HP 8903B
AUDIO ANALYZER
(Including Option 001)

Service Manual

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed:

2450A to 2948A and all *MAJOR* changes that apply to your instrument.

rev.20JUN91

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

Fifth Edition

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Service Manual (Volume 1, 2) HP Part 08903-90062

Other Documents Available:
Operation and Calibration Manual (Volume 1) HP Part 08903-90079
Microfiche Operation and Calibration and Service Manual HP Part 08903-90080

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08903-90062 Volume 1

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Sincerely,

Rebranding Team

1 Regulatory Information

(Updated March 1999)

Safety Considerations

GENERAL

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

This product has been designed and tested in accordance with *IEC Publication 1010*, "Safety Requirements for Electronic Measuring Apparatus," and has been supplied in a safe condition. This instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

SAFETY EARTH GROUND

A 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

Indicates instrument damage can occur if indicated operating limits are exceeded.

Indicates hazardous voltages.

Indicates earth (ground) terminal

WARNING	**A WARNING note 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	A CAUTION note denotes a hazard. It calls attention to an operation 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 an CAUTION note until the indicated conditions are fully understood and met.

Safety Considerations for this Instrument

WARNING **This product is a Safety Class I instrument (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.**

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 auto transformer (for voltage reduction), make sure the common terminal is connected to the earth terminal of the power source.

If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.

No operator serviceable parts in this product. Refer servicing to qualified personnel. To prevent electrical shock, do not remove covers.

Servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.

The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the product from all voltage sources while it is being opened.

The power cord is connected to internal capacitors that my remain live for 5 seconds after disconnecting the plug from its power supply.

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

Always use the three-prong ac power cord supplied with this product. Failure to ensure adequate earth grounding by not using this cord may cause product damage.

This product is designed for use in Installation Category II and Pollution Degree 2 per *IEC 1010* and *IEC 664* respectively. FOR INDOOR USE ONLY.

This product has autoranging line voltage input, be sure the supply voltage is within the specified range.

To prevent electrical shock, disconnect instrument from mains (line) before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

Ventilation Requirements: When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4° C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, then forced convection must be used.

Product Markings

CE - the CE mark is a registered trademark of the European Community. A CE mark accompanied by a year indicated the year the design was proven.

CSA - the CSA mark is a registered trademark of the Canadian Standards Association.

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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 resulting 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.

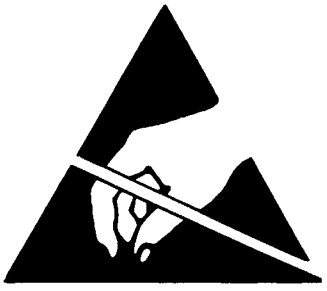
If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.

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 may 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 os 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 (electro-static discharge) protected environment. This is because most of the semi-conductor 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 of 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.

Section 6
REPLACEABLE PARTS

6-1. INTRODUCTION

This section contains information for ordering parts. Table 6-1 lists reference designations, and Table 6-2 lists abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-4 contains the names and addresses that correspond to the manufacturer's code numbers.

6-2. ABBREVIATIONS

Table 6-2 lists abbreviations used in the parts list, schematics, and throughout the manual. In some cases, two forms of the abbreviation are used, one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms are used with both lower case and upper case letters.

6-3. REPLACEABLE PARTS LIST

Table 6-3 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alphanumeric order by reference designation.

b. Chassis-mounted parts in alphanumeric order by reference designation.

c. Mechanical parts.

The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. Part number check digit (CD).

c. The total quantity (Qty) for the entire instrument except for option assemblies. (See following note.)

d. The description of the part.

e. A typical manufacturer of the part in a five-digit code.

f. The manufacturer's number for the part.

NOTE

The total quantity for each part is given only once, that is, at the first occurrence of the part number in the list. The total quantities for optional assemblies are totalled by assembly and not integrated into the standard list.

6-4. FACTORY SELECTED PARTS (*)

Parts marked with an asterisk (*) are factory selected parts. The value listed in the parts list is the nominal value. Refer to Sections 5 and 8 of this manual for information on determining what value to use for replacement.

6-5. PARTS LIST UPDATING (MANUAL UPDATES)

Production changes to the Audio Analyzer made after the publication date of this manual are accompanied by a change in the serial number prefix. Changes to the parts list are recorded by serial number prefix on an addition or replacement page(s). The MANUAL UPDATE pages can be ordered by filling out and returning the DOCUMENTATION UPDATE SERVICE REQUEST reply card found in the beginning of this service manual.

6-6. ILLUSTRATED PARTS BREAKDOWNS

Most mechanical parts are identified in Figure 6-1 through 6-5. These figures are located at the end of the replaceable parts table.

6-7. ORDERING INFORMATION

To order a part listed in the replaceable parts table, include the Hewlett-Packard part number (with the check digit) and the quantity required. Address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, description and function of the part, and the quantity of parts required. Address the order to the nearest Hewlett-Packard office.

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 Mail Order System".

6-8. 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. A complimentary copy of the "Recommended Spares" list may be requested from your nearest Hewlett-Packard office.

When stocking parts to support more than one Audio Analyzer 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						
2450A TO 2730A						
A1	08903-60166	9	1	KEYBOARD AND DISPLAY ASSEMBLY	28480	08903-60166
2724A AND ABOVE						
A1	08903-60193	2	1	KEYBOARD AND DISPLAY ASSEMBLY	28480	08903-60193
A1C1	0180-0229	7	1	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A1C2	0160-2055	9	4	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C3	0160-2291	5	1	CAPACITOR-FXD .18UF +-10% 80VDC POLYE	28480	0160-2291
A1C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
C1C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A1DS1	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS2	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS3	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS4	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS5	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS6	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS7	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS8	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS9	1990-0719	8	2	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
	0380-1231	7	2	SPACER-RND .365-IN-LG .12-IN-ID	00000	ORDER BY DESCRIPTION
A1DS10	1990-0719	8		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	HLMP-1301
	0380-1231	7		SPACER RND .365-IN-LG .12-IN-ID	00000	ORDER BY DESCRIPTION
A1DS11	1990-0618	6	6	LED-LAMP LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
	0340-1196	5	6	MOUNT-L.E.D. 0.120 +-.005 IN ID; 0.187	28480	0340-1196
A1DS12	1990-0618	6		LED-LAMP LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
	0340-1196	5		MOUNT-L.E.D. 0.120 +-.005 IN ID; 0.187	28480	0340-1196
A1DS13	1990-0618	6		LED-LAMP LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
	0340-1196	5		MOUNT-L.E.D. 0.120 +-.005 IN ID; 0.187	28480	0340-1196
A1DS14	1990-0618	6		LED-LAMP LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
A1DS15	1990-0618	6		LED-LAMP LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
	0340-1196	5		MOUNT-L.E.D. 0.120 +-.005 IN ID; 0.187	28480	0340-1196
A1DS16	1990-0618	6		LED-LAMP LUM-INT=800UCD IF=20MA-MAX	28480	HLMP-0301
	0340-1196	5		MOUNT-L.E.D. 0.120 +-.005 IN ID; 0.187	28480	0340-1196
A1DS17	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS18	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
A1DS19	1990-0719	8	14	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	1990-0719
2450A TO 2730A						
A1DS20				NOT ASSIGNED		
2724A AND ABOVE						
A1DS20	1990-0719	8		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	24840	1990-0719
	0380-1231	7	3	SPACER-RND .365-IN-LG .12-IN-ID	00000	ORDER BY DESCRIPTION
A1J1	1251-4736	1	1	CONNECTOR 26-PIN M RECTANGULAR	28480	1251-4736
A1MP1	5041-0319	7	6	KEY HALF GY-LIT	28480	5041-0319
A1MP2	5041-1832	1	1	KEY HALF HZ/MV	28480	5041-1832
A1MP3	5041-0319	7		KEY HALF GY-LIT	28480	5041-0319
A1MP4	5041-0385	7	3	KEY/HALF SMK GY	28480	5041-0385
A1MP5	5041-1839	8	1	KEY HALF AMPTD	28480	5041-1839
A1MP6	5041-0817	0	1	KEY/HALF SK/GY 7	28480	5041-0817
A1MP7	5041-0813	6	1	KEY/HALF SK/GY 3	28480	5041-0813
A1MP8	5041-1665	8	1	KEY/QUARTER LCL	28480	5041-1665
A1MP9	5041-1842	3	1	K/H PLOT LIMIT	28480	5041-1842
A1MP10	5041-1831	0	1	KEY HALF KHZ/V	28480	5041-1831

†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
A1MP11	5041-0319	7		KEY HALF GY-LIT	28480	5041-0319
A1MP12	5041-0319	7		KEY HALF GY-LIT	28480	5041-0319
A1MP13	5041-1838	7	1	KEY HALF FREQ	28480	5041-1838
A1MP14	5041-0816	9	2	KEY/HALF SK/GY 6	28480	5041-0816
A1MP15	5041-0812	5	1	KEY/HALF SK/GY 2	28480	5041-0812
A1MP16	5041-0408	5	1	KEY/QTR EB/BLK	28480	5041-0408
A1MP17	5041-1840	1	1	K/H FREQ/INCR	28480	5041-1840
A1MP18	5041-1837	6	1	K/H STOP/FREQ	28480	5041-1837
A1MP19	5041-0319	7		KEY HALF GY-LIT	28480	5041-0319
A1MP20	5041-0385	7		KEY/HALF SMK GY	28480	5041-0385
A1MP21	5041-0816	9		KEY/HALF SK/GY 6	28480	5041-0816
A1MP22	5041-0815	8	1	KEY/HALF SK/GY 5	28480	5041-0815
A1MP23	5041-0811	4	1	KEY/HALF SK/GY 1	28480	5041-0811
A1MP24	5041-0417	6	1	KEY/QTR BLK S/LT	28480	5041-0417
A1MP25	5041-1641	0	1	KEY HALF DIV GY	28480	5041-1641
A1MP26	5041-1836	5	1	K/H START/FREQ	28480	5041-1836
A1MP27	5041-0319	7		KEY HALF GY-LIT	28480	5041-0319
A1MP28	5041-0385	7		KEY/HALF SMK GY	28480	5041-0385
A1MP29	5041-0818	1	1	KEY/HALF SK/GY 8	28480	5041-0818
A1MP30	5041-0814	7	1	KEY/HALF SK/GY 4	28480	5041-0814
A1MP31	5041-0819	2	1	KEY/HALF SK/GY 0	28480	5041-0819
A1MP32	5041-1640	9	1	KEY HALF X10 GY	28480	5041-1640
A1MP33	5041-0808	9	1	KEY/HALF GY DOT	28480	5041-0808
A1MP34	5041-1841	2	1	K/H AMPTD/INCR	28480	5041-1841
A1MP35	5041-1834	3	1	KEY HALF CLEAR	28480	5041-1834
A1MP36	5041-1843	4	2	K/H ARROW	28480	5041-1843
A1MP37	5041-1835	4	1	KEY HALF	28480	5041-1835
A1MP38	5041-0286	7	1	KEY HALF GY LIT	28480	5041-0286
A1MP39	5041-1843	4		K/H ARROW	28480	5041-1843
A1MP40	5041-0508	6	1	KEY/HALF GR	28480	5041-0508
A1MP41	5041-0319	7	1	KEY CAP-HALF GRAY-LIT	28480	5041-0319
A1R1	1810-0402	6	11	NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R2	1810-0205	7	1	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A1R3	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A1R4	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A1R5	1810-0207	9	1	NETWORK-RES 8-SIP22.0K OHM X 7	01121	208A223
A1R6	1810-0208	0	1	NETWORK-RES 8-SIP68.0K OHM X 7	01121	208A683
A1R7	0757-0461	2	2	RESISTOR 68.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6812-F
A1R8	0698-0082	7	1	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-464R-F
A1R9	0698-3453	2	1	RESISTOR 196K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1963-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	1	RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A1R12	0757-0438	3	1	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A1R13	0698-3445	2	4	RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A1R14	0698-3445	2		RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A1R15	0698-3445	2		RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A1R16	0698-3445	2		RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A1R17	1810-0229	5	1	NETWORK-RES 8-SIP330.0 OHM X 7	01121	208A331
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

†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
A1R22	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R23	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R24	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R25	1810-0402	6		NETWORK RES 16-DIP330.0 OHM X 8	01121	316B331
A1R26	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R27	1810-0402	6		NETWORK-RES 16-DIP330.0 OHM X 8	01121	316B331
A1R28	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
2450A TO 2730A A1R29				NOT ASSIGNED		
2724A AND ABOVE A1R29	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	0698-3444
A1S1-A1S41	5060-9436	7	41	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
A1U1	1820-1729	3	13	IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U2	1990-0753	0	10	DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0	10	SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U3	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U4	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U5	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U6	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U7	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U8	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED (Refer to Note 1 on page 8D-114.1 for the correct orientation of A1U8)	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U9	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U10	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U11	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U12	1990-0753	0		DISPLAY-NUM-SEG 10-CHAR .43-H RED	28480	1990-0753
	1200-1027	0		SOCKET-DSPL 14-CONT DIP DIP-SLDR	28480	1200-1027
A1U13	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U14	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U15	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U16	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U17	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U18	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U19	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U20	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U21	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A1U22	1826-0412	1	1	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A1U23	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A1U24	1820-1417	6	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A1U25	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
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	1820-1216	3	2	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U29	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A1U30	1820-1427	8	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS156N

†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	08903-60170	5	1	INPUT AMPLIFIER ASSEMBLY (INCLUDES A2W3 AND A2W4, DOES NOT INCLUDE A2A1 OR A2A2)	28480	08903-60170
A2	08903-69170	3	1	INPUT AMPLIFIER ASSEMBLY (RESTORED)	28480	08903-69170
A2C1	0180-2195	0	2	CAPACITOR-FXD 15UF +-10% 35VDC TA	56289	150D156X9035R2
A2C2	0160-6370	9	2	C MPE 1.5U 600V	28480	0160-6370
A2C3	0121-0422	8	4	CAPACITOR-V TRMR-PSTN .8-4.5PF 1250V	18736	TP5G
	0340-0669	9	4	INSULATOR-XSTR SLBL-ORG-POLYM	28480	0340-0669
A2C4	0160-2265	3		CAPACITOR-FXD 22PF +-5% 500VDC CER 0+-30	28480	0160-2265
A2C5	0160-4832	4	58	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C6	0160-4786	7	5	CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A2C7	0160 2237	9	2	CAPACITOR-FXD 1.2PF +-.25PF 500VDC CER	28480	0160-2237
A2C8	0160-4801	7	7	CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A2C10	0121-0422	8		CAPACITOR-V TRMR-PSTN .8-4.5PF 1250V	18736	TP5G
	0340-0669	9		INSULATOR-XSTR SLBL-ORG-POLYM	28480	0340-0669
A2C11	0160-4786	7		CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A2C12	0160-2236	8	4	CAPACITOR-FXD 1PF +-.25PF 500VDC CER	28480	0160-2236
A2C13	0180-0228	6	4	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A2C14	0160-4835	7	36	CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C17	0180-2195	0	2	CAPACTIOR-FXD 15UF +-10% 35VDC TA	56289	150D156X9035R2
A2C18	0160-5549	2	2	CAPACITOR-FXD .068UF +-5% 100VDC	28480	0160-5549
A2C19	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C20	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C21	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C22	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C23	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C24				NOT ASSIGNED		
A2C25	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A2C26	0160-4803	9	3	CAPACITOR FXD 68PF +-5% 100VDC CER 0+-30	28480	0160-4803
A2C27	0160-4803	9		CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	28480	0160-4803
A2C28	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C29	0160 4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C30	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C31	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C32	0160-4803	9		CAPACITOR-FXD 68PF +-5% 100VDC CER 0+-30	28480	0160-4803
A2C33				NOT ASSIGNED		
A2C34	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C35	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C36	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C37	0180-2207	5	5	CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A2C38	0180-2207	5		CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A2C39	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C40	0160-4786	7		CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A2C41	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C42	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835

†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
A2C43-C52				NOT ASSIGNED		
A2C53	0180-0100	3	3	CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A2C54				NOT ASSIGNED		
A2C55				NOT ASSIGNED		
A2C56	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C57	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C58-C60				NOT ASSIGNED		
A2C61	0160-4834	6	3	CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A2C62-C69				NOT ASSIGNED		
A2C70	0160-4819	7	1	CAPACITOR-FXD 2200PF +-5% 100VDC CER	28480	0160-4819
A2C71-C76				NOT ASSIGNED		
A2C77	0160 4791	4	9	CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A2C78	0160 4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C79	0160 4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C80	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A2C81	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C82				NOT ASSIGNED		
A2C83				NOT ASSIGNED		
A2C84	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A2C85	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A2C86	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A2C87	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A2C88	0160 6370	9		C MPE 1.5U 600V	28480	0160-6370
A2C89	0160-2264	2		CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A2C90	0121-0422	8		CAPACITOR-V TRMR-PSTN .8-4.5PF 1250V	18736	TP5G
A2C91	0160-4786	7		CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A2C92	0121-0422	8		CAPACITOR-V TRMR-PSTN .8-4.5PF 1250V	18736	TP5G
A2C93	0160-5549	2		CAPACITOR-FXD .068UF +-5% 100VDC	28480	0160-5549
A2C94	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C95	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C96	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C97	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C98	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2C99	0160-2237	9		CAPACITOR-FXD 1.2PF +-.25PF 500VDC CER	28480	0160-2237
A2C100	0160-4786	7		CAPACITOR-FXD 27PF +-5% 100VDC CER 0+-30	28480	0160-4786
A2C101	0160-2236	8		CAPACITOR-FXD 1PF +-.25PF 500VDC CER	28480	0160-2236
A2C103	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A2C104	0160 4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A2C105	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A2C106	0160 4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A2C107	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A2C108	0160-4801	7		CAPACITOR-FXD 100PF +-5% 100VDC CER	28480	0160-4801
A2C109	0121-0527	4	2	CAPACITOR-V TRIMMER-POLYCARBONATE FILM	28480	0121-0527
A2C110	0121-0527	4		CAPACITOR-V TRIMMER-POLYCARBONATE FILM	28480	0121-0527

†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
A2CR1	1901-0050	3	57	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR8				NOT ASSIGNED		
2450A TO 2520A						
A2CR9	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A2CR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-354	28480	1901-0050
A2CR11	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A2CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
2601A AND ABOVE						
A2CR9	1901-0050	3	44	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR10	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A2CR11	1901-0050	3	44	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR12	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A2CR13-CR17				NOT ASSIGNED		
A2CR18	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR19				NOT ASSIGNED		
A2CR20				NOT ASSIGNED		
A2CR21	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR22	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR23				NOT ASSIGNED		
A2CR24	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
2450A TO 2520A						
A2CR25	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR26	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A2CR27	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR28	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2601A AND ABOVE						
A2CR25	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A2CR26	1901-0050	3	44	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR27	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A2CR28	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR29-CR34				NOT ASSIGNED		
A2CR35	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2K1	0490-0916	6	2	RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490-0916
A2K2	0490-0916	6		RELAY-REED 1A 500MA 100VDC 5VDC-COIL	28480	0490 0916
A2K3				NOT ASSIGNED		
A2K4	0490-1484	5	4	RRLY 50W2A 5VDC	28480	0490-1484
A2K5	0490-1484	5		RRLY 50W2A 5VDC	28480	0490-1484
A2K6	0490-1484	5		RRLY 50W2A 5VDC	28480	0490-1484
A2K7	0490-1484	5		RRLY 50W2A 5VDC	28480	0490-1484
A2L1	9140-0114	4	3	INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A2L2	9100-2430	7	2	INDUCTOR RF-CH-MLD 220UH 10%	28480	9100-2430
A2L3	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114

†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
A2MP1	4040-0748	3	8	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8	1	6 PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A2MP2	4040-0750	7	1	EXTR-PC BD RED POLYC .062-BD-THKNS	28480	4040-0750
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A2MP3	0380-1773	2	8	STDF .375L PCB	28480	0380-1773
A2Q1				NOT ASSIGNED		
A2Q2	1855-0277	7	3	TRANSISTOR J-FET 2N5268 P-CHAN D-MODE	04713	2N5268
A2Q3	1853-0459	3	2	TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A2Q4	1855-0277	7		TRANSISTOR J-FET 2N5268 P-CHAN D-MODE	04713	2N5268
A2Q5	1855-0277	7		TRANSISTOR J-FET 2N5268 P-CHAN D-MODE	04713	2N5268
A2Q6	1853-0459	3		TRANSISTOR PNP SI PD=625MW FT=200MHZ	28480	1853-0459
A2Q7, A2Q9	08903-80035	3	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0418
A2Q8	1855-0642	0		TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-71	28480	1855-0642
A2Q9				SEE A2Q7 (MATCHED PAIR)		
A2Q10	1855-0642	0		TRANSISTOR-JFET DUAL N-CHAN D-MODE TO-71	28480	1855-0642
A2R1				NOT ASSIGNED		
A2R2	0757-0159	5	2	RESISTOR 1K 1% .5W F TC=0+-100	28480	0757-0159
A2R3	0699-0413	0	2	RESISTOR 112.32K .1% 1W F TC=0+-25	28480	0699-0413
A2R4	0699-0526	6	3	RESISTOR 37.68K .1% .25W F TC=0+-25	28480	0699-0526
A2R5	0698-8825	2	3	RESISTOR 681K 1% .125W F TC=0+-100	28480	0698-8825
A2R6	0699-0402	7	2	RESISTOR 281.07K .1% .5W F TC=0+-25	28480	0699-0402
A2R7	0699-0405	0	2	RESISTOR 15.93K .1% .25W F TC=0+-25	28480	0699-0405
A2R8	0698-6348	0	6	RESISTOR 3K 1% .125W F TC=0+-25	28480	0698-6348
A2R9	0698-3455	4	2	RESISTOR 261K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2613-F
A2R10				NOT ASSIGNED		
A2R11				NOT ASSIGNED		
A2R12	0698-3152	8	3	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A2R13	0757-0465	6	14	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A2R14	0757-0290	5	9	RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A2R15	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A2R16				NOT ASSIGNED		
A2R17	0757-0833	2	2	RESISTOR 5.11K 1% .5W F TC=0+-100	28480	0757-0833
A2R18				NOT ASSIGNED		
A2R19				NOT ASSIGNED		
A2R20	0698-3150	6	5	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A2R21				NOT ASSIGNED		
A2R22	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A2R23-R25				NOT ASSIGNED		
A2R26	0698-7196	8	28	RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R27	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R28	0698-6447	0	2	RESISTOR 683.8 .1% .125W F TC=0+-25	28480	0698-6447
A2R29	0699-0412	9	2	RESISTOR 493 .1% .25W F TC=0+-25	28480	0699-0412
A2R30	0699-0412	9		RESISTOR 493 .1% .25W F TC=0+-25	28480	0699-0412
A2R31	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R32	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R33	0699-0407	2	1	RESISTOR 1.749K .1% .25W F TC=0+-25	28480	0699-0407
A2R34	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R35	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-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
A2R36	0699-0409	4	2	RESISTOR 1.3224K .1% .25W F TC=0+-25	28480	0699-0409
A2R37	0699-0409	4		RESISTOR 1.3224K .1% .25W F TC=0+-25	28480	0699-0409
A2R38	0757-0280	3	43	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R39	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R40	0698-8835	4	3	RESISTOR 5K .1% .125W F TC=0+-10	28480	0698-8835
A2R41	0698-8835	4		RESISTOR 5K .1% .125W F TC=0+-10	28480	0698-8835
A2R42	0699-0513	1	1	RESISTOR 4.98K .1% .1W F TC=0+-10	28480	0699-0513
A2R43	2100-0552	3	1	RESISTOR-TRMR 50 10% C SIDE-ADJ 1-TRN	28480	2100-0552
A2R44	2100-3355	0	3	RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	28480	2100-3355
A2R45	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R46	0698-8835	4		RESISTOR 5K .1% .125W F TC=0+-10	28480	0698-8835
A2R47	0698-7265	2	1	RESISTOR 16.2K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1622-F
A2R48	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R49	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R50	1810-0207	9	1	NETWORK-RES 8-SIP22.0K OHM X 7	01121	208A223
A2R51	0698-7256	1	3	RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F
A2R52				NOT ASSIGNED		
A2R53				NOT ASSIGNED		
A2R54	0698-7253	8	8	RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A2R55				NOT ASSIGNED		
A2R56	0698-7404	1	1	RESISTOR 1.005K .1% .125W F TC=0+-50	19701	MF4C1/8-T2-1005R-B
A2R57	0699-0411	8	1	RESISTOR 634 .1% .25W F TC=0+-25	28480	0699-0411
A2R58	0698-6355	9	1	RESISTOR 400 .1% .125W F TC=0+-25	28480	0698-6355
A2R59	0698-6447	0		RESISTOR 683.8 .1% .125W F TC=0+-25	28480	0698-6447
A2R60	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R61	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R62	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R63-R66				NOT ASSIGNED		
A2R67	0757-0438	3	24	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A2R68	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A2R69	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A2R70-R74				NOT ASSIGNED		
A2R75	0698-3157	3	13	RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A2R76	0757-0447	4	7	RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8 T0-1622-F
A2R77-R79				NOT ASSIGNED		
A2R80	0757-0439	4	4	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A2R81	0757-0441	8	3	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A2R82				NOT ASSIGNED		
A2R83	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1,8-T0-1001-F
A2R84-86				NOT ASSIGNED		
A2R87	0757-0442	9	39	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R88-R92				NOT ASSIGNED		

†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
A2R92				NOT ASSIGNED		
A2R93	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R94				NOT ASSIGNED		
A2R95				NOT ASSIGNED		
A2R96	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A2R97				NOT ASSIGNED		
A2R98	0698-7255	0	5	RESISTOR 6.19K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6191-F
A2R99	0698-7255	0		RESISTOR 6.19K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6191-F
A2R100	0699-0413	0		RESISTOR 112.32K .1% 1W F TC=0+-25	28480	0699-0413
A2R101	0699-0526	6		RESISTOR 37.68K .1% .25W F TC=0+-25	28480	0699-0526
A2R102	0698-8825	2		RESISTOR 681K 1% .125W F TC=0+-100	28480	0698-8825
A2R103	0699-0402	7		RESISTOR 281.07K .1% .5W F TC=0+-25	28480	0699-0402
A2R104	0757-0159	5		RESISTOR 1K 1% .5W F TC=0+-100	28480	0757-0159
A2R105	0757-0833	2		RESISTOR 5.11K 1% .5W F TC=0+-100	28480	0757-0833
A2R106	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A2R107	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A2R108	0698-7254	9	4	RESISTOR 5.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5621-F
A2R109	0698-7254	9		RESISTOR 5.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5621-F
A2R110	0698-7252	7	4	RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A2R111	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A2R112	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A2R113	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R114	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R115	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A2R116	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R117	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2R118	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A2R119				NOT ASSIGNED		
A2R120				NOT ASSIGNED		
A2R121	0699-0405	0		RESISTOR 15.93K .1% .25W F TC=0+-25	28480	0699-0405
A2R122	0698-6348	0		RESISTOR 3K .1% .125W F TC=0+-25	28480	0698-6348
A2R123	0698-3455	4		RESISTOR 261K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2613-F
A2R124	0698-7256	1		RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F
A2R125	0698-7255	0		RESISTOR 6.19K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6191-F
A2R126	0698-7255	0		RESISTOR 6.19K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6191-F
A2R127	0698-7267	4	3	RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A2R128	0698-7284	5	4	RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A2R129	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A2R130	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A2R131	0698-7284	5		RESISTOR 100K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1003-F
A2R132	0698-7260	7	3	RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A2R133	0698-7260	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A2R134	0698-7188	8	1	RESISTOR 10 1% .05W F TC=0+-100	24546	0698-7188
A2TP1	1251-0600	0	90	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
A2TP5	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
A2TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A2U1	1826-0421	2	2	IC CONV RMS/DC 14-DIP-C PKG	24355	AD536AJ
A2U2				NOT ASSIGNED		
A2U3	1826-0783	9	16	IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A2U4	1826-0759	9	4	IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A2U5	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A2U6	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A2U7	1826-0413	2	2	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	34371	HA2-2605-5
A2U8				NOT ASSIGNED		
A2U9	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A2U10	1826-1012	9	2	ANALOG SWITCH 4 SPST 16-PIN	28480	1826-1012
A2U11	1826-1012	9		ANALOG SWITCH 4 SPST 16-PIN	28480	1826-1012
A2U12	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A2U13				NOT ASSIGNED		
A2U14	1820-1202	7	2	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A2U15	1820-2795	5	1	IC DRVR TTL F LINE DRVR OCTL	28480	1820-2795
A2U16	1826-0759	9		IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A2U17	1826-0932	0	1	IC OP AMP PRCN 8-DIP-C PKG	06665	OP-27EZ
A2U18	1826-0759	9		IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A2U19				NOT ASSIGNED		
A2U20	1826-0413	2		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	34371	HA2-2605-5
A2VR1	1902-0029	8	2	DIODE-ZNR 12V 5% PD=1W IR=5UA	28480	1902-0029
A2VR2	1902-0029	8		DIODE-ZNR 12V 5% PD=1W IR=5UA	28480	1902-0029
A2W1	8159-0005	0	6	RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A2W2				NOT ASSIGNED		
A2W3	08903-60298	8	1	JUMPER WIRE	28480	08903-60298
A2W4	08903-60298	8	1	JUMPER WIRE	28480	08903-60298
A2XA2A1	1251-6065	3	2	CONNECTOR 10-PIN M POST TYPE	28480	1251-6065
A2XA2A2	1251-6065	3		CONNECTOR 10-PIN M POST TYPE	28480	1251-6065

†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
A2A1 (OPTION 010)						
A2A1	08903-60124	9	1	400HZ HIGH-PASS FILTER (OPTION 010 ONLY)	28480	08903-60124
OR						
A2A2 (OPTION 050)						
A2A2	08903-60124	9	1	400HZ HIGH-PASS FILTER (OPTION 050 ONLY)	28480	08903-60124
A2A_C1	0160-7018	4		CAPACITOR-FXD .022UF +-2% 100VDC POLYC	05176	0160-7018
A2A_C2	0160-7018	4		CAPACITOR-FXD .022UF +-2% 100VDC POLYC	05176	0160-7018
A2A_C3	0160-4787	8	3	CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A2A_C4	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2A_C5	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A2A_C6	0160-7018	4		CAPACITOR-FXD .022UF +-2% 100VDC POLYC	05176	0160-7018
A2A_C7	0160-7018	4		CAPACITOR-FXD .022UF +-2% 100VDC POLYC	05176	0160-7018
A2A_C8	0160-7018	4		CAPACITOR-FXD .022UF +-2% 100VDC POLYC	05176	0160-7018
A2A_C9	0160-4787	8		CAPACITOR FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A2A_C10	0160-5046	4	2	CAPACITOR-FXD .039UF +-2% 100VDC	28480	0160-5046
A2A_C11	0160-5046	4		CAPACITOR-FXD .039UF +-2% 100VDC	28480	0160-5046
A2A_C12	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C13	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_J1	1251-6063	1		CONNECTOR 10-PIN F POST TYPE	28480	1251-6063
A2A_R1	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R2	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R3	0699-0403	8	1	RESISTOR 45.2K 1% .25W F TC=0+-25	28480	0699-0403
A2A_R4	0698-8586	2	1	RESISTOR 4.71K 1% .125W F TC=0+-100	28480	0698-8586
A2A_R5	0698-7255	0		RESISTOR 6.19K 1% .05W F TC=0+-100	24546	C3-1/8-TO-6191-F
A2A_R6	2100-3351	6		RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A2A_R7	0699-0404	9	1	RESISTOR 29.3K 1% .25W F TC=0+-25	28480	0699-0404
A2A_R8	0698-7853	4	1	RESISTOR 101.5K .1% .125W F TC=0+-50	19701	MF4C1-8-T2-10152-B
A2A_R9	0699-0410	7	1	RESISTOR 938 1% .25W F TC=0+-25	28480	0699-0410
A2A_R10	0699-0408	3	1	RESISTOR 4.28K .1% .25W F TC=0+-25	28480	0699-0408
A2A_U1	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A2A_U2	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN

†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
A2A1 (OPTION 011)						
A2A1	08903-60125	0	1	CCITT WEIGHTING FILTER (OPTION 011 ONLY)	28480	08903-60125
OR						
A2A2 (OPTION 051)						
A2A2	08903-60125	0	1	CCITT WEIGHTING FILTER (OPTION 051 ONLY)	28480	08903-60125
A2A_C1	0160-6326	5	2	C MPC 1060P 50V	28480	0160-6326
A2A_C2	0160-5201	3	1	CAPACITOR-FXD .01UF +-1% 200VDC	28480	0160-5201
A2A_C3	0160 6327	6	1	C MPC 4000P 50V	28480	0160-6327
A2A_C4	0160-4759	4		CAPACITOR-FXD 6800PF +-1% 200VDC	28480	0160-4759
A2A_C5	0160-4622	0	2	CAPACITOR-FXD .1UF +-1% 160VDC MET-POLYC	28480	0160-4622
A2A_C6	0160-6324	3		C MPC 560P 50V	28480	0160-6324
A2A_C7	0160 6606	4	4	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_C8	0160 0578	7		CAPACITOR-FXD .047UF +-1% 50VDC	28480	0160-0578
A2A_C9	0160-0578	7		CAPACITOR-FXD .047UF +-1% 50VDC	28480	0160-0578
A2A_C10	0160-6606	4	4	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_C11	0160 6606	4	4	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_C12	0160-6606	4	4	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_C13	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C14	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_J1	1251-6063	1		CONNECTOR 10-PIN F POST TYPE	28480	1251-6063
A2A_R1	0757-0448	5	2	RESISTOR 18.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1822-F
A2A_R2	0757-0448	5		RESISTOR 18.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1822-F
A2A_R3	0698 7236	7	2	RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A2A_R4	2100 3351	6		RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A2A_R5	0698-7243	6		RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1961-F
A2A_R6	0698-7353	9	1	RESISTOR 19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1902-F
A2A_R7	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A2A_R8	0698-3515	7	2	RESISTOR 5.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5901-F
A2A_R9	0757-0200	7	3	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A2A_R10	0698-3515	7		RESISTOR 5.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5901-F
A2A_R11	0698-7240	3		RESISTOR 1.47K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1471-F
A2A_R12	0698-8607	8	1	RESISTOR 4.5K .1% .125W F TC=0+-25	28480	0698-8607
A2A_R13	0698-7270	9	2	RESISTOR 26.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2612-F
A2A_R14	0698-4508	0	1	RESISTOR 78.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7872-F
A2A_R15	0699 4489	6	1	RESISTOR 28K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2802-F
A2A_R16	0698-7254	9		RESISTOR 5.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5621-F
A2A_R17	0698-7195	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R18	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_U1	1826-1290	5		IC OP AMP LOW-BIAS-H-IMP'D QUAD 14-DIP-P	01295	TL7L04C40

†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
A2A1 (OPTION 012)						
A2A1	08903-60126	1	1	CCIR WEIGHTING FILTER (OPTION 012 ONLY)	28480	08903-60126
OR						
A2A2 (OPTION 052)						
A2A2	08903-60126	1	1	CCIR WEIGHTING FILTER (OPTION 052 ONLY)	28480	08903-60126
A2A_C1	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C2	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C3	0160-6323	2		C MPC 2000P 50V	28480	0160-6323
A2A_C4	0160-4759	4	5	CAPACITOR-FXD 6800PF +-1% 200VDC	28480	0160-4759
A2A_C5	0160-6324	3		C MPC 560P 50V	28480	0160-6324
A2A_C6	0160-4759	4		CAPACITOR-FXD 6800PF +-1% 200VDC	28480	0160-4759
A2A_C7	0160-6325	4		C MPC 2400P 50V	28480	0160-6325
A2A_C8	0160-6606	4	1	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_J1	1251-6063	1		CONNECTOR 10-PIN F POST TYPE	28480	1251-6063
A2A_R1	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R2	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R3	0698-5466	1	2	RESISTOR 5.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5701-F
A2A_R4	0698-7257	2	7	RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A2A_R5	0698-7282	3	2	RESISTOR 82.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-8252-F
A2A_R6	0698-7226	5	2	RESISTOR 383 1% .05W F TC=0+-100	24546	C3-1/8-TO-383R-F
A2A_R7	2100-3350	5	3	RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	28480	2100-3350
A2A_R8	0698-7239	0		RESISTOR 1.33K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1331-F
A2A_R9	0698-7257	2		RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A2A_R10	0698-3259	6	2	RESISTOR 7.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7871-F
A2A_R11	0698-7245	8	1	RESISTOR 2.37K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2371-F
A2A_R12	0698-7257	2		RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A2A_R13	0698-7250	5	1	RESISTOR 3.83K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3831-F
A2A_R14	0698-3484	9	3	RESISTOR 6.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6651-F
A2A_R15	0698-4430	7		RESISTOR 1.91K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1911-F
A2A_R16	0698-7241	4	2	RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1621-F
A2A_U1	1826-1290	5		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL7L04C40

†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
A2A1 (OPTION 013)						
A2A1	08903-60127	2	1	C-MESSAGE WEIGHTING FILTER (OPTION 013 ONLY)	28480	08903-60127
OR						
A2A2 (OPTION 053)						
A2A2	08903-60127	2	1	C-MESSAGE WEIGHTING FILTER (OPTION 053 ONLY)	28480	08903-60127
A2A_C1	0180-2661	5	12	CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C2	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C3	0160-5032	8	7	CAPACITOR-FXD .0223UF +-1% 200VDC	28480	0160-5032
A2A_C4	0160-6322	1	1	C MPC 3000P 50V	28480	0160-6322
A2A_C5	0160-4622	0		CAPACITOR-FXD .1UF +-1% 160VDC MET-POLYC	28480	0160-4622
A2A_C6	0160-6321	0	1	C MPC 958P 50V	28480	0160-6321
A2A_C7	0160 5032	8		CAPACITOR-FXD .0223UF +-1% 200VDC	28480	0160-5032
A2A_C8	0160 5032	8		CAPACITOR-FXD .0223UF +-1% 200VDC	28480	0160-5032
A2A_C9	0160-6606	4	2	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_C10	0160-6606	4	2	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_J1	1251-6063	1	6	CONNECTOR 10-PIN F POST TYPE	28480	1251-6063
A2A_R1	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R2	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R3	0698-8191	5	1	RESISTOR 12.5K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1252-B
A2A_R4	0698-7273	2	1	RESISTOR 34.8K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3482-F
A2A_R5	0698-7240	3	2	RESISTOR 1.47K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1471-F
A2A_R6	2100-3351	6		RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A2A_R7	0698-7243	6		RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1961-F
A2A_R8	0757-0273	4	2	RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A2A_R9	0698-4471	6	1	RESISTOR 7.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7151-F
A2A_R10	0757-0273	4		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A2A_R11	0698-7234	5	1	RESISTOR 825 1% .05W F TC=0+-100	24546	C3-1/8-T0-825R-F
A2A_R12	0698-4020	1	2	RESISTOR 9.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A2A_R13	0698-7267	4		RESISTOR 19.6K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1962-F
A2A_R14	0757-0454	3	1	RESISTOR 33.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3322-F
A2A_U1	1826-1290	5		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL7L04C40

†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
A2A1 (OPTION 014)						
A2A1	08903-60162	5	1	CCIR/ARM WEIGHTING FILTER (OPTION 014 ONLY)	28480	08903-60162
OR						
A2A2 (OPTION 054)						
A2A2	08903-60162	5	1	CCIR/ARM WEIGHTING FILTER (OPTION 054 ONLY)	28480	08903-60162
A2A_C1	0180 2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C2	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C3	0160-6323	2	2	C MPC 2000P 50V	28480	0160-6323
A2A_C4	0160-4759	4		CAPACITOR-FXD 6800PF +-1% 200VDC	28480	0160-4759
A2A_C5	0160 6324	3		C MPC 560P 50V	28480	0160-6324
A2A_C6	0160-4759	4		CAPACITOR-FXD 6800PF +-1% 200VDC	28480	0160-4759
A2A_C7	0160-6325	4	2	C MPC 2400P 50V	28480	0160-6325
A2A_C8	0160-6606	4	1	CAPACITOR-FXD .02UF 200VDC	28480	0160-6606
A2A_J1	1251-6063	1		CONNECTOR 10-PIN F POST TYPE	28480	1251-6063
A2A_R1	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A2A_R2	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8 TO-21R5-F
A2A_R3	0698-5466	1		RESISTOR 5.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5701-F
A2A_R4	0698-7257	2		RESISTOR 7.5K 1% .05W F TC=0 +-100	24546	C3-1/8-T0-7501-F
A2A_R5	0698-7282	3		RESISTOR 82.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-8252-F
A2A_R6	0698 7228	7		RESISTOR 464 1% .05W F TC=0+-100	24546	C3-1/8-TO-464R-F
A2A_R7	2100-3350	5		RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	28480	2100-3350
A2A_R8	0698-7239	0	2	RESISTOR 1.33K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1331-F
A2A_R9	0698-7257	2		RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A2A_R10	0698-3259	6		RESISTOR 7.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7871-F
A2A_R11	0698-7249	2	1	RESISTOR 3.48K 1% .05W F TC=0+-100	24546	C3-1/8-T0-3481-F
A2A_R12	0698 7257	2		RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A2A_R13	0698 7252	7		RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A2A_R14	0698-3484	9		RESISTOR 6.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6651-F
A2A_R15	0698-4430	7	2	RESISTOR 1.91K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1911-F
A2A_R16	0698-7252	7		RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A2A_U1	1826-1290	5		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL7L04C40

†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
A2A1 (OPTION 015)						
A2A1	08903-60161	4	1	"A" WEIGHTING FILTER (OPTION 015 ONLY)	28480	08903-60161
OR						
A2A2 (OPTION 055)						
A2A2	08903-60161	4	1	"A" WEIGHTING FILTER (OPTION 055 ONLY)	28480	08903-60161
A2A_C1	0160-6326	5		C MPC 1060P 50V	28480	0160-6326
A2A_C2	0160-6324	3	4	C MPC 560P 50V	28480	0160-6324
A2A_C3	0160-0578	7	6	CAPACITOR-FXD .047UF +-1% 50VDC	28480	0160-0578
A2A_C4	0160-0578	7		CAPACITOR-FXD .047UF +-1% 50VDC	28480	0160-0578
A2A_C5	0160-0578	7		CAPACITOR-FXD .047UF +-1% 50VDC	28480	0160-0578
A2A_C6	0160-0578	7		CAPACITOR-FXD .047UF +-1% 50VDC	28480	0160-0578
A2A_C7	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_C8	0180-2661	5		CAPACITOR-FXD 1UF+-10% 50VDC TA	25088	D1R0GS1A50K
A2A_J1	1251-6063	1		CONNECTOR 10-PIN F POST TYPE	28480	1251-6063
A2A_R1	0698-7262	9	2	RESISTOR 12.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1212-F
A2A_R2	0698-7215	2	1	RESISTOR 133 1% .05W F TC=0+-100	24546	C3-1/8-T0-133R-F
A2A_R3	2100 3351	6	4	RESISTOR-TRMR 500 10% C SIDE-ADJ 1-TRN	28480	2100-3351
A2A_R4	0698-7243	6	3	RESISTOR 1.96K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1961-F
A2A_R5	0698-7257	2		RESISTOR 7.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-7501-F
A2A_R6	0698-7254	9		RESISTOR 5.62K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5621-F
A2A_R7	0698-7260	7		RESISTOR 10K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1002-F
A2A_R8	0698-7252	7		RESISTOR 4.64K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4641-F
A2A_R9	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A2A_R10	0698-7275	4	1	RESISTOR 42.2K 1% .05W F TC=0+-100	24546	C3-1/8-T0-4222-F
A2A_R11	0698-7287	8	1	RESISTOR 133K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1333-F
A2A_R12	0698-7288	9	1	RESISTOR 147K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1473-F
A2A_R13	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-T0-21R5-F
A2A_R14	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-T0-21R5-F
A2A_R15	0698-7268	5	1	RESISTOR 21.5K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2152-F
A2A_U1	1826 1290	5	4	IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	01295	TL7L04C40

