480	0400-0010
	2190-0017	4		WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
	2580-0002	4		NUT-HEX-DBL-CHAM 8-32-THD .085-IN-THK	28480	2580-0002
2305A TO 2451A						
MP38	08902-20020	9	1	EXTRUSION ASSY LO	28480	08902-20020
	0403-0005	1	3	BUMPER FOOT-SCR .5-IN-MAX-OD.188-IN-THK	28480	0403-0005
	0624-0100	5		SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL	28480	0624-0100
	2190-0756	8	3	WASHER-FL MTLC NO. 5 .13-IN-ID .25-IN-OD	28480	2190-0756
2505A AND ABOVE						
MP38	08902-20037	8	1	EXTRUSION ASSY LO	28480	08902-20020
	0403-0005	1	3	BUMPER FOOT-SCR .5-IN-MAX-OD.188-IN-THK	28480	0403-0005
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
	2190-0756	8	3	WASHER-FL MTLC NO. 5 .13-IN-ID .25-IN-OD	28480	2190-0756
MP39	08901-00099	9	1	SCREEN, RFI	28480	08901-00099
	2200-0567	2		SCREW-MACH 4-40 .125-IN-LG PNA-HD-POZI	00000	ORDER BY DESCRIPTION
MP40	08901-20164	1	1	FRONT WINDOW	28480	08901-20164
	0460-1297	5		STAMPING-BE-CU CLIP WINDOW RETAINING	28480	1600-0692
MP41	08902-00008	1	1	GASKET, EXTRUSION	28480	08902-00008
2305A TO 2451A						
MP42	08901-20219	7	1	EXTRUSION ASSY, AUD FRONT	28480	08901-20219
	0624-0100	5		SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL	28480	0624-0100
2505A TO 2621A						
MP42	08901-20219	7	1	EXTRUSION ASSY, AUD FRONT	28480	08901-20219
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
2631A AND ABOVE						
MP42	08901-20278	8	1	EXTRUSION ASSY, AUD FRONT	28480	08901-20278
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2305A TO 2451A						
MP43	08901-20161	8	1	EXTRUSION ASSY, AUD REAR	28480	08901-20161
	0624-0100	5		SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL	28480	0624-0100
2505A TO 2530A						
MP43	08901-20161	8	1	EXTRUSION ASSY, AUD REAR	28480	08901-20161
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
2535A TO 2621A						
MP43	08901-20259	5	1	EXTRUSION ASSY, AUD REAR	28480	08901-20259
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
2631A AND ABOVE						
MP43	08901-20279	9	1	EXTRUSION ASSY, AUD REAR	28480	08901-20279
	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
2305A TO 2530A						
MP44	08901-20155	0	1	EXTRUSION ASSY, DIGTL	28480	08901-20155
2535A AND ABOVE						
MP44	08902-20054	9	1	EXTRUSION ASSY, DIGTL	28480	08901-20032
MP45				NOT ASSIGNED		
2305A TO 2530A						
MP46	08901-00121	8	1	OSCILLATOR MOUNTING PLATE	28480	08901-00121
	0360-0272	2	1	TERMINAL-SLDR LUG LK-MTG FOR-#4-SCR	28480	0360-0272
	2200-0119	0	3	SCREW-MACH 4-40 1-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2535A AND ABOVE						
MP46	08902-00025	2	1	OSCILLATOR MOUNTING PLATE	28480	08902-00025
	0360-0272	2	1	TERMINAL-SLDR LUG LK-MTG FOR-#4-SCR	28480	0360-0272
	2200-0119	0	3	SCREW-MACH 4-40 1-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP47	08901-20165	2	1	DISPLAY BD SHIELD	28480	08901-20165
	2190-0003	8		WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0003
	2200-0149	6		SCREW-MACH 4-40 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0105	6		WASHER-FL MTLC NO. 4 .125-IN-ID	28480	3050-0105
MP48	08901-00102	5	1	DISPLAY BOARD INSULATOR	28480	08901-00102
	2200-0149	6		SCREW-MACH 4-40 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP49	6960-0002	4	6	PLUG-HOLE DOME-HD FOR .5-D-HOLE STL	28480	6960-0002
MP50	6960-0046	6	1	PLUG-HOLE FL-HD FOR .688-D-HOLE BRS	28480	6960-0046
MP51	6960-0013	7	1	PLUG-HOLE DOME-HD FOR .812-D-HOLE STL	28480	6960-0013

†Refer to Section 7 for update information *Factory Selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
2305A TO 2621A						
MP52	08901-00090	0	1	DUCT SUPPORT	28480	08901-00090
	2190-0018	5	2	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0018
	3030-0139	4	2	SCREW-SKT HD CAP 6-32 .375-IN-LG SST	00000	ORDER BY DESCRIPTION
	08662-20028	6		HOLE PLUG	28480	08662-20028
2631A AND ABOVE						
MP52	08901-00172	9	1	DUCT SUPPORT	28480	08901-00172
	2190-0018	5	2	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0018
	3030-0139	4	2	SCREW-SKT HD CAP 6-32 .375-IN-LG SST	00000	ORDER BY DESCRIPTION
	08662-20028	6		HOLE PLUG	28480	08662-20028
MP53	08901-00089	7	1	RTNR DIGTL	28480	08901-00089
MP54	08901-20231	3	1	CENTER STRUT BRACE	28480	08901-20231
2305A TO 2621A						
MP55	08901-00077	3	1	SUPPORT BRACKET, AUD BOTTOM	28480	08901-00077
2631A AND ABOVE						
MP55	08901-00170	7	1	SUPPORT BRACKET, AUD BOTTOM	28480	08901-00170
MP56	7120-1254	1	1	NAMEPLATE .312-IN-WD .54-IN-LG AL	28480	7120-1254
MP57	7120-1927	5	1	LABEL-BLANK .625-IN-WD 1.5-IN-LG AL	28480	7120-1927
MP58				NOT ASSIGNED		
MP59	7120-4296	7	1	LABEL-WARNING .688-IN-WD 1.5-IN-LG AL	28480	7120-4296
2305A TO 2505A						
MP60	7120-5911	5	1	LABEL-WARNING 1-IN-WD 7-IN-LG PPR	28480	7120-5911
2515A AND ABOVE						
MP60	7120-8607	2	1	LABEL...THIS INSTRUMENT USES METRIC...	28480	7120-8607
MP61	7120-8053	2	1	LABEL-WARNING 15.1-MM-WD 45.6-MM-LG	28480	7120-8053
MP62	7120-8138	4	1	LABEL-WARNING 6-MM-WD 51-MM-LG VINYL	28480	7120-8138
MP63				NOT ASSIGNED		
2305A TO 2748A						
MP64	08901-00116	1	1	BOTTOM COVER INSULATOR	28480	08901-00116
2751A AND ABOVE						
MP64	08901-00193	4	1	BOTTOM COVER INSULATOR	28480	08901-00193
2305A TO 2621A						
MP65	08901-00127	4	1	BAFFLE AIR REAR LEFT	28480	08901-00127
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2631A AND ABOVE						
MP65	08901-00173	0	1	BAFFLE AIR REAR LEFT	28480	08901-00173
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
MP66	08901-00126	3	1	BAFFLE AIR FRONT RIGHT	28480	08901-00126
	2360-0115	4		SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
MP67	08901-00125	2	1	REAR AIR BAFFLE	28480	08901-00125
	2200-0103	2	2	SCREW-MACH 4-40 .25-IN-LG PAN-HD-POZI	28480	2200-0103
2305A TO 2621A						
MP68	08901-00213	0	1	AIR DUCT COVER	28480	08901-00123
2631A AND ABOVE						
MP68	08901-00177	4	1	AIR DUCT COVER	28480	08901-00177
MP69	08902-20025	4	1	INPUT SWITCH COVER	28480	08902-20025
2305A TO 2451A						
MP70	0624-0100	5		SCREW-TPG 4-40 .5-IN-LG PAN-HD-POZI STL (ATTACH MOTHERBOARDS TO FRAME)	28480	0624-0100
2505A AND ABOVE						
MP70	0624-0653	3		SCREW 440X1/2 TAPTITE T-10 PNTX	00000	ORDER BY DESCRIPTION
MP71	8160-0072	4		RFI ROUND STRIP MNL-MSH .062-IN-OD	28480	8160-0072
MP72	7120-7032	5	1	LABEL-INFORMATION .325-IN-WD 1.75-IN-LG	28480	7120-7032
MP73	08902-90026	2	1	SPECIAL FUNCTION INFORMATION CARD	28480	08902-90026
MP74	08902-90027	3	1	OPERATING INFORMATION CARD	28480	08902-90027
MP75	5020-8806	9	1	REAR FRAME	28480	5020-8806
MP76	7121-4617	8	1	VOLTAGE INFORMATION LABEL	28480	7121-4617
2305A TO 2406A						
MP77-MP80				NOT ASSIGNED		
2411A AND ABOVE						
MP77	08902-60032	7		GROUND STRAP	28480	08902-60032
MP78	08902-60032	7		GROUND STRAP	28480	08902-60032
MP79	08902-60032	7		GROUND STRAP	28480	08902-60032
MP80△	08901-00214	0	2	SPACER (BETWEEN T1 AND MP16)	28480	08901-00214
MP81	5040-6888	5	4	LIGHT PIPES	28480	5040-6888
MP82	0380-0003	9	4	SPACER-RND .125-IN-LG .18-IN-ID	00000	ORDER BY DESCRIPTION
MP83	08901-00157	0	1	COVER, EXTRUSION (EXCEPT OPTION 030)	28480	08901-00157
MP84	08902-00024	1	1	MOUNTING PLATE - S4 (OPTION 030 ONLY)	28480	08902-00024
	2360-0113	2		SCREW-MACH 6-32 .25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0003	8		WASHER-LK HLCL NO. 4 .115-IN-ID	28480	2190-0003
2305A TO 2702A						
MP85				NOT ASSIGNED		
MP86				NOT ASSIGNED		
2704A AND ABOVE						
MP85	2200-0107	6	6	SCREW-MACH 4-40 .625-IN-LG 82 DEG	00000	2200-01700
MP86	2200-0105	4		SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) △ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
MP87Δ	08901-00211	7	1	BD RETAINING BRACKET	28480	08901-00211
				(FOR RETAINING A13 AND A14)		
	0380-0003	9	5	SPACER .125L.181ID	28480	0380-0003
	2360-0115	4	1	SCREW-MACHINE 6-32 .312PNPD	28480	2360-0115
	2190-0006	1	1	LOCK WASHER .141ID	28480	2190-0006
2305A TO 2702A						
S1	08902-60024	7	2	COAX SWITCH	28480	08902-60024
S2	08902-60024	7		COAX SWITCH	28480	08902-60024
2704A AND ABOVE						
S1				REPLACED BY U3		
S2				REPLACED BY U3		
2305A TO 2912A						
S3	3101-2080	9	1	SWITCH-RKR BASIC DPDT 3A 250VAC SLDR-LUG	28480	3101-2080
	5041-1418	9	1	ROCKER	28480	5041-1418
	2200-0164	5	2	SCREW-MACH 4-40 .188-IN-LG UNCT 82 DEG	00000	ORDER BY DESCRIPTION
2914A AND ABOVE						
S3	3101-2915	9	1	SWITCH-RKR PRI-SW SPDT 5A 120VAC	02392	U11 J50 ZQE WHITE
	08902-00017	2	1	LABEL-RF SWITCH	28480	08902-00017
	2200-0115	6		SCREW-MACH 4-40 .75-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
T1	9100-4255	8	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-4255
	7100-1283	4		TRANSFORMER COVER	28480	7100-1283
	2190-0034	5	6	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
	2680-0131	2	2	SCREW-MACH 10-32 2.25-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2680-0132	3	4	SCREW-MACH 10-32 2.5-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2740-0002	4	2	NUT-HEX-DBL-CHAM 10-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
	3050-0006	6	2	WASHER-SHLDR NO. 10 .2-IN-ID .5-IN-OD	28480	3050-0006
	3050-0226	2	4	WASHER-FL MTLC NO. 10 .203-IN-ID	28480	3050-0226
	1400-0249	0	6	CABLE TIE .062-.625-DIA .091-WD NYL	28480	1400-02492
	08901-00140	1	1	BRACKET	28480	08901-00140
U1	08902-67001	4	1	RF AMP	28480	08902-67001
	2200-0107	6		SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
U2	5086-7283	2	1	LIMITER	28480	5086-7283
2305A TO 2702A						
U3				NOT ASSIGNED		
2704A AND ABOVE						
U3	08902-60121	9	1	ATTENUATOR/SWITCH	28480	08902-60121
	08902-80020	5	1	LABEL	28480	08902-80020

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
Y1	0960-0529	4	1	OSCILLATOR-CRYSTAL OVENIZED; 10MHZ; 1	28480	0960-0529
	2190-0006	1		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0203	1	4	SCREW-MACH 6-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	3050-0227	3		WASHER-FL MTLC NO. 6 .149-IN-ID	28480	3050-0227
	0380-1181	6		SPACER-PRESS-IN 0.250-IN-LG; 0.180-IN	28480	0380-1181
W1	08902-20008	3	1	SEMI-RIGID COAX CABLE ASSY RF INPUT (J1) - W3 (EXCEPT OPTION 001)	28480	08902-20008
2305A TO 2702A						
W2	08902-20030	1	1	COAX CABLE ASSY (6) REAR PANEL RF INPUT (J15)-W3	28480	08902-20030
2704A AND ABOVE						
W2	08902-20120	0	1	SEMI-RIGID COAX CABLE ASSY (OPT #001) REAR PANEL RF INPUT (J15)-W3	28480	08902-20120
2305A TO 2702A						
W3	08902-20009	4	1	SEMI-RIGID COAX CABLE ASSY	28480	08902-20009
2704A AND ABOVE						
W3				NOT ASSIGNED, REPLACED BY W61. RF INPUT CABLE (W1) - U3		
2305A TO 2702A						
W4	08902-20011	8	1	SEMI-RIGID COAX CABLE ASSY 10 DB PAD	28480	08902-20011
W5	08902-20010	7	1	SEMI-RIGID COAX CABLE ASSY SWITCH 1-2	28480	08902-20010
2704A AND ABOVE						
W4				NOT ASSIGNED		
W5				NOT ASSIGNED		
2305A TO 2702A						
W6	08902-20012	9	1	SEMI-RIGID COAX CABLE ASSY AMP IN	28480	08902-20012
2704A AND ABOVE						
W6				NOT ASSIGNED, REPLACED BY W62.		
2305A TO 2702A						
W7	08902-20013	0	1	SEMI-RIGID COAX CABLE ASSY AMP OUT	28480	08902-20013
2704A AND ABOVE						
W7				NOT ASSIGNED, REPLACED BY W63.		

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
W8	08902-60018	9	1	COAX CABLE ASSY (96) A16J1- U3, PORT 1.	28480	08902-60018
2305A TO 2312A						
W9	08901-60165	6	1	COAX CABLE ASSY (1) A52J2 - MODULATION OUT/AUDIO IN ALL INSTRUMENTS INCL OPT 001	28480	08901-60165
2413A AND ABOVE						
W9	08901-60165	6	1	COAX CABLE ASSY (1) A52J2 - MODULATION OUT/AUDIO IN (EXCEPT OPTION 001)	28480	08901-60165
W10	08901-60166	7	1	COAX CABLE ASSY (9) A50J2 TO CALIBRATION OUTPUT, AM/FM (EXCEPT OPTION 001)	28480	08901-60166
W11	08901-60178	1	1	COAX CABLE ASSY (98) CALIBRATION OUTPUT, RF POWER ALL INSTRUMENTS INCL OPT 001	28480	08901-60178
W12	08901-60166	7	1	COAX CABLE ASSY (9) CALIBRATION OUTPUT, AM/FM (OPTION 001 ONLY)	28480	08901-60166
W13	08901-60225	9	1	WIRING HARNESS A1J1 - A26J1	28480	08901-60225
W14	08901-60175	8	1	RIBBON CABLE ASSY A1J2 - A27J3	28480	08901-60175
W15	08902-60025	8	1	RIBBON CABLE ASSY A15J1 - A70J1	28480	08902-60025
W16	08901-60053	1	1	COAX CABLE ASSY (935) A2J1 - A6J1	28480	08901-60053
W17	08901-60056	4	1	COAX CABLE ASSY (947) A2J2 - A4J3	28480	08901-60056
W18	08901-60154	3	1	COAX CABLE ASSY (3) A11J1 - A19J1	28480	08901-60154
W19	08901-60064	4	1	COAX CABLE ASSY (934) A11J2 - A51J2	28480	08901-60064
W20	08901-60055	3	1	COAX CABLE ASSY (94) A11J3 - A4J2	28480	08901-60055
W21	08901-60169	0	1	COAX CABLE ASSY (4) A11J4 - Y1J1 (OPTION 002 ONLY)	28480	08901-60169
	1400-0510	8	5	CLAMP-CABLE .15-DIA .62-WD NYL	28480	1400-0510
W22	08901-60163	4	1	COAX CABLE ASSY (2) A11J5 - REAR TIME BASE OUTPUT (OPTION 002 ONLY)	28480	08901-60163
W23	08901-60161	2	1	COAX CABLE ASSY (5) A11J6 - REAR TIME BASE INPUT	28480	08901-60161

†Refer to section 7 for update information. *Factory selected Component (Refer to Section 5) Δ Errata part change

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
W24	08901-60054	2	1	COAX CABLE ASSY (926) A4J1 - A6J3	28480	08901-60054
W25	08902-60016	7	1	COAX CABLE ASSY (97) A6J2 - A54J1	28480	08902-60016
W26	08901-60162	3	1	COAX CABLE ASSY (902) A6J4 - OUTPUT IF	28480	08901-60162
W27	08901-60243	1	1	RIBBON CABLE ASSY A14J1 - A31J2	28480	08901-60243
W28	08901-60076	8	1	COAX CABLE ASSY (92) A50J1 - A51J1	28480	08901-60076
W29	08901-60157	6	1	COAX CABLE ASSY (941) A52J1 - A25J1	28480	08901-60157
W30	08902-60017	8	1	COAX CABLE ASSY (951) A54J2 - A55J1 OPTION 030 ONLY	28480	08902-60017
W31	08902-60015	6	1	COAX CABLE ASSY (957) A18J1 - A55J2	28480	08902-60015
W32	08901-60078	0	1	COAX CABLE ASSY (7) A17J3 - A19J3 (EXCEPT OPTION 003 OR 030)	28480	08901-60078
W33	08901-60168	9	1	COAX CABLE ASSY (927) A17J3 - REAR LO INPUT (OPTION 003 ONLY)	28480	08901-60168
W34	08901-60167	8	1	COAX CABLE ASSY (90) A19J3 - REAR LO OUTPUT (OPT 003 ONLY)	28480	08901-60167
W35	08901-20083	3	1	SEMI-RIGID COAX CABLE ASSY REAR PANEL J13 TO J14 (OPT 003 ONLY)	28480	08901-20083
W36	08901-60057	5	1	COAX CABLE ASSY (91) A21J2 - A23J1	28480	08901-60057
W37	08902-60020	3	1	COAX CABLE ASSY (934) A17J2 - AT1J2	28480	08902-60020
W38	08901-60063	3	1	COAX CABLE ASSY (916) A21J1 - A22J1	28480	08901-60063
W39	08901-60058	6	1	COAX CABLE ASSY (93) A23J2 - A24J2	28480	08901-60058
2314A TO 2636A *W40* *2742A AND ABOVE* *W40*	08901-60060	0	1	COAX CABLE ASSY (905) NOT ASSIGNED A17J1 - A18J2	28480	08901-60060
W41	08901-60179	2	1	WIRE HARNESS ASSY - RF POWER (EXCEPT OPT 001)	28480	08901-60179
W42	08901-60241	9	1	WIRE HARNESS ASSY - RF POWER (OPT 001 ONLY)	28480	08901-60241
W43	08902-60019	0	1	COAX CABLE ASSY (95) A16J2 - AT1J1	28480	08902-60019

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) Δ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
W44	08901-60059	7	1	COAX CABLE ASSY (956) A19J2 - A24J1	28480	08901-60059
W45	08901-60296	4	1	WIRING HARNESS - DIGTL A26J3 - A27J4	28480	08901-60072
	1252-0073	3		CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1252-0073
	1252-1763	0		CONNECTOR 6-CONT HDR POST TYPE	28480	1252-1763
	1400-0510	8		CLAMP-CABLE .15-DIA .62-WD NYL	28480	1400-0510
2305A TO 2530A						
W46	08901-60230	6	1	RIBBON CABLE ASSY A25J2 - A27J2	28480	08901-60230
	1400-1151	5	2	CLAMP-CABLE .625-WD NYL	28480	1400-1151
2535A AND ABOVE						
W46	08902-60039	4	1	RIBBON CABLE ASSY A25J2 - A27J2	28480	08902-60039
W47	08901-60231	7	2	RIBBON CABLE ASSY A27J1 - A28J3	28480	08901-60231
	1400-1511	1	1	CABLE CLAMP	28480	1400-1511
W48	08901-60231	7		RIBBON CABLE ASSY A25J3 - A28J2	28480	08901-60231
	1400-1151	5		CLAMP-CABLE .625-WD NYL	28480	1400-1151
W49	08901-60071	3	1	WIRING HARNESS - AUDIO A25J4 - A26J2	28480	08901-60071
	1251-3275	1		CONNECTOR 6-PIN F POST TYPE	28480	1251-3275
	1251-3897	3		CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3897
W50	08901-60232	8	1	WIRING HARNESS A26J6 - A28J1	28480	08901-60232
	1251-3275	1		CONNECTOR 6-PIN F POST TYPE	28480	1251-3275
	1251-3897	3		CONTACT-CONN U/W-POST-TYPE FEM CRP	28480	1251-3897
W51	08901-60176	9	1	WIRING HARNESS A25J5 - AM OUTPUT, FM OUTPUT, RECORDER OUTPUT AND FREQ OFFSET TTL OUT	28480	08901-60176
	1400-0510	8		CLAMP-CABLE .15-DIA .62-WD NYL	28480	1400-0510
W52	8120-1378	1		CABLE ASSY 18AWG 3-CNDCT JGK-JKT	28480	8120-1378
2305A TO 2412A						
W53				NOT ASSIGNED		
2413A AND ABOVE						
W53	08901-60258	8		COAX CABLE ASSEMBLY (1) A52J2 - MODULATION OUT/AUDIO IN (OPTION 001 ONLY)	28480	08901-60258
W54△	08902-60133	9	1	CABLE ASSEMBLY: A19J3 TO S4J5 (156) OPTION 030 ONLY	28480	08902-60133
W55	08902-60019	0	1	CABLE ASSEMBLY: A17J3 TO S4J4 (95) OPTION 030 ONLY	28480	08902-60019
W56	08902-60051	0	1	CABLE ASSEMBLY: A17J4 TO A72J2 (8)	28480	08902-60051

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5) △ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
				MISCELLANEOUS PARTS		
W57	08901-60078	0	1	CABLE ASSEMBLY: A72J1 TO A71J2 (7) OPTION 030 ONLY	28480	08901-60078
W58	08901-60255	5	1	WIRING HARNESS: A72J3 TO S4 BRN-"1", RED-"C+", ORN-"2" (OPTION 030 ONLY)	28480	08901-60255
W59	08902-60036	1	1	CABLE ASSEMBLY SEMI-RIGID: REAR PANEL J14 TO S4J3; OPTION 030 ONLY	28480	08902-60036
W60	08902-60037	2	1	CABLE ASSEMBLY SEMI-RIGID: REAR PANEL J13 TO S4J2; OPTION 030 ONLY	28480	08902-60037
2305A TO 2702A						
W61				NOT ASSIGNED		
W62				NOT ASSIGNED		
W63				NOT ASSIGNED		
2704A AND ABOVE						
W61	08902-20066	3	1	SEMI-RIGID COAX CABLE ASSY RF INPUT CABLE (W1-U3, PORT 4)	28480	08902-20066
W62	08902-20118	6	1	SEMI-RIGID COAX CABLE ASSY	28480	08902-20118
W63	08902-20119	7	1	SEMI-RIGID COAX CABLE ASSY (U1 TO U3 PORT 2)	28480	08902-20119

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

Table 6-4. Code List of Manufacturers

Mfr. Code	Manufacturer Name	Address	Zip Code
S0545	NIPPON ELECTRIC CO	TOKYO, JP	
00000	ANY SATISFACTORY SUPPLIER		
00853	SANGAMO ELEC CO S CAROLINA DIV	PICKENS, SC	29671
01121	ALLEN-BRADLEY CO	MILWAUKEE, WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS, TX	75222
02111	SPECTROL ELECTRONICS CORP	CITY OF IND, CA	91745
02114	FERROXCUBE CORP	SAUGERTIES, NY	12477
03508	GE CO SEMICONDUCTOR PROD DEPT	AUBURN, NY	13201
03888	K D I PYROFILM CORP	WHIPPANY, NJ	07981
03911	CLAIREX CORP	MT VERNON, NY	10050
04713	MOTOROLA SEMICONDUCTOR PRODUCTS.	PHOENIX, AZ	85008
06560	JEFFERS ELECTRONICS INC	NOGALES, AZ	85621
06665	PRECISION MONOLITHICS INC	SANTA CLARA, CA	95050
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW, CA	94040
07716	TRW INC BURLINGTON DIV	BURLINGTON, IA	52601
07933	RAYTHEON CO SEMICONDUCTOR DIV HQ	MOUNTAIN VIEW, CA	94040
11236	CTS OF BERNE INC	BERNE, IN	46711
13103	THERMALLOY CO	DALLAS, TX	75234
16299	CORNING GLASS WKS COMPONENT DIV	RALEIGH, NC	27604
17856	SILICONIX INC	SANTA CLARA, CA	95054
18324	SIGNETICS CORP	SUNNYVALE, CA	94086
19701	MEPCO/ELECTRA CORP	MINERAL WELLS, TX	76067
20932	EMCON DIV ITW	SAN DIEGO, CA	92129
20940	MICRO-OHM CORP	EL MONTE, CA	91731
24046	TRANSITRON ELECTRONIC CORP	WAKEFIELD, MA	01880
24355	ANALOG DEVICES INC	NORWOOD, MA	02062
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD, PA	16701
25088	SIEMENS CORP	ISELIN, NJ	08830
25403	N.V. PHILIPS-ELCOMA DEPARTMENT	EINDHOVEN, HL	02876
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA, CA	95051
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON, NC	28401
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO, CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE, NJ	
30983	MEPCO/ELECTRA CORP	SAN DIEGO, CA	92121
32293	INTERSIL INC	CUPERTINO, CA	95014
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE, CA	92507
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE, CA	94086
34371	HARRIS SEMICON DIV HARRISIINTERTYPE	MELBOURNE, FL	32901
34649	INTEL CORP	MOUNTAIN VIEW, CA	95051
51642	CENTRE ENGINEERING INC	STATE COLLEGE, PA	16801
52063	EXAR INTEGRATED SYSTEMS INC	SUNNYVALE, CA	94086
52763	STETTNER ELECTRONICS INC	CHATTANOOGA, TN	13035
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS, MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE, SC	06226
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE, PA	16512
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON, CA	92634
74970	JOHNSON E F CO	WASECA, MN	56093
75915	LITTELFUSE INC	DES PLAINES, IL	60016
90201	MALLORY CAPACITOR CO	INDIANAPOLIS, IN	46206
95275	VITRAMON INC	BRIDGEPORT, CT	06601

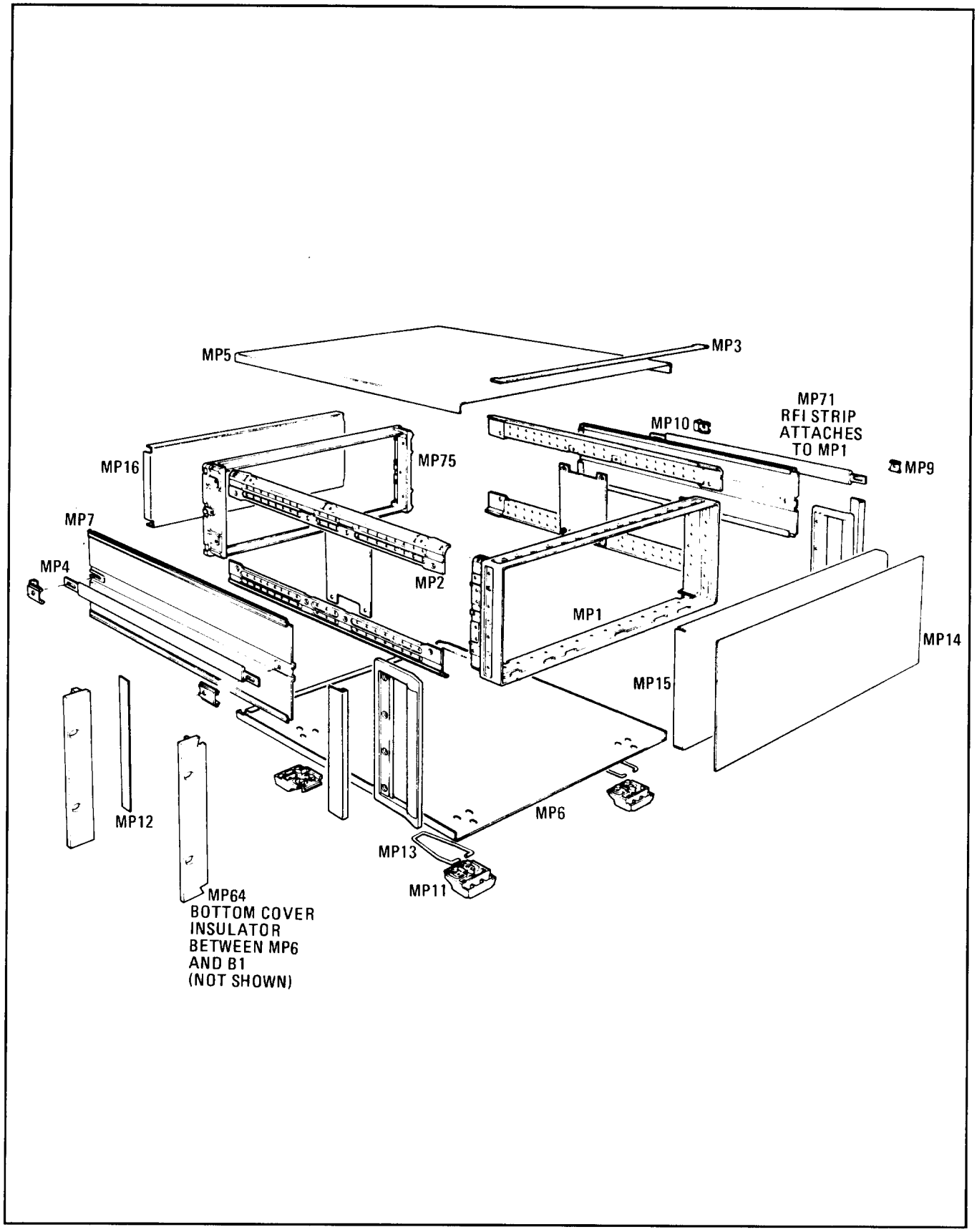


Figure 6–1. *Cabinet Parts*

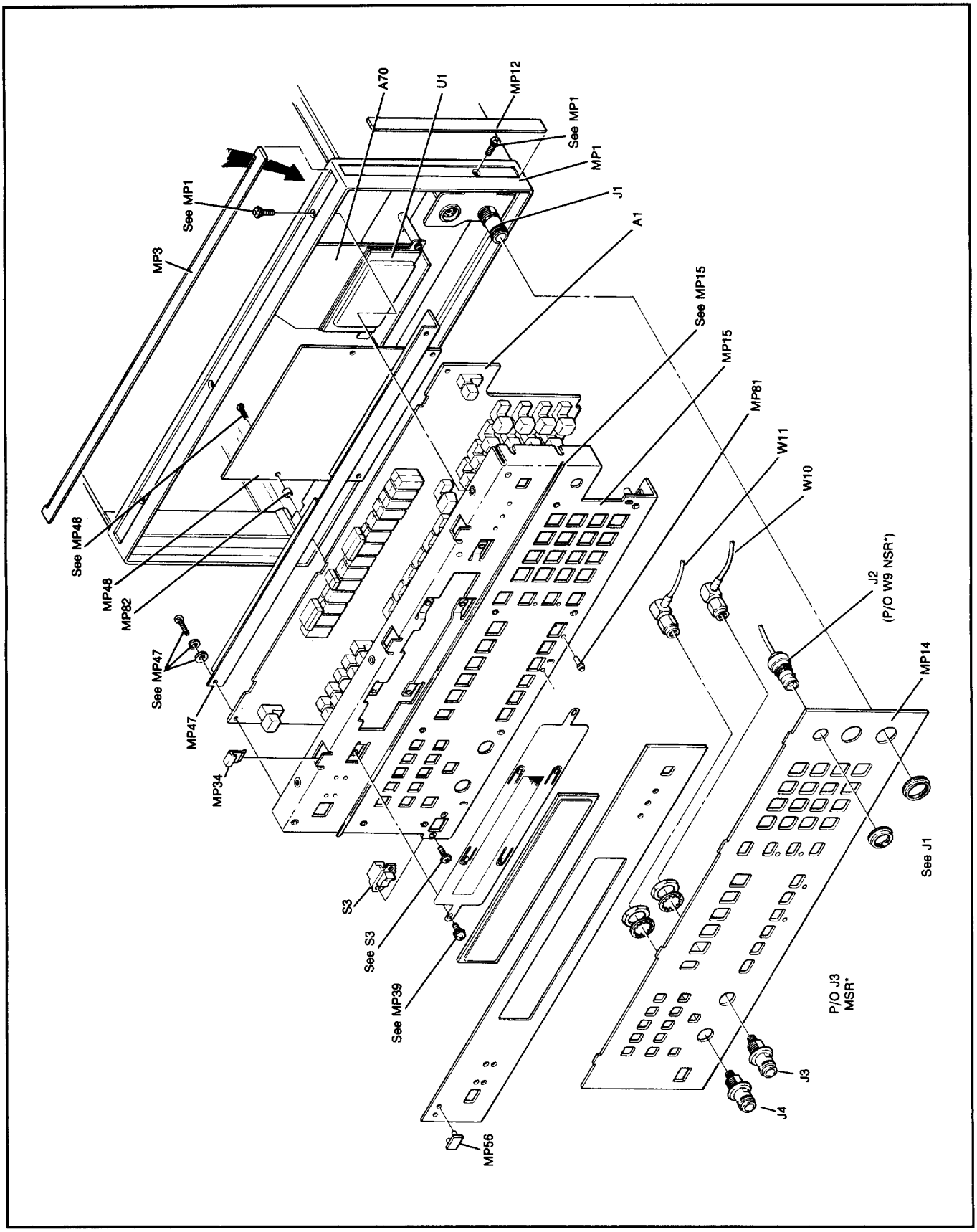


Figure 6–2. *Exploded View of the Front Panel (1 of 2)*

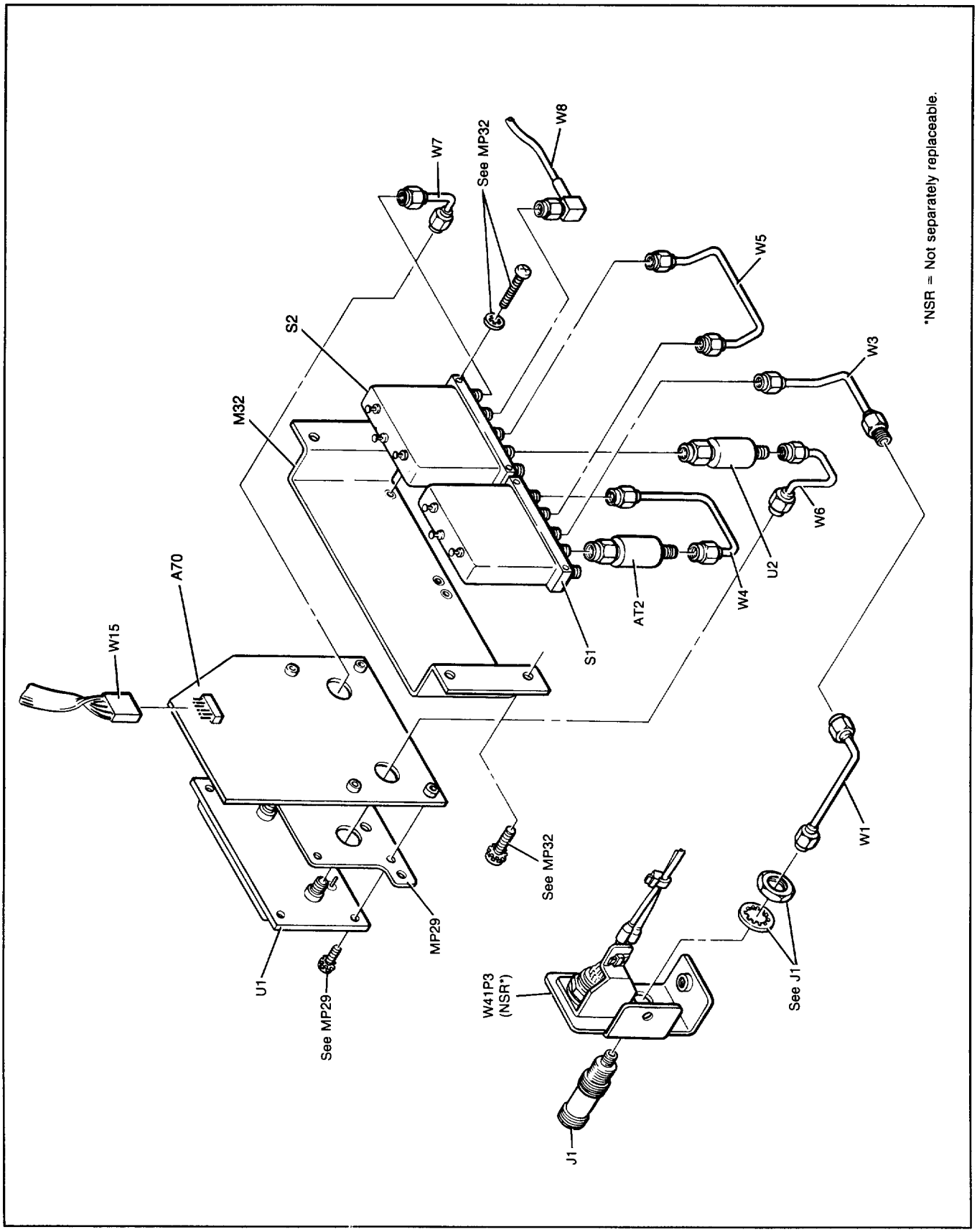


Figure 6-2. Exploded View of the Front Panel (2 of 2)(2305A to 2702A).

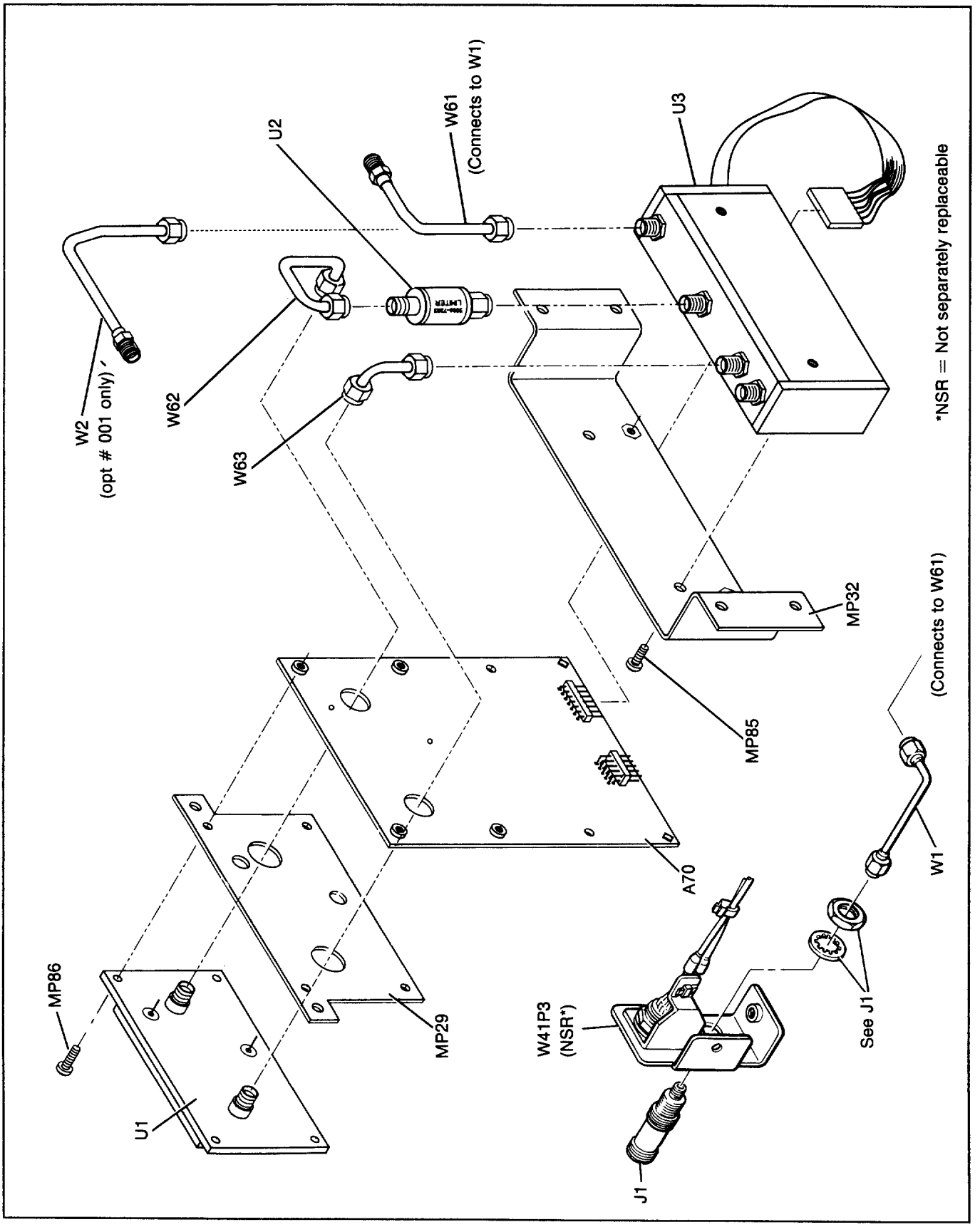


Figure 6-2. Exploded View of the Front Panel (2 of 2)(2704A and above).

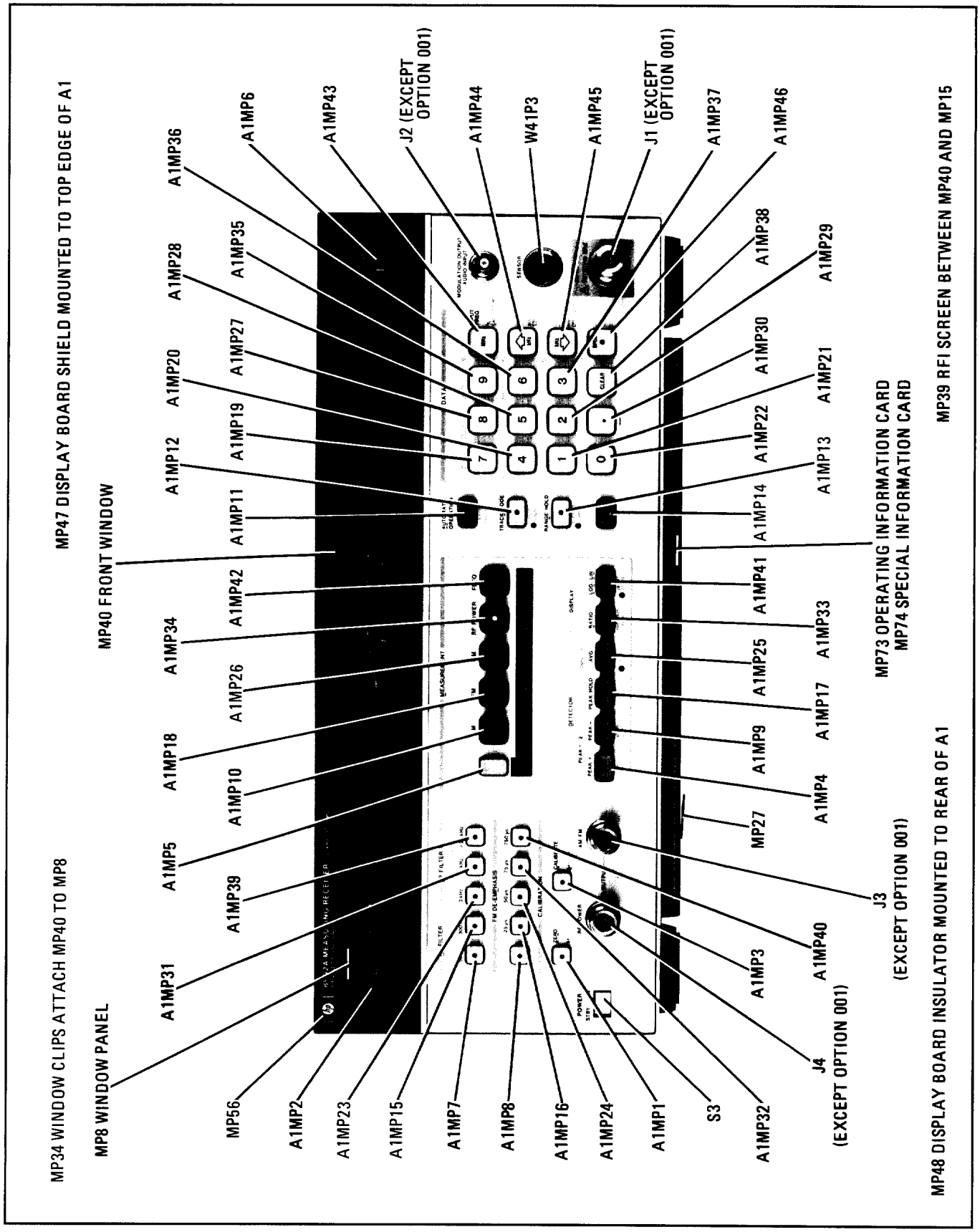


Figure 6–3. *Parts Identification (Front View)*

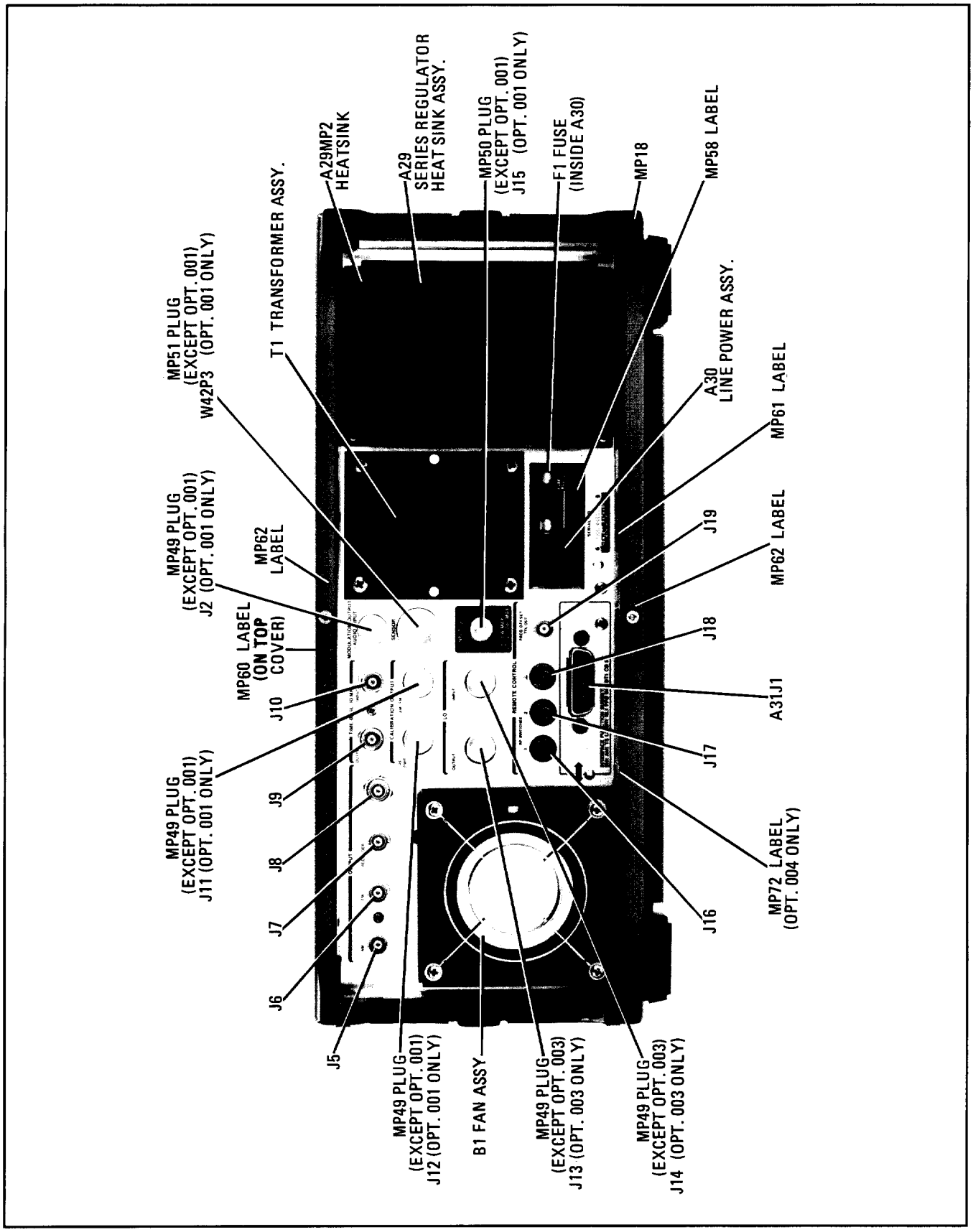


Figure 6–4. *Parts Identification (Rear View)*

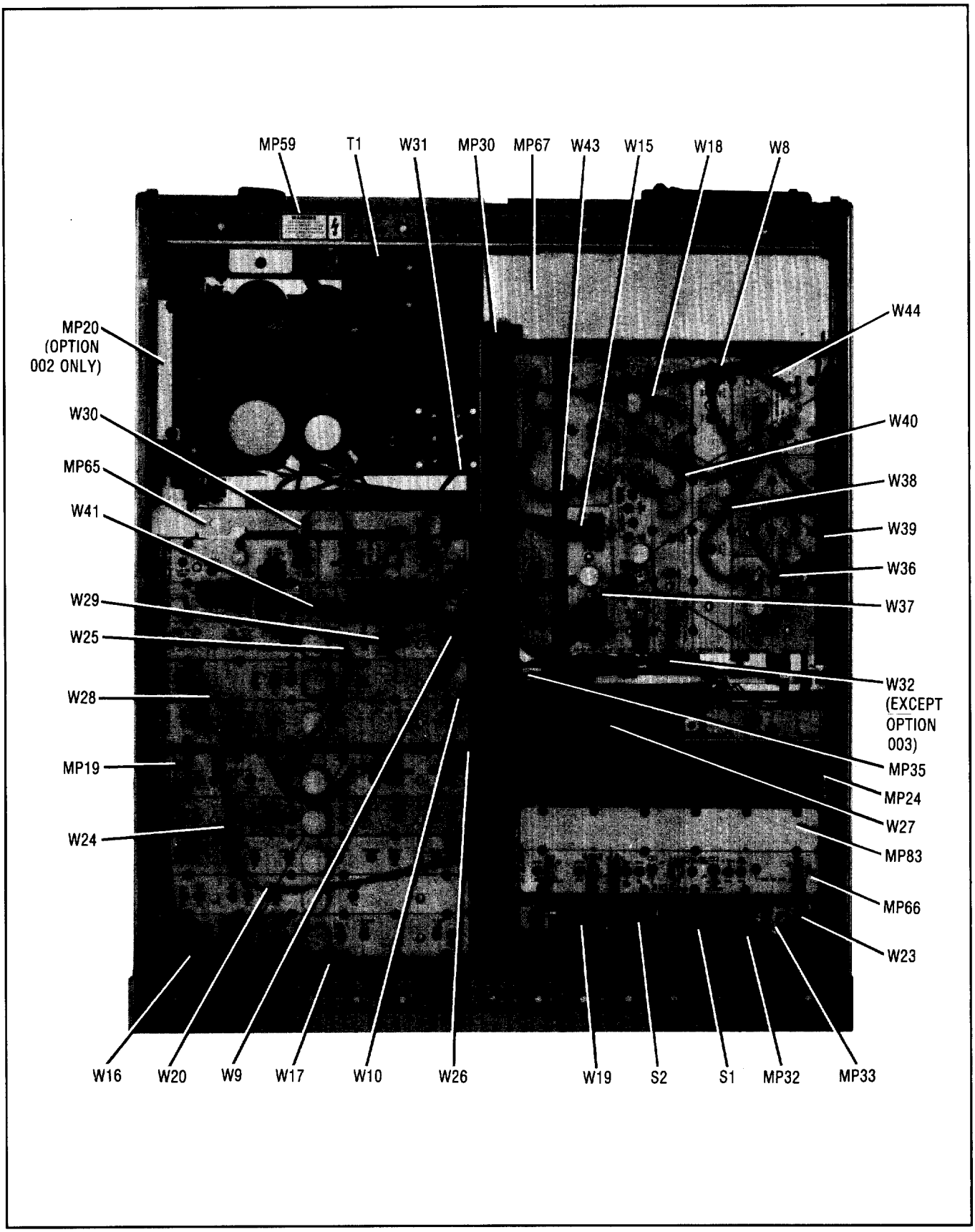


Figure 6–5. *Parts and Cable Identication (Top View)*

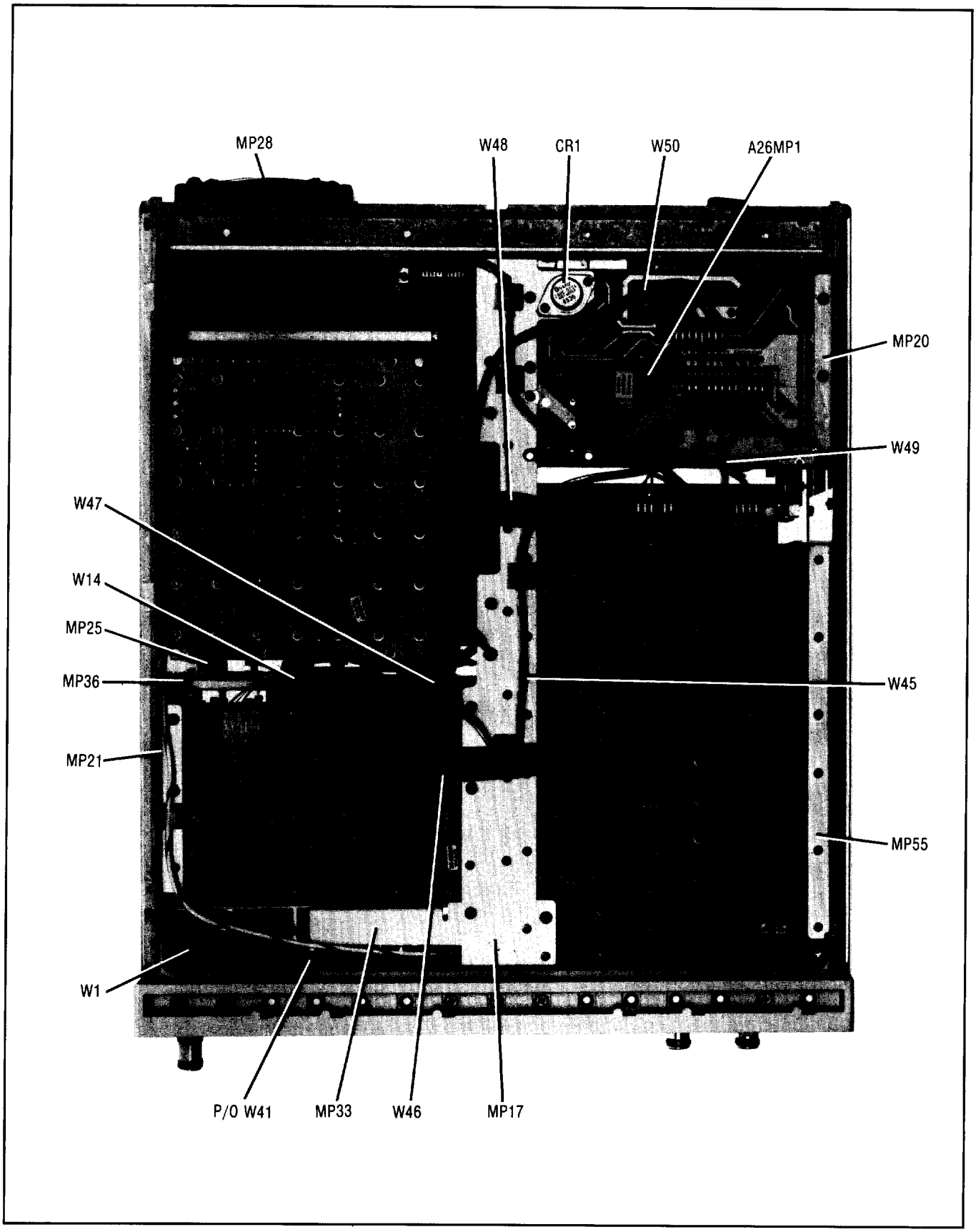


Figure 6–6. *Parts and Cable Identication (Bottom View)*

Section 7
INSTRUMENT CHANGES

7-1. INTRODUCTION TO THIS SECTION

This section contains instrument modification recommendations and procedures that could improve the performance and reliability of your instrument. Refer to *Instruments Covered by This Manual,* paragraph 1-5 in Section 1 for important information about serial number coverage.

7-2. MODIFICATION FOR INVALID ERROR 06 INDICATION *(2305A TO 2523A)*

Description

These instruments may indicate Error 06 (instrument overpower) under normal operating conditions. Three independent sources for this problem have been identified: (1) microphonic chatter of contacts in the +15V power supply relay (A26K1), (2) drift in the input RF peak detector circuits, and (3) switching transients in the RF input attenuator.

Procedure

For instruments of any serial prefix, check the +15V power supply relay by tapping gently on the relay with a wooden or plastic instrument. See A26K1 on Service Sheet 31. If Error 06 appears as a result, replace or clean the contacts of the relay.

For instruments with serial prefix 2305A to 2523A, check the following components and replace them with the recommended parts if they are different. See Service Sheets 4 and 24 and also *Firmware Change Summary,* Change 9 below.

Reference Designator	Value or Type	Part Number
A13U10[1]	EPROM	08901-80081
A13U7[1]	EPROM	08901-80082
A13U4[1]	EPROM	08901-80083
A16R10[2]	1 MΩ	0698-8827
A16R11[2]	162 kΩ	0757-0470
A16R15[2]	3.48 kΩ	0698-3152
A16C20[2]	470 pF	0160-4768
A16U2[3]	LM 211	1826-0098

(1) This revises firmware to date code 304.1985 (use 42.0 SPCL).
(2) Some of the passive component changes on the A16 RF Detector Assembly may already be installed in some instruments.
(3) This change replaces A16U2 with the same part from a different manufacturer.

7-3. FIRMWARE CHANGE SUMMARY *(2305A TO 2644A)*

Description

The instrument has undergone several changes in firmware. This article summarizes the changes and should be helpful in deciding whether to update firmware to a more recent edition.

The firmware is changed whenever anomalies are found in the instrument's operation which can be corrected by altering the Controller's program. Firmware is also changed to add new features which may be only changes in the program or which may also result from instrument hardware changes.

Since the program resides in the ROMs (the firmware), the ROMs are altered each time the program is changed. At that time the new ROMs are given new part numbers and the software (the program) date is changed. (To display the software date, key in Special Function 42.0.) Always update firmware with the latest edition, which is backward compatible. (See Service Sheet 24 for ROM identification.)

Summary of Software Editions

1. **Software date code: 167.1983** ***(2305A to 2331A)***

   ROM part numbers:

   ROM 1, 08901-80062
   ROM 2, 08901-80063
   ROM 3, 08901-80064

   This is a preliminary edition of software which should be replaced by the most recent edition.

2. **Software date code: 272.1983** ***(2337A to 2449A)***

   ROM part numbers:

   ROM 1, 08901-80066
   ROM 2, 08901-80067
   ROM 3, 08901-80068

   This is the first edition of software in production instruments.

3. **Software date code: 115.1984** ***(2451A to 2515A)***

   ROM part numbers:

   ROM 1, 08901-80071
   ROM 2, 08901-80072
   ROM 3, 08901-80073

   Change 1 adds a few function settings not stored by the Store/Recall feature. Previously, when the settings were recalled, the functions were set to their current settings instead of the stored settings. The unstored functions were: (1) manually selected Tuned RF Level filtering (Special Function 4), (2) power sensor calibration factor table entry when entry is in progress, (3) the last calibrated power sensor type, (4) the HP-IB SRQ mask, and (5) the HP-IB Status Byte.

   Change 2 eliminates a potential HP-IB bus hang-up in Tuned RF Level. During an HP-IB trigger immediate (T2) or trigger with settling (T3) measurement, HP-IB handshaking is inhibited until the measurement is completed. Except for the Interface Clear bus command, the HP-IB temporarily hangs up. Since most measurments are short, bus use is restored quickly. If the signal is lost during a measurement, "– –" is displayed and Error 96 is issued over HP-IB. (This is normal HP-IB operation.) In Tuned RF Level, however, if the signal is lost, the instrument searches for it indefinitely and hangs up the HP-IB indefinitely. With newer software if signal is lost in Tuned RF Level, the instrument now displays " – –" (and Error 96 over HP-IB) after 20s.

   Change 3 eliminates an invalid condition in the Set Reference mode in Tuned RF Level where it was possible to reference to the power sensor.

Change 4 increases RF Power measurment resolution by a factor of 10 to allow the instrument's power meter to be similar to other power meters. 1 mW now reads 1000.0 μW instead of 1.000 mW.

Change 5 adds Special Functions 23 and 24 which are used with Option Series 030, Selective Power measurements. New hardware and firmware Change 17 (below) must also be added to implement this feature. Compatability with all other measurements is maintained.

4. **Software date code: 119.1985** ***(2519A to 2523A)***

ROM part numbers:

ROM 1, 08901-80076
ROM 2, 08901-80077
ROM 3, 08901-80078

Change 6 eliminates the loading effects of the input RF peak detector when calibrating Tuned RF Level for range 2 to range 1. The RF peak detector sets input attenuation in other measurement modes. The new firmware turns off the detector after attenuator is set which eliminates a potential 0.7 dB error.

Change 7 increases digital averaging to reduce display bounce during noisy SINAD measurments (Special Function 5.1).

Change 8 adds two special functions to enter and retrieve the Set Reference calibration factor in Tuned RF Level. To read the current Set Reference calibration factor, key in 38.4 SPCL while in Tuned RF Level. The calibration factor is displayed with a maximum of 8 digits and a resolution of 0.01%. To enter a Set Reference calibration factor, key in 39.4 SPCL then enter the calibration factor and press blue key and % CAL FACTOR (the MHZ key).

5. **Software date code: 234.1985** ***(2528A to 2530A)***

ROM part numbers:

ROM 1, 08901-80084
ROM 2, 08901-80077
ROM 3, 08901-80078

Change 9 eliminates a false Error 06 which is sometimes generated by an attenuator switching transient during instrument preset. Only ROM 1 was changed.

6. **Software date code: 304.1985** ***(2535A to 2606A)***

ROM part numbers:

ROM 1, 08901-80081
ROM 2, 08901-80082
ROM 3, 08901-80083

Change 10 adds track tune mode in Tuned RF Level measurements. Several hardware changes are also required to add this feature, but the new firmware is compatible with all instruments.

Change 11 adds Special Function 31 which corrects for the noise floor when using the average detector in Tuned RF Level on the lowest range. Special Function 31.0 disables the noise floor correction. Special Function 31.1 enables the noise floor correction. Special Function 31.2 displays the noise-floor correction status.

Change 12 adds Special Function 32 which alters several default conditions for specialized applications. Special Function 32.0 sets the "normal" defaults. Special Function 32.1 sets the "special" defaults (RF power resolution 0.001 dB and minimum audio frequency resolution 0.1 Hz). Special Function 32.2 displays the status of this special function.

Change 13 adds Special Function 7.4 to increase the display resolution of RF frequency to 0.1 Hz below 10 MHz and 1 Hz above 10 MHz.

Change 15 extends the frequency offset mode range to 200 GHz.

Change 16 adds Special Function 47 which displays certain instrument configuration details for troubleshooting purposes. After keying in 47.0 SPCL the display will be of the form

<Tracking Synchronous Detector >. <New Opt. Series 030 ><Old Opt. Series 030 >

where 1 is yes and 0 is no. The new Option Series 030 refers to instruments with serial prefix 2535A and above; old refers to older versions of the HP 8901B Modulation Analyzer (which shares the firmware).

Change 17 adds hardware identification of certain instrument configuration details needed for Option Series 030 measurements. (Refer also to Change 16 above.)

Change 18 adds Special Functions 49.C to read the Option Series 030 IF RMS Detector.

Change 19 increases the averaging time in Tuned RF Level for instruments when Special Function 32.1 is in effect. (See also Change 12.)

7. **Description** *(2621A and Above)* The A19 L.O. Divider Assembly has been changed to part number 08901-60274 for improved performance and reliability. The Top cover (A19MP1) has been changed to 08901-00166 to fit the new A19 L.O. Divider Assembly.

8. **Software date code: 70.1986** *(2616A to 2631A)*

   ROM part numbers:

   ROM 1, 08901-80087
   ROM 2, 08901-80088
   ROM 3, 08901-80089

   Change 20 updates the original firmware released for the Option 030 and E04 for more efficient operation. The new firmware is compatible with all instruments.

9. **Software date code: 149.1986** *(2644A to 2706A)*

   ROM part numbers:

   ROM 1, 08901-80090
   ROM 2, 08901-80091
   ROM 3, 08901-80092

   Change 21 allows for displaying the previously entered frequency when displaying RF Power Calibration Factors.

   Change 22 prevents the instrument from generating a 10 dB error when in Tuned RF Level range to range calibration. This would happen only on very rare occasions when the voltmeter was at a particular level.

   Change 23 adds increased "ERROR 01" limits up to ± 100 kHz for the testing of drifting signal generators (when in Track Mode).

10. **Software date code: 351.1986** *(2717A and Above)*

    ROM part numbers:

    ROM 1, 08901-80105
    ROM 2, 08901-80106
    ROM 3, 08902-80107

    Change 24 updates the firmware to increase averaging (special function 32.1) and to reduce settling time when making power meter measurments.

7–4. CABINET PARTS COLOR CHANGE

(2912A and above)

NOTE

Serial prefix 2912A changes the color of the instrument covers and accessories. The old color cover and accessories are no longer availiable. If your instrument has serial prefixes 2911A and below, and you must replace one of these parts, we recommend that you order the full set of covers and accessories. Affected cabinet parts are MP3-12, MP14, MP18, (see Table 6-3).

7–5. LEDS A1DS31-37, A1DS42-45

(2305A to 2914A)

If the serial prefix of your instrument falls within 2305A to 2914A and you must replace A1DS31-37 or A1DS42-45 you must also order a new spacer and light pipe listed under MP15 (2920A and above) in the miscellaneous replaceable parts list.

Section 8
SERVICE

8-1. INTRODUCTION TO THIS SECTION

This section contains information for troubleshooting and repairing the Measuring Receiver. Included are troubleshooting tests, block and schematic diagrams, and principles of operation.

8-2. HOW THE SECTION IS ORGANIZED

Section 8 is contained in this and two other volumes as:

Volume 2

- General Service Information:
  Safety Considerations
  Service Tools and Aids
  General Troubleshooting Information
  Assembly and Service Sheet Cross Reference Index
  Assembly Locations
  Schematic Diagram Notes
- Service Aids:
  Special Functions
  Error Messages
  Power-Up Checks
  Controller Test LEDs and Test Points
  Signature Analysis
- Disassembly (for the front panel)
- Block Diagram (BD) Theory and Troubleshooting
  The circuit descriptions and troubleshooting procedures for all the block diagrams.
- BD1 through BD5 Block Diagrams
  Block Diagrams (foldouts) for the Measuring Receiver.

Volume 3

- Schematic Diagram Theory and Troubleshooting
  Circuit descriptions and troubleshooting procedures for Service Sheets (SS) 1 through 34.

Volume 4

- SS1 through SS35 Schematic Diagrams
  Schematic Diagrams (foldouts) and Component Locator Diagrams for the Measuring Receiver.
- SSA Summary
  Service Special Functions and Error Message Summary.
- SSB and SSC Summary
  Direct Control Special Function Summary.

8-3. SAFETY CONSIDERATIONS

Before Applying Power

Verify that the instrument is set to match the available line voltage and that the correct fuse is installed. An uninterrupted safety earth ground must be provided from the main power source to the instrument input wiring terminals, power cord, or supplied power cord set. In addition, verify that a common ground exists between the Measuring Receiver and all test equipment.

Safety

Pay attention to WARNINGS and CAUTIONS. They must be followed both for your protection and to avoid damage to the equipment.

WARNING

Maintenance described herein is performed with power supplied to the instrument and with the protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). When maintenance can be performed without power supplied, the power should be removed.

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnection of the protective earth terminal will create a potential shock hazard that could result in personal injury. Grounding one conductor of a two conductor outlet is not sufficient. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative (that is, secured against unintended operation).

If this instrument is to be energized via an autotransformer, make sure that the autotransformer's common terminal is connected to the earth terminal of the power source.

Capacitors inside the instrument can still be charged even if the instrument is disconnected from its source of supply.

Make sure that only 250 volt fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. Do not use repaired fuses or short-circuited fuseholders. To do so could create a shock or fire hazard.

A13BT1 is a Lithium battery. The following procedure is recommended for its disposal:

Discharge A13BT1 by soldering a 50 kΩ resistor across both battery terminals. Complete discharge will occur after one year, at 25°C.

Under Resource Conservation Recovery Act (RCRA) regulations, the completely discharged battery is considered "nonhazardous." However, the user must be responsible for individual state regulations for battery disposal.

CAUTION

Do not unplug any boards in the Measuring Receiver unless the instrument is unplugged or switched to STBY (standby). Some boards contain devices which can be damaged if the board is removed when the power is on. Use conductive foam when removing MOS devices from sockets. Use care when unplugging ICs from high-grip sockets.

8-4. SERVICE TOOLS, AIDS, AND INFORMATION

Service Accessory Kit

The Service Accessory Kit (HP 08901-60287) contains extender boards, extender cables, and other items needed for servicing the Measuring Receiver. The extender boards have a height that matches the assembly extrusions and, for 12 pin connectors, improves the mechanical stability of the extended assembly. The kit contains a special Digital Test/Extender Board (HP 08901-60081) which facilitates troubleshooting of the A13 Controller and A14 Remote Interface Assemblies (see Figure 8A-1).

The kit also contains a special conductive polyurethane foam pad (HP 4208-0094) that is required for the protection of MOS devices as cautioned in paragraph 8-3.

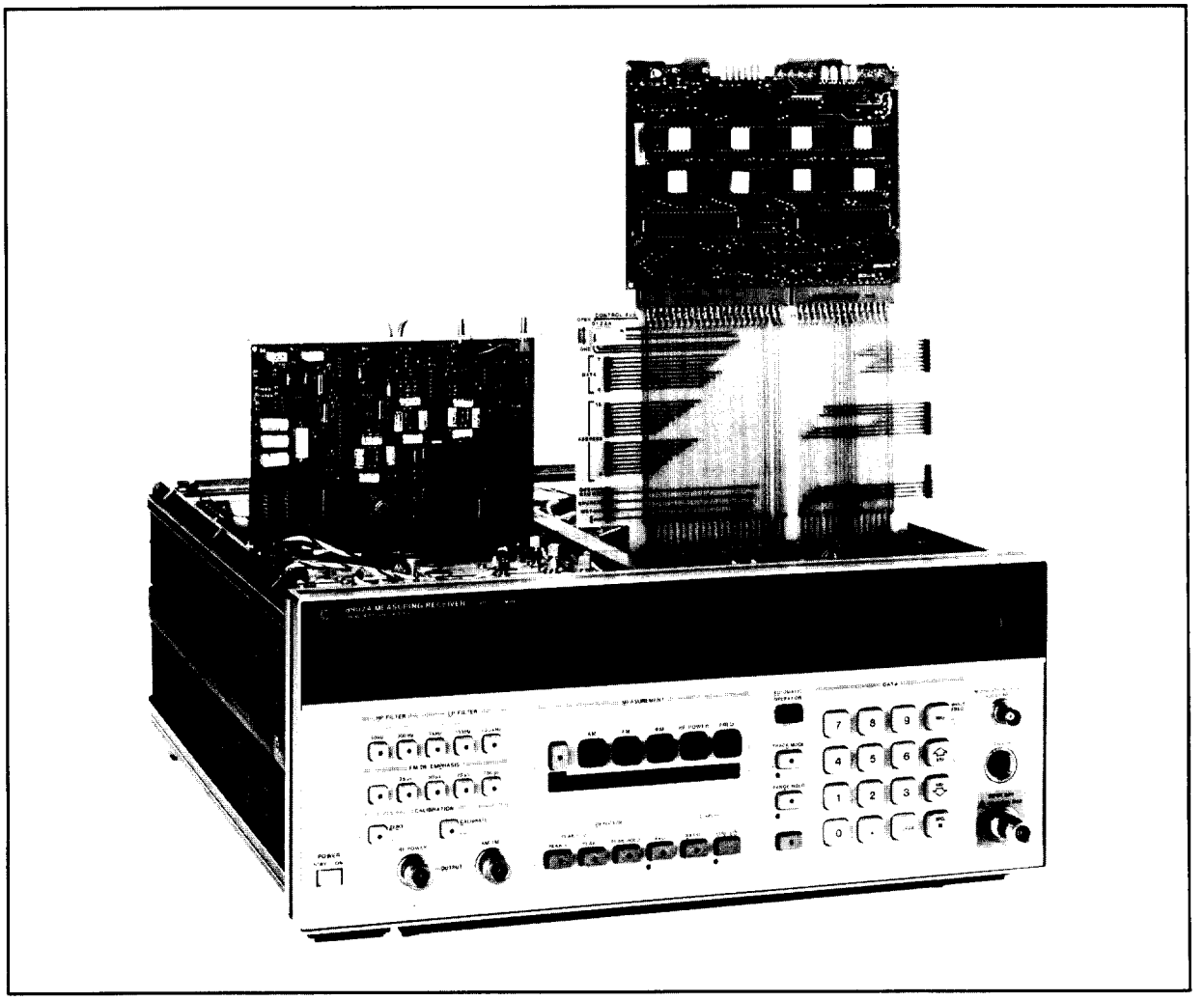


Figure 8A-1. *Assemblies on Extender Boards*

Heat-Staking Tool

The front-panel pushbutton switches have small plastic pins protruding from the back. These tabs fit through holes in the front-panel printed-circuit board (assembly A1) and are melted down to hold the switch in place. This process is known as heat staking. The heat-staking tool is a standard soldering iron with a special tip attached (see Figure 8A-2). The special tip may be ordered as HP part number 5020-8160.

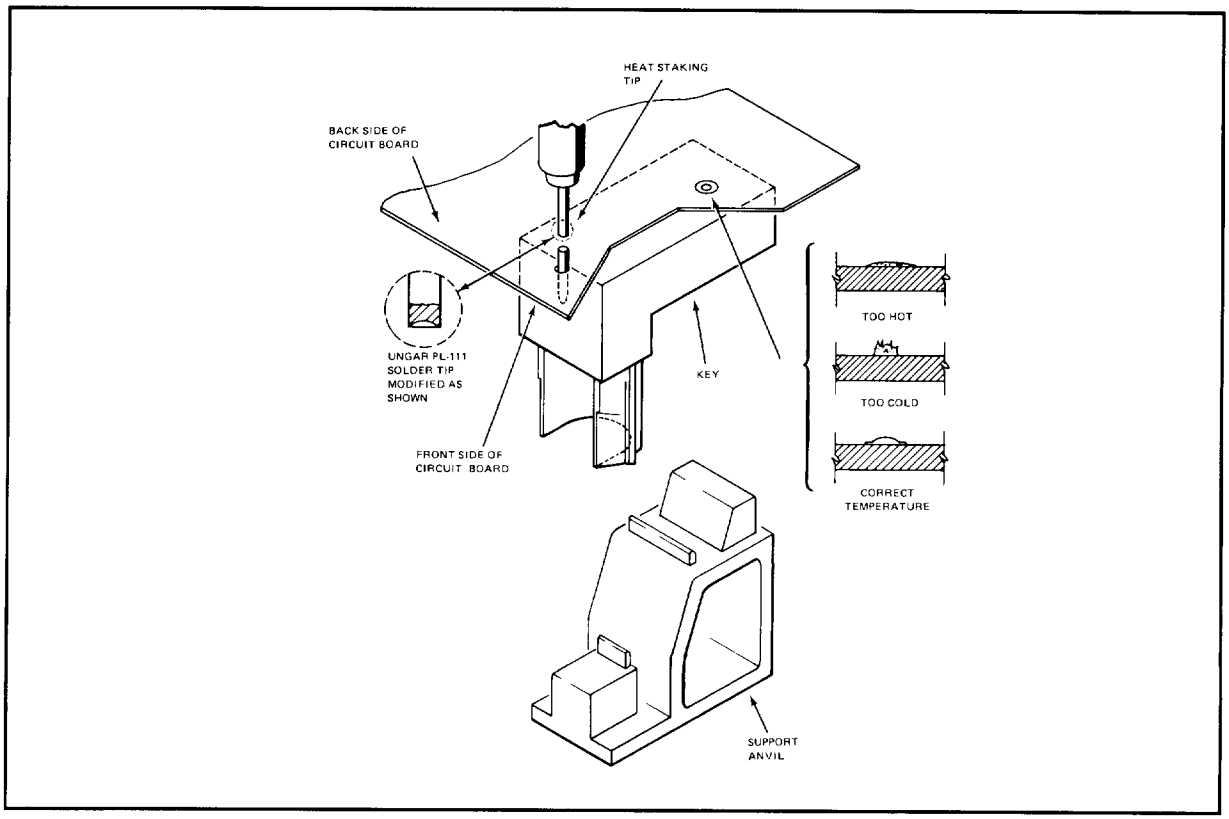


Figure 8A-2. *Heat-Staking Tip*

Assembly Locations

Assemblies in the Measuring Receiver are numbered sequentially from front to back, left to right, and top to bottom as shown in Figures 8A-3 and 8A-3a. However, to facilitate the direct use of assemblies from other HP 8901 or 8902 series instruments, the sequence in the Audio Section of the instrument is interrupted after A6. Assemblies A50 to A55 replace assemblies A7 to A9. Assemblies A13 and A14 have color-coded board extractors. (For example, assembly A13 has a brown left extractor and orange right extractor. Thus, the color code of A13 is 13.) Assembly A1 is part of the front-panel assembly of the instrument. Instruments with serial prefixes ***2535A and above*** have slots for assemblies A71 and A72 sandwiched between A11 and A13. Switch S4 is behind A14. Assemblies A71 and A72 and switch S4 enable the HP 8902A to be fitted with Option Series 030 Selective Power Measurements.

Parts and Cable Locations

The locations of individual components mounted on printed-circuit boards or other assemblies are shown adjacent to the schematic diagram on the appropriate service sheet. The part reference designator is the assembly designator plus the part designator. For example, A6R9 is resistor R9 on the A6 assembly. For specific component descriptions and ordering information, refer to Table 6–3, *Replaceable Parts*, in Section 6. Chassis and frame parts, as well as mechanical parts and cables, are identified on Figures 6–1 through 6–6.

Major mechanical parts have reference designations that begin with the letters MP. Other mechanical parts, such as screws, are listed in the replaceable-parts list below the part to which they fasten. To find the part number and description of a mechanical part, find the part in one of the figures in Section 6 or Section 8. The part in the figure will be labeled with its reference designator. Look up that reference designator in the *Replaceable Parts* table. If the part is a fastener, such as a screw, nut, or washer, look to the figure for the part to which it fastens. Then, look up the fastened part in the parts list. Just below it are the part numbers and a description of the desired hardware.

Component Replacement Procedures

The A3, A4, A6, A13, A14, A15, A21, A26, A31, A52, A53, A54 and A70 printed circuit board assemblies are manufactured using a Hot Air Leveled (HAL) process. The printed circuit board traces, pads and plated-through holes (PTH) are copper. While the process has several advantages over conventional processes, the printed circuit boards are more susceptible to broken traces, lifted pads and damage to the plated-through holes. Therefore, additional care must be taken when replacing components on HAL printed circuit boards.

Listed below are soldering considerations that apply to all printed circuit boards:

- The temperature of the soldering iron tip and time the tip is in contact with the printed circuit board.
- The size and shape of the soldering iron tip.
- The pressure of the soldering iron tip on the pad.
- The operator's skill.

When replacing components on HAL printed circuit boards the following steps should also be taken.

1. Use a temperature controlled soldering iron set at a temperature of 600°F (315°C).

   Extensive tests were made by Hewlett-Packard using commercial brands of soldering irons. As a result of these tests, the recommended soldering iron was the HEXACON THERM-O-TRAC STATION #1000 with the FINGER GRIP SLEEVE 21 A-5 and solder tip #J 301X. During soldering, the tip temperature of the HEXACON THERM-O-TRAC STATION remained very stable.

2. Cut out the body of the component to be removed. (Leave leads as long as possible for easier removal.)

3. Apply heat to the lead only, add solder as required, slide tip down to the pad and remove solder with solder sucker.

CAUTION

Tip pressure on the pad is most critical and is totally operator dependent. Excessive tip pressure will damage or destroy the board. Do not use tin desoldering braid or solder wicking techniques on Hot Air Leveled boards.

The melting point of solder in the plated through hole (PTH) is reached in 2.5 seconds at tip temperature of 600°to 750°F (315°to 400°C). The *recommended* time for heat to be applied is 3 seconds.

Keep the solder sucker clean and do not let the tip of the solder sucker hit the pad when removing solder. Breaking the lead loose can damage the PTH. If the lead is attached to the PTH after the solder has been removed, reheat the lead to remove it.

4. When soldering or desoldering multilead components, do not consecutively apply heat to adjacent leads. Distribute heat by skipping leads or crossing to opposite side of device.

Other Service Documents

Service Notes, Manual Updates, and other service literature are available through Hewlett-Packard. For further information about Manual Updates, refer to Volume 1, paragraph 1-6.

Recommended Test Equipment and Accessories

Test equipment and test accessories required to maintain the Measuring Receiver are listed in Tables 1-3 and 1-4. Equipment other than that listed may be used if it meets the listed critical specifications.

8-1. GENERAL TROUBLESHOOTING

Instrument problems usually fall into three general categories: operator errors, operation out of specification, and catastrophic failures. The troubleshooting strategy is different for each category.

Operator Errors

Apparent failures sometimes can result from using the instrument outside of its range. Usually, the instrument can sense the condition and will display an error message. At other times it cannot: for example when it attempts to measure signals with frequencies higher than 1300 MHz. Consult the *Specifications* table (Table 1-1) and the *Detailed Operating Instructions* in Section 3 for more operation limitations.

Operation Out of Specification

The specifications are listed in Volume 1, Table 1-1. Performance tests that can be used to verify the specifications are found in Volume 1, Section 4. If instrument performance is only slightly out of limits, it can sometimes be corrected by an adjustment. The procedures for adjustments are in Volume 1, Section 5. References listed for each adjustment indicate which service sheet to consult when the adjustment procedure fails. In general, however, it is also a good practice to perform the troubleshooting checks on Service Sheet BD1, since they take only a few minutes and reveal much information.

Catastrophic Failures

Begin troubleshooting catastrophic failures by performing the troubleshooting checks on Service Sheet BD1. The simple procedures there take only a few minutes and will quickly differentiate a control (digital) problem from a hardware (analog) problem. The checks give cross-references to the detailed block diagrams (Service Sheets BD2 to BD5) which then direct you to the necessary schematic.

The troubleshooting information found on all service sheets consists of a series of performance checks. The purpose of the checks is not to identify which circuit or component has failed but rather to verify whether the assembly or circuit is operating correctly. Information on the possible cause of failure is given in the form of hints whenever they can be given reliably. The limits given in the troubleshooting checks are rather loose to facilitate the use of general-purpose equipment (usually an oscilloscope). If a slightly out-of-tolerance condition is suspected, the test can usually be run more rigorously paying greater attention to measurement accuracy.

Troubleshooting on the block diagram level normally utilizes User and Service Special Functions, while troubleshooting on the schematic level often utilizes Direct Control Special Functions. Direct Control Special Functions will require some study of their operation before using them for the first time.

Table 8A–1. *Assembly and Service Sheet Cross Reference Index*

Reference Designator	Assembly Name	Schematic Service Sheet Number	Block Diagram
A1	Keyboard and Display	25, 26, 27	5
A2	Audio Filters	12	4
A3	Audio De-emphasis and Output	13	4
A4	FM Demodulator	10, 11	3
A5	Voltmeter	14, 15	4
A6	AM Demodulator	8, 9	3
A7–A9	(Not Assigned)		
A10	Power Supply Regulators	31, 32	5
A11	Counter	22, 23	5
A12	(Not Assigned)		
A13	Controller	24	5
A14	Remote Interface	28	5
A15	RF Input Control	4	2
A16	RF Detector	4	2
A17	Input Mixer	5	2
A18	IF Amplifier	5	2
A19	LO Divider	17	2
A20	LO Control	20, 21	2
A21	Low Frequency VCXO Filter	19	2
A22	Low Frequency VCXO	19	2
A23	Sampler	18	2
A24	High Frequency VCO	18	2
A25	Audio Motherboard		
A26	Power Supply Motherboard	31, 32	5
A27	Digital Motherboard		
A28	RF Motherboard		
A29	Series Regulator Heat Sink	31, 32	5
A30	Line Power	31	5
A31	Remote Interface Connector	28	5
A32	Power Reference Oscillator	3	2
A33–A49	(Not Assigned)		
A50	AM Calibrator	30	3
A51	FM Calibrator	29	3
A52	Audio Counter/Distortion Analyzer	16	4
A53	Power Meter	1, 2	2
A54	IF Synchronous Detector	7	3
A55	IF Amplifier/Filter	6	3
A56–A69	(Not Assigned)		
A70	Amplifier/Switch Interconnect	4	2
A71	IF Channel Filter (Option Series 030)	33	3
A72	IF Amplifier/Detector (Option Series 030)	34	3

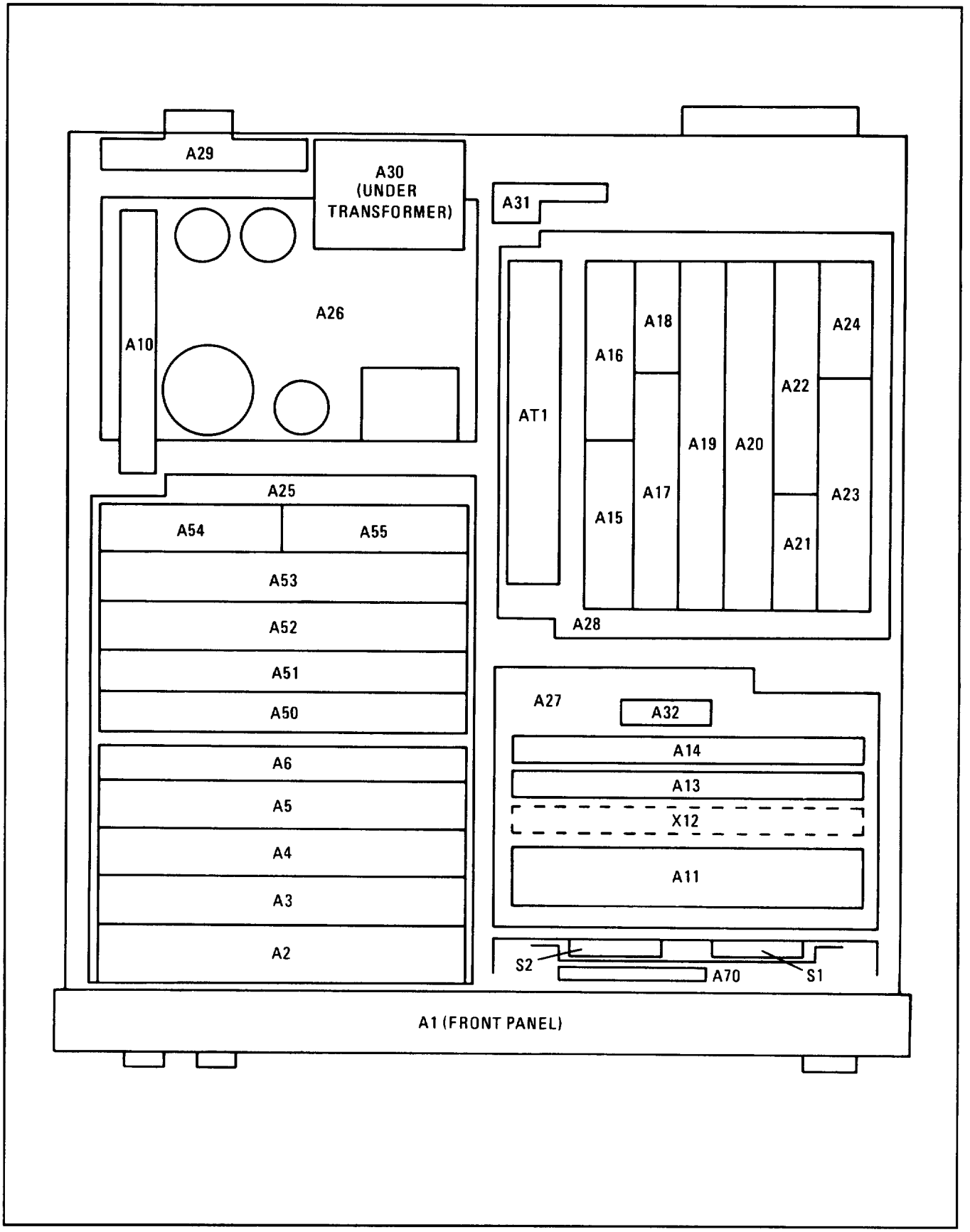
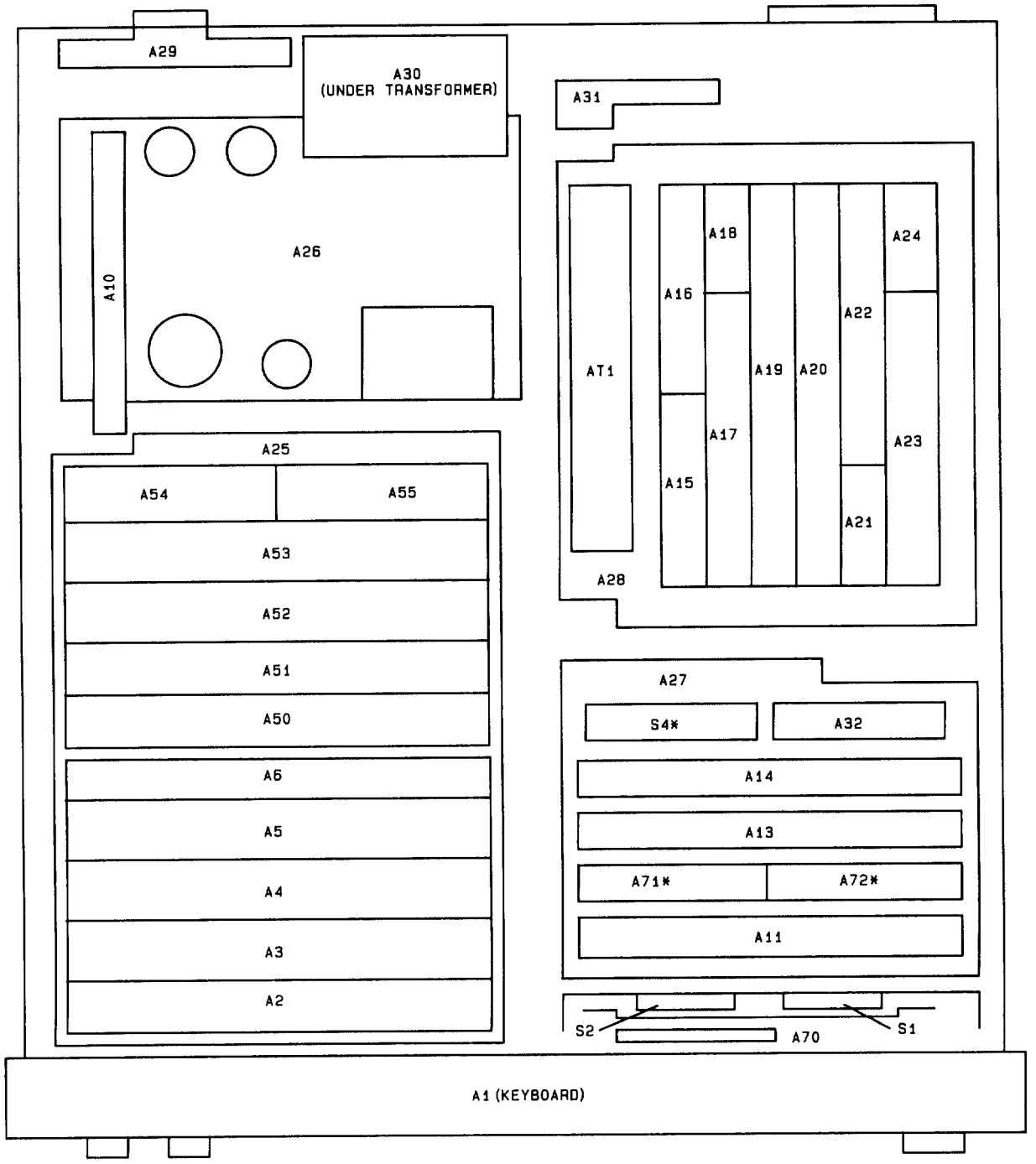


Figure 8A–3. *Assembly Locations* ***(2305A to 2530A)***



*Option 030 assemblies only available for instruments with serial number prefixes 2535A and above.