†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	08903-60163	6	1	NOTCH FILTER ASSEMBLY	28480	08903-60163
A3C1	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C2	0180-0049	9	2	CAPACITOR-FXD 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A3C3	0180-0049	9		CAPACITOR-FXD 20UF+75-10% 50VDC AL	56289	30D206G050CC2
A3C4	0160-4834	6		CAPACITOR-FXD .047UF +-10% 100VDC CER	28480	0160-4834
A3C5	0160-4795	8	4	CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
A3C6	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C7	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C8				NOT ASSIGNED		
A3C9	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C11	0160-4590	1	4	CAPACITOR-FXD .18UF +-1% 200VDC	28480	0160-4590
A3C12	0160-5032	8		CAPACITOR-FXD .0223UF +-1% 200VDC	28480	0160-5032
A3C13	0160-3293	9	4	CAPACITOR-FXD 2470PF +-1% 100VDC MICA	28480	0160-3293
A3C14	0160-3918	5	2	CAPACITOR-FXD 355PF +-1% 100VDC MICA	28480	0160-3918
A3C15	0160-4795	8		CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
A3C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C17	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C18	0160-4795	8		CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
A3C19	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C20	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C21	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A3C22				NOT ASSIGNED		
A3C23	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C24	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C25	0160-4590	1		CAPACITOR-FXD .18UF +-1% 200VDC	28480	0160-4590
A3C26	0160-5032	8		CAPACITOR-FXD .0223UF +-1% 200VDC	28480	0160-5032
A3C27	0160-3293	9		CAPACITOR-FXD 2470PF +-1% 100VDC MICA	28480	0160-3293
A3C28	0160-3918	5		CAPACITOR-FXD 355PF +-1% 100VDC MICA	28480	0160-3918
A3C29	0180-0374	3	5	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A3C30	0180-0094	4	1	CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A3C31	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C32	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C33	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C34	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C35	0160-4814	2	4	CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A3C36	0160-4795	8		CAPACITOR-FXD 4.7PF +-.5PF 100VDC CER	28480	0160-4795
A3C37	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C38	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C39	0160-4807	3	3	CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A3C40	0160-4807	3		CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A3C41△	0160-5550	0	1	CAPACITOR-FXD .10UF +-5% 100VDC MET-POLYC	28480	0160-5550
A3C42	0160-5527	6	1	CAPACITOR-FXD .033UF +-5% 100VDC	28480	0160-5527
A3C43	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C44	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C45	0160-3510	3	1	CAPACITOR-FXD 3UF +-10% 50VDC MET-POLYC	28480	0160-3510

†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
A3C46	0160-4233	9	1	CAPACITOR-FXD .47UF +-5% 50VDC MET-POLYC	28480	0160-4233
A3C47	0160-3531	8	1	CAPACITOR-FXD 2UF +-5% 50VDC MET-POLYC	28480	0160-3531
A3C48	0160-5528	7	1	CAPACITOR-FXD .22UF +-5% 100VDC	28480	0160-5528
A3C49	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C50	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C51				NOT ASSIGNED		
A3C52	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C53	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C54	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C55	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A3C56	0160-0577	6	1	CAPACITOR-FXD 1.8UF +-20% 50VDC	28480	0160-0577
A3C57	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C58	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A3C59	0160-5559	4	1	CAPACITOR-FXD .82UF +-5% 100VDC	28480	0160-5559
A3CR1	1901-0033	2	6	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A3CR2	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A3CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR9				NOT ASSIGNED		
A3CR10				NOT ASSIGNED		
A3CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR14	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A3CR15	1901-0518	8	5	DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3CR16	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A3L1	9140-0114	4		INDUCTOR RF-CH-MLD 10UH 10% .166DX.385LG	28480	9140-0114
A3L2	9100-2430	7		INDUCTOR RF-CH-MLD 220UH 10%	28480	9100-2430
A3MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A3MP2	4040-0751	8	1	EXTR-PC BD ORN POLYC .062-BD-THKNS	28480	4040-0751
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A3MP3	0403-0026	6	3	PLUG-HOLE BDR-HD FOR .187-D-HOLE NYL	02768	207-120241 03-0101
A3Q1	1855-0414	4	8	TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q2	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q3	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q4	1855-0420	2	27	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q5	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q6	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q7	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q8	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q9	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q10	1855-0414	4		TRANSISTOR J-FET 2N4393 N-CHAN D-MODE	04713	2N4393
A3Q11	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420

†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
A3Q12	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q13	1855-0420	2		TRANSISTOR J-FET N24391 N-CHAN D-MODE	28480	1855-0420
A3Q14	1855 0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q15	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q16	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q17	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q18	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q19	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q20	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q21	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q22	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q23	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q24	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q25	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q27	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q28	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q29	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q30	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q31	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q32	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q33	1855 0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q34	1855 0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3Q35	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	28480	1855-0420
A3R1	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A3R2	1810-0208	0	2	NETWORK-RES 8-SIP68.0K OHM X 7	01121	208A683
A3R3	1810-0208	0		NETWORK-RES 8-SIP68.0K OHM X 7	01121	208A683
A3R4	0698-3160	8	6	RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A3R5	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A3R6	0698-6360	6	18	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R7	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R8	0698-0004	9	7	RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A3R9	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R10	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R11	0698-8204	1	6	RESISTOR 7.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-7981-B
A3R12	0698-8205	2	5	RESISTOR 15.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-15981-B
A3R13	0698-8047	0	5	RESISTOR 32K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-3202-B
A3R14	0698-8049	2	5	RESISTOR 64K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-6402-B
A3R15	0698-8053	8	5	RESISTOR 128K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1283-B
A3R16	0698-8050	5	5	RESISTOR 256K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2563-B
A3R17	0698-8958	2	2	RESISTOR 511K 1% .125W F TC=0+-100	28480	0698-8958
A3R18	0698-8827	4	5	RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A3R19	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R20	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R21	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R22	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R23	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R24	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R25	0698-8204	1		RESISTOR 7.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-7981-B

†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
A3R26	0698-8205	2		RESISTOR 15.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-15981-B
A3R27	0698-8047	0		RESISTOR 32K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-3202-B
A3R28	0698-8049	2		RESISTOR 64K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-6402-B
A3R29	0698-8053	8		RESISTOR 128K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1283-B
A3R30	0698-8050	5		RESISTOR 256K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2563-B
A3R31	0698-8958	2		RESISTOR 511K 1% .125W F TC=0+-100	28480	0698-8958
A3R32	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A3R33	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R34	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R35	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R36	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R37	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R38	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R39	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R40	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R41	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R42	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R43	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R44	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A3R45	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R46	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R47	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R48	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R49	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A3R50	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A3R51	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R52	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R53	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A3R54	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R55	0698-3200	7	1	RESISTOR 8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8001-F
A3R56	0757-0279	0	14	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R57	0757-0458	7	2	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A3R58	0698-3245	0	1	RESISTOR 20.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2052-F
A3R59	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A3R60	0698-3454	3	1	RESISTOR 215K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2153-F
A3R61	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A3R62	2100-3355	0		RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	28480	2100-3355
A3R63	2100-3355	0		RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	28480	2100-3355
A3R64	0698-3453	2	3	RESISTOR 196K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1963-F
A3R65	0698-3453	2		RESISTOR 196K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1963-F
A3R66	0757-0416	7	7	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R67	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R68	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R69	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R70	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A3R71	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A3R72	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R73	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R74				*NOT ASSIGNED*		
A3R75	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-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
A3R76	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A3R77	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R78	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A3R79	0757-0956	0	2	RESISTOR 22K 2% .125W F TC=0+-100	24546	C4-1/8-T0-2202-G
A3R80	0757-0956	0		RESISTOR 22K 2% .125W F TC=0+-100	24546	C4-1/8-T0-2202-G
A3R81	0757-1094	9	7	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A3R82	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A3R83	0757-0278	9	4	RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A3R84	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A3R85	0698-8869	4	2	RESISTOR 2.15K .25% .125W F TC=0+-100	28480	0698-8869
A3R86	0698-8869	4		RESISTOR 2.15K .25% .125W F TC=0+-100	28480	0698-8869
A3R87	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R88	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A3R89	0698-4339	5	2	RESISTOR 11.111K .1% .125W F TC=0+-50	28480	0698-4339
A3R90	0698-4339	5		RESISTOR 11.111K .1% .125W F TC=0+-50	28480	0698-4339
A3R91	0698-8655	6	2	RESISTOR 13.3K .1% .125W F TC=0+-50	28480	0698-8655
A3R92	0698-8655	6		RESISTOR 13.3K .1% .125W F TC=0+-50	28480	0698-8655
A3R93	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R94	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A3R95	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A3R96	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A3R97	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R98	0698-6630	3	7	RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A3R99	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R100	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A3R101	0699-0594	8	1	RESISTOR 2.21K .1% .125W F TC=0+-25	28480	0699-0594
A3R102	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
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
A3TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP12	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP13	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP14	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP15	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3U1	1826-1491	9	4	IC OP AMP GP DIP-PKG	01295	LM201AL
A3U2	1826-0025	2	2	IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM208AH
A3U3	1826-0025	2		IC OP AMP LOW-DRIFT TO-99 PKG	27014	LM208AH
A3U4	1826-0014	9	3	IC MULTIPLIER 14-DIP-C PKG	04713	MC1595L
A3U5	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN

†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
A3U6	1826-0662	3	4	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	28480	1826-0662
A3U7	1826-0109	3	4	IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A3U8	1826 0412	1	1	IC COMPARATOR PRCN DUAL 8-DIP-P PKG	27014	LM393N
A3U9	08903-80041	1		IC LIN SPECIAL	28480	08903-80041
A3U10	1826-0138	8	10	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A3U11	1826 0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A3U12	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A3U13	1826-0662	3		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	28480	1826-0662
A3U14	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A3U15	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A3U16	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A3U17	1826-0421	2		IC CONV RMS/DC 14-DIP-C PKG	24355	AD536AJ
A3U18	1826-1796	6		IC OP AMP H-SLEW-RATE DUAL 8-DIP-P PKG	02037	MC34082P
A3U19	1826-0740	8	1	IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE

†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	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4	08903-60128	3	1	OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY	28480	08903-60128
A4C1	0180-2207	5		CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A4C2	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A4C3	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C4	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A4C5	0180-0291	3	15	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C6	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C7	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C8	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C9	0160-4805	1	6	CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C10	0160-2236	8		CAPACITOR-FXD 1PF +-.25PF 500VDC CER	28480	0160-2236
A4C11	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C12	0160-4843	7	2	CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-4843
A4C13	0160-5876	8	1	CAPACITOR-FXD 1300PF +-1% 50VDC CER	28480	0160-5876
A4C14	0160-5409	3	1	CAPACITOR-FXD 3000PF +-5% 50VDC CER	28480	0160-5409
A4C15	0160-0336	5	2	CAPACITOR-FXD 100PF +-1% 300VDC MICA	28480	0160-0336
A4C16	0160-4679	7	1	CAPACITOR-FXD 270PF +-1% 300VDC MICA	28480	0160-4679
A4C17	0160-4456	8	2	CAPACITOR-FXD 750PF +-1% 300VDC MICA	28480	0160-4456
A4C18	0160-0335	4	1	CAPACITOR-FXD 91PF +-1% 300VDC MICA 0+70	28480	0160-0335
A4C19	0160-3046	0	1	CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A4C20	0160-4456	8		CAPACITOR-FXD 750PF +-1% 300VDC MICA	28480	0160-4456
A4C21	0160-3324	7	4	CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C22	0160-4793	6	2	CAPACITOR-FXD 6.8PF +-.5PF 100VDC CER	28480	0160-4793
A4C23	0160-3324	7		CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C24	0160-4799	2	3	CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A4C25	0180-2206	4	3	CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A4C26	0180-0229	7	4	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A4C27	0160-3324	7		CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C28	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C29	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C30	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C31	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C32*	0160-4382	9		CAPACITOR-FXD 3.3PF +-.25PF 200VDC CER NOT NORMALLY LOADED. SEE SECTION 5, TABLE 5-1		
A4C33	0160-4799	2		CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A4C34	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A4C35	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C36	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C37	0160-2236	8		CAPACITOR-FXD 1PF +-.25PF 500VDC CER	28480	0160-2236
A4C38	0180-2207	5		CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A4C39	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C40	0160-4793	6		CAPACITOR-FXD 6.8PF +-.5PF 100VDC CER	28480	0160-4793
A4C41	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A4C42	0160-4810	8	1	CAPACITOR-FXD 330PF +-5% 100VDC CER	28480	0160-4810
A4C43	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C44	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C45	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2

†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	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4C46	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C47	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C48	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C49	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C50	0160-4799	2		CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A4C51	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A4C52	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A4C53	0160-3324	7		CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C54	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C55	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C56	0160-4653	7	6	CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C57	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C58	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A4C59	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C60	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C61	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C62	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C63	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C64	0160-4843	7		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-4843
A4C65	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C66	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C67	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C68	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A4C69	0160-4807	3		CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A4C70	0160-4397	6	1	CAPACITOR-FXD .1UF +-1% 100VDC POLYSTY	28480	0160-4397
A4C71	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C72	0160-5254	6	1	CAPACITOR-FXD 1.5PF +-.25PF 100VDC CER	28480	0160-5254
A4C73	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C74	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C75	0160-4797	0	1	CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A4C76	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C77	0160 4790	3	1	CAPACITOR-FXD 12PF +-5% 100VDC CER 0+-30	28480	0160-4790
2150A TO 2520A						
A4CR1	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR2	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2601A AND ABOVE						
A4CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR3	1901-0040	1	7	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
2150A TO 2520A						
A4CR4	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR5	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR6	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR7	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2601A AND ABOVE						
A4CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR6	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050

†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	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4CR10	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR11	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
2450A TO 2520A						
A4CR13	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2601A AND ABOVE						
A4CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
2450A TO 2520A						
A4CR16	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A2CR17	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR18	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR19	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR20	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR21	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR22	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR23	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A4CR24	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2601A AND ABOVE						
A4CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR17	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR18	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR19	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR20	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR21	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR22	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR23	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR24	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR25	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
2450A TO 2520A						
A4CR26	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2601A AND ABOVE						
A4CR26	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR27	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR28	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4K1	0490-1423	2	1	RELAY-REED 1C 250MA 28VDC 5VDC-COIL 3VA	28480	0490-1423
A4L1	9140-0210	1	10	INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A4L2	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A4L3	9100-0539	3	3	INDUCTOR (MISC ITEM)	28480	9100-0539
A4L4	9100-0539	3		INDUCTOR (MISC ITEM)	28480	9100-0539
A4L5	9100-0539	3		INDUCTOR (MISC ITEM)	28480	9100-0539
A4MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A4MP2	4040-0752	9	1	EXTR-PC BD YEL POLYC .062-BD-THKNS	28480	4040-0752
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A4MP3	0403-0026	6		PLUG-HOLE BDR-HD FOR .187-D-HOLE NYL	02768	207-120241-03-0101
A4Q1Δ	08903-80069	3	2	TRANSISTOR-DUAL NPN TO-71 PD = 500MW	28480	08903-80069
	1205-0202	1	2	THERMAL LINK DUAL TO-18-CS	28480	1205-0202
A4Q2	1854-0753	2		TRANSISTOR-DUAL NPN TO-71 PD = 500MW	28480	1854-0753
	1205-0202	1		THERMAL LINK DUAL TO-18-CS	28480	1205-0202
A4Q3	1855-0420	2	36	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q4	1854-0830	6	1	TRANSISTOR-DUAL NPN PD = 500MW	27014	LM394

†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	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4Q5	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q6	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q7	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q8	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q9	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q10	1854 0071	7	1	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A4Q11	1853 0281	9	4	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A4Q12	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A4R1	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R2	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A4R3	0698-6343	5	7	RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R4	0698-6362	8	7	RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R5	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A4R6	0757-0422	5	4	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A4R7	0698 8822	9	10	RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R8	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R9	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R10	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R11	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R12	0698-6360	6		RESISTOR 10K 1% .125W F TC=0+-25	28480	0698-6360
A4R13	0698-6631	4	7	RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R14	0757 0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R15	0757-0274	5	3	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1211-F
A4R16	0757 0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8 TO-1211-F
A4R17	0757-0443	0	1	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A4R18	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R19	0757-0438	3		RESISTOR 5 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R20	0757-0437	2	1	RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
A4R21				NOT ASSIGNED		
A4R22	0757-1094	9		RESISTOR 1 47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R23	0698 3484	9		RESISTOR 6.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6651-F
A4R24	0698-4470	5	1	RESISTOR 6.98K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6981-F
A4R25	0698 3151	7	6	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R26	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R27	0698 3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R28	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4 1/8-T0-6811-F
A4R29	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R30	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R31	0757 0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A4R32	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8 T0 1001-F
A4R33	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A4R34	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R35	0698 6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R36	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R37	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R38	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R39	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R40	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R41	0757-0470	3	4	RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-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
A4	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4R42	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R43	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R44	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R45	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R46	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R47	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A4R48	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R49	0698 6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R50	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R51	0698 6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R52	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R53	0699-0550	6	1	RESISTOR 620 5% .25W CC TC=0+-800	28480	0699-0550
A4R54	0698 0085	0	2	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A4R55	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R56	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A4R57	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A4R58	0757 0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R59	0757 0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R60	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R61	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A4R62	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R63	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R64	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R65	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R66	0698 3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A4R67	0698-3153	9	5	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A4R68	0757-1108	6	1	RESISTOR 300 1% .125W F TC=0+-100	24546	C4-1/8 T0-301-F
A4R69	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R70	0698-6530	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R71	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R72	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R73	0698 3136	8	2	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A4R74	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R75	0757-0401	0	21	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A4R76	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R77	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R78	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R79	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A4R80	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R81	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R82	0757 0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R83	0698 3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A4R84	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R85	2100-3004	6	2	RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	02111	43P503
A4R86	0698 3223	4	1	RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A4R87	0698-3459	8	2	RESISTOR 383K 1% .125W F TC=0+-100	28480	0698-3459
A4R88	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R89	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R90	0699-0526	6		RESISTOR 37.68K 1% .25W F TC=0+-25	28480	0699-0526
A4R91	2100 3056	8	1	RESISTOR-TRMR 5K 10% C SIDE-ADJ 17-TRN	02111	43P502

†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	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4R92	0698-8799	9	1	RESISTOR 21.5K .1% .125W F TC=0+-25	28480	0698-8799
A4R93	2100-3109	2	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 17-TRN	02111	43P202
A4R94	0698-3266	5	2	RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A4R95	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R96	0698-3266	5		RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A4R97	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R98	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R99	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R100	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R101	0698-3243	8	1	RESISTOR 178K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1783-F
A4R102				NOT ASSIGNED		
A4R103				NOT ASSIGNED		
A4R104	0757-0470	3		RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-F
A4R105	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A4R106				NOT ASSIGNED		
A4R107	0757-0464	5	2	RESISTOR 90.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9092-F
A4R108	0698-3456	5	1	RESISTOR 287K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2873-F
A4R109	0698-3453	2		RESISTOR 196K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1963-F
A4R110	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R111	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R112	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R113	0757-0470	3		RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-F
A4R114	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R115	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R116	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R117	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R118	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A4R119	0757-0421	4	1	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A4R120	0698-3443	0	1	RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A4R121	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A4R122	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A4R123	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A4R124	0698-0082	7	1	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A4R125	2100-3103	6	2	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	02111	43P103
A4R126	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R127	0699-0239	8	1	RESISTOR 59K .1% .1W F TC=0+-15	28480	0699-0239
A4R128	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A4R129	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A4R130	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A4R131	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R132	0757-0405	4	2	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A4R133	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A4R134	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R135	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A4R136	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R137	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R138	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R139	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R140	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A4R141	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-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
A4	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4R142	2100-3350	5		RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	28480	2100-3350
A4R145	0698-7270	9		RESISTOR 26.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2612-F
A4R146	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R147	0698-7256	1		RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F
A4R148	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R149	2100-3054	6		RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	02111	43P503
A4R150	0698-3459	8		RESISTOR 383K 1% .125W F TC=0+-100	28480	0698-3459
A4R151	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R152	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R153	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A4R154	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A4R155	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-TO-21R5-F
A4R156	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A4R157				NOT ASSIGNED		
A4R157	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R158	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R159-R199				NOT ASSIGNED		
A4R200	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R201	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4RT1	0837-0239	2	1	THERMISTOR TUB WITH AXL LEADS 1K-OHM	28480	0837-0239
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
A4TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP9	1251 0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4U1	1826-0574	6	3	IC OP AMP LOW-DRIFT TO-99 PKG	07263	UA714LHC
A4U2	1826-0574	6		IC OP AMP LOW-DRIFT TO-99 PKG	07263	UA714LHC
A4U3	1826-1491	8	3	IC OP AMP GP DIP PKG	01295	LM201AL
A4U4	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ
A4U5	1826-1491	8	3	IC OP AMP GP DIP PKG	01295	LM201AL
A4U6	1826-0109	3		IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A4U7	1826-0606	5	1	IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A4U8	1826-0109	3		IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A4U9	1826-0606	5	1	IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A4U10	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	04713	MC34004BL
A4U11	1820-1197	9	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A4U12	1826-0574	6		IC OP AMP LOW-DRIFT TO-99 PKG	07263	UA714LHC
A4U13	1826-0109	3		IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A4U14	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	02195	TL072ACJG
A4U15	1826-1491	8	3	IC OP AMP GP DIP PKG	01295	LM201AL

†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	**08903-60128 – SERIAL PREFIX 2450A TO 2720A (HP8903B)**					
A4U16	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ
A4U17	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	04713	MC34004BL
A4U18	1826-0609	8		IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A4U19	1826-0138	8	10	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A4U20	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ
A4U21	1826-0582	6	2	IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A4U22	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ
A4U23	1826-0740	8	1	IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A4U24	1826-0740	8	1	IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A4VR1	1902-0943	5	3	DIODE-ZNR 2.4V 5% DO-35 PD=.4W TC=-.037%	28480	1902-0943
A4VR2	1902-0064	1	1	DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.05%	28480	1902-0064
A4VR3	1902-3024	9	1	DIODE-ZNR 2.87V 5% DO-7 PD=.4W TC=-.07%	28480	1902-3024
A4VR4	1902-0680	7	2	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A4VR5	1902-0953	7	1	DIODE-ZNR 6.2V 5% DO-35 PD= 4W TC=+.053%	28480	1902-0953

†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	**08903-60183 – SERIAL PREFIX 2730A TO 2813A (HP8903B)**					
A4	08903-60183	0	1	OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY	28480	08903-60183
A4	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4	08903-60283	1	1	OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY	28480	08903-60283
A4	08903-60282	0	1	OUTPUT AMPLIFIER/VOLTMETER ASSSEMBLY (THIS IS AN EQUIVALENT TO THE 08903-60283 EXCEPT FOR THE POSTION OF W1, REFER TO THE PARTIAL SCHEMATIC. THE 08903-60282 IS A DIRECT REPLACEMENT FOR THE 08903-60128)	28480	08903-60282
A4C1	0180-2207	5		CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A4C2	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A4C3	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C4	0180-0100	3		CAPACITOR-FXD 4.7UF+-10% 35VDC TA	56289	150D475X9035B2
A4C5	0180-0291	3	15	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C6	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C7	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C8	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C9	0160-4805	1	6	CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C10	0160-2236	8		CAPACITOR-FXD 1PF +-.25PF 500VDC CER	28480	0160-2236
A4C11	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A4C12	0160-4843	7	2	CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-4843
A4C13	0160-5876	8	1	CAPACITOR-FXD 1300PF +-1% 50VDC CER	28480	0160-5876
A4C14	0160-5409	3	1	CAPACITOR-FXD 3000PF +-5% 50VDC CER	28480	0160-5409
A4C15	0160-0336	5	2	CAPACITOR-FXD 100PF +-1% 300VDC MICA	28480	0160-0336
A4C16	0160-4679	7	1	CAPACITOR-FXD 270PF +-1% 300VDC MICA	28480	0160-4679
A4C17	0160-4456	8	2	CAPACITOR-FXD 750PF +-1% 300VDC MICA	28480	0160-4456
A4C18	0160-0336	5		CAPACITOR-FXD 100PF +-1% 300VDC MICA	28480	0160-0336
A4C19	0160-3046	0	1	CAPACITOR-FXD 250PF +-1% 100VDC MICA	28480	0160-3046
A4C20	0160-4456	8		CAPACITOR-FXD 750PF +-1% 300VDC MICA	28480	0160-4456
A4C21	0160-3324	7	4	CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C22	0160-4793	6	2	CAPACITOR-FXD 6.8PF +-.5PF 100VDC CER	28480	0160-4793
A4C23	0160-3324	7		CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C24	0160-4799	2	3	CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A4C25	0180-2206	4	3	CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A4C26	0180-0229	7	4	CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A4C27	0160-3324	7		CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C28	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C29	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C30	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C31	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C32	0160-4382	9		CAPACITOR-FXD 3.3PF +-.25PF 200VDC CER	28480	0160-4382
A4C33	0160-4799	2		CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A4C34	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A4C35	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C36	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C37	0160-2236	8		CAPACITOR-FXD 1PF +-.25PF 500VDC CER	28480	0160-2236
A4C38	0180-2207	5		CAPACITOR-FXD 100UF+-10% 10VDC TA	56289	150D107X9010R2
A4C39	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C40	0160-4793	6		CAPACITOR-FXD 6.8PF +-.5PF 100VDC CER	28480	0160-4793

†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	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4C41	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A4C42	0160-4810	8	1	CAPACITOR-FXD 330PF +-5% 100VDC CER	28480	0160-4810
A4C43	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C44	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C45	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C46	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C47	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A4C48	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C49	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C50	0160-4799	2		CAPACITOR-FXD 2.2PF +-.25PF 100VDC CER	28480	0160-4799
A4C51	0180-1746	5		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A4C52	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A4C53	0160-3324	7		CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYC	28480	0160-3324
A4C54	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C55	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C56	0160-4653	7	6	CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C57	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C58	0160-4814	2		CAPACITOR-FXD 150PF +-5% 100VDC CER	28480	0160-4814
A4C59	0160-4653	7		CAPACITOR-FXD 1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C60	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C61	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C62	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C63	0160-4653	7		CAPACITOR-FXD .1UF +-5% 100VDC MET-POLYP	28480	0160-4653
A4C64	0160-4843	7		CAPACITOR-FXD .47UF +80-20% 50VDC CER	28480	0160-4843
A4C65	0180-0228	6		CAPACITOR-FXD 22UF+ 10% 15VDC TA	56289	150D226X9015B2
A4C66	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C67	0180-0228	6		CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A4C68	0180-2206	4		CAPACITOR-FXD 60UF+-10% 6VDC TA	56289	150D606X9006B2
A4C69	0160-4807	3		CAPACITOR-FXD 33PF +-5% 100VDC CER 0+-30	28480	0160-4807
A4C70	0160-4397	6	1	CAPACITOR-FXD .1UF +-1% 100VDC POLYSTY	28480	0160-4397
A4C71	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A4C72	0160-5254	6	1	CAPACITOR-FXD 1.5PF +-.25PF 100VDC CER	28480	0160-5254
A4C73	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C74	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A4C75	0160-4797	0	1	CAPACITOR-FXD 3.3PF +-.25PF 100VDC CER	28480	0160-4797
A4C76	0160-4835	7		CAPACITOR-FXD .1UF +-10% 50VDC CER	28480	0160-4835
A4C77	0160-4790	3	1	CAPACITOR-FXD 12PF +-5% 100VDC CER 0+-30	28480	0160-4790
A4C78	0160-4590	1		CAPACITOR-FXD 18UF +-1% 200VDC	28480	0160-4590
A4C79	0160-5622	2		CAPACITOR-FXD 1.25UF +-2% 50VDC	28480	0160-5622
A4CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A2CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR3	1901-0040	1	7	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR6	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR10	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR11	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A4CR12	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR14	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR15	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040

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Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A4	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR17	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR18	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR19	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR20	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR21	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR22	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR23	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR24	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR25	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A4CR26	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR27	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR28	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A4CR29	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR30	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR31	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR32	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR33	1901-0050	3		DIODE-SWITCHING 80V 200MA2NS D0-35	28480	1901-0050
A4CR34	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4K1	0490-1423	2	1	RELAY-REED 1C 250MA 28VDC 5VDC-COIL 3VA	28480	0490-1423
A4L1	9140-0210	1	10	INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A4L2	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A4L3	9100-0539	3	3	INDUCTOR (MISC ITEM)	28480	9100-0539
A4L4	9100-0539	3		INDUCTOR (MISC ITEM)	28480	9100-0539
A4L5	9100-0539	3		INDUCTOR (MISC ITEM)	28480	9100-0539
A4MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A4MP2	4040-0752	9	1	EXTR-PC BD YEL POLYC .062-BD-THKNS	28480	4040-0752
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A4MP3	0403-0026	6		PLUG-HOLE BDR-HD FOR .187-D-HOLE NYL	02768	207-120241-03-0101
A4Q1△	08903-60069	3	2	TRANSISTOR-DUAL NPN TO-71 PD = 500MW	28480	08903-60069
	1205-0202	1	2	THERMAL LINK DUAL TO-18-CS	28480	1205-0202
A4Q2	1854-0753	2		TRANSISTOR-DUAL NPN TO-71 PD = 500MW	28480	1854-0753
	1205-0202	1		THERMAL LINK DUAL TO-18-CS	28480	1205-0202
A4Q3	1855-0420	2	36	TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q4	1854-0830	6	1	TRANSISTOR-DUAL NPN PD = 500MW	27014	LM394
A4Q5	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q6	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q7	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q8	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q9	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A4Q10	1854-0071	7	1	TRANSISTOR NPN SI PD = 300MW FT = 200MHZ	28480	1854-0071
A4Q11	1853-0281	9	4	TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A4Q12	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD = 400MW	04713	2N2907A
A4R1	0757-0279	0		RESISTOR 3.16K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-3161-F
A4R2	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A4R3	0698-6343	5	7	RESISTOR 9K .1% .125W F TC = 0 + -25	28480	0698-6343
A4R4	0698-6362	8	7	RESISTOR 1K .1% .125W F TC = 0 + -25	28480	0698-6362
A4R5	0757-0441	8		RESISTOR 8.25K 1% .125W F TC = 0 + -100	24546	C4-1/8-T0-8251-F
A4R6	0757-0422	5	4	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). △ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A4	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4R7	0698-8822	9	10	RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R8	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R9	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R10	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R11	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R12	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R13	0698-6631	4	7	RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R14	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R15	0757-0274	5	3	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1211-F
A4R16	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1211-F
A4R17	0757-0443	0	1	RESISTOR 11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1102-F
A4R18	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R19	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R20	0757-0437	2	1	RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
A4R21				NOT ASSIGNED		
A4R22	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R23	0698-3484	9		RESISTOR 6.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6651-F
A4R24	0698-4470	5	1	RESISTOR 6.98K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6981-F
A4R25	0698-3151	7	6	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R26	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R27	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R28	0757-0439	4		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A4R29	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R30	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R31	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2152-F
A4R32	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R33	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A4R34	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R35	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R36	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R37	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R38	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R39	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R40	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R41	0757-0470	3	4	RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-F
A4R42	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R43	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A4R44	0698-3151	7		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A4R45	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R46	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R47	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A4R48	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R49	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R50	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R51	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A4R52	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R53	0699-0550	6	1	RESISTOR 620 5% .25W CC TC=0+-800	28480	0699-0550
A4R54	0698-0085	0	2	RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A4R55	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R56	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-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
A4	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4R57	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A4R58	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R59	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R60	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R61	0698-3152	8		RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A4R62	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R63	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R64	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R65	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R66	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A4R67	0698-3153	9	5	RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A4R68	0757-1108	6	1	RESISTOR 300 1% .125W F TC=0+-100	24546	C4-1/8-T0-301-F
A4R69	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R70	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R71	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R72	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R73	0698-3136	8	2	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A4R74	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R76	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R77	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R78	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A4R79	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A4R80	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R81	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R82	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R83	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A4R84	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R85	2100-3054	6	2	RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	02111	43P503
A4R86	0698-3223	4	1	RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A4R87	0698-3459	8	2	RESISTOR 383K 1% .125W F TC=0+-100	28480	0698-3459
A4R88	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R89	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R90	0699-0526	6		RESISTOR 37.68K .1% .25W F TC=0+-25	28480	0699-0526
A4R91	2100-3056	8	1	RESISTOR-TRMR 5K 10% C SIDE-ADJ 17-TRN	02111	43P502
A4R92	0698-8799	9	1	RESISTOR 21.5K .1% .125W F TC=0+-25	28480	0698-8799
A4R93	2100-3109	2	1	RESISTOR-TRMR 2K 10% C SIDE-ADJ 17-TRN	02111	43P202
A4R94	0698-3266	5	2	RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A4R95	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R96	0698-3266	5		RESISTOR 237K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2373-F
A4R97	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R98	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R99	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R100	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R101	0698-3243	8	1	RESISTOR 178K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1783-F
A4R102				NOT ASSIGNED		
A4R103				NOT ASSIGNED		
A4R104	0757-0470	3		RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-F
A4R105	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A4R106				NOT ASSIGNED		
A4R107	0757-0464	5	2	RESISTOR 90.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9092-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
A4	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4R108	0698-3456	5	1	RESISTOR 287K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2873-F
A4R109	0698-3453	2		RESISTOR 196K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1963-F
A4R110	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R111	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R112	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R113	0757-0470	3		RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-F
A4R114	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R115	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R116	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R117	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R118	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A4R119	0757-0421	4	1	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A4R120	0698-3443	0	1	RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A4R121	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A4R122	0757-0422	5		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A4R123	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0+-100	24546	C4-1/8-T0-215R-F
A4R124	0698-0082	7	1	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A4R125	2100-3103	6	2	RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	02111	43P103
A4R126	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A4R127	0699-0239	8	1	RESISTOR 59K .1% .1W F TC=0+-15	28480	0699-0239
A4R128	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A4R129	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2611-F
A4R130	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A4R131	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R132	0757-0405	4	2	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A4R133	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A4R134	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A4R135	0757-0405	4		RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A4R136	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A4R137	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R138	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A4R139	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A4R140	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A4R141	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R142	2100-3350	5		RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	28480	2100-3350
A4R145	0698-7270	9		RESISTOR 26.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-2612-F
A4R146	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R147	0698-7256	1		RESISTOR 6.81K 1% .05W F TC=0+-100	24546	C3-1/8-T0-6811-F
A4R148	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630
A4R149	2100-3054	6		RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	02111	43P503
A4R150	0698-3459	8		RESISTOR 383K 1% .125W F TC=0+-100	28480	0698-3459
A4R151	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A4R152	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A4R153	0698-7253	8		RESISTOR 5.11K 1% .05W F TC=0+-100	24546	C3-1/8-T0-5111-F
A4R154	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-T0-21R5-F
A4R155	0698-7196	8		RESISTOR 21.5 1% .05W F TC=0+-100	24546	C3-1/8-T0-21R5-F
A4R156	0698-7236	7		RESISTOR 1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1001-F
A4R157				NOT ASSIGNED		
A4R157	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R158	0698-6630	3		RESISTOR 20K .1% .125W F TC=0+-25	28480	0698-6630

†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	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4R159-R199				*NOT ASSIGNED*		
A4R200	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R201	0698-6631	4		RESISTOR 2.5K .1% .125W F TC=0+-25	28480	0698-6631
A4R202	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A4R203	0698-8607	8		RESISTOR 4.5K .1% .125W F TC=0+-25	28480	0698-8607
A4R204	0698-7248	1		RESISTOR 3.16K 1% .05W F TC=0+-100	28480	0698-7248
A4R205	0699-0069	2		RESISTOR 2.15M 1% .125W F TC=0+-100	28480	0699-0069
A4R206	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A4R207	2100-3274	2		RESISTOR-TRMR 10K C SIDE-ADJ 1-TRN	28480	2100-3274
A4R208	0757-0470	3		RESISTOR 162K 1% .125W F TC=0+-100	25456	C4-1/8-TO-1623-F
A4R209	0698-8615	8		RESISTOR 75K 1% .05W F TC=0+-100	28480	0698-8615
A4R210	0698-4543	3		RESISTOR 487K 1% .125W F TC=0+-100	28480	0698-4543
A4R211	0698-3243	8		RESISTOR 178K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1783-F
A4RT1	0837-0239	2	1	THERMISTOR TUB WITH AXL LEADS 1K-OHM	28480	0837-0239
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
A4TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A4U1	1826-0574	6	3	IC OP AMP LOW-DRIFT TO-99 PKG	07263	UA714LHC
A4U2	1826-0574	6		IC OP AMP LOW-DRIFT TO-99 PKG	07263	UA714LHC
A4U3	1826-1491	8	3	IC OP AMP GP DIP PKG	01295	LM201AL
A4U4	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ
A4U5	1826-1491	8	3	IC OP AMP GP DIP PKG	01295	LM201AL
A4U6	1826-0109	3		IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A4U7	1826-0605	5	1	IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A4U8	1826-0109	3		IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A4U9	1826-0605	5	1	IC SWITCH ANLG QUAD 16-DIP-C PKG	17856	DG201BK
A4U10	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	04713	MC34004BL
A4U11	1820-1197	9	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A4U12	1826-0574	6		IC OP AMP LOW-DRIFT TO-99 PKG	07263	UA714LHC
A4U13	1826-0109	3		IC OP AMP WB TO-99 PKG	34371	HA2-2625-B0593
A4U14	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	02195	TL072ACJG
A4U15	1826-1491	8	3	IC OP AMP GP DIP PKG	01295	LM201AL
A4U16	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ
A4U17	1826-0753	3		IC OP AMP LOW-BIAS-H-IMPD QUAD 14-DIP-P	04713	MC34004BL
A4U18	1826-0609	8		IC MULTIPLXR ANLG 16-DIP-C PKG	06665	MUX08FQ
A4U19	1826-0138	8	10	IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A4U20	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ

†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	**08903-60283 – SERIAL PREFIX 2816A AND ABOVE (HP8903B)**					
A4U21	1826-0582	6	2	IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A4U22	1826-1097	0	4	IC OP AMP WB 8-DIP-C PKG	06665	OP-17FZ
A4U23	1826-0740	8	1	IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A4U24	1826-0740	8	1	IC SWITCH ANLG DUAL 16-DIP-C PKG	32293	IH5043CDE
A4U25	1826-0606	5		IC SWITCH ANLG QUAD 16-DIP-C PRP 126MA	17856	DGZO1BK
A4U26	1826-0488	1		IC OP AMP WB TO-99 PKG	27014	LM218H
A4U27	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TLO72ACJG
A4U28	1826-1097	0		IC OP AMP WB 8-DIP-C PKG	28480	1826-1097
A4U29	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A4VR1	1902-0943	5	3	DIODE-ZNR 2.4V 5% DO-35 PD=.4W TC=-.037%	28480	1902-0943
A4VR2	1902-0064	1	1	DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.05%	28480	1902-0064
A4VR3	1902-3024	9	1	DIODE-ZNR 2.87V 5% DO-7 PD=.4W TC=-.07%	28480	1902-3024
A4VR4	1902-0680	7	2	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A4VR5	1902-0953	7	1	DIODE-ZNR 6.2V 5% DO-35 PD=.4W TC=+.053%	28480	1902-0953
2450A TO 2712A						
A4W1				NOT ASSIGNED		
2817A AND ABOVE						
A4W1	1251-4670	2	1	CONNECTOR 3-PIN M POST TYPE	28480	1251-4670

†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						
A5	08903-60006	6	1	OSCILLATOR ASSEMBLY	28480	08903-60006
A5C1	0160-2055	9	61	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C2	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C9	0160-4590	1		CAPACITOR-FXD .18UF +-1% 200VDC	28480	0160-4590
A5C10	0160-5032	8		CAPACITOR-FXD .0223UF +-1% 200VDC	28480	0160-5032
A5C11	0160-3293	9		CAPACITOR-FXD 2470PF +-1% 100VDC MICA	28480	0160-3293
A5C12	0180-2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A5C13	0180 2620	6		CAPACITOR-FXD 2.2UF+-10% 50VDC TA	25088	D2R2GS1B50K
A5C14	0160 3934	5	2	CAPACITOR-FXD 350PF +-1% 100VDC MICA	28480	0160-3934
A5C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C16	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C18	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C19	0160-3934	5		CAPACITOR-FXD 350PF +-1% 100VDC MICA	28480	0160-3934
A5C20	0160-4590	1		CAPACITOR-FXD .18UF +-1% 200VDC	28480	0160-4590
A5C21	0160-5032	8		CAPACITOR-FXD .0223UF +-1% 200VDC	28480	0160-5032
A5C22	0160-3293	9		CAPACITOR-FXD 2470PF +-1% 100VDC MICA	28480	0160-3293
A5C23	0160-3874	2	1	CAPACITOR-FXD 10PF +-.5PF 200VDC CER	28480	0160-3874
A5C24	0160-0194	3	1	CAPACITOR-FXD .015UF +-10% 200VDC POLYE	28480	0160-0194
A5C25	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C26	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C27	0160-4494	4	1	CAPACITOR-FXD 39PF +-5% 200VDC CER 0+-30	28480	0160-4494
A5C28	0180-0197	8	13	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C29	0180-2141	6	1	CAPACITOR-FXD 3.3UF+-10% 50VDC TA	56289	150D335X9050B2
A5C30	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C31	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A5C32	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A5C33	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C34	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C35	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C36	0160-2225	5	1	CAPACITOR-FXD 2000PF +-5% 300VDC MICA	28480	0160-2225
A5C37	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A5C38	0160-3454	4	1	CAPACITOR-FXD 220PF +-10% 1KVDC CER	28480	0160-3454
A5C39	0160 4251	1	1	CAPACITOR-FXD 3300PF +.0000000033-3%	84411	863UW
A5C40	0160-3466	8	3	CAPACITOR-FXD 100PF +-10% 1KVDC CER	28480	0160-3466
A5C41	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C42	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A5C43	0180 0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A5C44	0160-4521	8	2	CAPACITOR-FXD 12PF +-5% 200VDC CER 0+-30	28480	0160-4521
A5C45	0160-4402	4	1	CAPACITOR-FXD .1UF +-10% 100VDC POLYP	28480	0160-4402

†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
A5C46	0160-2255	1	1	CAPACITOR-FXD 8.2PF +-.25PF 500VDC CER	28480	0160-2255
A5C47	0160-4084	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A5C48	0160-3456	6	3	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A5C49	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A5C50	0160-5031	7	1	CAPACITOR-FXD .047UF +-2% 100VDC	28480	0160-5031
A5C51	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C52	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C53	0160-4521	8		CAPACITOR-FXD 12PF +-5% 200VDC CER 0+-30	28480	0160-4521
A5C54	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A5C55	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C56	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A5C57	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C58	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
2450A TO 2720A						
A5C59				NOT ASSIGNED		
A5C60				NOT ASSIGNED		
2723A AND ABOVE						
A5C59	0160-5254	6		CAPACITOR-FXD 1.5PF +-.25PF 100VDC CER	28480	0160-5254
A5C60	0160-5254	6		CAPACITOR-FXD 1.5PF +-.25PF 100VDC CER	28480	0160-5254
2450A TO 2520A						
A5CR1	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR2	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR3	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR4	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR5	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR6	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR7	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR8	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR9	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR10	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR11	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR12	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR13	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR14	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A5CR15	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2601A AND ABOVE						
A5CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR6	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR7	1901-0880	7		DIODE-GEN PRP 125MA DO 35	28480	1901-0880
A5CR8	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR9	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR10	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR11	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR12	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR13	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR14	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A5CR15	1901-0880	7		DIODE-GEN PRP 125MA DO-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
A5CR16	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A5MP2	4040-0753	0	1	EXTR-PC BD GRN POLYC .062-BD-THKNS	28480	4040-0753
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A5MP3	0403-0026	6		PLUG-HOLE BDR-HD FOR .187-D-HOLE NYL	02768	207-120241-03-0101
A5Q1	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A5Q2	1854-0477	7	3	TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A5Q3	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q4	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q5	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q6	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q7	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q8	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q9	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q10	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q11	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q12	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q13	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q14	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q15	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q16	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q17	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q18	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q19	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q20	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q21	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q22	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q23	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q24	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q25	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q26	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q27	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q28	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q29	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q30	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q31	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5Q32	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A5Q33	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A5Q34	1855-0420	2		TRANSISTOR J-FET 2N4391 N-CHAN D-MODE	01295	2N4391
A5R1	0698-3430	5	27	RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R2	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R3	1810-0206	8	5	NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A5R4	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A5R5	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R6	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R7	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R8	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R9	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R10	0698-8204	1		RESISTOR 7.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-7981-B