Figure 8A–3a. *Assembly Locations* ***(2535A and Above)***

8-6. SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

Table 8A-6 summarizes the symbology used in presenting many devices found in the instrument. The logic symbols used in this manual are based on the Institute of Electrical and Electronic Engineers (IEEE) in IEEE-STD 91-1984, *Graphic Symbols for Logic Functions*. This publication may be purchased from:

Institute of Electrical and Electronic Engineers
345 East 47th Street
New York, NY 10017

Table 8-6.Schematic Diagram Notes (1 of 11)

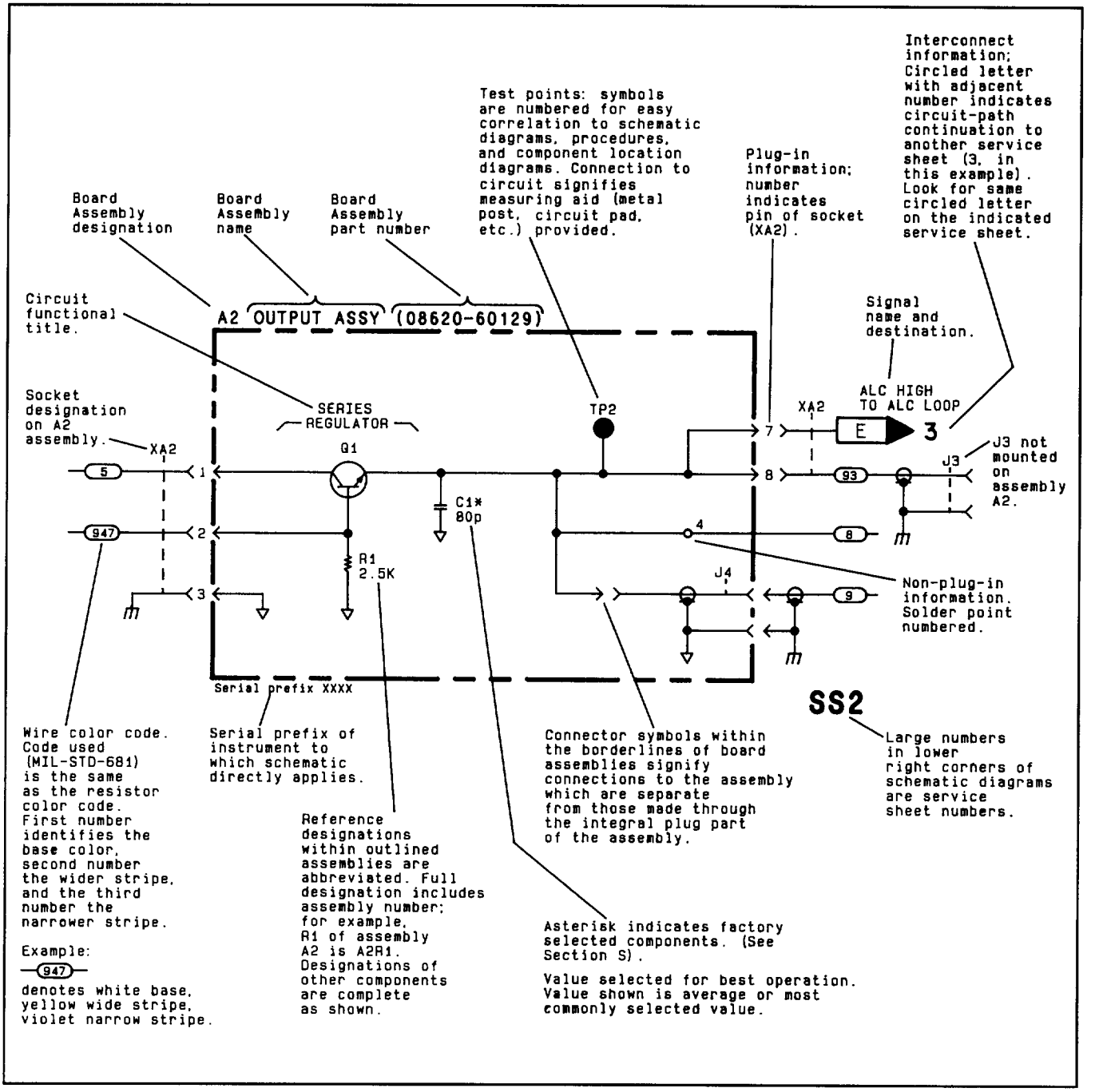


Table 8-6.Schematic Diagram Notes (2 of 11)

Values for all components are marked in units of farads, henries, and ohms unless otherwise specified.

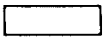
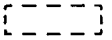
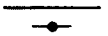
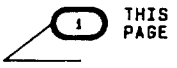
*	Asterisk denotes a factory-selected value. Value shown is typical. See Section V.
	Tool-aided adjustment.
	Encloses front-panel designation.
	Encloses rear-panel designation
	Circuit assembly borderline.
	Other assembly borderline.
	Heavy line with arrows indicates path and direction of main signal.
	Heavy dashed line with arrows indicates path and direction of main feedback.
	Indicates stripline (i.e., RF transmission line above ground).
	Wiper moves toward cw with clockwise rotation of control (as viewed from shaft or knob).
	Numbered Test Point measurement aid provided.
	Encloses wire or cable color code. Code used is the same as the resistor color code. First number identifies the base color, second number identifies the wider stripe, and the third number identifies the narrower stripe, e.g., (947) denotes white base, yellow wide stripe, violet narrow stripe.
	A direct conducting connection to earth, or a conducting connection to a structure that has a similar function (e.g., the frame of an air, sea, or land vehicle).
	A conducting connection to a chassis or frame.
	Common connections. All like-designation points are connected.
	Letter = off-page connection. Number = Service Sheet number for off-page connection. In the example, signal flow is continued on Service Sheet 12, at the point marked
	Number (only) = on-page connection.

Table 8-6.Schematic Diagram Notes (3 of 11)

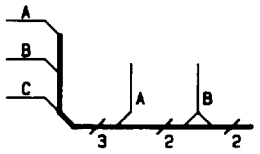
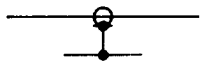
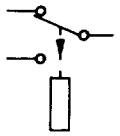
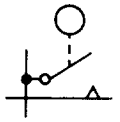
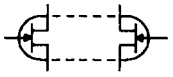
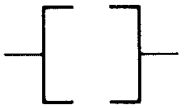
	Indicates multiple paths represented by only one line. Letters or names identify individual paths. Numbers indicate number of paths represented by the line.
	Coaxial or shielded cable.
	Ferrite bead. (Increases the self-inductance of the conductor passing through the bead.)
	Relay. Contact moves in direction of arrow when energized.
	Indicates a pushbutton switch with a momentary (ON) position.
	Feedthrough capacitor. (Acts as a feedthrough terminal when mounted on a chassis or a frame.)
	Indicates a PIN diode.
	Indicates a current regulation diode.
	Indicates a voltage regulation diode.
	Indicates a capacitive (varactor) diode.
	Indicates a Schottky (hot-carrier) diode.
	Light-emitting diode.
	Multiple transistors in a single package—physical location of the pins is shown in package outline on schematic.
	Identification of logic families as shown (in this case, ECL).

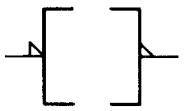
Table 8-6.Schematic Diagram Notes (4 of 11)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

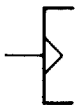
Input and Output Indicators



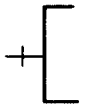
Implied Indicator—Absence of polarity indicator (see below) implies that the active state is a relative high voltage level. Absence of negation indicator (see below) implies that the active state is a relative high voltage level at the input or output.



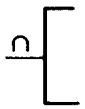
Polarity Indicator—The active state is a relatively low voltage level.



Dynamic Indicator—The active state is a transition from a relative low to a relative high voltage level.



Inhibit Input—Input that, when active, inhibits (blocks) the active state outputs of a digital device.



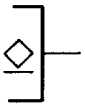
Analog Input—Input that is a continuous signal function (e.g., a sine wave).



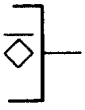
Polarity Indicator used with Inhibit Indicator—Indicates that the relatively low level signal inhibits (blocks) the active state outputs of a digital device.



Output Delay—Binary output changes state only after the referenced input (m) returns to its inactive state (m should be replaced by appropriate dependency or function symbols).



Open Collector Output.



Open Emitter Output.



Three-state Output—Indicates outputs can have a high impedance (disconnect) state in addition to the normal binary logic states.

Table 8-6.Schematic Diagram Notes (5 of 11)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Combinational Logic Symbols and Functions

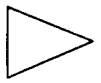
Σ	Summing Junction—Outputs added together at a common point.
&	AND—All inputs must be active for the output to be active.
≥1	OR—One or more inputs being active will cause the output to be active.
≥m	Logic Threshold—m or more inputs being active will cause the output to be active (replace m with a number).
=1	EXCLUSIVE OR—Output will be active when one (and only one) input is active.
=m	m and only m—Output will be active when m (and only m) inputs are active (replace m with a number).
=	Logic Identity—Output will be active only when all or none of the inputs are active (i.e., when all inputs are identical, output will be active).
	Amplifier—The output will be active only when the input is active (can be used with polarity or logic indicator at input or output to signify inversion).
X/Y	Signal Level Converter—Input level(s) are different than output level(s).
	Bilateral Switch—Binary controlled switch which acts as an on/off switch to analog or binary signals flowing in both directions. Dependency notation should be used to indicate affecting/affected inputs and outputs. Note: amplifier symbol (with dependency notation) should be read to indicate unilateral switching.
X→Y	Coder—Input code (X) is converted to output code (Y) per weighted values or a table.
(Functional Labels)	The following labels are to be used as necessary to ensure rapid identification of device function.
MUX	Multiplexer—The output is dependent only on the selected input.
DEMUX	Demultiplexer—Only the selected output is a function of the input.
CPU	Central Processing Unit

Table 8-6.Schematic Diagram Notes (6 of 11)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Sequential Logic Functions

1	Monostable—Single shot multivibrator. Output becomes active when the input becomes active. Output remains active (even if the input becomes inactive) for a period of time that is characteristic of the device and/or circuit.
G 	Oscillator—The output is a uniform repetitive signal which alternates between the high and low state values. If an input is shown, then the output will be active if an only if the input is in the active state.
FF	Flip-Flop—Binary element with two stable states, set and reset. When the flip-flop is set, its outputs will be in their active states. When the flip-flop is reset, its outputs will be in their inactive states.
T	Toggle Input—When active, causes the flip-flop to change states.
S	Set Input—When active, causes the flip-flop to set.
R	Reset Input—When active, causes the flip-flop to reset.
J	J Input—Analogous to set input.
K	K Input—Analogous to reset input.
D	Data Input—Always enabled by another input (generally a C input—see Dependency Notation). When the D input is dependency-enabled, a high level at D will set the flip-flop; a low level will reset the flip-flop. Note: strictly speaking, D inputs have no active or inactive states—they are just enabled or disabled.
+m	Count-Up Input—When active, increments the contents (count) of a counter by "m" counts (m is replaced with a number).
−m	Count-Down Input—When active, decrements the contents (count) of a counter by "m" counts (m is replaced with a number).
→m	Shift Right (Down) Input—When active, causes the contents of a shift register to shift to the right or down "m" places (m is replaced with a number).
←m	Shift Left (Up) Input—When active, causes the contents of a shift register to shift to the left or up "m" places (m is replaced with a number).

NOTE

For the four functions shown above, if m is one, it is omitted.

(Functional Labels)	The following functional labels are to be used as necessary in symbol build-ups to ensure rapid identification of device function.
mCNTR	Counter—Array of flip-flops connected to form a counter with modules m (m is replaced with a number that indicates the number of states: 5 CNTR, 10 CNTR, etc.).

Table 8-6.Schematic Diagram Notes (7 of 11)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Sequential Logic Functions (Cont'd)

REG	Register—Array of unconnected flip-flops that form a simple register or latch.
SREG	Shift Register—Array of flip-flops that form a register with internal connections that permit shifting the contents from flip-flop to flip-flop.
ROM	Read Only Memory—Addressable memory with read-out capability only.
RAM	Random Access Memory—Addressable memory with read-in and read-out capability.

Dependency Notation

Cm	Control Dependency—Binary affecting input used where more than a simple AND relationship exists between the C input and the affected inputs and outputs (used only with D-type flip-flops).
Gm	Gate (AND) Dependency—Binary affecting input with an AND relationship to those inputs or outputs labeled with the same identifier. The m is replaced with a number or letter (the identifier).
Vm	OR Dependency—Binary affecting input with an OR relationship to those inputs or outputs labeled with the same identifier. The m is replaced with a number or the letter (the identifier).
mAm	Address Dependency—Binary affecting inputs of affected outputs. The m prefix is replaced with a number that differentiates between several address inputs, indicates dependency, or indicates demultiplexing of address inputs and outputs. The m suffix indicates the number of cells that can be addressed.
ENm	Enable Dependency—Binary affecting input which, when active enables all outputs. When inactive open-collector and open-emitter outputs are off, and three-state outputs are at an external high impedance state. When the enable input affects only certain inputs and outputs, they will be numbered to indicate the logic connection.
Xm	Transmission Dependency—Binary affecting input which bidirectionally connects dependent inputs and outputs.
Mm	Mode Dependency—Binary affecting input used to indicate that the effects of particular inputs and outputs of an element depend on the mode in which the element is operating. The m is replaced with a number or letter (the identifier).
Zm	Interconnection Dependency—Indicates the existence of internal logic connections between inputs, outputs, internal inputs, and/or internal outputs. The m is replaced with a number (the identifier).
,	Comma—AND Function.
/	Slant—OR Function.

NOTE

The identifier (m) is omitted if it is one—that is, when there is only one dependency relationship of that kind in a particular device. When this is done, the dependency indicator itself (G, C, EN, or V) is used to prefix or suffix the affected (dependent) input or output.

Table 8-6.Schematic Diagram Notes (8 of 11)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

Miscellaneous



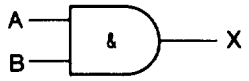
Schmitt Trigger—Input characterized by hysteresis; one threshold for positive going signals and a second threshold for negative going signals.

Active

Active State—A binary physical or logical state that corresponds to the true state of an input, an output, or a function. The opposite of the inactive state.

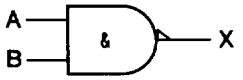
Table 8-6.Schematic Diagram Notes (9 of 11)

AND GATE



A	B	X
H	H	H
H	L	L
L	H	L
L	L	L

NAND GATE

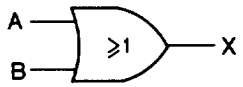


OR GATE WITH INVERTED INPUTS



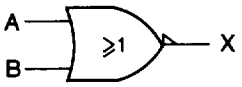
A	B	X
H	H	L
H	L	H
L	H	H
L	L	H

OR GATE

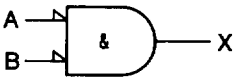


A	B	X
H	H	H
H	L	H
L	H	H
L	L	L

NOR GATE

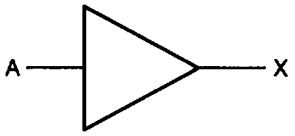


AND GATE WITH INVERTED INPUTS



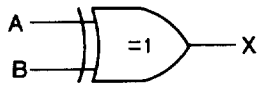
A	B	X
H	H	L
H	L	L
L	H	L
L	L	H

BUFFER

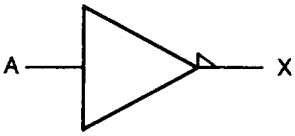


A	X
H	H
L	L

EXCLUSIVE-OR GATE



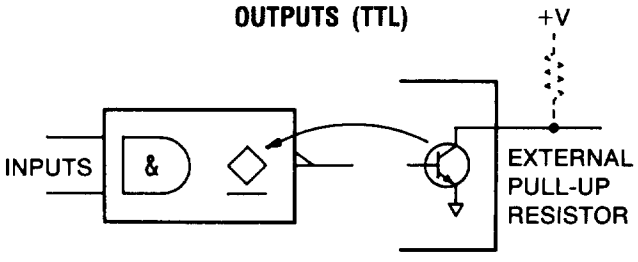
A	B	X
H	H	L
H	L	H
L	H	H
L	L	L



A	X
H	L
L	H

INVERTER

OPEN COLLECTOR OUTPUTS (TTL)



OPEN EMITTER OUTPUTS (ECL)

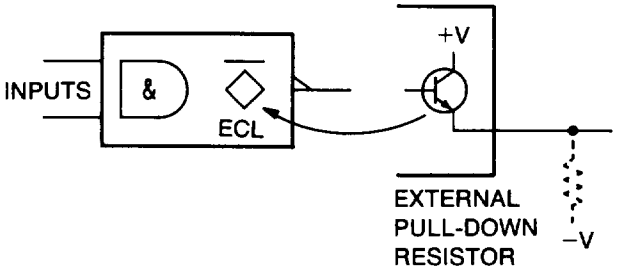
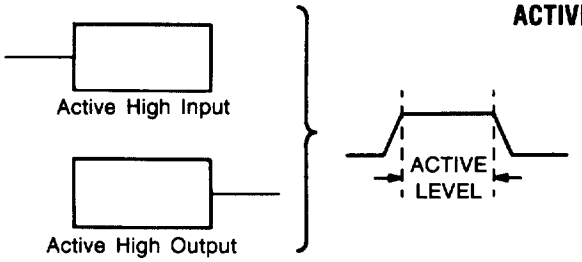
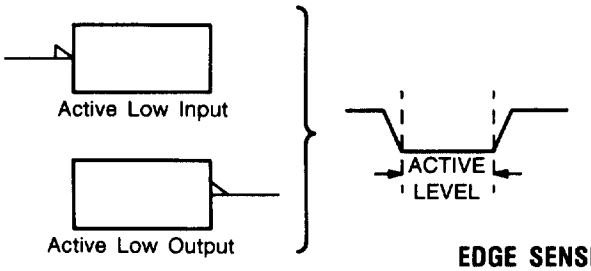


Table 8-6.Schematic Diagram Notes (10 of 11)

ACTIVE LEVELS

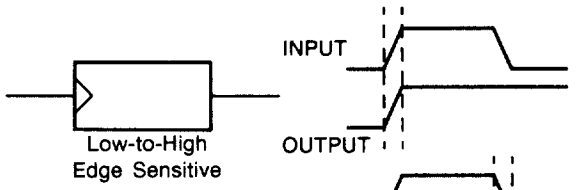


ACTIVE HIGH inputs and outputs are indicated by the absence of the polarity indicator symbol.

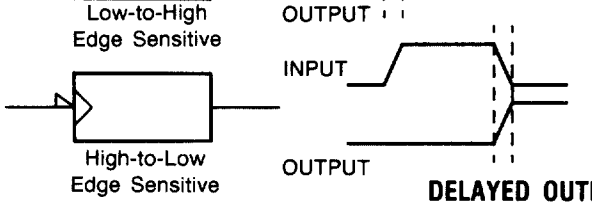


ACTIVE LOW inputs and outputs are indicated by the presence of the polarity indicator symbol ( ).

EDGE SENSITIVE INPUTS

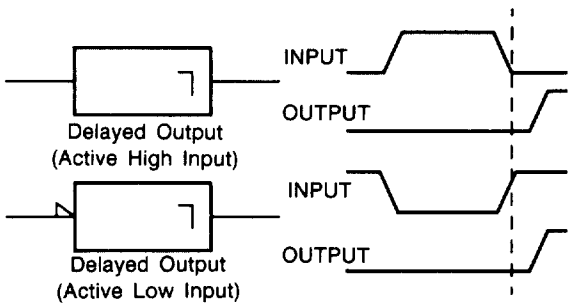


EDGE SENSITIVE (low-to-high) inputs are indicated by the presence of the dynamic indicator symbol ( ).



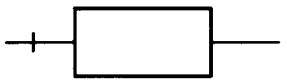
EDGE SENSITIVE (high-to-low) inputs are indicated by the presence of both the dynamic indicator and the polarity indicator symbols ( ).

DELAYED OUTPUT RESPONSE



OUTPUT DELAY indicator symbol ( ) shows that the output becomes effective *after* the input signal returns to its inactive state.

INHIBIT INPUTS



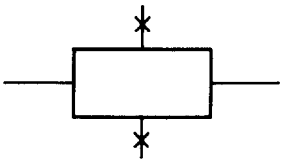
INHIBIT indicator symbol (+) indicates an input that, when active, inhibits (blocks) the output(s) from achieving their active states (the outputs remain inactive).

ANALOG LINES



ANALOG indicator symbol ( ) indicates a line that has an analog input or output.

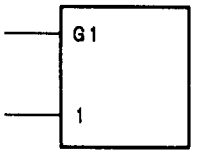
NONLOGIC CONNECTION



The Nonlogic Connection symbol (X) indicates a connection that does not carry any logic information.

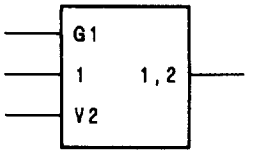
Table 8-6.Schematic Diagram Notes (11 of 11)

AND



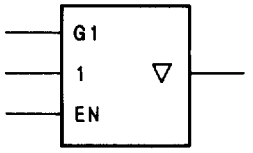
The input that controls or gates other inputs is labeled with a C or a G, followed by an identifying number.
The controlled or gated input or output is labeled with the same number. In this example, 1 is controlled by G1.

OR



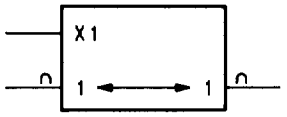
When a V input is active, the output will be in its active state. With the V input inactive, the device functions as if the V input doesn't exist.

ENABLE



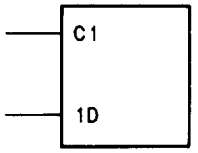
When the EN input is active, the output is enabled to function normally. When the EN input is inactive, the three-state output (▽), in this case, becomes a high impedance, effectively removing that device from the circuit.

TRANSMISSION

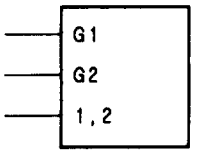


When the X1 input is active, the associated input-output pair are bi-directionally connected together. When X1 is inactive, the connection is broken.

CONTROL

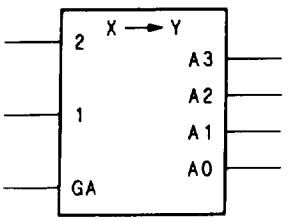


When the controlled or gated input or output already has a functional label (D is used here), that label will be prefixed by the identifying number.



If the input or output is affected by more than one gate or control input, then the identifying numbers of each gate or control input will appear separated by commas.

ADDRESS



When GA is active, the active address line (0 through 3) is the decoded value of the 1 and 2 binary inputs. When the controlled address lines have a functional value, that value will be prefixed by the identifying letter.

8-7. SPECIAL FUNCTIONS

General

Special Functions extend user control of the instrument beyond that normally available from the front panel. They are intended for the user who has a thorough understanding of the instrument and the service technician who needs arbitrary control of the instrument functions. During normal use, the Measuring Receiver safeguards itself against invalid measurements. Safeguards come in the form of automatic tuning and ranging, overpower protection, squelch, modulation output blanking, and error messages. When Special Functions are used, some of these safeguards are removed, and thus there is a degree of risk that the measurement may be invalid. However, there is no risk of damage to the instrument.

To enter a Special Function, enter the Special Function code (usually a prefix, decimal, and suffix), then press the SPCL key. The Special Function code will appear on the display as it is being entered. If a mistake is made during entry of the Special Function code, press the CLEAR key and start over. When a Special Function is entered, the light in the SPCL key will usually go on (if it is not already on). The readout on the display will depend on the Special Function entered. The readout may be a measured quantity, an instrument setting, a special code, or, in some cases, the display is unaltered. Special Functions can be entered from the HP-IB by issuing the Special Function code followed by the code SP or sp.

The Special Functions are grouped by prefix range as follows:

0: Direct Control Special Functions. These functions are used for service. They halt the functioning of the Controller and configure the instrument hardware as dictated by the suffix. All software safeguards are relinquished.

1-39: User Special Functions. These functions are used during normal instrument operation when a special configuration, measurement, or information is required. Many of the instrument safeguards remain implemented. More information on User Special Functions can be found under *Special Functions* in the *Detailed Operating Instructions* in Section 3 and on the Operating Information pull-out cards.

40-99: Service Special Functions. These functions are used to assist in troubleshooting an instrument fault. The functions available are quite diverse and include special internal measurements, software control, and special service tests and configurations. Safeguards are generally relinquished.

Direct Control Special Functions (Prefix 0)

Communication between the instrument's Controller and its hardware is via the Instrument Bus. During normal instrument operation, the Instrument Bus carries measurement results, status information, and commands (which control hardware). The Direct Control Special Functions halt the bus activity and send out commands as determined by the code suffix. One command is sent for each Special Function entry. A summary of the Direct Control Special Functions and codes is contained in Service Sheets A and B.

Direct Control Special Function Code Format. The Direct Control Special Function code is in the form 0.*esd*, where 0 is the prefix (which may be omitted) and *esd* represents a three-digit hexadecimal number. The significance of *esd* (which stands for enable, select, and data) is discussed in the Principles of Operation for Service Sheet BD5. Specific Direct Control Special Function codes are used in the troubleshooting section of the individual service sheets.

As the Direct Control code is entered, the code will appear on the display. Pressing the SPCL key initiates the Special Function. The display will then be in the form 00*rrrr.wwww*, where each digit represents a binary bit (0 or 1). The *rrrr* is the *d* (data) read back from the Instrument Bus. The *wwww* is the *d* (data) written to the bus. Thus *rrrr* and *wwww* are normally the binary form of the hexadecimal value for *d*. Exceptions to this are Special Functions 0.5*sd* and 0.6*sd*, which control the display itself.

The hexadecimal characters A, B, C, D, E, and F are displayed on entry as A, b, C, d, E, and F, and they are entered from the keyboard as Shift 0, Shift 1, Shift 2, etc., or from the HP-IB as X0, X1, X2, etc. Table 8B-1 summarizes the hexadecimal entry and readback for Direct Control Special Functions.

Table 8B-1. *Hexadecimal Information for Direct Control Special Functions*

Hexadecimal Character	Decimal Equivalent	Binary Equivalent	Keystroke Entry	HP-IB Code Entry	Display On Entry
0	0	0000	0	0	0
1	1	0001	1	1	1
2	2	0010	2	2	2
3	3	0011	3	3	3
4	4	0100	4	4	4
5	5	0101	5	5	5
6	6	0110	6	6	6
7	7	0111	7	7	7
8	8	1000	8	8	8
9	9	1001	9	9	9
A	10	1010	S (Shift) 0	X0	A
B	11	1011	S (Shift) 1	X1	b
C	12	1100	S (Shift) 2	X2	C
D	13	1101	S (Shift) 3	X3	d
E	14	1110	S (Shift) 4	X4	E
F	15	1111	S (Shift) 5	X5	F

Direct Control Special Function Applications. Direct Control Special Functions are most often used to provide manual control of various switches or digital-to-analog devices in the hardware. The following examples illustrate how to use Direct Control Special Functions:

Example 1

In the path of the demodulated audio signal is a set of selectable, active high-pass filters which are located on the A3 Audio De-emphasis and Output Assembly. A simplified diagram of the filters is shown in Figure 8B-1. The filters and through path are selected by analog switches U12A, U12B, and U12C. Table 8B-2, which is associated with the troubleshooting of the filters, lists the Direct Control Special Functions normally used to control the switches.

Table 8B-2. *Audio High-Pass Filter and FM Pre-Display De-Emphasis Direct Control Special Functions*

Check	Direct Control Special Function	
	Pre-Display On	Pre-Display Off
Thru Path	0.141	0.149
50 Hz HPF	0.142	0.14A
300 Hz HPF	0.144	0.14C

To insert the 50 Hz High-Pass Filter, key in 0.142 SPCL or .142 SPCL. The display will show 000010.0010, indicating that the Controller received $d = 2$ from the keyboard (or HP-IB), issued it to the Instrument Bus, and read it back. If the circuitry on the assembly is working properly, switch U12A will close and the audio signal will pass through the 50 Hz High-Pass Filter.

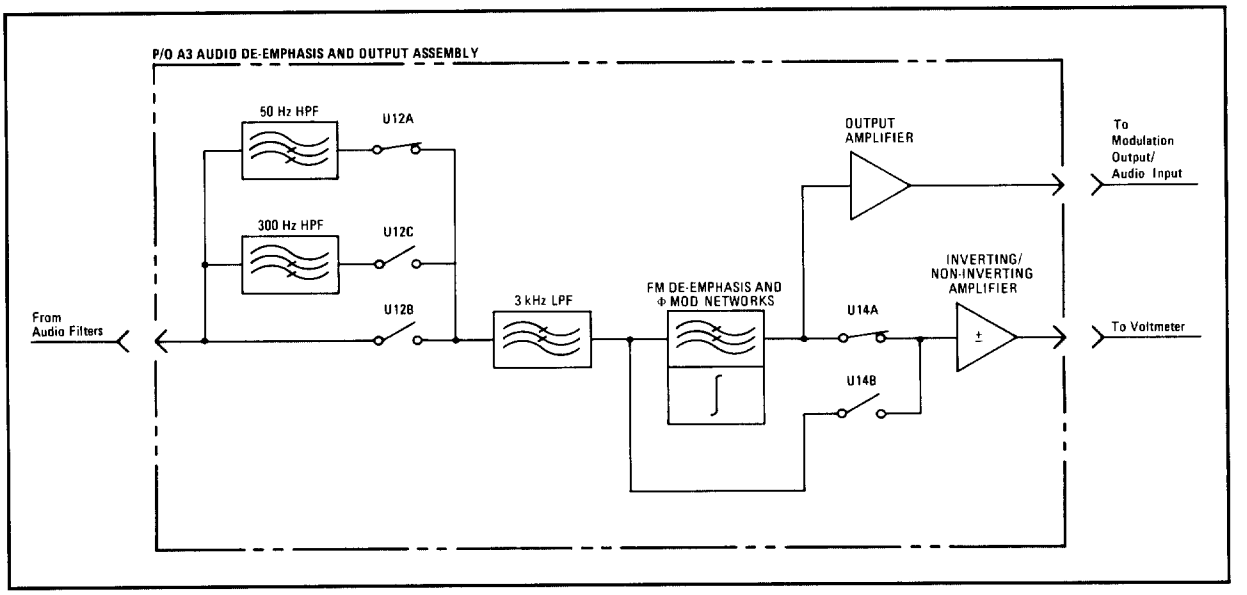


Figure 8B–1. *Example Showing High-Pass Filter Switching*

Notice that the display no longer shows a measurement result. No annunciators are lighted (except those related to HP-IB, if the Special Function is entered via HP-IB), and only the SPCL key is lighted. If any key other than a number key, S (Shift) key, or the LCL key is pressed, the instrument hardware will revert back to the measurement mode it was in before the Direct Control Special Function was entered. Thus, in this example, unless the 50 Hz High-Pass Filter had been previously selected with the front-panel key, it would be removed from the audio path, when any other key is pressed. (However, note that there are some Service Special Functions that will maintain the requested configurations even if another key is pressed.)

Table 8B-2 indicates that 0.14A will also select the 50 Hz High-Pass Filter. Any Direct Control Special Function of the form 0.14*d* also controls the pre-display filter on/off switches U14A and U14B. For pre-display on (0.142), U14A is closed. For pre-display off (0.14A), U14B is closed. As it turns out, 0.14*d* codes other than those shown in the table will also affect the high-pass filters. For example, 0.147 will close U12A, U12B, and U12C, simultaneously (with U14A also closed). This fact is ascertained from the service sheet schematic.

Example 2

A second example from the A3 assembly illustrates data readback when using the Direct Control Special Function. One of the means of detecting an overrange of the audio circuits is by the Audio Overvoltage Detector. The detector is on the audio input line before any active (and hence, distortable) filters (see Figure 8B-2). The audio input line is the same as in the previous example. The Audio Overvoltage Detector senses the peak signal level on the line and U9 compares it against a reference. If the detected level rises above the reference, the output of U9 goes low and resets flip-flop U19D. Other flip-flops (not shown) are also reset and open the audio path ahead of the detector (without intervention of the Controller). U21D and U21C, when enabled, invert the output of U19D twice. The output of U21C is across the least-significant bit of the readback data line of the Instrument Bus. In the normal measurement cycle, the Controller reads the status of the Audio Overvoltage Detector (by enabling U21D and reading the output of U21C) and displays an error if U9 has tripped.

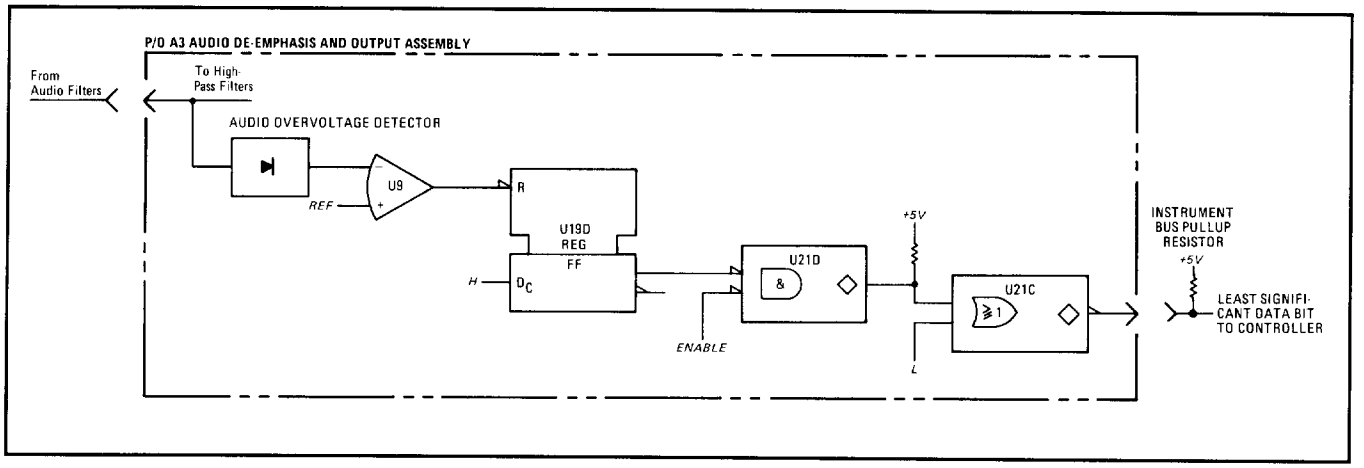


Figure 8B–2. *Example Showing Audio Overvoltage Detector Readback*

At this point in the discussion, a more detailed description of the Instrument Bus is needed. Data (*d*) is read out from the I/O port of the Controller to the Instrument Bus through buffers (TTL inverters). However, data is read back to the I/O port directly, bypassing the buffers. An I/O port outputs a low by actively pulling the line to ground. It outputs a high by allowing the output to be passively pulled up by an external pull-up resistor. When a Controller I/O port inputs data from other circuits of the Measuring Receiver, these circuits must operate against the passive pull-up resistor.

Readback devices that are read out to the data lines, such as U12C, are similarly configured. U21C has an open-collector TTL output. When not outputting data, its output device is off, pulling it to a high-impedance (inactive) state. When it outputs data, a low is produced by switching the output device to ground. A high is produced by switching the device off and allowing the output to be passively pulled up. The readback lines are low true (that is, $r = 1$ when the line is low).

When U12D is disabled (enable is high), its output is low. Therefore, U21C is high (inactive) and has no effect on the data line. U12D is enabled by Direct Control Special Function 0.15*d*. The value of *d* is arbitrary to enable U21D, but the least-significant bit must be 0 (that is, *d* must be even) to switch off the output device of the I/O data port.

To clarify this concept, suppose that U19D has not been reset. If Direct Control Special Function 0.152 is entered, the display will show 000010.0010. (0.15*d* also controls FM squelch. Using 0.152 deactivates squelch.) The four digits following the decimal are 0010 because $d = 2$ was received by the Controller from the keyboard and issued to the Instrument Bus. The set flip-flop (U19D) puts a high on the input of U21D and an inactive high on the least-significant data line. This is read by the Controller as $r = 0$ and thus is the same as the bit issued. The other three data readback lines are unaffected by the readback command and remain 001. Therefore, the *d* read back is 0010.

If U19D is reset, U21D puts a low on the least-significant data bit ($r = 1$), and the data read back is 0011. The display is therefore 000011.0010. (Note that *rrrr* is different from *wwww*.) If *d* is keyed as a hexadecimal F, the display is 001111.1111 regardless of the state of U21D. This is because all output devices on the data I/O port of the Controller are on (logical 1).

One final note, after a Direct Control Special Function is entered, it is periodically issued to the Instrument Bus. If a fault causes *rrrr* to indicate a malfunction, the display will begin to read correctly as soon as the fault is removed.

Service Special Functions (Prefix 40-99)

The Service Special Functions are used to perform a variety of tasks related to service. The functions are cataloged below. A suffix N indicates that a parameter other than 0 may be required to complete the Special Function code. Information within pointed brackets appears on the Measuring Receiver's display. See Table 8B-1 for entry of hexadecimal suffixes (A, B, C, D, E, and F).

40.0 Controller Reset. Initializes the Controller to its power-up state and is equivalent to switching the POWER switch to STBY and back to ON. Because this function affects the HP-IB hardware, it is unavailable from HP-IB (causes Error 24). See *Default Conditions and Power-Up Sequence* in Section 3.

41.0 Controller Clear. Initializes the Controller to its power-up state but bypasses the operational checks and is equivalent to pressing the blue key and INSTR PRESET (Instrument Preset) or giving the device clear command via HP-IB. Leaves HP-IB hardware unaffected but clears any service request message (SRQ) being issued by the Measuring Receiver, sets the service request condition to its power-up state, and clears all bits in the status byte. See *Default Conditions and Power-Up Sequence* in Section 3.

42.0 Display Software Date. Displays the date of the software in the form <day of year>.<year>. The display times out after 5s.

43.N Measurement Progress and Service Error Message Display Control. Measurement Progress Error Messages are Errors 40 through 64. Service Error Messages are Errors 65 through 89. Refer to *Error Messages*, paragraph 8-8.

N=0 Disables display of Service Error Messages (65 to 89).

N=1 Enables display of Service Error Messages (65 to 89). Cleared by the AUTOMATIC OPERATION key.

N=2 Enables display of Service Error Messages (65 to 89). Not cleared by the AUTOMATIC OPERATION key.

N=40 to N=89 Enables measurement to pause on the Measurement Progress and Service Error Message determined by N. See *Error Messages*, paragraph 8-8.

N=140 to N=189 Enables measurement to halt on the Measurement Progress and Service Error Message determined by N. See *Error Messages*, paragraph 8-8.

44.N Tuned-Flag Control. After successfully completing the tuning sequence during a tuned RF measurement, a tuned-flag is set. As the measurement sequence progresses, various status indicators are checked. If there is any indication that tuning may now be invalid (such as the input signal having drifted), the tuned-flag is cleared. The action taken after this depends upon the measurement mode. This Special Function permits manual setting and clearing of the tuned-flag.

N=0 Clears the internal tuned-flag. May initiate tuning.

N=1 Sets the internal tuned-flag.

45.N AM and FM Calibrator and RF Power Reference Control. See Service Sheets 30 (AM Calibrator), 29 (FM Calibrator), and 3 (RF Power Reference).

N	AM Calibrator		FM Calibrator Frequency	RF Power Reference
	Channel A	Channel B		
0	Off	Off	Low	Off
1	On	Off	Low	Off
2	Off	On	Low	Off
3	On	On	Low	Off
4	Switching 33% AM		Low	Off
5	Switching 100% AM		Low	Off
6	On	Off	High	Off
7	Off	On	High	Off
8	On	On	High	Off
9	Switching 33% AM		High	Off
10	Switching 100% AM		High	Off
11	On	Off	Switching	Off
12	Off	On	Switching	Off
13	On	On	Switching	Off
14	Switching 33% AM		Switching	Off
15	Switching 100% AM		Switching	Off
16	Off	Off	Low	On
17	On	Off	Low	On
18	Off	On	Low	On
19	On	On	Low	On
20	Switching 33% AM		Low	On
21	Switching 100% AM		Low	On
22	On	Off	High	On
23	Off	On	High	On
24	On	On	High	On
25	Switching 33% AM		High	On
26	Switching 100% AM		High	On
27	On	Off	Switching	On
28	Off	On	Switching	On
29	On	On	Switching	On
30	Switching 33% AM		Switching	On
31	Switching 100% AM		Switching	On

46.N Count Internal Signals. The Counter counts the internal signal selected by N for 100 ms and displays the count. This is equivalent to measuring the frequency of the signal with 10 Hz resolution for most signals. See Service Sheets 22 and 23.

N=1 Intermediate Frequency. See Service Sheet 10.

N=2 Voltage-to-Time Converter. 10 000 counts equal 1V, but includes a 0.6V offset. See Service Sheet 15 or Special Functions 49 and 50.

N=3 FM Calibrator. See Service Sheet 29.

N=4 High Frequency VCO Divided by 8. This is the 40 to 80 MHz signal proportional to the LO frequency. See Service Sheet 17.

N=8 Selected Time Base Reference. The display should read 1000000±1. See Service Sheet 22.

N=9 External Time Base Reference. The display should read 1000000±1 when an external reference is connected. See Service Sheet 22.

N=A Internal Time Base Reference. The display should read 1000000±1 when no external reference is connected. See Service Sheet 22.

N=B Audio Counter Input or IF Synchronous Detector VCO. If the Audio Frequency measurement mode has been selected, the frequency of the signal at the input of Audio Counter is displayed. (The frequency is measured with the Counter in the A11 Counter Assembly. The Audio Counter in the A52 Audio Counter/Distortion Assembly is not exercised except for its Schmitt trigger input.) See Service Sheet 16. If the Tuned RF Level measurement mode has been selected, the frequency of the VCO of the IF Synchronous Detector (and hence the frequency of the IF) is read. See Service Sheet 7 and Special Function 48.2 (which is similar).

47.0 Instrument Configuration Display *(2535A and Above).* Displays certain instrument configuration details in the following form

<Tracking Synchronous Detector>.<New Opt. Series 030>< Old Opt. Series 030>

where 1 is yes and 0 is no. The new Option Series 030 refers to instruments with serial prefixe 2535A and above; old refers to older versions of the HP 8901B Modulation Analyzer (which shares the firmware).

48.N IF Synchronous Detector Control. See Service Sheet 7.

NOTE

Frequencies are displayed with 10 Hz resolution.

N=0 Displays the dc output voltage (in volts).

N=1 Disconnects the input to the Synchronous Detector and displays the output offset voltage (in volts).

N=2 Disables VCO sweep and displays the VCO frequency.

N=3 Enables VCO fast sweep up and displays the VCO frequency.

N=4 Enables VCO fast sweep down and displays the VCO frequency.

N=5 Enables VCO slow sweep up and displays the VCO frequency.

N=6 Enables VCO slow sweep down and displays the VCO frequency.

N=7 Pretunes the VCO and displays the VCO frequency.

N=8 Disables the VCO and displays the VCO frequency (which should be 0 or 1 since the VCO is disabled).

N=9 Displays lock status. <0> indicates unlocked. <1> indicates locked.

49.N Display Internal Voltages. The Voltmeter measures and displays the internal voltage (in volts) selected by N. This special function also controls the rear-panel RECORDER output as explained in the following note.

N=0 Ground. See Service Sheet 15.

N=1 RF Peak Detector Ground. See Service Sheet 4.

N=2 RF Peak Detector ÷3. See Service Sheets 4 and 15.

N=3 RF Peak Detector. See Service Sheet 4.

N=4 ×10 AM Calibrator. See Service Sheet 30.

N=5 ×1 AM Calibrator. See Service Sheet 30.

N=6 Audio Range Detector. See Service Sheet 13.

N=7 RMS-to-DC Converter. See Service Sheet 16.

N=8 Ground. See Service Sheet 15.

N=9 Audio Average Detector. See Service Sheet 14.

N=A Audio Peak Detector. See Service Sheet 14.

N=B IF Average Detector. See Service Sheet 8.

N=C IF RMS Detector (Option Series 030) *(2535A and Above)*. See Service Sheet 34.

N=D IF Peak Detector. See Service Sheet 9.

N=E ALC Current. See Service Sheet 8.

N=F RF Average Power or Sensor Identifier. To read average power, precede with Special Function 0.212. To read sensor identifier, precede with Special Function 0.211. See Service Sheet 2.

NOTE

The suffix N can also be two digits, XY. The displayed result is equivalent to the display of 49.X SPCL minus the display of 49.Y SPCL. For example, 49.3 SPCL or 49.30 SPCL gives a display of the level from the RF Peak Detector with respect to ground. 49.31 SPCL gives a display of the level from the RF Peak Detector with respect to the level from the RF Peak Detector ground.

The rear-panel RECORDER output is connected to the output of the Voltmeter's selector switch (see Service Sheet 15). During normal operation, the selector is constantly being switched between the various inputs. Each voltage measurement also includes a separate measurement of ground. The displayed result is derived from the difference between the selected voltage and ground readings.

The switching at the RECORDER output can be halted by keying in Special Function 49.XY with X equal to 0 or 8 and Y equal to the desired input. The dc level at the RECORDER output is constant and equal to the selected input; the displayed measurement result is equal to the result using Special Function 49.Y. This feature is useful for troubleshooting the Voltmeter and for improving the accuracy of the RF Power and Tuned RF Level measurements (see Recorder Output *in Section 3).*

50.N Display Internal Voltages. The Voltmeter measures and displays the internal voltage (in volts) selected by N. See also the previous note.

N=0 Ground. See Service Sheet 15.

N=1 −15V Supply. The display should read between 2.7200 and 3.000. See Service Sheet 15.

N=2 −5V Supply. The display should read between 2.7300 and 3.1500. See Service Sheet 15.

N=3 +5V Supply. The display should read between 2.8500 and 3.3200. See Service Sheet 15.

N=4 +15V Supply. The display should read between 2.8500 and 3.1500. See Service Sheet 15.

N=5 +40V Supply. The display should read between 2.9800 and 3.2900. See Service Sheets 15 and 20.

N=6 IF Synchronous Detector without DC-to-RMS Converter. See Service Sheets 7 and 15.

N=7 IF Synchronous Detector with DC-to-RMS Converter. See Service Sheets 7 and 15.

52.N Read-Only Memory Verification. The Controller displays the checksum of the read-only memory (ROM) specified by N. When specifying a ROM, use N=1 through 3. The display is in the form <actual checksum>.<expected checksum>. An initial zero (or zeros) will be blanked. Thus, for example, 24.024 would be a valid checksum, 24.124 would be invalid. The display times out after approximately 5s. See Service Sheet 24.

53.N IF Synchronous Detector Test. The Controller sequences the IF Synchronous Detector through groups of tests specified by N and returns a fault code corresponding to the test that failed. For N=1 to N=4, four tests are performed for each group. If all tests in the group pass, 0 will be displayed. If any tests fail, the fault codes appear on the display in the positions indicated. (The digit positions are numbered under the display window.) All leading zeros in the display are blanked. For example, in the group defined by N=1, if the VCO pretunes too high (Fault 3), the failure will result in the display " 300" (five leading zeros blanked). The tests are continuously sequenced, and the display will be updated as the fault is corrected. When multiple faults are displayed, troubleshoot the lowest-numbered fault first. Most of the tests can be done manually using Special Function 48. (Some tests make use of the AM Calibrator.) For all tests, see Service Sheet 7.

N=0 Performs all tests in the groups listed for N=1 through N=4 (below). Displays the number of the first test that failed. If no test fails, a zero is displayed. Run this test with a cable connected between the CALIBRATION AM/FM OUTPUT and INPUT. The test takes approximately 15s to complete.

N=1 Tests the presence and pretune frequency of the VCO. The VCO is pretuned and its frequency measured by the Counter. No signal should be connected to the instrument's INPUT.

Fault 1. VCO signal not present. If the VCO frequency is less than 100 Hz, 1 will be displayed in digit position 2. (This error will be generated if the IF Synchronous Detector Assembly is not present.)

Fault 2. VCO pretune frequency too low. If the VCO frequency is less than 456.5 kHz, 2 will be displayed in digit position 4.

Fault 3. VCO pretune frequency too high. If the VCO frequency is more than 457.5 kHz, 3 will be displayed in digit position 6.

Fault 4. Undefined.

N=2 Tests the direction and speed of the VCO sweep. The VCO sweep configurations are checked by counting the VCO frequency after a timed interval. No signal should be connected to the instrument's INPUT.

Fault 5. VCO will not fast sweep up. If the VCO frequency has not increased by at least 2 kHz after a 670 ms interval, 5 will be displayed in digit position 2.

Fault 6. VCO will not slow sweep down. If the VCO frequency has not decreased by at least 2 kHz after a 4s interval, 6 will be displayed in digit position 4.

Fault 7. VCO fast sweep too fast or too slow. If the VCO frequency has changed at a rate less than 4 or greater than 9 kHz/s, 7 will be displayed in digit position 6.

Fault 8. VCO slow sweep too fast or too slow. If the VCO frequency has changed at a rate less than 800 or greater than 1200 Hz/s, 8 will be displayed in digit position 8.

N=3 Tests the sweep limits of the VCO. The VCO is pretuned and allowed sweep to its limits and the VCO frequency is checked by the Counter. No signal should be connected to the instrument's INPUT.

Fault 9. VCO lower sweep limit to high or to low. If the lower limit of the VCO is less than 439 or greater than 449 kHz, 9 will be displayed in digit position 2.

Fault 10. VCO upper sweep limit too high or too low. If the upper limit of the VCO is less than 462 or greater than 469 kHz, 10 will be displayed in digit positions 3 and 4.

Fault 11. Undefined.

Fault 12. Undefined.

N=4 Tests the ability of the VCO to lock and tests the output and linearity of the Synchronous Detector. A signal of known level (the signal from the AM Calibrator, which can be stepped by 6 dB) is measured by the IF Synchronous Detector (the Tuned RF Level measurement).

Lock status is checked and the output of the Synchronous Detector is checked at two different signal levels and with no signal. Connect a cable between the instrument's CALIBRATE AM/FM OUTPUT and INPUT.

Fault 13. Phase Detector does not lock. Lock status is checked. If the status is "unlocked", 13 will be displayed in digit positions 1 and 2.

Fault 14. Synchronous Detector output too high or too low. If the output of the Synchronous Detector, with the AM Calibrator at maximum level, is less than 0.977 or greater than 1.949V, 14 will be displayed in digit positions 3 and 4.

Fault 15. Synchronous Detector offset too high. If the output of the Synchronous Detector, with its input shut off, is greater than 10 mV, 15 will be displayed in digit positions 5 and 6.

Fault 16. Synchronous Detector linearity too low. If the output of the Synchronous Detector drops more 6.2 or less than 5.8 dB when the AM Calibrator level drops 6 dB, 16 will be displayed in digit positions 7 and 8.

54.N Local Oscillator Test. The Controller sequences the local oscillator (LO) through groups of tests specified by N and returns a fault code corresponding to the tests that failed. For N=1 to N=5, four tests are performed for each group. If all tests in the group pass, 0 will be displayed. If any tests fail, the test numbers appear on the display in the positions indicated. (The digit positions are numbered under the display window.) All leading zeros in the display are blanked. For example, in the group defined by N=1, a simultaneous time base (Test 2) and HF VCO or Divider (Test 4) failure will result in the display " 20004" (three leading zeros blanked). The tests are continuously sequenced, and the display will be updated as the fault is corrected. The tests are most easily visualized by referring to Figures 8D-1 through 8D-4.

N=0 Performs all tests in the group listed for N=1 through N=5 (below). Displays the number of the first test that failed. If no test fails, 0 is displayed.

NOTE

If the display is not zero, it is important that all other tests be checked (N=1 through N=5). Some LO faults cause more than one test to fail. For example, if the HF VCO÷8 output fails, the following tests will fail:

N=1, Test 4,
N=2, Tests 5, 6, and 7,
N=3, Tests 9 and 10,
N=4, Tests 17 and 18.

This is because a frequency measurement of the LO is made in these particular tests. If the +40V Supply fails, the following tests will fail:

N=2, Tests 5 and 6,
N=3, Tests 9 and 10,
N=4, Tests 17 and 18.

Begin troubleshooting at the lowest-numbered test.

This test is run automatically at power-up. Results are not displayed, but a pass-fail indication is made on internal LEDs. (See Power-up Check, *paragraph 8-9.)*

Counter Tests

N=1 Test 1. Undefined.

N=1 Test 2. Time Base Test. See Service Sheets 22 and 23.

Tests the 6.25 kHz TTL time base signal to determine if it toggles within a reasonable length of time. The Controller looks at A11U15D's output for 260 μs. At least one transition (high-to-low or low-to-high) of the clock should occur during this time. If no clock transition occurs, 2 will be displayed in digit position 3. However, if a transition is detected, a second (verification) check is made by the Controller.

N=1 Test 3. Counter Test. See Service Sheet 23.

Counts the selected Time Base, which should be exactly 1000000. If the result is not 1000000, 3 will be displayed in digit position 6.

N=1 Test 4. HF VCO and Divider Output. See Service Sheets 17 and 18.

Connects the DAC output to the HF VCO and counts the LO frequency to determine if it is within certain limits. The Controller turns off the Sweep-Up and Sweep-Down Current Sources and LF VCXO tune filter, allowing the HF VCO to free run. The Controller then outputs the approximate center frequency code to the tuning DAC and checks if the HF VCO output is between 250 and 800 MHz. If the frequency is not within these limits, 4 will be displayed in digit position 8.

DAC and HF VCO Range Tests

N=2 Test 5. HF VCO Top of Range Test. See Service Sheet 18.

Tests the DAC's ability to drive the HF VCO to the top of its frequency range. The DAC is programmed to output the highest tune voltage. If the HF VCO does not tune to between 655 and 800 MHz, 5 will be displayed in digit position 2.

N=2 Test 6. HF VCO Bottom of Range Test. See Service Sheet 18.

Tests the DAC's ability to drive the HF VCO to the bottom of its frequency range. The DAC is programmed by the Controller to output the lowest tune voltage. If the HF VCO does not tune to between 280 and 310 MHz, 6 will be displayed in digit position 4.

NOTE

Test 6 is not always conclusive. The test may not always detect a failure of the VCO to tune to the bottom of the band. If the VCO does fail to tune to the bottom of its band, the instrument will not tune to certain frequencies in the track mode.

N=2 Test 7. HF VCO Mid-Range Test. See Service Sheet 18.

Tests the DAC's ability to control the HF VCO near the center of its frequency range. The DAC is programmed by the Controller to output a tune voltage near the center of the range. If the HF VCO does not tune to between 454 and 575 MHz, 7 will be displayed in digit position 6.

N=2 Test 8. Undefined.

DAC and HF VCO Incremental Range Tests

N=3 Test 9. Gain Test For Most Significant DAC. See Service Sheet 20.

Tests the gain of the most significant DAC. The Controller sends a hexadecimal 55 to the most-significant DAC (MSDAC) and a hexadecimal AA to the least-significant DAC (LSDAC). The Controller then counts the frequency of the HF VCO. The MSDAC is then changed to AA. The Controller again counts the frequency of the HF VCO and then computes the difference between the first and second frequencies. This difference should fall between 139 and 285 MHz. If it does not, 9 will be displayed in digit position 2.

N=3 Test 10. Gain Test For Least Significant DAC. See Service Sheet 20.

Tests the gain of the least significant DAC. The Controller sends a hexadecimal AA to the most-significant DAC (MSDAC) and a hexadecimal 55 to the least-significant DAC (LSDAC). The Controller then counts the frequency of the HF VCO. The LSDAC is then changed to AA. The Controller again counts the output of the HF VCO and then computes the difference between the first and second frequencies. This difference should fall between 1.95 and 4.5 MHz. If it does not, 10 will be displayed in digit positions 3 and 4.

N=3 Test 11. Undefined.

N=3 Test 12. Undefined.

LF VCXO Lock Acquisition Tests

N=4 Test 13. Phase Lock Loop Acquisition. See Service Sheets 18 and 20.

Tests the HF VCO's ability to lock to the LF VCXO. The Controller turns off the Sweep Current Sources and the LF VCXO tune filter. It then programs the DAC to output a tune voltage which causes the HF VCO to operate near the center of its frequency range. The Controller rapidly switches the DAC output to the LF VCXO (with the DAC still programmed to midrange). The sampler loop is then closed and the output of the HF VCO is counted. If the HF VCO is operating properly, it will drift until it locks to a harmonic of the LF VXCO (via the sampler). If the HF VCO frequency has moved more than 2 MHz, it has failed to lock to a harmonic of the LF VCXO, and 13 will be displayed in digit positions 1 and 2.

N=4 Test 14. Phase Lock Loop Stability. See Service Sheet 20.

Tests the ability of the HF VCO to follow step changes in the LF VCXO. The Controller sends the DAC a code which forces the LF VCXO to the bottom of its frequency range. The frequency of the HF VCO is counted. The DAC is then instructed to quickly slew the LF VCXO to the top of its frequency range and then back down to the bottom again. When the DAC output voltage reaches minimum, the HF VCO is again counted. The frequency change of the HF VCO should be less than 100 kHz. If it is not, 14 will be displayed in digit positions 3 and 4.

N=4 Test 15. Undefined.

N=4 Test 16. Undefined.

LF VCXO Lock Range Tests

N=5 Test 17. LF VCXO Range Test. See Service Sheets 19 and 20.

Tests to see if the DAC moves the LF VCXO within the proper frequency limits. Since the LF VCXO frequency cannot be measured directly, an indirect process is used. The Controller sends a hexadecimal 00 to the DAC, which drives the LF VCXO to its minimum frequency. This frequency change causes a proportional change in the HF VCO frequency, which is measured by the Counter. The Controller then sends a hexadecimal FF to the DAC, driving the LF VCXO to its highest frequency. The HF VCO output is again counted. The difference between the highest and lowest frequencies from the HF VCO should be between 2.95 and 5.5 MHz. If the frequency difference does not fall within this range, 17 will be displayed in digit positions 1 and 2.

N=5 Test 18. Gain of the LF VCXO Drive. See Service Sheets 19 and 20.

Tests the gain of the LF VCXO. This is the hardest test in this series for the instrument to pass. The Controller sends a hexadecimal 55 to the most-significant DAC (MSDAC) and a hexadecimal AA to the least-significant DAC (LSDAC) and then counts the frequency of the HF VCO. The Controller then changes the MSDAC to a hexadecimal AA and the LSDAC to a hexadecimal 55, and again counts the frequency of the HF VCO. The difference between the first and second frequencies should be within the range of 1.05 and 2.4 MHz. If it is not, 18 will be displayed in digit positions 3 and 4.

N=5 Test 19. Undefined.

N=5 Test 20. Undefined.

55.0 Sweep Doubler Band. Sweeps the LO slowly back and forth across the doubler band. See Service Sheet 17.

56.0 Sweep Bands 4 through 8. Sweeps the LO slowly and sequentially across bands 4 through 8. See Service Sheet 17.

57.0 Sweep Bands DBLR through 3. Sweeps the LO slowly and sequentially across bands DBLR through 3. See Service Sheet 17.

60.0 Key Scan. The keyboard is scanned and a key code is displayed and output to the HP-IB. The key codes are shown in Figure 8B-3.

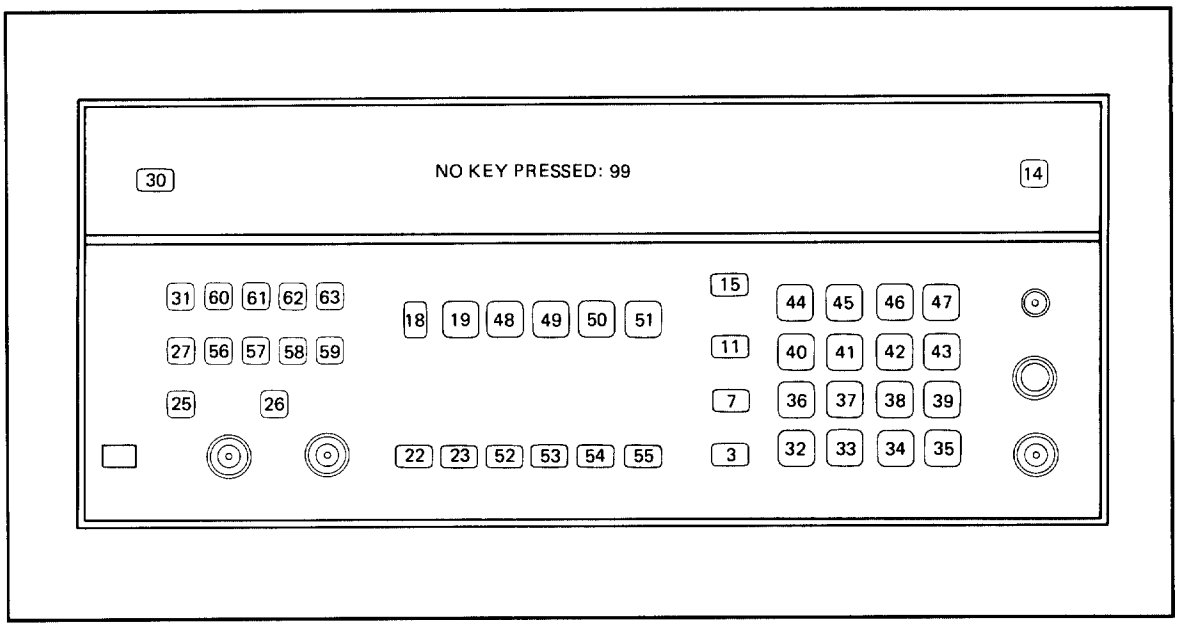


Figure 8B-3. *Key Codes for Key Scan (Service Special Function 60)*

To use the Key Scan Special Function, remove the instrument top cover. Key in 60.0 SPCL then jumper A13TP3 (INT) to A13TP1 (GND) on the A13 Controller Assembly. Press the front-panel keys and observe the display. If two or more keys are pressed simultaneously, the display shows the code corresponding to the first one found in its normal scan. See Service Sheet 25.

Two simple programs for displaying the key codes on a computing controller are shown in Table 8B-3. Removal of the top and bottom covers is unnecessary. The Measuring Receiver is assumed to have HP-IB address 14.

Table 8B-3. *Key Scan Programs*

HP 9825A (HPL)	HP 85A (BASIC)
0: rem 714;llo 7 1: wrt 714, "60.0SP" 2: red 714,A 3: dsp A 4: jmp -2 5: end	10 REMOTE 714 20 LOCAL LOCKOUT 7 30 OUTPUT 714; "60.0SP" 40 ENTER 714 50 DISP A 60 GOTO 40 70 END

61.N Display HP-IB Status. Displays the status of the HP-IB lines selected by N. The display is in binary. See Service Sheet 28 for troubleshooting and a complete list of HP-IB mnemonics.

NOTE

Information within pointed brackets appears on the Measuring Receiver's display.

N=0 <Addressed to Talk>.<Addressed to Listen>. This function reads back and displays the present state of the Talk and Listen Address flip-flops (A14U16A and B). For example, if the display shows 1.0, the Measuring Receiver is addressed to talk (and unaddressed to listen). This means the Talk Address flip-flop is set (and the Listen Address flip-flop is reset).

N=1 <DAV>.<RFD><DAC>. This function reads back and displays the present state of the three bus handshake lines. <DAV> reflects the state of the Data Valid bus handshake line as being driven by the Measuring Receiver (1=being driven; 0=not being driven). Thus, when in Listen Only, this display will always show 0 for <DAV>. The <RFD> and <DAC> always track the bus lines Ready For Data and Data Accepted. For example, 1 for <RFD> means line Ready For Data is true (high).

N=2 <ATN>.<REN>. This function reads back and displays the present state of the ATN (Attention) bus control line and the state of the Remote Enable Flip-Flop. A 1 for either <ATN> or <REN> indicates ATN is true (low at the bus) or that the Remote Enable Flip-Flop is set.

N=3 <SPM>.<SRQ>. This function reads back and displays the state of the Serial-Poll flip-flop and the state of the SRQ bus-control line as being driven by the Measuring Receiver is in serial-poll mode (SPM) or that it is presently driving the SRQ bus control line.

N=4 PIO Port A. This function inputs and displays (without modifying) the data at PIO port A (A14U13). Leading zeros are blanked. The following table interprets the display.

PIO Port A

A14U13 Pin	2	37	36	31	30	25	24	19
Display Digit	1	2	3	4	5	6	7	8
Mnemonic	IO8	IO7	IO6	IO5	IO4	IO3	IO2	IO1
1 = True								

N=5 PIO Port B. This function is similar to the function above except PIO port B is displayed. The display is interpreted as shown in the table below.

PIO Port B

A14U13 Pin	1	38	35	32	29	26	23	20
Display Digit	1	2	3	4	5	6	7	8
Mnemonic	ATN	ARD	AAD	SRQ	RNL	ATT	ATL	SDV
1 = True								

8-8. ERROR MESSAGES

General

The instrument generates error messages to indicate operating problems, incorrect keyboard entries, or service-related problems. The error message is cleared when the error condition is removed.

Error Message Catagories

Errors 01 through 19, 30 through 39, and 90 through 99. These are Operating Error Messages, which indicate that not all conditions have been met to assure a calibrated measurement. Operating Error Messages can usually be cleared by readjustment of the front-panel controls. The Error Disable Special Function 8 can be used to selectively disable certain error messages. More information on Operating Error Messages and error message disabling can be found under *Error Message Summary* and *Error Disable* in Section 3 and on the *Operating Information* pull-out card.

Errors 20 through 29. These are Entry Error Messages, which indicate that an invalid key sequence or keyboard entry has been made. These errors require that a new keyboard entry or function selection be made. More information on Entry Error Messages can be found under *Error Message Summary* in Section 3 and on the *Operating Information* pull-out card.

Errors 40 through 64. These are Measurement Progress Error Messages which indicate if a given segment of the measurement cycle has been traversed. These messages are not normally enabled.

Errors 65 through 89. These are Service Error Messages which provide additional service-related information and are discussed below. Service Error Messages do not necessarily infer that the instrument has a problem but may indicate a normal phenomenon under the particular circumstances. These messages are not normally enabled.

Enabling Measurement Progress and Service Error Messages

Service Error Messages (Errors 40 through 89) are not normally displayed. When a service-related problem is suspected, enable the display Measurement Progress and Service Error Messages by keying in Special Function 43.N with N determined as follows:

N=0 Disables display of Service Error Messages 65 through 89.

N=1 Enables display of Service Error Messages 65 through 89. Cleared by AUTOMATIC OPERATION key.

N=2 Enables display of Service Error Messages 65 through 89. Not cleared by AUTOMATIC OPERATION key.

N=40 through N=89 and N=140 through N=189. Enables measurement to pause or halt on Measurement Progress and Service Error Message indicated by N. See the following paragraphs for details.

Measurement Progress Error Messages (Errors 40 through 64)

These Service Error Messages are used to check the progress of a measurement. Refer to Table 8B-4, *Measurement Progress Error Codes* and Figure 8D-5, *Measuring Receiver Software Supervisor Flow Chart.* To see if the measurement progresses through a particular segment of the flow chart, enable the error code corresponding to the segment in either of the two following ways:

1. To cause the measurement to pause momentarily (approximately $^1/_2$ second) and display the error code when the segment is encountered and then to continue on, key in 43.N SPCL, where the suffix N is the error code of the segment.
2. To cause the measurement to halt and display the error code when the segment is encountered, key in 43.N SPCL, where N is the error code of the segment plus 100. Press CLEAR to exit.

Table 8B–4. Measurement Progress Error Codes

Error Code	Flow Chart Segment
44	Non-Measurement Display
46	Measurement Display
48	Set Up Hardware
50	Frequency Tuning
52	Signal Leveling
54	Audio Ranging
56	Measure
58	Manipulate
60	Exit Manipulate

Service Error Messages (Errors 65 through 89)

These Service Error Messages are quite diverse and are enabled in three ways.

1. Special Function 43.1 enables the Service Error Messages and allows the AUTOMATIC OPERATION key to clear them.
2. Special Function 43.2 enables the Service Error Messages but does not allow AUTOMATIC OPERATION to clear them.
3. Special Function 43.N enables the measurement to pause or halt when the Service Error Message specified by N or 100 minus N is encountered. The two alternatives are as follows:
   a. To cause the measurement to pause (approximately $1/2$ second) when a specified Service Error Message occurs, key in 43.N SPCL, where N is the Service Error Message code. After pausing and displaying the Service Error Message code, the measurement will continue on.
   b. To cause the measurement to halt when a specified Service Error Message occurs, key in 43.N SPCL, where N is the specified Service Error Message code plus 100. Once the measurement is halted, pressing any key will terminate the halt feature unless testpoint TEST A on the A13 Controller Assembly is grounded. If the testpoint is grounded, pressing any key allows the measurement to proceed until the error is encountered again (permitting single-stepping of the measurement cycle). Press the AUTOMATIC OPERATION key rapidly twice in succession to exit this function.

The Service Error Messages are as follows:

Error 67. Tuned RF Level Ranging. The instrument has attempted to change ranges and found the signal either too high or too low after ranging. This may be due to improper switching of the RF Amplifier or attenuator, or it may be due to a fault on the IF Amplifier/Filter Assembly. See Service Sheets 4 and 6.

Error 68. RF Amplifier Overpower. Overpower status of the RF Amplifier was checked and found to be overpowered. See Service Sheet 4.

Error 69. IF Synchronous Detector Fails to Lock. Lock status of the IF Synchronous Detector was checked and found to be unlocked. Measuring a signal with significant drift or residual FM may cause this error. See Service Sheet 7.

Error 70. Phase Lock Loop Step-Down. The LO phase lock loop has stepped to a lower harmonic of the LF VCXO in an attempt to tune the LO to the required frequency. Stepping down once is occasionally necessary during normal tuning. See Service Sheet BD2 and *Service Special Function 54* in paragraph 8–7.

Error 71. Phase Lock Loop Step-Up. This error message is the same as Error 70 except that the loop has stepped to a higher harmonic.

Error 72. Audio Overload. The Audio Overvoltage Detector has tripped. This may have been due to the nature of the audio signal (for example, a high-frequency audio signal which overrides the circuits preceeding a low-pass filter) or due to a problem in the audio circuits. See Service Sheet BD4.

Error 73. No IF Signal Found after Finding an RF Input. An RF input signal has been sensed by the Peak RF Level Detector but no IF signal has been sensed by the IF Level Detector. See Service Sheets 4 and 9.

Error 74. FM Calibrator Underdeviation. The frequency deviation of the FM Calibrator is less than 30 kHz. See Service Sheet 29.

Error 75. FM Calibrator Overdeviation. The frequency deviation of the FM Calibrator is greater than 38 kHz. See Service Sheet 29.

Error 76. AM Calibrator Modulators Unequal. The difference between the ×10 AM Cal signal for the two channels is greater than 0.6V. See Service Sheet 30.

Error 77. AM Calibrator Channel B Out of Range. The AM Cal level from Channel B is not within the range of +1.8 to +2.2V. An unterminated CALIBRATION AM/FM OUTPUT will cause this error. See Service Sheet 30.

Error 78. Key Not Found. A key closure was not found after a keyboard interrupt (except when a keyboard entry is in progress). See Service Sheet 25.

Error 79. Audio Autorange Rangeback. The audio autorange routine has found the audio signal level is too high, has changed to a less sensitive range, and has immediately found the signal is too low. The routine does not then range back, but instead displays Error 79 and remains on the low-sensitivity range for the rest of the measurement cycle. The error signifies that the routine would normally have ranged back but did not actually do it. This may have been due to the nature of the audio signal (for example, the voice signal) or due to a problem in the audio gain stages or detection circuits. See Service Sheet BD4.

Error 80. Audio Settling Timeout. First-time measurement results are not output to the display until the measurement result has settled or until one second has elapsed, whichever is first. Settling is determined by comparing successive measurements. This error message indicates that a one-second timeout has occurred. This may be due to the nature of the signal or an instability in the audio circuits. See Service Sheet BD4.

Error 81. LO Tuning Adjusted to Center Signal in IF Passband. This error message only occurs in automatic tuning, low-noise lock. If the signal in the IF drifts out of the acceptable pass-band limits (see the spectrum diagram in *RF Frequency Tuning* in Section 3) but is still acceptable, the LO frequency will be adjusted to center the signal in the IF passband. When this occurs, Error 81 will be displayed. In certain situations it is possible to trick the Controller into making this tuning adjustment when the signal is properly tuned; for example, when the IF signal has an excessively high AM depth (greater than 99% at normal RF signal levels) which cannot be accurately counted during the trough. Also note that if tuning adjustments are necessary three times in a row (without any intervening measurement), then the full auto-tuning sequence will be initiated, searching the entire spectrum for a signal.

Error 82. Unable to Make Audio Count. The audio count routine utilizes the main Counter in its frequency count sequence. The Controller initializes the Counter, which then waits for a "stop count" signal from the Audio Counter. If this "stop count" signal does not occur within 100 ms the audio count routine will time out. See Service Sheets 16 and 23.

Error 89. Software Error. Perform the Read Only Memory Verification. See *Service Special Function 52.N* in paragraph 8-7.

8-9. POWER-UP CHECKS

When the Measuring Receiver is first turned on (or if 40.0 SPCL is entered), the instrument goes through a series of operational checks. If a check fails, an error code is displayed for two seconds on the four internal TEST LEDs on the A13 Controller Assembly. The sequence then continues on to the next check.

Except for the check of the front-panel LED annunciators, no indication of the power-up sequence or its results is given on the front-panel display. The principal advantage to using the Power-Up Checks is that the keyboard and display need not be operational.

To use the Power-Up Checks, remove the top cover, remove any jumpers that may be on the four TEST test points (A, B, C, and D) on the A13 Controller Assembly, remove any signal at the INPUT and switch POWER to STBY for five seconds (to discharge the supplies) and back to ON. Observe the four TEST LEDs on the top of the Controller Assembly as the instrument powers up. The LEDs should light in the following sequence:

1. Indeterminate for about $1/4$ second.
2. ( )( )( )(1) for about 2 seconds.
3. ( )( )(2)( ) for about $1/4$ second.
4. ( )(4)( )( ) for about $1/4$ second.
5. (8)(4)(2)(1) for about 10 seconds.
6. ( )( )( )(1), with (1) blinking indefinitely until a key is pressed.

The Power-Up Checks proper begin at step 2 and are carried out in the following order:

1. **Front-Panel Annunciator Check.** All front-panel LEDs and display segments and decimal points are lighted and remain so throughout the tests that follow and for a few seconds afterwards. Failure of one or more LEDs or display segments to light indicates that the respective components or drive circuits have failed. See Service Sheets 26 and 27.
2. **Read Only Memory Check.** The checksum of each of the read only memories (ROMs) is read and compared against a stored reference (stored in ROM 1). This is similar to issuing a series of 52.N SPCL commands (see *Service Special Functions,* paragraph 8-7). When a wrong checksum is found, the four TEST LEDs blink for one second with the binary code of the ROM number. For example, if ROM 3 is faulty, the TEST LEDs will blink ( )( )(2)(1) (that is, a binary 3). The check then continues on to the next ROM. See Service Sheets BD5 and 24. If no faulty ROM is found, a steady ( )( )( )(1) appears for about 2 seconds.
3. **Random Access Memory Check.** Data is written into and retrieved from the random access memory (RAM). During the test, ( )( )(2)( ) is output to the TEST LEDs for about second. If the data read back differs from the data entered, the failure is indicated by outputting the same code for an additional 2 seconds. See Service Sheet 24.
4. **Instrument Bus Parity Check.** A parity check of the data lines of the Instrument Bus is made. A failure is indicated by ( )( )(2)(1) on the TEST LEDs for about 2 seconds. See Service Sheets BD5, 15, and 24.
5. **Local Oscillator Check.** The Local Oscillator (LO) is given a series of tests similar to issuing the 54.0 SPCL command (see *Service Special Functions,* paragraph 8-7). During the test, ( )(4)( )( ) is output to the TEST LEDs for about second. A failure is indicated by outputting the same code for an additional 2 seconds. See Service Sheet BD2.
6. **Keyboard Check.** The keyboard is scanned to see if any keys are down. If a key is down, error code ( )(4)( )(1) is output to the TEST LEDs for 2 seconds. See Service Sheets BD5 and 25.

8-10. CONTROLLER TEST LEDS AND TEST POINTS

Near the top edge of the A13 Controller Assembly are located four testpoints and four associated LED annunciators labeled TEST which are used primarily for troubleshooting the instrument. The LED annunciators are labeled (from left to right) 8, 4, 2, and 1 and are associated with test points A, B, C, and D respectively.

The label on the annunciators is sometimes used to represent a binary weighting. They function in the following ways:

1. At instrument power-up the TEST annunciators light in a certain sequence that indicates proper functioning of several vital areas of the instrument. A failure in any of the areas is indicated on the annunciators. For details see *Power-Up Checks* in paragraph 8-9.
2. After power-up, annunciator 1 toggles once for each measurement cycle.
3. After power-up, annunciator 2 toggles once for each keyboard interrupt (that is, each time a key is pressed).
4. After power-up, annunciator 4 toggles once for each HP-IB interrupt.
5. After power-up, annunciator 8 lights when the tracking circuit of the IF Synchronous Detector is sweeping and blinks briefly when the sweep changes direction. See Service Sheet 7.

Grounding of certain of the TEST testpoints alters instrument operation in the following ways:

1. Grounding testpoint A is used to alter the measurement halt function of Special Function 43.N. See *Service Error Messages* in paragraph 8-8.
2. Grounding testpoint B causes some of the power-up sequence to be bypassed and thus shortens the turn-on time of the instrument. The power-up checks are now invalid.
3. Grounding testpoint C initiates the Counter signature analysis troubleshooting routine. See Service Sheet 23.
4. Grounding testpoint D initiates the Keyboard signature analysis troubleshooting routine. The signature analyzer's start and stop leads are then connected to testpoint A and the probe is connected to testpoint B. See Service Sheet 25.

Whenever a testpoint is grounded, the associated annunciator is extinguished.

8-11. SIGNATURE ANALYSIS

Signature analysis is a simple method of verifying the operation of digital circuitry. When properly used, signature analysis can detect extremely subtle hardware faults. Signatures must identically match those given in the signature tables. If everything is working correctly, signatures will all match exactly. If they don't match, by even one digit, something is wrong.

The Counter, Controller, and Keyboard and Display Assemblies are designed for troubleshooting with signature analysis. Signature Analysis is a method of digital signal tracing using test routines programmed in the Measuring Receiver's ROM. With the Measuring Receiver's Controller executing the signature analysis routine, the signature analyzer's test probe is used to check nodes in the circuit under test. The signature analyzer converts the signals at the node into a four-digit "signature", which it displays. This signature is then compared to the signature in the troubleshooting checks adjacent to the appropriate schematic. These two signatures must be identical.

Signature analysis can be speeded up if the following considerations are kept in mind:

1. Make sure that every step is performed as described in the set-up procedure. That is, make sure that the clock, start, and stop connections and triggering are correct.
2. Double-check that the signatures are being taken at the correct node.
3. Make sure that the signature analyzer probe is making good contact with the pin being checked. Oxidation on pins can cause invalid signatures due to poor contact.
4. When you think you have found a bad signature, double check to make sure.
5. When checking a node, check that the unstable-signature indicator is not blinking.

8-12. GENERAL DISASSEMBLY PROCEDURES

Top Cover Removal

1. Remove the two top plastic standoffs on the rear panel by removing the Pozidriv screws from each standoff.
2. Unscrew the Pozidriv screw at the middle of the rear edge of the top cover. This is a captive screw and will cause the top cover to push away from the frame.
3. Lift the top cover off the instrument.

Bottom Cover Removal

1. Turn the instrument upside down.
2. Remove the two top plastic standoffs on the rear panel by removing the Pozidriv screws from each standoff.
3. Unscrew the Pozidriv screw at the middle of the rear edge of the bottom cover. This is a captive screw and will cause the bottom cover to push away from the frame.
4. Lift the bottom cover off the instrument.

Side Cover Removal

1. Remove the two screws holding each side panel strap handle in place (there is one screw at either end of each strap handle).
2. Remove the strap handle caps and the strap handles.
3. Slide the side panel towards the rear of the instrument and then pull it off.

Information Card Tray Removal

1. Turn the instrument upside down.
2. Remove two plastic feet from one side of the bottom cover.
3. Rotate the information card tray away from the remaining two plastic feet and remove.

8-13. FRONT-PANEL DISASSEMBLY PROCEDURE

Front-Panel Assembly Removal

1. Remove the information card tray (refer to Information Card Tray Removal).
2. Remove the knurled nuts on the RF input (Type-N) and the modulation output/audio input (BNC) connectors.
3. Pry up the plastic trim strip on the top of the instrument's front frame with a small screwdriver.
4. Remove the three screws in the channel covered by the trim strip.
5. Remove the two outside screws and the center screw from the channel on the bottom of the front frame.
6. Pull the front-panel assembly outwards.
7. To completely separate the front panel from the instrument, disconnect the ribbon cable connectors and the RF cables.

A1 Keyboard and Display Assembly Removal

1. Remove the front-panel assembly from the instrument (refer to Front-Panel Assembly Removal Procedure).
2. To separate the A1 Keyboard and Display Assembly from the front-dress panel MP14 and sub-panel MP15, first remove the Keyboard and Display insulator MP48 by unscrewing the four pan-head screws, and removing the washers and spacers which hold it in place.
3. Remove the six remaining screws and washers which fasten the A1 assembly to the sub-panel.
4. Disconnect the front panel LINE switch S3 jumpers at the A1 assembly.
5. Separate the A1 assembly from the front-dress panel and sub-panel.

Front-Dress Panel and Display Window Removal

1. Remove the front-panel assembly from the instrument (refer to Front-Panel Assembly Removal Procedure).
2. To remove the front display window MP40, remove the three retaining clips and slide the screen straight up (towards the top edge of the front sub-panel).
3. To remove the front-dress panel MP14, remove the front-panel jacks (if present) and slide the dress panel downward (toward the bottom edge of the front panel). The bottom edge of the front dress panel will have to be pulled out slightly to allow for clearance of the LINE switch.

Replacement Of Pushbutton Switches And Annunciator Leds

Key Cap Replacement

1. To replace a front-panel pushbutton key cap, pull it off and snap on a new one. You will have to either remove the Keyboard from the Front Panel Assembly (refer to Front Panel Disassembly Procedure) or carefully use a pair of pliers to remove the keycap.

NOTE

Watch the angular position of the key cap as you snap it in place, since eight different positions for installation are possible.

Key Cap Led Replacement

Many of the front-panel pushbutton key caps have molded-in clear lenses which are illuminated by miniature LEDs located in the center portion of the switch at the circuit board. During production of the instrument, the LEDs are first soldered in place and then the switch is slid down around them and heat staked in place. If replacement of the LED becomes necessary (due to burnout), it can be replaced without having to remove the switch. To replace a key cap LED, use the following procedure:

1. Remove the pushbutton key cap (refer to Key Cap Replacement Procedure).
2. Place the Modulation Analyzer on a table top. Lower the front panel so that it is facing downward (refer to the Front-Panel Disassembly Procedure). Unsolder the LED leads on the circuit side of the printed circuit board as you pull the LED down through the middle of the switch stem with a pair of small tweezers.
3. Insert a new LED (one with long leads). Make sure the polarity is right. Pull the leads through the circuit board and solder.
4. Clip off the excess LED lead length on the circuit side of the keyboard.
5. Put the front panel in place. Snap on the key cap. With the instrument power on, test the switch function to make sure that the LED works.

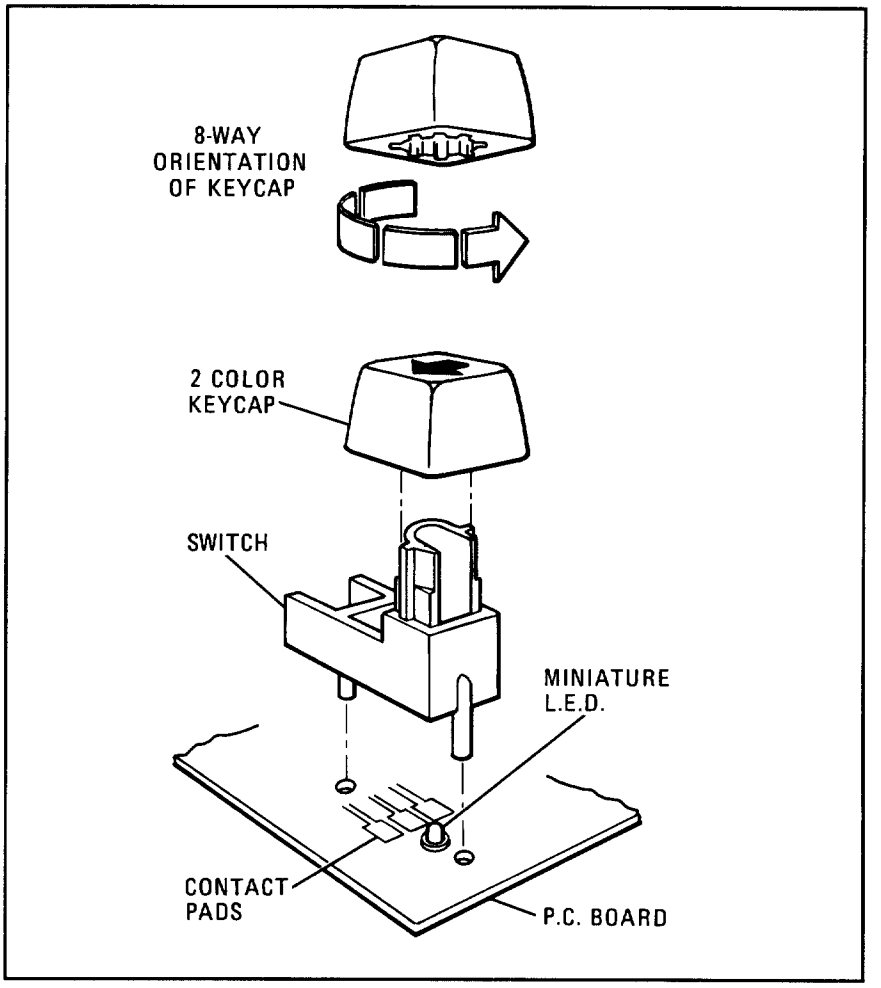


Figure 8C–1. *Front-Panel Pushbutton Switch Assembly*

Switch Replacement

The front-panel switches have a very high cycle life. However, if one becomes faulty and needs replacement, follow the procedure outlined below:

1. Remove the pushbutton key cap. You will have to pull hard. Use your free hand to hold the board down as you pull.
2. Lower the front panel (refer to the Front-Panel Disassembly Procedure).
3. Remove the switch by chipping away the melted plastic tabs at the circuit of the keyboard which hold the switch in place.
4. To assure long life and reliable electrical performance, the circuit board contact traces (which are found underneath the switch) should be clean and free of surface imperfections. Clean the switch contact pads before installing a new switch. Make sure the LEDs are not tilted and that there is no excess solder around the leads.
5. For reliable operation, any method of assembly must assure that the switch is mounted tightly against the pc board. To facilitate the heat staking operation, specially molded support anvils (HP 5040-6881) can be ordered.

NOTE

The following operation should be done in a well ventilated area. If the heat staking tip is too hot, the plastic will vaporize and emit fumes. These fumes, however, are non-toxic.

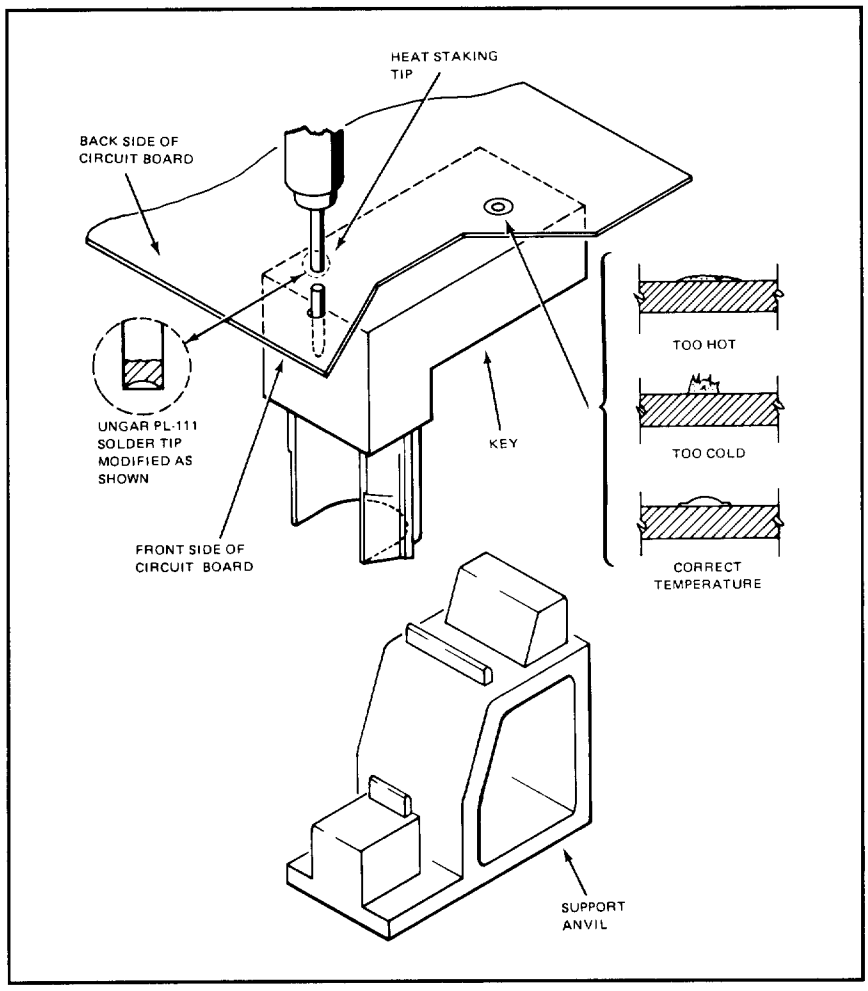


Figure 8C–2. *Typical Assembly for Heat Staking Operation*

6. To assure proper switch assembly, verify that the switch is pushed firmly against the circuit board and, with the hot (440°C or 825°F) staking tip, push down on each of the posts (2) of the switch. Each post should take about one second to stake. With the proper cycle, the post should turn a darker color and, in about ten seconds, return to its original bright red color. The correctly staked post should have a smooth round "rivet" like top.

CAUTION

Do not disturb the assembly for at least 10 seconds after heat staking.

If not enough heat is applied, the plastic will tend to stick to the tip of the iron.

If too much heat is applied, the plastic will fume profusely, the "rivet" will be irregularly shaped, and the plastic will be permanently discolored.