†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
A5R11	0698-8205	2		RESISTOR 15.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-15981-B
A5R12	0698-8047	0		RESISTOR 32K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-3202-B
A5R13	0698-8049	2		RESISTOR 64K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-6402-B
A5R14	0698-8053	8		RESISTOR 128K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1283-B
A5R15	0698-8050	5		RESISTOR 256K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2563-B
A5R16	0699-0676	7	2	RESISTOR 511K .1% .125W F TC=0+-50	28480	0699-0676
A5R17	0699-0730	4	3	RESISTOR 1M .1% .125W F TC=0+-25	28480	0699-0730
A5R18	0757-0417	8	2	RESISTOR 562 1% .125W F TC=0+-100	24546	C4-1/8-T0-562R-F
A5R19	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1622-F
A5R20	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A5R21	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A5R22	0757-0394	0	6	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A5R23	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R24	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R25	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R26	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R27	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R28	0698-8204	1		RESISTOR 7.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-7981-B
A5R29	0698-8205	2		RESISTOR 15.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-15981-B
A5R30	0698-8047	0		RESISTOR 32K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-3202-B
A5R31	0698-8049	2		RESISTOR 64K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-6402-B
A5R32	0698-8053	8		RESISTOR 128K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1283-B
A5R33	0698-8050	5		RESISTOR 256K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2563-B
A5R34	0699-0676	7		RESISTOR 511K .1% .125W F TC=0+-50	28480	0699-0676
A5R35	0699-0730	4		RESISTOR 1M .1% .125W F TC=0+-25	28480	0699-0730
A5R36	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R37	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R38	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A5R39	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R40	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R41	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R42	0698-8049	2		RESISTOR 64K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-6402-B
A5R43	0698-8047	0		RESISTOR 32K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-3202-B
A5R44	0698-8205	2		RESISTOR 15.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-15981-B
A5R45	0698-8204	1		RESISTOR 7.98K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-7981-B
A5R46	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R47	0698-3450	9	2	RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A5R48	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A5R49	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A5R50	0699-0730	4		RESISTOR 1M .1% .125W F TC=0+-25	28480	0699-0730
A5R51	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R52	0698-8050	5		RESISTOR 256K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-2563-B
A5R53	0698-8053	8		RESISTOR 128K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1283-B
A5R54	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A5R55	0757-1094	9		RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A5R56	0698-0083	8	4	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A5R57	0757-0288	1	2	RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A5R58	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A5R59	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R60	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-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
A5R61	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R62	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R63	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R64	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R65	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R66	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R67	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R68				NOT ASSIGNED		
A5R69	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R70	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R71				NOT ASSIGNED		
A5R72	0698-3435	0	7	RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A5R73	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A5R74	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R75				NOT ASSIGNED		
A5R76	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R77	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R78	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R79	0757-0417	8		RESISTOR 562 1% .125W F TC=0+-100	24546	C4-1/8-T0-562R-F
A5R80	0698-3450	9		RESISTOR 42.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4222-F
A5R81	0757-0470	3		RESISTOR 162K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1623-F
A5R82	0757-0288	1		RESISTOR 9.09K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-9091-F
A5R83	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R84	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R85	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A5R86	0698-3161	9	2	RESISTOR 38.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3832-F
A5R87	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R88	0757-0317	7	2	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A5R89	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A5R90	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A5R91	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R92	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R93	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A5R94	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A5R95	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R96	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R97	0699-0400	5	1	RESISTOR 3.6K .1% .125W F TC=0+-25	28480	0699-0400
A5R98	0698-8204	1		RESISTOR 7.98K 1% .125W F TC=0+-25	19701	MF4C1/8-T9-7981-B
A5R99	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A5R100	0698-3445	2	1	RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A5R101	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R102	2100-3103	6		RESISTOR-TRMR 10K 10% C SIDE-ADJ 17-TRN	02111	43P103
A5R103	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R104	0698-6320	8	2	RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A5R105	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-25	03888	PME55-1/8-T9-5001-B
A5R106	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A5R107	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R108	0698-3161	9		RESISTOR 38.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3832-F
A5R109	0757-0428	1	3	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A5R110	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
A5R111	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A5R112	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A5R113	0698-3435	0		RESISTOR 38.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-38R3-F
A5R114	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R115	0698-3150	6		RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A5R116	0757-0459	8	1	RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
A5R117	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R118	0698-7262	9		RESISTOR 12.1K 1% .05W F TC=0+-100	24546	C3-1/8-T0-1212-F
A5R119	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R120	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A5R121	0698-7241	4		RESISTOR 1.62K 1% .05W F TC=0+-100	24546	C3-1/8-TO-1621-F
A5R122	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R123	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R124	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A5R125	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2151-F
A5R126	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R127	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A5R128	0698-3153	9		RESISTOR 3.83K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3831-F
A5R129	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R130	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R131	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A5R132	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-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
A5TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A5U1	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A5U2	1826-0026	3	1	IC COMPARATOR PRCN TO-99 PKG	01295	LM311L
A5U3				NOT ASSIGNED		
A5U4	1826-0662	3		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	28480	1826-0662
A5U5	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A5U6	08903-80041	4	1	IC, LINEAR	02480	08903-80041
A5U7	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A5U8	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A5U9	1826-0371	1	3	IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A5U10	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
A5U11	1826 0662	3		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	28480	1826-0662
A5U12	1826-0716	8	4	IC OP AMP LOW-NOISE DUAL 8-DIP-C PKG	18324	NE5532AFE
A5U13	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A5U14	1826-1492	9	2	IC OP AMP	28480	1826-1492
A5U15	1826-1492	9		IC OP AMP	28480	1826-1492

†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	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A5U17	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A5U18	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A5U19	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A5U20	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A5VR1	1902-0951	5	2	DIODE-ZNR 5.1V 5% DO-35 PD=.4W TC=+.035%	28480	1902-0951
A5VR2	1902-0951	5		DIODE-ZNR 5.1V 5% DO-35 PD=.4W TC=+.035%	28480	1902-0951
A5VR3	1902-0943	5		DIODE-ZNR 2.4V 5% DO-35 PD=.4W TC=-.037%	28480	1902-0943
A5VR4	1902-0954	8	1	DIODE-ZNR 6.8V 5% DO-35 PD=.4W TC=+.057%	28480	1902-0954
A5VR5	1902-0680	7		DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.4W	24046	1N827
A5VR6	1902-0955	9	1	DIODE-ZNR 7.5V 5% DO-35 PD=.4W TC=+.062%	28480	1902-0955

†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	08903-60132	9	1	OUTPUT ATTENUATOR ASSEMBLY	28480	08903-60132
A6C1	0180-0116	1	21	CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C2				NOT ASSIGNED		
A6C3	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C4	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C5	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C6				NOT ASSIGNED		
A6C7	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C8	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C9	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C10				NOT ASSIGNED		
A6C11	0160-4791	4		CAPACITOR-FXD 10PF +-5% 100VDC CER 0+-30	28480	0160-4791
A6C13	0180-2207	5		CAPACITOR-FXD 100UF +-10% 10VDC TA	56289	150D107X9010R2
A6C14	0160-4787	8		CAPACITOR-FXD 22PF +-5% 100VDC CER 0+-30	28480	0160-4787
A6C15	0160-4800	6	2	CAPACITOR-FXD 120PF +-5% 100VDC CER	28480	0160-4800
A6C16-C19				NOT ASSIGNED		
A6C20	0160-4800	6		CAPACITOR-FXD 120PF +-5% 100VDC CER	28480	0160-4800
A6C21	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C22	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C23	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C24	0180-0116	1		CAPACITOR-FXD 6.8UF +-10% 35VDC TA	56289	150D685X9035B2
A6C25	0121-0493	3	1	CAPACITOR-V TRMR-AIR 1.7-11PF 175V	74970	187-0306-125
A6C26	0160-4789	0	2	CAPACITOR-FXD 15PF +-5% 100VDC CER 0+-30	28480	0160-4789
A6C27				NOT ASSIGNED		
A6C28	0180-0374	3		CAPACITOR-FXD 10UF +-10% 20VDC TA	56289	150D106X9020B2
A6C29				NOT ASSIGNED		
A6C30	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C31	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C32	0180-1794	3	4	CAPACITOR-FXD 22UF +-10% 35VDC TA	56289	150D226X9035R2
A6C33	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C34	0180-1794	3		CAPACITOR-FXD 22UF +-10% 35VDC TA	56289	150D226X9035R2
A6C35	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C36	0180-1794	3		CAPACITOR-FXD 22UF +-10% 35VDC TA	56289	150D226X9035R2
A6C37	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C38	0180-1794	3		CAPACITOR-FXD 22UF +-10% 35VDC TA	56289	150D226X9035R2
A6C39	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A6C40	0160-3466	8		CAPACITOR-FXD 100PF +-10% 1KVDC CER	28480	0160-3466
A6C41	0160-3466	8		CAPACITOR-FXD 100PF +-10% 1KVDC CER	28480	0160-3466
A6CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR3				NOT ASSIGNED		
A6CR4	1901-0880	7		DIODE-GEN PRP 125MA DO-35	03406	1901-0880
A6CR5	1901-0880	7		DIODE-GEN PRP 125MA DO-35	03406	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
A6CR6	1901-0880	7		DIODE-GEN PRP 125MA DO-35	03406	1901-0880
A6CR7	1901-0880	7		DIODE-GEN PRP 125MA DO-35	03406	1901-0880
A6CR8	1901-0873	8	4	DIODE-HV RECT 600V 1A	28480	1901-0873
A6CR9	1901-0873	8		DIODE-HV RECT 600V 1A	28480	1901-0873
A6CR10	1901-0873	8		DIODE-HV RECT 600V 1A	28480	1901-0873
A6CR11	1901-0873	8		DIODE-HV RECT 600V 1A	28480	1901-0873
A6CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR13	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6CR14	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
2450A TO 2520A						
A6CR15	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A6CR16	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A6CR17	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A6CR18	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A6CR19	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A6CR20	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A6CR21	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
A6CR22	1901-0376	6		DIODE-GEN PRP 35V 50MA DO-35	28480	1901-0376
2001A AND ABOVE						
A6CR15	1901 0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A6CR16	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR17	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A4CR18	1901-0880	7		DIODE-GEN PRP 125MA DO-35	28480	1901-0880
A6CR19	1901-0179	7		DIODE-SWITCHING 15V 50MA 75OPS DO-7	28480	1901-0179
A6CR20	1901-0179	7		DIODE-SWITCHING 15V 50MA 75OPS DO-7	28480	1901-0179
A6CR21	1901-0179	7		DIODE-SWITCHING 15V 50MA 75OPS DO-7	28480	1901-0179
A6CR22	1901-0179	7		DIODE-SWITCHING 15V 50MA 75OPS DO-7	28480	1901-0179
A6CR23	1902-0627	2	4	DIODE-CUR RGLTR 1N5312 100V DO-7	04713	1N5312
A6CR24	1902-0627	2		DIODE-CUR RGLTR 1N5312 100V DO-7	04713	1N5312
A6CR25	1902 0627	2		DIODE-CUR RGLTR 1N5312 100V DO-7	04713	1N5312
A6CR26	1902-0627	2		DIODE-CUR RGLTR 1N5312 100V DO-7	04713	1N5312
A6CR27	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A6K1	0490-1190	0	2	RELAY 2C 5VDC-COIL .5A 125VAC	28480	0490-1190
A6K2	0490 1501	7	2	RELAY-R 200W 2A 5 VDC	28480	0490-1501
A6K3	0490-1501	7	2	RELAY-R 200W 2A 5 VDC	28480	0490-1501
A6K4	0490-1190	0		RELAY 2C 5VDC-COIL .5A 125VAC	28480	0490-1190
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				NOT ASSIGNED		
A6L4				NOT ASSIGNED		
A6L5	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A6MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A6MP2	4040-0754	1	1	EXTR-PC BD BLU POLYC .062-BD-THKNS	28480	4040-0754
	1480 0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A6Q1	1854 0637	1	2	TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
	0340-0834	0	4	INSULATOR-XSTR POLYI	28480	0340-0834
	1205-0095	0	4	HEAT SINK SGL TO-5/TO-39-CS	30161	3225B
A6Q2	1853-0314	9	2	TRANSISTOR PNP 2N2905A SI TO-39 PD=600MW	04713	2N2905A
	0340-0834	0		INSULATOR-XSTR POLYI	28480	0340-0834
	1205-0095	0		HEAT SINK SGL TO-5/TO-39-CS	30161	3225B

†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
A8Q3	1853-0314	9		TRANSISTOR PNP 2N2905A SI TO-39 PD=600MW	04713	2N2905A
	0340-0834	0		INSULATOR-XSTR POLYI	28480	0340-0834
	1205-0095	0		HEAT SINK SGL TO-5/TO-39-CS	30161	3225B
A8Q4	1854-0637	1		TRANSISTOR NPN 2N2219A SI TO-5 PD=800MW	01295	2N2219A
	0340-0834	0		INSULATOR-XSTR POLYI	28480	0340-0834
	1205-0095	0		HEAT SINK SGL TO-5/TO-39-CS	30161	3225B
A8Q5	1855-0418	8		TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0418
A8R1	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A8R2	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A8R3				NOT ASSIGNED		
A8R4	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A8R5	0698-8822	9		RESISTOR 6.81 1% .125W F TC=0+-100	28480	0698-8822
A8R6-R13				NOT ASSIGNED		
A8R14	0698-8812	7	3	RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A8R15				NOT ASSIGNED		
A8R16	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R17-R19				NOT ASSIGNED		
A8R20	0698-8812	7		RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A8R21	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R22	0698-7847	6	2	RESISTOR 1.111K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1111R-B
A8R23	0698-8812	7		RESISTOR 1 1% .125W F TC=0+-100	28480	0698-8812
A8R24	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A8R25	0698-6343	5		RESISTOR 9K .1% .125W F TC=0+-25	28480	0698-6343
A8R26	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A8R27	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A8R28	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A8R29	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R30	0698-6362	8		RESISTOR 1K .1% .125W F TC=0+-25	28480	0698-6362
A8R31	0698-7847	6		RESISTOR 1.111K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1111R-B
A8R32	2100-3353	8	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	28480	2100-3353
A8R33	0698-8825	2		RESISTOR 681K 1% .125W F TC=0+-100	28480	0698-8825
A8R34-R45				NOT ASSIGNED		
A8R46	0698-6624	5	2	RESISTOR 2K 1% .125W F TC=0+-25	28480	0698-6624
A8R47	0699-1728	2	2	RESISTOR 2.652K .1% .12W	28480	0699-1728
A8R48	0698-6624	5		RESISTOR 2K .1% .125W F TC=0+-25	28480	0698-6624
A8R49	0699-1728	2		RESISTOR 2.652K .1% .12W	28480	0699-1728
A8R50	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A8R51	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A8R52	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A8R53	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A8R54	0699-1726	0	2	RESISTOR 1.150K .1% .12W	28480	0699-1726
A8R55	0698-6348	0		RESISTOR 3K .1% .125W F TC=0+-25	28480	0698-6348
A8R56	0698-6348	0		RESISTOR 3K .1% .125W F TC=0+-25	28480	0698-6348
A8R57	0698-6348	0		RESISTOR 3K .1% .125W F TC=0+-25	28480	0698-6348
A8R58	0698-6348	0		RESISTOR 3K .1% .125W F TC=0+-25	28480	0698-6348
A8R59	0698-3430	5		RESISTOR 21.5 1% .125W F TC=0+-100	03888	PME55-1/8-T0-21R5-F
A8R60	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
A6R61	0699-1726	0		RESISTOR 1.150K .1% .12W	28480	0699-1726
A6R62-R65				NOT ASSIGNED		
A6R66	0757-0346	2	4	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R67	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R68	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R69	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R70	0811-3726	4	2	RESISTOR 25.42 .1% .75W	28480	0811-3726
A6R71	0811-3726	4	2	RESISTOR 25.42 .1% .75W	28480	0811-3726
A6R72-R74				NOT ASSIGNED		
A6R75	0811-3720	8	2	RESISTOR 40.91 .1% .4W	28480	0811-3720
A6R76	0811-3725	3		RESISTOR 10.10 .1% .4W	28480	0811-3725
A6R77	0811-3720	8	2	RESISTOR 40.91 .1% .4W	28480	0811-3720
A6R78-R81				NOT ASSIGNED		
A6R82	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R83				NOT ASSIGNED		
A6R84	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A6R85				NOT ASSIGNED		
A6R86				NOT ASSIGNED		
A6R87	0757-0464	5		RESISTOR 90.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9092-F
A6R88	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R89	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R90	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
2450A TO 2816A						
A6R91	0757-0123	3	2	RESISTOR 34.8K 1% .125W F TC=0+-100	28480	0757-0123
2818A AND ABOVE						
A6R91	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2152-F
A6R92	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
2450A TO 2816A						
A6R93	0757-0123	3		RESISTOR 34.8K 1% .125W F TC=0+-100	28480	0757-0123
2818A AND ABOVE						
A6R93	0757-0199	3		RESISTOR 21.5K 1% .125W F TC=0+-100	24546	C4-1/8-TO-2152-F
2450A TO 2816A						
A6R94	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
A6R95	0757-0278	9		RESISTOR 1.78K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1781-F
2818A AND ABOVE						
A6R94	0698-0085	0		RESISTOR 2.61K 1% .125 F TC=0+-100	24546	C4-1/8-TO-2611-F
A6R95	0698-0085	0		RESISTOR 2.61K 1% .125 F TC=0+-100	24546	C4-1/8-TO-2611-F
A6R96	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A6R97	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A6R98	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R99	0698-8821	8	4	RESISTOR 5.62 1% .125W F TC=0+-100	28480	0698-8821
A6R100	0698-8821	8		RESISTOR 5.62 1% .125W F TC=0+-100	28480	0698-8821
A6R101	0698-8821	8		RESISTOR 5.62 1% .125W F TC=0+-100	28480	0698-8821
A6R102	0698-8821	8		RESISTOR 5.62 1% .125W F TC=0+-100	28480	0698-8821
A6R103	0699-1727	1	1	RESISTOR 550 .1% .25W	28480	0699-1727
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
A6TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP5	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
A6TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A6U1	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A6U2	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A6U3	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A6U4	1820-0535	7	1	IC DRVR TTL AND DUAL 2-INP	01295	SN75451BP
A6U5	1826-0606	5	1	IC SWITCH ANLG QUAD 16 DIP-C PKG	17856	DG201BK
A6U6	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A6U7	1826-0180	0	1	IC TIMER TTL MONO/ASTBL	01295	NE555P
A6U8	1826-0759	9		IC COMPARATOR GP QUAD 14-DIP-C PKG	04713	LM339J
A6U9	1826-0783	9		IC OP AMP LOW-NOISE 8-DIP-C PKG	52063	XR5534ACN
A6U10	1826-0921	7	2	D/A 10-BIT 16-CBRZ/SDR CMOS	28480	1826-0921
A6U11	08903-80013	7	1	PROM 1816-0916	28480	08903-80013
A6U12	08903-80014	8	1	PROM 1816-0916	28480	08903-80014
A6U13	1826-0921	7		D/A 10-BIT 16-CBRZ/SDR CMOS	28480	1826-0921
A6U14	1820-1197	9	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A6VR1	1902-1397	5	2	DIO-ZNR 12V 5%	28480	1902-1397
A6VR2	1902-1397	5		DIO-ZNR 12V 5%	28480	1902-1397
A6VR3	1902-0966	2	1	DIODE-ZNR 22V 5% DO-35 PD=.4W TC=+.093%	28480	1902-0966
A6VR4-VR6				NOT ASSIGNED		
A6VR7	1902-0962	8	1	DIODE-ZNR 15V 5% DO-35 PD=.4W TC=+.087%	28480	1902-0962
A6W1	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A6W2	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
A7						
A7	08903-60130	7	1	LATCH ASSEMBLY	28480	08903-60130
A7C1	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A7C2	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A7C3	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C4	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C5	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A7C6	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C7	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C8	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C9	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C10	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C11	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C12	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C13	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C14	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C15	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C16	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C17	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C18	0160-4832	4		CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A7C19	0180-0376	5	7	CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A7C20	0180-0376	5		CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A7C21	0160-4822	2	2	CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A7C22	0160-4822	2		CAPACITOR-FXD 1000PF +-5% 100VDC CER	28480	0160-4822
A7C23	0180-2249	5	2	CAPACITOR-FXD 47UF+-10% 20VDC TA	56289	150D476X9020R2
A7C24	0180-2249	5		CAPACITOR-FXD 47UF+-10% 20VDC TA	56289	150D476X9020R2
A7C25	0180-0376	5		CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A7C26	0180-0376	5		CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A7C27	0180-0376	5		CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A7C28	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A7C29	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A7C30	0160-4789	0		CAPACITOR-FXD 15PF +-5% 100VDC CER 0+-30	28480	0160-4789
A7C31	0180-0376	5		CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A7C32	0180-0376	5		CAPACITOR-FXD .47UF+-10% 35VDC TA	56289	150D474X9035A2
A7CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A7CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A7CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR7	1906-0042	3	1	DIODE-DUAL 70V VF DIFF=10MV	28480	1906-0042
A7CR8Δ	1906-0388	0	1	DIODE-DUAL 50V 200MA VF DIFF=3MV	02037	MSD6101
A7CR9	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR10	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050

†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
A7MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A7MP2	4040-0755	2	1	EXTR-PC BD VIO POLYC .062-BD-THKNS	28480	4040-0755
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A7R1				NOT ASSIGNED		
A7R2	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R3	1810-0205	7	1	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A7R4				NOT ASSIGNED		
A7R5	0698-3155	1	1	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A7R6	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A7R7	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A7R8*	0757-0440	7	7	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A7R9	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A7R10*	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A7R11	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A7R12	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-100	03888	PME55-1/8-T9-5001-B
A7R13	0698-6320	8		RESISTOR 5K .1% .125W F TC=0+-100	03888	PME55-1/8-T0-5001-B
A7R14	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1962-F
A7R15	0675-1021	8	2	RESISTOR 1K 10% .125W CC TC=-330/+800	01121	BB1021
A7R16	0675-1021	8		RESISTOR 1K 10% .125W CC TC=-330/+800	01121	BB1021
A7R17	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R18	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R19	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R20	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R21	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R22	0699-0070	5	2	RESISTOR 3.16M 1% .125W F TC=0+-100	28480	0699-0070
A7R23	0699-0070	5		RESISTOR 3.16M 1% .125W F TC=0+-100	28480	0699-0070
A7R24	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R25	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R26	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R27	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R28	0683-1015	7	1	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A7TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A7U1	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A7U2	1826-0138	8		IC COMPARATOR GP QUAD 14-DIP-P PKG	01295	LM339N
A7U3	1826-0323	3	1	IC OP AMP GP QUAD 14-DIP-C PKG	28480	1826-0323
A7U4	1826-0188	8	2	IC CONV 8-B-D/A 16-DIP-C PKG	04713	MC1408L-8
A7U5	1820-1729	3	12	IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U6	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U7	1820-1216	3	4	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A7U8	1820-1211	8	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86N
A7U9	1820-1195	7	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A7U10	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
A7U11	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A7U12	1820-1112	8	7	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A7U13	1820 1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A7U14	1820 1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A7U15	1820-0269	4	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7403N
A7U16	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A7U17	1826-0371	1		IC OP AMP LOW-BIAS-H-IMPD TO-99 PKG	27014	LF256H
A7U18	1826-1018	5	1	ANALOG-SWITCH 4SPST 16-DIP-P	28480	1826-1018
A7U19	1826-0188	8		IC CONV 8-B-D/A 16-DIP-C PKG	04713	MC1408L-8
A7U20	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U21	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U22	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U23	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U24	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U25	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U26	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U27	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U28	1820 1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U29	1820-1729	3		IC LCH TTL LS COM CLEAR 8-BIT	01295	SN74LS259N
A7U30	1820-1199	1	4	IC INV TTL LS HEX 1-INP	01295	SN74LS04N

†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
A8	**08903-60134 – SERIAL PREFIX 2450A TO 2614A**					
A8	08903-60134	1	1	CONTROLLER/COUNTER ASSEMBLY	28480	08903-60134
A8C1	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C2	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C11	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C12	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C13	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A8C14	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A8C15	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C16	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A8C17	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C18	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C19	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C20	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C21	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C22	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C23				NOT ASSIGNED		
A8C24	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C25	0160-2264	2		CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-2264
A8C26	0160-4789	0	1	CAPACITOR-FXD 15PF +-5% 100VDC CER 0+-30	28480	0160-4789
A8C27	0121-0436	4	1	CAPACITOR-V TRMR-AIR 2 6-23.5PF 350V	74970	189-0309-125
A8C28	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C29	0180-0553	0	1	CAPACITOR-FXD 22UF+-20% 25VDC TA	28480	0180-0553
A8C30	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C31	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C32	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C33	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C34	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C35				NOT ASSIGNED		
A8C36	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C37	0180-1745	4	1	CAPACITOR-FXD 1.5UF+-10% 20VDC TA	56289	150D155X9020A2
A8CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR9	1901-0539	3	1	DIODE-SM SIG SCHOTTKY	28480	1901-0539

†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
A8	**08903-60134 – SERIAL PREFIX 2450A TO 2614A**					
A8DS1	1990-0524	3	4	LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4550
A8DS2	1990-0524	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4550
A8DS3	1990-0524	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4550
A8DS4	1990-0524	3		LED-LAMP LUM-INT=1MCD IF=20MA-MAX BVR=5V	28480	5082-4550
A8J1	1200-0507	9	1	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A8MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A8MP2	4040-0747	2	1	EXTR-PC BD GRA POLYC .062-BD-THKNS	28480	4040-0747
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A8MP3	08903-00060	6	1	LBL-BD 03E MON	28480	08903-00060
A8Q1	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A8R1	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R2	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A8R3	1810-0055	5	1	NETWORK-RES 9-SIP10.0K OHM X 8	28480	1810-0055
A8R4	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R5	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R6	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R7	1810-0363	8	1	NETWORK-RES 6-SIP330.0 OHM X 5	01121	206A331
A8R8	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R10	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R11	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R12	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R13	0757-0459	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A8TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP12	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP13	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP14	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP15	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP16	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP17	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8TP18	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A8U1	1820-1193	5	4	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U2	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U3	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A8U4	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A8U5	1820-1920	4	1	IC-F8-MPU; CLK FREQ=2 MHZ	28480	1820-1928
	1200-0654	7	3	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A8U6	1820-2027	9	1	IC-STATIC MEMORY INTERFACE	28480	1820-2027
	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A8U7	1820-1417	6	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
	1200-0638	7	2	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0538

†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
A8	**08903-60134 – SERIAL PREFIX 2450A TO 2614A**					
2450A TO 2520A						
A8U8	08903-80017	1	1	ROM-PROG #2	28480	08903-80017
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U9	08903-80016	0	1	ROM-PROG #1	28480	08903-80016
	1200 0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U10	08903-80018	2	1	ROM-PROG #3	28480	08903-80018
	1200 0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U11	08903-80019	3	1	ROM-PROG #4	28480	08903-80019
	1200 0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200 0541
A8U12	08903-80022	8	1	ROM-PROG #7	28480	08903-80022
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U13	08903-80021	7	1	ROM-PROG #6	28480	08903-80021
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
2537A TO 2611A						
A8U8	1818-3742	9	1	ROM-PROG #2	28480	1818-3742
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U9	1818-3741	8	1	ROM-PROG #1	28480	1818-3741
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U10	1818-3743	0	1	ROM-PROG #3	28480	1818-3743
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U11	1818 3744	1	1	ROM-PROG #4	28480	1818-3744
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U12	1818-3747	4	1	ROM-PROG #7	28480	1818-3747
	1200 0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U13	1818-3746	3	1	ROM-PROG #6	28480	1818-3746
A8U14	1820 1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U15	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U16	1820-1287	8	1	IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS37N
A8U17	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A8U18	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A8U19	1820-1202	7		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A8U20	1820 1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A8U21	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A8U22	1820 1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A8U23	1820-0174	0	1	IC INV TTL HEX	01295	SN7404N
A8U24	1820-1418	7	1	IC DCDR TTL LS BCD-TO-DEC 4-TO-10-LINE	01295	SN74LS42N
A8U25				NOT ASSIGNED		
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
	1200 0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
2450A TO 2520A						
A8U26	08903-80024	0	1	ROM-PROG #9	28480	08903 80024
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U27	08903-80023	9	1	ROM-PROG #8	28480	08903-80023
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U28	08903-80020	6	1	ROM-PROG #5	28480	08903-80020
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
2537A TO 2611A						
A8U26	1818 3749	6	1	ROM-PROG #9	28480	1818-3749
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U27	1818-3748	5	1	ROM-PROG #8	28480	1818-3748
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
A8U28	1818-3745	2	1	ROM-PROG #5	28480	1818-3745
	1200-0541	1		SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541

†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
A8	**08903-60134 – SERIAL PREFIX 2450A TO 2614A**					
A8U29	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A8U30	1818-0197	2	1	IC NMOS 1024 (1K) STAT RAM 400-NS 3-S	34335	AM91L11BDC
	1200-0539	7	1	SOCKET-IC 18-CONT DIP DIP-SLDR	28480	1200-0539
A8Y1	0410-0757	5	1	CRYSTAL-QUARTZ 2.000 MHZ HC-6/U-HLDR	28480	0410-0757
	1200-0770	8	1	SOCKET-XTAL 2-CONT HC-6/U DIP-SLDR	28480	1200-0770

†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
A8	**08903-60184 – SERIAL PREFIX 2652A TO 2922A**					
A8	08903-60184	1	1	CONTROLLER/COUNTER ASSEMBLY	28480	08903-60184
A8C1	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C2	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C3	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C4	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C5	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C7	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C8	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C9	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C10	0160 4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C11	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C12	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
2652A TO 2836A						
A8C13	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C14	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
2908A TO 2922A						
A8C13	0160-4822	2		CAPACITOR-FXD 1000PF +-10% 100VDC	28480	0160-4822
A8C14	0160-4822	2		CAPACITOR-FXD 1000PF +-10% 100VDC	28480	0160-4822
A8C15	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C16	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A8C17	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C18	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C19	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A8C20	0160 4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C21	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C22	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C23	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C24	0160-4832	4		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-4832
A8C25	0160-4787	8		CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-4787
A8C26*	0160-4787	8	4	CAPACITOR-FXD 20PF +-5% 500VDC CER 0+-30	28480	0160-4787
A8C27	0121-0436	4	1	CAPACITOR-V TRMR-AIR 2.6-23.5PF 350V	74970	189-0509-125
A8C28				NOT ASSIGNED		
A8C29				NOT ASSIGNED		
A8C30				NOT ASSIGNED		
A8C31				NOT ASSIGNED		
A8C32				NOT ASSIGNED		
A8C34				NOT ASSIGNED		
A8C35				NOT ASSIGNED		
A8C36				NOT ASSIGNED		
A8C37	0180-1745	4	1	CAPACITOR-FXD 1.5UF+-10% 20VDC TA	56289	150D155X9020A2
A8C38	0160-4832	4	1	CAPACITOR-FXD .01UF +-10% 100VDC CER	28480	0160-4832
A8C44	0180-0197	8	1	CAPACITOR-FXD 2.2UF +-10% 20VDC TA	28480	0180-0197
A8CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR4	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR5	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR6	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR7	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR8	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A8CR9	1901-0539	3	1	DIODE-SM SIG SCHOTTKY	28480	1901-0539

†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
A8	**08903-60184 – SERIAL PREFIX 2652A TO 2922A**					
A8DS1	1990-1110	5	4	LED-LAMP LUM-INT=1.5 MCD IF=15MA-MAX	28480	1990-1110
A8DS2	1990-1110	5	4	LED-LAMP LUM-INT=1.5 MCD IF=15MA-MAX	28480	1990-1110
A8DS3	1990-1110	5	4	LED-LAMP LUM-INT=1.5 MCD IF=15MA-MAX	28480	1990-1110
A8DS4	1990-1110	5	4	LED-LAMP LUM-INT=1.5 MCD IF=15MA-MAX	28480	1990-1110
A8J1	1200-0507	9	1	SOCKET-IC 16-CONT DIP-SLDR	28480	1200-0507
A8MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A8MP2	4040-0747	2	1	EXTR-PC BD GRA POLYC .062-BD-THKNS	28480	4040-0747
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A8MP3				NOT ASSIGNED		
A8Q1	1854-0810	2	1	TRANSISTOR NPN SI PD=625MW FT=200MHZ	28480	1854-0810
A8R1	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A8R2	0698-3440	7	1	RESISTOR 196 1% .125W F TC=0+-100	24546	C4-1/8-T0-196R-F
A8R3	1810-0286	2	1	NETWORK-CAPACITOR SIP 390 PF EA 8 PINS	2	8480-1810-0286
A8R4	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R5	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R6	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R7				NOT ASSIGNED		
A8R8	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R10	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R11	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R12	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R13	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A8TP1	1251-5039	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	22526	65500-116
A8TP2				NOT ASSIGNED		
A8TP3				NOT ASSIGNED		
A8TP4				NOT ASSIGNED		
A8TP5				NOT ASSIGNED		
A8TP6				NOT ASSIGNED		
A8TP7				NOT ASSIGNED		
A8TP8				NOT ASSIGNED		
A8TP9				NOT ASSIGNED		
A8TP10				NOT ASSIGNED		
A8TP11				NOT ASSIGNED		
A8TP12				NOT ASSIGNED		
A8TP13				NOT ASSIGNED		
A8TP14				NOT ASSIGNED		
A8TP15				NOT ASSIGNED		
A8TP16				NOT ASSIGNED		
A8TP17				NOT ASSIGNED		
A8TP18				NOT ASSIGNED		

†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
A8	**08903-60184 – SERIAL PREFIX 2652A TO 2922A**					
A8U1	1820-1193	5	4	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U2	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U3	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A8U4	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A8U5	1820-1928	4	1	IC-F8-MPU, CLK FREQ=2 MHZ	28480	1820-1928
	1200-0654	7	3	SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A8U6	1820-2027	6	1	IC-STATIC MEMORY INTERFACE	28480	1820-2027
	1200-0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A8U7	1820-1417	6	4	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
	1200-0638	7	2	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A8U8				NOT ASSIGNED		
A8U9				NOT ASSIGNED		
A8U10				NOT ASSIGNED		
A8U11				NOT ASSIGNED		
A8U12				NOT ASSIGNED		
A8U13				NOT ASSIGNED		
A8U15	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U16	1820-1287	8	1	IC BFR TTL LS NAND QUAD 2-INP	01295	SN74LS37N
A8U17	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
	1200-0638	7		SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0638
A8U18	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A8U19	1820-1202	7		IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A8U20	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A8U21	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A8U22	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A8U23	1820-0174	0	1	IC INV TTL HEX	01295	SN7404N
A8U24				NOT ASSIGNED		
A8U25				NOT ASSIGNED		
A8U26				NOT ASSIGNED		
A8U27				NOT ASSIGNED		
A8U28				NOT ASSIGNED		
A8U29	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A8U30	1818-0197	2	1	IC NMOS 1024 (1K) STAT RAM 400-NS 3-S	34335	AM91L11RDC
	1200-0539	7	1	SOCKET-IC 18-CONT DIP DIP-SLDR	28480	1200-0539
2150A TO 2818A						
A8U31	08903-80036	4	1	ROM-PROG 10 (8903B ONLY)	28480	08903-80036
	1200-1121	5	1	SOCKET-IC DIP PC	28480	1200-1121
2836A TO 2922A						
A8U31	08903-80050	2	1	ROM-PROG 10 (8903B ONLY)	28480	08903-80050
	1200-1121	5	1	SOCKET-IC DIP PC	28480	1200-1121
A8U34	1820-1281	2	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS139N
A8Y1	0410-0757	5	1	CRYSTAL-QUARTZ 2.000 MHZ HC-6/U-HLDR	28480	0410-0757
A8Y1	0410-0757	5	1	CRYSTAL-QUARTZ 2.000 MHZ HC-6/U-HLDR	28480	0410-0757

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). Δ Errata part change.

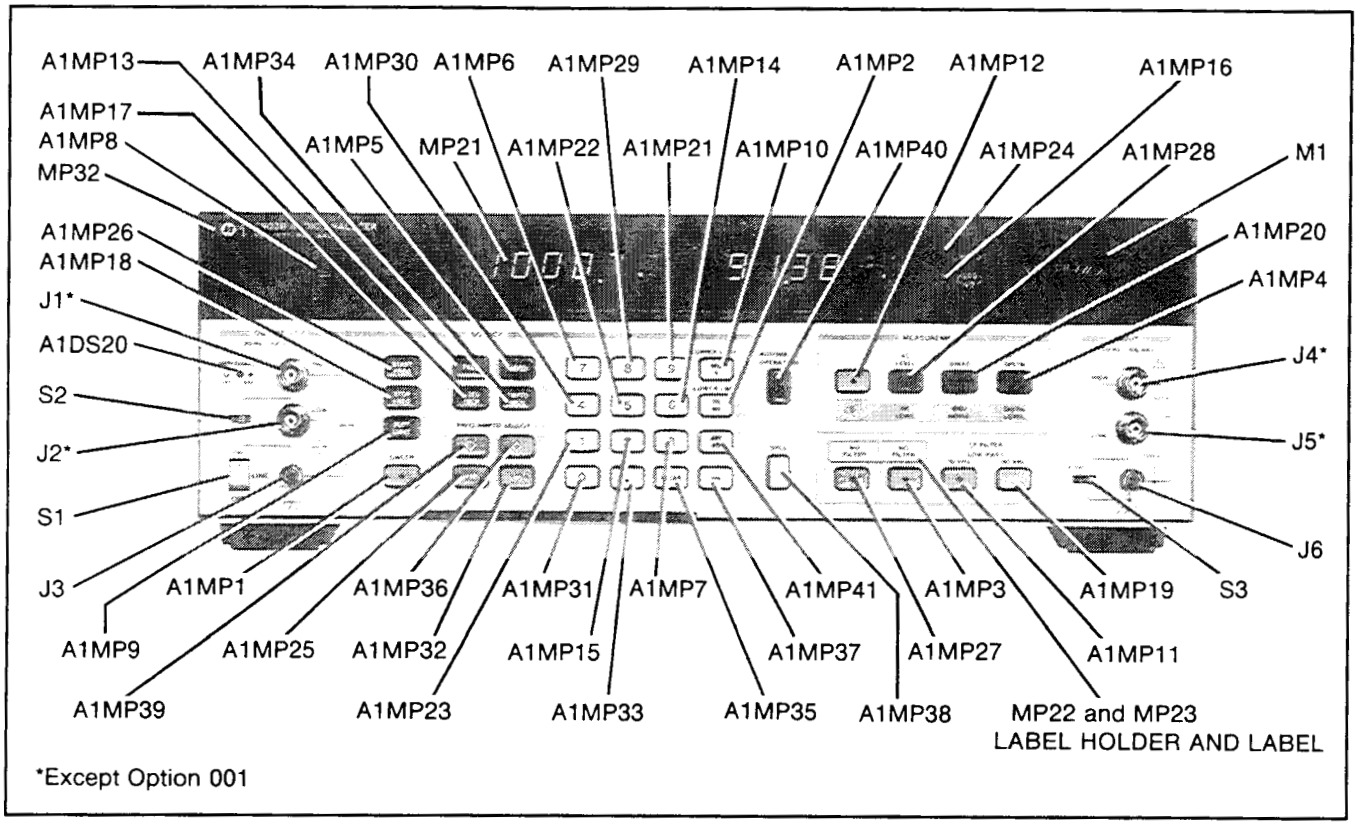


Figure 6–3. *Chassis and Mechanical Parts Identification - Front Panel*

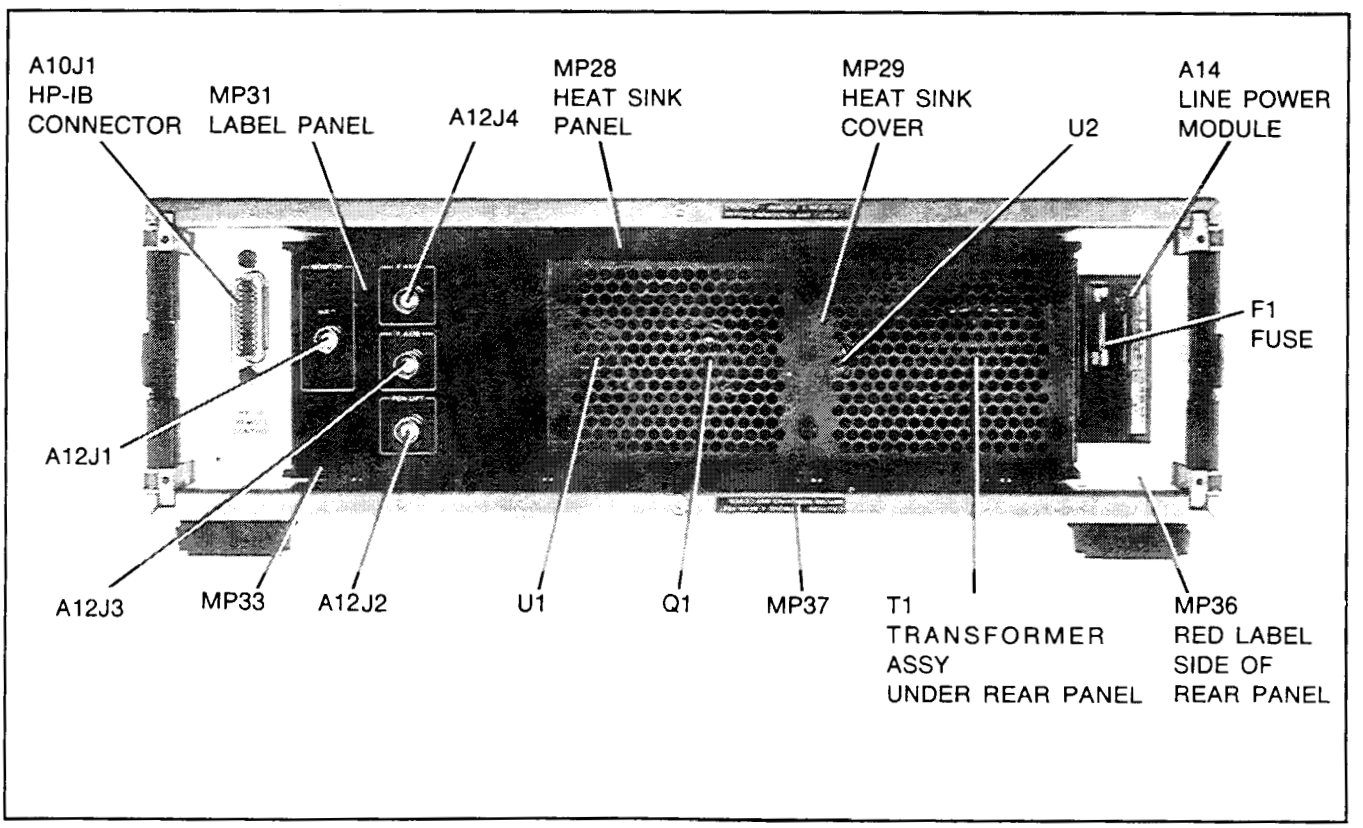


Figure 6–4. *Chassis and Mechanical Parts Identification - Rear Panel (2742A and above)*