If the staking tool is worn or flaked, it will cause a misshaped rivet and/or a contamination deposit on the surface.

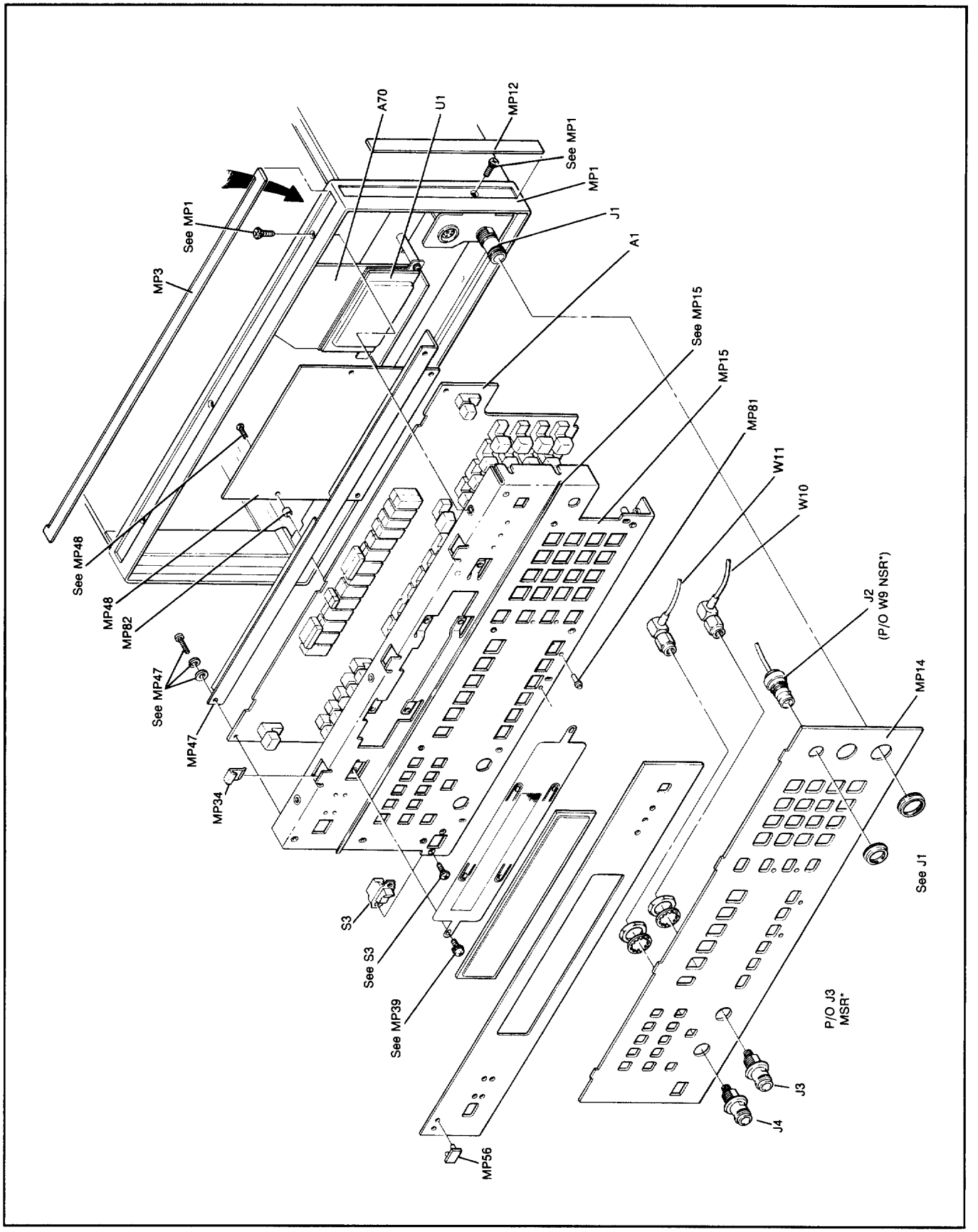


Figure 8C–3. *Illustrated Parts Breakdown of the Front Panel (1 of 2)*

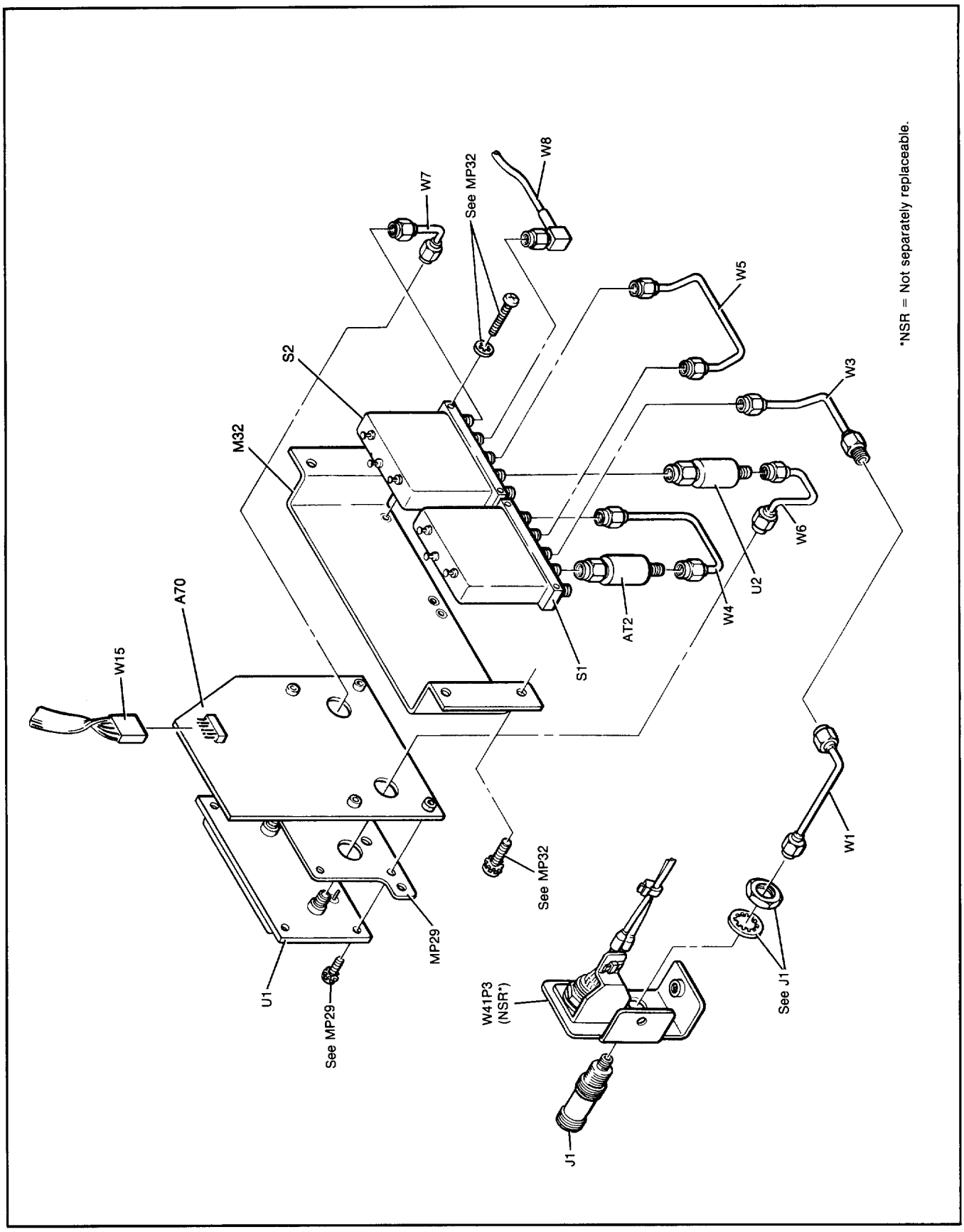


Figure 8C–3. *Illustrated Parts Breakdown of the Front Panel (2 of 2)*

SERVICE SHEET BD1

Block

- Overall Instrument

Principles of Operation

NOTE

The following discussions cover the principles of operation of the Measuring Receiver. Each discussion is based on and referenced to a service sheet. An introductory-level discussion of the principles of operation can be found in Section 1 of the Operation and Calibration Manual *under the title,* Principles of Operation for Simplified Block Diagram.

General

The Measuring Receiver is a general-purpose, tuned, signal-measuring instrument. The Overall Block Diagram breaks up the instrument's functions so they correspond to those of a receiver: RF Block, IF Block, and Audio Block. The Digital Block (using the receiver analogy) roughly corresponds to the human operator. Each of the functional blocks is shown in greater detail in Service Sheets BD2 through BD5.

Sensor Module

During normal operation, the RF input signal is applied to an external Sensor Module such as the HP 11722A. The Input Switch in the Sensor Module routes the RF signal to the Power Sensor when the RF Power measurement mode is selected or during the calibration portion of the Tuned RF Level measurement. The Power Sensor converts the RF input signal to a chopped dc voltage which is proportional to the average power level of the signal. For other measurement modes, the switch routes the input signal to the INPUT connector of the Measuring Receiver. The Sensor Module also contains a resistor which provides a means for the Measuring Receiver to identify the type of Power Sensor in the Sensor Module.

Power Meter

The Power Sensor and Power Meter amplify the dc voltage from the Power Sensor's transducer so the voltage can be measured by the Voltmeter in the Audio Block. To minimize the effect of dc drift in the amplifiers (which may even exceed the dc voltage from the transducer itself), the transducer's output is converted to an ac voltage by a chopper in the Power Sensor. The chopper drive comes from the 220 Hz Multivibrator. The resultant ac signal is ac coupled to the narrow-band Input Amplifier, and the gain of this amplifier is autoranged by the Controller. The amplified ac signal is converted back to dc by the Synchronous Detector, which full-wave rectifies the ac signal by rechopping it in phase. Noise on the resultant dc signal is filtered by the Noise Filters to stabilize the displayed reading. The heaviest filtering is done on the most sensitive ranges and results in an increase in the measurement response time. Before an RF power measurement is initiated, the switch at the output of the Power Meter connects the Sensor Identifier Resistor circuit to the Voltmeter. The voltage across the resistor indicates the type of Power Sensor present.

The Zeroing DAC is set by the Controller to cancel any dc offset of the Power Sensor when no input is applied. In the zeroing sequence, the RF Input to the Power Sensor is switched out, a power reading is taken, and the Zeroing DAC is automatically adjusted for a zero reading. (In actual implementation, the Zeroing DAC is adjusted for a pre-determined offset voltage reading. The offset is subtracted out

in subsequent power measurements by the Controller. The Voltmeter then operates in its most linear region.)

Calibration of the Power Sensor is verified by connecting the Sensor Module to the CALIBRATION RF POWER OUTPUT connector, which outputs a calibrated 1 mW signal from the 50 MHz Power Reference Oscillator. If desired, a calibration factor can be stored and used to correct subsequent power readings as explained in the *Detailed Operating Instructions* in Section 3.

RF Input

For all measurements which use the Input Mixer, the 10 dB Attenuator and the Input Attenuator are set by the Controller to provide the Input Mixer with an optimum input level. The Controller receives signal level information from the RF Peak and IF Peak Detectors and, for some measurements, the IF Synchronous and AM and IF Average and Detectors (in the IF Block). Because of its low input SWR, the 10 dB Attenuator is switched in whenever input attenuation is required. The RF Amplifier replaces the 10 dB Attenuator in the Tuned RF Level measurement mode when the RF input signal is low.

An Overpower Detector in the RF Amplifier senses RF overloads (approximately 0 dBm or more) and sets the switches at the input and output of the RF Amplifier to the bypass mode without intervention of the Controller. This detector does not degrade the input SWR of the RF Amplifier. The RF Limiter ahead of the RF Amplifier adds additional protection to the amplifier.

Next in the signal path is the overpower protection and power-level detection circuitry. The RF Peak Detector senses the signal level and the measured voltage is used to set the proper input attenuation. If the power at the front-panel input exceeds 1W, the measured voltage is also used to trip the Overpower Protection relay. When the 10 dB Attenuator is in, the overpower level reference is reduced to 0.1W, which corresponds to 1W at the input.

The 5.25 MHz High-Pass Filter is manually selectable. Since the IF generally responds to signals up to 2.5 MHz, the filter eliminates any low frequencies which may be present on the input. For input signals 150 kHz to 10 MHz, the filter should be switched out.

Input Mixer and IF

The Input Mixer down-converts the RF input to the intermediate frequency (IF). The IF frequency is normally the frequency of the LO minus the frequency of the RF signal.

Except for the Tuned RF Level measurement mode, the IF is centered at 1.5 MHz for input signals 10 to 1300 MHz. (However, an IF of 455 kHz can be manually selected.) For signals between 2.5 MHz and 10 MHz or for the Tuned RF Level measurement mode, the IF is 455 kHz. Below 2.5 MHz, the signal is passed directly into the IF without being down converted (unless the 455 kHz IF has been manually selected).

The First IF Amplifier is a low-noise, 33 dB amplifier. When the 1.5 MHz IF is selected, the frequency response is determined by the 2.5 MHz Low-Pass Filter. When the 455 kHz IF is selected, the 455 kHz Bandpass IF Filter preceeding the First IF Amplifier determines the IF response. In addition, in the Tuned RF Level measurement mode, the 455 kHz Bandpass Filter following the Second IF Amplifier is selected and determines the IF frequency response.

The IF signal is sent to the Third IF Amplifier and then to the 2.5 MHz Low-Pass Filter where it is buffered and sent to both the rear-panel IF OUTPUT connector and to the FM Demodulator circuitry. The IF Peak Detectors sense the presence of the IF signal (and thus the input RF signal) during an automatic signal search (via the IF Present and Stop Sweep lines). The Voltmeter measures detected IF level (via the IF Peak Level line) to help determine the setting of input attenuation.

Low Level IF

The Tuned RF Level measurement uses an IF substitution technique. The signal is down-converted to a 455 kHz IF, amplified, detected by the IF Synchronous Detector, and then measured by the Voltmeter. Since the level range of the input signal is much greater than the linear range of the IF Synchronous Detector, the gain of the Second IF Amplifier is selected (in 10 dB increments) to bring the IF level into the range of the detector. The high step-to-step accuracy of the Second IF Amplifier is due to the tight tolerances of the gain-determining components and because the operating frequency is fixed and relatively low (455 kHz).

Although the relative accuracy of the IF detection scheme is excellent, source SWR and variations in the instrument's input circuits and mixer make a direct measurement of absolute power less accurate. An initial, operator-initiated calibration, however, removes most of the front-end error. During calibration, the operator applies a CW input signal (either from the signal source itself or from another source at the same frequency) at a level within the range of the Power Sensor being used. The instrument then measures the signal level at the Power Sensor with the Power Meter, switches the signal (via the Input Switch in the Sensor Module) to the Measuring Receiver's INPUT, and measures the power level with the IF Synchronous Detector. The two power-level measurements are compared and, using the Power Sensor reading as the reference, a calibration factor is computed and applied to successive Tuned RF Level measurements made at that frequency.

As the signal level is decreased, the Second IF Amplifier may run out of range, making it necessary to readjust the RF gain by inserting the RF Amplifier, adjusting the Input Attenuator, and recalibrating the IF. To recalibrate, the signal level is detected by the IF Synchronous Detector both before and after the RF gain is readjusted. (The IF gain is also readjusted as required by the IF Synchronous Detector.) Since the RF input level remains constant during recalibration, any difference between the two readings of the IF Synchronous Detector represents an error which the Controller uses to correct the calibration factor for that RF range. Further decreases in RF level may necessitate one further recalibration.

A narrow (30 kHz wide), 455 kHz Bandpass Filter improves the sensitivity of the measurement at very low levels where the signal-to-noise ratio is poor. Furthermore, the IF Synchronous Detector is able to track the signal over a 10 kHz range by phase locking a 455 kHz voltage-controlled oscillator (VCO, not shown) to the IF signal. The phaselock loop has a very narrow bandwidth (150 Hz), which further increases the detector's sensitivity. The VCO frequency is monitored by the Controller via the Counter to determine if the IF frequency has drifted out of limit, since at low levels, the normal IF input to the counter is very noisy. The frequency measurement also makes it possible to determine the frequency of the RF input signal at very low levels. The status of the phaselock loop is monitored by measuring the output of the detector. If no signal is sensed, the Controller initiates a search routine to sweep the VCO through the bandwidth of the IF.

The Third IF Amplifier provides additional IF gain for the signal during a signal search. After the IF Synchronous Detector locks onto the signal, the IF gain is switched back to normal to maintain IF calibration.

Tuned RF Level measurements can also be made with the AM and IF Average Detector. The wider bandwidth of this detector tolerates noisier signals but is less sensitive than the IF Synchronous Detector. Calibration is the same as for the IF Synchronous Detector.

Selective Power Options (Option Series 030) *(2535A and Above)*

The Selective Power Options (Option Series 030) add a set of selectable bandpass filters and a programmable IF amplifier to enable the instrument to make accurate adjacent-channel power and single-sideband noise measurements on transmitters and signal generators. For these measurements, the instrument is first tuned to the incoming signal using the 455 kHz IF. The IF level is then measured with the IF RMS Detector after the IF is bandpass filtered and amplified. Next, the RF frequency is offset (as required by the specific test), and the IF level is again measured. The ratio of the two IF level measurements is the relative adjacent-channel power or single-sideband noise. (Refer to *Selective Power Measurements* in the *Detailed Operating Instructions* in Section 3.)

Two bandpass filters in series define the measurement bandwidth. The First Channel Filters are one of two pairs of IF filters. The Option Series 030 specifies the pairs of channel filters installed in the instrument. The pair of Second Channel Filters have bandwidths of 30 kHz (for adjacent channel power measurements) or 2.5 kHz (for single-sideband noise measurements). Filter selection is listed in Table 8D-1. The measurement bandwidth indicated in the table is the total bandwidth of the selected filters. In addition to determining the total measurement bandwidth, the second filter pair remove broadband noise generated by the preceding IF amplifiers. The Programmable IF Amplifier, governed by the Controller, keeps the IF signal within the linear range of the IF RMS Detector and increase the dynamic measurement range to 95 dB.

Table 8D-1. *Option Series 030 Filter Selection*

Option Number	Typical Measurement Application	Typical Channel Spacing	Measurement Bandwidth
032	Adjacent Channel Power	12.5 kHz	8.5 kHz
033	Adjacent Channel Power	20 or 25 kHz	16 kHz
035	Adjacent Channel Power	60 kHz	30 kHz
037	SSB Noise	–	2.5 kHz

At frequencies above 300 MHz, a low-noise, external LO is recommended for best performance. The LO is conveniently switched by the LO Input Switch. (This feature is not allowed in combination with Option 003, rear-panel LO connections.)

AM Demodulator

The AM Demodulator is an automatic leveling control (ALC) loop with a relatively slow response time. The IF signal is amplified and detected by the AM and IF Average Detector, and the dc component of the detected signal is compared to a stable, dc reference. If the dc voltage is different from the reference, the difference is amplified by the ALC Feedback Amplifier which drives the Current-Variable Amplifier to force the detected voltage to equal the reference.

Since the AM on the IF carrier is too fast for the ALC loop to respond to, the ALC loop produces an ac voltage in the detector which is proportional to the AM. The ALC Bandwidth and Defeat line can be used either to completely defeat the ALC action or to speed up the ALC response time in response to variations in IF level (at the sacrifice of accuracy at low AM rates).

After demodulation, the recovered AM is filtered and processed by the Audio Circuits. The unfiltered AM from the AM and IF Average Detector (containing both ac and dc components) is sent to the rear-panel AM OUTPUT connector. The dc component from the detector is measured by the Voltmeter (1) to determine setting of the RF input attenuators when the ALC loop is switched off, (2) to determine the IF Level in the IF Level measurement mode (where it is compared to the ALC reference), (3) to determine the IF gain required for the Tuned RF Level measurement, and (4) as the alternate IF detector for the Tuned RF Level measurement mode.

FM Demodulator

The FM Demodulator consists of IF Limiters and an FM Discriminator (frequency-to-voltage converter). The limiter-amplifier provides 66 dB of gain and limits the output voltage swing to approximately 1 Vpp to reduce the influence of AM and noise on FM measurements. The signal from the limiters also drives a Counter input for measuring the IF frequency (except for the Tuned RF Level measurement where the IF Synchronous Detector is used). The FM Discriminator produces a voltage linearly proportional to the IF frequency, and the FM variations in the IF frequency appear as an ac component on the output. The ac component is amplified, filtered, and then processed by the Audio Circuits. The output from the FM Discriminator (with both ac and dc components) is sent to the rear-panel FM OUTPUT connector. The filtered dc component is used to tune the LO in the track-tune mode.

Audio Circuits

The signal from the AM or FM Demodulators is filtered by a 260 kHz Low-Pass Filter. Before the audio signal is measured or sent to the MODULATION OUTPUT/AUDIO INPUT connector, it is processed further by various filters, amplifiers, and attenuators. For FM, the audio may also be de-emphasized. For ΦM the signal is integrated. Factors which control the audio processing are: measurement mode, selected features, audio level, input frequency, and any selected special functions. Table 8D-2 summarizes the types of signal processing.

Table 8D-2. *Types of Audio Signal Processing*

Type of Processing	Selections Available
High-Pass Filters	<20 Hz (through path) 50 Hz 300 Hz
Low-Pass Filters	3 kHz 15 kHz >20 kHz (low ringing) >200 kHz (260 kHz LPF)
FM De-emphasis Networks	25 μs 50 μs 75 μs 750 μs None
FM De-emphasis Selection	Pre-display On Pre-display Off
Signal Polarity	Inverting Non-inverting
Relative Gain	0 dB 20 dB 40 dB

The Audio Range Detectors are used to determine the audio gain (the Audio Range Level line) and to sense audio overloading (the Audio Overvoltage Status line).

Voltmeter

The demodulated signal is detected by both the Audio Average Detector and the Audio Peak Detector. The detector outputs are two of several Voltmeter inputs switched by the Input Selector. The Voltmeter consists of a Voltage-to-Time Converter whose output is applied to the Counter. The Voltage-to-Time Converter produces a Stop-Count pulse with an interval between pulses proportional to the dc input voltage. The pulse gates the Counter, which counts the 10 MHz time base reference. The count accumulated during the gate interval is proportional to the input voltage.

Other inputs into the Voltmeter include:

- RF Peak Level
- IF Peak Level
- IF Average Level (normally equal to the ALC reference)
- Audio Range Level
- RF Average Power Level
- AM Calibration
- Tuned RF Level (from the IF Synchronous Detector and including the level through an rms-to-dc converter, which corrects for noise errors on low-level signals)

- Audio Distortion (from an audio rms-to-dc coverter)
- Various service-related voltages not shown.

The output from the Input Selector is always present at the rear-panel RECORDER OUTPUT connector. Normally, the output is constantly switching between inputs, but by means of special functions any of the measurement results can be selected and held. This feature is especially useful for making precise RF power measurements.

Audio Distortion Analyzer

The input to the Distortion Analyzer is selected by the Output Switch. The input can be either the internal demodulated RF signal or an audio signal input to the front-panel MODULATION OUTPUT/AUDIO INPUT connector. The distortion measurement is limited to audio signals with a frequency of 400 Hz or 1 kHz.

The distortion measurement consists of measuring the rms level of the total audio signal then remeasuring the signal after it passes through a notch filter that removes the fundamental of the signal—leaving the distortion components, hum, and noise. Both measurements use the RMS-to-DC Converter to obtain true rms measurements. The dc level from the RMS-to-DC Converter is measured by the Voltmeter. The Post-Notch Amplifier and the Audio Amplifier optimize the signal level into the RMS-to-DC Converter. The Controller computes the distortion as the ratio of the output of the Notch Filter to its input (with corrections made to account for amplifier gain). (In the SINAD measurement mode, the reciprocal of distortion is computed.)

Audio Counter

The input to the Audio Counter is selected by the Output Switch. As with the Audio Distortion Analyzer, the input can be either the internally demodulated RF signal or an audio signal input to the front-panel MODULATION OUTPUT/AUDIO INPUT connector.

The audio signal is first conditioned by the Schmitt Trigger to make it compatible with the digital circuits it drives. When a frequency count is to be made, the Controller, after clearing both the Counter and Audio Counter and after opening the Audio Switch, arms the Counter Control Logic. The first signal pulse from the Schmitt Trigger causes the Counter Control Logic to close the Audio Switch and the Counter Gate switch (in the main Counter). The number of cycles of the audio signal are counted by the Audio Counter. The number of time-base reference pulses are counted by the main Counter. After a fixed period of time, the Controller readies the count to to stop. The next signal pulse from the Schmitt Trigger causes the two switches to open. The counts in the two counters are then read back, and the audio frequency is computed and displayed.

Local Oscillator

The heart of the LO is a 320 to 650 MHz High-Frequency, Voltage-Controlled Oscillator (HF VCO). After passing through the programmable LO Divider, the HF VCO signal becomes the LO drive to the Input Mixer. The LO Divider is programmed to divide the HF VCO by powers of two from 2^{-1} to 2^{8}, (that is, from a times 2 divide by 256). Thus the LO can tune from 1300 MHz to 1.25 MHz in ten octave ranges. A fixed divide-by-eight output from the LO Dividers is the LO (HF VCO÷8) input to the Counter.

There are four tuning modes:

- manual tuning and low noise,
- automatic tuning and low noise,
- automatic tuning and signal tracking,
- manual tuning and signal tracking.

Manual Tuning and Low Noise. Consider the sequence followed for manual tuning. When a frequency is entered from the Keyboard, the LO is configured as in Figure 8D-1. The Digital-to-Analog Converter (DAC) is connected to the HF VCO tune input as shown. Knowing the desired frequency, the Controller

computes the octave number (n) for the LO Divider and sets the DAC to its midrange. Then, an iterative sequence of counting the LO and adjusting the DAC is carried out until the LO is near the correct frequency.

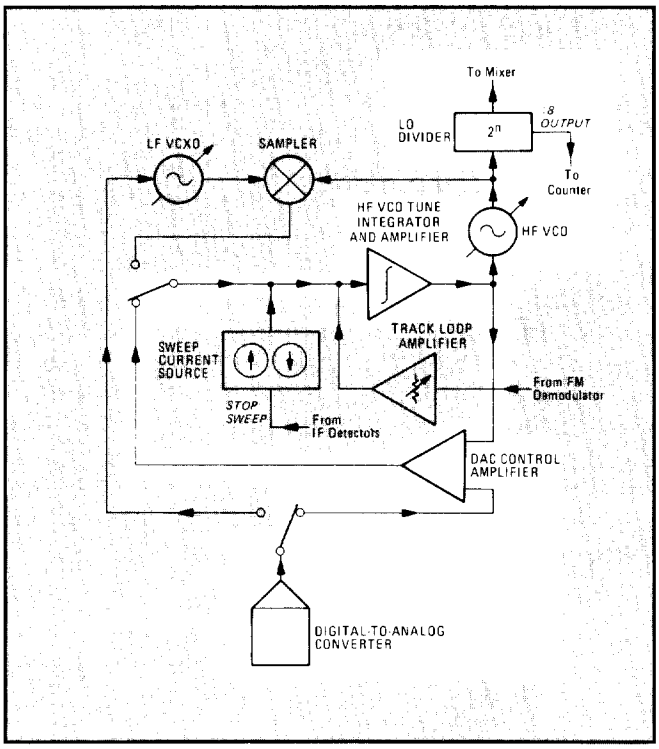


Figure 8D–1. *LO Configuration: DAC to HF VCO*

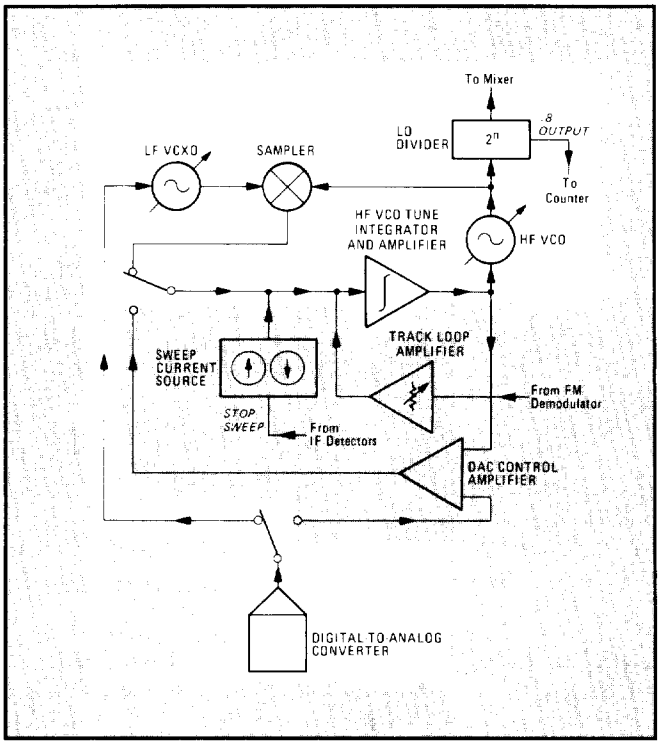


Figure 8D–2. *LO Configuration: DAC to LF VCXO*

Next, the LO is configured as a phase-lock-loop as shown in Figure 8D-2. The DAC is now connected to the tune input of a highly stable, Low-Frequency, Voltage-Controlled, Crystal Oscillator (LF VCXO). The LF VCXO drives the Sampler at a nominal (but tunable) 2 MHz rate. The other input to the Sampler is the HF VCO. The Sampler drives the HF VCO tune line through the Tune Integrator and Amplifier. The HF VCO is thus phase locked to a harmonic of the LF VCXO, which greatly improves the noise and frequency stability of the HF VCO.

Before closing the phase-lock-loop, the DAC is set near the low end of its range. When the loop is first locked, the LO frequency is slightly low, but after an iterative sequence of counting the HF VCO and tuning the LF VCXO by the DAC, the LO is brought to within 500 Hz of the desired frequency. During the process of fine tuning the LO, the DAC may reach the end of its tuning range. If this happens, the Controller will break the lock loop, set the DAC to the other end of its range, and lock will be re-established to a different harmonic of the LF VCXO.

Automatic Tuning and Low Noise. The automatic tune mode is similar to the manual tune mode except the LO is first swept from the top to the bottom of each octave range by the Sweep Current Source. See Figure 8D-3. If the LO sweeps past a signal at the INPUT, the down-converted signal appears in the IF and is detected by the IF Detectors. The signal on the Stop Sweep line immediately turns off the Sweep Current Source. With no input to the Tune Integrator and Amplifier, the HF VCO will remain approximately tuned to the input signal, and the frequency of the LO (and thus the input) can be determined by the Controller. Once the signal has been found after a sweep of all octaves, it is found four more times by sweeping just the octave where it was first found and two octaves above it. This is necessary in case the signal has AM which was in a deep trough when the fundamental of the LO passed through and was out of the trough when the strong third harmonic of the LO passed through.

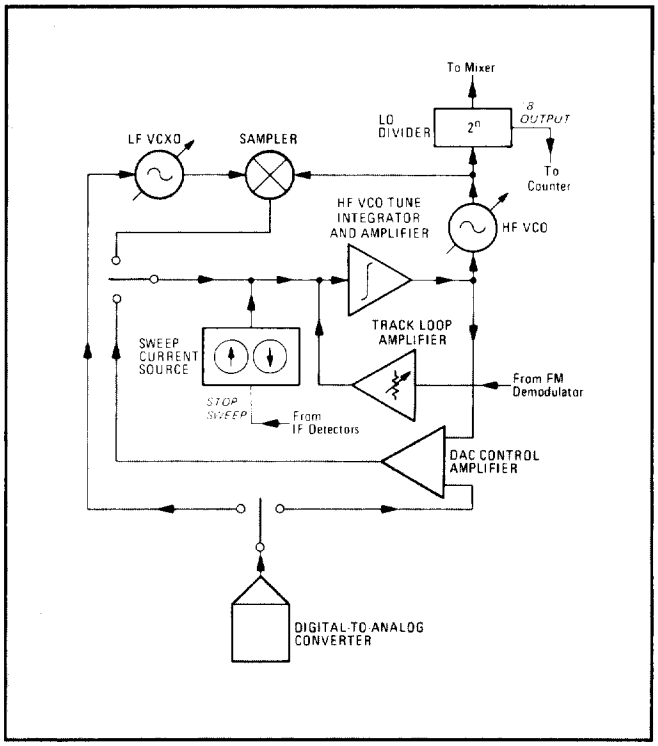


Figure 8D-3. *LO Configuration: HF VCO Sweep*

Having now found an input signal, the Controller manipulates the LO through a series of tuning sequences to search for the fundamental of the input that was found. Once the fundamental of the input signal is identified, the LO is tuned to approximately 1.5 MHz above that signal. The Controller then accurately counts the LO and the IF and thus determines the frequency of the input signal. (Signal frequency = LO frequency − intermediate frequency.)

At this point the LO is configured as in Figure 8D-1, and the tuning continues as in the manual tune mode using the computed frequency in place of a keyboard-entered frequency.

Automatic Tuning and Signal Tracking. In the track mode an automatic signal search is performed as described above. When a signal is found, the the LO is configured as in Figure 8D-4. Here, a dc voltage from the FM Demodulator is fed back to the HF VCO tune line to form a frequency lock loop. If the frequency of the input signal changes, the HF VCO is tuned to follow it. The gain of the loop depends on the octave number of the LO Divider. This gain variation is compensated for by adjusting the gain of the Track Loop Amplifier in the tune line.

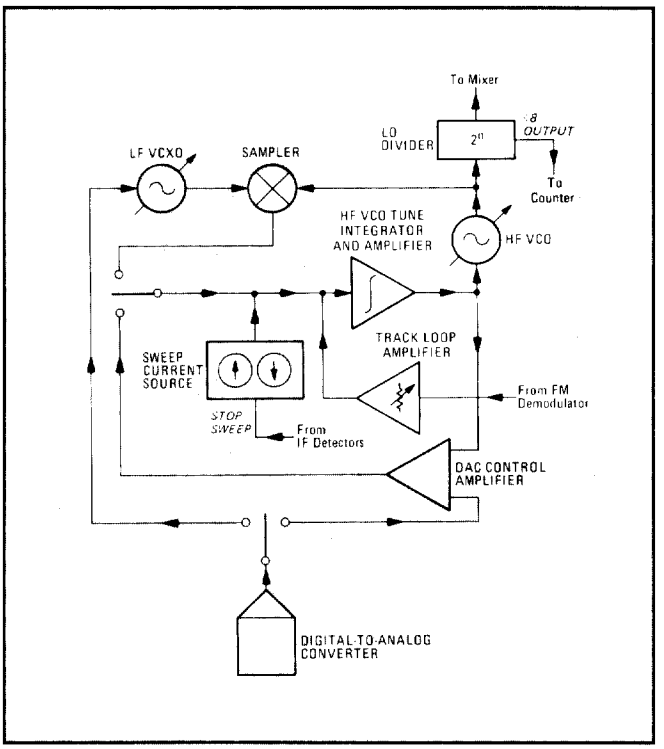


Figure 8D-4. *LO Configuration: Track*

Manual Tuning and Signal Tracking. In the manual track tune mode the LO is first tuned as in the manual tune mode discussed above. The LO is then configured as in Figure 8D-4. Manual track tuning permits the tracking of a moving signal in the presence of stronger signals. Track tuning has a slightly higher residual FM level than low-noise tuning.

Counter

Operation of the Counter is conventional. The input signal to the Counter is gated by a train of periodic time base pulses via the Time Base 6.25 kHz line. The period of the pulse train pulses is accurately known. While the Counter is gated, the Counter increments one count for each input cycle. When the time base disables the Counter, the accumulated count is transferred to storage registers (in this case, the Controller), and the Counter is cleared. When the time base again gates the Counter, the count sequence repeats. The stored count is then processed by the Controller (it is multiplied by an appropriate scale factor) and transferred to the display or used internally by the Controller. The Controller itself also forms the final stages of the Counter and keeps track of the number of time base pulses that occur while the Counter is gated.

The time base is derived from a 10 MHz reference. The reference can be either internal or external. Switching to external is done automatically when an external reference is applied to the rear-panel TIME BASE 10 MHz INPUT connector. The Time Base Dividers divide the 10 MHz reference by

1600. The output from the dividers becomes the Counter gate. A 2 MHz output (from a divide-by-five) is used as the Controller clock.

The Input Selector selects one of several possible inputs to the Counter. When the Voltmeter function is selected, the 10 MHz reference, gated by the Stop Count switch, is counted. The Stop Count switch closes when the Controller initiates a Ramp Gate pulse; it remains closed until opened by the Voltage-to-Time Converter. When the audio frequency function is selected, the 10 MHz reference is counted as for the Voltmeter function. The Stop Count switch, however, is now controlled by the Counter Control Logic of the Audio Counter.

AM and FM Calibrators

The FM Calibrator consists of a 10.1 MHz VCO which toggles between two frequencies at a 10 kHz rate. Selecting the FM Calibration mode initiates a sequence of measurement cycles. During a measurement cycle, the VCO is measured by the Counter at the upper frequency and then measured at the lower frequency. The Controller then computes the deviation (one-half the difference between the two frequencies). The Controller then allows the FM Source to toggle at its 10 kHz rate. When the signal from the CALIBRATION AM/FM OUTPUT is connected to the INPUT of the Measuring Receiver (either directly, or through a Sensor Module), the FM on the calibrator signal is measured, and the FM calibration factor (the ratio of the measured FM to the computed FM) is displayed.

The AM Calibrator receives its input from the output of the 10.1 MHz VCO of the FM Calibrator, which is not toggled during AM calibration. This signal is limited and applied to the Amplitude Modulator. The AM Source toggles the modulator at a 10 kHz rate between a nominal level and twice that level to produce 33% AM.

To enhance the accuracy of the calibrator, measurements are made at the output of the modulator with the Amplifier/Detector while the AM Source is off. From these measurements the actual AM depth is computed. As with the FM Calibrator, the AM Calibrator output, when measured by the instrument, displays the AM calibration factor.

Power Supplies

The instrument is run from five regulated supplies: +40V, +15V, −15V, +5V, and −5V. The +15V supply continues to power the high-stability, time base reference (Option 002) when POWER is switched to STBY.

Controller and Remote Interface

The Controller plays a key role in governing the instrument operation. The Microprocessor in the Controller outputs information to configure the instrument, reads back and processes measurement results, reads back vital status information to prevent invalid measurements, and services interrupts from the Keyboard or Remote Interface. Information from the Input/Output (I/O) port of the Microprocessor is carried to the rest of the instrument by the Instrument Bus. Typically, the data on the Instrument Bus is decoded and latched at the various assemblies, then the decoded information is distributed to the appropriate circuit.

Information within the Controller itself is handled by three main buses: the ROM Control (ROMC) Bus (which coordinates the various devices which make up the Controller), the Address Bus (which addresses ROM and RAM), and the Data Bus (which carries information to or from ROM and RAM). Since the Remote Interface also contains Controller devices, these buses are also distributed to it. A battery backup to the RAM devices makes the memory non-volatile; that is, the instrument remembers key values even with the power switched off.

The Remote Interface receives inputs from the external interface bus (HP-IB), processes the information, and interrupts the Controller in a manner similar to the Keyboard. The Remote Interface also processes the measurement information and outputs it on the HP-IB if requested and is designed to make operation from an external computing controller as similar as possible to operation from the front panel.

Instrument Software Supervisor Flowchart

The instrument's software is structured in a form called the supervisor. See Figure 8D-5. It is a loop that is continuously traversed, with measurements made near the end, after checks for proper frequency tuning, proper RF and IF level, and correct audio range. Arithmetic manipulation (for example, for the ratio function) follows the measurement, and the program then loops back up to the display.

The frequency, level, and audio blocks verify that the instrument is adjusted to make an accurate measurement. A measurement is not made until all of the tests are passed in immediate succession. If a test is not passed, corrective action is taken. The decision after that block forces the program back to the top of the supervisor, bypassing the measurement for that loop.

The software interface with the hardware makes use of two concepts called software state and hardware state. The software state is stored in 38 bytes of RAM and totally describes the state of the instrument. On power-up, the initialization procedure loads the software state from ROM. Keyboard and HP-IB entry routines modify only the software state and do not affect the hardware immediately. The setup block in the supervisor is where the hardware state is made to conform with the software state. Setup is not the only place where hardware is affected; the frequency tuning, leveling, audio ranging, and measurement blocks manipulate the hardware as well.

In a normal, stable measurement cycle, the program takes the measurement display branch at the top of the supervisor and so avoids the time overhead associated with the setup block. However, if the program loops back before taking a measurement, or if an error condition exists, the non-measurement display branch will be traversed, thus lighting an appropriate display and going through the setup block.

The Keyboard and HP-IB interrupt the flow around the loop, forcing the Microprocessor to execute a short program and then return to the loop as shown in the diagram. Since the supervisor can be interrupted at any point but always returns to a single location, Keyboard and HP-IB interrupts must abort the current measurement and start a new measurement cycle.

The Keyboard and HP-IB can be thought of as a medium through which the user requests a certain instrument setup. It is important to note that the actual instrument setup is guaranteed to conform to the Keyboard request only at the moment a measurement is taken. The Controller may change the instrument hardware at other times to optimize its tuning, leveling, and ranging functions. For example, in troubleshooting, 3.1 SPCL may be keyed in to check if the 455 kHz IF filter is being selected properly. If there is no RF input signal and the instrument is trying to auto-tune, it would be discovered that both IF filters (wide 455 kHz and 1.5 MHz) are being used. The proper test would have been to use a Direct Control Special Function (0.031 SPCL).

The microprocessor-based Controller interacts closely with the hardware of the instrument. Many circuits are used by the Controller for different functions at different times. Thus, a specific failure in one circuit can show up as a collection of symptoms that superficially seem unrelated. For example, a failure of the squelch detector in the FM Demodulator can result in frequency errors when tuning to an RF signal with large amounts of AM. The appearance of several symptoms can often be used as an advantage since they provide many avenues to pursue when tracking down a problem.

A distinct difference exists between special functions used for service (that is, Direct Control Special Functions and Service Special Functions) and those used for normal instrument operation. When service special functions are used, normal instrument functions are suspended. When the special function mode is left to resume normal measurements, all effects of these special functions on hardware are lost (with some exceptions such as AM or FM calibration and enabling of service errors). (Refer to paragraph 8-7 for details.) As an example, a Direct Control Special Function can be used to activate a particular Input Attenuator to check its operation. But once normal measurements are resumed, the attenuator setting will revert back to what it was before the Direct Control Special Function was invoked.

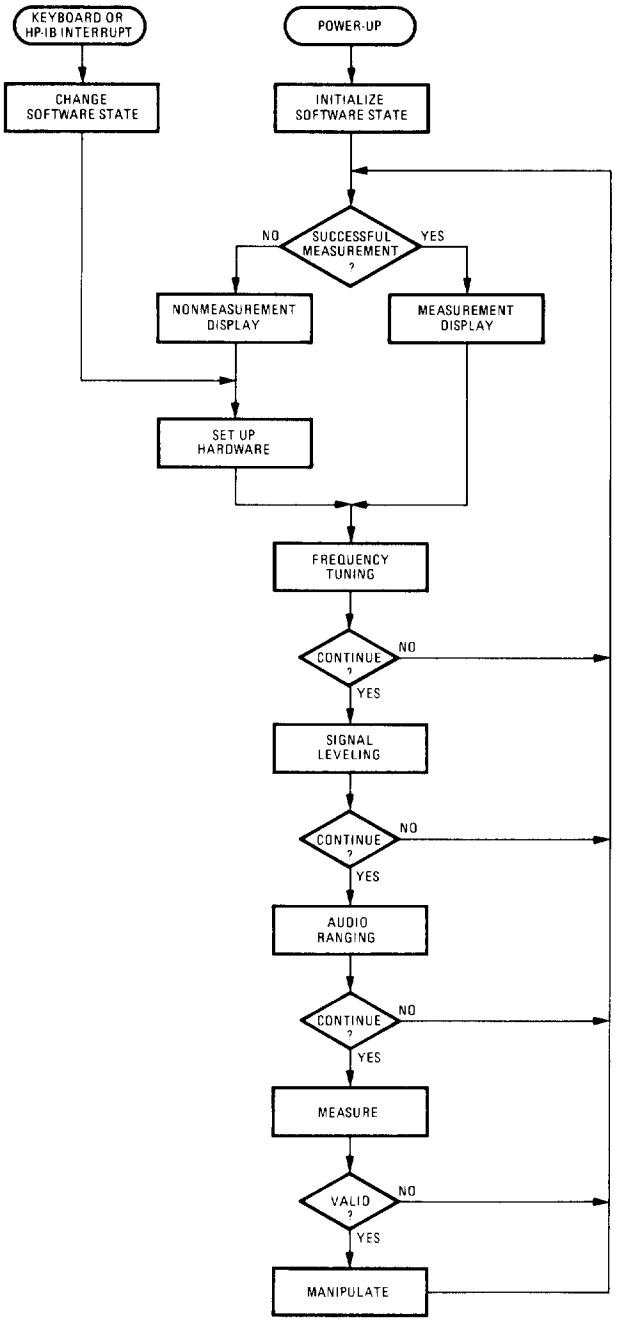


Figure 8D–5. *Measuring Receiver Software Supervisor Flow Chart*

Troubleshooting

General

The troubleshooting checks that follow are a starting place for locating an instrument fault. They are easy to perform and give much key information in a short amount of time. In most instances they can differentiate between an instrument hardware failure and a Controller or software problem. The checks should be done in order.

⟨√1⟩ Line Check

Procedure: Remove instrument top cover (three screws) and switch POWER to ON.

Normal Indication:

1. The fan runs indicating power is present on the power transformer secondaries.
2. The five green LEDs on the A10 Power Supply Regulators Assembly are lighted indicating that the supplies are nominally operating.

If Indication Abnormal:

1. Check the rear-panel line fuse and line voltage selector. Check Mains wiring. (See Service Sheet 31.)
2. Check the individual regulators. (See Service Sheet BD5.)

⟨√2⟩ Power-Up Checks

Procedure: If there are any jumpers on the TEST test points on the A13 Controller Assembly, remove them. Switch POWER to STBY for five seconds and back to ON. Note the sequencing of the four TEST LEDs on the top of the Controller Assembly as the instrument powers up.