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A8	**08903-60300 – SERIAL PREFIX 2948A AND ABOVE**					
A8	08903-60300	3	1	CONTROLLER/COUNTER ASSEMBLY	28480	08903-60300
A8C1	0160-4832	4	22	CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C2	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C3	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C4	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C5	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C6	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C7	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C8	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C9	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C10	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C11	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C12	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C13	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C14	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C15	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C16	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C17	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C18	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C19	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C20	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C21	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C22	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A8C27	0160-4822	2	2	CAP-FXD 1000pF 100 V	09969	RPA20C0G102J100V
A8C28	0160-4822	2		CAP-FXD 1000pF 100 V	09969	RPA20C0G102J100V
A8C29	0180-1974	1	1	CAP-FXD 10uF 35 V TA	56289	150D106X9035R2
A8C30	0160-4835	7	1	CAP-FXD 0.1uF 50 V	09969	RPA20X7R104K50VPT
A8C31*	0160-4783	4	1	CAP-FXD 15pF +-2% 200V CER COG	06352	FD112COG2D150G
A8C32	0160-4765	2	1	CAP-FXD 36pF 200 V	09969	RPE121-105C0G360J200V
A8C33	0180-2111	0	4	CAP-FXD 33uF 35 V TA	56289	150D336X9035SA
A8C34	0180-0197	8	4	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2
A8C35	0180-0197	8		CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2
A8C36	0180-0197	8		CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2
A8C37	0180-0197	8		CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2
A8C38	0180-2111	0		CAP-FXD 33uF 35 V TA	56289	150D336X9035SA
A8C39	0180-2111	0		CAP-FXD 33uF 35 V TA	56289	150D336X9035SA
A8C40	0180-2111	0		CAP-FXD 33uF 35 V TA	56289	150D336X9035SA
A8C41	0121-0436	4	1	CAP-VAR 23.5pF 2.6pF 350 V AIR	74970	189-0509-125
A8CR1	1901-1098	1	8	DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A8CR2	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A8CR3	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A8CR4	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A8CR5	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A8CR6	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A8CR7	1901-1098	1		DIODE-SWITCHING 1N4150 50V 200MA 4NS	9N171	1N4150
A8CR8	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
A8	**08903-60300 – SERIAL PREFIX 2948A AND ABOVE**					
A8DS1	1990-1110	5	4	LED-LAMP LUM-INT=1.5MCD IF=15MA-MAX	28480	HLMP-3600
A8DS2	1990-1110	5		LED-LAMP LUM-INT=1.5MCD IF=15MA-MAX	28480	HLMP-3600
A8DS3	1990-1110	5		LED-LAMP LUM-INT=1.5MCD IF=15MA-MAX	28480	HLMP-3600
A8DS4	1990-1110	5		LED-LAMP LUM-INT=1.5MCD IF=15MA-MAX	28480	HLMP-3600
A8R1	0757-0401	0	1	RESISTOR 100 +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-101-F
A8R2	0698-3440	7	1	RESISTOR 196 +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-196R-F
A8R3	0757-0416	7	1	RESISTOR 511 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-511R-F
A8R6	0757-0442	9	2	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A8R7	0757-0442	9		RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A8R8	1810-0206	8	2	NETWORK-RES 8-SIP 10.0K OHM X 7	C1433	750-81
A8R9	1810-0206	8		NETWORK-RES 8-SIP 10.0K OHM X 7	C1433	750-81
A8S1	3101-0418	3	1	SWITCH-DIP RKR 10-1A 0.1A 30VDC	81073	76RSB10SL
A8TP1	1251-0600	0	2	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A8TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	12360	94-155-1010-01-03-00
A8U1	1820-1193	5	4	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U2	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U3	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A8U4	1820-1197	9	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A8U5	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U6	1820-1193	5		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS197N
A8U7	1820-1417	6	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A8U8	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A8U9	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A8U10	1820-1202	7	1	IC GATE TTL LS NAND TPL 3 INP	01295	SN74LS10N
A8U11	1820-1216	3	2	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A8U12	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A8U13	1820-1208	3	1	IC GATE TTL LS OR QUAD 2-INP	01295	SN74LS32N
A8U14	1820-2624	9	1	IC-MPU: CLK FREQ=2 MHZ, ENHANCED 6800	04713	MC68B09P
A8U15	08903-87003	9	1	PROGRAMMED ROM	28480	08903-87003
A8U16	1820-1281	2	1	IC DCDR TTL LS 2-TO-4-LINE DUAL	01295	SN74LS139AN
A8U17	1818-3183	2	1	IC CMOS 65536 (64K) STAT RAM 150-NS 3-S	S4013	HM6264LP-15
A8U18	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A8U19	1820-2983	3	1	IC-PERIPHERAL INTERFACE ADAPTER,CLK=2MHZ	04713	MC68B21P
A8U20	1820-1917	1	1	IC DRVR TTL LS LINE OCTL	01295	SN74LS240N
A8U21	1820-3608	1	1	IC INV TTL AS HEX	01295	SN74AS04N
A8U22	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A8VR1	1826-1338	2	1	IC MISC 8-DIP-P PKG	01295	TL7705A
A8Y1	0410-0779	1	1	CRYSTAL-QUARTZ 8.0 MHZ HC-18/U-HLDR	11236	020-1746-0
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
	4040-0747	2	1	EXTR-PC BD GRA POLYC .062-IN-BD-THKNS	28480	4040-0747
	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	73957	GP24 063 X 250-17
	0361-0026	6	1	RIVET-SEMITUB OVH .089DIA .125LG	28480	0361-0026
	1400-0973	7	1	CLIP-CMPNT .139-.154-DIA STL	91506	6180-1A
	1200-0587	1	1	SOCKET-IC-DIP 28-CONT DIP DIP-SLDR	01295	C8728-01
	1200-0654	7	2	SOCKET-IC-DIP 40-CONT DIP DIP-SLDR	01295	C8740-01

†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
A9	**08903-60118 – SERIAL PREFIX 2450A TO 2922A**					
A9	08903-60118	1	1	REMOTE INTERFACE ASSEMBLY	28480	08903-60118
A9C1	0180-0374	3		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A9C2	0180-0229	7		CAPACITOR-FXD 33UF+-10% 10VDC TA	56289	150D336X9010B2
A9C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C4	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A9C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C11	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C12	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C13	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C14	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C15	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C16	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A9C17	0160-0574	3	2	CAPACITOR-FXD .022UF +-20% 100VDC CER	28480	0160-0574
A9C18	0140-0196	3	1	CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J0300WV1CR
A9C19	0160-0574	3		CAPACITOR-FXD .022UF +-20% 100VDC CER	28480	0160-0574
A9CR1	1901-0518	8		DIODE-SM SIG SCHOTTKY	28480	1901-0518
A9MP1	4040-0748	3		EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A9MP2	4040-0756	3	1	EXTR-PC BD WHT POLYC .062-BD-THKNS	28480	4040-0756
	1480-0116	8		PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
A9R1	0698-3444	1	2	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8 T0 316R-F
A9R2	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
A9R3	1810-0206	8		NETWORK-RES 8-SIP10.0K OHM X 7	01121	208A103
△ A9R4	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A9R5	0757-0416	7		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A9R6	1810-0136	3	1	NETWORK-RES 10-SIP MULTI-VALUE	28480	1810-0136
A9R7	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A9R8	0698-3444	1		RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A9R9	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A9S1	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
A9TP1	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A9TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A9TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A9TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A9TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A9TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A9TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A9TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM BSC-SZ SQ	28480	1251-0600
A9TP9	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). △ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A9	**08903-60118 – SERIAL PREFIX 2450A TO 2922A**					
A9U1	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A9U2	08901-80004	4	1	PROM 1816-0915	28480	08901-80004
A9U3	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A9U4	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A9U5	1820-2740	0	1	IC COMPTR TTL LS MAGTD 2-INP 8-BIT	01295	SN74LS688N
A9U6	1820-1905	7	1	IC GATE TTL LS NOR DUAL 5-INP	07263	74LS260PC
A9U7	1820-1198	0	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A9U8	1820 1689	4	2	IC UART TTL QUAD	O1295	1820-1689
A9U9	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A9U10	1820-1689	4	2	IC UART TTL QUAD	O1295	1820-1689
A9U11	1820-1200	5	2	IC INV TTL LS HEX	01295	SN74LS05N
A9U12	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A9U13	1820-1200	5		IC INV TTL LS HEX	01295	SN74LS05N
A9U14	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A9U15	1820 0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A9U16	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A9U17	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A9U18	1820 2100	6	1	IC MICPROC-ACCESS NMOS DUAL 8-BIT	07263	3861EPC
	1200 0654	7		SOCKET-IC 40-CONT DIP DIP-SLDR	28480	1200-0654
A9U19	1820 1416	5	1	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A9U20	1820-0621	2	1	IC BFR TTL NAND QUAD 2-INP	01295	SN7438N

†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
A9	**08903-60297 – SERIAL PREFIX 2948A AND ABOVE**					
A9	08903-60297	7		REMOTE INTERFACE ASSEMBLY	28480	08903-60297
A9C2	0180-2111	0	1	CAP-FXD 33uF 35 V TA	56289	150D336X9035SA
A9C4	0180-0197	8	1	CAP-FXD 2.2uF 20 V TA	56289	150D225X9020A2
A9C5	0160-4832	4	12	CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C6	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C7	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C8	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C9	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C10	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C11	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C12	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C13	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C14	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C15	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C16	0160-4832	4		CAP-FXD 0.01uF 100 V	09969	RPA10X7R103K100V
A9C17	0160-4833	5	2	CAP-FXD 0.022uF 100 V	09969	RPA20X7R223K100V
A9C18	0160-4814	2	1	CAP-FXD 150pF 100 V	09969	RPA10C0G151J100V
A9C19	0160-4833	5		CAP-FXD 0.022uF 100 V	09969	RPA20X7R223K100V
A9CR1	1901 0518	8	1	DIODE-SCHOTTKY SM SIG	12403	5082-2800
A9R1	0698 3444	1	2	RESISTOR 316 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-316R-F
A9R2	1810-0206	8	3	NETWORK-RES 8-SIP 10.0K OHM X 7	C1433	750-81
A9R3	1810 0206	8		NETWORK-RES 8-SIP 10.0K OHM X 7	C1433	750-81
A9R4	0698-0084	9	1	RESISTOR 2.15K +-1% .125W TF TC=0+-100	24546	C4-1/8-T0-2151-F
A9R5	0757-0416	7	1	RESISTOR 511 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-511R-F
A9R6	1810 0136	3	1	NETWORK-RES 10-SIP MULTI-VALUE	01121	410S003
A9R7	0698 0083	8	1	RESISTOR 1.96K +-1% .125W TF TC=0+-100	12498	CT4-1/8-TO-1961-F
A9R8	0698-3444	1		RESISTOR 316 +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-316R-F
A9R9	0757-0442	9	1	RESISTOR 10K +-1% .125W TF TC=0+-100	12498	CT4-1/8-T0-1002-F
A9R10	1810-0206	8		NETWORK-RES 8-SIP 10.0K OHM X 7	C1433	750-81
A9S1	3101-1973	7	1	SWITCH-DIP SL 7-1A 0.1A 50VDC	11236	11P-1028
A9TP1	1251-0600	0	8	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9TP6	1251 0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SO	12360	94-155-1010-01-03-00
A9U1	1820-1112	8	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A9U2	08901-80004	4	1	PROM 1816-0915	28480	08901-80004
A9U3	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A9U4	1820-1417	6	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A9U5	1820-2740	0	1	IC COMPTR TTL LS MAGTD 2-INP 8-BIT	34335	AM25LS2521PC

†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
A9	**08903-60297 – SERIAL PREFIX 2948A AND ABOVE**					
A9U6	1820-1905	7	1	IC GATE TTL LS NOR DUAL 5-INP	18324	74LS260N
A9U7	1820-1198	0	2	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A9U8	1820-1689	4	2	IC-INTERFACE XCVR INSTRUMENT BUS IEEE	01295	MC3446N
A9U9	1820-1198	0		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS03N
A9U10	1820-1689	4		IC-INTERFACE XCVR INSTRUMENT BUS IEEE	01295	MC3446N
A9U11	1820-1200	5	2	IC INV TTL LS HEX	01295	SN74LS05N
A9U12	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74AN
A9U13	1820-1200	5		IC INV TTL LS HEX	01295	SN74LS05N
A9U14	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A9U15	1820-0054	5	1	IC GATE TTL NAND QUAD 2-INP	01295	SN7400N
A9U16	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A9U17	1820-1417	6		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS26N
A9U18	1820-2983	3	1	IC-PERIPHERAL INTERFACE ADAPTER;CLK=2MHZ	04713	MC68B21P
A9U19	1820-1416	5	1	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A9U20	1820-0621	2	1	IC BFR TTL NAND QUAD 2-INP	01295	SN7438N
A9XS1	1200-0485	2	1	SOCKET-IC-DIP 14-CONT DIP DIP-SLDR	51167	14-820-90
A9XU18	1200-0654	7	1	SOCKET-IC-DIP 40-CONT DIP DIP-SLDR	01295	C8740-01
	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	73957	GP24-063 X 250-17
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-IN-BD-THKNS	28480	4040-0748
	4040-0756	3	1	EXTR-PC BD WHT POLYC .062-IN-BD-THKNS	28480	4040-0756
	7121-4611	2	1	LABEL-INFORMATION .15-IN-WD .6-IN-LG	09535	L01003
	7121-4611	2	1	LABEL-INFORMATION .15-IN-WD .6-IN-LG	09535	L01003

†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						
A10	08903-60108	9	1	REMOTE INTERFACE CONNECTOR ASSEMBLY	28480	08903-60108
A10J1	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A10MP1	0380-0644	4	2	STANDOFF-HEX .327-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	2190-0034	5	2	WASHER-LK HLCL NO. 10 .194-IN-ID	28480	2190-0034
A10MP2	1530-1098	4	2	CLEVIS 0.070-IN W SLT; 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
	2190-0019	6	8	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
A11						
A11	08903-60015	7	1	SERIES REGULATOR SOCKET ASSEMBLY	28480	08903-60015
A11C1	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A11C2	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A11C3	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A11C4	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A11F1	2110-0001	8	2	FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
A11F2	2110-0294	1	1	FUSE 4A 32V NTD 1.25X.25	28480	2110-0294
A11F3	2110-0001	8		FUSE 1A 250V NTD 1.25X.25 UL	75915	312001
A11MP1	2110-0269	0	6	FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A11MP2	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A11MP3	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A11MP4	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A11MP5	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A11MP6	2110-0269	0		FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
A11XQ1	1200-0041	6	3	SOCKET-XSTR 2-CONT TO-3 SLDR-EYE	28480	1200-0041
A11XU1	1200-0041	6		SOCKET-XSTR 2-CONT TO-3 SLDR-EYE	28480	1200-0041
A11XU2	1200-0041	6		SOCKET-XSTR 2-CONT TO-3 SLDR-EYE	28480	1200-0041

†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
A12						
A12	08903-60016	8	1	CONNECTOR FILTER ASSEMBLY	28480	08903-60016
A12C1	0160-2307	4	5	CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A12C2	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A12J1Δ	1250-1096	8	4	CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1096
	2190-0347	3	4	WASHER-FL MTLC 7/16 IN .467-IN-ID	05057	P-1476-1
A12J2				NOT ASSIGNED		
A12J3	1250-1096	8		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1096
A12J4	1250-1096	8		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1096
A12J5	1250-1096	8		CONNECTOR-RF BNC FEM SGL-HOLE-RR 50-OHM	28480	1250-1096
A12L1	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A12L2	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A12L3	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A12L4	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210

†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	**08903-60129/192/292 – SERIAL PREFIX 2450A TO 2922A**					
2450A TO 2652A						
A13	08903-60129	4	1	POWER SUPPLY MOTHERBOARD	28480	08903-60129
2717A TO 2742A						
A13	08903-60192	1	1	POWER SUPPLY MOTHERBOARD	28480	08903-60192
2813A TO 2922A						
A13	08903-60292	2	1	POWER SUPPLY MOTHERBOARD	28480	08903-60292
2717A TO 2742A						
A13C1	0180-2317	8	2	CAPACITOR-FXD 3600UF+75-10% 40VDC AL	00853	539-7445-02
	2680-0271	1	6	SCREW-MACH 10-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A13C2	0180-2317	8		CAPACITOR-FXD 3600UF+75 10% 40VDC AL	00853	539-7445-02
	2680-0271	1	6	SCREW-MACH 10-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A13C3	0180-0452	8	1	CAPACITOR-FXD .013F+75-10% 25VDC AL	28480	0180-0452
	2680-0271	1	6	SCREW-MACH 10-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
2813A TO 2922A						
A13C1	0180-2317	8	2	CAPACITOR-FXD 3600UF+75-10% 40VDC AL	00853	539-7445-02
	2680-0099	1	6	SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0012	9	6	WASHER-LK EXT T NO. 10 .195-IN-ID	00000	ORDER BY DESCRIPTION
A13C2	0180-2317	8		CAPACITOR-FXD 3600UF+75 10% 40VDC AL	00853	539-7445-02
	2680-0099	1	6	SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0012	9	6	WASHER-LK EXT T NO. 10 .195-IN-ID	00000	ORDER BY DESCRIPTION
A13C3	0180-0452	8	1	CAPACITOR-FXD .013F+75-10% 25VDC AL	28480	0180-0452
	2680-0099	1	6	SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0012	9	6	WASHER-LK EXT T NO. 10 .195-IN-ID	00000	ORDER BY DESCRIPTION
2450A TO 2922A						
A13C1	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A13C5	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A13C6	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A13C7	0140-0210	2	1	CAPACITOR-FXD 270PF +-5% 300VDC MICA	72136	DM15F271J0300WV1CR
A13C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C9	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C10	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A13C11	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C12	0160-0576	5	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A13C13	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C14	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C15	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C16	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C17	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
2450A TO 2652A						
A13C18	0160-4535	4	3	CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A13C19	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
A13C20	0160-4535	4		CAPACITOR-FXD 1UF +-10% 50VDC CER	28480	0160-4535
2717A TO 2922A						
A13C18	0160-5469	5	3	CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A13C19	0160-5469	5		CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A13C20	0160-5469	5		CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A13CR1	1901-0200	5	4	DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR2	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR3	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR4	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR5	1906-0231	2	1	DIODE-CT-RECT 200V 15A	28480	1906-0231
	1200-0043	8	4	INSULATOR-XSTR ALUMINUM	28480	1200-0043
	1205-0021	2	1	HEAT SINK TO-3-CS	28480	1205-0021
	2190-0006	1	4	WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0229	1	2	SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2420-0002	6	4	NUT-HEX-DBL-CHAM 6-32-THD .109-IN-THK	28480	2420-0002
	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
A13	**08903-60129/192/292 – SERIAL PREFIX 2450A TO 2922A**					
2150A TO 2922A						
A13CR6	1901-0159	3	7	DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR7	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR8	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR9	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR10	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR11	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
2450A TO 2922A						
A13CR12	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR13	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR14	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR15	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR16	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13DS1	1990 0485	5	4	LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
2450A TO 2922A						
A13DS2	1990-0485	5		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A13DS3	1990-0485	5		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A13DS4	1990-0485	5		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A13J1	1251-4736	1	1	CONNECTOR 26-PIN M RECTANGULAR	28480	1251-4736
A13J2	1251-3412	8	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-3412
A13J3	1251-5169	6	2	CONNECTOR 6-PIN M POST TYPE	28480	1251-5169
A13JP1-B	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A13JP1-E	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A13J4	1251-5169	6		CONNECTOR 6-PIN M POST TYPE	28480	1251-5169
2450A TO 2922A						
A13L1	9140-0137	1	1	INDUCTOR RF-CH-MLD 1MH 5% .2DX 45LG Q=60	28480	9140-0137
A13L2	9100-3922	4	5	INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L4	9100 3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L5	9100 3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L6	9100 3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L7	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX 385LG	28480	9140-0210
A13MP1	0403-0285	9	8	BUMPER FOOT-ADH MTG 12.7-MM-WD	28480	0403-0285
A13Q1	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
	1205-0012	1	1	HEAT SINK TO-18-CS	28480	1205-0012
A13Q2	1884-0005	0	1	THYRISTOR-SCR VRRM=50	04713	MCR649P-2
	2190-0006	1		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0229	1		SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2420 0002	6		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
A13Q3	1884-0276	7	1	THYRISTOR-TRIAC TO-220AB	28480	1884-0276
	2190-0006	1		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0229	1		SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2420-0002	6		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
2450A TO 2910A						
A13Q4	1884-0244	9	3	THYRISTOR-SCR VRRM=400	3L585	S2600D
A13Q5	1884-0244	9		THYRISTOR-SCR VRRM=400	3L585	S2600D
A13Q6	1884-0244	9		THYRISTOR-SCR VRRM=400	3L585	S2600D
2922A ONLY						
A13Q4	1884-0345	1	3	THYRISTOR-SCR VRRM=400	3L585	S2600D
A13Q5	1884-0345	1		THYRISTOR-SCR VRRM=400	3L585	S2600D
A13Q6	1884-0345	1		THYRISTOR-SCR VRRM=400	3L585	S2600D
2450A TO 2652A						
A13Q7				NOT ASSIGNED		
2717A TO 2922A						
A13Q7	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04712	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
A13	**08903-60129/192/292 – SERIAL PREFIX 2450A TO 2922A**					
A13R1	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R2	0698-3429	2	1	RESISTOR 19.6 1% .125W F TC=0+-100	03888	PME55-1/8-T0-19R6-F
A13R3	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R4	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A13R5	8110-0180	0	1	RIBBON-RES .157-OHM/FT .0253X.0625	28480	8110-0180
A13R6	0757-0460	1	1	RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A13R7	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A13R8	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A13R9	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A13R10	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A13R11	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A13R12	0698-4020	1		RESISTOR 9.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A13R13	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1211-F
A13R14	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
2450A TO 2922A						
A13R15	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R16	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R17	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R18	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A13R19	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
2450A TO 2910A						
A13R20	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
2922A ONLY						
A13R20	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-TO-133R-F
2450A TO 2922A						
A13R21	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
2450A TO 2910A						
A13R22	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
2922A ONLY						
A13R22	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-TO-101-F
A13R23	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R24	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R25	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
2450A TO 2910A						
A13R26	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
2922A ONLY						
A13R26	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-TO-133R-F
A13R27	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
2450A TO 2652A						
A13R28				NOT ASSIGNED		
A13R29				NOT ASSIGNED		
2717A TO 2922A						
A13R28	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	25456	C4-1/8-TO-1001-F
A13R29	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	25456	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
A13	**08903-60129/192/292 – SERIAL PREFIX 2450A TO 2922A**					
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
2450A TO 2922A						
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
2450A TO 2652A						
A13U1	1826-0785	1		IC OP AMP LOW-BIAS-H-IMPD DUAL 8-DIP-C	01295	TL072ACJG
2717A TO 2922A						
A13U1	5180-1817	1		IC OP AMP LOW-BIAS-H-IMPD DUAL I-DIP-C	01295	TL072ACJG
2450A TO 2922A						
A13U2	1826-0117	3	1	IC 7812 V RGLTR TO-3	07263	7812KC
	2190-0006	1		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0229	1		SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A13VR1	1902-3381	1	2	DIODE-ZNR 68.1V 5% DO-7 PD=.4W TC=+.079%	28480	1902-3381
A13VR2	1902-3381	1		DIODE-ZNR 68.1V 5% DO-7 PD=.4W TC=+.079%	28480	1902-3381
A13VR3	1902-0960	6	2	DIODE-ZNR 12V 5% DO-35 PD=.4W TC=+.077%	28480	1902-0960
2450A TO 2922A						
A13VR4	1902-0957	1	1	DIODE-ZNR 9.1V 5% DO-35 PD=.4W TC=+.069%	28480	1902-0957
A13VR5	1902-0943	5		DIODE-ZNR 2.4V 5% DO-35 PD=.4W TC=-.037%	28480	1902-0943
A13VR6	1902-0960	6		DIODE-ZNR 12V 5% DO-35 PD=.4W TC=+.077%	28480	1902-0960
A13VR7	1902-3214	9	2	DIODE-ZNR 16.2V 2% DO-35 PD=.4W	28480	1902-3214
2450A TO 2922A						
A13VR8	1902-3194	4	1	DIODE-ZNR 13.3V 2% DO-35 PD=.4W	28480	1902-3194
A13VR9	1902-3107	9	1	DIODE-ZNR 5.76V 2% DO-35 PD=.4W	28480	1902-3107
A13VR10	1902-3214	9		DIODE-ZNR 16.2V 2% DO-35 PD=.4W	28480	1902-3214
A13VR11	1902-3094	3	1	DIODE-ZNR 5.11V 2% DO-35 PD=.4W	28480	1902-3094
A13XA2A	1251-2035	9	7	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA2B	1251-1365	6	10	CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA3A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA3B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA4A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA4B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA5A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA5B	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA6A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA6B	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA7A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA7B	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA7C	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
A13	**08903-60129/192/292 – SERIAL PREFIX 2450A TO 2922A**					
A13XA8A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA8B	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA9A	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA9B	1251-1365	6		CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-1365
A13XA10	1251-1626	2	1	CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS	28480	1251-1626
A13XA11	1251-0472	4	1	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A13XA12	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A13XA12	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
A13	**08903-60392 – SERIAL PREFIX 2948A AND ABOVE**					
A13	08903-60392	3	1	POWER SUPPLY MOTHERBOARD	28480	08903-60392
A13C1	0180-2317	8	2	CAPACITOR-FXD 3600UF+75-10% 40VDC AL	00853	539-7445-02
	2680-0099	1	6	SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0012	9	6	WASHER-LK EXT T NO. 10 .195-IN-ID	00000	ORDER BY DESCRIPTION
A13C2	0180-2317	8		CAPACITOR-FXD 3600UF+75-10% 40VDC AL	00853	539-7445-02
	2680-0099	1	6	SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0012	9	6	WASHER-LK EXT T NO. 10 .195-IN-ID	00000	ORDER BY DESCRIPTION
A13C3	0180-0452	8	1	CAPACITOR-FXD .013F+75-10% 25VDC AL	28480	0180-0452
	2680-0099	1	6	SCREW-MACH 10-32 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2190-0012	9	6	WASHER-LK EXT T NO. 10 .195-IN-ID	00000	ORDER BY DESCRIPTION
A13C4				NOT ASSIGNED		
A13C5				NOT ASSIGNED		
A13C6	0180-0291	3		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A13C7	0140-0210	2	1	CAPACITOR-FXD 270PF +-5% 300VDC MICA	72136	DM15F271J0300WV1CR
A13C8	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C9	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C10	0180-0116	1		CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X9035B2
A13C11	0180-0197	8		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A13C12	0160-0576	5	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A13C13	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C14	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C15	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C16	0160-2307	4		CAPACITOR-FXD 47PF +-5% 300VDC MICA	28480	0160-2307
A13C17	0160-4805	1		CAPACITOR-FXD 47PF +-5% 100VDC CER 0+-30	28480	0160-4805
A13C18	0160-5469	5	3	CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A13C19	0160-5469	5		CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A13C20	0160-5469	5		CAPACITOR-FXD 1UF 10% 50VDC	28480	0160-5469
A13CR1	1901-0200	5	4	DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR2	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR3	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR4	1901-0200	5		DIODE-PWR RECT 100V 1.5A	28480	1901-0200
A13CR5△	1906-0231	2	1	DIODE-CT-RECT 200V 15A	28480	1906-0231
	1200-0043	8	4	INSULATOR-XSTR ALUMINUM	28480	1200-0043
	1205-0021	2	1	HEAT SINK TO-3-CS	28480	1205-0021
	2190-0018	5		WASHER-LK HLCL NO. 6 .141-IN-ID	04604	2190-0018
	2360-0229	1	2	SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2420-0003	7	4	NUT-HEX-DBL-CHAM 6-32-THD .094-IN-THK	04939	2420-0003
	3050-0010	2		WASHER-FL MTLC NO. 6 .147-IN-ID	04719	65

†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
A13	**08903-60392 – SERIAL PREFIX 2948A AND ABOVE**					
A13CR6				NOT ASSIGNED		
A13CR7	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR8	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR9	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR10	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A13CR11	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR12				NOT ASSIGNED		
A13CR13	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR14	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR15	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13CR16	1901-0159	3		DIODE-PWR RECT 400V 750MA DO-41	28480	1901-0159
A13DS1	1990-0485	5	4	LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A13DS2				NOT ASSIGNED		
A13DS3	1990-0485	5		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A13DS4	1990-0485	5		LED-LAMP LUM-INT=800UCD IF=30MA-MAX	28480	5082-4984
A13J1	1251-4736	1	1	CONNECTOR 26-PIN M RECTANGULAR	28480	1251-4736
A13J2	1251-3412	8	1	CONNECTOR 6-PIN M POST TYPE	28480	1251-3412
A13J3	1251-5169	6	2	CONNECTOR 6-PIN M POST TYPE	28480	1251-5169
A13JP1-B	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A13JP1-E	8159-0005	0		RESISTOR-ZERO OHMS 22 AWG LEAD DIA	28480	8159-0005
A13J4	1251-5169	6		CONNECTOR 6-PIN M POST TYPE	28480	1251-5169
A13L1				NOT ASSIGNED		
A13L2	9100-3922	4	5	INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L3	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L4	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L5	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L6	9100-3922	4		INDUCTOR-FIXED 120-1300 HZ	28480	9100-3922
A13L7	9140-0210	1		INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A13MP1	0403-0285	9	8	BUMPER FOOT-ADH MTG 12.7-MM-WD	28480	0403-0285
A13Q1	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
	1205-0012	1	1	HEAT SINK TO-18-CS	28480	1205-0012
A13Q2	1884-0005	0	1	THYRISTOR-SCR VRRM=50	04713	MCR649P-2
	2190-0006	1		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0229	1		SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2420-0002	6		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
A13Q3	1884-0276	7	1	THYRISTOR-TRIAC TO-220AB	28480	1884-0276
	2190-0006	1		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0229	1		SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2420-0002	6		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
A13Q4				NOT ASSIGNED		
A13Q5	1884-0345	1		THYRISTOR-SCR VRRM=400	3L585	S2600D
A13Q6	1884-0345	1		THYRISTOR-SCR VRRM=400	3L585	S2600D
A13Q7	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04712	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
A13	**08903-60392 – SERIAL PREFIX 2948A AND ABOVE**					
A13R1	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R2	0698-3429	2	1	RESISTOR 19.6 1% .125W F TC=0+-100	03888	PME55-1/8-T0-19R6-F
A13R3	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R4	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A13R5	8110-0180	0	1	RIBBON-RES .157-OHM/FT .0253X.0625	28480	8110-0180
A13R6	0757-0460	1	1	RESISTOR 61.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A13R7	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1001-F
A13R8	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1961-F
A13R9	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A13R10	0757-0394	0		RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A13R11	0757-0290	5		RESISTOR 6.19K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-6191-F
A13R12	0698-4020	1		RESISTOR 9.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A13R13	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-TO-1211-F
A13R14	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R15				NOT ASSIGNED		
A13R16	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R17	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R18	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A13R19	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R20	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-TO-133R-F
A13R21				NOT ASSIGNED		
A13R22				NOT ASSIGNED		
A13R23	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R24	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A13R25	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A13R26	0698-3437	2		RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-TO-133R-F
A13R27	0698-8827	4		RESISTOR 1M 1% .125W F TC=0+-100	28480	0698-8827
A13R28	0757-0280	3		RESISTOR 1K 1% .125W F TC=0+-100	25456	C4-1/8-TO-1001-F
A13R29	0698-3132	4		RESISTOR 261 1% .125W F TC=0+-100	25456	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
A13	**08903-60392 – SERIAL PREFIX 2948A AND ABOVE**					
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				NOT ASSIGNED		
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
A13U1	5180-1817	1		IC OP AMP LOW-BIAS-H-IMPD DUAL I-DIP-C	01295	TL072ACJG
A13U2				NOT ASSIGNED		
	2190-0006	1		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0006
	2360-0229	1		SCREW-MACH 6-32 .562-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A13VR1	1902-3381	1	2	DIODE-ZNR 68.1V 5% DO-7 PD = .4W TC = +.079%	28480	1902-3381
A13VR2	1902-3381	1		DIODE-ZNR 68.1V 5% DO-7 PD = .4W TC = +.079%	28480	1902-3381
A13VR3	1902-0960	6	2	DIODE-ZNR 12V 5% DO-35 PD = .4W TC = +.077%	28480	1902-0960
A13VR4				NOT ASSIGNED		
A13VR5	1902-0943	5		DIODE-ZNR 2.4V 5% DO-35 PD = .4W TC = -.037%	28480	1902-0943
A13VR6	1902-0960	6		DIODE-ZNR 12V 5% DO-35 PD = .4W TC = +.077%	28480	1902-0960
A13VR7	1902-3214	9	2	DIODE-ZNR 16.2V 2% DO-35 PD = .4W	28480	1902-3214
A13VR8				NOT ASSIGNED		
A13VR9	1902-3107	9	1	DIODE-ZNR 5.76V 2% DO-35 PD = .4W	28480	1902-3107
A13VR10	1902-3214	9		DIODE-ZNR 16.2V 2% DO-35 PD = .4W	28480	1902-3214
A13VR11	1902-3094	3	1	DIODE-ZNR 5.11V 2% DO-35 PD = .4W	28480	1902-3094
A13XA2A	1251-2035	9	7	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA2B△	1252-4187	8	10	CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA3A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA3B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA4A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA4B	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA5A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA5B△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA6A	1251-2035	9		CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-2035
A13XA6B△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA7A△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA7B△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA7C△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA8A△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA8B△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA9A△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA9B△	1252-4187	8		CONNECTOR-PC EDGE 22-CONT/ROW 3-ROWS	28480	1252-4187
A13XA10	1251-1626	2	1	CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS	28480	1251-1626
A13XA11	1251-0472	4	1	CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A13XA12	1251-0472	4		CONNECTOR-PC EDGE 6-CONT/ROW 2-ROWS	28480	1251-0472
A13XA12	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). △ Errata part change.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A14						
A14	0960-0443	1	1	LINE POWER MODULE	28480	0960-0443
A14TB1	0960-0736	5	1	LINE VOLTAGE SELECTION CARD	28480	0960-0736

†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
2450A TO 2601A						
F1	2110-0059	6	1	FUSE 1.5A 250V TD 1.25X.25 UL (FOR 115V OPERATION)	71400	MDX 1-1/2
F1	2110-0360	2	1	FUSE .75A 250V TD 1.25X.25 UL (FOR 230V OPERATION)	28480	2110-0360
2611A AND ABOVE						
F1	2110-0043	8	1	FUSE 1.5A 250V NTD 1.25X.25 UL (FOR 115V OPERATION)	28480	2110-0043
F1	2110-0001	8	1	FUSE 1A 250V NTD 1.25X.25 UL (FOR 230V OPERATION)	75915	312001
J1				CONNECTOR "OUTPUT HIGH" NSR P/O W1 (EXCEPT OPTION 001)		
J2				CONNECTOR "OUTPUT LOW" NSR P/O W1 (EXCEPT OPTION 001)		
J3	1510-0038	8	2	BINDING POST ASSY SGL THD-STUD	28480	1510-0038
	2190-0027	6	2	WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0027
	2950-0006	3	2	NUT-HEX-DBL-CHAM 1/4-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J4				CONNECTOR "INPUT HIGH" NSR P/O W2 (EXCEPT OPTION 001)		
J5				CONNECTOR "INPUT LOW" NSR P/O W2 (EXCEPT OPTION 001)		
J6	1510-0038	8		BINDING POST ASSY SGL THD-STUD	28480	1510-0038
	2190-0027	6		WASHER-LK INTL T 1/4 IN .256-IN-ID	28480	2190-0027
	2950-0006	3		NUT-HEX-DBL-CHAM 1/4-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
J7				CONNECTOR "OUTPUT HIGH" NSR P/O W3 (EXCEPT OPTION 001)		
J8				CONNECTOR "OUTPUT LOW" NSR P/O W3 (EXCEPT OPTION 001)		
J9				CONNECTOR "INPUT HIGH" NSR P/O W4 (EXCEPT OPTION 001)		
J10				CONNECTOR "INPUT LOW" NSR P/O W4 (EXCEPT OPTION 001)		
M1	1120-0694	5	1	METER 1 MA; LESS THAN 500 OHMS; 1.75 X	28480	1120-0694
	0380-1155	4	4	SPACER-RND .2-IN-LG .12-IN-ID .25-IN-OD	00000	ORDER BY DESCRIPTION
	2260-0009	3	4	NUT-HEX-W/LKWR 4-40-THD .094 IN-THK	00000	ORDER BY DESCRIPTION
	0360-0053	7	2	TERMINAL-SLDR LUG LK MTG FOR #10-SCR	28480	0360-0053
	2820-0002	4	2	NUT-HEX-DBL-CHAM 10-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	0590-1580	4		THREADED INSERT-STDF M3X0.5 14-MM-LG	28480	0590-1580
2450A TO 2908A						
MP1				NO LONGER AVAILABLE. (SEE SECTION 7)		
2910A AND ABOVE						
MP1	08903-20298	4	1	FRONT FRAME, MODIFIED	28480	08903-20298
2450A ONLY						
MP2	5020-8836	5	4	CORNER STRUT	28480	5020-8836
	2510-0192	6	16	SCREW-MACH 8-32 .25-IN-LG 100 DEG (ATTACHES CORNER STRUT TO FRONT AND REAR FRAME)	00000	ORDER BY DESCRIPTION
MP3	08903-60168	1	1	REAR PANEL ASSEMBLY	28480	08903-60168
	2360-0115	4	38	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI (ATTACH MOTHERBOARD TO REAR PANEL ASSY)	00000	ORDER BY DESCRIPTION
2520A AND ABOVE						
MP2	5021-5836	1	4	CORNER STRUT	28480	5021-5836
	0515-1331	5	16	SCREW-METRIC SPECIALTY M4 X 0.7 THD. 6 (ATTACHES CORNER STRUT TO FRONT AND REAR FRAME)	28480	0515-1331
MP3	08903-60169	2	1	REAR PANEL ASSEMBLY	28480	08903-60169
	0515-1950	4		SCREW-MACH M3 X 0.5 8MM-LG PNTX (ATTACH MOTHERBOARD TO REAR PANEL ASSY)	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
2450A TO 2908A						
MP4				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP5				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP6				NO LONGER AVAILABLE, (SEE SECTION 7)		
2910A AND ABOVE						
MP4	08903-00148	1	1	COVER, TOP	28480	08903-00148
MP5	5062-3892	1	1	COVER, BOTTOM	28480	5062-3892
MP6	5041-8802	9	1	TRIM STRIP, TOP	28480	5041-8802
MP7	08903-60156	7	1	COVER, CARD CAGE	28480	08903-60156
2450A TO 2730A						
MP8 (STD)	08903-00034			FRONT PANEL, STANDARD	28480	08903-00034
MP8 (OPT 001)	08903-00055			FRONT PANEL, OPTION 001 ONLY	28480	08903-00055
2742A TO 2908A						
MP8 (STD)				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP8 (OPT 001)			1	NO LONGER AVAILABLE, (SEE SECTION 7)		
2910A AND ABOVE						
MP8	08903-00145	8	1	FRONT PANEL, STANDARD	28480	08903-00145
MP8	08903-00146	9	1	FRONT PANEL, OPTION 001 ONLY	28480	08903-00146
2450A TO 2730A						
MP9	08903-00110	6	1	SUB-PANEL	28480	08903-00110
	0515-1227	8	6	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD (ATTACH SUB-PANEL TO FRONT FRAME)	28480	0515-1227
	0515-1950	4		SCREW-MACH M3 X 0.5 8MM-LG PNTX (ATTACHES GROUND LUG TO SUB-PANEL)	00000	ORDER BY DESCRIPTION
	1400-0519	7		CLAMP-HOSE 1.313-2.25-DIA .562-WD SST	28480	1400-0519
2742A AND ABOVE						
MP9	08903-00135	6	1	SUB-PANEL	28480	08903-00135
	0515-1227	8	6	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD (ATTACH SUB-PANEL TO FRONT FRAME)	28480	0515-1227
	0515-1950	4		SCREW-MACH M3 X 0.5 8MM-LG PNTX (ATTACH KEYBOARD TO SUB-PANEL)	00000	ORDER BY DESCRIPTION
	1400-0519	7		CLAMP-HOSE 1.313-2.25-DIA .562-WD SST	28480	1400-0519
2450A TO 2908A						
MP10				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP11				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP12				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP13				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP14				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP15				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP16				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP17				NO LONGER AVAILABLE, (SEE SECTION 7)		
2910A AND ABOVE						
MP10	5001-0539	9	1	TRIM STRIP, SIDE	28480	5001-0539
MP11	5041-8819	8	2	HANDLE CAP, FRONT	28480	5041-8819
	0515-0262	9	2	SCREW-THD-RLG M3 X 0.5 7MM-LG PAN-HD (ATTACHES HANDLE TO SIDE COVER)	00000	ORDER BY DESCRIPTION
MP12	5062-3703	3	2	STRAP HANDLE	28480	5062-3703
MP13	5041-8820	1	1	HANDLE CAP, REAR	28480	5041-8820
	2680-0118	5		SCREW-MACH 10-32 .5-IN-LG 82 DEG (ATTACHES HANDLE TO SIDE COVER)	00000	ORDER BY DESCRIPTION
MP14	5062-3836	3	2	COVER, SIDE	28480	5062-3836
MP15	08903-00150	5	1	PULL-OUT CARD, OPERATING INFO	28480	08903-00150
MP16	08903-00151	6	1	PULL-OUT CARD, ERROR DISPLAY, HP-IB	28480	08903-00151
MP17	08903-00149	2	1	PULL-OUT INFO CARD TRAY	28480	08903-00149
MP18	1460-1345	5	1	TILT STAND SST	28480	1460-1345
2450A TO 2908A						
MP19				NO LONGER AVAILABLE, (SEE SECTION 7)		
MP20				NO LONGER AVAILABLE, (SEE SECTION 7)		
2910A AND ABOVE						
MP19	5041-8801	8	4	FOOT, BOTTOM	28480	5041-8801
MP20	5041-8821	2	4	STANDOFF, REAR PANEL	28480	5041-8821
	0515-0067	2	4	SCREW-MACH M3.5 X 0.6 10MM-LG PAN-HD (ATTACH STANDOFF TO REAR PANEL ASSEMBLY)	28480	0515-0067

†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
MP21				NOT ASSIGNED		
MP22	08903-40001	9	1	LABEL HOLDER	28480	08903-40001
MP23	08903-90047	8		LABELS, SHEET OF 51 FILTER INCLUDES: 400Hz HIGH-PASS FILTER C-MESSAGE WEIGHTING FILTER CCIR/ARM WEIGHTING FILTER "A" WEIGHTING FILTER	28480	08903-90047
MP24	08903-60201	3	1	CARD CAGE	28480	08903-60201
	0515-1950	4		SCREW-MACH M3 X 0.5 8MM-LG PNTX (ATTACHES CARD CAGE TO MOTHERBOARD AND TO CORNER STRUTS)	00000	ORDER BY DESCRIPTION
	2190-0584	0	12	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
	1400-1016	1		CLAMP MULTIPLE TYPE	28480	1400-1016
MP25	1400-0997	0	1	CLAMP-FL-CA 1-WD	06915	CFCC-6
	0510-1839	8		SCREW-MACH M3 X 0.5 8-MM-LG PAN-HD (ATTACHES CLAMP TO CARD CAGE)	00000	ORDER BY DESCRIPTION
	2190-0584	0	12	WASHER-LK HLCL 3.0 MM 3.1-MM-ID	28480	2190-0584
MP26				NOT ASSIGNED		
MP27	08903-00102	7	1	SUPPORT, LEFT	28480	08903-00103
	0515-1950	4		SCREW-MACH M3 X 0.5 8MM-LG PNTX (ATTACHES SUPPORT TO CORNER STRUT AND MOTHERBOARD)	00000	ORDER BY DESCRIPTION
MP28	08903-20054	0	1	HEAT SINK PANEL	28480	08903-20054
	0515-0365	3	6	SCREW-MACH ASSY M2 X 0.4 4MM LG	00000	ORDER BY DESCRIPTIONN
	0515-0374	4	6	SCREW-MACH ASSY M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
MP29	08903-00010	6	2	HEAT SINK COVER	28480	08903-00010
	0515-1329	8		SCREW-MACH M3 X 0.5 8MM-LG PAN-HD	00000	ORDER BY DESCRIPTION
	0515-0374	4	6	SCREW-MACH ASSY M3 X 0.5 10MM-LG	00000	0515-0374
	0515-0365	3	6	SCREW-MACH ASSY M2 X 0.4 4MM-LG	00000	0515-0365
2305A TO 2726A *MP30*	08903-00017	3	1	POWER SHIELD	28480	08903-00017
2720A AND ABOVE *MP30*				NOT ASSIGNED		
MP31	08903-00043	5	1	LABEL PANEL, REAR (OPTION 001 ONLY)	28480	08903-00043
	0515-1950	4		SCREW-MACH M3 X 0.5 8MM-LG PNTX (ATTACHES PANEL TO HEATSINK PANEL)	00000	ORDER BY DESCRIPTION
	0515-0365	3	6	SCREW-MACH ASSY M3 X 0.5 10MM=LG	00000	ORDER BY DESCRIPTION
	0515-0374	4	6	SCREW-MACH ASSY M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
MP31	08903-00018	4	1	LABEL PANEL, REAR (EXCEPT OPTION 001)	28480	08903-00018
	0515-1950	4		SCREW-MACH M3 X 0.5 8MM-LG PNTX (ATTACHES PANEL TO HEATSINK PANEL)	00000	ORDER BY DESCRIPTION
	0515-0365	3	6	SCREW-MACH ASSY M2 X 0.4 4MM-LG	00000	ORDER BY DESCRIPTION
	0515-0374	4	6	SCREW-MACH ASSY M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
MP32	7121-4963	1	1	NAMEPLATE 9.23-MM-WD 13.7-MM-LG CU	03211	7121-4963
MP33				NOT ASSIGNED		
MP34	7120-4295	6	1	LABEL "WARNING: HAZARDOUS VOLTAGE ALWAYS PRESENT IN THIS AREA..."	28480	7120-4295
2450A ONLY *MP35*	7120-5911	5	1	LABEL "CAUTION: METRIC THREADED"	28480	7120-5911
2520A AND ABOVE *MP35*				NOT ASSIGNED		
MP36				NOT ASSIGNED		
MP37	7120-8138	4	1	LABEL "CAUTION REMOVE FOUR FEET..."	28480	7120-8138
MP38				NOT ASSIGNED		
MP39				NOT ASSIGNED		
MP40	0590-1251	6		NUT-SPCLY 15/32-32-THD .1-IN-THK .562-WD	00000	ORDER BY DESCRIPTION
MP41	2190-0068	5		WASHER-LK INTL T 1/2-IN .505 IN-ID	28480	2190-0068
MP42	2190-0102	8		WASHER-LK INTL T 15/32-IN .472-IN-ID	28480	2190-0102
MP43	2950-0035	8		NUT-HEX-DBL-CHAM 15/32-32-THD	00000	ORDER BY DESCRIPTION
MP44	1250-2164	3	4	CONNECTOR 3-PIN F CIRC AUDIO	28480	1250-2164

†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
Q1	1854-0669	9	1	TRANSISTOR NPN 2N6057 SI TO-3 PD = 150W	04713	2N6057
	08640-20057	5	4	INSULATOR SPACER	28480	08640-20057
	1200-0043	8		INSULATOR-XSTR ALUMINUM	28480	1200-0043
	0624-0459	7	3	SCREW-TPG 6-20 .75-IN-LG PAN-HD-POZI STL	00000	ORDER BY DESCRIPTION
	2190-0018	5		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0018
S1	3101-2080	9	2	SWITCH "POWER" (P/O W6)	28480	3101-2080
	08903-20055	1	2	NUT	28480	08903-20055
	5041-1418	9	2	CAP, ROCKER SWITCH	28480	5041-1418
S2	3101-1903	3	6	SWITCH "OUTPUT FLOAT"	28480	3101-1903
	08640-40052	2	18	LEVER SLIDE SWITCH	28480	08640-40052
	0515-0365	3	6	SCREW-MACH ASSY M2 X 0.4 4MM-LG	00000	0515-0365
	0515-0374	4	6	SCREW-MACH ASSY M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
S3	3101-1903	3		SWITCH "INPUT FLOAT"	28480	3101-1903
	08640-40052	2		LEVER SLIDE SWITCH	28480	08640-40052
	0515-0365	3	6	SCREW-MACH ASSY M2 X 0.4 4MM-LG	00000	ORDER BY DESCRIPTION
	0515-0374	4	6	SCREW-MACH ASSY M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
2450A TO 2730A						
S4	3101-1903	3		SWITCH "OUTPUT IMPEDENCE"	28480	3101-1903
	08640-40052	2		LEVER SLIDE SWITCH	28480	08640-40052
	0515-0365	3	6	SCREW-MACH ASSY M2 X 0.4 4MM-LG	00000	ORDER BY DESCRIPTION
	0515-0374	4	6	SCREW-MACH ASSY M3 X 0.5 10MM-LG	00000	ORDER BY DESCRIPTION
2742A AND ABOVE						
S4				NOT ASSIGNED		
2520A TO 2601A						
T1	9100-4118	2	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-4118
	0515-1408	7	4	SCREW-MACH 4.0 60MM-LG PAN-HD	28480	0515-1408
	2190-0586	2	4	WASHER-LK HLCL 4.0 MM 4.1-MM-ID	28480	2190-0586
	0535-0006	1	4	NUT-HEX DBL-CHAM M4 X 0.7 3.2MM-THK	00000	ORDER BY DESCRIPTION
	3050-0893	9		WASHER-FL MTLC 4.0 MM 4.4-MM-ID	28480	3050-0893
	3050-2007	1		WASHER-SHLDR NO.6 .169-IN-ID .375-IN-OD	28480	3050-2007
	1400-0249	0	4	CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
2614A AND ABOVE						
T1	9100-4516	4	1	TRANSFORMER-POWER 100/120/220/240V	28480	9100-4516
	0515-1408	7	4	SCREW-MACH 4.0 60MM-LG PAN-HD	28480	0515-1408
	2190-0586	2	4	WASHER-LK HLCL 4.0 MM 4.1-MM-ID	28480	2190-0586
	0535-0006	1	4	NUT-HEX DBL-CHAM M4 X 0.7 3.2MM-THK	00000	ORDER BY DESCRIPTION
	3050-0893	9		WASHER-FL MTLC 4.0 MM 4.4-MM-ID	28480	3050-0893
	3050-2007	1		WASHER-SHLDR NO.6 .169-IN-ID .375-IN-OD	28480	3050-2007
	1400-0249	0	4	CABLE TIE .062-.625-DIA .091-WD NYL	06383	PLT1M-8
U1△	1826-1181	3	1	IC V RGLTR-FXD-POS 14.7/15.3V TO-3 PKG	03406	LM340AK-15
	08640-20057	5		INSULATOR SPACER	28480	08640-20057
	1200-0043	8		INSULATOR-XSTR ALUMINUM	28480	1200-0043
	0624-0459	7		SCREW-TPG 6-20 .75-IN-LG PAN-HD-POZI STL	00000	ORDER BY DESCRIPTION
	2190-0918	4		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0918
U2	1826-0169	5	1	IC V RGLTR TO-3	27014	LM320K-15
	08640-20057	5		INSULATOR SPACER	28480	08640-20057
	1200-0043	8		INSULATOR-XSTR ALUMINUM	28480	1200-0043
	0624-0459	7		SCREW-TPG 6-20 .75-IN-LG PAN-HD-POZI STL	00000	ORDER BY DESCRIPTION
	2190-0918	4		WASHER-LK HLCL NO. 6 .141-IN-ID	28480	2190-0918

†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
W1	08903-60197	6	1	CABLE ASSEMBLY, FRONT OUTPUT (EXCEPT	28480	08903-60197
W2	08903-60045	3	1	CABLE ASSEMBLY, FRONT INPUT (EXCEPT	28480	08903-60045
W3	08903-60198	7	1	CABLE ASSEMBLY, REAR OUTPUT (OPTION 001	28480	08903-60198
W4	08903-60047	5	1	CABLE ASSEMBLY, REAR INPUT (OPTION 001	28480	08903-60047
W5	08903-60028	2	1	RIBBON CABLE ASSEMBLY (A13J1 TO A1J1)	28480	08903-60028
△ W6	08903-60029	3	1	CABLE ASSEMBLY, POWER (S1 TO A14)	28480	08903-60029
	08903-20055	1		NUT-SPECIAL M2.5 (PART OF W6)	28480	08903-20055
	0837 0366	6	1	THERMISTOR SURGE PTCTR 5Ω AT 25deg C (PART OF W6)	04379	SG200
	0960 0443	1	1	LINE MODULE-FILTERED	28480	0960-0443
W7	8120-1378	1	1	LINE POWER CORD	28480	8120 1378
2450A TO 2520A						
W8	08903-60176	1		GROUND CABLE (54) T1 TO CHASSIS	28480	08903-60176
2520A AND ABOVE						
W8				NOT ASSIGNED		

†Refer to Section 7 for update information. *Factory Selected Component (Refer to Section 5). △ Errata part change.

Table 6-4. Code List of Manufacturers

Mfr. Code	Manufacturer Name	Address	Zip Code
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
02768	ILLINOIS TOOL WORKS INC FASTEX DIV	DES PLAINES IL	60016
03888	K D I PYROFILM CORP	WHIPPANY NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX AZ	85008
06383	PANDUIT CORP	TINLEY PARK IL	60477
06665	PRECISION MONOLITHICS INC	SANTA CLARA CA	95050
06915	RICHCO PLASTIC CO	CHICAGO IL	60646
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW CA	94042
17856	SILICONIX INC	SANTA CLARA CA	95054
18736	VOLTRONICS CORP	HANOVER NJ	07936
19701	MEPCO/ELECTRA CORP	MINERAL WELLS TX	76067
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
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE NJ	
30161	AAVID ENGINEERING INC	LACONIA NH	03246
32293	INTERSIL INC	CUPERTINO CA	95014
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE CA	94086
34371	HARRIS SEMICON DIV HARRIS-INTERTYPE	MELBOURNE FL	32901
52063	EXAR INTEGRATED SYSTEMS INC	SUNNYVALE CA	94086
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MA	01247
71400	BUSSMAN MFG DIV OF MCGRAW-EDISON CO	ST LOUIS MO	63107
72136	ELECTRO MOTIVE CORP	FLORENCE SC	06226
74970	JOHNSON E F CO	WASECA MN	56093
75915	LITTELFUSE INC	DES PLAINES IL	60016
84411	TRW CAPACITOR DIV	OGALLALA NE	69153

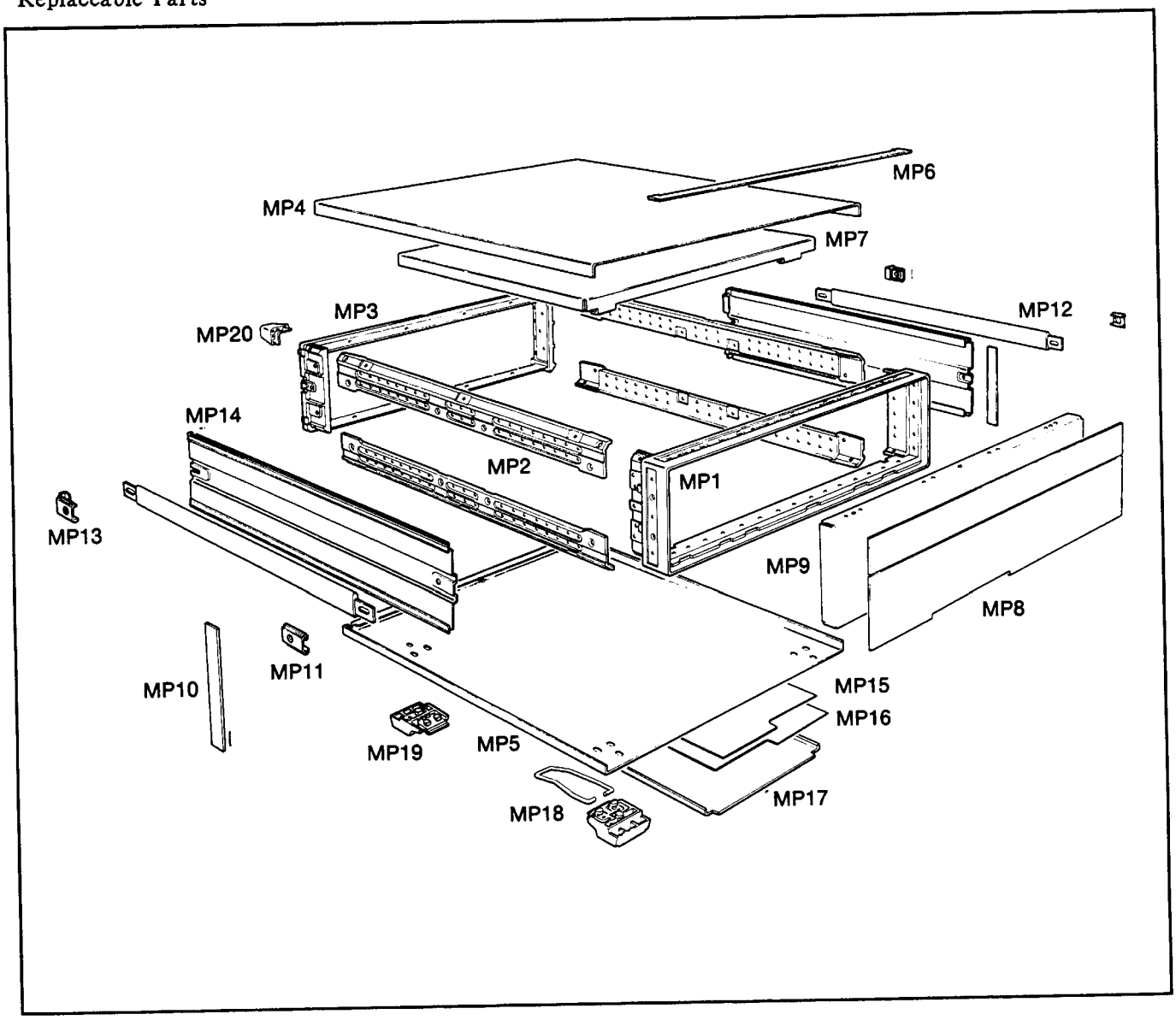
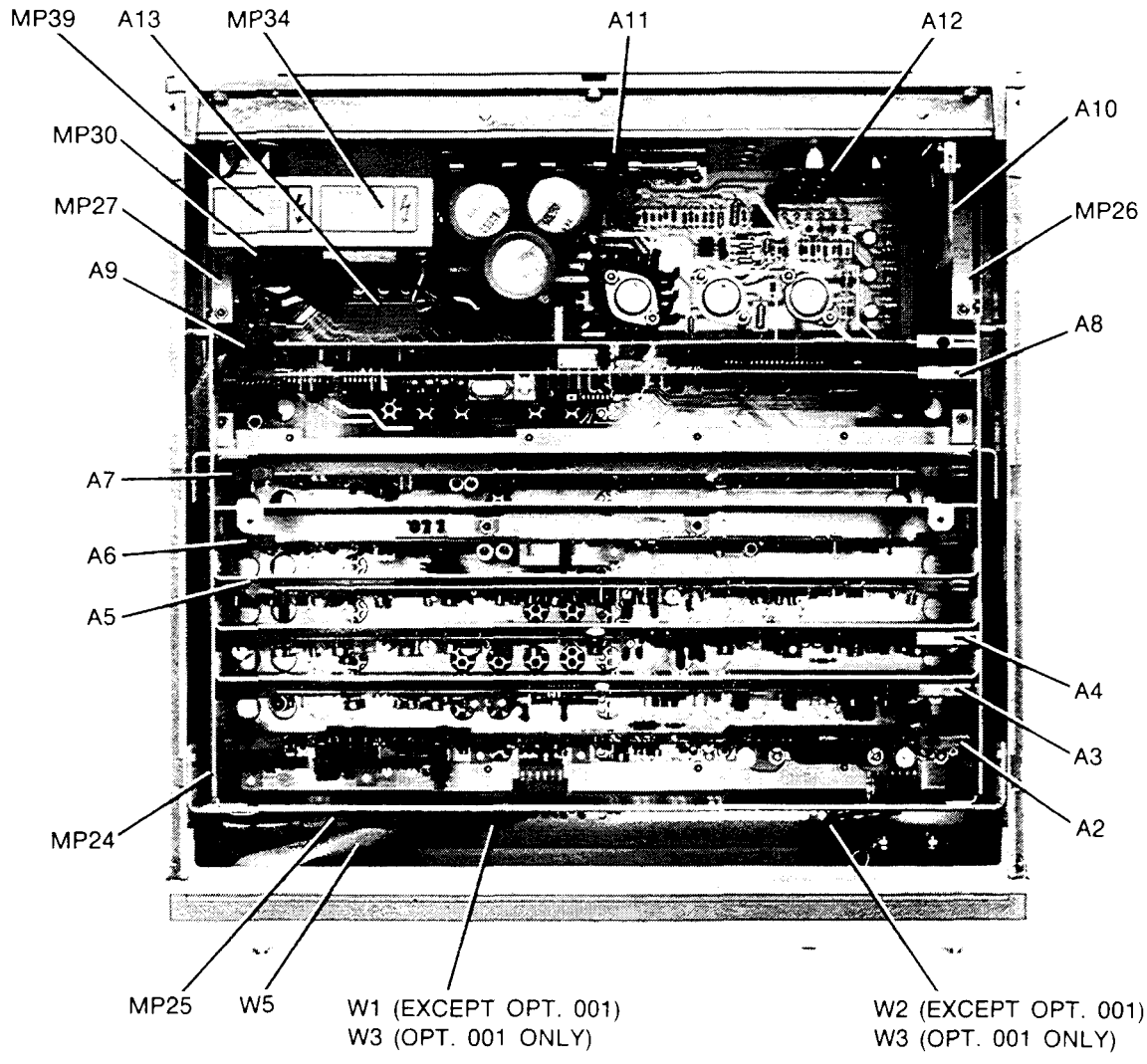


Figure 6-1. Cabinet Parts


MP39
A13
MP34
A11
A12
A10
MP30
MP27
MP26
A9
A8
A7
A6
A5
A4
A3
A2
MP24
MP25
W5
W1 (EXCEPT OPT. 001)
W3 (OPT. 001 ONLY)
W2 (EXCEPT OPT. 001)
W3 (OPT. 001 ONLY)

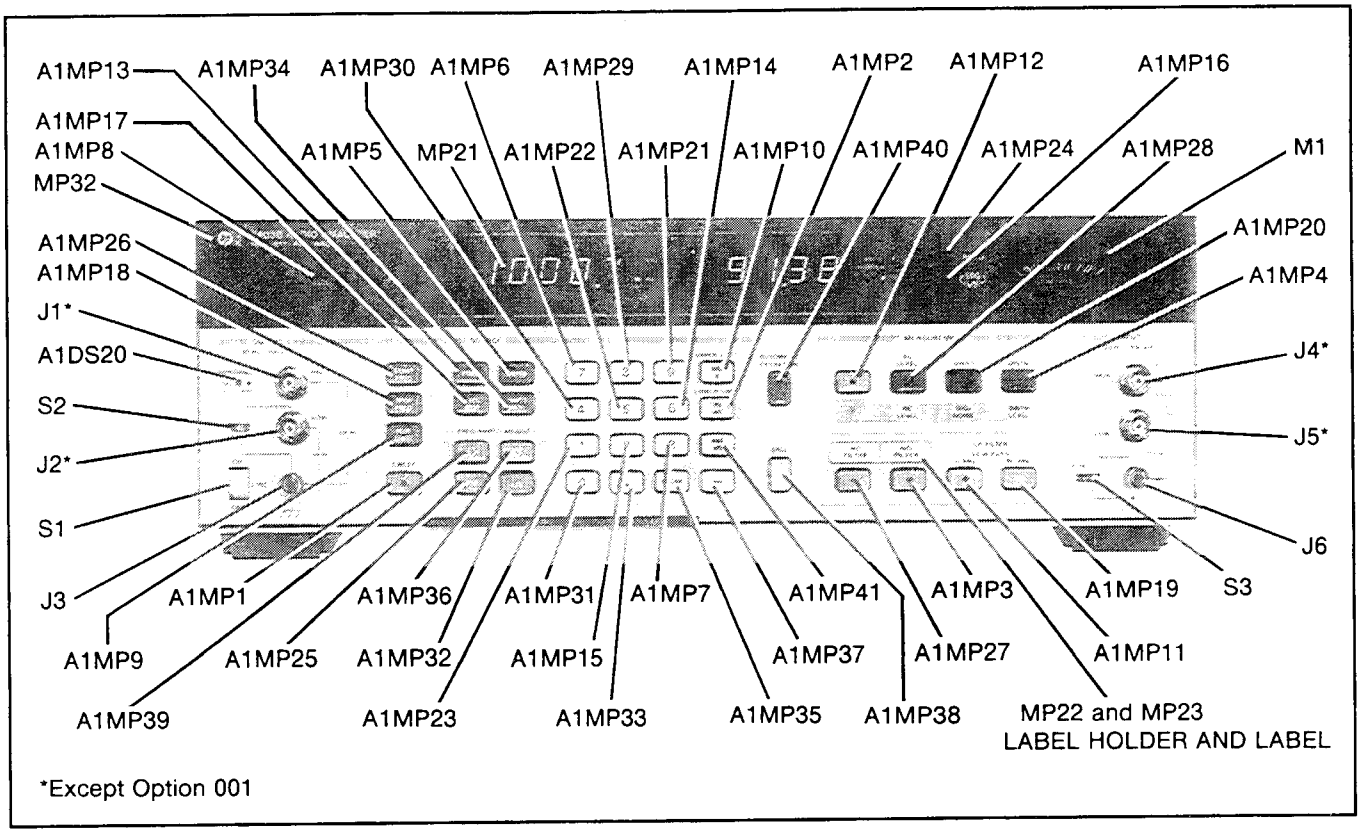


Figure 6–3. *Chassis and Mechanical Parts Identification - Front Panel*

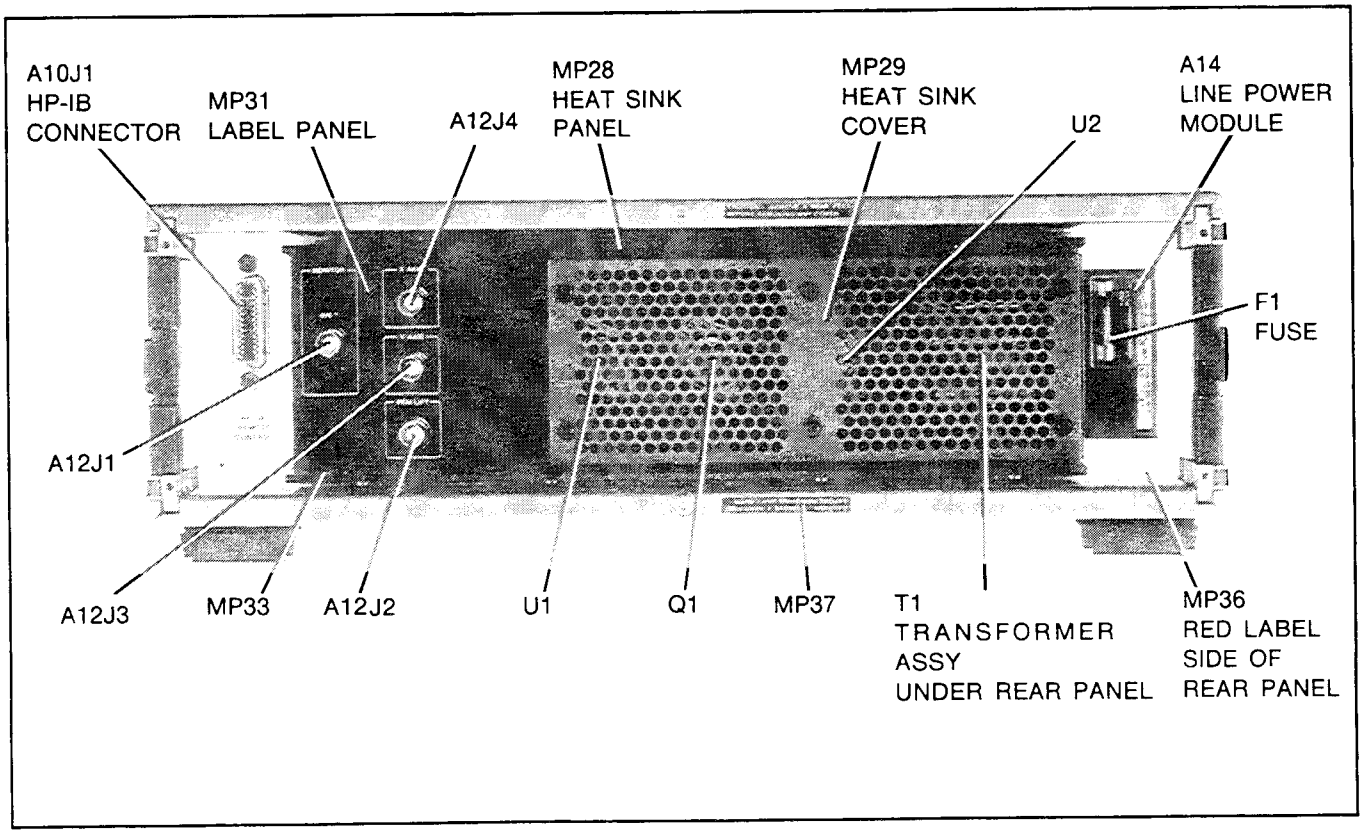


Figure 6–4. *Chassis and Mechanical Parts Identification - Rear Panel (2742A and above)*

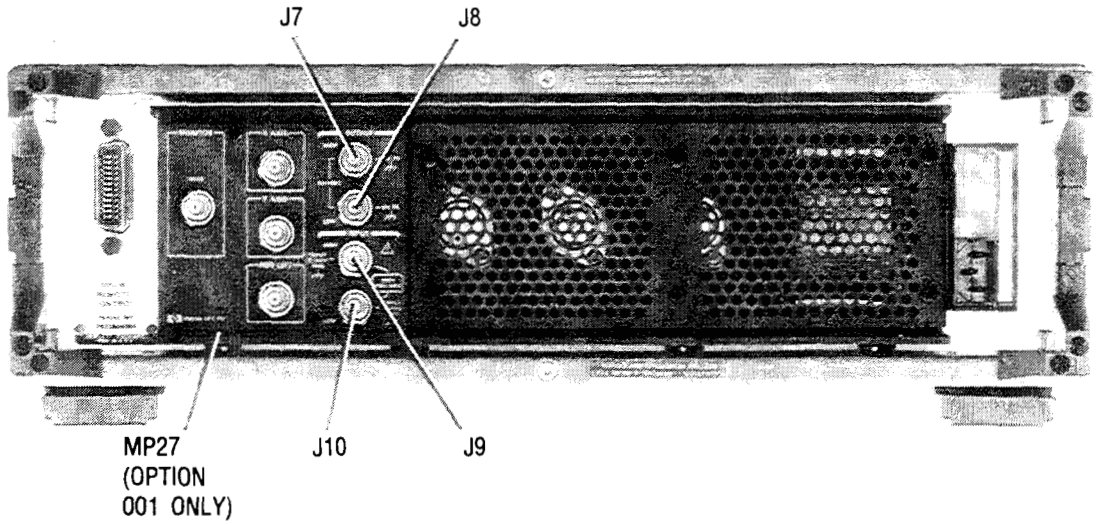


Figure 6-5. Chassis and Mechanical Parts Identification — Rear Panel, Including Option 001

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 *Instrument Covered by This Manual,* paragraphs 1 through 4 in Section 1 for important information about serial number coverage.

7-2. MODIFICATIONS/CHANGES

Description

Instruments with Serial Prefix 2450A have System II cabinet parts and hardware that are English thread. Instruments with Serial Prefix 2520A and higher have System II cabinet parts and hardware that are METRIC thread.

In Section 6, *Replaceable Parts,* both English and Metric thread part numbers are listed. The correct part numbers are referenced to the instrument's serial number prefix.

7-3. FIRMWARE CHANGE SUMMARY

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 changed 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 15 and 16 for ROM identification.)

1. **Software date code: 11.15 1984** *(2450A to 2520A)*
1. ROM part numbers:
   ROM 1, 08903-80016
   ROM 2, 08903-80017
   ROM 3, 08903-80018
   ROM 4, 08903-80019
   ROM 5, 08903-80020
   ROM 6, 08903-80021
   ROM 7, 08903-80022
   ROM 8, 08903-80023
   ROM 9, 08903-80024

2. **Software date code: 2.11 1985** *(2520A to 2614A)*
   ROM part numbers
   ROM 1, 1818-3741
   ROM 2, 1818-3742
   ROM 3, 1818-3743
   ROM 4, 1818-3744
   ROM 5, 1818-3745
   ROM 6, 1818-3746
   ROM 7, 1818-3747
   ROM 8, 1818-3748
   ROM 9, 1818-3749

3. **Software date code: 8.22 1986** *(2652A to 2818A)* The instrument has undergone a change in firmware. ROM memory has been consolidated into 1 single ROM (ROM 10, U31).

   ROM part number
   ROM 10, 08903-80036

4. **Software date code: 2829** *(2836A and above)* The 08903-80050 is now capable of being programmed to 17.78 dBm (6.0 volts) in the log mode. The previous ROM (08903-80036) could not be programmed above +15.56 dBm (4.64 volts) in the log mode.

   ROM part number
   ROM 10, 08903-80050

7-4. HARDWARE CHANGE SUMMARY

1. **2730A and above**

   A quasi-peak detector is added to the Output RMS/AVG detector on the A4 Voltmeter assembly. The part number for the new A4 assembly is 08903-60183.

2. **2742A and above**

   The selectable 600Ω or 50Ω Source Output Impedance is now enabled from the front panel as a special function, and is programmable over HP-IB.

7-5. CABINET PARTS COLOR CHANGE

1. **2910A and above**

NOTE

Serial prefix 2910A changes the color of the instrument covers and accessories. The old color cover and accessories are no longer available. If your instrument has serial prefixes 2908A and below, and you must replace one of these parts, we recommend that you order the full set of covers and accessories using the part numbers for serial prefix 2910A and above. Affected cabinet parts are MP1, MP4-6, MP8, MP10-17, MP19, and, MP20 (see Table 6-3).

Section 8
SERVICE

8-1. INTRODUCTION

This section contains information for troubleshooting and repairing the Audio Analyzer. Included are troubleshooting tests, block and schematic diagrams, and principles of operation.

8-2. SERVICE SHEETS

The foldout pages in the last part of this section are block diagrams (BD1 through BD5) and service sheets (1 to 21 and A to C).

8-3. Block Diagrams

Block Diagram 1 (BD1) is an overall block diagram that breaks the instrument into functional sections. It serves as an index to the other block diagrams and as a starting point for troubleshooting (refer to *General Troubleshooting*, paragraph 8-16). The other block diagrams (BD2 through BD5) cover the Measurement, Source, Digital, and Power Supply Sections of the instrument, respectively. These block diagrams break the sections into physical assemblies and serve as an index to the schematic service sheets. Included with the block diagrams are troubleshooting checks and discussions of the principles of operation.

8-4. Schematics

Service Sheets 1 through 21 consist of assembly schematic diagrams, principles of operation discussions, component locator drawings, troubleshooting checks and hints, and, when necessary, mnemonic tables.

8-5. Additional Service Sheets

Service Sheets A and B contain disassembly procedures and exploded views of the front- and rear-panel assemblies. Service Sheet C contains a summary of Service Special Functions and Error Messages.

8-6. SAFETY CONSIDERATIONS

8-7. 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 Audio Analyzer and all test equipment.

8-8. Safety

Pay attention to WARNINGS and CAUTIONS. They must be followed 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). Where 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.

CAUTION

Do not unplug any boards in the Audio Analyzer unless the instrument is unplugged or switched to OFF. 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.

8-9. RECOMMENDED TEST EQUIPMENT AND ACCESSORIES

Test equipment and test accessories required to maintain the Audio Analyzer are listed in Tables 1-3 and 1-4. Equipment other than that listed may be used if it meets the listed critical specifications.

8-10. SERVICE TOOLS, AIDS, AND INFORMATION

8-11. Service Accessories

The accessory items required for servicing the Audio Analyzer are listed in Table 1-4. Three 44-contact extender boards (HP 08901-60084) are required for the observation of waveforms and signatures on the A7 assembly. Two 30-contact extender boards (HP 08901-60085) are required for the A3 and A4 assemblies. One each of the 44 and 30 contact extender boards are required for use with the A2, A5, and A6 assemblies. The Digital Test/Extender Board (HP 08903-60018) is required for troubleshooting the A8 Controller/Counter Assembly. Refer to Figure 8-1. The conductive polyurethane foam pad (HP 4208-0094) is required for the protection of MOS devices as cautioned in paragraph 8-8 and Service Sheets BD4 and 14.

8-12. 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 8-2).

8-13. Assembly Locations

Assemblies in the Audio Analyzer are numbered sequentially from front to back as shown in Figure 8-3. Assemblies A2 through A9 have color-coded board extractors. (For example, assembly A6 has a black left extractor

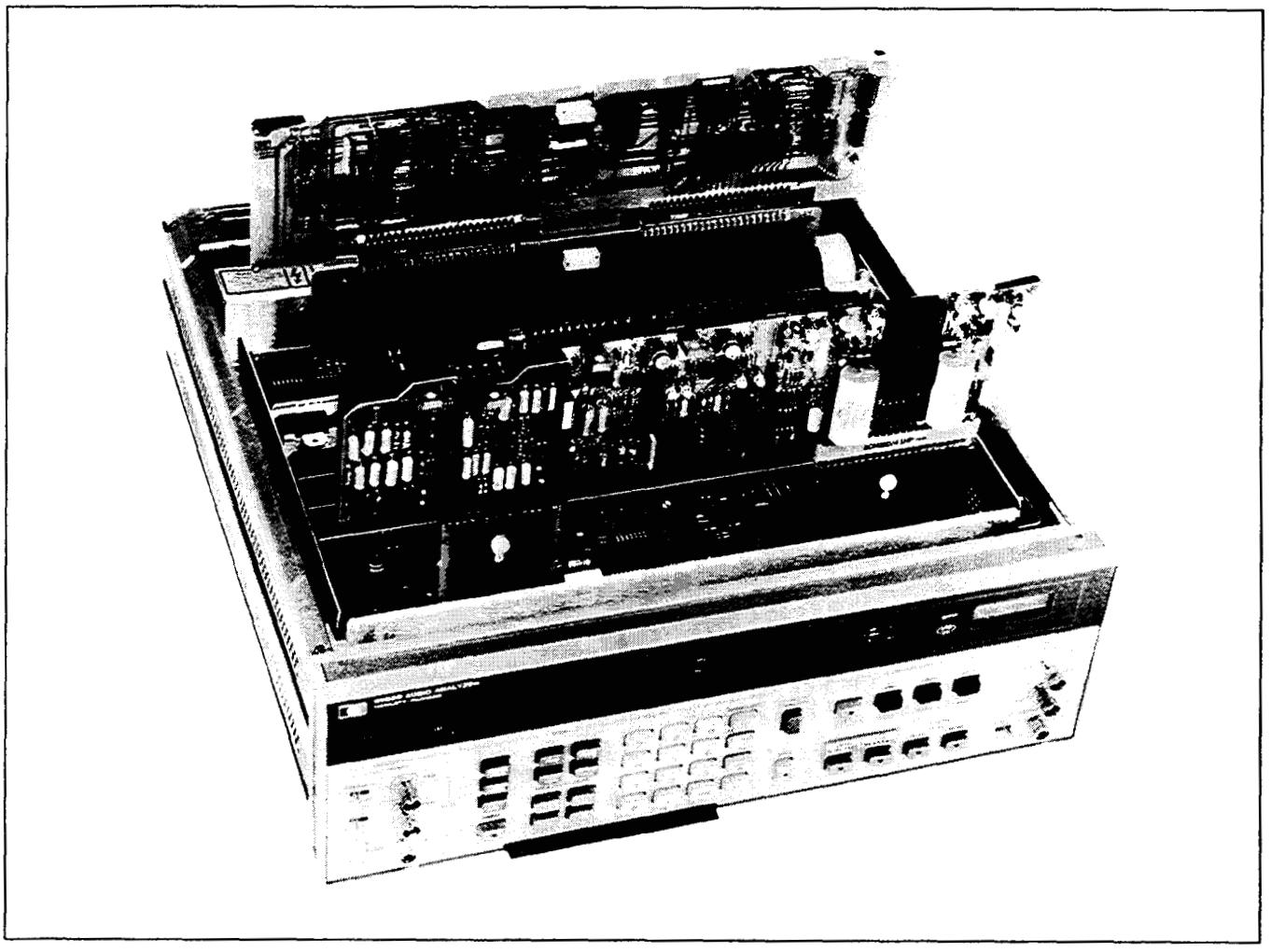


Figure 8-1. Assemblies A2 and A9 Shown on Extender Boards

and blue right extractor. Thus, the color code of A6 is 06.) Assembly A1 is part of the front-panel assembly of the instrument.

8-14. 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 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 6-5. In addition, Service Sheets A and B in this section contain illustrated parts breakdowns that locate many mechanical parts and cables.

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 description of the desired hardware.

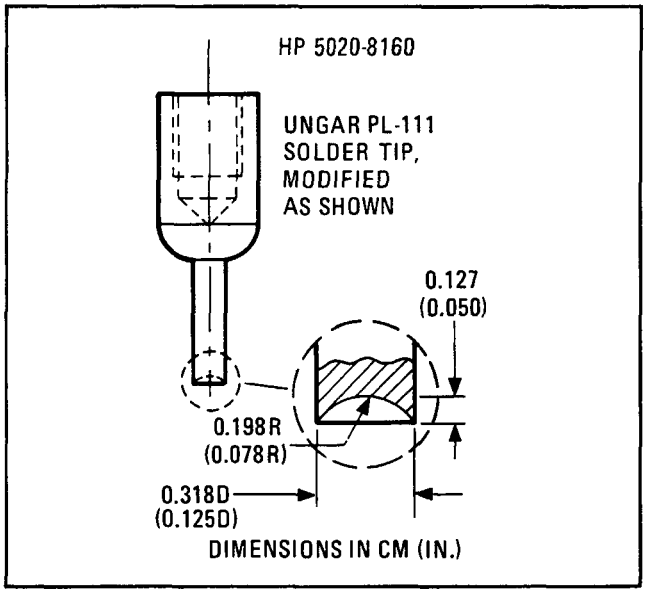


Figure 8-2. Heat-Staking Tip

8-15. Other Service Documents

Service Notes, Manual Updates, and other service literature are available through Hewlett-Packard. For further information, contact your nearest Hewlett-Packard office.

8-15.1 Component Replacement Procedures

The A2A1 Options 010, 011, 012, 013 ,015, A2A2 Options 050, 051, 052, 053, 055, A3, A4, A5, A6, A7, A9, A10, A11, A12 and A13 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 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.

8-16. 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.

8-17. 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, such as when it attempts to measure signals with frequencies higher than 100 kHz. Consult the *Specifications* table (Table 1-1) and the *Detailed Operating Instructions* in Section 3 for more detailed information.

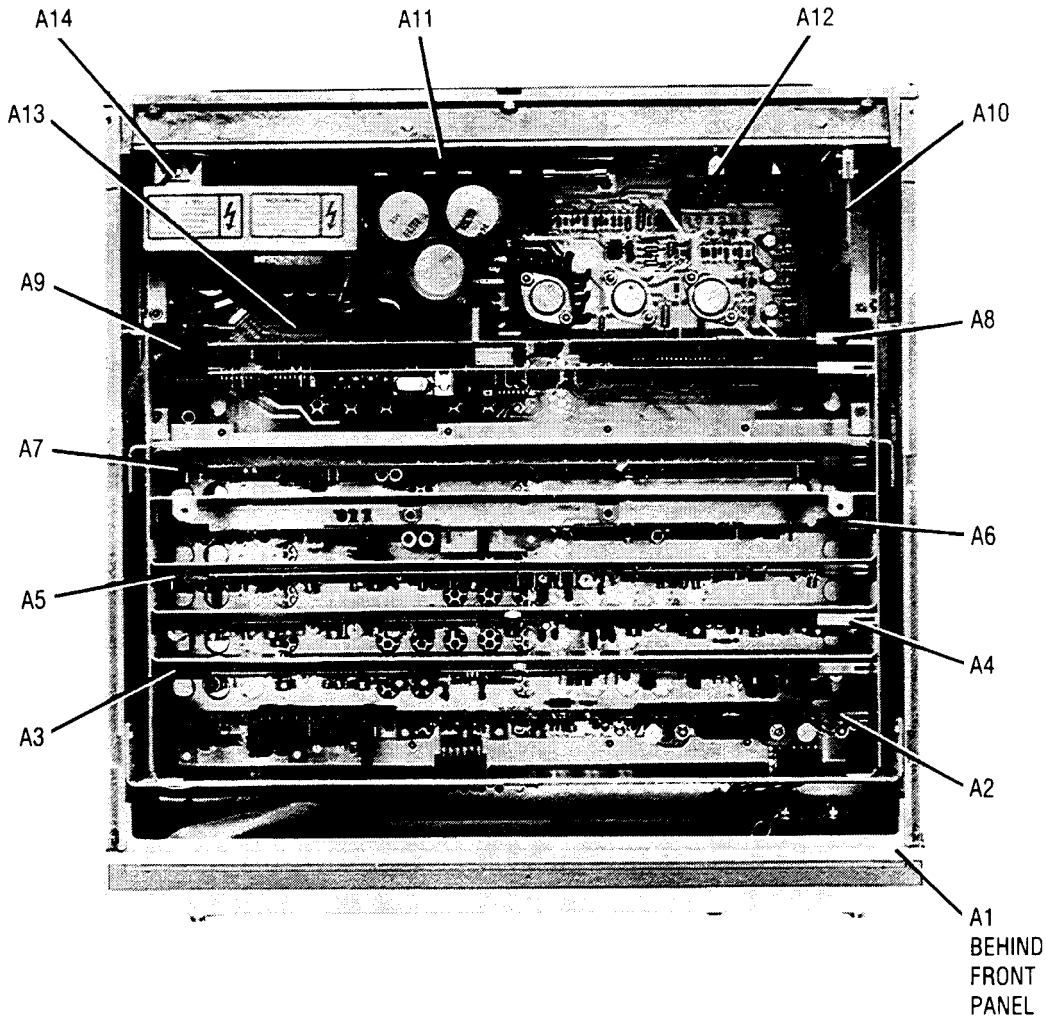
8-18. Operation Out of Specification

The specifications are listed in Table 1-1. Performance tests that can be used to verify the specifications are found in 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 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.

8-19. 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 then give cross-references to the detailed block diagrams (Service Sheets BD2 to BD5) or to a 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 or not 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



Reference Designator	Assembly
A1	Keyboard and Display
A2	Input Amplifier
A3	Notch Filter
A4	Output Amplifier/Voltmeter
A5	Oscillator
A6	Output Attenuator
A7	Latch
A8	Controller/Counter
A9	Remote Interface
A10	Remote Interface Connector
A11	Series Regulator Socket
A12	Connector/Filter
A13	Power Supply and Mother Board
A14	Line Power Module

Figure 8-3. Assembly Locations

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 that 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.

8-20. SPECIAL FUNCTIONS

8-21. 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 an understanding of the instrument and the service technician who needs arbitrary control of the instrument functions. During normal use, the Audio Analyzer safeguards itself against invalid measurements. Safeguards come in the form of automatic tuning and ranging, overvoltage protection, and error messages. When Special Functions are used, some of these safeguards are removed, depending on the Special Function selected, 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, or 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. **SERIAL PREFIX 2742A AND ABOVE**: Special Function 47 selects either 50 or 600 ohm Source Output Impedance.

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.

8-22. 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.

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 BD4. Specific direct control codes are given in the *Troubleshooting* section of the individual service sheets.

As the Direct Control code is entered, the code will appear on the left display. Pressing the SPCL key initiates the Special Function. The displays will then be in the form *rrrr* (left display) and *wwww* (right display), where each digit represents a binary bit (1 or 0). 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 *d*. Exceptions to this are Special Functions 0.03*d* through 0.06*d* and 0.0B*d* through 0.0F*d*, which control the display itself.

Since the display has a limited set of segments for alphabetic characters, the hexadecimal characters A, B, C, D, E, and F are displayed on entry as –, E, H, L, P, and blank respectively, 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 8-1 summarizes the hexadecimal entry and readback for Direct Control Special Functions.