Normal Indication: The four TEST LEDs light in the following sequence:

1. Indeterminate for about $1/4$ second.
2. ( ) ( ) ( ) (1) for about 2 seconds. This indicates the start of the power-up routines and the run of the Read Only Memory Check.
3. ( ) ( ) (2) ( ) for about $1/4$ second. This indicates the start of the power-up routines and the run of the Random Access Memory Check.
4. ( ) (4) ( ) ( ) for about $1/4$ second. This indicates the running of the Local Oscillator Check.
5. (8) (4) (2) (1) for about 10 seconds. This indicates that all power-up checks passed and that a visual front-panel check can be made. (See ⟨√3⟩ below.)
6. ( ) ( ) ( ) (1), with (1) blinking indefinitely until a key is pressed. The behavior of the LED (1) is also affected by the presence of an input signal.

Any other sequence indicates a failure of the check. Passing this check indicates that the Controller is functioning properly and that there is no catastrophic failure in the following circuits:

Read Only Memory,
Random Access Memory,
Instrument Bus,
Local Oscillator (tuning only),
Keyboard (only that no key is down).

If Indication Abnormal: If the TEST LEDs come on and remain in the random state of step 1 above, unplug the A14 Remote Interface Assembly and try again. If still faulty, check the Controller Kernel. (See Service Sheet BD5.)

If other indications appear in or after step 2 above, consult *Power-Up Checks,* paragraph 8-9, which discusses the individual checks, documents the error indications, and cross references to the service sheets.

⟨√3⟩ Front-Panel LED Check

Procedure: Disconnect any connection to the INPUT connector. Switch POWER to STBY and back to ON.

Normal Indication: After less than one second, all front-panel LEDs and display segments and decimal points should light for about 10 seconds. The display should blank for one second, then show "−−" with the MHz annunciator. The FREQ key, the AUTO TUNING, and the FM MODULATION OUTPUT annunciators should all light. This indicates that the Controller is able to output to the front-panel LED and display latches which are all operative.

If Indication Abnormal: If one or more LEDs or display segments fail, check the respective components and drive circuits. (See Service Sheets 26 and 27.) Also check the CPU I/O port. (See Service Sheet BD5.)

⟨√4⟩ Measurement Error Check

Procedure: Key in 43.1 SPCL to enable Service Errors. Make the measurement in which the fault appears.

Normal Indication: As the Special Function code is entered, 43.1 should appear in the display. This indicates that the Controller responds to keyboard interrupts. After pressing the SPCL key, measurements should proceed as normal.

If Indication Abnormal: If the keys have no effect, check the Keyboard interrupt. (See Service Sheet 25.) If the keystrokes produce an erroneous display, check the Keyboard. (See Service Sheet BD5.) If the measurement is improper or error messages appear in the display, consult the error message tables (see *Error Messages* in the *Detailed Operating Instructions* of the *Operation and Calibration Manual,* or see *Error Messages,* paragraph 8-8, or see *Error Codes* in the *Operating Information* pullout card) or consult the block diagram service sheet that documents the section of the instrument that appears to have the fault. (See Service Sheets BD2 through BD5.)

NOTE

For problems that are exclusive to the HP-IB, see Service Sheet BD5.

SERVICE SHEET BD2

Block

- RF

Principles of Operation

General

The RF Block Diagram documents the Power Meter, Power Reference Oscillator, RF Input, IF Amplifier, and Local Oscillator. The diagram also shows a typical Sensor Module connected to the Measuring Receiver's INPUT and SENSOR connectors.

Sensor Module

The Measuring Receiver is designed to be used with an external module containing a Power Sensor, RF switch, and interconnecting cable. The Sensor Module permits direct connection of either the Power Sensor or the RF INPUT to the RF source being measured. The direct connection to the Power Sensor minimizes power measurement errors that result from insertion and mismatch losses in interconnecting cables and connectors. The instrument's Controller switches the RF signal between the input to the Power Sensor and the front-panel RF INPUT depending on the measurement being made. This internal switching eliminates the need for manual reconnection and shortens measurement time.

The RF Power Sensing Element in the Power Sensor converts the absorbed RF power to a dc voltage proportional to the average power level. The element may be a thermocouple or a diode. Because the voltage from the RF Power Sensing Element is very small, dc amplifiers, which are subject to drift, are unsuitable for the first stages of amplification. Instead, the voltage is converted to a 220 Hz ac signal by the Chopper and then ac coupled into the AC Amplifier. The AC Amplifier is actually integrated in the first stage of Amplifier 1 in the A53 Power Meter Assembly.

The Power Meter circuitry in the Measuring Receiver is designed to work with a wide variety of power sensors with varying frequency and sensitivity ranges. The power sensors contain a Sensor Identifier Resistor which is unique for each type. The particular sensor is identified by driving the resistor with a known current and measuring the voltage across it. If no Power Sensor is connected, the instrument makes RF level measurements using the RF Peak Detector in the A16 RF Detector Assembly. (Refer to *RF Level, Special Function 35* in the *Detailed Operating Instructions* of the *Operation and Calibration Manual.*)

Power Meter Assembly (A53)

The Power Meter Assembly contains circuitry for amplifying and detecting the small ac signal from the external Power Sensor and for controlling the external input switch and Power Reference Oscillator. AC Amplifiers 1 and 2 and Attenuators 1 and 2 accurately amplify the chopped dc voltage from the external RF Power Sensing Element. (The AC Amplifier in the Power Sensor forms the first stage of Amplifier 1.) The amplifiers have a bandpass response tuned to 220 Hz to minimize noise. Table 8D-3 lists the attenuation for the power meter ranges. (The ranges are not listed in terms of absolute power because the sensitivity of the power sensors varies with type. Also, the attenuation in dB is the voltage attenuation; a step of 20 dB of attenuation corresponds to a 10 dB step in power level.) Special Function 10 controls selection of the attenuators.

Table 8D–3. *Power Meter Attenuator Selection*

Power Meter Range	Attenuator 1 (dB)	Attenuator 2 (dB)
1 (most sensitive)	0	0
2	0	20
3	0	40
4	40	20
5 (least sensitive)	40	40

The amplified ac signal, which is proportional to the input power, is converted to dc by the Synchronous Detector. The Synchronous Detector is a unity-gain amplifier which alternates between a non-inverting configuration and an inverting configuration at a 220 Hz rate. The 220 Hz drive signal is synchronized with the signal that drives the Chopper in the Power Sensor. Since the phase shift between the signal from the Power Sensor Chopper and the input of the Synchronous Detector is zero, the ac signal is full-wave rectified and has a dc component proportional to the output of the RF Power Sensing Element of the Power Sensor. After filtering by the Noise Filters, the dc voltage representing the recovered power level of the input signal is measured by the Voltmeter. The 220 Hz drive signal for the Power Sensor Chopper and for the Synchronous Detector is generated by the 220 Hz Multivibrator.

The Ground Regulator is a unity-gain, non-inverting amplifier which assures minimum voltage difference between the Sensor Ground and the Power Meter Assembly ground. High current flow through the ground return of the interconnecting cable causes the voltage difference, especially if the cable is quite long.

The Zeroing Control Digital-to-Analog Converter (DAC) compensates for the small dc offset voltage generated by the Power Sensing Element when no RF is present. To zero the sensor, the Controller switches the Input Switch of the Sensor Module away from the Power Sensor and measures the output from the Power Meter. If the output does not correspond to 0W power, the Zeroing Control DAC is programed to inject a current into the RF Power Sensing Element to cancel the offset. (To keep the Synchronous Detector in its most-linear range, the voltage corresponding to 0W input power is offset slightly above 0 Vdc. The offset voltage is subtracted out by the Controller when actual power measurements are made.) The DAC remains set until re-zeroing is requested.

The Sensor Module Switch Control and Switch Drive One-Shot control switching of the Input Switch in the external Sensor Module. The circuitry is designed to drive latching-type RF switches which may or may not have automatic drive disconnect. The Power Reference Oscillator Control switches on the 50 MHz Oscillator when requested. To enable the assembly of a user-built sensor module, the switching voltages are made available at the rear-panel REMOTE CONTROL RF SWITCH connectors.

The rear-panel FREQ OFFSET TTL OUT connector outputs a dc voltage that indicates the state of the Frequency Offset Mode and whether the entered LO frequency is above or below 18 GHz. This feature is useful for controlling external microwave down converters, such as the HP 11793A, whose output is fed to the input of the Measuring Receiver. Special Function 27 controls the Frequency Offset Mode. Table 8D-4 shows the status of the FREQ OFFSET TTL OUT voltage.

Table 8D–4. *Status of FREQ OFFSET TTL OUT Connector*

State of Frequency Offset Mode	Entered LO Frequency (GHz)	Nominal Voltage (Vdc) at FREQ OFFSET TTL OUT
Not Offset	Any	0
Offset	0	0
Offset	0 <frequency ≤18	+5
Offset	18 <frequency ≤40.7	+3

Power Reference Oscillator Assembly (A32)

Since the Power Meter uses an open-loop measurement technique (as opposed to a dc substitution technique), an independent power reference is required to calibrate (that is, determine the sensitivity of) the external Power Sensor. The Power Reference Oscillator produces a 50 MHz RF signal which is set, during calibration of the reference, to deliver 1 mW to a 50Ω load. The output of the oscillator is accurately controlled by the Automatic Leveling Control (ALC) Loop. A Level Detector at the output of the oscillator senses the peak RF level. The level is compared to a stable, dc reference by the Level Error Amplifier. The error is amplified and fed back to the level-control circuitry in the oscillator to correct the error.

RF Input Circuits (A15, A70, AT2, S1, S2, U1, U2)

The RF input circuits, along with the RF Detector Assembly (A16) and the Input Attenuator (AT1), amplify or attenuate the RF input signal to an optimum level for the Input Mixer. The RF input circuits are configured in three basic ways for three types of RF measurements:

(1) When measuring RF power with an external Power Sensor, the RF input circuits are not used; they remain in their previous state. Instead, the RF signal is routed to the Power Sensor.

(2) When measuring RF peak level (Special Function 35), the RF Switches (S1 and S2) are set to the through paths and the Input Attenuator (AT1) is set to 50 dB.

(3) When making any tuned RF measurement (for example, frequency or AM), the RF input signal is routed through the two RF Switches (S1 and S2), the RF Detector Assembly (A16), the Input Attenuator (AT1), and into the Input Mixer Assembly (A17). Normally, the 10 dB Attenuator (AT2) is switched in whenever 10 dB attenuation or more is required. The RF Amplifier (U1) is normally switched in only on the lowest level ranges of the Tuned RF Level measurement mode. (Note that during the initial, high-level calibration in the Tuned RF Level measurement mode, the RF input is switched momentarily to the Power Sensor in the Sensor Module.)

The 10 dB Attenuator is placed immediately after the INPUT connector to maintain a low and constant input SWR even though the devices that follow are switched. Special Function 1 controls the RF attenuation and gain. When making Tuned RF Level measurements, Special Function 1.9 leaves the 10 dB Attenuator in on all ranges, improving the input SWR but sacrificing sensitivity.

The RF Amplifier (U1) improves the sensitivity of the instrument when measuring low-level signals in the Tuned RF Level measurement mode. The amplifier has a 455 kHz notch filter (not shown) to reject noise at 455 kHz which would otherwise pass directly into the IF and add to the down-converted signal being measured. The Limiter (U2) protects the RF Amplifier in the event of an input overload. Further protection is provided by the RF Amplifier itself. Overloads cause the bias of the amplifier to shift enough to be sensed by the RF Amplifier Overpower Detector. When an overload is sensed, the Overpower Latch trips and sets RF Switch S2 to the through path.

The two RF Switches are controlled via the Switch Drivers of the A15 RF Input Control Assembly. The AT1 Input Attenuator and AT2 10 dB Attenuator are also controlled by the Switch Drivers. The Attenuator Decoding switches in AT2 whenever 10 dB or more attenuation is requested by the Controller. (Exceptions are for Special Functions 1.9 and 35.)

The Overpower Latch switches out the RF Amplifier when an overload occurs and outputs the status of the RF Amplifier to inform the Controller that the amplifier has been switched out (presumably due to an overload condition).

CAUTION

The overload protection for the RF Amplifier offers only limited protection. The protection is somewhat less than that provided for the A16 RF Detector Assembly. Be careful not to overdrive the input when measuring tuned RF level. Signal levels should remain below 0 dBm when the RF Amplifier is in use.

RF Detector Assembly (A16)

The RF level is sensed by the RF Peak Detector. The output of the detector is buffered by the Detector Amplifier and Detector Output Amplifier and then sent to the Voltmeter. The Controller uses data from the RF Peak Detector when automatically setting the Input Attenuator (AT1) and the 10 dB Attenuator (AT2), and when making a Peak RF Level measurement. (Refer to Special Function 35 in the *Detailed Operating Instructions* of the *Operation and Calibration Manual.*) The Detector Output Amplifier sensitivity is increased when the 10 dB Attenuator (AT2) is switched in. (When Special Function 35 is used, the 10 dB Attenuator (AT2) is not switched in and the Input Attenuator (AT1) is set to 50 dB.)

The Detector On/Off Switch shuts off the RF Peak Detector when not needed to prevent the slight clipping of the RF signal which can occur at high signal levels. The trip voltage of this switch is reduced when the 10 dB Attenuator is in. An overpower condition at the input will override the Detector On/Off Switch.

The Overpower Detector compares the detected RF level with a reference. If the peak RF level (including AM envelope peaks) exceeds 1W, the Overpower Protection relay is opened (de-activated) and latched. Pressing any key will reset the relay. The Detector Attenuator reduces the detected voltage when the 10 dB Attenuator (AT2) is not in.

Note that the Overpower Output/Detector Control line is bidirectional. It is an input line that both controls the Detector On/Off Switch and momentarily discharges the Detector Amplifier before a measurement is taken from the detector. Discharging the amplifier assures an up-to-the-moment reading of peak RF level should the level have decreased just prior to the measurement.

If the instrument is tuned to a frequency greater than 10 MHz, the 5.25 MHz High-Pass Filter can be switched in to eliminate low-frequency signals on the input (which can pass directly into the IF). Special Function 3 controls the selection of the 5.25 MHz High-Pass Filter (as well as the IF filter).

Input Attenuator (AT1)

The Input Attenuator has a range of 0 to 70 dB in 10 dB steps. The three individual pads are each switched in by a solenoid. When thrown, the switches latch and disconnect the drive current to the solenoids. Special Function 1 controls the attenuation of the Input Attenuator.

Input Mixer Assembly (A17)

The Input Mixer Assembly converts the RF input signal to the IF. Part of the IF filtering is included in this assembly. In the automatic tuning mode, the Local Oscillator (LO) is tuned so that the LO frequency minus the signal frequency equals the IF. Using manual tuning, it is also possible to tune the LO so that the IF responds to the image; that is, when the signal frequency minus LO frequency equals the IF. In this case, the phase of the FM and ΦM is inverted.

The Input Mixer has two modes of operation. (1) For input signals in the range 2.5 to 1300 MHz, the Input Mixer down converts the input signal to the 1.5 MHz or the 455 kHz IF. (2) For signals below 2.5 MHz, the Input Mixer passes the signal directly into the IF. (Down conversion can be extended below 2.5 MHz using the 455 kHz IF and manual tuning.) The normal operating signal level is less than −16 dBm for AM and −6 dBm for FM and ΦM.

The LO signal for the Input Mixer comes from the LO Dividers through the LO Amplifier.

(The next two paragraphs apply to 2305A to 2530A.)

The IF frequency response for most measurements is determined by the IF Filters and the IF amplifier in the A18 IF Amplifier Assembly. The 455 kHz Wide Bandpass Filter in the A17 Input Mixer Assembly determines the response of the 455 kHz IF except in the case of the Tuned RF Level measurement. The 455 kHz Wide Bandpass Filter is switched in automatically for input signals in the range of 2.5 to 10 MHz. (In tuned RF level, the much-narrower 455 kHz Narrow Bandpass Filter in the A55 IF Amplifier/Filter Assembly determines the frequency response.) When the 455 kHz IF is chosen, the 455 KHZ IF annunciator lights.

Automatic IF filter selection provides the optimum IF frequency and IF filter selection for each measurement mode. The frequency response of the IF filter is determined by the RF input blocking capacitors (not shown), the 4 MHz Low-Pass Filter, and (principally) the 2.5 MHz Low-Pass Filter in the A6 AM Demodulator Assembly (in Service Sheet BD3). Special Function 3 controls the IF frequency selection (as well as the 5.25 MHz High-Pass Filter in the RF Input Assembly).

(The next three paragraphs apply to 2535A and above.)

The IF frequency response for most measurements is determined by the IF filters and the IF amplifiers here and in the A18 IF Amplifier Assembly. The 455 kHz Wide Bandpass Filter in the A17 Input Mixer Assembly determines the response of the 455 kHz IF except in the case of the Tuned RF Level and the Selective Power measurements. The 455 kHz Wide Bandpass Filter is switched in automatically for input signals in the range of 2.5 to 10 MHz. (In tuned RF level, the much-narrower 455 kHz Narrow Bandpass Filter in the A55 IF Amplifier/Filter Assembly determines the frequency response. In the Selective Power measurement mode, the narrower channel filters in the A72 Channel Filter and A71 IF Amplifier/Detector Assemblies determine the frequency response.) When the 455 kHz IF is chosen, the 455 KHZ IF annunciator lights.

Automatic IF filter selection provides the optimum IF frequency and IF filter selection for each measurement mode. The frequency response of the IF filter is determined by the RF input blocking capacitors (not shown), 4 MHz Low-Pass Filters 1 and 2, and (principally) the 2.5 MHz Low-Pass Filter in the A6 AM Demodulator Assembly (in Service Sheet BD3). Special Function 3 controls the IF frequency selection (as well as the 5.25 MHz High-Pass Filter in the RF Input Assembly).

The First and Second IF Amplifiers function as buffers and provide the same IF gain for the assembly as in older instrument configurations.

IF Amplifier Assembly (A18)

The IF Amplifier increases the signal from the Input Mixer Assembly to a level suitable to drive the AM and FM Demodulators. The IF strip is designed for low noise, linear phase shift vs. frequency (that is, constant group delay) to minimize FM distortion, and for flat frequency response to minimize incidental AM (that is, AM occurring as the result of FM).

Local Oscillator

The Local Oscillator consists of the LO Divider Assembly (A19), LO Control Assembly (A20), Low Frequency VCXO Filter Assembly (A21), Low Frequency VCXO Assembly (A22), Sampler Assembly (A23), and High Frequency VCO Assembly (A24). The overall operation and different tuning modes of the LO are described in the *Principles of Operation* for Service Sheet BD1.

High Frequency VCO Assembly (A24)

The High-Frequency, Voltage-Controlled Oscillator (HF VCO) has a nominal frequency range of 320 to 650 MHz. The output is buffered by two Output Buffer Amplifiers. One output drives the LO Divider, the other drives the Sampler. The tune input to the HF VCO has a switchable lead-lag network (Tune Voltage Filter) to reduce phase noise. The network is switched out while the LO is tuning and is switched in when tuned.

LO Divider Assembly (A19)

The signal from the HF VCO, after passing through the LO Divider Assembly, is the LO drive to the Input Mixer. The LO Divider Assembly has one Doubler stage (640 to 1300 MHz LO range), one through path (320 to 640 MHz range), and eight LO Dividers (1.25 to 325 MHz ranges). Each divider is a high-speed, divide-by-two device. The Divider Output Gates enable and cascade the appropriate dividers for the range selected. The first three dividers are always enabled. The 40 to 81.25 MHz output of the third divider is the LO (HF VCO÷8) input to the Counter.

To prevent mistuning on the doubler range (which can result from spurious LO signals) the input to the Doubler is filtered by a tunable, Doubler Input Filter. The filter primarily suppresses the third harmonic of the HF VCO which becomes the $^3/_2$ harmonic of the doubled signal. The Doubler High-Pass Filter following the Doubler suppresses feedthrough of the fundamental frequency (the $^1/_2$ harmonic).

Low Frequency VCXO and Filter Assemblies (A22 and A21)

The Low-Frequency, Voltage-Controlled, Crystal Oscillator (VCXO) is a highly stable, tunable, reference oscillator to which the HF VCO is locked in the low-noise tune modes. It consists of two tunable crystal oscillators (nominally 9.26 and 11.26 MHz) mixed together to produce a 2 MHz output. The two oscillators can each be tuned approximately 6.25 kHz in opposition for a total tuning range of 2 MHz ±6.25 kHz. This tuning scheme allows a broad tuning range while retaining the high stability of the individual oscillators. The 2 MHz Low-Pass Filter and 2 MHz Bandpass Filter (A21) reject unwanted mixing products which appear as spurious AM and FM residual tones. Careful selection of the crystal frequencies minimizes the output of spurious mixing products.

Sampler Assembly (A23)

The Sampler is the phase detector of the phase lock loop. The tunable 2 MHz signal from the LF VCXO (A21) drives the Sampling Bridge through the 2 MHz Limiter and Impulse Generator. The output of the impulse generator is a train of extremely short-duration pulses with the repetition rate of the 2 MHz signal. The two pulses momentarily turn on the diodes (that is, close the switch) of the Sampling Bridge and pass the signal from the HF VCO (A24). The output from the Sampling Bridge is thus the HF VCO sampled at a 2 MHz rate. If the two signals are harmonically coherent, the output is a dc voltage with a level determined by the phase and amplitude of the HF VCO. The action of the phase lock loop tunes the HF VCO to drive the voltage to zero. If the relationship is not strictly harmonic (that is, phase lock is broken), the output is a beat note with a frequency equal to the difference between the HF VCO and the nearest harmonic of the LF VCXO. The output of the Sampling Bridge, which is the phase error voltage, is smoothed and buffered by the Sampler Amplifier.

The tune voltage for the HF VCO is supplied by the HF VCO Tune Integrator and Amplifier. The tune integrator has several sources of input: the Sampler Amplifier, the Track Loop Amplifier, the Sweep Up Current Source, the Sweep Down Current Source, and the DAC Control Amplifier. Only one input is active at a time. If one of the sweep current sources is active, the tune integrator sweeps the HF VCO. If the input is one of the amplifier outputs, the HF VCO Tune Integrator and Amplifier is configured as part of a feedback loop.

The grounding switch at the input of the HF VCO Tune Integrator and Amplifier is open only when the Sampler Amplifier is connected to its input. When the amplifier is not connected, the switch is closed to keep signals at the Sampler Amplifier output from coupling into the tune integrator. The Out-of-Lock Detector at the Sampler Amplifier output senses the presence of ripple and lights the OUT OF LOCK annunciator to indicate lock has broken. A BW Control line also lights the annunciator when the Tune Voltage Filter (in the HF VCO Assembly) has not been turned on. This line also controls the bandwidth of the HF VCO Tune Integrator and Amplifier. The bandwidth is narrowed in the low-noise phase lock and the track modes (that is, whenever the instrument is properly tuned).

The No-HF-VCO Detector lights the NO HF VCO annunciator if the amplitude of the signal from the HF VCO is too low. The 700 MHz Low-Pass Filter in the Sampling Bridge input line filters out harmonics of the HF VCO to assure proper sampler gain.

LO Control Assembly (A20)

The LO Control Assembly contains the digital decoders and latches for the entire RF Section (that is, the section housing assemblies A15 through A24) and the low-frequency analog circuits that control and tune the LO.

The Digital-to-Analog Converters (DACs) drive either the LF VCXO (through the LF VCXO Tune Amplifier) or the HF VCO (through the DAC Control Amplifier and HF VCO Tune Integrator and Amplifier). The DAC outputs a current proportional to the weighting of the bits of its digital input. The amplifiers following the DAC convert the current into a tune voltage.

The LF VCXO Tune Filter filters the tune line of the LF VCXO to reduce phase noise in the low-noise phase lock mode. The filtering is necessary because the tune-line input is external to the phase lock loop.

The Sweep Down Current Source sweeps the HF VCO when the Controller searches for the input signal. The Sweep Up Current Source is the retrace for the sweep.

The Track Loop Amplifier is used only in the track tune modes. Its input is the dc output from the FM Demodulator which is proportional to the IF center frequency. If the input signal changes frequency, the HF VCO is tuned via the Track Loop Amplifier and HF VCO Tune Integrator and Amplifier (in A23) to keep the IF at a nominal 1.5 MHz. (Track tuning is not permitted with the 455 kHz IF ***(2305A to 2530A)***.) Thus the track mode is the only tuning mode where the LO "locks" to the input signal (that is, a frequency lock loop is formed). The Track Loop Amplifier has a different gain for each LO range. This compensates for the change in LO tuning sensitivity caused by the LO Dividers.

Troubleshooting

General

Procedures for checking the RF Section of the instrument are given below. The blocks or points to check are marked on the block diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩ . Before performing any check, perform all the checks on Service Sheet BD1.

CAUTION

Tighten SMA connectors to 0.8 to 1.1 N·m (7 to 10 in·lb). Tighten SMC connectors to 0.6 N·m (5 in·lb). Hand tightening of connectors is insufficient. Hand-tightened connectors can work loose and cause reduced performance or malfunctions.

Equipment

Oscilloscope ..... HP 1740A
Power Supply ..... HP 6215A
Signal Generator ..... HP 8640B
Spectrum Analyzer ..... HP 8559A/182T
Voltmeter ..... HP 3455A

⟨√1⟩ Front End Check

1. Set the signal generator to 11 MHz CW at −30 dBm. Connect its RF output to the input of an ac coupled oscilloscope.
2. Switch the input impedance of the oscilloscope to 50Ω or terminate the input in 50Ω using a tee. Set the oscilloscope to observe the RF input waveform. Adjust the vertical sensitivity for a waveform amplitude of 4 divisions peak-to-peak.
3. Connect the oscilloscope's input to the end of W8 where it connects to A16J1 (RF IN) on the A16 RF Detector Assembly. Connect the signal generator's output to the Measuring Receiver's INPUT.
4. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in the special functions listed in Table 8D-5. For each setting, the waveform amplitude should be within the limits indicated. If out of limits, see Service Sheet 4 and check the RF Switches, 10 dB Attenuator, the Limiter and RF Amplifier, and the Amplifier/Switch Interconnect Assembly.

   Hint: If faulty, also check the status of the PAD and AMP annunciators on the Amplifier/Switch Interconnect Assembly.

Table 8D-5. *Levels at W8,* ⟨√1⟩ *Step 4*

Special Function	Gain (dB)	Oscilloscope Display Limits (div pk-pk)		Annunciator Status	
		Minimum	Maximum	PAD	AMP
1.1	0	3.9	4.1	Off	Off
1.2	−10	1.2	1.4	On	Off
1.7*	+24	5.7	7.0	Off	On
1.8*	+14	1.8	2.2	On	On
* Reduce the oscilloscope's vertical gain by 10.					

5. Key in 1.7 SPCL. Slowly increase the signal generator's level to +3 dBm and observe the AMP annunciator. The AMP annunciator should remain on until the signal generator level is between

−1 and +1 dBm. If faulty, see Service Sheet 4 and check the RF Amplifier and the RF Amplifier Overpower Detector.

6. Reduce the signal generator level.

⟨√2⟩ Input Attenuator and 5.25 MHz High-Pass Filter Check

1. Set the signal generator to 5.25 MHz CW at −33 dBm. Connect its RF output to the input of an ac coupled oscilloscope.
2. Switch the input impedance of the oscilloscope to 50Ω or terminate the input in 50Ω using a tee. Set the oscilloscope to observe the RF input waveform. Adjust the signal generator's level for a waveform of 15 mVpp.
3. Connect the oscilloscope's input to AT1J2 (RF OUT) on the Measuring Receiver. Connect the signal generator's output to A16J1 (RF IN).
4. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in the Special Functions listed in Table 8D-6 to set the input attenuation. (Special Function 35.0 is used to set the input attenuation to 50 dB.) Also set the signal generator level in 10 dB steps as listed. For each setting, the 5.25 MHz signal should appear within the limits indicated. If out of limits, see Service Sheet 4 and check the Input Attenuator.

Table 8D-6. *Levels at AT1J2, ⟨√2⟩ Step 4*

Special Function	Attenuation (dB)	Signal Generator Level (dBm)	Oscilloscope Display Limits (mVpp)	
			Minimum	Maximum
1.1	0	−33	13	17
1.3	10	−23	13	17
1.4	20	−13	13	17
1.5	30	−3	13	17
1.6	40	+7	13	17
35.0	50	+17	13	17

5. Key in 3.4 SPCL to insert the 5.25 MHz High-Pass Filter. The signal on the oscilloscope display should drop to between 8 and 12 mVpp. If out of limits, see Service Sheet 4 and check the High-Pass Filter.

⟨√3⟩ Overpower Protection Check

1. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument.
2. Set the power supply to 20 Vdc. Touch the +20V lead to the Measuring Receiver's INPUT (the minus side should be at ground). The display should show Error 06. If faulty, see Service Sheet 4 and check the Overpower Protection.

NOTE

If step 2 is repeated, it is necessary to first perform step 3 in order to discharge the input dc blocking capacitor. Also, disconnect the supply from the INPUT before setting the voltage to 20 Vdc.

3. Set the supply to zero (without turning it off) and while still connected to the INPUT, press CLEAR. Error 06 should go away. If it doesn't, see Service Sheet 4 and check the Overpower Protection.

⟨√4⟩ RF Detector Check

1. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Connect the CALIBRATION RF POWER OUTPUT to A16J1 (RF IN).
2. Key in 45.16 SPCL to turn on the RF power calibrator. Key in 35.0 SPCL to measure RF level with the RF peak level. The display should read between 0.6 and 1.6 mW. If faulty, see Service Sheet 4 and check detector circuits.
3. Key in 49.3 SPCL to read the voltage from the RF peak detector. Note the voltage reading.

   Voltmeter Reading _____ Vdc

4. Key in FREQ, 1.6 SPCL, 0.024 SPCL, and 49.3 SPCL to read the RF peak detector on its most sensitive range. The display should read between 2.5 and 3.8 times the level noted in step 3. If faulty, see Service Sheet 4 and check the detector circuits.

⟨√5⟩ Local Oscillator Tuning Check

1. Key in 54.0 SPCL. If the display shows other than 0, see *Special Function 54.N*, paragraph 8-7.

⟨√6⟩ Local Oscillator Level Check

1. Set RF spectrum analyzer to measure a 0 dBm, 0 to 1400 MHz signal. Connect its input to the end of the cable connected to A17J3 (LO IN).
2. Key in 57.0 SPCL to cause the LO to sweep sequentially across bands DBLR through 3. The LO signal should sweep slowly from above 1300 to below 40 MHz. The sweep will occur over five bands. As the low end of a band is reached, the sweep will stop, jump up slightly in frequency, then continue to sweep. Throughout the sweep, the LO should maintain an amplitude of at least 0 dBm. If it does not, see Service Sheet 17 and check the dividers and gates associated with the bad band.

NOTE

The sweep can be halted by pressing the SPCL key. If the power level is marginal at a particular frequency, halt the sweep at the frequency and make a more precise measurement with a power meter.

3. Set the spectrum analyzer to view a 0 to 40 MHz signal.
4. Key in 56.0 SPCL to cause the LO to sweep sequentially across bands 4 through 8. The LO signal should sweep slowly from above 40 to below 1.25 MHz in the manner described in step 2 above. If the amplitude is not at least 0 dBm, see Service Sheet 17 and check the dividers and gates associated with the bad band.

NOTE

The low-frequency bands can also be viewed on an oscilloscope. The oscilloscope should have a 50Ω termination. The signal should be a squarewave with an amplitude of 0.5 Vpp or greater.

⟨√7⟩ Track Mode Check

NOTE

This check assumes that ⟨√5⟩ Local Oscillator Tuning Check *and* ⟨√6⟩ Local Oscillator Level Check *give positive results, but that track-mode tuning is suspected to be faulty.*

1. Set signal generator to approximately 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.
2. Connect high-impedance, dc coupled oscilloscope to the rear-panel FM OUTPUT.
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. After the Measuring Receiver is tuned, press MHz, then S (Shift) FREQ ERROR. The oscilloscope should show −1 to +1 Vdc. If it does not, see Service Sheet 11 and begin by checking the Charge-Count Discriminator.
4. Adjust the oscilloscope to vertically center the trace. Adjust the signal generator's frequency until the displayed frequency error is 500 kHz. The oscilloscope display should move down to between −3.2 and −2.8V. If faulty, see Service Sheet 11 and check the Charge-Count Discriminator.
5. Adjust the signal generator's frequency until the displayed frequency error is −500 kHz. The oscilloscope display should move up to between 2.8 to 3.2V. If faulty, see Service Sheet 11 and check the Charge-Count Discriminator.
6. Adjust the signal generator's frequency until the displayed frequency error is 0.0 kHz. Key in 3.1 SPCL to set the IF to 455 kHz. The oscilloscope display should move down to between −8 to −6V. If faulty, see Service Sheet 11 and check the Charge-Count Discriminator. If not faulty, see Service Sheet 20 and check the Track Loop Amplifier.

⟨√8⟩ Input Mixer and IF Check

NOTE

This check assumes that ⟨√5⟩ Local Oscillator Tuning Check *and* ⟨√6⟩ Local Oscillator Level Check *give positive results.*

1. Set signal generator to approximately 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.
2. Connect an ac coupled oscilloscope to rear-panel IF OUTPUT. Switch the input impedance of the oscilloscope to 50Ω or terminate the input in 50Ω using a tee.
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 1.3 SPCL to set the attenuation range to 20 dB. The waveform should be a sinewave 80 to 126 mVpp with a period of between 645 and 690 ns (that is, nominally 1.5 MHz). If faulty, see Service Sheets BD3, 5, and check the Input Mixer, IF Filters, IF Amplifiers, and FM IF Buffer.
4. Key in 3.1 SPCL to set the IF to 455 kHz. The waveform should be a sine wave 67 to 106 mVpp with a period of 2.19 to 2.21 μs (that is, nominally 455 kHz). If faulty, see Service Sheet 5 and check the 455 kHz Wide Bandpass Filter ***(2305A to 2530A)*** and in addition the First and Second IF Amplifiers ***(2535A and Above)***.

⟨√9⟩ Power Meter Check

1. Perform *Performance Test 8—Power Meter* in Section 4. If the Zero Set test fails, see Service Sheet 2 and check the Zeroing DAC. If the Range-to-Range Error test fails, see Service Sheets 1 and 2 and check the Attenuators, Amplifiers, Synchronous Detector, and Noise Filter. If the Accuracy within a Range test fails, see Service Sheet 1 and check the Synchronous Detector.

⟨√10⟩ Power Reference Oscillator Check

1. Perform *Performance Test 6 or 7—Power Reference* in Section 4. (Either of the two procedures can be followed.) If faulty, see Service Sheet 3.

⟨√11⟩ Sensor Module Switch Control Check

1. With no power sensor or sensor module connected to the SENSOR connector, connect a high-impedance, dc coupled oscilloscope to pin A of the SENSOR connector. (See Service Sheet 1 for the location of pin A.)
2. Set the oscilloscope sweep to 20 ms per division and vertical sensitivity to 10V per division.
3. Alternately press RF POWER and FREQ. Each time a new key is pressed, the signal on the oscilloscope display should drop to −15V for approximately 30 ms, then return to 0V. If faulty, see Service Sheet 2 and check the Sensor Module Switch Control.
4. Connect an ohmmeter to pin B of the SENSOR connector. Press FREQ, then press RF POWER. The resistance should be less than 5Ω for each setting. If faulty, see Service Sheet 2 and check the Sensor Module Switch Control.

SERVICE SHEET BD3

Block

- IF

Principles of Operation

General

The IF Block Diagram documents the circuits that further amplify, filter, level detect, and demodulate the IF signal. The diagram also documents the AM and FM calibrators.

IF Amplifier/Filter Assembly (A55)

When the instrument is in the Tuned RF Level measurement mode, the amplifiers and attenuators in the A55 IF Amplifier/Filter Assembly provide highly accurate 10 dB steps of gain over a 60 dB range. The maximum overall gain of the three amplifier stages is fixed at approximately 60 dB. Attenuators 1, 2, and 3 are programed as indicated in Table 8D-7. Normally, gain stepping is used only in the Tuned RF Level measurement mode. For other tuned measurements (such as AM, FM, or frequency), the IF gain is held constant at its minimum of 0 dB (60 dB of gain minus 60 dB of attenuation). Special Function 9 controls the IF gain.

Table 8D-7. *IF Attenuator Selection (Attenuation and Gain in dB)*

Atten 1	Atten 2	Atten 3	Total Attenuation	Overall Gain
20	20	20	60	0
20	20	10	50	10
0	20	20	40	20
0	20	10	30	30
0	0	20	20	40
0	0	10	10	50
0	0	0	0	60

In the Tuned RF Level measurement mode, the frequency response for the 455 kHz IF is determined primarily by the 455 kHz Narrow Bandpass Filter. When this filter is not used, the IF signal bypasses the filter and is routed through a 6 dB attenuator (which matches the filter's passband insertion loss). Special Function 3 controls the IF frequency and bandpass selection.

The Programmable IF Gain Buffer is normally set for a gain of 6 dB. In the Tuned RF Level measurement mode, the gain of this amplifier is momentarily increased to maximize the sensitivity of the IF Synchronous Detector while the detector's VCO is swept in search of an IF signal.

IF Synchronous Detector Assembly (A54)

The IF Synchronous Detector, which is used in the Tuned RF Level measurement mode, enables the Measuring Receiver to measure the amplitude of extremely low-level signals.

Because low signal levels are typically being measured, the IF Synchronous Detector is designed to automatically lock to the 455 kHz IF signal and track it. The IF signal is fed into a Synchronous Detector. At the same time, in the Phase Detector, the signal from a Voltage Controlled Oscillator (VCO) is locked to the IF signal. (The VCO functions as an interpolation oscillator.) The Synchronous Detector mixes the low-level IF signal with the high-level VCO signal which has been synchronized with the IF signal. The 90° phase shift between the VCO drive signals to the two detectors causes the output of the Synchronous Detector (after low-pass filtering) to be a dc voltage proportional to the

average level of the input signal. Because the noise bandwidth of the loop is narrow (approximately 200 Hz), the measurement is relatively undisturbed by the presence of random noise. Amplitude noise is reduced by filtering on the dc output (see the Voltmeter on Service Sheet BD4). Phase noise is reduced by the Integrator in the VCO tune line of the phase lock loop.

The waveforms of Figure 8D-6 will help visualize the action of the IF Synchronous Detector. The first figure shows the detector when phase locked. In order to work properly, the two VCO signals driving the high-level inputs of the Phase Detector and Synchronous Detector must be in quadrature (that is, 90° out of phase) with each other. This phase relationship is obtained by shifting the phase of the VCO signal driving the Phase Detector by +45° and the phase of the VCO driving the Synchronous Detector by −45°. The drive signals to the two high-level ports of the detectors should be considered as switching functions which chop the input signal, rather than as drive voltages.

When the loop is locked, the dc value of the output of the Phase Detector is 0V. If either the IF signal or the VCO drifts, a dc voltage (which represents the phase difference of the two signals) is developed. (See the second set of waveforms.) The Integrator amplifies and filters the phase error voltage and tunes the VCO to correct the error.

When the loop is locked, the Synchronous Detector fullwave rectifies the input signal. The dc level of this signal (obtained by low-pass filtering) is proportional to the average level of the IF signal. Note that if the loop is not locked, as when the IF or LO frequency drifts out of range, the level of the output of the Synchronous Detector drifts back and forth and forms a beat frequency signal.

Total loss of IF signal is sensed by comparing the Synchronous Detector's output to a reference with the Out-of-Lock-Detector. Loss of VCO signal is sensed by the No-VCO Detector. Either condition causes the OUT OF LOCK annunciator to light. The Controller reads the LOCK STATUS line to determine whether the IF Synchronous Detector is locked. The Controller can also determine the VCO frequency by counting it via the Counter Buffer.

Whenever a loss of IF signal is sensed, the Controller enables the Pretune circuit to set the VCO to 457 kHz, then manipulates the Sweep Control logic (containing fast and slow, up and down sweep current sources) to sweep the VCO in an effort to find an IF input signal. When an IF signal within the capture range is found (by noting the presence of a dc output from the IF Synchronous Detector), the sweep routine is stopped. The capture range is about ±10 kHz.

Channel Filter Assembly (A72, Option Series 030)

The A72 Channel Filter Assembly and A71 IF Amplifier/Detector Assembly are used only in the Selective Power measurement mode. The assemblies are installed only in Option Series 030 (the Selective Power Option) ***(2535A and above only)*** as defined in Table 8D-1. The Adjacent-Channel Power measurement is controlled by Special Function 24.

The 455 kHz IF signal is routed through an IF Step-Up Transformer to one of two channel filter paths. The channel filter path is determined by Special Function 24: First Channel 1 Filter (the "wide" filter) is selected by Special Functions 24.1 and 24.2; First Channel 2 Filter (the "narrow" filter) is selected by Special Functions 24.3, 24.4, 24.5, and 24.6. Four filters are available (specified by the option number) and two filter options must be chosen. Of the two filter options, the wider-bandwidth filter becomes First Channel 1 Filter; the narrower-bandwidth filter becomes First Channel 2 Filter. (Again, refer to Table 8D-1.) The total IF measurement bandwidth is the series combination of the First Channel Filters and the Second Channel Filters in the A71 IF Amplifier/Detector Assembly.

Each channel has an input channel buffer (0 dB gain) and an output channel amplifier (6 dB gain). The channel output has a selectable gain of 0 or 20 dB (the Channel Output Attenuator followed by the Channel Output Amplifier).

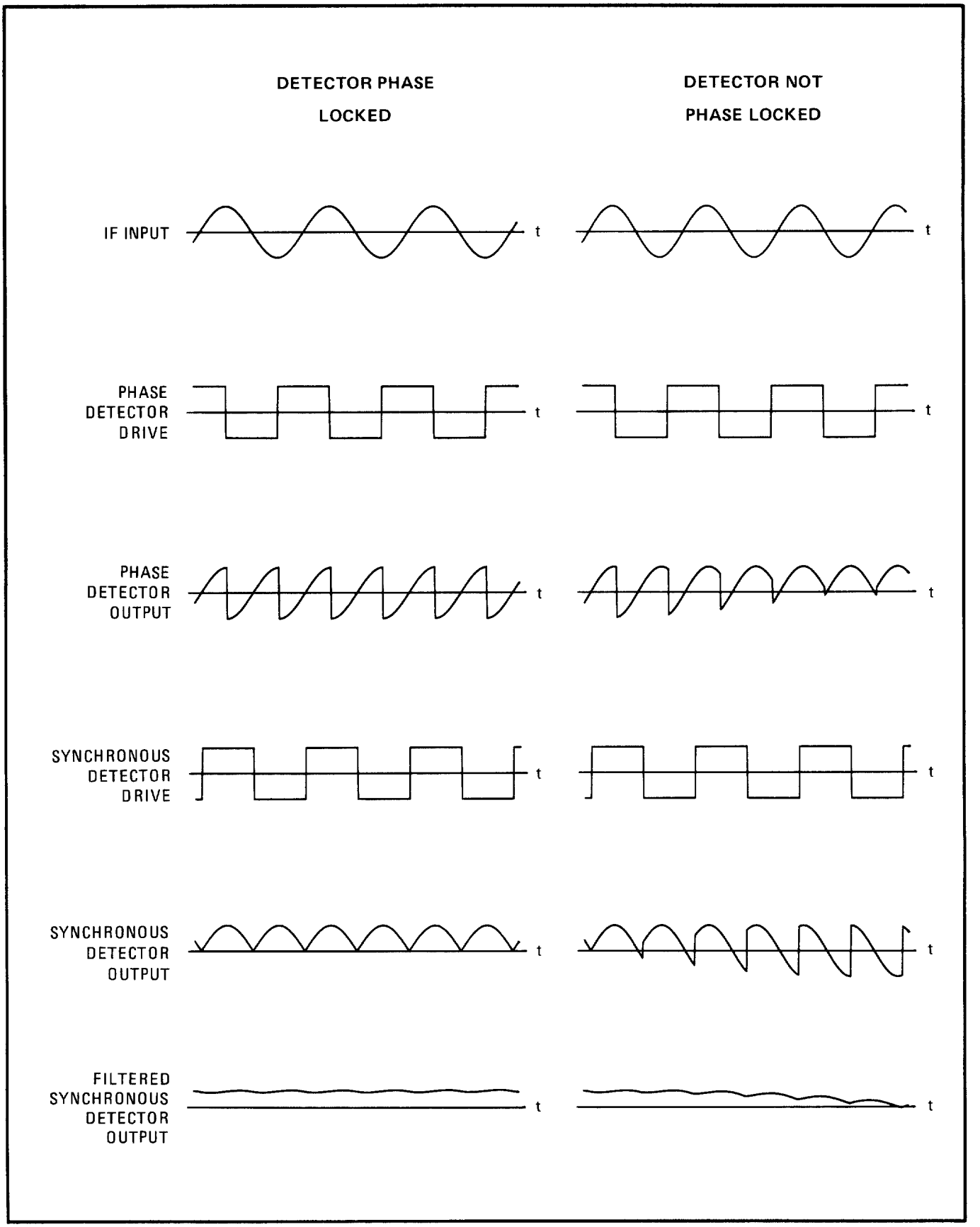


Figure 8D–6. *IF Synchronous Detector Waveforms*

IF Amplifier/Detector Assembly (A71, Option Series 030)

The 455 kHz IF signal from the A72 Channel Filter Assembly is further amplified and filtered by the A71 IF Amplifier/Detector Assembly, which also converts the IF level to a dc voltage which is then measured by the Voltmeter.

The IF gain is determined by the combination of selectable Attenuators 1 through 4 and fixed-gain Amplifiers 1 through 3. Attenuators 1 through 3 have 0 and 20 dB steps. Attenuator 4 has 5 dB steps from 0 to 15 dB.

The Second Channel 1 Filter is always a 33 kHz wide bandpass filter. It is selected by Special Functions 24.1, 24.2, 24.3, or 24.4. The Second Channel 2 Filter is always a 2.5 kHz wide bandpass filter and has the same nominal bandwidth as the Option 037 filter in the A72 Channel Filter Assembly. It is selected by Special Function 24.5 or 24.6 for SSB noise measurements. The Channel Output Amplifier has 33 dB gain. The IF RMS Detector converts the 455 kHz level to its dc rms level equivalent.

AM Demodulator Assembly (A6)

The down-converted signal from the IF Amplifier is filtered by a 2.5 MHz Low-Pass Filter. The AM IF Buffer drives the AM Demodulator. The FM IF Buffer drives the FM Demodulator and rear-panel IF OUTPUT connector.