Table 8-1. 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	–
B	11	1011	S (Shift) 1	X1	E
C	12	1100	S (Shift) 2	X2	H
D	13	1101	S (Shift) 3	X3	L
E	14	1110	S (Shift) 4	X4	P
F	15	1111	S (Shift) 5	X5	(blank)

Direct Control Special Function Applications. Direct Control Special Functions are used in troubleshooting to provide manual control of various switches or digital-to-analog devices in the hardware where other special functions or front-panel keys prove ineffective. Some examples will illustrate how to use Direct Control Special Functions.

Example 1

In the measurement path of the input signal is a Programmable Gain Amplifier located on the A2 Input Amplifier Assembly. A simplified diagram of the circuit is shown in Figure 8-4. Amplifier gain is selected by analog switches U11(1), U11(2), U11(3), and U11(4). Table 8-2 shows the Direct Control Special Functions that can be used to control the switches. (Special Function 1.N is normally used to set the amplifier gain in troubleshooting. This example was chosen to illustrate the concept of Direct Control Special Functions because of its simplicity.)

To set the gain to 8 dB, key in 0.722 SPCL or .722 SPCL. The displays will show 0010 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 circuitry on the assembly is working properly, only switch U11(3) should be closed, and thus the signal is amplified by 8 dB.

Table 8-2. Programmable Gain Amplifier Switching Direct Control Special Functions

Direct Control Special Function	Switch Closed	Gain (dB)
0.720	U11(2)	0
0.724	U11(4)	4
0.722	U11(3)	8
0.721	U11(1)	12

Notice that the display no longer shows a measurement result. No annunciators are lighted (except REMOTE and ADDRESSED if the Special Function is entered via HP-IB) and only the SPCL key is lighted. If any key other than a number key, the S (Shift) key, or the LCL key is pressed, the instrument

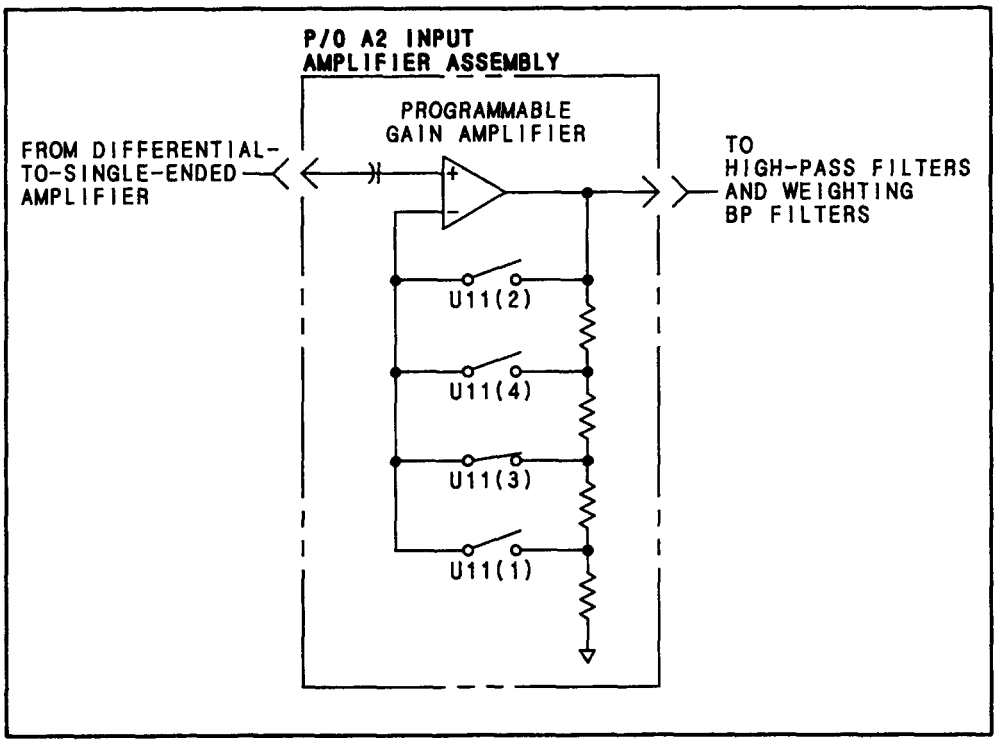


Figure 8-4. Example Showing Programmable Gain Amplifier Switching

hardware will revert back to the measurement mode it was in before the Direct Control Special Function was entered. Thus, in this example, unless 8 dB gain had been previously set, 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.)

As it turns out, other 0.72*d* codes than those shown in Table 8-2 will affect the gain of the Programmable Gain Amplifier. For example, 0.723 will close U11(3) and U11(1) simultaneously (gain is now 10.6 dB). This fact is ascertained from the service sheet schematics.

Example 2

A second example from the A2 assembly illustrates data readback. One of the means of detecting an overrange of the input circuits is by the Input Overload Detector. The detector connects to both the high and low inputs (directly) and output (through the Input Range Detector) of the Programmable Gain Amplifier of Example 1. See Figure 8-5. At the input of the amplifier, the Input Overload Detector senses the dc level and compares it against both a positive and negative reference. At the output of the Input Range Detector it also compares the dc level (and hence the ac level of the signal) against a reference. If any detected level exceeds a reference, the output of the detector goes low and resets flip-flop A7U14 on the A7 Latch Assembly. A7U14 also sets the gain of all input circuits up to and including the Programmable Gain Amplifier to minimum gain without intervention of the Controller. A7U15B, when enabled, inverts the output of A7U14. The output of A7U14 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 Input Overload Detector (by enabling A7U15B and reading its output) and takes corrective action if A7U14 has tripped.

At this point in the discussion, a more detailed description of the Instrument Bus data lines is needed. Data (*d*) is sent 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 Audio Analyzer, these circuits must operate against the pull-up resistor.

Readback devices that are read out to the data lines, such as A7U15B, are similarly configured. A7U15B has an open-collector TTL output. 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 A7U15B is disabled (enable is low), the output is high (inactive) and has no effect on the data line. A7U15B is enabled by Direct Control Special Function 0.70d. The value of d is arbitrary to enable A7U15B, 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.

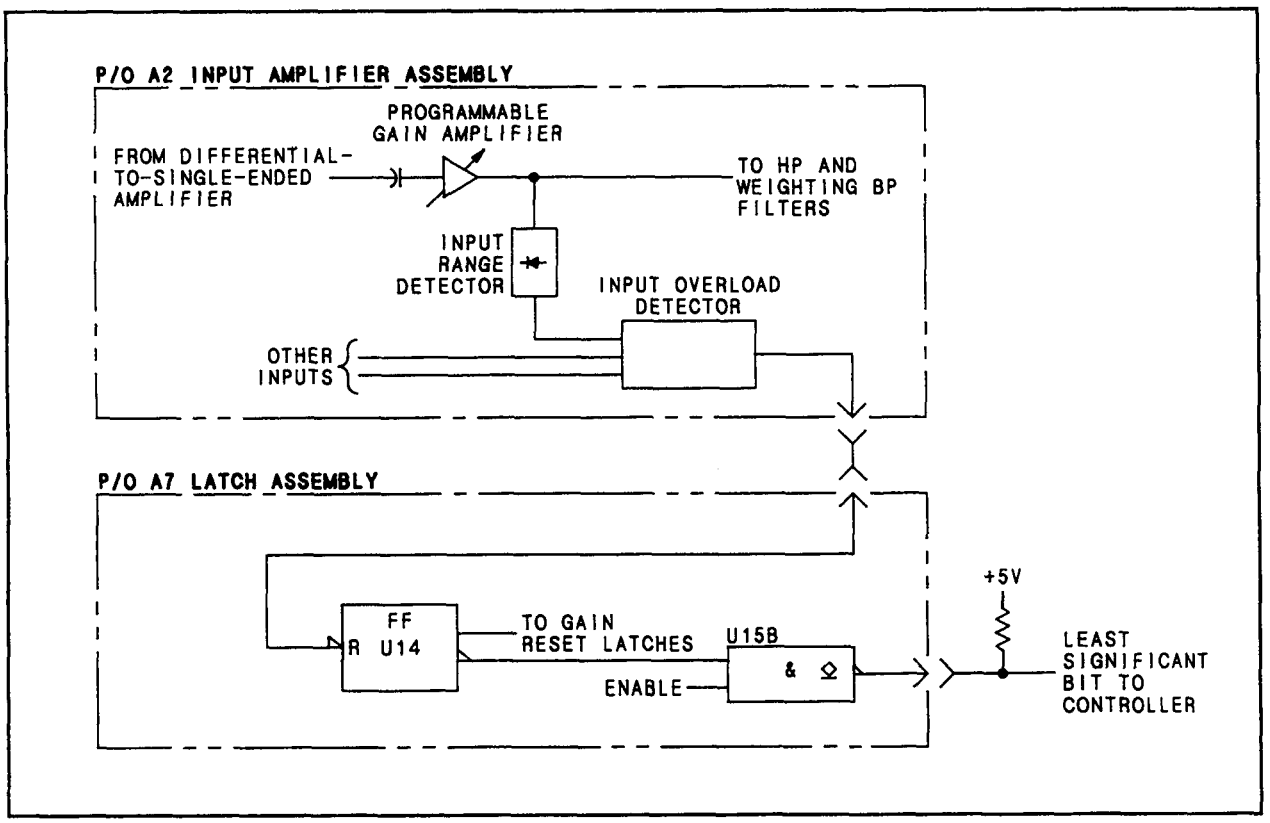


Figure 8-5. Example Showing Input Overload Detector Readback

To clarify this, suppose that A7U14 has not been reset. If Direct Control Special Function 0.700 is entered, the displays will show 0000 0000. The second four digits are 0000 because d=0 was received by the Controller from the keyboard and issued to the Instrument Bus. The un-reset flip-flop puts a low on the input of A7U15B 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 000. Thus the d read back is 0000.

If A7U14 is reset, A7U15B puts a low on the least-significant data bit (r=1), and the data read back is 0001. The displays are therefore 0001 0000. (Note that *rrrr* is different from *wwww*.) If d is keyed in as a hexadecimal F, the displays are 1111 1111 regardless of the state of A7U15B. 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 re-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. For example, if you key in 0.700 SPCL then increase the input signal level until an overload condition is reached, you will find that the displays show 0000 0000 continuously except for the instant the overload is detected (when the displays momentarily blink 0001 0000). An automatic resetting of the input circuits removes the overload as soon as it is detected so the overload is observed only for one period of the Direct Control Special Function cycle.

8-23. 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. See Table 8-1 for entry of hexadecimal suffixes.

40.0 Controller Reset. Initializes the Controller to its power-up state. Because this disturbs the HP-IB hardware, it is unavailable from HP-IB (gives Error 24). The power-up sequence is discussed in paragraph 8-27.

41.0 Controller Clear. Initializes the Controller to its power-up state but bypasses the operational checks (see paragraph 8-27). Leaves HP-IB hardware unaffected but clears any service request message (SRQ) being issued by the Audio Analyzer, sets the service request condition to its power-up state, and clears all bits in the status byte.

42.0 Display Software Date. Displays the date of the software in the form: <month of year>.<day of month> in the left display and <year> in the right display.

43.N Service Error Display Control. Service Errors are numbered 65 to 95. Refer to paragraph 8-26.

N=0 Disables display of Service Errors.

N=1 Enables display of Service Errors.

N=65 to N=95 quad Enables display of only the Service Error specified by N. Operating and Entry Errors remain enabled.

44.N Notch Filter Mode Select. Permits manual selection of one of three configurations of the Notch Filter.

N=0 Notch Filter mode selected automatically as required by the measurement mode.

N=1 Notch Filter in notch mode.

N=2 Notch Filter in flat mode.

N=3 Notch Filter in bandpass mode.

45.N SINAD Meter Enable. Permits the SINAD meter to be enabled for measurement modes other than SINAD and, in the SINAD mode, for measurements greater than 24 dB. It is most often useful for reading distortion when the displayed reading is very noisy. When this Special Function is invoked, the meter reads the ratio of the level at the Pre-Notch RMS/Average Detector to the Output RMS/Average/Quasi-peak Detector, expressed in dB. The reading must, therefore, be interpreted relative to the dB reading in the right display. Usually, this entails ignoring the minus sign and subtracting multiples of 20 dB. For example, a distortion reading of −66.80 dB in the right display may be indicated as 6.8 dB on the SINAD meter or −76.80 dB may be indicated as 16.8 dB. AC level readings will normally be 0 dB.

N=0 SINAD meter enabled normally. See *Detailed Operating Instructions* in Section 3.

N=1 SINAD meter enabled in all measurement modes except dc level.

46.N Count Internal Signals. The Counter counts the internal signal selected by N and displays the count. The resolution is the same as would normally be displayed.

N=0 Oscillator Frequency. See Service Sheets 9 and 13.

N=1 Input Frequency. See Service Sheets 2 and 13.

N=3 Output Amplifier Frequency. See Service Sheets 5 and 13.

48.N Defeat Output Amplifier Overdrive Protection. In the ac level and signal-to-noise measurement modes, the gain of the Output Amplifier is normally set to 0 dB whenever the signal detected by the Pre-Notch RMS/Average Detector exceeds 0.6V and a low-pass filter has been selected. This prevents the first amplifier after the Notch Filter from being overdriven by signals in the stopband which would normally be detected by the Output RMS/Average/Quasi-peak Detector. When this Special Function is invoked, the Output RMS/Average/Quasi-peak Detector is used to determine the gain setting of the Output Amplifier. Use of this function permits measurement of filters (such as the internal, optional weighting bandpass filters) with extended dynamic range, but care must be taken not to overload the selected low-pass filter (either 30 or 80 kHz).

N=0 Output Amplifier gain determined normally.

N=1 Output Amplifier gain determined by the Output RMS/Average/Quasi- peak Detector.

49.N Display Internal Voltages. The Voltmeter measures and displays the internal voltage selected by N.

N=0 Ground. See Service Sheet 7.

N=1 Pre-Notch RMS/Average Detector with Ripple Filter. See Service Sheets 2 and 7.

N=2 DC Input Voltage without Filter. See Service Sheet 1.

N=3 Output RMS/Average/Quasi-peak Detector with Ripple Filter. See Service Sheets 6 and 7.

N=4 Output RMS/Average/Quasi-peak Detector. See Service Sheet 6.

N=5 Output RMS/Average/Quasi-peak Detector with SINAD Filter. See Service Sheets 6 and 7.

N=6 Notch Tune Voltage. See Service Sheet 4.

N=7 DC Input Voltage with Filter. See Service Sheet 1.

N=B Input Range Detector. See Service Sheet 2.

NOTE

The suffix can also be two digits, XY. The difference (49.X SPCL − 49.Y SPCL) is then displayed. For example, 49.3 SPCL or 49.30 SPCL gives a display of the Output RMS/Average/Quasi-peak Detector with Ripple Filter with respect to ground. 49.34 SPCL gives a display of the difference between the Output RMS/Average/Quasi-peak Detector with Ripple Filter and the same detector without the Ripple Filter.

50.N Display Oscillator Frequency. The frequency of the Oscillator is displayed in the left display in all measurement modes except dc level and where a valid measurement cannot be made. The right display operates as usual. Resolution is the same as it would be if it had been an input signal.

N=0 Display frequency as normal.

N=1 Display Oscillator frequency.

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 10. The display is in the form: <actual checksum> in the left display and <expected checksum> in the right display. Both displays should show 0 for ROM 10. See Service Sheet 16. **Serial Prefix 2652A and Above:** ROM consolidation does not change this Verification.

53.N Notch Filter Frequency Range. Permits the frequency range of the Notch Filter to be displayed or manually set. If no suffix is keyed in (that is, 53. SPCL), the current Notch Filter range is displayed, where 0 is the lowest range and 3 is the highest. For N=0 through 3, the Notch Filter is set to the range specified by N. See Service Sheet 3 and Special Function 54.N.

54.N Notch Filter Coarse Tune. Permits the coarse-tune code of the Notch Filter to be displayed or manually set. If no suffix is keyed in (that is, 54. SPCL), the current Notch Filter coarse-tune code is displayed, where 0

is the lowest frequency and 255 is the highest. For N=0 through 255, the Notch Filter coarse-tune code is set to the number specified by N. (N is keyed in as a decimal value and not a hexadecimal value.) Fine tuning of the Notch Filter is via the automatic tuning circuitry on the Notch Filter Assembly. See Service Sheet 3 and Special Function 53.N.

55.N Oscillator Frequency Range. Permits the frequency range of the Oscillator to be displayed or manually set. If no suffix is keyed in (that is, 55. SPCL), the current Oscillator range is displayed, where 0 is the lowest range and 3 is the highest. For N=0 through 3, the Oscillator is set to the range specified by N. See Service Sheet 8 and Special Functions 56.N and 57.N.

56.N Oscillator Coarse Tune. Permits the coarse-tune code of the Oscillator to be displayed or manually set. If no suffix is keyed in (that is, 56. SPCL), the current Oscillator coarse-tune code is displayed, where 0 is the lowest frequency and 255 is the highest. For N=0 through 255, the Oscillator coarse-tune code is set to the number specified by N. (N is keyed in as a decimal value and not a hexadecimal value.) See Service Sheet 9 and Special Functions 55.N and 57.N.

57.N Oscillator Fine Tune. Same as Special Function 56.N except that it pertains to fine tuning.

58.N Source Fine Level. Permits the fine-level code of the Source to be displayed or manually set. If no suffix is keyed in (that is, 58. SPCL), the current Source fine-level code is displayed, where 0 is the lowest level and the 255 is the highest. For N=0 through 255, the Source fine-level code is set to the number specified by N. (N is keyed in as a decimal value and not a hexadecimal value.) See Service Sheet 10 and Special Function 59.N.

59.N Source Coarse Level. Permits the coarse-level code of the Source to be displayed or manually set. If no suffix is keyed in (that is, 59. SPCL), the current Source coarse-level code is displayed where 31 is the lowest level, 0 is the highest, and 32 through 63 switch the level off. For N=0 through 63, the Source coarse-level code is set to the number specified by N. For N=0 through 31, the level is controlled in 2.5 dB steps, where the attenuation is N *times* 2.5 dB. (N is keyed in as a decimal value and not a hexadecimal value.) See Service Sheet 11 and Special Function 58.N.

60.0 Key Scan. The keyboard is scanned and a keycode is displayed and output to the HP-IB. The key codes are shown in Figure 8-6.

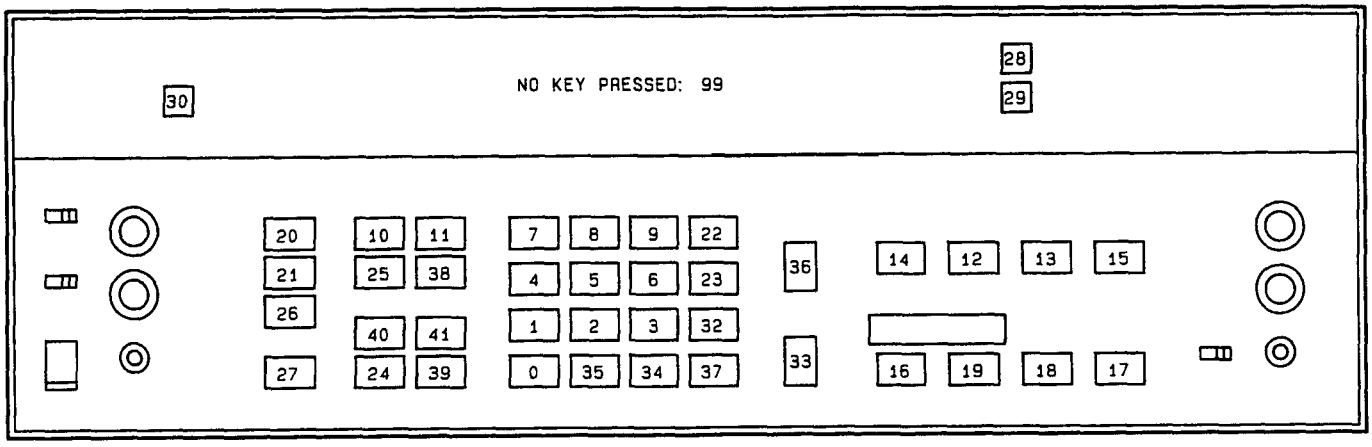


Figure 8-6. Key Codes for Key Scan (Service Special Function 60.0)

To use the Key Scan Special Function, remove the instrument top cover. Key in 60.0 SPCL, then jumper A8U6 pin 7 to A8TP3 (GND) on the A8 Controller/Counter Assembly. Press the front-panel keys and observe the right display. If two or more keys are pressed simultaneously, the display shows the first one found in its normal scan. See Service Sheet 17.

Two simple programs for displaying the key codes on a computing controller are shown in Table 8-3. Removal of the top cover is unnecessary. The Audio Analyzer is assumed to have HP-IB address 28.

Table 8-4. PIO Port A

A9U18 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								

Table 8-5. PIO Port B

A9U18 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								

8-24. ERROR MESSAGES

8-25. General

The instrument generates error messages to indicate operating problems, incorrect keyboard entries, or service-related problems. The error message is generally cleared when the error condition is removed. The error messages are grouped by error code as follows:

Error 10 through Error 39 and Error 96. These are Operating and Entry Errors which indicate that not all conditions have been met to assure a calibrated measurement or that an invalid key sequence or keyboard entry has been made. Operating Errors can usually be cleared by readjustment of the front-panel controls. The Error Disable Special Function (8.N) can be used to selectively disable certain operating error messages. Entry Errors require that a new keyboard entry or function selection be made. More information on Operating and Entry Errors and error message disabling can be found under *Error Message Summary* and *Error Disable* in the *Detailed Operating Instructions* in Section 3 and on the Operating Information pull-out cards.

Error 65 through Error 95. These are Service Errors which provide additional service-related information and are discussed below.

8-26. Service Errors (Error 65 through Error 95)

Service Errors are not normally displayed. When a service-related problem is suspected, enable the Service Errors by keying in 43.1 SPCL. Also a specific error message can be enabled by keying in 43.N where N is the number of the desired error message (N=65 through 95). Service Errors can be disabled by keying in 43.0 SPCL or by pressing AUTOMATIC OPERATION. Not all Service Errors are an indication of a problem but may be a normal occurrence under the circumstances. When Service Errors are not enabled, a Service Error will often map into an Operating or Entry Error; when Service Errors are enabled, both Service and Operating or Entry Errors are displayed sequentially.

Error 65 Decimal Point Fixed Too Far to the Left. The decimal point has been held by Special Function 4.N and the reading to be displayed is too large to fit the display. This error maps into Error 10.

Error 70 Cannot Count Oscillator Frequency. When the Oscillator is being tuned (that is, when a new frequency is entered or a new measurement mode requiring tuning has been selected), the frequency count is 0. See Service Sheets BD3 and BD4. This error maps into Error 19.

Error 71 Oscillator Tune Abort. The Oscillator failed to tune after three attempts. See Service Sheet BD3. This error is identical to Error 18.

Error 72 AC Input Overload with Input Range Held. For all measurements except dc level, the Input Overload Detector has tripped while the input level range has been held with Special Function 1.N. See Service Sheet BD2. This error maps into Error 30.

Error 73 Input AC Level Abort. For all measurements except dc level, the Input Amplifier failed to level after three attempts. This would be normal for an unstable signal. See Service Sheet BD2. This error maps into a display of "----" until Error 31 appears.

Error 74 Output Amplifier Overload with Output Amplifier at 0 dB Gain. The Output Overload Detector has tripped with the Output Amplifier gain at 0 dB. See Service Sheet BD2. This error maps into a display of "----" until Error 31 appears.

Error 75 DC Input Overload with Input Range Held. For a dc level measurement only, the Input Overload Detector has been tripped while the input level range has been held with Special Function 2.N. See Service Sheet BD2. This error maps into Error 30.

Error 76 Too Much AC for DC Level Measurement. For a dc level measurement, the Input Overload Detector has tripped because of too much ac (as sensed by the Input Range Detector). This error maps into Error 14 or generates a normal range down.

Error 77 Output Amplifier Gain Too High after Leveling Once. The Output RMS/Average/Quasi-peak Detector has sensed too high a level after one attempt to set the Output Amplifier gain. This would be normal for an unstable signal. See Service Sheet BD3. This error maps into a display of "----" until Error 31 appears.

Error 78 Output Amplifier Overload after Leveling Once. The Output Overload Detector has tripped after one attempt to set the Output Amplifier gain. This would be normal for an unstable signal. See Service Sheet BD3. This error maps into a display of "----" until Error 31 appears.

Error 79 Output Amplifier Overload with No Post-Notch Gain Hold. The Output Overload Detector remains tripped after three attempts to set the Output Amplifier gain and Special Function 3.N is in automatic selection. See Service Sheet BD3. This error maps into a display of "----" until Error 31 appears.

Error 80 Cannot Count Oscillator Frequency in SINAD. When the Oscillator is attempting to tune to the frequency of the Notch Filter, the frequency count is 0. See Service Sheets BD3 and BD4. This error maps into Error 19.

Error 81 Cannot Count Input Frequency. The input frequency cannot be counted in ac level, distortion, distortion level, or signal-to-noise measurement modes. See Service Sheet BD2. This error maps into Error 13.

Error 82 Notch Filter Does Not Null. The Notch Filter does not null after three attempts. This would be normal for an erratic signal. See Service Sheet BD2. This error maps into Error 13.

Error 83 Cannot Count Input Frequency. After sensing the presence of a signal, the count is 0. This would be normal when the input signal is filtered by the High-Pass and Weighting Bandpass Filters. See Service Sheet BD2. This error gives rise to a display of 0.00 Hz.

Error 84 Output Amplifier Overvoltage with No Overload. The Output RMS/Average/Quasi-peak Detector senses an overvoltage, the Output Amplifier gain is 0 dB, but the Output Overload Detector has not tripped. See Service Sheet BD2. This error maps into a display of "----" until Error 31 appears.

Error 85 Period of the Voltage-to-Time Converter 0. The Counter receives no pulses from the Voltage-to-Time Converter. This can occur if the input to the Voltage-to-Time Converter is too negative. See Service Sheet BD2. This error is identical to Error 17.

Error 86 Frequency Count Greater Than 200 kHz. This error causes a display of 0.000 kHz.

Error 87 Output Amplifier Overload with Post-Notch Gain Hold. The Output Overload Detector remains tripped after three attempts to set the Output Amplifier gain and Special Function 3.N has been selected. See Service Sheet BD2. This error maps into Error 19.

Error 88 Attempt to Take Log of Negative Ratio. This error maps into Error 11.

Error 89 Attempt to Take Log of Negative Number. This error maps into Error 11.

Error 90 Decimal Point Fixed and Exponent Too Large. One of the mV ranges has been requested by Special Function 4.N for a measurement that does not use those ranges. This error maps into Error 10.

Error 91 Decimal Point Fixed Too Far to the Left. The decimal point has been held by Special Function 4.N and the reading to be displayed is too large to fit the display. This error maps into Error 10.

Error 92 Decimal Point Fixed and Unable to Display. This error maps into Error 10.

Error 93 Number to Be Displayed Greater Than 9999. This error maps into Error 10.

Error 94 Attempt to Divide by Zero in Ratio. This error maps into Error 11.

Error 95 Signal-to-Noise Ratio Too Large to Calculate. This error maps into Error 10.

8-27. POWER-UP CHECKS

When the Audio Analyzer is first turned on (or if Special Function 40.0 is entered), the instrument goes through a series of operational checks. When a check fails, an error code is output for two seconds on the four internal TEST LEDs on the A8 Controller/Counter 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 results is given on the front-panel displays. The principal advantages to using the Power-Up Checks are that the keyboard and display need not be operational.

To use the Power-Up Checks, remove the top cover (refer to *Top and Bottom Cover Removal*, Service Sheet A), remove any signal at the INPUT, and switch the LINE to OFF for five seconds (to discharge the supplies) and back to ON. Observe the four TEST LEDs on the top of the Controller/Counter Assembly as the instrument powers up. The LEDs should light in the following sequence:

1. Indeterminate for about 1/8 second.
2. ( )( )( )(1) for about 1 second.
3. (8)(4)(2)(1) for about 2 seconds.
4. (8)(4)(2)(1), with (1) blinking indefinitely until a key is pressed.

The Power-Up Checks actually begin at step 2 (above) 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 about one second afterwards. Failure of one or more LEDs or segments indicates that the respective components or drive circuits have failed. See Service Sheet 18.
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 entering a series of 52.N SPCL commands—see *Service Special Functions*, paragraph 8-23.) 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 5 is faulty, the TEST LEDs will blink ( )(4)( )(1)—that is, 0101, a binary 5. The check then continues on to the next ROM. See Service Sheets BD4 and 16. If no faulty ROM is found, a steady ( )( )( )(1) appears for about char'370 second. **Serial Prefix 2652A and Above**: ROM Consolidation does not change this Check. Note however, that if any "ROM" check produces an error, the entire ROM 10 needs to be replaced.
3. **Random Access Memory Check.** Data is stored into and retrieved from the random access memory (RAM). If the data read back differs from the data entered, error code ( )( )(2)( ) is output to the TEST LEDs for two seconds. See Service Sheet 15.
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 two seconds. See Service Sheets BD4, 12, and 16.
5. **Keyboard Check.** The keyboard is scanned to see if any keys are down. If a key is down, error code ( )(4)( )( ) is output to the TEST LEDs for two seconds. See Service Sheets BD4 and 17.

8-28. CONTROLLER TEST LEDS AND TEST POINTS

Near the top edge of the A8 Controller/Counter Assembly are located four test points 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 way:

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,* paragraph 8-27.
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.

Grounding of certain of the TEST test points alters instrument operation in the following ways:

1. Grounding test point C on power-up initiates the Counter, Latch, and Controller I/O signature analysis troubleshooting routines. See Service Sheet 14.
2. Grounding test point D on power-up initiates the Keyboard signature analysis troubleshooting routine. The signature analyzer's start and stop leads are then connected to test point A and the probe leads are then connected to test point B. See Service Sheet 17.

Whenever a test point is grounded, the associated annunciator is extinguished.

8-29. 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 Keyboard and Display, Latch, and Counter/Controller Assemblies (A1, A7, and A8) are designed for troubleshooting with signature analysis. Signature analysis is a method of digital signal tracing using test routines programmed in the Audio Analyzer's ROM. With the Audio Analyzer's Controller executing the signature analysis routine, 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:

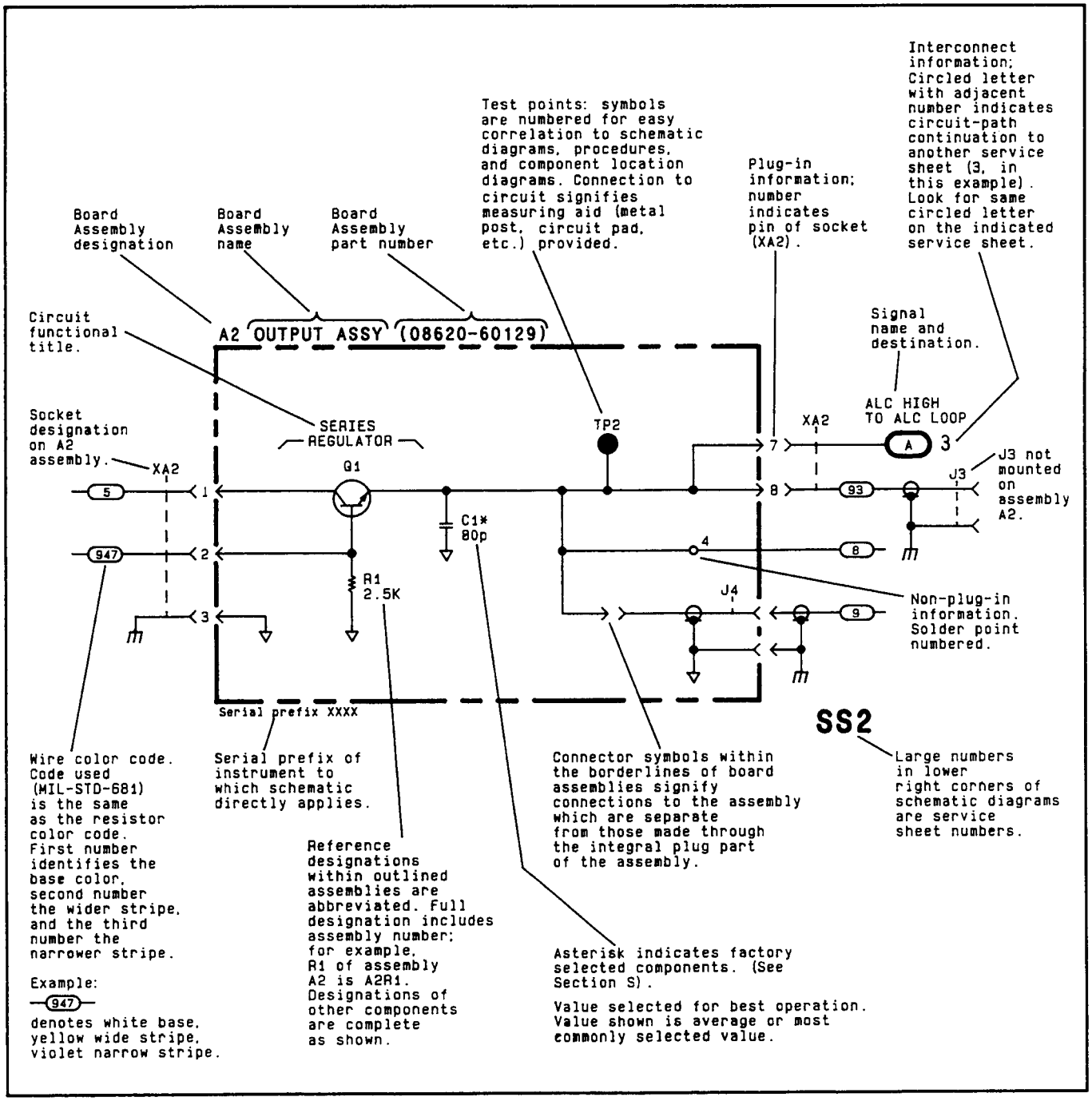
1. Make sure that every step is performed as described in the set-up procedure. That is, make sure that the clock, start, and stop connections and triggering are correct.
2. Double-check to ensure that the signatures are being taken at the correct node.
3. Make sure that the signature analyzer probe is making good contact with the pin being checked. Oxidation on pins can cause invalid signatures due to poor contact.
4. When you think that you have found a bad signature, double check to make sure.
5. When checking a node, be sure that the unstable signature indicator is not blinking.

8-30. SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

Table 8-6 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 Inc.
345 East 47th Street
New York, NY 10017

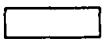
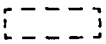
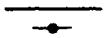
Table 8-6. Schematic Diagram Notes (1 of 11)



SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

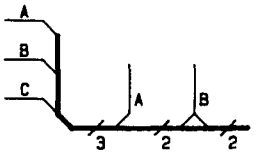
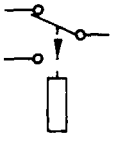
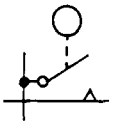
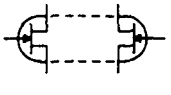
Table 8-6. Schematic Diagram Notes (2 of 11)

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.

SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

Table 8-6. Schematic Diagram Notes (3 of 11)

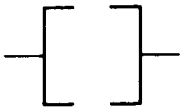
	Indicates multiple paths represented by only one line. Letters or names identify individual paths. Numbers indicate number of paths represented by the line.
	Coaxial or shielded cable.
	Ferrite bead. (Increases the self-inductance of the conductor passing through the bead.)
	Relay. Contact moves in direction 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).

SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

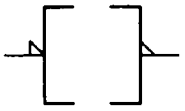
Table 8-6. Schematic Diagram Notes (4 of 11)

DIGITAL SYMBOLOGY REFERENCE INFORMATION

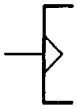
Input and Output Indicators



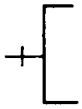
Implied Indicator—Absence of polarity indicator (see below) implies that the active state is a relative high voltage level. Absence of negation indicator (see below) implies that the active state is a relative high voltage level at the input or output.



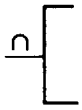
Polarity Indicator—The active state is a relatively low voltage level.



Dynamic Indicator—The active state is a transition from a relative low to a relative high voltage level.

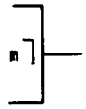


Inhibit Input—Input that, when active, inhibits (blocks) the active state outputs of a digital device.

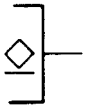


Analog Input—Input that is a continuous signal function (e.g., a sine wave).

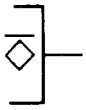
Polarity Indicator used with Inhibit Indicator—Indicates that the relatively low level signal inhibits (blocks) the active state outputs of a digital device.



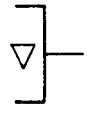
Output Delay—Binary output changes state only after the referenced input (m) returns to its inactive state (m should be replaced by appropriate dependency or function symbols).



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.

SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

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

SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

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.

SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

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.

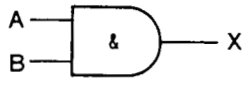
Active

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.

SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

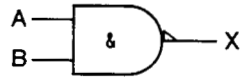
Table 8-6. Schematic Diagram Notes (9 of 11)

AND GATE



A	B	X
H	H	H
H	L	L
L	H	L
L	L	L

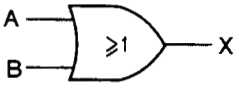
NAND GATE



A	B	X
H	H	L
H	L	H
L	H	H
L	L	H

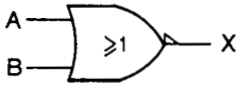
OR GATE WITH INVERTED INPUTS

OR GATE



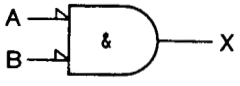
A	B	X
H	H	H
H	L	H
L	H	H
L	L	L

NOR GATE

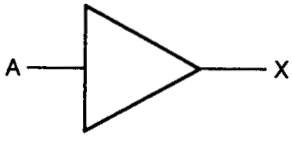


A	B	X
H	H	L
H	L	L
L	H	L
L	L	H

AND GATE WITH INVERTED INPUTS

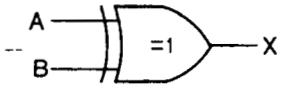


BUFFER

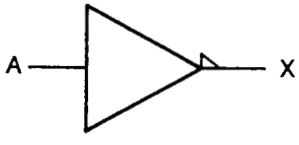


A	X
H	H
L	L

EXCLUSIVE-OR GATE



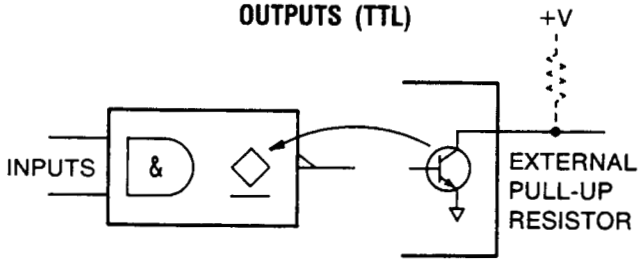
A	B	X
H	H	L
H	L	H
L	H	H
L	L	L



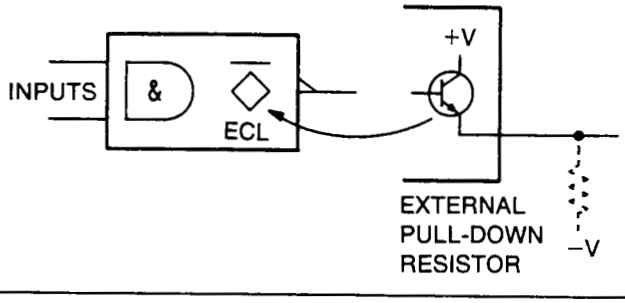
A	X
H	L
L	H

INVERTER

OPEN COLLECTOR OUTPUTS (TTL)



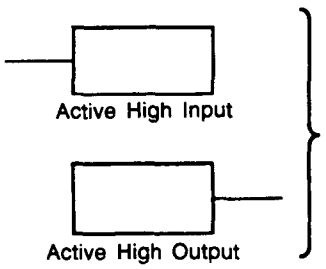
OPEN EMITTER OUTPUTS (ECL)



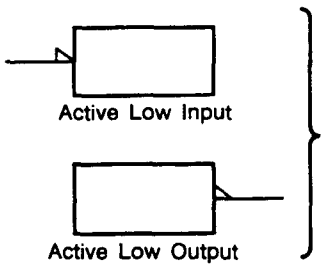
SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

Table 8-6. Schematic Diagram Notes (10 of 11)

ACTIVE LEVELS

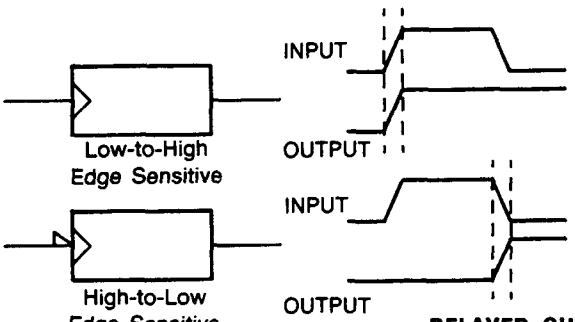


ACTIVE HIGH inputs and outputs are indicated by the absence of the polarity indicator symbol.



ACTIVE LOW inputs and outputs are indicated by the presence of the polarity indicator symbol (▷).

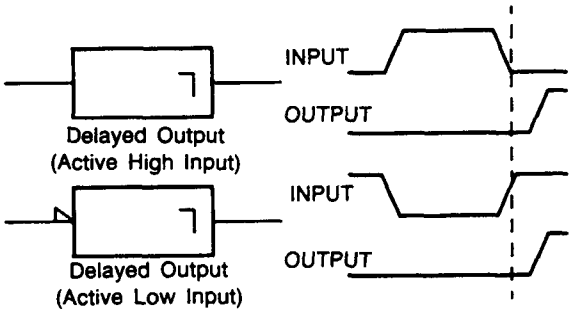
EDGE SENSITIVE INPUTS



EDGE SENSITIVE (low-to-high) inputs are indicated by the presence of the dynamic indicator symbol (→ ▷).

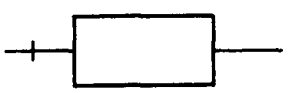
EDGE SENSITIVE (high-to-low) inputs are indicated by the presence of both the dynamic indicator and the polarity indicator symbols (→ ▷).

DELAYED OUTPUT RESPONSE



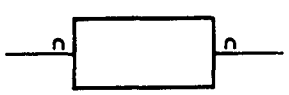
OUTPUT DELAY indicator symbol (⌐) shows that the output becomes effective *after* the input signal returns to its inactive state.

INHIBIT INPUTS



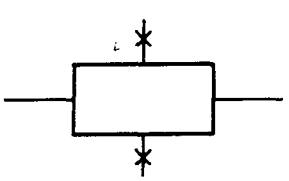
INHIBIT indicator symbol (+) indicates an input that, when active, inhibits (blocks) the output(s) from achieving their active states (the outputs remain inactive).

ANALOG LINES



ANALOG indicator symbol (∩) indicates a line that has an analog input or output.

NONLOGIC CONNECTION

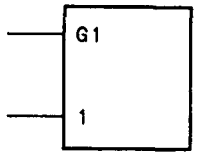


The Nonlogic Connection symbol (X) indicates a connection that does not carry any logic information.

SCHEMATIC SYMBOLOGY AND SCHEMATIC DIAGRAM NOTES

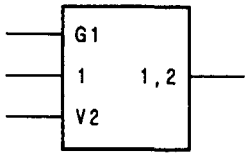
Table 8-6. Schematic Diagram Notes (11 of 11)

AND



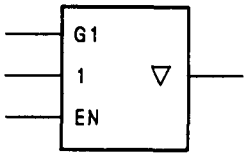
The input that controls or gates other inputs is labeled with a C or a G, followed by an identifying number.
The controlled or gated input or output is labeled with the same number. In this example, 1 is controlled by G1.

OR



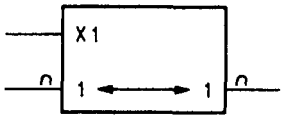
When a V input is active, the output will be in its active state. With the V input inactive, the device functions as if the V input doesn't exist.

ENABLE



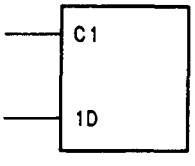
When the EN input is active, the output is enabled to function normally. When the EN input is inactive, the three-state output (▽), in this case, becomes a high impedance, effectively removing that device from the circuit.

TRANSMISSION

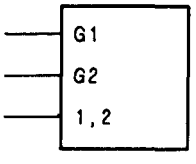


When the X1 input is active, the associated input-output pair are bi-directionally connected together. When X1 is inactive, the connection is broken.

CONTROL

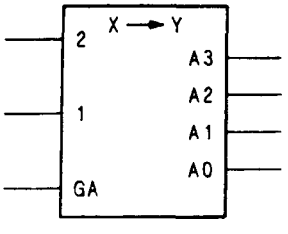


When the controlled or gated input or output already has a functional label (D is used here), that label will be prefixed by the identifying number.



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.

SERVICE SHEET BD1—Overall Block Diagram

PRINCIPLES OF OPERATION

General

The Audio Analyzer can be conceptually broken down into four subsections. The subsections are shown in Table 8A-1. Service Sheets BD2 through BD5 break the operation of the instrument along similar lines as indicated in the table.

Table 8A-1. Instrument Block Diagram and Subsection Breakdown

Service Sheet	Subsection	Circuits
BD2	Measurement	Input, Notch Filter, Output Amplifier, Detectors, DC Voltmeter
BD3	Source	Oscillator, Output Attenuator
BD4	Digital	Controller, Counter, Keyboard and Display, Remote Interface
BD5	Power Supply	Power Supplies, Motherboard

Input Circuits

Measurements on the input signal are made on the difference between the HIGH and LOW INPUT connectors. The range of signals at the INPUT connectors is 20 Hz to 100 kHz and 0 to 300 Vrms for ac signals and 0 to 300V (either polarity) for dc signals. Either INPUT connector (HIGH or LOW) can be floated upto 300V with respect to ground.

For ac measurements, the AC/DC Switches insert a capacitor into both the high and low paths. The ac input impedance for each path is 100 kΩ with respect to ground. The dc impedance is 101 kΩ.

The Input Attenuator has voltage dividers on both high and low paths which can be set to 0, −12, −24, or −40 dB. In automatic operation the gain is set to 0 dB when the input signal is 3V or less.

The Over-Voltage Protection circuitry limits the input signal level of either the high or low path to ±13 Vp. In addition, the output of the protection circuit is sensed by the Input Overload Detector. If the level exceeds a preset reference, all input circuits are set to minimum gain.

The Differential-to-Single-Ended Amplifier converts the non-referenced, differential signal to a signal referenced to ground. The gain of the amplifier can be set to 0, 8, 16, or 20 dB. (For the dc level measurement mode, the gain is always 0 dB.) The amplifier is dc coupled. When dc level is selected, the output of the amplifier is measured by the dc voltmeter. The output is also sensed by the Input Overload Detector. If the level is more positive than +8.7V or more negative than −8.7V, the detector sets the Input Attenuator to the 40 dB range until the proper range has been determined by the Controller.

The Programmable Gain Amplifier can be set for 0, 4, 8, or 20 dB gain and is ac coupled.

The Input Range Detector is used to set the gain of the input path (Input Attenuator, Differential-to-Single-Ended Amplifier, and Programmable Gain Amplifier). Since it is positioned before the Weighting Bandpass and High-Pass Filters, it prevents overloading of the filters by input signals located in the filter stopbands. The gain of the detector is programed to match the passband gain of the selected filter. (The gain is programed indirectly by the Controller via the filter circuits.)

The gain of the input path is set so that the signal is between 1.7 and 3V at the Input Range Detector. This is the optimum level for the Input Range Detector, the Pre-Notch RMS/Average Detector, and the Notch Filter.

At this point, one of two filters can be inserted in the audio path. The filters available depend upon the options installed. Two types of filters are available: a 400 Hz high-pass filter or a weighted-response, bandpass filter. Table 8A-2 enumerates the filter combinations available. The two filters can be installed in either order with respect to the two front-panel keys (or HP-IB codes); thus each filter has two option numbers. (If no filter options are installed, the filter positions are jumpered.)

Table 8A-2. Filter Options

Filter	Option Numbers
400 Hz High-Pass	010 or 050
CCITT or Psophometric Bandpass	011 or 051
CCIR Bandpass	012 or 052
C-Message Bandpass	013 or 053
CCIR/ARM Bandpass	014 or 054
"A" Weighting Bandpass	015 or 055

Filter selection is via front-panel keys or HP-IB. Both are active filters. The Weighting Bandpass Filter generally has a standardized frequency response that simulates the response of a telecommunications system as perceived by human hearing. It gives predominance to 1 kHz.

The Pre-Notch RMS/Average Detector is read by the Controller via the dc voltmeter for the distortion and SINAD measurements (and also the analog SINAD meter). Its output becomes the numerator of the SINAD measurement and the denominator of the distortion measurement.

Notch Filter

The Notch Filter is inserted into the signal path in the distortion, distortion level, and SINAD measurement modes. It is coarse tuned by the Controller. When measuring distortion, the Controller sets the Notch Filter to the frequency of the signal counted at the input. When measuring SINAD, the Controller sets it to the programed frequency of the internal oscillator.

A notch-filter frequency response is obtained by passing the signal through a unity-gain, inverting, active bandpass filter, then summing the filter's output with its input. At the center frequency of the bandpass filter, the two signals into the Sum and Output Amplifier nearly cancel. This results in significant rejection of the signal at that frequency. Since the notch is very narrow, only the fundamental is rejected while noise and harmonic components are passed.

The Balance and Fine Tune control circuit uses negative feedback to fine tune the bandpass filter to the signal and to fine adjust (balance) its gain to maximize the depth of the notch. The tuning range of the fine tune control is 8% of the nominal center frequency. Feedback for the Balance and Fine Tune Control circuit comes from Amplifier 1 which follows the Notch Filter. The tuning error is also measured by the DC Voltmeter which is monitored by the Controller. If a large error exists, the Controller takes steps to either retune the Notch Filter or display an error message.

In the other measurement modes, the bandpass filter is not switched in and a flat response results.

Output Circuits

The output from the Notch Filter is attenuated, amplified, and filtered to condition the signal for the most accurate measurement by the Voltmeter. The signal level at the input to the Output RMS/Average/Quasi-peak Detector is normally between 0.3 and 3V. Attenuator 1 is set to either 0 or 20 dB. Amplifier 1 has a gain of 14 dB. The Low-Pass Filters are selected from the front panel or HP-IB. The 3 dB frequencies of the filters are 30 kHz, 80 kHz, and 750 kHz. The latter filter is selected when the other two filters are off. The filters are active-types and have 6 dB gain.

Attenuator 2 is set to either 0 or 20 dB. Amplifier 3 has a gain of 20 dB. Attenuator 3 is set to either 0 or 20 dB. The Buffer amplifier has 0 dB gain. The High-Pass Filter is set to 0.3 Hz in the ac level measurement mode to ensure accuracy down to 20 Hz; otherwise, it is set to 13 Hz to speed up measurement time. Amplifier 4 has 20 dB gain. The output from Amplifier 4 is the rear-panel MONITOR output signal, an input to the Counter (since this is the point of greatest sensitivity in the ac level measurement mode), and the input to the Output RMS/Average/Quasi-peak Detector.

The Output RMS/Average/Quasi-peak Detector is used to set the gain of the output path (Attenuators 1, 2, and 3) and, after processing by the Controller, its output is also used as the numerator of the distortion measurement or the denominator of the SINAD measurement. The detector can also be configured to respond to the absolute average or quasi-peak value of the signal instead of the true RMS value. The Output Overload Detector senses the output of the Output RMS/Average/Quasi-peak Detector. If the output exceeds 3V, the gain of the output path is set to 0 dB. The state of the output can also be read by the Controller, which then takes appropriate action.

The SINAD panel meter is normally used only in the SINAD measurement mode when the SINAD is between 0 and 18 dB. On that range, since the gain of the output path is 0 dB, SINAD is equal to the log of the ratio of the output of the Pre-Notch RMS Detector to the output of the Output RMS/Average/Quasi-peak Detector. The mathematical manipulation takes place in the SINAD Log Ratio Meter Amplifier. The Meter Transconductance Amplifier converts the voltage at its input to a current to drive the SINAD meter. If SINAD is not in the range 0 to 18 dB or if some other measurement mode has been selected, the Controller either pegs the meter to full scale or switches it off via the Meter Peg/Off Switch.

DC Voltmeter

Various dc voltages are routed to the Voltmeter Input Selector switch. The outputs from the Pre-Notch RMS/Average Detector and the Output RMS/Average/Quasi-peak Detector are measured through Ripple Filters when measurements are made on noisy ranges. The DC Voltmeter consists of the Counter, the Controller, and the Voltage-to-Time Converter. The output of the Voltage-to-Time Converter controls one of the input gates of the Counter. The voltage-measurement cycle begins when the Controller gates the 2 MHz Clock into the Clock Counter. Counting proceeds until the Voltage-to-Time converter produces a Stop Count pulse which opens the Stop Count Gate. The time lapse between the gating of the clock and the opening of the Stop Count Gate is proportional to the dc input voltage. The count thus accumulated during the interval is proportional to the input voltage.

Source

The source consists of a 10 Hz to 100 kHz Oscillator and output level-setting circuits. Oscillator tuning is programed by the Controller which uses the Counter to check frequency. The Oscillator output is self-leveled to about 3 Vrms via an automatic leveling control (ALC) circuit. The circuit senses the level with a peak Level Detector. The output from the detector is compared against a dc reference voltage by the Level Error amplifier. The output of the amplifier drives the level-varying circuitry in the Oscillator to eliminate the error condition.

The amplifiers and attenuators in the output path are:

- Amplifier 1, an active attenuator with a gain of 0 to −6 dB settable in 256 steps;
- Amplifier 2, an active attenuator with a gain of 0 to −17.5 dB settable in 2.5 dB steps;
- Attenuator A, a passive attenuator with 0, 20, and 40 dB attenuation;
- Output Amplifier Driver, a non-programmable buffer with a gain of 1.9 (+5.58 dB);
- Floating Output Amplifier with a gain of about +1 dB; and
- Attenuator B, a passive attenuator with 0 or 20 dB attenuation.

In the signal-to-noise ratio measurement mode, Amplifiers 1 and 2 and Attenuator A are switched between a normal and an "off" state. (The Controller reads the Output RMS/Average/Quasi-peak Detector for both states and computes the ratio.) In the "off" state the gain of Amplifier 1 is lowered by 6 dB, Amplifier 2 is set to −60 dB gain, and Attenuator A is shorted to ground. This "off" state also occurs when a source level of 0V is selected.

The Floating Output Amplifier generates a differential output signal, that is, a signal not referenced to ground. Either OUTPUT terminal (HIGH or LOW) may be grounded or floated up to 10 Vpk. This feature is useful for breaking up ground loops, summing signals, and adding dc offsets to the output. Attenuator B is also floating. For instruments with serial prefix 2730A and below, the output impedence is selected by a non-programmable, front panel IMPEDENCE switch for either 50Ω or 600Ω. For instruments with serial prefix 2742A and above, the output impedance can be selected from the front panel or via HP-IB by using Special Functions (47.X).

The Over-Voltage Protect circuit protects the output circuits from the inadvertent application of a reverse voltage to either the HIGH or LOW OUTPUT connector. The reverse voltage is sensed by an over-voltage detector, which opens two output relays. The relays automatically reset about 1s after the overvoltage is removed. The Voltage Clamp protects the output circuits during the time between the application of the reverse voltage and the opening of the relay contacts.

Counter

When the frequency of the input signal or Oscillator is to be counted, two sub-counters (the Cycle and Clock Counters) operate simultaneously. The signal itself is directed into the Cycle Counter. In the case of counting the input signal, the signal is first routed through the Counter Input Schmitt Trigger which converts the analog signal into square wave pulses which are compatible with the Cycle Counter. The 2 MHz Clock signal is directed into the Clock Counter.

To count frequency, the Controller first sets the Clock Counter Gate switch to route the path from the Frequency Gate switch into the Clock Counter. Then, the Controller arms the Cycle Counter Gate and Frequency Gate switches, and the first signal pulse closes the switches. Both counters (which were previously cleared) then begin to accumulate counts. The Cycle Counter is a divide by 32, the Clock Counter is a divide by 2048. The overflow or carry pulses of each counter are counted by the Controller. After a pre-determined minimum number of carries from the Clock Counter and at least one carry from the Cycle Counter, the Frequency Gate and Cycle Counter Gate switches are disabled by the Controller. The first signal pulse opens the switches and counting ceases. The Controller then reads the contents of the Cycle and Clock Counters and computes the signal frequency which is

$$f = \frac{|\text{Count of Cycle Counter} + (32 \times \text{Cycle Counter Carries})| \times 2\,\text{MHz}}{(2048 \times \text{Clock Counter Carries}) + \text{Count of Clock Counter}}.$$

The count sequence is also timed out to prevent hang-up of the instrument should there be no input signal or should the signal be interrupted during a count cycle.

During a voltage measurement cycle, only the Clock Counter is used. The Controller first sets the Clock Counter Gate to receive the signal from the Voltmeter Gate and closes the Voltmeter Gate. (The Controller had also previously closed the Stop Count Gate by deactivating the Voltage-to-Time Converter via the Ramp Gate line.) The 2 MHz Clock is now routed into the Clock Counter. After a time interval which is proportional to the dc voltage being measured, the Voltage-to-Time Converter opens the Stop Count Gate. The accumulated count is proportional to the dc voltage at the input of the DC Voltmeter.

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 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 are decoded by the Decoders and Latches and distributed to the appropriate circuit. For the Counter, Keyboard and Display, and Remote Interface, decoding of the Instrument Bus is done on the assemblies.

Information within the Controller itself is handled by three main buses: the ROM Control Bus (which coordinates the various devices which make up the Controller), the Address Bus (which addresses the ROM and RAM), and the Data Bus (which carries information to or from the ROM and RAM). Since the Remote Interface contains some Controller devices, these buses are also distributed to it.

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. It also processes the measurement information and outputs it on the HP-IB if requested. The Remote Interface 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 8A-1. The supervisor is a loop that is continually traversed with displays made near the end after checks for oscillator tuning, input and output leveling, notch tuning, and measurements. Arithmetic manipulation (for example, for the ratio function) follows the measurement, and the programs loop back to the beginning after outputting to the display.

The various level and tune 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 succession. If a test is not passed, corrective action is taken. The decision after that block then forces the program back to the top of the supervisor, bypassing the measurement for that loop if corrective action is unsuccessful. The software interface with the hardware makes use of two concepts called software state and hardware state. The software state is located in the 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 effect 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; tune, level, and measurement blocks manipulate the hardware as well.

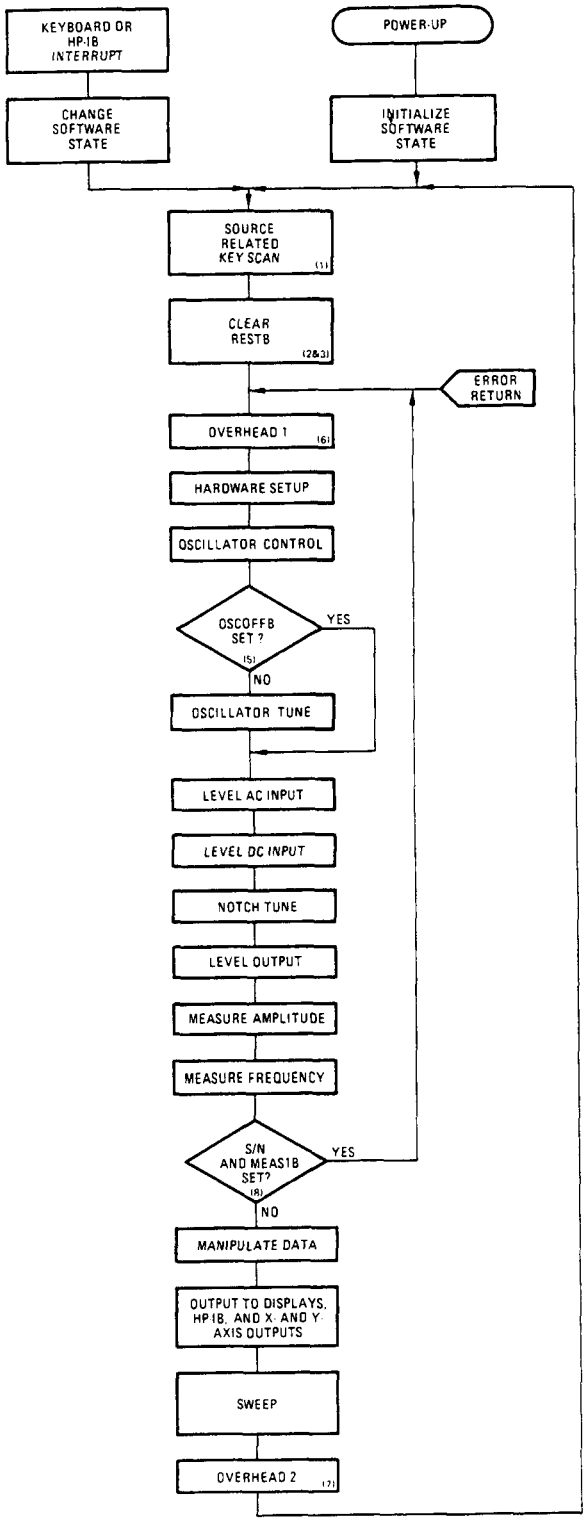
The Keyboard and HP-IB interrupt the flow around the loop, forcing the Microprocessor to execute a short program and then return to the loop as shown in the diagram. Since the supervisor can be interrupted at any point but always returns to a single location, Keyboard and HP-IB interrupts must abort 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 setup.

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. The appearance of several symptoms can often be used to advantage as they provide many avenues to pursue when tracking down a problem.

A clear line is drawn between Service Special Functions and normal instrument operation. When most Service Special Functions are used, normal instrument functions are suspended. When the Service Special Function mode is left to resume normal measurements, all effects of the Service Special Function on hardware are lost. As an example, a Service Special Function can be used to display the oscillator frequency. But once normal measurements are resumed, the display will revert back to what it was before the Service Special Function was invoked.

Power Supplies

The instrument is run from four regulated supplies: +15V, −15V, +12V, and +5V. All supplies are independent except the +5V supply which is dependent on the +15V and −15V supplies.



NOTES

1. *The SOURCE RELATED KEY SCAN block monitors the FREQ, FREQ INCR, AMPTD, AMPTD INCR, ↑ (step up), and ↓ (step down) keys.*

2. *On errors, the instrument exits the current block, jumps to the error return point, and sets the GUARB (guarantee bit), RESTB (reset bit), and FIRSTB (first bit).*

3. *If RESTB is set, the OSCILLATOR CONTROL block will not execute and RESTB will be cleared.*

4. *Certain blocks may or may not execute during different measurement modes depending upon relevancy bits and other conditions.*

5. *The OSCOFFB (oscillator off bit) is set on alternate Signal-to-Noise (S/N) measurement cycles.*

6. *The GUARB indicates a valid measurement is guaranteed. It is set by most interrupts, errors, trigger mode, and under some conditions in the OVERHEAD 1 block (e.g., it is always set in Signal-to-Noise measurement mode). It is also cleared by some conditions in OVERHEAD 1 block.*

7. *The FIRSTB indicates the first cycle after an interrupt or error. It is cleared in the OVERHEAD 2 block.*

8. *MEAS1B is set if the instrument is in the Signal-to-Noise measurement mode and it is the first pass after an interrupt. It takes two passes to measure Signal-to-Noise. Therefore, the instrument must restart without a display output and clear MEAS1B at the end of the first pass.*

Figure 8A-1. Supervisor Flowchart

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 time. In most instances they can differentiate between an instrument hardware failure and a Controller or software problem. The comments associated with each procedure summarize the information known as a result of passing or failing the check. The checks should be done in order. For additional information on the troubleshooting philosophy used in these checks, refer to *General Troubleshooting,* paragraph 8-16.

⟨√1⟩ Line Check

Procedure: Remove the instrument top cover (three screws) and switch LINE to ON.

Normal Indication: The four green LEDs on the A13 Power Supply and Motherboard Assembly are lighted indicating that the supplies are nominally operating.

If Indication Abnormal: Check rear panel line fuse and line voltage selector. Check Mains wiring. See Service Sheet 20. Check individual regulators. See Service Sheet BD5.

⟨√2⟩ Power-Up Checks

Procedure: If there are any jumpers on the TEST test points on the A8 Controller/Counter Assembly, remove them. Switch LINE to OFF for five seconds then back to ON. Note the sequencing of the four TEST LEDs on the top of the Controller/Counter Assembly as the instrument powers up.

Normal Indication: The four TEST LEDs light in the following sequence:

1. Indeterminate for about 1/8 second.
2. ( )( )( )(1) for about second. This indicates the start of the power up routines and the run of the Read Only Memory Check.
3. (8)(4)(2)(1) for about 2 seconds. This indicates that all power-up checks passed and that a visual front-panel check is in progress (see ⟨√3⟩).
4. (8)(4)(2)(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, and
Keyboard (only that no key is down).

If Indication Abnormal: If the TEST LEDs come on and remain in the indeterminate state of step 1, check the Controller Kernel. See Service Sheet BD4. If other indications appear in or after step 2, consult *Power-Up Checks,* paragraph 8-27, which discusses the individual checks, documents the error indications, and cross references to the service sheets.

⟨√3⟩ Front-Panel LED Check

Procedure: Disconnect all connections to the INPUT. Switch LINE to OFF and back to ON.

Normal Indications: After less than 1/8 second, all front-panel LEDs, display segments and decimal points should light for about three seconds, then the displays blank for one second then after a few seconds settle to readings of 0.000 kHz in the left display and <0.100 mV in the right display. The measurement cycle indicator LED in the upper left-hand corner of the right display should blink rapidly. The kHz and mV annunciators and the AC LEVEL and 80 kHz LOW PASS key lights should be on. 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 Sheet 18. Also check the CPU I/O port. See Service Sheet BD4.

⟨√4⟩ Measurement Error Check

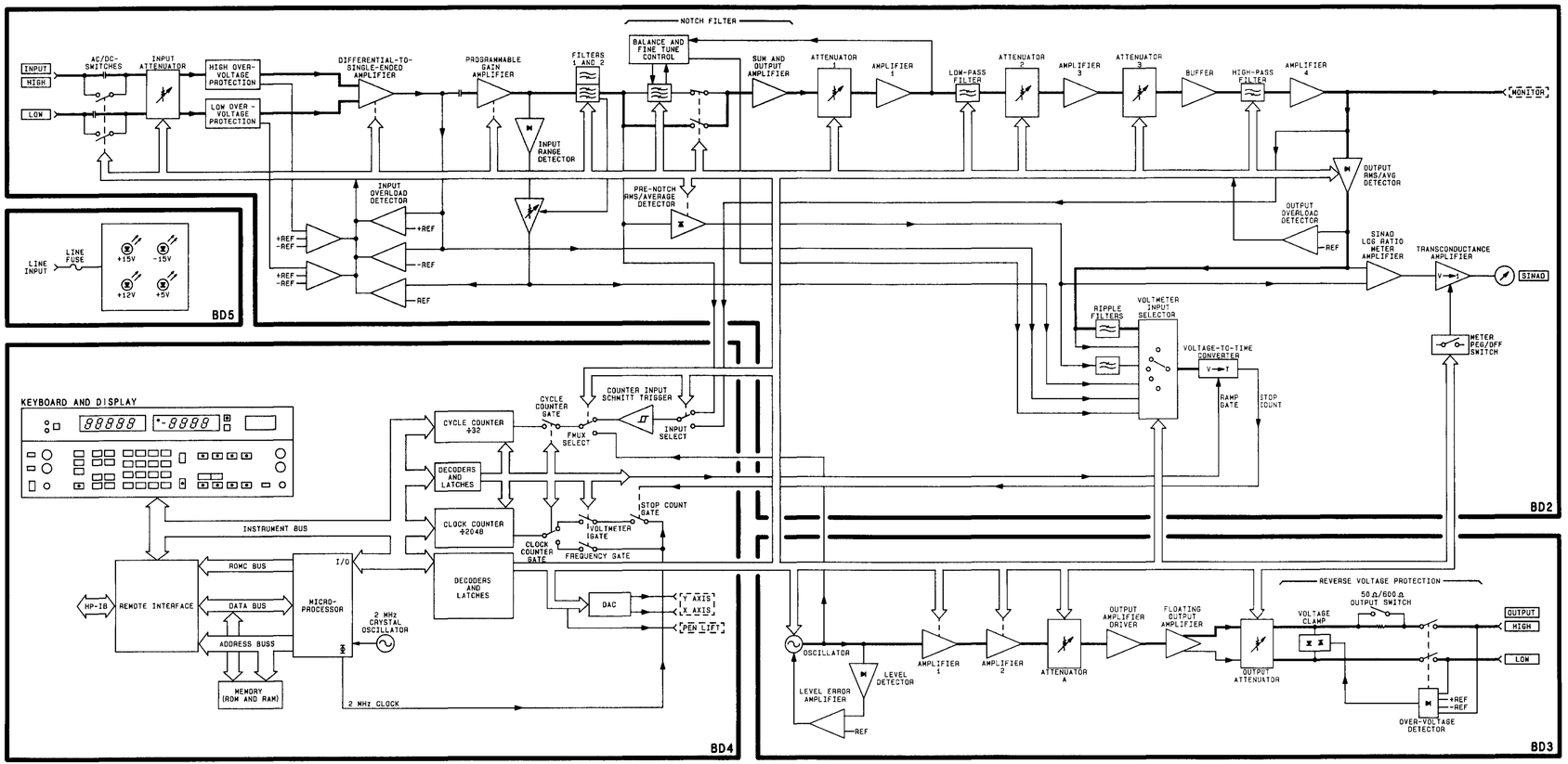
Procedure: Key in 43.1 SPCL. This enables Service Errors. Make the measurement in which the fault appears.

Normal Indications: As the Special Function code is entered, 43.1 should appear in the left 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 17. If the keystrokes produce an erroneous display, check the Keyboard. See Service Sheet BD4. If the measurement is improper or error messages appear in the display, consult the error messages tables (see *Error Messages* in the *Detailed Operating Instructions*, Section 3 and *Error Messages*, paragraph 8-24) 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 BD4.



BD1
Figure 8A-101
8A-101

SERVICE SHEET BD2—Measurement Circuits Block Diagram

PRINCIPLES OF OPERATION

General

Service Sheet BD2 covers the input circuits, notch filter, output circuits, and part of the voltmeter; that is, it covers most of the measurement (analyzer) circuits of the instrument.

Input Amplifier (A2)

The Input Amplifier circuits amplify or attenuate the input signal so that its output is within 1.9 to 3V at the input to the Notch Filter. The overall input gain can be controlled by Special Function 1 for ac measurements and Special Function 2 for dc. Other circuits provide ac or dc coupling, over-voltage protection, differential-to-single-ended conversion, filtering, and level sensing.

The HIGH and LOW INPUT connectors are the differential inputs. A front-panel switch permits convenient grounding of the LOW INPUT. For ac measurements, the AC/DC Switch is set to ac couple the input.

Two pairs of voltage dividers form a balanced Input Attenuator. The first divider pair is 12 dB; the second divider pair have taps at 24 and 40 dB. The input level range and the associated attenuation are summarized in Table 8B-1 for dc measurements and Table 8B-2 for ac measurements.

Table 8B-1. Input Attenuation for DC Measurements

DC Input Level Range		Input Attenuation (dB)
Range (Vdc)	Special Function	
4	2.4	0
16	2.3	12
64	2.2	24
300	2.1	40

The Over-Voltage Protection circuit clamps the high and low inputs of the Differential-to-Single-Ended amplifier when the signal level exceeds ±13V. The diodes of the protection circuit are in parallel with the signal path and are normally biased off. The amplifiers ac couple signal to the clamp diodes to prevent the signal from modulating the diode capacitance and creating distortion. The output of the amplifier is also fed to the Input Overload Protection.

The signals on the high and low paths are each amplified by programmable-gain amplifiers. The outputs from the two amplifiers are subtracted to create a single-ended signal (that is, one that is referenced with respect to ground). The gain of the Differential-to-Single-Ended Amplifier is 0, 8, 16, or 20 dB. The gain is 0 dB when measuring dc. The gain for ac is summarized in Table 8B-2.

DC measurements are made at the output of the Differential-to-Single-Ended Amplifier by the DC Voltmeter.

The Programmable Gain Amplifier has a gain of 0, 4, 8, or 12 dB. The gain is summarized in Table 8B-2. The amplifier input is ac coupled.

The rms level at the output of the Programmable Gain Amplifier is converted to dc by the Input Range Detector. The output is measured by the DC Voltmeter and sets the input gain. The gain of the detector is programed to match the peak gain of the Weighting Bandpass Filters that follow the Programmable Gain Amplifier.

The output of the Input Range Detector and the dc at the input of the Programmable Gain Amplifier are compared to positive and negative references by the Input Overload Detector. This is to determine if the signal levels are too large for the input gain settings.

The output of the Programmable Gain Amplifier can be filtered with optional audio filters: either a 400 Hz High-Pass Filter or one or two of several Weighting Bandpass Filters. All are active filters. The 400 Hz High-Pass Filter is a 7-pole filter. The Weighting Bandpass Filters are designed to match certain international standards. The filters plug onto the A2 assembly.

Table 8B-2. Gain Summary for AC Measurements

Range (Vrms)	Special Function	Gain (dB)		
		Input Attenuator	Differential-to-Single-Ended Amplifier	Programmable Gain Amplfier
300	1.1	−40	0	0
189	1.2	−40	0	4
119	1.3	−40	0	8
75.4	1.4	−40	0	12
47.6	1.5	−24	0	0
30.0	1.6	−24	0	4
18.9	1.7	−24	0	8
11.9	1.8	−12	0	0
7.45	1.9	−12	0	4
4.76	1.10	−12	0	8
3.00	1.11	0	0	0
1.89	1.12	0	0	4
1.19	1.13	0	0	8
0.745	1.14	0	0	12
0.476	1.15	0	8	8
0.300	1.16	0	8	12
0.189	1.17	0	16	8
0.119	1.18	0	16	12
0.0745	1.19	0	20	12

Notch Filter (A3)

The input to the Notch Filter is measured by the Pre-Notch RMS/Average Detector. The measured level is used as the denominator in the distortion calculation and the numerator in the SINAD calculation. Its output also is fed to the analog SINAD meter circuitry. The Pre-Notch RMS/Average Detector can be switched to respond to the true rms or the absolute average value of the input voltage by Special Function 5.

The Notch Filter is a state-variable filter, that is, a filter which is formed by combining various circuit blocks which perform simple mathematical functions (amplification, inversion, summation, and integration). A simplified diagram of the basic filter is shown in Figure 8B-1. The transfer functions at various points in the diagram are also given. Band-reject, bandpass, high-pass, and low-pass responses are all generated by the circuit. The output of the circuit diagram is V_2 (the notch filter output).

In actual use, the circuit is configured to obtain three types of responses: band-reject or notch (in the SINAD, distortion, and distortion level measurement modes), bandpass (in Special Function 44.3), and flat (in the other ac measurement modes). Referring now to Block Diagram 2, the transfer function has a notch filter response when both switches at the input to the Sum and Output Amplifier are closed. The transfer function has a bandpass response when the path from the input to the Sum and Output Amplifier is open. The transfer function has a flat response when the path from Integrator 1 to the Sum and Output Amplifier is broken.

In the notch-filter configuration, the notch frequency is coarse tuned by adjusting ω_0 in the simplified diagram (Rs and Cs in Integrators 1 and 2). This is done by the Controller. Coarse tuning accuracy is about 8%. Special Functions 53 and 54 can be used to manually set the tuning of the Notch Filter. The damping factor α is fixed and is approximately equal to 0.15. (Thus the low- and high-pass filters are underdamped.) To improve the depth of the notch, the phase and level of the output of the Notch Filter are sensed. The phase and level error voltages then correct the tuning and balance by controlling the amount of signal of the appropriate magnitude and phase injected into Sum Amplifier 2. (The amplifier is not depicted in Figure 8B-1. It is a summing amplifier inserted before Integrator 2.) Operation of the fine-tune and balance circuit is independent of the Controller.

Figure 8B-2 shows the essential parts of the phase and level sensing circuits and the associated waveforms. The input to the circuit (V_{NOTCH}) comes from the output of the Notch Filter after being amplified by the combination

of Attenuator 1 and Amplifier 1 of the Output Amplifier/Voltmeter Assembly (A4) and the Notch Amplifier. The total gain is either 5.5 or 55 depending on the setting of Attenuator 1. The input (V_{NOTCH}) can be considered as having components in phase with the input to the Notch Filter and in quadrature (that is, 90° out-of-phase) with it. The waveform for V_{NOTCH} in Figure 8B-2 is shown as being totally in phase with the input.

The in-phase component represents a balance error in the Notch Filter, that is, the notch does not completely null out the signal. The quadrature component represents a tuning error. When perfectly tuned, any output from an imperfectly balanced Notch Filter will be in phase with the input.

To sense the in-phase component, a current, produced by the input signal (V_{NOTCH}), is chopped in phase with the input to the Notch Filter. Chopper S_i is driven by the bandpass output of the Notch Filter which is in phase with the fundamental component of the input to the Notch Filter. If V_{NOTCH} is in phase with S_i (as in this example), the chopped current (I_{1i}) will be a half-wave-rectified signal. Current I_2 is proportional to the input voltage but half the level of the chopped current. I_{1i} and I_2 are summed together to produce a current (I_{3i}) whose average (dc) level represents the level error of the in-phase component of the signal. For this example, the result is a full-wave-rectified signal (I_{3i}). I_{3i} is integrated (that is, amplified and filtered). The integrated current controls the gain of the Balance Multiplier which balances the Notch Filter.

Sensing the quadrature component is similar. A current, produced by the input signal (V_{NOTCH}), is chopped in quadrature with the input to the Notch Filter. Chopper S_q is driven by the low-pass output of the Notch Filter which is 90° out of phase with the fundamental of the input to the Notch Filter. If V_{NOTCH} is in quadrature with S_q (as in this example), the chopped current (I_{1q}) will consist only of the half cycles going from the positive to the negative peak. (The dc component of this signal is zero.) Current I_2 is as before. I_{1q} and I_2 are summed together to produce a current (I_{3q}) whose average (dc) level represents the level error of the quadrature component of the signal. For this example, the result has a dc value of zero. I_{3q} is integrated and controls the gain of the Tune Multiplier which tunes the Notch Filter.

More commonly, V_{NOTCH} will have both quadrature and in-phase components. The tune and balance detectors isolate the respective components and drive the respective multiplier with the error signal. The resistors through which I_{1i}, I_{1q}, and I_2 flow can be switched to change the magnitude of the current by a factor of ten. This compensates for the gain change in Attenuator 1 of assembly A4.

In summary, the Tune and Balance Multipliers can be visualized as variable-gain amplifiers with ac inputs from the bandpass and high-pass outputs of the Notch Filter respectively. (The bandpass output is in phase with the fundamental of the input to the Notch Filter; the high-pass output is in quadrature.) The dc inputs (from the Tune and Balance Integrators) control the gain of the multipliers, including the sense of the gain (that is, inverting or non-inverting). The output currents of the multipliers are summed together (their outputs are in parallel) and the composite signal is summed with the output from Integrator 1 in Sum Amplifier 2 to create a feedback loop that fine adjusts the tuning and balance of the Notch Filter.

Output Amplifier/Voltmeter (A4)

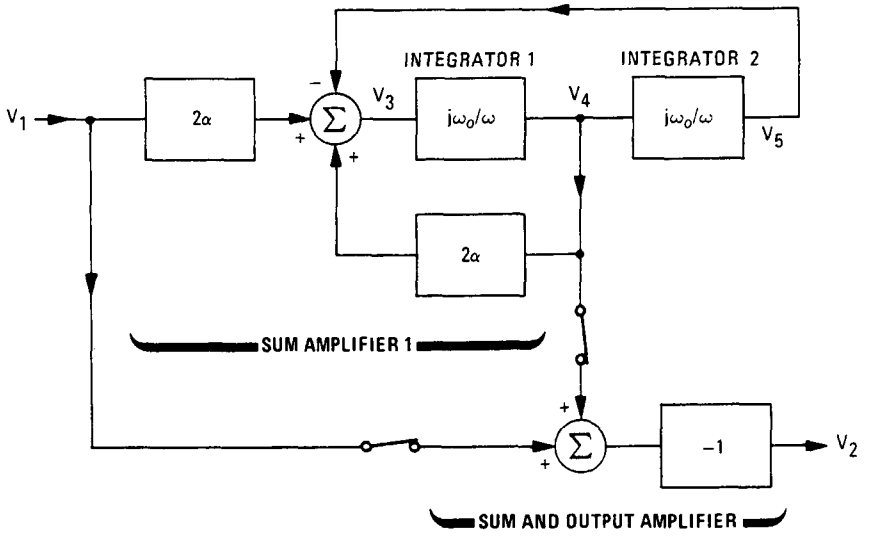
The signal from the Notch Filter is further processed before being detected by the voltmeter or sent the the rear-panel MONITOR output. The signal is amplified by Amplifier 1 (gain=5), the Low-Pass Filters (gain=2), Amplifier 3 (gain=10), and Amplifier 4 (gain=10). The maximum gain is thus 1000 (or 60 dB). Attenuators 1, 2, and 3 each have a selectable attenuation of 0 or 20 dB. The overall gain is set by the Controller so that the level sensed by the Output RMS/Average/Quasi-peak Detector is 3V or less. Switching of the attenuators can be controlled by Special Function 3 and is summarized in Table 8B-3.

Selection of the active low-pass filters is from the front panel or HP-IB. When no filtering is selected, the 750 kHz filter is active. The other two filters are 80 and 30 kHz.

The Buffer amplifier has 0 dB gain. The High-Pass Filters following the Buffer are either 0.3 Hz in ac level or 13 Hz in the other measurement modes. The 13 Hz filter is an active filter. Amplifier 4 drives the MONITOR output, the Output RMS/Average/Quasi-peak Detector, and the Counter Input Schmitt Trigger (see Service Sheet BD4).

The Output RMS/Average/Quasi-peak Detector converts its input into a dc voltage corresponding to the rms level of the signal. The detector can also be configured to produce the absolute-average or quasi-peak value of the signal using Special Function 5. The output is measured by the DC Voltmeter for computing measurement

PRINCIPLES OF OPERATION---SERVICE SHEET BD2



Transfer Function	Type of Response	Transfer Function at		
		$\omega = 0$	$\omega = \omega_0$	$\omega = \infty$
$\frac{V_2}{V_1} = -\frac{\omega^2 - \omega^2_0}{\omega^2 - j2\alpha\omega_0\omega - \omega^2_0}$	Notch Filter	−1	0	−1
$\frac{V_3}{V_1} = \frac{2\alpha\omega^2}{\omega^2 - j2\alpha\omega_0\omega - \omega^2_0}$	High-Pass Filter	0	j	2α
$\frac{V_4}{V_1} = \frac{j2\alpha\omega_0\omega}{\omega^2 - j2\alpha\omega_0\omega - \omega^2_0}$	Bandpass Filter	0	−1	0
$\frac{V_5}{V_1} = -\frac{2\alpha\omega^2_0}{\omega^2 - j2\alpha\omega_0\omega - \omega^2_0}$	Low-Pass Filter	2α	−j	0

Figure 8B-1. Simplified Diagram of the Notch Filter with Transfer Functions Given for Various Points

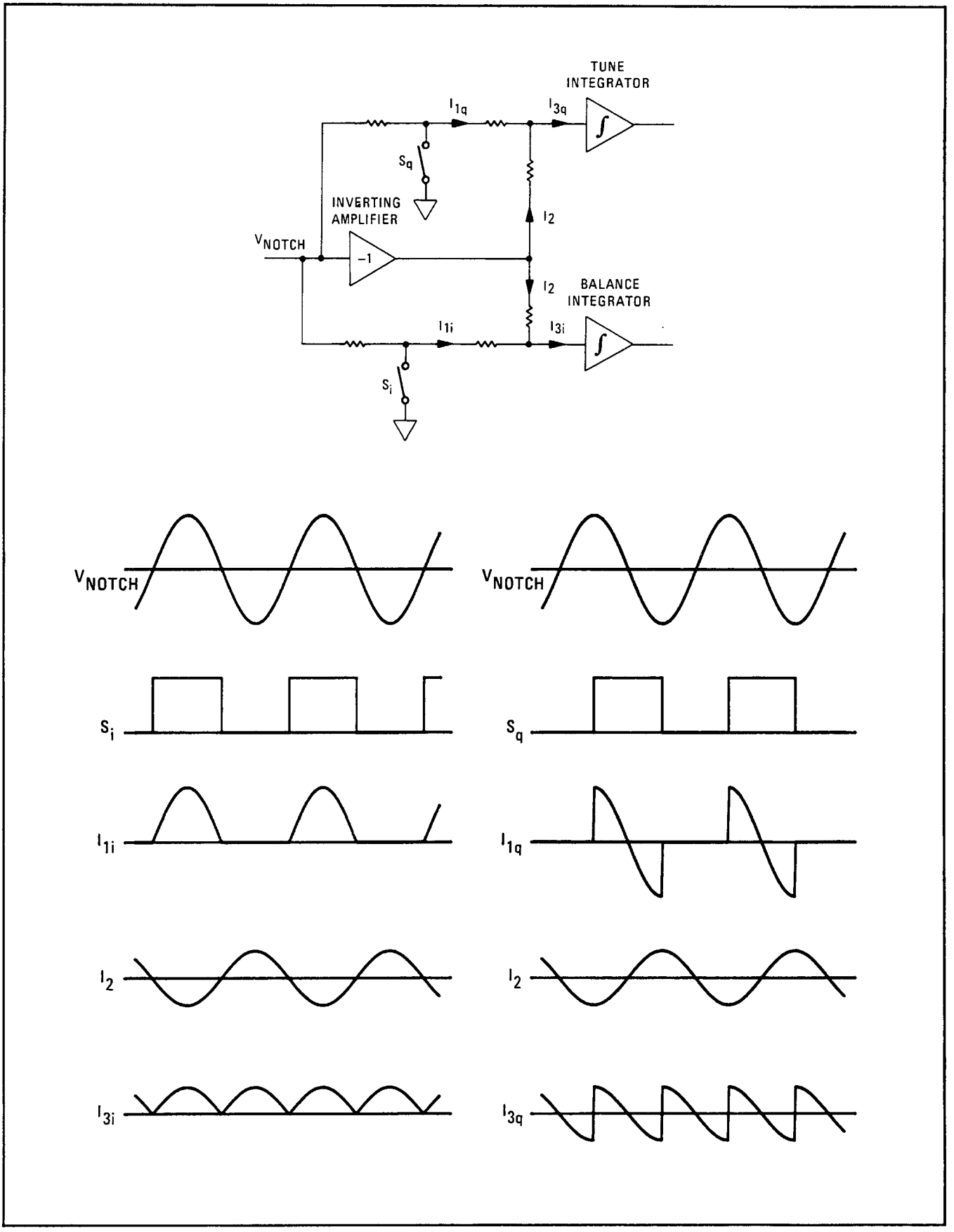


Figure 8B-2. Notch Filter Tune and Balance Detectors

Table 8B-3. Summary of Attenuator Switching

Post-Notch Amplifier		Attenuation (dB)		
Gain (dB)	Special Function	Attenuator 1	Attenuator 2	Attenuator 3
0	3.1	20	20	20
20	3.2	20	20	0
40	3.3	0	0	20
60	3.4	0	0	0

results and setting the gain of the Output Amplifier. In the rms configuration the circuit is an analog computer consisting of a full-wave rectifier, log amplifier, and antilog amplifier and filter.

The Output Overload Detector compares the output of the Output RMS/Average/Quasi-peak Detector with a reference and sets the Output Amplifier gain to 0 dB if an overload is sensed (unless defeated by Special Function 3).

The SINAD Log Ratio Meter Amplifier produces an output voltage which is the log of the ratio of the outputs of the Pre-Notch and Output RMS/Average/Quasi-peak Detectors. The amplifier drives a Meter Transconductance Amplifier which converts the log-ratio voltage to a current which drives the front-panel SINAD meter.