The AM is demodulated by means of a precision, half-wave rectifier in an automatic level control (ALC) circuit. The buffered IF signal is amplified by a Current-Variable Amplifier then rectified (detected) by the AM and IF Average Level Detector. The detected signal, after carrier filtering, represents the carrier level (dc component) plus AM (ac component). The ac component accurately represents the AM only if the dc component is known or set to a known level. The detected signal is filtered and amplified by the Level Amplifier and Carrier Filter. The signal is then compared to a constant ALC Reference by the BW Control and Level Comparison Amplifier. The output of this amplifier is the carrier level error. The error voltage is amplified by the Resistor Drive Amplifier which sets the current input to the Current-Variable Amplifier. Current-variable resistors in the amplifier adjust the amplifier gain to cause the dc component of the carrier to equal the ALC Reference.

The amount of filtering in the Bandwidth Control and Level Comparison Amplifier determines the minimum AM rate which can be accurately demodulated. An ALC Bandwidth Control line sets the ALC loop for a fast or slow response. The feedback loop may also be defeated by the ALC Defeat line. Special Function 6 controls the ALC loop.

The second output of the AM and IF Average Level Detector is buffered by the AM Output Buffer. One output of the buffer is fed to the rear-panel AM OUTPUT connector. The other output is fed to the audio circuits for filtering and audio processing.

The output of the FM IF Buffer is detected by two detectors. The IF Peak Detector output is read by the Voltmeter. It is used in the automatic tuning routine and for making Tuned RF Level measurements using the IF Peak Detector. (Refer to the *Peak Tuned RF Level* detailed operating instruction in the *Operation and Calibration Manual*, Special Function 36. This measurement should not be confused with the two much more accurate and sensitive Tuned RF Level measurements initiated by the TUNED RF LEVEL key or Special Function 4 explained in the next paragraph.) The IF Present Detector is used to stop the LO sweep during a signal search (independent of the Controller).

The Voltmeter also receives IF level information from the output of the Level Amplifier and Carrier Filter. The IF level is measured after completion of tuning to confirm that the AM ALC loop is operating within range. The IF level is also measured for two other IF level measurements: IF Level and Average Tuned RF Level.

The IF Level measurement mode (invoked by pressing the S (shift) and IF LEVEL keys) compares the level from the Level Amplifier and Carrier Filter with the ALC reference and displays the ratio of the two (normally 100% unless the IF signal is too low or Special Function 6.2 is used). The Average Tuned RF Level measurement mode (invoked by Special Function 4) is similar to Tuned RF Level except that the IF level is measured by the Level Amplifier and Carrier Filter (with ALC off) instead

of the IF Synchronous Detector. The initial calibration and recalibration are the same as for the Tuned RF Level measurement mode.

The voltage from the Resistor Drive Amplifier is an indication of the ALC current driving the input resistor circuit. It is used for setting the AT1 Step Attenuator and AT2 10 dB Attenuator (see Service Sheet BD2) when the ALC is on. (When the ALC is off, the Input Attenuator is set using the IF Peak Detector for FM or the level read on the IF AVG Level line for AM.)

FM Demodulator (A4)

The signal from the FM IF Buffer drives the FM IF Limiters. The limiters strip AM and noise off the IF to minimize demodulation of AM by the FM Demodulator (called incidental FM). The three stages each have 22 dB of gain. The output of the limiters is a squarewave which drives a Precision Limiter. This limiter clamps the upper and lower levels of the squarewave to highly-stable references required by the Charge-Count Discriminator. For each cycle of the IF signal, the discriminator passes a fixed quantity of charge through the feedback resistor of an amplifier. The voltage developed at the amplifier's output is proportional to the amount of charge delivered per unit of time. Fluctuations in IF frequency (FM) produce fluctuations in the voltage at the output of the discriminator. The demodulated FM passes through the FM Output Amplifier and on to the audio circuits for further filtering and audio processing.

The Squelch Switch grounds the output of the discriminator whenever the IF level detected by the Squelch Detector is insufficient. This squelch action attenuates the large noisy output that results when discriminating only noise and speeds recovery of the audio circuits from tuning-induced transients. The Controller also activates squelch during certain other measurement modes.

The signal from the FM IF Limiters also drives the Counter via the Counter IF Buffer.

FM Calibrator Assembly (A51)

The heart of the FM Calibrator is a 10.1 MHz VCO. A 10 kHz trapezoidal wave is applied to the tune line of the VCO, which generates FM. During the calibration measurement, the VCO input is switched to the upper frequency, f_U, and the frequency is measured by the Counter. Then the VCO input is switched to the lower frequency, f_L, and the frequency is again measured. The Controller calculates the peak deviation as

$$FM = \frac{f_U - f_L}{2}.$$

A measurement of residual FM is also made on the unmodulated VCO and entered into the calculation of the FM calibration factor. The FM signal is then measured, and the calibration factor is calculated and shown on the display. The sensitivity of the VCO and tune voltage are designed to give approximately 34 kHz peak deviation.

To prevent ringing of the demodulated signal in the audio circuits, the modulation signal is given a slow risetime by the Trapezoid Generator—a soft limiter which receives its input from the Triangle Generator. The Triangle Generator and Mode Control comparator together form a relaxation oscillator. The output from the Mode Control comparator switches between a positive and negative output current.

The Triangle Generator (an integrator) generates a negative or positive ramp depending on its input. When its output reaches the Mode Control reference, the comparator output switches to initiate a ramp in the opposite direction.

Special Function 12 controls the FM Calibrator and permits its use with another Measuring Receiver or modulation analyzer.

AM Calibrator Assembly (A50)

The RF input to the AM Calibrator is the unmodulated 10.1 MHz from the FM Calibrator. The signal passes through a Limiter to the inputs of two similar Amplifiers (A and B) and through to two similar Modulators (A and B). Current Source B switches Modulator B on and off while Current Source A latches Modulator A on. The outputs from the two Modulators are summed in the Summing Amplifier, and the summed signal appears (after attenuation) at the CALIBRATION AM/FM OUTPUT connector. If both signal paths are identical, the output from the calibrator is periodically toggling between a specific RF level and twice that level. This produces 33.33% AM.

Rather than relying of the two signal paths being identical, the AM is computed by careful, static measurement of the signal levels from the Modulators during a calibration sequence. First, Modulator

A is switched off and the voltage from the Amplifier/Detector is measured with Modulator B on, via the ×1 DC Amplifier (V_B). This voltage is also measured via the ×10 DC Amplifier (V_{10B}). Then Modulator B is switched off, Modulator A switched on, and the level is measured via the ×10 DC Amplifier (V_{10A}). AM is then calculated by the formula

$$\%AM = \frac{100\%}{3 - \frac{2}{10}\frac{V_{10A} - V_{10B}}{V_B}}.$$

For near-identical modulators the formula can be written in the form

$$\%AM = \frac{100\%}{3 - \epsilon}$$

where ϵ is a small error term which need not be determined with great accuracy. Note that if Modulators A and B are identical, ϵ approaches zero, and the formula reduces to 100%/3 or 33.33%.

A measurement of residual AM is also made on the unmodulated RF and entered into the calculation of the AM calibration factor. The AM signal is then measured and the calibration factor is calculated and shown on the display.

To prevent ringing of the demodulated signal in the audio circuits, the modulation squarewave is given a slow risetime by the Current Sources. Special Function 13 controls the AM Calibrator and permits its use with another Measuring Receiver or modulation analyzer.

Troubleshooting

General

Procedures for checking the IF Section of the instrument are given below. The blocks or points to check are marked on the block diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩ . Before performing any check, perform all the checks on Service Sheet BD1.

CAUTION

Tighten SMC connectors to 0.6 N· m (5 in· lb). Hand tightening of connectors is insufficient. Hand-tightened connectors can work loose and cause reduced performance or malfunctions.

Equipment

Audio Synthesizer ..... HP 3336C
Oscilloscope ..... HP 1740A
Signal Generator ..... HP 8640B

⟨√1⟩ IF Amplifier/Filter Check

1. Set the signal generator or audio synthesizer to between 454 and 456 kHz CW at −7 dBm. Connect its RF output to A55J2 (IF IN) on the Measuring Receiver.
2. Connect a high-impedance, ac coupled oscilloscope to A55J1 (IF OUT).
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 9.1 SPCL to set the relative IF gain to 0 dB. The 455 kHz waveform on the oscilloscope should have an amplitude between 500 and 700 mVpp. If faulty, see Service Sheet 6 and begin by checking the Second IF Amplifier.

   Hint: The amplifier gain is adjustable. See *Adjustment 23—Narrow 455 kHz IF Filter* in Section 5.
4. Adjust the signal generator's level for a waveform of 600 mVpp. Key in the Special Functions listed in Table 8D-8 to set the IF gain. Also set the signal generator level in 10 dB steps as listed. For each setting the 455 kHz signal should appear within the limits indicated. If out of limits, see Service Sheet 6 and begin by checking the Second IF Amplifier.

Table 8D–8. *Signal Level at A55J1, ⟨√1⟩ Step 4*

Special Function	Gain (dB)	Signal Generator Level (dBm)	Oscilloscope Display Limits (mVpp)	
			Minimum	Maximum
9.1	0	−7	580	620
9.2	10	−17	580	620
9.3	20	−27	580	620
9.4	30	−37	580	620
9.5	40	−47	580	620
9.6	50	−57	580	620
9.7	60	−67	580	620

5. Set the signal generator's level to −7 dBm.
6. On the Measuring Receiver, key in 9.1 SPCL. Key in 100 MHz to stop the automatic signal search. Key in 3.5 SPCL to insert the 455 kHz Narrow Bandpass Filter. The signal on the oscilloscope

should be between 580 and 620 mVpp. If faulty, see Service Sheet 6 and check the 455 kHz Narrow Bandpass Filter.

7. Tune the signal generator to 430 and 480 kHz. In each case the level on the oscilloscope should drop below 100 mVpp. If faulty, see Service Sheet 6 and check the 455 kHz Narrow Bandpass Filter.

   Hint: The filter response is adjustable. See *Adjustment 23—Narrow 455 kHz IF Filter* in Section 5.

8. On the Measuring Receiver, key in 0.2 S (Shift) 36 SPCL to remove the narrow IF filter and to set the Programmable IF Gain Buffer to maximum gain. The level on the oscilloscope should increase to more than 2 Vpp. If faulty, see Service Sheet 6 and check the Programmable IF Gain Buffer.

   Hint: This buffer is used in the Tuned RF Level measurement mode while searching for a signal within the 30 kHz IF bandwidth.

⟨√2⟩ IF Synchronous Detector Check

1. Perform all tests of Special Function 53.N, *IF Synchronous Detector Tests,* paragraph 8-7.

⟨√3⟩ FM IF Buffer Check

1. Perform the Input Mixer and IF Check on Service Sheet BD2.

⟨√4⟩ IF Detector Check

NOTE

This check assumes that the ⟨√3⟩ FM IF Buffer Check *gives positive results.*

1. Set the signal generator to 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.
2. Connect an ac coupled oscilloscope to rear-panel IF OUTPUT. Switch the input impedance of the oscilloscope to 50Ω or terminate the input in 50Ω using a tee.
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 20 MHz. If Error 01 appears, press MHz again. Key in 1.3 SPCL to set the attenuation range to 20 dB. Adjust the signal generator level for a 100 mVpp waveform on the oscilloscope.
4. Key in 49. S (Shift) 3 SPCL. This causes the IF level to be displayed. The display should read between 0.85 and 0.95. If it does not, see Service Sheet 9 and check the IF Peak Detector.
5. Switch signal generator's RF off.
6. Press CLEAR to clear the IF Present Latch. Key in 0.0 S (Shift) 4 SPCL. The display now reads the IF Present status. The display should read 000000.0000. If faulty, see Service Sheet 9 and check the IF Present Detector.
7. Switch the signal generator's RF on. The display should read 000001.0000 indicating that IF has been detected. If faulty, see Service Sheet 9 and check the IF Present Detector.

NOTE

To repeat steps 5 through 7, it is necessary to press CLEAR first to clear the IF Present Latch.

⟨√5⟩ AM Demodulator Check

NOTE

This check assumes that the ⟨√3⟩ IF FM Buffer Check *gives positive results.*

1. Set the signal generator to approximately 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.
2. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press AM. Key in 49. S (Shift) 1 SPCL. This causes the average IF level (which the ALC loop is supposed to hold constant) to be displayed. The display should read between 2.096 and 2.104. If only slightly out of limits, perform the *Adjustment 8—ALC Reference* in Section 5; otherwise, see Service Sheet 8.
3. Connect a high-impedance, ac coupled oscilloscope to rear-panel AM OUTPUT.
4. Modulate the signal generator with 50% AM at a 400 Hz rate. The oscilloscope should show the demodulated AM with an ac amplitude of 750 to 850 mVpp. If faulty, see Service Sheet 8.
5. Key in 6.1 SPCL to set the ALC response time to fast. The amplitude should drop between 40 and 120 mVpp. If faulty, see Service Sheet 8 and check the Bandwidth Control and Level Comparison Amplifier.

⟨√6⟩ FM Demodulator Check

NOTE

This check assumes that the ⟨√3⟩ FM IF Buffer Check *gives positive results.*

1. Set the signal generator to approximately 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.
2. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press FM. Allow the instrument to tune then press MHz. Pressing the MHz key sets tuning to manual.
3. Connect a high-impedance, dc coupled oscilloscope to A4J2 (IF OUT). The waveform should be TTL pulses with a period of approximately 670 ns. If faulty, see Service Sheet 10 and check the IF Limiters.
4. Reconnect the cable to A4J2. Connect the ac coupled oscilloscope to the rear-panel FM OUTPUT.
5. Modulate the signal generator with 100 kHz peak deviation FM at a 1 kHz rate. The oscilloscope should show the demodulated FM with an ac amplitude of 1.0 to 1.4 Vpp. If faulty, see Service Sheet 11 and check the Charge-Count Discriminator.

NOTE

A slight fuzziness on the waveform is normal. It is the doubled 1.5 MHz IF carrier.

6. Connect the oscilloscope to A4TP5 (FM OUT). The waveform should be 3.6 to 4.4 Vpp. If faulty, see Service Sheet 11 and check the FM Output Amplifier and Squelch.

NOTE

This waveform will have even more of the doubled 1.5 MHz carrier on it.

⟨7⟩ FM Calibrator Check

1. Connect a high-impedance, ac coupled oscilloscope (with 10:1 divider probe) to A51TP2 (TRAPEZOID OUT).

2. Press FM and CALIBRATE. The waveform should be trapezoidal with round edges and an ac amplitude of 300 to 340 mVpp and period of 90 to 110 μs. (Ignore Error 08 in the display.) If faulty, see Service Sheet 29 and check the trapezoid generation circuits.

3. Key in 12.1 SPCL and 46.3 SPCL. This sets the FM Calibrator to CW and causes the display to show its frequency. The display should read between 1009000 and 1011000. If only slightly out of limits, perform the *Adjustment 9—FM Calibrator* in Section 5. Otherwise, see Service Sheet 29 and check the 10.1 MHz VCO.

4. Key in 12.0 SPCL. This causes the display to read the computed peak deviation. The display should read between 31 and 37 kHz. If only slightly out of limits, perform *Adjustment 9—FM Calibrator.* Otherwise, see Service Sheet 29 and check the 10.1 MHz VCO.

5. Key in 12.1 SPCL. Connect the ac coupled oscilloscope to the CALIBRATION AM/FM OUTPUT. Switch the input impedance of the oscilloscope to 50Ω or terminate the input in 50Ω using a tee. The waveform should be approximately sinusoidal and have an ac amplitude of 35 to 45 mVpp. If faulty, see Service Sheet 29 and check the Output Amplifier. If it is good, see Service Sheet 30 and check the RF path through the AM Calibrator.

⟨8⟩ AM Calibrator Check

1. Connect an ac coupled oscilloscope to the CALIBRATION AM/FM OUTPUT. Switch the input impedance of the oscilloscope to 50Ω or terminate the input in 50Ω using a tee.

2. Key in 13.1 SPCL to set the AM Calibrator to CW. The waveform should be approximately sinusoidal with an ac amplitude of 35 to 45 mVpp. If faulty, see Service Sheet 30 and check the RF path beginning at the input of the FM Calibrator.

3. Key in 13.0. This causes the display to show the AM depth. The display should show between 33.0 and 33.7%. If faulty, see Service Sheet 30 and begin by checking the Modulators.

4. Press AM then CALIBRATE. The waveform should show the carrier with AM. The AM envelope should be a rounded squarewave with a period of 90 to 110 μs. The amplitude of the peak should be twice that of the trough. If faulty, see Service Sheet 30 and check the 10 kHz Modulation Oscillator.

⟨√9⟩ Channel Filter Check (Option Series 030)

1. Set the signal generator or audio synthesizer to between 454 and 456 kHz CW at −10 dBm (70.7 mVrms into 50Ω). Connect its RF output to A72J2 (IF IN) on the Measuring Receiver.
2. Connect a high-impedance, ac coupled oscilloscope to A72J1 (IF OUT).
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 0.3D0 SPCL to switch in the Channel Output Attenuator and select channel 1. Fine tune the signal source to peak the signal on the oscilloscope. (Filter passband ripple can be as high as 2 dB. Find the highest peak of the ripple.) The 455 kHz waveform on the oscilloscope should have an amplitude between 640 and 1000 mVpp. If faulty, see Service Sheet 33 and check the circuits of channel 1.
4. Set the oscilloscope gain for a display of 6 divisions peak-to-peak. Key in 0.3D1 SPCL to switch out the Channel Output Attenuator. Decrease the oscilloscope's vertical gain by a factor of 10. The waveform should be between 5.9 and 6.1 divisions peak-to-peak. If faulty, see Service Sheet 33 and check the Channel Output Attenuator.
5. Increase the signal source frequency until the waveform drops to 3 divisions peak-to-peak. Record the signal source's frequency.
6. Decrease the signal source frequency until the waveform rises to 6 divisions peak-to-peak then drops to 3 divisions peak-to-peak. Note the signal source's frequency. The difference between this frequency and the frequency in step 5 should be as indicated in Table 8D-9. (The filter bandwidth depends on the option installed.) If faulty, see Service Sheet 33 and check the First Channel 1 Filter.

Table 8D-9. *Bandwidth of First Channel 1 Filter,* ⟨√9⟩ *Step 6*

Option Combination	Frequency Difference Limits (kHz)	
	Minimum	Maximum
032 and 035 033 and 035 035 and 037	25.0	35.0
032 and 033 033 and 037	12.4	16.9
032 and 037	6.4	10.4

7. Key in 0.3D3 SPCL to select channel 2. Set the signal source frequency to 455 kHz then fine tune the source to peak the signal on the oscilloscope. (Filter passband ripple can be as high as 2 dB. Find the highest peak of the ripple.) The 455 kHz waveform on the oscilloscope should have an amplitude between 4 and 7 divisions peak-to-peak. If faulty, see Service Sheet 33 and check the circuits of channel 2.
8. Set the oscilloscope gain for a display of 6 divisions peak-to-peak. Increase the signal source frequency until the waveform drops to 3 divisions peak-to-peak. Record the signal source's frequency.
9. Decrease the signal source frequency until the waveform rises to 6 divisions peak-to-peak then drops to 3 divisions peak-to-peak. Note the signal source's frequency. The difference between this frequency and the frequency in step 8 should be as indicated in Table 8D-10. If faulty, see Service Sheet 33 and check the First Channel 2 Filter.

Table 8D–10. *Bandwidth of First Channel 2 Filter,* ⟨√9⟩ *Step 9*

Option Combination	Frequency Difference Limits (kHz)	
	Minimum	Maximum
032 and 037 033 and 037 035 and 037	3.0	7.0
032 and 033 032 and 035	6.4	10.4
033 and 035	12.4	16.9

10. Key in 23.1 to switch the LO to external. The EXT LO indicator on A72 should go on and the LO input switch should make an audible click. If faulty, see Service Sheet 33 and check the LO Input Switch (S4) Control.

⟨√10⟩ IF Amplifier/Detector Check (Option Series 030)

1. Set the signal generator or audio synthesizer to between 454 and 456 kHz CW at −70 dBm (70.7 μVrms into 50Ω). Connect its RF output to A71J2 (IF IN) on the Measuring Receiver.
2. Connect a high-impedance, ac coupled oscilloscope to A71J1 (TEST JACK).
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Key in 0.397 SPCL and 0.3E7 SPCL to switch in maximum IF gain and select the Second Channel 1 Filter. Fine tune the signal source to peak the signal on the oscilloscope. (Filter passband ripple can be as high as 2 dB. Find the highest peak of the ripple.) The 455 kHz waveform on the oscilloscope should have an amplitude between 1 and 2 Vpp. If faulty, see Service Sheet 34 and check the circuits of channel 1.
4. Key in 49.C SPCL to read the IF with the IF RMS Detector. Calculate

   reading of step 3 × 1.63.

   The Measuring Receiver's display should read within 10% of the calculated value. If faulty, see Service Sheet 34 and check the IF RMS Detector.
5. Set the signal source level for a Measuring Receiver display of 2.00.
6. Key in the Direct Control Special Functions listed in Table 8-11 followed each time by 49.C SPCL. For each setting, the Measuring Receiver's display should be as indicated. If faulty, see Service Sheet 34 and check the corresponding attenuator.

Table 8D–11. *Attenuation Stepping,* ⟨√10⟩ *Step 6*

Direct Control Special Function	Attenuator	Display Limits	
		Minimum	Maximum
0.396	1	0.12	0.22
0.395	2	0.18	0.22
0.393	3	0.18	0.22
0.397, 0.3EB	4, 5 dB	1.02	1.24
0.3ED	4, 10 dB	0.57	0.70
0.3EE	4, 15 dB	0.32	0.39

7. Key in 0.3E7 SPCL and 49.C SPCL. Increase the signal source frequency until the display drops to 1.0. Record the signal source's frequency.

8. Decrease the signal source frequency until the display rises to 2.0 then drops to 1.0. Note the signal source's frequency. The difference between this frequency and the frequency in step 7 should be between 33 and 55 kHz. If faulty, see Service Sheet 34 and check the Second Channel 1 Filter.
9. Key in 0.39F SPCL to select channel 2. Key in 49.C SPCL. Set the signal source frequency to 455 kHz then fine tune the source to peak the signal on the Measuring Receiver's display. (Filter passband ripple can be as high as 2 dB. Find the highest peak of the ripple.) The display should read between 1.5 and 2.5. If faulty, see Service Sheet 34 and check Second Channel 2 Filter.
10. Set the signal source level for a Measuring Receiver display of 2.00.
11. Increase the signal source frequency until the display drops to 1.0. Record the signal source's frequency.
12. Decrease the signal source frequency until the display rises to 2.0 then drops to 1.0. Note the signal source's frequency. The difference between this frequency and the frequency in step 11 should be between 3 and 7 kHz. If faulty, see Service Sheet 34 and check the Second Channel 2 Filter.
13. Key in 0.3F0 SPCL to read back the Option Series 030 Installed Indicator. The Measuring Receiver should display 000001.0000. If faulty, see Service Sheet 34 and check the Option Series 030 Installed Indicator.

SERVICE SHEET BD4

Block

- Audio

Principles of Operation

General

The Audio Block Diagram documents the audio circuits which process the demodulated IF signal and convert the audio signal to dc for measurement by an internal digital voltmeter. The audio circuits include amplifiers, filters, attenuators, switches, ac to dc converters, an integrator, a counter, a distortion analyzer, etc.

Audio Filters Assembly (A2)

The residual IF carrier on the demodulated AM or FM is filtered by the 260 kHz Low-Pass Filter in each path. These filters determine the audio bandwidth when LP FILTER is set to >200 kHz. 20 dB Attenuator 1 partially determines the audio gain in the FM and ΦM modes.

The demodulated signal passes through Amplifier 1, which has a gain of 8.9 dB, and when selected, the 15 kHz or >20 kHz Low-Pass Filter further filters the signal. The 15 kHz Low-Pass Filter is automatically selected for the 455 kHz IF. The >20 kHz Low-Pass Filter can also be selected. The 6 dB Attenuator in the through-path matches the 6 dB loss through the two filters.

Amplifier 2 has 13.7 dB of gain. 20 dB Attenuator 2 gives further audio-range control. Amplifier 3 has 20 dB of gain. Amplifiers 1, 2, and 3 distribute the audio gain for optimum noise reduction and distortion. Special Function 2 controls the overall audio gain. Table 8D-12 lists the modulation ranges and the associated attenuation. (The ranges in the table apply only for the PEAK+, PEAK−, and AVG audio detectors.)

Table 8D-12. *Attenuation vs. Modulation Range*

Modulation Range			20 dB Attenuator	
AM Depth (%)	FM Deviation (kHz)*	ΦM Deviation (rad)	1	2
40	4	4	out	out
100	40	40	out	in
100	400	400	in	in
* With 750 μs FM DE-EMPHASIS and PRE-DISPLAY selected the FM ranges are 0.4, 4, and 40 kHz.				

Audio De-emphasis and Output Assembly (A3)

The Audio De-emphasis and Output Assembly contains audio filters, FM de-emphasis networks, a ΦM integrator, audio output amplifiers, and two audio level detectors.

The 50 and 300 Hz High-Pass and 3 kHz Low-Pass Filters are active filters selected from the front panel. The four FM de-emphasis networks are single-pole, low-pass filters with time constants of 750, 75, 50, and 25 μs. The 750 μs network also adds 20 dB of gain.

The phase deviation of the RF input signal is recovered by integrating the demodulated FM with the Phase Modulation Integrator. In mathematical terms, the instantaneous phase deviation is the integral of the instantaneous frequency deviation.

The audio output path to the Voltmeter (A5) is through the Inverting/Non-Inverting Amplifier. The amplifier usually has a gain of −1, but when PEAK+ is selected or, for FM and ΦM, when the input signal is down converted by the Input Mixer (A17), the gain is +1. By using PRE-DISPLAY, the input to the amplifier can be selected to include the FM de-emphasis networks.

The Absolute Peak Detector, the Audio Overvoltage Detector, and the Voltmeter together sense the audio signal level to determine the audio range. The Audio Overvoltage Detector compares the audio voltage to a reference. If the audio level is too high, the Audio Overvoltage Detector reacts quickly to set the audio gain to minimum and to set a status flag which can be read by the Controller. The output of the Absolute Peak Detector (which detects the greater of the positive and negative peaks) is read by the Voltmeter.

If automatic ranging has been selected, the Controller reduces the audio gain depending on the following conditions governed by the Controller: (1) the magnitude of the positive or negative peak of the audio signal or (2) the voltage read from the Audio Peak Detector of the A5 Voltmeter Assembly. Most often the audio autoranging is determined by the voltage read from the Audio Peak Detector. However, situations arise where the predominant component of the audio signal is filtered out by one of the active filters in the audio chain (for example, a 10 kHz signal into the 3 kHz Low-Pass Filter). Having the Absolute Peak Detector ahead of the active filters prevents such situations from overdriving the audio circuits.

The front-panel MODULATION OUTPUT/AUDIO INPUT is driven by an inverting Output Amplifier via the A52 Audio Counter/Distortion Analyzer Assembly. The output of this connector is always affected by audio filtering and FM de-emphasis, when selected.

Voltmeter Assembly (A5)

The Voltmeter consists of an average detector, a peak detector, and a voltage-to-time converter.

The Audio Average Detector consists of a precision Half-Wave Rectifier and a Summer and Filter. The summer amplifier adds the input signal, weighted by a factor of one, to the inverted and half-wave-rectified input, weighted by a factor of two. The resultant sum is a full-wave-rectified output. After filtering, the output dc voltage is equal to the signal's rectified average.

The Audio Peak Detector captures the positive, ac peak. The Sample-and-Hold Switch controls the transfer of the detector's output to the Voltage-to-Time Converter (via the Buffer Amplifier) and also controls the discharging of the Audio Peak Detector. Special Function 5 controls the discharge rate.

The voltage is actually measured by the Voltage-to-Time Converter. The Input Selectors select one of many dc inputs into the converter. The output of the selectors is a reference input to a Comparator. The Comparator's other input is a linear ramp. As the ramp (initiated by the Counter) rises, the Counter counts the time base reference (10 MHz). When the ramp voltage equals the level of the Comparator's other input, the Comparator signals the Counter to stop counting. The accumulated count represents the dc voltage. Ground is measured separately and subtracted from the Voltmeter measurement.

The True RMS-to-DC Converter improves the accuracy of the Tuned RF Level measurement at low levels by converting the sum of the dc level and noise on the signal from the IF Synchronous Detector (see Service Sheet BD3) to a dc level which represents the signal's true rms value. At low levels, this compensates for the effect of noise on the IF Synchronous Detector. The Voltmeter, by its nature, averages out this noise, whereas a true rms converter doesn't. Special Functions 49 and 50 allow direct access and display of the Voltmeter readings.

Audio Counter/Distortion Analyzer (A52)

Inputs to the Audio Counter/Distortion Analyzer come from either the internal audio circuits via the Output Amplifiers in the A3 Audio De-emphasis and Output Assembly or from the external MODULATION OUTPUT/AUDIO INPUT as determined by the Internal/External Source Switch.

The distortion (plus noise) on a 400 Hz or 1 kHz audio signal is measured by comparing the level of the input signal with the level of that same signal which has had the fundamental removed by a

notch filter. The distortion measurement result (which also includes noise) is the ratio of the signal, with fundamental removed, to the unfiltered signal. In both measurements, the signal level is measured by the RMS-to-DC Converter which is then read by the Voltmeter. The voltage from the RMS-to-DC Converter can be measured and displayed by means of Special Function 30, which automatically switches the Input/Output Switch to the external, audio input position.

Since the notch-filter frequency is fixed at either 1 kHz or 400 Hz, the signal being measured should be within ±5% of the selected frequency. Amplifier 1 and Amplifier 2, which together have an overall gain of 0, 20, or 40 dB, are programmed to provide an optimum level to the RMS-to-DC Converter. The voltage measured when the Notch Select Switch is set to include the Notch Filters is the numerator in the distortion calculation. The voltage measured when the Notch Select Switch is set to bypass the Notch Filters is the denominator in the distortion calculation. Since the signal minus its fundamental is often noisy, the signal to the Voltmeter is filtered by an active Ripple Filter to smooth the voltage readings. Special Function 29 puts the instrument in the SINAD measurement mode. The SINAD measurement is the same as the Audio Distortion measurement except that the reciprocal of the distortion measurement is displayed.

To calculate the frequency of an internal or external audio signal, the Controller counts signals from both the Audio Counter and the main Counter (on Service Sheet BD5). First, the analog audio signal is conditioned by the Schmitt Trigger to make it compatible with the digital circuits that follow. To begin the count, the Controller resets Counter Stages 1–4. At this time, Count/Pulse Switch 2 is set to receive the output from Counter Stage 2 and the Output Switch is closed. Count/Pulse Switch 1 is readied but not closed until the next pulse from the Schmitt Trigger triggers the Counter Gate Control and sets Count/Pulse Switch 1 to receive pulses from the Schmitt Trigger. The Counter Stages 1–4 now begin counting pulses from the Schmitt Trigger. Overflows from Stage 4 (every 65 536 counts) are counted by the Controller via the Output Switch and Instrument Bus.

Coincident with the closing of Count/Pulse Switch 1, the Voltmeter/Audio Gate (on Service Sheet BD5) closes and the main Counter begins counting the 10 MHz time base reference. After 100 ms, the Controller enables the Counter Gate Control to respond to the next pulse from the Schmitt Trigger. When the pulse arrives, it triggers the Counter Gate Control to open Count/Pulse Switch 1 and the Voltmeter/Audio Gate via the Stop Count Buffer. If no pulse is received from the Schmitt Trigger after a fixed time, the count sequence is aborted.

The count from Audio Counter Stages 1–4 is read back in two steps. First, the Controller reads back the count of Stages 3 and 4 by sending a series of pulses into Stage 3 via Count/Pulse Switch 2, looking for the overflow from Stage 4. By knowing the number of pulses sent to Stage 3, the Controller can calculate the accumulated count. Next, the Controller sends 255 pulses to Stages 3 and 4 to fill them, sets Count/Pulse Switch 2 to the output of Stage 2, and sends a series of pulses to Stage 1 via Count/Pulse Switch 1 while looking for an overflow from Stage 4. Again, by knowing the number of pulses sent to Stage 1, the Controller can calculate the accumulated count from Stages 1 and 2. The count from the main Counter is also read back by the Controller. Knowing the counts of the Audio and main Counters (including overflows), the Controller calculates and displays the signal frequency.

Troubleshooting

General

Procedures for checking the Audio Section of the instrument are given below. The blocks or points to check are marked on the block diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩ . Before performing any check, perform all the checks on Service Sheet BD1.

CAUTION

Tighten SMC connectors to 0.6 N· m (5 in· lb). Hand tightening of connectors is insufficient. Hand-tightened connectors can work loose and cause reduced performance or malfunctions.

Equipment

Audio Synthesizer	HP 3336C
Oscilloscope	HP 1740A
Signal Generator	HP 8640B

⟨√1⟩ Audio Filters and Gain Check

1. Set the audio synthesizer to 1 kHz at −17 dBm. (The synthesizer output impedance should be 50Ω.) Connect its output to A2J1 (AM IN).

CAUTION

If the Measuring Receiver is to be turned off, disconnect the audio synthesizer first to prevent damage to the CMOS switches the large signal present.

2. Connect a high-impedance, ac coupled oscilloscope (with 10:1 divider probe) to A2TP4 (AMPL 3 OUT).

3. Set the signal generator to approximately 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.

4. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press AM. Key in 2.1 SPCL to set the audio gain to maximum. The oscilloscope should show the 1 kHz sinusoidal waveform with an ac amplitude of 2.4 to 2.8 Vpp. If faulty, see Service Sheet 12 and check the audio path beginning at the 260 kHz Low-Pass Filter at the AM output.

5. Increase the synthesizer frequency to 260 kHz without altering the amplitude. The waveform should have an ac amplitude of 1.2 to 1.6 Vpp. If faulty, see Service Sheet 12 and check the 260 kHz Low-Pass Filter at the AM output as well as checking to see if the 15 kHz or >20 kHz are in the circuit. (They should be out.)

NOTE

This is not a valid measurement of the filter bandwidth since the source impedance is incorrect. It will, however, show up a severe problem. For a more precise test of bandwidth, see Service Sheet 12 or perform Performance Test 4—Audio Filters *in Section 4.*

6. Set the synthesizer level to −27 dBm and frequency to 1 kHz. Connect its output to A2J2 (FM IN). Press FM. The waveform should have an ac amplitude of 3.0 to 3.6 Vpp. If faulty, see Service Sheet 12 and check the 260 kHz Low-Pass Filter at the FM output.
7. Increase the synthesizer frequency to 260 kHz. The waveform should have an ac amplitude of 1.1 to 1.5 Vpp. If faulty, see Service Sheet 12 and check the 260 kHz Low-Pass Filter at the FM output.

NOTE

See previous note.

8. Set the synthesizer level to −17 dBm and frequency to 1 kHz. Key in 2.2 SPCL to reduce the audio gain by 20 dB. The waveform should have an ac amplitude of 950 to 1150 mVpp. If faulty, see Service Sheet 12 and check 20 dB Attenuator 1.
9. Key in 2.3 SPCL to reduce the audio gain another 20 dB. The waveform should have an ac amplitude of 95 to 115 mVpp. If faulty, see Service Sheet 12 and check 20 dB Attenuator 2.
10. Key in 2.2 SPCL. Set the synthesizer frequency to 110 kHz. Set LP FILTER to >20 kHz. The waveform should have an ac amplitude of 400 to 600 mVpp. If faulty, see Service Sheet 12 and check the >20 kHz Low-Pass Filter.
11. Set the synthesizer frequency to 15 kHz. Set LP FILTER to 15 kHz. The waveform should have an amplitude of 600 to 900 mVpp. If faulty, see Service Sheet 12 and check the 15 kHz Low-Pass Filter.

⟨√2⟩ Audio Filters and De-emphasis Check

NOTE

This check assumes that ⟨√1⟩ Audio Filters and Gain Check *gives positive results.*

1. Set the audio synthesizer to 1 kHz at −17 dBm. (The synthesizer output impedance should be 50Ω.) Connect its output to A2J2 (FM IN).
2. Connect a high-impedance, ac coupled oscilloscope (with 10:1 divider probe) to A3TP3 (DE-EM OUT).
3. Set the signal generator to approximately 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.
4. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press FM. Key in 2.2 SPCL to set the audio gain to an intermediate range. The oscilloscope should show a sinusoidal waveform with an ac amplitude of 1.9 to 2.3 Vpp. If faulty, see Service Sheet 13 and check the audio path beginning at the high-pass filters.
5. Set the synthesizer frequency to 300 Hz. Set HP FILTER to 300 Hz. The waveform should have an ac amplitude of 1.3 to 1.7 Vpp. If faulty, see Service Sheet 13 and check the 300 Hz High-Pass Filter.

6. Set the synthesizer frequency to 50 Hz. Set HP FILTER to 50 Hz. The waveform should have an ac amplitude of 1.3 to 1.7 Vpp. If faulty, see Service Sheet 13 and check the 50 Hz High-Pass Filter.
7. Set the synthesizer frequency to 3 kHz. Set HP FILTER off and the LP FILTER to 3 kHz. The waveform should have an ac amplitude of 1.2 to 1.8 Vpp. If faulty, see Service Sheet 13 and check the 3 kHz Low-Pass Filter.
8. Set the LP FILTER off and FM DE-EMPHASIS to PRE-DISPLAY. Set the synthesizer frequency and FM DE-EMPHASIS as listed in Table 8D-13. For each setting, the ac amplitude of the waveform should be as indicated. If faulty, see Service Sheet 13 and check the appropriate de-emphasis filter.

Table 8D-13. *Amplitude at A3TP3,* ⟨√2⟩ *Step 8*

Synthesizer Frequency (Hz)	FM DE-EMPHASIS (μs)	Waveform Amplitude Limits (Vpp)	
		Minimum	Maximum
6366	25	1.3	1.7
3183	50	1.3	1.7
2122	75	1.3	1.7
212.2	750*	1.3	1.7
* Key in 2.3 SPCL to reduce the gain by 20 dB.			

9. Key in 2.2 SPCL. Switch PRE-DISPLAY off. The waveform should have an ac amplitude of 1.9 to 2.3 Vpp. If faulty, see Service Sheet 13 and check the Pre-Display Switching.
10. Set the synthesizer frequency to 1 kHz. Press ΦM. The waveform should have an ac amplitude of 1.9 to 2.3 Vpp. If faulty, see Service Sheet 13 and check the Phase Modulation Integrator.
11. Press PEAK−. The waveform should not noticeably change amplitude. If faulty, see Service Sheet 13 and check the Inverting/Non-Inverting Amplifier.
12. Press FM. Switch off all FM DE-EMPHASIS. Connect the oscilloscope to MODULATION OUTPUT/AUDIO INPUT. The waveform should have an ac amplitude of 1.9 to 2.3 Vpp. If faulty, see Service Sheet 13 and check the Output Amplifiers.
13. Key in 49.6 SPCL. This causes the output of the audio range detector to be displayed. The display should read 0.4 to 0.6. If faulty, see Service Sheet 13 and check the Absolute Peak Detector.
14. Key in 0.15 SPCL. The display now shows the audio overvoltage status. The display should read 000000.0000. If faulty, see Service Sheet 13 and check the Audio Overvoltage Detector.
15. Increase the synthesizer level to +10 dBm. The display should read 000001.0000 indicating that an audio overload has been detected. If faulty, see Service Sheet 13 and check the Audio Overvoltage Detector.

NOTE

To repeat steps 13 and 14, it is necessary to press CLEAR first to clear the audio overvoltage latch.

⟨√3⟩ Audio Average and Peak Detector Check

NOTE

This check assumes that ⟨√2⟩ Audio Filters and De-emphasis Check *gives positive results.*

1. Set the audio synthesizer to 1 kHz at −17 dBm. (The synthesizer output impedance should be 50Ω.) Connect its output to A2J2 (FM IN).
2. Connect a high-impedance, ac coupled oscilloscope (with 10:1 divider probe) to A3TP3 (DE-EM OUT).
3. Set the signal generator to approximately 20 MHz CW at 0 dBm. Connect its RF output to the Measuring Receiver's INPUT.
4. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press FM. Key in 2.2 SPCL to set the audio gain to an intermediate range. Fine adjust the synthesizer level for an ac waveform of 2 Vpp.
5. Connect a dc coupled oscilloscope to A5TP4 (AVG OUT). (Check the dc reference of the oscilloscope.) The level on the oscilloscope should be 660 to 760 mVdc. If faulty, see Service Sheet 14 and check the Average Detector.
6. Connect oscilloscope to rear-panel RECORDER OUTPUT. Key in 49.0 S (Shift) 0 SPCL to switch the output of the Audio Peak Detector to the RECORDER OUTPUT. The level on the oscilloscope should be 0.9 to 1.1 Vdc. If faulty, see Service Sheet 14 and check the Audio Peak Detector. Also check the Input Selectors to the Voltage-to-Time Converter; see Service Sheet 15.
7. Remove then reconnect the synthesizer output. The waveform should drop and rise (in a step-like manner) in less than one second. If faulty, see Service Sheet 13 and check the Sample-and-Hold Switch.
8. Key in 5.1 SPCL to set the Audio Peak Detector time constant to slow. Again key in 49.0 S 0 SPCL. Repeat step 7 above. The decay and rise time should be about two seconds.

⟨√4⟩ Voltage-to-Time Converter Check

1. Key in 50.3 SPCL. This causes the +5V supply to be displayed. The display should read 2.85 to 3.15. If faulty, see Service Sheet 15 and begin troubleshooting with the Voltage-to-Time Converter.
2. Check the Input Selectors by keying in the Service Special Functions listed for 49.N and 50.N. Consult *Service Special Functions* in *Special Functions,* paragraph 8-7, for more information. If any reading seems faulty when the input is known to be good, see Service Sheet 15 and check the Input Selectors.

⟨√5⟩ Parity Check

1. Perform the Power-Up Checks on Service Sheet BD1.

⟨√6⟩ Distortion Analyzer Check

1. Set the audio synthesizer to 1 kHz at 1 Vrms (into a high impedance). Connect its output to A52J1 (AUDIO IN).
2. Connect an ac coupled, high-impedance oscilloscope to the MODULATION OUTPUT/AUDIO INPUT.
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. The 1 kHz audio signal should be displayed with an amplitude between 2.6 and 3.0 Vpp. If faulty, see Service Sheet 16 and check the Internal/External Source Switch.

4. Readjust the level from the synthesizer for a display of 3 Vpp. Key in 30.0 SPCL to set the instrument to measure External Audio RMS Level. The 1 kHz signal should disappear. If faulty, see Service Sheet 16 and check the Internal/External Source Switch.
5. Connect the oscilloscope to A52TP4 (BUF OUT). Connect the synthesizer to the MODULATION OUTPUT/AUDIO INPUT. The 1 kHz audio signal should be displayed with an amplitude between 2.8 and 3.2 Vpp. If faulty, see Service Sheet 16 and check the Audio Input Buffer.
6. Connect the oscilloscope to A52TP2 (AMPL 1 OUT). Key in 2.3 SPCL to assure that the 20 dB attenuator of Amplifier 1 is in. The amplitude of the displayed audio signal should be between 2.8 and 3.2 Vpp. If faulty, see Service Sheet 16 and check Amplifier 1 and the Notch Select Switch.
7. Reduce the amplitude of the signal from the synthesizer by 10 (that is, −20 dB). Key in 2.4 SPCL to bypass the 20 dB attenuator. The amplitude of the displayed audio signal should be between 2.8 and 3.2 Vpp. If faulty, see Service Sheet 16 and check Amplifier 1.
8. DC couple the oscilloscope and connect it to A52TP1 (RMS OUT). The oscilloscope should display a voltage between 0.9 and 1.2 Vdc. If faulty, see Service Sheet 16 and check the RMS-to-DC Converter and the Ripple Filter.
9. AC couple the oscilloscope and connect it to A52TP3 (NOTCH FLTR OUT). Key in 0.2 S (Shift) 0 S 4 SPCL to keep the Notch Select Switch in the through position, keep the gain of Amplifier 1 at 20 dB, switch in the 400 Hz Notch Filter, and set the gain of Amplifier 2 to 20 dB. The amplitude of the displayed audio signal should be between 2.7 and 3.3 Vpp. If faulty, see Service Sheet 16 and check the Notch Filters and Amplifier 2.
10. Key in 0.2 S 0 S 0 SPCL to reduce the gain of Amplifier 2 by 20 dB. The amplitude of the displayed audio signal should be between 270 and 330 mVpp. If faulty, see Service Sheet 16 and check Amplifier 2.
11. Key in 0.2 S 0 6 SPCL to switch in the 1 kHz Notch Filter and increase the gain of Amplifier 2 by 20 dB. The 1 kHz audio signal should disappear into the noise. If faulty, see Service Sheet 16 and check the Notch Filter.
12. Set the synthesizer frequency to 400 Hz. Key in 0.2 S 0 S 4 SPCL to insert the 400 Hz Notch Filter. The 400 Hz audio signal should disappear into the noise. If faulty, see Service Sheet 16 and check the Notch Filter.
13. Connect the oscilloscope again to A52TP2. Key in 0.2 S 0 5 SPCL to set the Notch Filter to 1 kHz, keep the gain of Amplifier 2 at 20 dB, set the gain of Amplifier 1 to 0 dB, and set the Notch Select Switch to the notch filter position. The 400 Hz audio signal should have an amplitude between 2.7 and 3.3 Vpp. If faulty, see Service Sheet 17 and check the Notch Select Switch.

⟨√7⟩ Audio Counter Check

1. Set the audio synthesizer to 1 kHz at 1 Vrms (into a high impedance). Connect its output to the MODULATION OUTPUT/AUDIO INPUT.
2. Connect an ac coupled, high-impedance oscilloscope to A52TP4 (BUF OUT).
3. Press the blue key, then press INSTR PRESET (the AUTOMATIC OPERATION key) to preset the instrument. Press S (Shift) AUDIO FREQ. Press AUDIO INPUT. The 1 kHz audio signal should be displayed on the oscilloscope with an amplitude between 2.6 and 3.0 Vpp. If faulty, perform ⟨√6⟩.

4. Set the synthesizer to 100 mVrms (into a high impedance) and set the frequency as shown in Table 8D-14. For each setting, the displayed frequency should be within the limits indicated. If faulty, see Service Sheet 16 and begin by checking the Counter Buffer and Schmitt Trigger.

Table 8D-14. *Displayed Frequency,* ⟨√7⟩ *Step 4*

Synthesizer Frequency (Hz)	Displayed Count (kHz)	
	Minimum	Maximum
1 000	0.99998	1.00002
20	0.0199800	0.0200200
250 000	249.997	250.003

SERVICE SHEET BD5

Blocks

- Digital
- Power Supply

Principles of Operation

General

The Digital and Power Supply Block Diagram documents the Controller, Counter, Keyboard and Display, Remote Interface (HP-IB), and the Power Supply.

Counter Assembly (A11)

The Counter consists of a 10 MHz Reference Oscillator, Time Base Dividers, Input Selector, four counter stages, and counter control circuits. The input to Stages 2 through 4 is selected by the Input Selector switch. When the LO frequency is counted, counter Stage 1 is enabled and fed into Stage 2. The input to Stage 1 is the High Frequency VCO signal divided by eight (HF VCO ÷8). When the Voltmeter or Audio Counter input is selected, the Selected 10 MHz Time Base Reference (from the Time Base Select Switch), gated by the Voltmeter/Audio Gate (the VOLTMETER/AUDIO line), is the input to Stage 2. Other signals which can be counted are the IF, the 10.1 MHz VCO of the FM Calibrator (the CALIBRATED FM 2 line), three 10 MHz Time Base References (Internal, External, or Selected), and the 455 kHz VCO from the IF Synchronous Detector (the 455 kHz VCO line). Counting of the Internal and External Time Base Reference is useful as a Counter self-check. Special Function 46 controls the Input Selector.

The Counter counts in binary. Stage 1 is a divide-by-eight, and Stages 2 through 4 are divide-by-sixteens. Additional stages of counting are contained in the Microprocessor (in A13), which counts the output carries from Stage 4 via the Counter Output and Time Base Gate.

At the end of a count sequence, the Time Base disables the Counter via the Counter Gate Control. The Counter Transfer Logic then transfers the count of the individual stages in parallel to the Controller (A13) via the Counter Output and Time Base Gate. First, the output from Stage 4 is transferred. Then the output from Stage 3 is loaded into Stage 4, and the output from Stage 4 is again transferred. The transfer process is again repeated with Stage 2 loading into Stage 4 via Stage 3, and transferring. Finally, Stage 1 is loaded into Stage 4 via Stages 2 and 3, and transferred. (The output from Stage 1 is used only when counting the LO frequency.)

To make a voltage measurement, the Voltage-to-Time Converter (in the A5 Voltmeter Assembly of Service Sheet BD4) generates a pulse whose time interval is proportional to its dc input voltage. During this time interval, the Counter counts the Selected 10 MHz Time Base Reference (via the VOLTMETER/AUDIO line). The count thus accumulated is proportional to the input voltage. The count is initiated when the Counter Gate Control enables the Input Selector and the Voltage-to-Time Converter (via the Ramp Gate). The Voltage-to-Time Converter then closes the Voltmeter/Audio Gate (via the Stop Count line) and the Selected Time Base Reference passes into Counter Stage 2. When the time interval ends, the Voltmeter/Audio Gate is opened. The Controller disables the Counter and transfers the accumulated count to the Controller.

The Audio Counter also makes use of the Stop Count line to control the counting of the Selected Time Base Reference during the count sequence. (See the discussion of the Audio Counter in Block Diagram BD4.)

The Selected Time Base Reference is either the standard 10 MHz Reference Oscillator, the Option 002 10 MHz High-Stability, Crystal Oscillator, or an external input from the rear-panel TIME BASE 10 MHz INPUT connector. For Option 002, the crystal from the 10 MHz Reference Oscillator is removed

and the oscillator's circuitry is driven by the High-Stability, Crystal Oscillator. In either case, when an external reference is applied, a detector senses the signal and throws the Time Base Select Switch to the external position. This switching is done in such a way as to minimize the interruption of the reference, since (after it is divided by five) it is also the Controller clock.

The Time Base Dividers divide the 10 MHz reference by 1600. During a frequency count, Controller synchronizes itself to the 6.25 kHz Time Base signal (via the Counter Output and Time Base Gate). Since the Controller controls the enable period of the Counter (via the Counter Gate Control), the Time Base signal ultimately determines the Counter accuracy. (The Counter is enabled for more than one period of the 6.25 kHz Time Base signal. The number of periods is counted by the Microprocessor via the Counter Output and Time Base Gate.)

Controller Assembly (A13) and Memory Assembly (A12)

The Controller consists of the Central Processing Unit (CPU), Static Memory Interface (SMI), Read-Only Memory (ROM), CPU External Register (or random-access memory, RAM), Memory Select Decoders, and input/output interface circuitry. The CPU and SMI form the Microprocessor. When the Controller interfaces with the HP-IB via the A14 Remote Interface Assembly, the Microprocessor also includes the Peripheral Input/Output (PIO in A14).

The Controller's program is stored in ROM. To retrieve information from ROM, the SMI, under control of the CPU, outputs the appropriate address on the Address Bus. Two of the sixteen address bits are decoded by the Memory Select Decoders to enable one of the ROMs. The fourteen other address bits address the individual ROMs. The enabled ROM then outputs eight bits of data onto the Data Bus from the location corresponding to the input address. ROM information may be either a program instruction or data. In a similar manner, temporary information is written to or read from RAM. The RAM is addressed by eight of the eleven address bits; it inputs or outputs eight data bits.

The RAM is non-volatile, that is, it is not erased when the instrument is powered down or unplugged. When either the +12V or +5V Power Supply voltage drops, the +12V and +5V Power Supply Drop Detector disables the RAM (which prevents data access for read or write operations), and the Battery supplies power to the RAM and associated circuits.

The CPU interprets bytes from the ROM as data or instructions depending on the context of the program. If the byte is an instruction, the outcome depends on the nature of the instruction. A simple instruction (such as add or shift) is executed immediately, and the instruction in the next address is fetched. More complex instructions fetch additional data or instructions from following addresses and, in the case of jumps and subroutine calls, cause program execution to move to another location in memory.

When a front-panel key is pressed, an interrupt is generated. The interrupt causes program execution to jump to a specified address where the interrupt service subroutine is located. The subroutine interrogates the Keyboard to determine which key was pressed and then takes the appropriate action. HP-IB codes and commands interrupt the Microprocessor in a similar way.

The CPU communicates with the SMI and PIO through the ROM Control (ROMC) lines and the Data Bus. The CPU manipulates data (arithmetic and logic computations) and contains the clocking and control circuitry. The clock is normally derived from the Counter's Time Base Reference; however, if the clock fails (to an open circuit) or if the Counter Assembly is unplugged, a clock (internal to the CPU) will continue to generate clock pulses. The SMI interfaces with the external ROM and RAM.

The CPU also contains bidirectional input/output (I/O) ports to communicate with the instrument's hardware via the Instrument Bus. Four I/O bits are reserved for servicing of the Controller. Four LEDs driven from the port indicate errors encountered during power-up verification tests, measurement cycles, and Keyboard and HP-IB interrupts. Four test points on the port can be used to initiate troubleshooting routines which use signature analysis. See *Controller Test LEDs and Test Points,* paragraph 8-10.

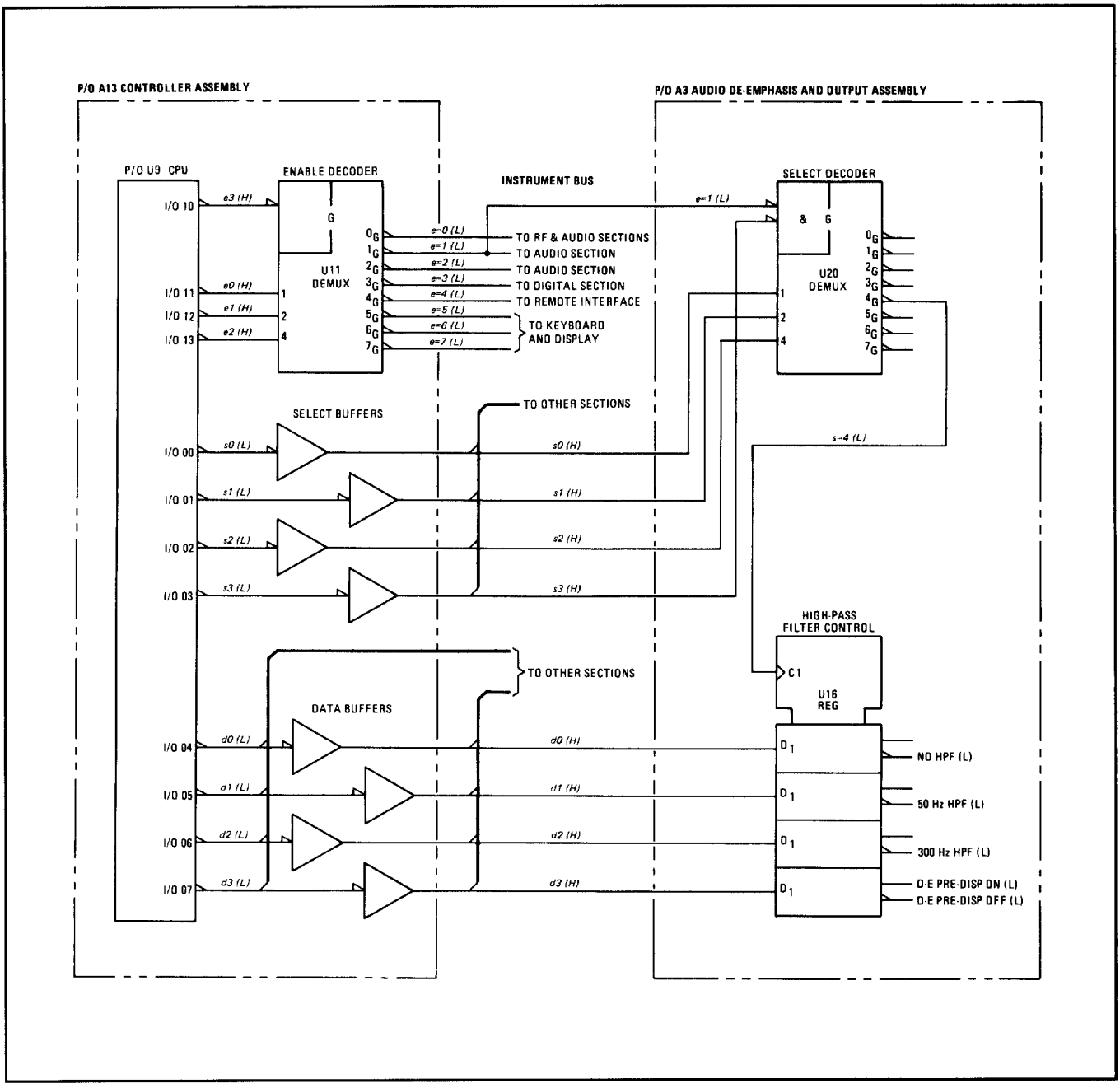


Figure 8D–7. *Example Showing Instrument Bus Hookup*

Instrument Bus

Figure 8D–7 shows a typical hookup on the Instrument Bus. The Instrument Bus lines are broken down into three groups: enable (e), select (s), and data (d). The enable code (*e*0 to *e*3) comes from I/O lines 10 through 13 of the CPU (A13U9).

Three of the enable lines (e0, e1, and e2) are decoded by the Enable Decoder (A13U11) to activate one of eight unique enable lines (e=0 to e=7). The fourth line (e3) enables the decoder itself. The enable lines run to various instrument sections. Typically, each line is dedicated to a specific section or operational function; for example, enable line e=1 controls audio-related functions in the Audio Section.

The select (s0 to s3) and data (d0 to d3) lines come from I/O ports 00 to 07. The eight lines run in parallel to all sections of the instrument where they are decoded on the assemblies. (In the RF Section one assembly, the A20 LO Control Assembly, decodes the Instrument Bus for the entire section.) Up to 16 data codes for each of the 16 select codes are possible for each active enable line. The select code typically selects a functional category on an assembly, and the data code selects the specific function or configuration. On a given assembly, the select codes are decoded only while the corresponding enable line is active. The data codes are, in turn, decoded and latched only when triggered by the decoded select line. The latched data drive the digital-to-analog devices which control the instrument hardware.

On the schematic diagrams the lines leaving the I/O ports of the CPU are labeled with a mnemonic such as s2(L) for I/O line 02. The "s" indicates a select code, "2" indicates that it is the third, least-significant bit of the undecoded select code, and "(L)" indicates that the line is true (1) when the logic level is low. All bit-position numbering begins with 0. The select codes go out on the Instrument Bus through Select Buffers, which are simple inverters. Thus s2(L) goes out on the bus as s2(H). Decoded codes are labeled as e=1(L) for example. The "e" indicates an enable code, "=" indicates decoding, "1" indicates a decoded hexadecimal 1 (binary 0001), and "(L)" indicates the logic level corresponding to a true. The mnemonic "e=1" corresponds to $e3e2e1e0 = 0001$. Data codes are also buffered. However, unbuffered data lines are also connected to the Instrument Bus for reading back data to the I/O ports.

Figure 8D-7 illustrates how the 50 Hz High-Pass Filter is selected. The filter (not shown) is activated when the output line of the High-Pass Filter Control (A3U16) labeled 50 Hz HPF(L) goes low. Register U16 is simply a latch; it does not decode the data. To activate the 50 Hz High-Pass Filter, the CPU sends out the binary enable code 0001 (hexadecimal 1), select code 0100 (hexadecimal 4), and data code 0010 (hexadecimal 2). The Enable Decoder activates the line e=1(L). The decoder was enabled because e3(H) was low. Since s3(H) is low, and since e=1(L) is also low, the Select Decoder (A3U20) is enabled. The three least-significant bits of the select code are decoded and activate the s=4(L) line out of the decoder. This line clocks the data into the High-Pass Filter Control latch. Since the d1(H) line is high, the 50 Hz HPF(L) line goes low. This selects the 50 Hz High-Pass Filter.

There is a direct relationship between the codes output on the Instrument Bus and the Direct Control Special Functions discussed in paragraph 8-7. The enable, select, and data codes, combined into a hexadecimal number "esd", create the Direct Control suffix. In the example used in the previous paragraph, the suffix is 142 (corresponding to Direct Control code 0.142). Instrument control can be visualized as a series of Direct Control Special Functions issued under program control.

The example above decoded only three of the four select code bits and used the data bits directly (or inverted them). Notice that if the code $esd = 147$ were issued, the through path (NO HPF), 50 Hz High-Pass Filter, 300 Hz High-Pass Filter, and De-emphasis Pre-Display On switches would all be activated. On some assemblies the data codes may be decoded and select codes above 7 may be used. On other assemblies certain select codes are used to enable readback devices which read back status or measurement data onto the unbuffered data lines. This is discussed in more detail in connection with Direct Control Special Functions in Service Aids.

Keyboard and Display Assembly (A1)

The Keyboard and Display Assembly is both an input peripheral and an output peripheral to the Controller. The pressing of a key is sensed by the Keystroke Detector. The detector interrupts the Microprocessor which then enters an interrupt service routine. The routine causes the key rows and columns to be scanned sequentially via the Key Row and Column Scanner to ascertain which key is down. This scan is accomplished by driving the rows in sequence with the select decoder and reading the state of the columns with the data-readback lines. If no key closure is found (due, perhaps, to key bounce), the scan repeats. If no key closure is found after 50 ms, the Microprocessor leaves the key-service routine and returns to the measurement being made prior to the key interrupt (starting at the beginning of the measurement cycle).

Lighting of the key and annunciator lights, display digits, and decimal points is by a straightforward decoding of the Instrument Bus. Note that the lights in the keys do not light as a direct result of a key closure. Instead the Microprocessor, having recognized a key closure, sends the command out on the Instrument Bus to light the key light.

Remote Interface Assembly (A14)

The Remote Interface Assembly interfaces the Controller with the Hewlett-Packard Interface Bus (HP-IB). It performs necessary handshake operations, interprets the HP-IB control lines, and is both an input and output peripheral to the Controller.

The Remote Interface Assembly consists of Handshake Logic, HP-IB Input/Output Transceivers, Interface Control Logic, Address Decoder, part of the Microprocessor, and Instrument Bus interface circuits.

As an input peripheral, the Remote Interface accepts a byte from the HP-IB data lines under control of the bus handshake lines. It then interprets the data byte and the bus-control lines to see if the byte is an address (talk or listen), a command, or a data byte. When a byte is processed, one of three things happens: (1) the byte is ignored, (2) the byte is processed in hardware (for example, some bus commands), or (3) the byte causes a Microprocessor interrupt (for example, codes received while addressed to listen). The Microprocessor treats an HP-IB interrupt as it would an interrupt from the Keyboard. However, the HP-IB interrupt service routine first checks whether the byte is a command (for example, Device Clear), address, or data (for example, "M1"). If the byte is an address or command, it is processed. If the byte is data, the routine first checks whether the instrument is in remote. If it is, the incoming byte is processed as program code. If not, the byte is ignored. After processing a byte, Microprocessor tells the Remote Interface what to do next (for example, input another byte, set a status latch, or prepare to output a byte).

As an output peripheral, the Remote Interface takes a byte of status or measurement data from the Microprocessor and processes it over the HP-IB. It does this only after determining that the Measuring Receiver has been addressed to talk. The require-service message (SRQ) is also output via the Remote Interface.

The Handshake Logic controls the asynchronous transfer of bytes over the HP-IB. The bytes are transferred without interrupting the Microprocessor in two cases: when the byte is data but the Measuring Receiver is not addressed to listen, or when the byte is not an interrupting bus command. The Handshake Logic also provides the means for the Microprocessor to complete the handshake if the byte is an interrupting type.

When the Measuring Receiver is accepting bytes, the Handshake Logic (1) monitors the Microprocessor and HP-IB and signals the HP-IB talker or bus controller when the Measuring Receiver is ready to receive, (2) tells the Microprocessor when valid data is on the HP-IB, and (3) tells the HP-IB talker when the Microprocessor has accepted the data. When the Measuring Receiver is outputting data or status bytes, the Handshake Logic (1) tells the Microprocessor when the HP-IB listener is ready to receive, (2) provides the Microprocessor with logic to tell the listener when data is valid, and (3) tells the Microprocessor when the listener has accepted data.

The HP-IB Input/Output transceiver acts as an HP-IB buffer and send/receive switch. It is controlled by the Interface Control Logic.

The Interface Control Logic, together with the Address Decoder, determines the talk or listen status of the interface and whether or not the Microprocessor should be interrupted. The ROM in the Interface Control Logic is addressed by two of the HP-IB data lines, the Address Decoder, and one of the HP-IB control lines (Attention, ATN). The ROM contains the control information for the Interface Control Logic and the Microprocessor.

If the Measuring Receiver's listen address is recognized by the Address Decoder, the Microprocessor attempts to set the Remote Enable Flip-Flop. If the HP-IB Remote Enable (REN) control line is true, the flip-flop is set (if not already set), and the Microprocessor sets a status bit in memory. Each time the Microprocessor performs any remote-dependent operation, it checks both the status bit and the flip-flop output (Remote Enable Latch, RNL). Both must be set for the instrument to remain in remote. If REN goes false at any time, the Remote Enable Flip-Flop is cleared, and the instrument is no longer in remote.

The Address Decoder compares the address set by the Address Switches with the five least-significant I/O bytes to determine if the instrument is being addressed. The Interface Control Logic looks at the

output of the Address Decoder and the next two input bits to determine if it is a talk or listen address and if the instrument should respond to it. The result of this determination modifies the address to the ROM in the Interface Control Logic.

The Address Readback outputs the address from the Address Switches to the Instrument Bus data lines when Special Function 21 (HP-IB Address) is selected. The Controller reads the HP-IB address from the Address Switches. (See *HP-IB Address* in the *Detailed Operating Instructions* in the *Operation and Calibration Manual.*)

The HP-IB input/output is directly handled by a portion of the Microprocessor that resides in the Remote Interface Assembly—the Peripheral Input/Output (PIO). The PIO is a device that routes the HP-IB data to and from the CPU and the HP-IB. It provides a communication link between the CPU and the Remote Interface hardware, and provides the means for interrupting the CPU. One of the two, eight-bit PIO output ports connects to the HP-IB data lines. The other output port connects to the Handshake Logic and Interface Control Logic.

NOTE

For purposes of troubleshooting the Controller, the Remote Interface Assembly may be unplugged. Provision has been made to allow the instrument to work with only the loss of HP-IB operation.

Although the Remote Interface Assembly receives data and operating information from the PIO, it is primarily through the Instrument Bus that it is controlled. (Commands such as SRQ that need rapid processing come from the PIO.) A Select Decoder decodes the select lines when enabled by code e=4. The decoded select lines enable or disable parts of the Remote Interface Assembly. Special Function 61 provides a means of reading back HP-IB status information to the front-panel display.

Power Supply Assemblies (A10 and A26)

The five regulated power supplies are: +15V, −15V, +40V, +5V, and −5V. Each supply has its own secondary winding on the Line Transformer and all supplies except the +40V Supply have their own full-wave rectifier. The latter four supplies are referenced from the +15V supply. Each supply is a series regulator type. When the instrument is switched to STBY, the +15V supply remains on and supplies current only to the High-Stability, Crystal Oscillator (Option 002). In STBY, the other supplies become referenced to 0V and thereby shut themselves off. The supply switching is via the ON/STBY Relay. The fan is also switched by the relay.

TROUBLESHOOTING

General

Procedures for checking the Digital and Power Supply Sections of the instrument are given below. The blocks or points to check are marked on the block diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩ . Before performing any check, perform all the checks on Service Sheet BD1.

CAUTION

Tighten SMC connectors to 0.6 N·m (5 in·lb). Hand tightening connectors is insufficient. Hand-tightened connectors can work loose and cause reduced performance or malfunctions.

Equipment

Digital Test/Extender Board	HP 08901-60081
Oscilloscope	HP 1740A
Signature Analyzer	HP 5005A
Voltmeter	HP 3455A

⟨√1⟩ Time Base Reference Check

1. Disconnect any input to the rear-panel TIME BASE 10 MHz INPUT.
2. Connect high-impedance, dc coupled oscilloscope to A11J5 (INT 10 MHZ OUT). The waveform should be a TTL square wave with a period of 100 ns. If faulty, see Service Sheet 22 and check the 10 MHz Time Base Reference Oscillator.
3. Check A11TP4 (TB) with an oscilloscope. The waveform should be TTL pulses with a period of 160 μs. If faulty, see Service Sheet 22 and check the Time Base Divider.

⟨√2⟩ Counter Check

NOTE

This check assumes that the ⟨√1⟩ Time Base Reference Check give positive results. For Option 002, disconnecting the cable from the time base reference halts the Controller.

1. Connect a jumper cable between A11J5 (INT 10 MHZ OUT) and A11J1 (÷8 IN). Key in 46.4 SPCL. This switches the Counter to measure the HF VCO divided by 8. The display should read 1000000±1. If faulty, see Service Sheet 23.
2. Disconnect the jumper from A11J1 and connect it to A11J3 (IF IN). Key in 46.1 SPCL. This switches the Counter to measure the IF. The display should read 1000000±1. If faulty, see Service Sheet 23 and check the Input Selector.
3. Disconnect the jumper from A11J3 and connect it to A11J2 (10 MHZ IN). Key in 46.3 SPCL. This switches the Counter to measure the output of the FM Calibrator. The display should read 1000000±1. If faulty, see Service Sheet 23 and check the Input Selector.
4. Remove the jumper cable. Short A11TP1 (GND) to A11TP6 (VM GATE). Key in 46.1 SPCL. This switches the Counter to measure the 10 MHz time base reference via the Voltage-to-Time Converter input. The display should read 1000000±1. If faulty, see Service Sheet 23 and check the Input Selector and Voltmeter Gate logic.

⟨√3⟩ Controller Kernel Check

CAUTION

MOS and CMOS ICs can be damaged by static charges and circuit transients. Do not remove the A13 Controller Assembly or the A14 Remote Interface Assembly from the instrument while power is applied. Discharge the board and replacement IC to the same potential. (Use a conductive foam pad such as provided in the Service Accessory Kit HP 08901-60089.) When unplugging ICs, place the board on a conductive pad. When the IC is unplugged, insert it into the foam also.

A13 also contains a soldered-in battery. To prevent shorting out the battery, do not lay the board on a metal surface.

Several ICs on these assemblies are held in high-grip sockets. Both the socket and the device can be damaged if an attempt is made to remove the device with an IC extraction tool. The recommended procedure is to first ground the tip of a small blade-type screwdriver, then slide the tip between the IC and the socket and slowly pry up the IC one pair of pins at a time.

1. Switch POWER to STBY. Extend the A13 Controller Assembly with the Digital Test/Extender Board. Switch POWER to ON.
2. Check A13TP12 (+12V) with dc voltmeter. The voltage should be between +11.4 and +12.6 Vdc. If faulty, see Service Sheet 24 and check the +12V Regulator.
3. Short A13TP9 (RESET) to A13TP10 (+5V). This resets the Controller and forces a short write (instruction) cycle. Connect a high-impedance, dc coupled oscilloscope to A13TP4 (WRT) or the WRT test point on the extender board. The waveform should be TTL pulses with a period of 2 μs. If faulty, see Service Sheet 24 and check the clock and Φ lines and the Power-On Reset circuit.
4. Set the ROMC switches on extender board to GND. This forces the SMI to step through its addresses. On the extender board, connect the signature analyzer clipleads as follows:

   Clock ..... WRT
   Start ..... ADDRESS 15
   Stop ..... ADDRESS 15
   Ground ..... GND

5. Set the signature analyzer's start, stop, and clock to trigger as follows:

   Start ..... Falling Edge
   Stop ..... Falling Edge
   Clock ..... Rising Edge

6. Check the test points on the extender board with the signature analyzer probe as listed in Table 8D-15. If all signatures are bad except GND, see Service Sheet 24 and replace the SMI. If only one ADDRESS line is faulty, see Service Sheet 24 and check the SMI and the address line.
7. Check the RAM WRT and CPU READ test points on the extender board with an oscilloscope. RAM WRT should be a TTL high, CPU READ should be a TTL square wave with a period of 2 μs. If faulty, see Service Sheet 24 and check the SMI and the load on the first two lines.
8. Switch POWER to STBY. Remove A13U1 (CPU External Register or RAM) from its socket.

Table 8D–15. *Address Line Signatures,* ⟨√3⟩ *Step 6*

Test Point	Signature	Test Point	Signature
+5V*	0001	ADDRESS 8	HC89
GND	0000	ADDRESS 7	52F8
ADDRESS 15	755U	ADDRESS 6	UPFH
ADDRESS 14	3827	ADDRESS 5	0AFA
ADDRESS 13	3C96	ADDRESS 4	5H21
ADDRESS 12	HAP7	ADDRESS 3	7F7F
ADDRESS 11	1293	ADDRESS 2	CCCC
ADDRESS 10	HPP0	ADDRESS 1	5555
ADDRESS 9	2H70	ADDRESS 0	UUUU
* Test point on Controller Assembly A13TP10 (+5V).			

9. Switch POWER to ON. Check the CONTROL BUS test points on the extender board with the signature analyzer probe as listed in Tables 8-16a through 8-16f. If signatures are faulty, see Service Sheet 24 and check the Decoders and ROMs.

NOTE

The signatures below are valid only for the firmware with the specified ROM part numbers. Consult Section 7, Instrument Changes, *or the* Manual Changes Packet *for signatures corresponding to other firmware part numbers.*

Table 8D–16a. *Data Line Signatures,* ⟨√3⟩ *Step 9* ***(2305A to 2331A)***

Test Point	Signature*	Test Point	Signature*
DATA 0	Replace with latest parts.	DATA 4	Replace with latest parts.
DATA 1		DATA 5	
DATA 2		DATA 6	
DATA 3		DATA 7	

*Valid ROM part numbers:	ROM Number	Part Number
	1	08901-80062
	2	08901-80063
	3	08901-80064

Table 8D–16b. *Data Line Signatures,* ⟨√3⟩ *Step 9* ***(2337A to 2449A)***

Test Point	Signature*	Test Point	Signature*
DATA 0	4F0C	DATA 4	3FH0
DATA 1	2C60	DATA 5	48FC
DATA 2	10H0	DATA 6	9H29
DATA 3	C14U	DATA 7	89CU

*Valid ROM part numbers:	ROM Number	Part Number
	1	08901-80066
	2	08901-80067
	3	08901-80068

Table 8D–16c. *Data Line Signatures,* ⟨√3⟩ *Step 9* ***(2451A to 2515A)***

Test Point	Signature*	Test Point	Signature*
DATA 0	AA89	DATA 4	43HA
DATA 1	P326	DATA 5	H133
DATA 2	F2CC	DATA 6	2H0U
DATA 3	8A55	DATA 7	5A6A

*Valid ROM part numbers:

ROM Number	Part Number
1	08901-80071
2	08901-80072
3	08901-80073

Table 8D–16d. *Data Line Signatures,* ⟨√3⟩ *Step 9* ***(2519A to 2523A)***

Test Point	Signature*	Test Point	Signature*
DATA 0	04C0	DATA 4	8344
DATA 1	H656	DATA 5	F017
DATA 2	UA85	DATA 6	60H7
DATA 3	A0U6	DATA 7	5U3F

*Valid ROM part numbers:

ROM Number	Part Number
1	08901-80076
2	08901-80077
3	08901-80078

Table 8D–16e. *Data Line Signatures,* ⟨√3⟩ *Step 9* ***(2528A and 2546A)***

Test Point	Signature*	Test Point	Signature*
DATA 0	4454	DATA 4	HC6U
DATA 1	P20F	DATA 5	1862
DATA 2	UCHA	DATA 6	8066
DATA 3	H5PF	DATA 7	8A44

*Valid ROM part numbers:

ROM Number	Part Number
1	08901-80084
2	08901-80077
3	08901-80078

Table 8D–16f. *Data Line Signatures,* ⟨√3⟩ *Step 9* ***(2550A to 2706A)***

Test Point	Signature*	Test Point	Signature*
DATA 0	00C2	DATA 4	4742
DATA 1	9904	DATA 5	U1UH
DATA 2	0731	DATA 6	U02U
DATA 3	CC13	DATA 7	82UF

*Valid ROM part numbers:

ROM Number	Part Number
1	08901-80081
2	08901-80082
3	08901-80083

Table 8D–16g. *Data Line Signatures,* ◇3◇ *Step 9* ***(2717A and Above)***

Test Point	Signature*	Test Point	Signature*
DATA 0	AU23	DATA 4	7A46
DATA 1	F8A4	DATA 5	H187
DATA 2	56H1	DATA 6	252P
DATA 3	F364	DATA 7	4FU3

*Valid ROM part numbers:

ROM Number	Part Number
1	08901-80105
2	08901-80106
3	08902-80107

⟨√4⟩ CPU External Register (RAM) Check

1. Perform the Power-Up Checks on Service Sheet BD1.

⟨√5⟩ CPU I/O Port Check

1. If the Digital Test/Extender Boards is not already extending A12 or A13, plug it into the empty slot in the Digital Section.

NOTE

Check that the ROMC switches on the extender board are in the OPEN position.

2. Key in 0.2 SPCL. Check the INSTRUMENT BUS test points on the extender board with an oscilloscope or signature analyzer probe (used as a logic probe) as listed in Table 8D-17. If faulty, see Service Sheet 24 and check the CPU and I/O port decoders and buffers.

Table 8D-17. *Instrument Bus Data, ⟨√4⟩ Step 2*

Test Point	Measured Signal
ENABLE 2	Low-Going TTL Pulses, Period ≈60 ms
SELECT 0 to 3	TTL Low
DATA (H) 0 to 3	TTL Low
DATA (L) 0 to 3	TTL High

3. Key in 0.2 S (Shift) 5 S 5 SPCL. Recheck the test points listed in Table 8D-18. If faulty, see Service Sheet 24 and check the CPU and I/O port decoders and buffers.

Table 8D-18. *Instrument Bus Data, ⟨√4⟩ Step 3*

Test Point	Measured Signal
SELECT 0 to 3	TTL High
DATA (H) 0 to 3	TTL High
DATA (L) 0 to 3	TTL Low

4. Key in the Special Functions listed in Table 8D-19. For each entry, the indicated ENABLE test point on the extender board should show low-going TTL pulses with a period of approximately 60 ms. All other ENABLE test points should be TTL highs. If faulty, see Service Sheet 24 and check the Enable Decoder and CPU.

Table 8D-19. *Instrument Bus Data, ⟨√4⟩ Step 4*

Special Function	Test Point
0.0	ENABLE 0
0.1	ENABLE 1
0.3	ENABLE 3
0.4	ENABLE 4
0.5	ENABLE 5
0.6	ENABLE 6
0.7	ENABLE 7

⟨√6⟩ Keyboard Key Check

1. Key in 60.0 SPCL. As the Special Function code is entered, 60.0 should appear in the display. This indicates that the Controller responds to keyboard interrupts. If faulty, see ⟨√7⟩ and ⟨√8⟩. While the SPCL key is down, 35 should appear in the display. After releasing the SPCL key, 99 should appear in the display. If another number appears, continue on.
2. Jumper A13TP3 (INT) to A13TP15 (GND). This defeats the keyboard interrupt.
3. Press the keys one at a time and compare the display with the key codes shown in Figure 8D-8. If a code other than 99 appears in the display with no key pressed, the key corresponding to the displayed key code is probably stuck down; see Service Sheet 25. If a wrong code appears for one or more keys, check the corresponding key and decoder; see Service Sheet 25.

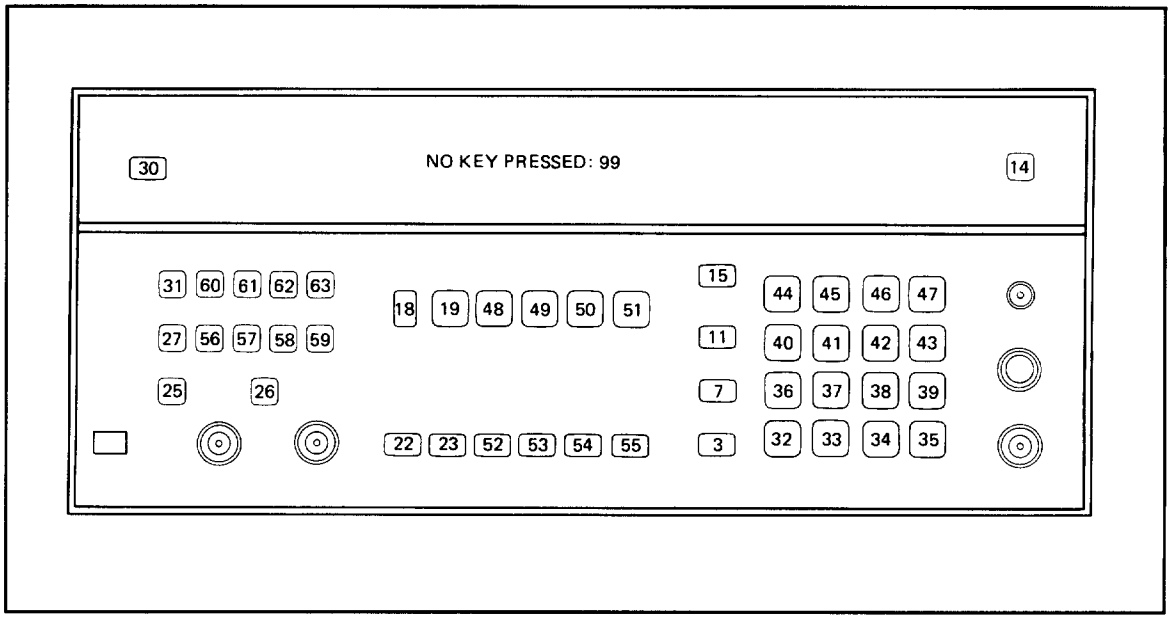


Figure 8D-8. *Key Codes for Key Scan*

⟨√7⟩ Keyboard Interrupt Check

1. Connect high-impedance, dc coupled oscilloscope to A13TP3 (INT). The voltage should read a TTL high. Pressing any key should result in a TTL low which should remain low for 40 to 60 ms after the key is released. If faulty, see Service Sheet 25 and check the Keystroke Detector.

⟨√8⟩ Front-Panel LED Check

1. Perform the Front-Panel LED Check on Service Sheets 26 and 27.

⟨√9⟩ HP-IB Check

1. See Service Sheet 28.

⟨√10⟩ Nonvolatile Memory Backup Check

1. Measure A13TP13 (BATT) with a dc voltmeter. The voltages should be between 2.7 and 2.9 Vdc. Repeat the measurement with POWER set to STBY. The voltage should not change. If faulty, see Service Sheet 24 and check the Nonvolatile Memory Supply.

   Hint: The switching point between the normal and backup memory is adjustable. See *Adjustment 22—Battery Backup* in Section 5.

⟨√11⟩ Power Supply Check

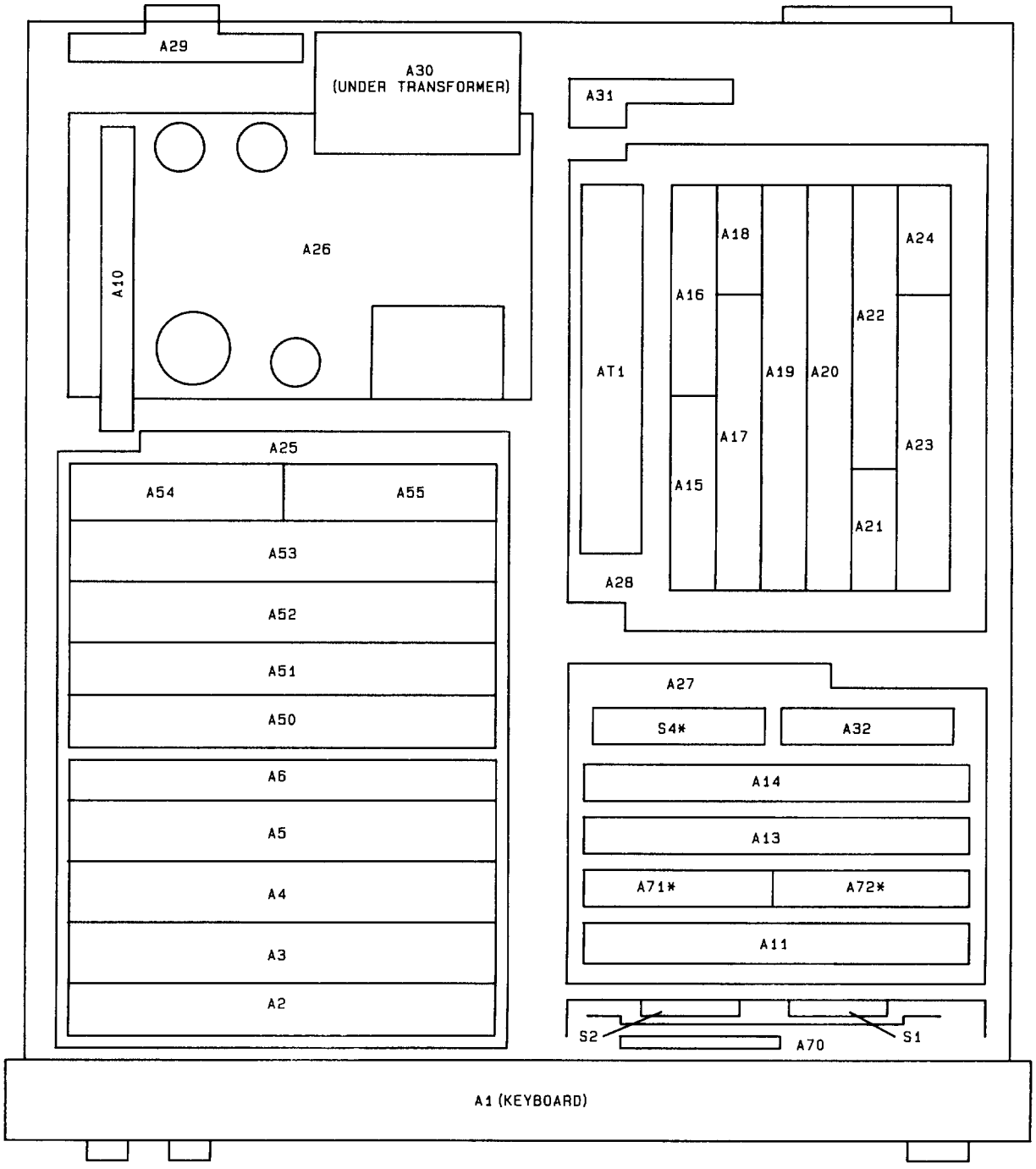
1. Check test points A10TP2 through TP7 with a dc voltmeter. The voltages should be within the limits shown on Block Diagram 5. If a short on the supply is suspected, continue with step 2. If a regulator is suspected, see Service Sheets 31 and 32.

NOTE

The supplies are interdependent. Often a short on one supply will shut down another. All supplies are dependent on the +15V Supply.

The switched +15V Supply line is normally grounded when the instrument is in standby. The +15V Supply (unswitched) LED should remain lighted when the POWER is set to STBY.

2. Remove the plugs connected to A26J6 (RF SECTION), A26J3 (DIGITAL SECTION), and A26J2 (AUDIO SECTION) one at a time and observe the five power supply LEDs. (The plugs are located on the circuit side of the A26 Power Supply Motherboard.) An extinguished LED will light when the short is removed from the supply. The assemblies in the faulty section can then be removed one at a time until the one with the short is discovered.
3. Remove the plug connected to A26J1 (KEYBOARD). (This plug is on the component side.) Jumper pins 2 and 6 of A26J1 (where the green and black wires of W13 normally connect) to turn the instrument on. If the short is on the A1 Keyboard and Display Assembly, the extinguished LED will light. If the short still persists, see Service Sheets 31 and 32 and check the faulty regulator.



*Option 030 assemblies only available for instruments with serial number prefixes 2535A and above.

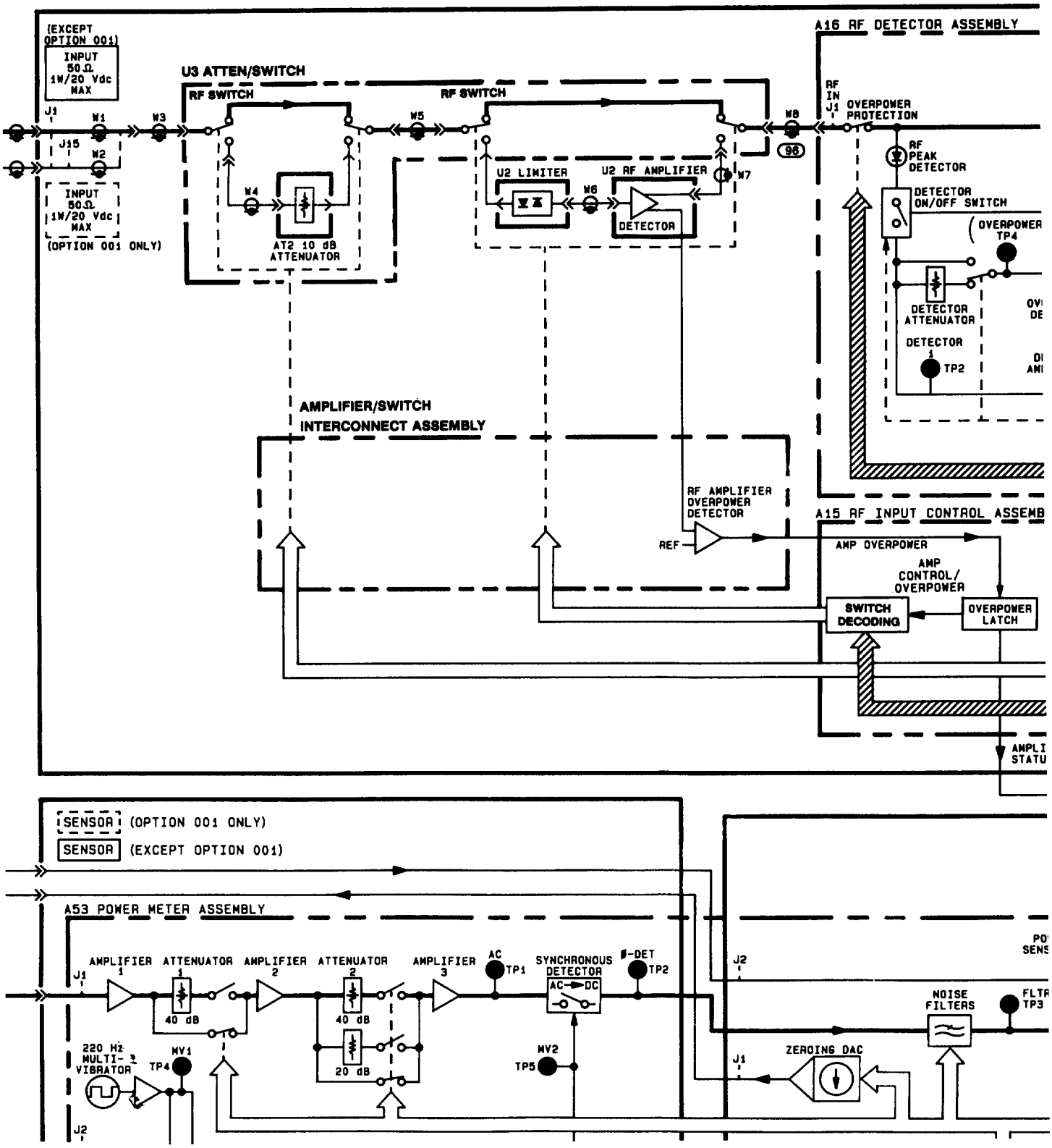
Block Diagram Assembly Locations

CHANGES

Serial Prefix 2704A

On the schematic:

- Replace the appropriate portion of the block diagram with the partial on page 8E-4.3.



CHANGES TO FIGURE 8E-5 (2704A AND ABOVE)

BD 2

CHANGES

2413A and above

On the block diagram:

- W9 - In the lower, right portion of the block diagram, change the OPTION 001 ONLY cable from W9 to W53.

CHANGES

All serial prefixes	On the Component Locator: • BD3 callout X - In the upper left hand corner of the schematic, change BD3 callout X to BD4 callout X.