The state of the Meter Peg/Off Switch is set by the Controller. If the SINAD reading exceeds 18 dB (or 24 dB when Special Function 7.1 is invoked), the switch is set to peg (force off scale) the meter. If the SINAD measurement mode has not been selected, the meter is switched off. Special Function 45.1 enables the meter for all ac measurement modes.

The Voltmeter Input Selector selects one of the dc inputs into the Voltage-to-Time Converter. The Ripple Filters on lines from the Input to Output RMS Detectors add low-pass filtering to reduce display fluctuation on noisy measurements. The output from the Output RMS/Average/Quasi-peak Detector is also heavily filtered by the SINAD Filter in the SINAD measurement mode.

The output of the selector is the reference input for a Comparator. The Comparator's other input is a constant slope ramp. The ramp is initiated by the Controller. As the ramp rises, the Counter counts the time-base reference (2 MHz). When the ramp voltage equals the level of the reference input, the Comparator signals the Counter to stop counting. The accumulated count is proportional to the dc voltage. Ground is measured before each reading and subtracted from the DC Voltmeter measurement to eliminate the effect of offsets. The ramp begins at approximately −6V, which permits measurement of negative voltages.

TROUBLESHOOTING

General

Procedures for checking the measurement circuits 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⟩. The procedures assume that the source is working properly. A second audio source is needed only if distortion is out of specification and it cannot be determined whether the instrument's source or distortion measurement is at fault. Before performing any check, perform all the checks on Service Sheet BD1.

Equipment

Audio Analyzer ..... HP 8903B or HP 339A
Oscilloscope ..... HP 1740A

⟨✓1⟩ Input Amplifier Check

NOTE

This check does not test the Over-Voltage Protection. If the Over-Voltage Protection is suspected to be faulty, see Service Sheet 1.

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Set IMPEDANCE to 600Ω. Key in AMPTD 3 V. Connect the HIGH OUTPUT to the HIGH INPUT through a tee adapter.

2. Connect a high-impedance, ac coupled oscilloscope to the tee at the HIGH INPUT. Use the oscilloscope's vertical gain controls to adjust the display amplitude for 5 divisions peak-to-peak deflection of the sinusoidal signal. (The period of the signal should be 1 ms.)

3. Connect the oscilloscope to A2TP5 (SING END). Key in the Special Functions listed in Table 8B-4. For each setting, increase the oscilloscope's vertical gain by the amount indicated. The peak-to-peak amplitude, displayed on the oscilloscope, should be within the limits indicated. If faulty, see Service Sheet 1 and check the High Input Attenuator.

Table 8B-4. Amplitude Limits at A2TP5, ⟨✓1⟩ Step 3

Special Function	Total Change in Oscilloscope Vertical Gain	Amplitude Limits (divisions pk-pk)	
		Minimum	Maximum
1.11	×1	4.9	5.1
1.8	×1	1.2	1.3
1.5	×10	3.0	3.3
1.1	×100	4.8	5.2

4. Set the INPUT switch to FLOAT. Connect the HIGH OUTPUT to the LOW INPUT. Short the HIGH INPUT to ground.

5. Key in the Special Functions listed in Table 8B-5. For each setting, decrease the oscilloscope's vertical gain by the amount indicated. The peak-to-peak amplitude, displayed on the oscilloscope, should be within the limits indicated. If faulty, see Service Sheet 1 and check the Low Input Attenuator.

6. On the Audio Analyzer, key in AMPTD .1 V. Readjust the oscilloscope's vertical gain for a display of 5 divisions peak-to-peak.

7. Reduce the oscilloscope's gain by a factor of 10. Key in the Special Functions listed in Table 8B-6. The peak-to-peak amplitude displayed on the oscilloscope should be within the limits indicated. If faulty, see Service Sheet 1 and check the Differential-to-Single-Ended Amplifier.

Table 8B-5. Amplitude Limits at A2TP5, ⟨√1⟩ Step 5

Special Function	Total Change in Oscilloscope Vertical Gain	Amplitude Limits (divisions pk-pk)	
		Minimum	Maximum
1.1	×1	4.8	5.2
1.5	÷10	3.0	3.3
1.8	÷100	1.2	1.3
1.11	÷100	4.9	5.1

Table 8B-6. Amplitude Limits at A2TP5, ⟨√1⟩ Step 7

Special Function	Amplitude Limits (divisions pk-pk)	
	Minimum	Maximum
1.15	1.2	1.3
1.17	3.0	3.3
1.19	4.8	5.2

8. On the Audio Analyzer, key in 1.11 SPCL. On the oscilloscope, set the gain back to ×1. (Check that the waveform is still 5 divisions peak-to-peak.)

9. Connect the oscilloscope to A2TP4 (PGM AMP). On the Audio Analyzer, key in the Special Functions listed in Table 8B-7. For each setting, decrease the oscilloscope's gain by the amount indicated. The peak-to-peak amplitude, displayed on the oscilloscope, should be within the limits indicated. If faulty, see Service Sheet 2 and check the Programmable Gain Amplifier.

Table 8B-7. Amplitude Limits at A2TP4, ⟨√1⟩ Step 9

Special Function	Total Change in Oscilloscope Vertical Gain	Amplitude Limits (divisions pk-pk)	
		Minimum	Maximum
1.11	×1	4.8	5.2
1.12	×1	7.7	8.2
1.13	÷10	1.2	1.3
1.14	÷10	1.9	2.1

10. On the Audio Analyzer, key in 1.11 SPCL. On the oscilloscope, set the gain back to ×1. (Check that the waveform is still 5 divisions peak-to-peak.)

11. Connect the oscilloscope to A2TP3 (OUT). The oscilloscope display should be between 4.9 and 5.1 divisions peak-to-peak. If faulty, see Service Sheet 2 and check the Weighting Bandpass and High-Pass Filters.

12. On the Audio Analyzer, key in AMPTD 300 mV. Decrease the vertical gain of the oscilloscope for a display of 5 divisions peak-to-peak.

13. On the Audio Analyzer, key in the frequencies and the weighting bandpass or high-pass filter indicated in Table 8B-8 for the filters installed in the instrument. (If no filter options are installed, go on to the next step.) For each setting, the peak-to-peak amplitude, displayed on the oscilloscope, should be within the limits indicated. If faulty, see Service Sheets 2, 2A, and 2B, and check the Weighting Bandpass and High-Pass Filters.

Table 8B-8. Amplitude Limits at A2TP3, (√1) Step 13

Weighting Bandpass or High-Pass Filter	Source Frequency (Hz)	Amplitude Limits (divisions pk-pk)	
		Minimum	Maximum
400 Hz HIGH-PASS	1 000	4.9	5.1
	400	2.5	4.5
CCITT WEIGHTING	800	4.8	5.2
	300	1.2	1.8
	3 000	2.2	3.1
CCIR WEIGHTING	6 300	2.0*	2.1*
	200	0.9	1.1
	10 000	1.2*	1.4*
C-MESSAGE WEIGHTING	1 000	4.9	5.1
	500	1.8	2.5
	3 000	3.1	4.5
CCIR/ARM WEIGHTING	6 300	1.0*	1.1*
	200	0.5	0.6
	10 000	6.2	7.1
"A" WEIGHTING	1 000	4.9	5.1
	200	1.3	1.5
	10 000	3.4	4.1
*Reduce the oscilloscope's vertical gain by 10.			

14. On the Audio Analyzer, set the Weighting Bandpass or High-Pass Filter off if one is on. Key in FREQ 1 kHz and AMPTD 1 V. Connect the oscilloscope to A2TP4 (PGM AMP). Adjust the oscilloscope's vertical gain for 7.1 divisions peak-to-peak amplitude.

15. DC couple the oscilloscope and connect it to A2TP2 (RMS). The waveform should be a dc voltage between 2.4 and 2.6 divisions (with respect to ground). If faulty, see Service Sheet 2 and check the Input Range Detector.

16. If the Audio Analyzer has the CCIR Weighting, CCIR/ARM Weighting, or "A" Weighting Filter, key in the filter. The dc voltage should be within the limits given in Table 8B-9. If faulty, see Service Sheet 2 and check the Input Range Detector and the respective Weighting Bandpass Filter.

Table 8B-9. Amplitude Limits at A2TP2, (√1) Step 16

Weighting Filter	Amplitude Limits (divisions)	
	Minimum	Maximum
CCIIR WEIGHTING	0.9*	1.1*
CCIR/ARM WEIGHTING	5.1	5.4
"A" WEIGHTING	3.0	3.2
* Reduce the oscilloscope's vertical gain by 10.		

17. Set the oscilloscope for 2 V/division. On the Audio Analyzer, set the Weighting Bandpass or High-Pass Filter off. Key in 1.12 SPCL. Key in AMPTD 5.1 V. The voltage, displayed on the oscilloscope, should be approximately

8.1 Vdc. (Ignore the display.) If faulty, see Service Sheet 2 and check the Input Range Detector and Input Overload Detector.

18. On the Audio Analyzer, key in AMPTD 5.5 V. The voltage should drop to approximately 0 Vdc. The display should show Error 30. If faulty, see Service Sheet 2 and check the Input Range Detector and Input Overload Detector.

19. On the Audio Analyzer, press AUTOMATIC OPERATION. Press S (Shift) DC LEVEL. Key in 2.3 SPCL to set the dc level range to 16V. Connect the oscilloscope to A2TP5 (SING END).

20. Connect A8TP16 (+5V) to the LOW INPUT. The oscilloscope should show a dc voltage approximately 1.25 Vdc. If faulty, see Service Sheet 1 and check the AC/DC Switch.

21. Press AC LEVEL. The oscilloscope should show a dc voltage of approximately 0 Vdc. If faulty, see Service Sheet 1 and check the AC/DC Switch.

22. Remove the short from the HIGH INPUT. Remove the connection from the LOW INPUT and connect it to the HIGH INPUT. Set the INPUT switch to ground. The oscilloscope should remain as in step 21. If faulty, see Service Sheet 1 and check the AC/DC Switch.

23. Press S DC LEVEL. Key in 2.3 SPCL again. The oscilloscope should show a dc voltage approximately −1.25 Vdc. If faulty, see Service Sheet 1 and check the AC/DC Switch.

⟨√2⟩ Notch Filter Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Set the 80 kHz LOW PASS filter off. Key in AMPTD 3 V and FREQ 98.7 Hz. Key in 1.11 SPCL to set the input to 3V range. Key in 53.0 SPCL to set the Notch Filter to its lowest frequency range. Key in 54.115 SPCL to set the Notch Filter Coarse Tune near the middle of its range (approximately 98.7 Hz). Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A2TP3 (OUT). The waveform on the oscilloscope should be a sine wave with a amplitude between 8 and 9 Vpp and a period of approximately 10 ms. If faulty, see ⟨√1⟩ *Input Amplifier Check.*

3. Use the oscilloscope's vertical gain controls to adjust the display amplitude for 5 divisions peak-to-peak deflection of the signal.

4. On the Audio Analyzer, connect A3TP3 (TUNE) and A3TP4 (BAL) to A3TP1 (GND) to defeat the fine tune and balance control. Connect the oscilloscope to A3TP5 (BP OUT). The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.7 and 5.3 divisions. If faulty, see Service Sheet 3 and check Sum Amplifiers 1 and 2 and Integrators 1 and 2.

5. Connect the oscilloscope to A3TP7 (OUT). The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.9 and 5.1 divisions. If faulty, see Service Sheet 3 and check the Sum and Output Amplifier.

6. On the Audio Analyzer, key in 44.3 SPCL to set the Notch Filter to the bandpass mode. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.7 and 5.3 divisions. The amplitude display on the Audio Analyzer should read between 2.8 and 3.2V. If the oscilloscope waveform is faulty, see Service Sheet 3 and check the Sum and Output Amplifier. If the amplitude display is faulty, see Output Amplifier Check and Voltmeter Check.

7. On the Audio Analyzer, key in the Special Functions listed in Table 8B-10. For each setting, key in the first frequency, set RATIO off (if on), and, after settling, note the displayed amplitude. Then press RATIO to establish a ratio reference. Key in the other two frequencies, and after settling, note the relative amplitude. The levels should be within the limits indicated. If faulty, see Service Sheet 3 and check Sum Amplifiers 1 and 2 and Integrators 1 and 2.

8. On the Audio Analyzer, key in 53.2 SPCL. Key in the frequencies listed in Table 8B-11. For each setting, key in the pair of Special Functions indicated. After keying in the first member of the pair of Special Functions, press RATIO twice to establish a new ratio reference. After keying in the second Special Function, the amplitude read

Table 8B-10. Amplitude Limits on Display, ⟨√2⟩ Step 7

Special Function	Source Frequency (Hz)	Amplitude Limits	
		Minimum	Maximum
53.0	98.7	2.8V	3.2V
	49.4	15%	25%
	197	15%	25%
53.1	781	2.8V	3.2V
	390	15%	25%
	1 560	15%	25%
53.2	6 250	2.8V	3.2V
	3 130	15%	25%
	12 500	15%	25%
53.3	50 000	2.8V	3.2V
	25 000	15%	25%
	100 000	15%	25%

Table 8B-11. Amplitude Limits on Display, ⟨√2⟩ Step 8

Source Frequency (Hz)	Special Functions	Amplitude Limits (%)	
		Minimum	Maximum
9120	54.128, 54.127	97	99
4560	54.64, 54.63	94	97
2280	54.32, 54.31	90	94
1140	54.16, 54.15	82	88
570	54.8, 54.7	68	76
285	54.4, 54.3	46	58
142.5	54.2, 54.1	20	40

on the Audio Analyzer's display should be within the limits shown. If faulty, see Service Sheet 3 and check Sum Amplifiers 1 and 2 and Integrators 1 and 2.

9. On the Audio Analyzer, key in FREQ 1 kHz, 53.1 SPCL, and 54.147 SPCL. Connect the oscilloscope to A3TP2 (NOTCH AMP) and set it for absolute vertical calibration. The waveform should be a heavily clipped sine wave with an amplitude between 20 and 25 Vpp. If faulty, see Service Sheet 4 and check the Notch Amplifier.

10. Press RATIO twice to establish a new ratio reference. Key in 44.1 SPCL to set the Notch Filter to the notch mode. The amplitude display should be less than 25%. If faulty, see Service Sheet 3 and check the Sum and Output Amplifier.

11. Remove the ground from A3TP3 and connect the oscilloscope (dc coupled) to it instead. On the Audio Analyzer, key in FREQ 800 Hz. The waveform should be a dc voltage between 4.0 and 4.6 Vdc. If faulty, see Service Sheet 4 and check the tune control circuits.

12. On the Audio Analyzer, key in 1.2 kHz. The waveform should be between −4.6 and −4.0 Vdc. If faulty, see Service Sheet 4 and check the tune control circuits.

13. On the Audio Analyzer, key in 1 kHz. The waveform should be between −1 and +1 Vdc. If faulty, see Service Sheet 3 and check the Sum Amplifier 2 and Service Sheet 4 and check the Tune Multiplier.

14. Remove the ground from A3TP4. The amplitude display should read 1% or less. If faulty, see Service Sheet 3 and check the Sum Amplifier and Service Sheet 4 and check the balance control circuits.

15. On the Audio Analyzer, key in 41.0 SPCL. Key in AMPTD 3 V. Press DISTN. The amplitude display should read 0.01% or less. If the level is slightly out of limit, perform the *Notch Filter Tune and Balance Adjustment*, paragraph 5-12. Otherwise, the Notch Filter is functioning, but the automatic tuning sequence is faulty. See Service Sheet BD4 and check the Counter.

⟨√3⟩ Output Amplifier Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Set the 80 kHz LOW PASS filter off. Key in AMPTD 300 mV. Key in 1.11 SPCL to set the input to the 3V range. Key in 3.1 SPCL to set the output to the least sensitive range. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A3TP7 (OUT). The waveform on the oscilloscope should be a sine wave with an amplitude between 800 and 900 mVpp and a period of approximately 1 ms. If faulty, see ⟨√2⟩ *Notch Filter Check.*

3. Use the oscilloscope's vertical gain controls to adjust the display amplitude for 5 divisions peak-to-peak deflection.

4. Connect the oscilloscope to A4TP8 (AMP 1). The peak-to-peak amplitude, displayed on the oscilloscope, should be between 2.4 and 2.6 divisions. If faulty, see Service Sheet 5 and check Attenuator 1 and Amplifier 1.

5. On the Audio Analyzer, key in AMPTD 30 mV. Key in 3.3 SPCL. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 2.4 and 2.6 divisions. If faulty, see Service Sheet 5 and check Attenuator 1.

6. Connect the oscilloscope to A4TP6 (AMP 2). The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.8 and 5.2 divisions. If faulty, see Service Sheet 5 and check the Low-Pass Filters.

7. Connect the oscilloscope to A4TP5 (AMP 3). Decrease the vertical gain of the oscilloscope by a factor of 10. The peak-to-peak amplitude, displayed by the oscilloscope, should be between 4.8 and 5.2 divisions. If faulty, see Service Sheet 5 and check Attenuator 2 and Amplifier 3.

8. On the Audio Analyzer, key in AMPTD 300 mV. Key in 3.2 SPCL. Increase the vertical gain of the oscilloscope by a factor of 10. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.8 and 5.2 divisions. If faulty, see Service Sheet 5 and check Attenuator 2.

9. Connect the oscilloscope to A4TP4 (AMP 4). Decrease the vertical gain of the oscilloscope by a factor of 10. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.8 and 5.2 divisions. If faulty, see Service Sheet 5 and check Attenuator 3, the Buffer, the High-Pass Filter, and Amplifier 4.

10. On the Audio Analyzer, key in 3.1 SPCL. Increase the vertical gain of the oscilloscope by a factor of 10. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.8 and 5.2 divisions. If faulty, see Service Sheet 5 and check Attenuator 3.

11. On the Audio Analyzer, key in FREQ 80 kHz. Set the 80 kHz LOW PASS filter on. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 3 and 4 divisions. If faulty, see Service Sheet 5 and check the 80 kHz Low-Pass Filter.

12. On the Audio Analyzer, key in FREQ 30 kHz. Set the 30 kHz LOW PASS filter on. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 3 and 4 divisions. If faulty, see Service Sheet 5 and check the 30 kHz Low-Pass Filter.

13. On the Audio Analyzer, key in 55.0 SPCL, 56.15 SPCL, and 57.140 SPCL to set the internal source to 13 Hz. The peak-to-peak amplitude, displayed on the oscilloscope, should be between 4.6 and 5.4 divisions. If faulty, see Service Sheet 5 and check the High-Pass Filter.

14. On the Audio Analyzer, key in 0.435 SPCL to insert the 13 Hz High-Pass Filter. (Ignore the displays.) The peak-to-peak amplitude, displayed on the oscilloscope, should be between 3 and 4 divisions. If faulty, see Service Sheet 5 and check the High-Pass Filter.

⟨√4⟩ Voltmeter Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 300 mV. Key in 1.11 SPCL to set the input to the 3V range. Key in 3.2 SPCL to set the output to the 20 dB range. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A4TP4 (AMP 4). The waveform on the oscilloscope should be a sine wave with an amplitude between 8 and 9 Vpp and a period of approximately 1 ms. If faulty, see ⟨√3⟩ *Output Amplifier Check.*

3. DC couple the oscilloscope and connect it to A4TP1 (DC OUT). The waveform should be a dc voltage between 2.8 and 3.2 Vdc. If faulty, see Service Sheet 6 and check the Output RMS/Average/Quasi-peak Detector.

4. On the Audio Analyzer, key in AMPTD 400 mV. Key in 0.76 SPCL to enable readback of the Output Overload Detector. The displays should read 0000 0000. If faulty, see Service Sheet 6 and check the Output Overload Detector.

5. On the Audio Analyzer, key in AMPTD 420 mV. Key in 0.76 SPCL. the displays should read 0001 0000. If faulty, see Service Sheet 6 and check the Output Overload Detector.

Hint: Because of the hysteresis in the Output Overload Detector, it will be necessary to key in AMPTD 300 mV first if it is desired to repeat steps 4 and 5.

6. On the Audio Analyzer, key in AMPTD 300 mV. Connect the oscilloscope to A4TP9. The waveform should be a pulse waveform switching between 0 Vdc and 2.9 to 3.1 Vdc. If faulty, see Service Sheet 7 and check the Voltmeter Input Selector.

7. The right display should read between 0.29 and 0.31V. If faulty, see Service Sheet 7 and begin troubleshooting with the Voltage-to-Time Converter.

Hint: If the other inputs to the Voltmeter Input Selector are suspected to be faulty, see Service Sheet 7 and check the Voltmeter Input Selector.

8. On the Audio Analyzer, press SINAD. Key in AMPTD 3 V. Key in 3.0 SPCL. Key in 45.1 SPCL to enable the SINAD meter. The amplitude display should read greater than 80 dB. The SINAD meter should read beyond full scale. If the amplitude display is faulty, see ⟨√2⟩ *Notch Filter Check.* If the SINAD meter is faulty, see Service Sheet 6 and check the SINAD meter circuits.

9. On the Audio Analyzer, key in 6.1 SPCL to hold the Notch Filter at its present setting. Key in FREQ 900 Hz. The amplitude display should read between 15 and 20 dB, but more importantly, the SINAD meter should agree with this reading to within 1 dB. If the SINAD meter is faulty, see Service Sheet 6 and check the SINAD meter circuits.

10. On the Audio Analyzer, key in 0.524 SPCL. The SINAD meter should read beyond full scale. If faulty, see Service Sheet 6 and check the Meter Peg/Off Switch.

11. On the Audio Analyzer, key in 0.528 SPCL. The SINAD meter should read between 0 and +0.5 dB. If faulty, see Service Sheet 6 and check the Meter Peg/Off Switch.

⟨√5⟩ Pre-Notch RMS/Average Detector Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input to the 3V range. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A2TP3 (OUT). The waveform on the oscilloscope should be a sine wave with a amplitude between 8 and 9 Vpp and a period of approximately 1 ms. If faulty, see ⟨√3⟩ *Input Amplifier Check.*

3. Use the oscilloscope's vertical gain controls to adjust the display amplitude for 5 divisions peak-to-peak deflection of the signal.

4. DC couple the oscilloscope and connect it to A2TP15 (RMS2). The waveform should be a dc voltage between 1.7 and 1.8 divisions. If faulty, see Service Sheet 3 and check the RMS Detector.

5. On the Audio Analyzer, key in 5.2 SPCL to switch to the Average Detector. The waveform should be a dc voltage between 1.7 and 1.8 divisions. If faulty, see Service Sheet 3 and check the Average Detector.

SERVICE SHEET 1---A2 Input Amplifier Assembly (Input Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Input Amplifier Assembly (A2) contains the AC/DC Switch, Input Attenuator, Over-Voltage Protection, and Differential-to-Single-Ended Amplifier. These and the other circuits on the Input Amplifier Assembly condition the signal to be suitable to drive the Notch Filter and Output Amplifier.

Input Circuits and Input Attenuator

The signals at the HIGH and LOW INPUT connectors are filtered by RFI filters A13L2 and A13C16 and A13L3 and A13C15. The INPUT connectors are both floating. The LOW INPUT can be shorted to ground by chassis part S3. The inputs are ac coupled by C2 and C88 except in the dc level measurement mode where the capacitors are effectively shorted by R2 and R104 which are switched in by K7.

The High and Low Input Attenuators are identical. Only the High Input Attenuator will be discussed. The attenuator is a set of two divider legs with four outputs which are selected by relays K4, K5, and K6 and FET Q2. The two dividers present a combined input impedance of 100 kΩ. (R2 adds another 1 kΩ for dc measurements.) R3 and R4 form a 12 dB divider. C3, C4, C6, C7, and R5 compensate stray capacitance for flattest frequency response. R6, R7, and R8 form a 24 and 40 dB divider. The 24 dB tap is at the junction of R7 and R8. C9, C10, C11, C12, and R9 frequency compensate the 24 dB divider. In addition, C8, C109, and R96 are switched in by Q3 to frequency compensate the 40 dB divider. For input levels below 3V, the attenuation is set to 40 dB.

Over-Voltage Protection

The Over-Voltage Protection clips the input signal on either high or low path when the signal exceeds a magnitude of 15V. The circuit for both paths is identical.

Using the high path as an example, the clipping diodes are CR9, CR10, CR11, and CR12. VR1 and VR2 reference the clipping diodes to +12 and −12V. Follower amplifier U7 feeds the signal through C20 and C21 to the clipping diodes to prevent ac modulation of the capacitance of the clipping diodes to eliminate distortion. The signal from voltage divider R108 and R112 is fed to the Input Overload Detector (see Service Sheet 2).

Differential-to-Single-Ended Amplifier

U6, U12, and U5 convert the differential signal from the High and Low Input Attenuators to a single-ended signal (that is, one that is referenced to ground). The differential gain of U6 and U12 is programed by K1 and K2 as cataloged in Table 8B-12. In the dc level measurement mode, only 0 dB gain is used.

Table 8B-12. Gain of the Differential-to-Single-Ended Amplifier

State of K1	State of K2	Gain (dB)
Open	Open	0
Open	Closed	8
Closed	Open	16
Closed	Closed	20

U5 subtracts the output of U6 from U12. Its gain with respect to the output of U6 is −1; its gain with respect to U12 is +1 if the divide-by-two voltage divider (R41, R42, and R43) is taken into account. R43 is adjusted to equalize the two gains and thus reject the common-mode signal. C25, C26, C27, and C32 flatten the frequency response of the two amplifiers. Dual FETs Q7 and Q9 provide a high input impedance. Dual FETs Q8 and Q10 minimize high-frequency distortion generated by ac modulation of the drain-to-gate capacitance of Q7 and Q9.

Relay Drivers

U15 is a TTL octal peripheral driver capable driving the relays. The relays energize when the relay-driver outputs go low. The diodes across the relay coils suppress the inductive transient generated by the coil when the current is interrupted. U14 decodes the attenuation control lines for the 40 dB attenuator.

Humidity Sealing

The area surrounding the relays of this assembly have been coated with a humidity seal. The area is marked on the circuit board. If components in the sealed area are replaced, it is recommended that solder flux *not* be removed and that a humidity sealant (such as HP 8500-3266) be applied with a cotton swab over the affected area.

TROUBLESHOOTING

General

Procedures for checking the Input Amplifier Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the source is working properly.

Equipment

Oscilloscope ..... HP 1740A
Test Oscillator ..... HP 3310A

⟨✓1⟩ Input Attenuator and AC/DC Switch Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT switch to FLOAT and the OUTPUT switch to ground. Key in AMPTD 3 V. Connect the HIGH OUTPUT to the HIGH INPUT. Connect a high-impedance, ac coupled oscilloscope to the gate of Q7A.

2. Key in the Special Functions listed in Table 8B-13. For each setting the peak-to-peak amplitude should be within the limits indicated. (The period of the signal should be approximately 1 ms.) If the signal level is incorrect, also check the control signals indicated.

Table 8B-13. Amplitude Limits at the Gate of Q7A or Q9A, ⟨✓1⟩ Steps 2 and 4

Check	Special Function	Oscilloscope Display (mVpp)	Level (TTL) at U15 Pins		
			4, 16	17, 3	6, 14
0 dB	1.11	8100 to 8900	L	H	H
12 dB	1.8	2000 to 2200	H	L	H
24 dB	1.5	500 to 560	H	H	L

Hint: Pin 1 of U16A should be between +10 and +12 Vdc. Pin 8 of U14C should be a TTL high. Q2 and Q5 should be off.

3. Key in 1.1 SPCL to set the input attenuation to 40 dB. The waveform should have an amplitude between 81 and 89 mVpp.

Hint: Pin 1 of U16A should be between −15 and −14 Vdc. Pins 16, 14, and 3 of U15 should be TTL high. Pin 8 of U14C should be a TTL low. Q2 and Q5 should be on.

4. Connect the oscilloscope to the gate of Q9A. Connect the HIGH OUTPUT to the LOW INPUT. Repeat steps 2 and 3. The results should be the same.

5. On the Audio Analyzer, key in 1.11 SPCL. Connect A8TP16 (+5V) to the LOW INPUT. The oscilloscope, dc coupled, should read 0 Vdc.

Hint: Pins 8 and 12 of U15A should be a TTL high. K7 should be open.

6. On the Audio Analyzer, press S (Shift) DC LEVEL. Key in 2.4 SPCL to set the input attenuation to 0 dB (in the dc mode). The oscilloscope should read approximately +5 Vdc.

Hint: Pins 8 and 12 of U15A should be a TTL low. K7 should be closed.

7. Connect the oscilloscope to the gate of Q7A. Connect the HIGH OUTPUT to the HIGH INPUT. Press AC LEVEL. Repeat steps 5 and 6. The results should be the same.

⟨J2⟩ Over-Voltage Protection Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT switch to FLOAT. Key in 1.11 SPCL to set the input amplifier gain to 0 dB.

2. Set the test oscillator to 1 kHz and level to approximately 1 Vrms. Connect the output to the Audio Analyzer's HIGH INPUT.

3. Connect a high-impedance, dc coupled oscilloscope to the gate of Q7A.

4. Short A7TP6 (RSI) to A8TP16 (+5V) to inhibit the Input Overload Flip-Flop. (See Service Sheet 12.)

5. Increase the test oscillator level to approximately 30 Vpp. The waveform on the oscilloscope should appear as shown in Figure 8B-3.

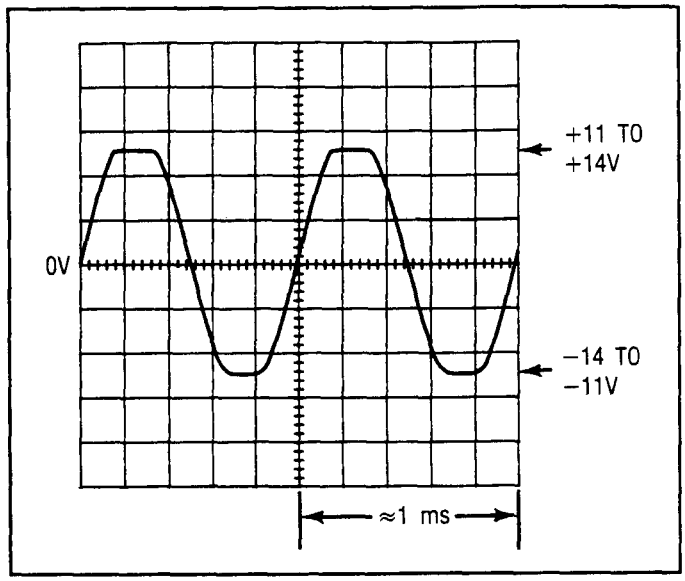


Figure 8B-3. Waveform for ⟨J2⟩ Steps 5 and 6

6. Connect the oscilloscope to the gate of Q9A. Connect the test oscillator to the LOW INPUT. The waveform should appear as shown in Figure 8B-3.

⟨J3⟩ Differential-to-Single-Ended Amplifier

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT switch to FLOAT and the OUTPUT switch to ground. Key in AMPTD 80 mV. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to the gate of Q7A. The waveform on the oscilloscope should be between 216 and 236 mVpp. (The period of the signal should be 1 ms.)

3. Use the oscilloscope's vertical gain controls to adjust the waveform amplitude for 2 divisions peak-to-peak.

4. Connect the oscilloscope to A2TP5 (SING END). Key in the Special Functions listed in Table 8B-14. For each setting, increase the oscilloscope's vertical gain by the amount indicated. The peak-to-peak amplitude, displayed on the oscilloscope, should be within the limits indicated. If the signal level is incorrect, also check the control signals indicated.

5. Disconnect the HIGH INPUT. Set the oscilloscope to measure dc voltage. The voltage should be between −0.1 and +0.1 Vdc.

Hint: If the dc voltage is only slightly out of limits, perform the *Input DC Offset Adjustment*, paragraph 5-10.

6. Connect the HIGH OUTPUT to the LOW INPUT. Set the oscilloscope back to the × 1 gain that begins step 4. Repeat step 4. The results should be the same.

Table 8B-14. Amplitude at A2TP5, ◇3◇ Step 4

Special Function	Increase in Oscilloscope Vertical Gain	Amplitude Limits (div pp)	Level (TTL) at U15B Pin	
			9, 11	7, 13
1.11	×1	1.9 to 2.1	H	H
1.15	×1	4.7 to 5.3	H	L
1.17	×10	1.2 to 1.3	L	H
1.19	×10	1.9 to 2.1	L	L

7. Using a tee adapter, connect the HIGH OUTPUT to the HIGH and LOW INPUTs in parallel. Key in AMPTD 1 V. The waveform on the oscilloscope should have an amplitude less than 50 mVpp. (The waveform may be non-sinusoidal.)

Hint: If the signal is only slightly out of limits, perform the *Common-Mode Rejection Adjustment*, paragraph 5-9.

SERVICE SHEET 2---A2 Input Amplifier Assembly (Output Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Input Amplifier Assembly (A2) contains a stage of programmable amplification, the Weighting Bandpass and High-Pass Filters, and the Input Range and Overload Detectors. The output of the assembly drives the Notch Filter.

Programmable Gain Amplifier

The input of the Programmable Gain Amplifier is ac coupled by C37 and C38. The amplifier itself is noninverting and has a gain as cataloged in Table 8B-15. (Only one switch is closed at a time.)

Table 8B-15. Gain of the Programmable Gain Amplifier

Switch Closed	Gain (dB)
U11(2)	0
U11(4)	4
U11(3)	8
U11(1)	12

Weighting Bandpass and High-Pass Filters

The Weighting Bandpass and High-Pass Filters are optional plug-on filters used for specialized testing applications. None, one, or two filters can be installed. If no filter is installed, the filters are replaced by jumpers. See Service Sheets 2A and 2B for a discussion of the filter circuits.

Input Range Detector

The Input Range Detector (U1) is a true rms detector which senses the signal level at the input to the Weighting Bandpass and High-Pass Filters. The output drives the dc voltmeter which is read by the Controller to determine the setting of input gain. The detector is placed before the active filters to sense overloading, since the filters can filter the overload signal components.

Since some filters have gain, the sensitivity of the detector is increased to match the filters. The Gain 1 and Gain 2 resistors in the filters set the overall detector sensitivity by setting the gain of U17.

Input Overload Detector

The Input Overload Detector produces a low output that resets the Input Overload Flip-Flop on the Latch Assembly and sets the input Attenuators to 40 dB (see Service Sheets 1 and 12). The low is produced if the output of the Input Range Detector exceeds 8V or if the output of the Differential-to-Single-Ended Amplifier or the signal from the Input Attenuators goes more positive than +7.5V or more negative than −7.5V. (See Service Sheet 1.)

Comparators U4 and U18 are wire-ORed in such a way that if any comparator senses an overload condition, the INPUT OVLD line goes low. R76 and C61 add delay to the circuit that prevents the recognition of short-duration overloads. R87 and C70 form a high-frequency interference filter.

TROUBLESHOOTING

General

Procedures for checking the Input Amplifier Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the source is working properly.

Equipment

Oscilloscope ..... HP 1740A

⟨✓1⟩ Programmable Gain Amplifier Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 1 V. Key in 1.11 SPCL to set the input gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A2TP5 (SING END). The waveform should be 2.7 to 2.9 Vpp. (The period of the signal should be approximately 1 ms.)

Hint: If the signal is faulty, see Service Sheet 1 and check the Differential-to-Single-Ended Amplifier.

3. Use the oscilloscope's vertical gain controls to adjust the waveform amplitude for 2 divisions peak-to-peak.

4. Connect the oscilloscope to A2TP4 (PGM AMP). On the Audio Analyzer, key in the Special Functions listed in Table 8B-16. For each setting the peak-to-peak amplitude should be within the limits indicated. If the signal level is incorrect, also check the control signals indicated. (Checking U11 will require unplugging the leftmost plug-on filter A2A1 or probing from the circuit side of A2.)

Table 8B-16. Amplitude Limits at A2TP4, ⟨✓1⟩ Step 4

Gain (dB)	Special Function	Amplitude Limits (div pp)	Level (TTL) at U11 Pins			
			8	9	16	1
0	1.11	1.9 to 2.1	L	H	H	H
4	1.12	3.0 to 3.3	H	L	H	H
8	1.13	4.7 to 5.3	H	H	L	H
12	1.14	7.6 to 8.4	H	H	H	L

⟨✓2⟩ Weighting Bandpass and High-Pass Filters Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 1 V. Key in 1.11 SPCL to set the input gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A2TP4 (PGM AMP). The waveform should be 2.7 to 2.9 Vpp. (The period of the signal should be approximately 1 ms.)

Hint: If the signal is faulty, check the Programmable Gain Amplifier.

3. Use the oscilloscope's vertical gain controls to adjust the waveform amplitude for 2 divisions peak-to-peak.

4. Connect the oscilloscope to A2TP3 (OUT).

5. Set the source frequency as listed in Table 8B-17. For each setting, press the appropriate filter key. The peak-to-peak amplitude should be within the limits indicated.

Table 8B-17. Amplitude at A2TP3, ⟨✓2⟩ Step 5

SOURCE Frequency (Hz)	Weighting Bandpass or High-Pass Filter	Amplitude Limits (div pp)
1000	(Both Off or None)	1.9 to 2.1
1000	HIGH PASS 400 Hz	1.9 to 2.1
800	CCITT WEIGHTING	1.9 to 2.1
6800	CCIR WEIGHTING	7.7 to 8.6
1000	C-Message WEIGHTING	1.9 to 2.1
6800	CCIR/ARM WEIGHTING	4.1 to 4.5
1000	"A" WEIGHTING	1.9 to 2.1

Hint: If the signal level is incorrect, check the control signals indicated in Table 8B-18. (Checking U10 will require probing from the circuit side of A2.)

Table 8B-18. Control Signals, ⟨✓2⟩ Step 5 Hint

Position of On-Filter	Level (TTL) at U10 Pin		
	1	8	16
(Both Off)	L	H	H
Left A2A1	H	L	H
Right A2A2	H	H	L

Hint: If the signal is only slightly out of limits, perform the *400 Hz High-Pass and Weighting Bandpass Filters Adjustment*, paragraph 5-11.

Hint: See Service Sheet 2A or 2B for hints in checking the individual filters.

6. Perform the *Audio Filters Performance Test*, paragraph 4-11 or the filter check portion of the simpler *Basic Functional Checks*, paragraph 3-10.

Hint: If the passband gain is correct but the frequency response is out of limits, check the frequency-response-determining resistors and capacitors of the respective filter. See Service Sheet 2A or 2B.

⟨✓3⟩ Input Range Detector Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 1 V. Key in 1.11 SPCL to set the input gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A2TP5 (SING END). The waveform should be 2.7 to 2.9 Vpp. (The period of the signal should be approximately 1 ms.)

Hint: If the signal is faulty, see Service Sheet 1 and check the Differential-to-Single-Ended Amplifier.

3. Use the oscilloscope's vertical gain controls to adjust the waveform amplitude for 7.1 divisions peak-to-peak.

4. Connect the oscilloscope, dc coupled, to A2TP2 (RMS). Press the appropriate filter key indicated in Table 8B-19. For each setting, the dc level (with respect to ground) should be within the limits indicated.

Hint: The sensitivity of the rms converter (U1) is 1 Vdc/Vrms. The gain of U17 is determined by R115 and the Gain 1 or Gain 2 resistor of A2A1 or A2A2 respectively. FET Q4 is on when filter A2A1 is selected. (Pin 8 of U10 is a TTL low.) Switch 4 of U10 is on when filter A2A2 is selected. (Pin 16 of U10 is a TTL low.)

Table 8B-19. Level at A2TP2, ⟨J3⟩ Step 4

Weighting Bandpass or High-Pass Filter	Amplitude Limits (div dc)
(Both Off or None)	2.4 to 2.6
HIGH PASS 400 Hz	2.4 to 2.6
CCITT WEIGHTING	2.4 to 2.6
CCIR WEIGHTING	0.9 to 1.1*
C-Message WEIGHTING	2.4 to 2.6
CCIR/ARM WEIGHTING	5.1 to 5.4
"A" WEIGHTING	3.0 to 3.2
* Reduce the oscilloscope's vertical gain by 10.	

⟨J4⟩ Input Overload Detector Input

1. Unplug the A2A2 assembly, if present, to gain access to the components beneath. (Refer to *Filter Board Removal* in *Troubleshooting* for Service Sheet 2A.

2. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 1 V. Key in 1.11 SPCL to set the input gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

3. Connect a high-impedance, dc coupled oscilloscope to A2TP3 (RMS). The dc level should be between +0.9 and +1.1 Vdc.

Hint: If the signal is faulty, check the Input Range Detector.

4. Connect the oscilloscope or a logic probe to A7TP6 (RSI). The signal should be a TTL high.

Hint: All outputs of U4 and U18 should be in the high (open) state.

5. Perform the following procedure. Each procedure should generate a TTL low at A7TP6. (Remove the shorts after each step is completed.)

a. Short out R81. (This will also generate Error 30.)

b. Short pin 4 of U4A to +15V.

c. Short pin 4 of U4A to −15V.

d. Short pin 6 of U18B to +15V.

e. Short pin 6 of U18B to −15V.

f. Short pin 9 of U18C to +15V.

g. Short pin 9 of U18C to −15V.

SERVICE SHEETS 2A AND 2B---A2A1 and A2A2 Weighting Bandpass and High-Pass Filter Assemblies

PRINCIPLES OF OPERATION

The Weighting Bandpass and High-Pass Filter Assemblies (A2A1 or A2A2) are optional audio filters which plug onto the A2 Input Amplifier Assembly to filter the signal before being measured by the Pre-Notch RMS/Average or Output RMS/Average Detector. In general the filters are quite similar. The filters are active types composed of multiple high-pass, low-pass, and bandpass sections. The CCITT Weighting Filter will serve as an example.

The CCITT Weighting Filter (sometimes referred to as a psophometric filter) is a complex collection of poles and zeros which produces a bandpass response. U1A, U1B, U1D, and their associated resistors and capacitors have low-pass responses. U1C and its associated resistors and capacitors have a bandpass response. U9 on the A2 Input Amplifier Assembly (see Service Sheet 2) and its associated resistors and capacitors have a high-pass response. R8 and C5 is a single-pole, passive low-pass filter. C10 and R14 is a single-pole, passive high-pass filter. R4 adjusts the overall filter gain.

Some filters, such as the "A" Weighting Filter, have a resistor (R15) which increases the sensitivity of the Input Range Detector. (See Service Sheet 2.)

TROUBLESHOOTING

Begin troubleshooting the Weighting Bandpass and High-Pass Filter Assemblies by performing the *Weighting Bandpass and High-Pass Filters Check* on Service Sheet 2. If the passband gain is faulty, check the input offset on the individual ICs on the filter assembly using the following guidelines. (Note that A2U9 is part of a filter stage. It lies behind A2A1 but can be probed from the circuit side or, if desired, A2A1 can be move to the position of A2A2 while A2U9 is checked. See Service Sheet 2.)

a. Where bias voltages are shown on the schematic diagram, the dc voltage should be within the limits shown.

b. Where bias voltages are not shown on the schematic diagram, the differential offset voltage at between the input pins should be within ±15 mVdc.

c. If the offset exceeds these limits, check the polarity of the output of the IC. If the polarity corresponds with the polarity of the input offset, the IC is probably good.

If the filters appear to work properly except that the frequency response is out of limits, check the frequency response of the individual filter stages against the following plots. An easy way to do this is as follows.

a. Set the source to the desired frequency at 1V.

b. Set the LOW INPUT and OUTPUT switches to ground. Set IMPEDANCE to 50Ω. Connect the HIGH OUTPUT to the HIGH INPUT.

c. Connect an ac voltmeter to A2TP4 (PGM AMP). The voltmeter reading is a reference.

d. Connect the voltmeter to the output of the filter stage to be checked. The voltmeter reading relative to the reading in step c should agree with the plots in Figures 8B-4 to 8B-31 for the particular frequency and filter stage. (Note that the plots use a logarithmic magnitude scale. The dB reading is 20 log (reading of step d ÷ reading of step c).)

Filter Board Removal

To remove a filter board assembly, turn the screw in each of the four plastic standoffs one-quarter turn counter-clockwise, then work the board off the standoffs and interconnect plug. To install a board assembly, align the board with the standoffs and the interconnect plug, then press the board into place. If the board hangs up on a standoff, squeeze the top of the standoff with needle-nose pliers while pressing on the board. (The standoff has memory and remains slightly spread apart.) Relock the standoffs by turning the plastic screws one-quarter turn clockwise.

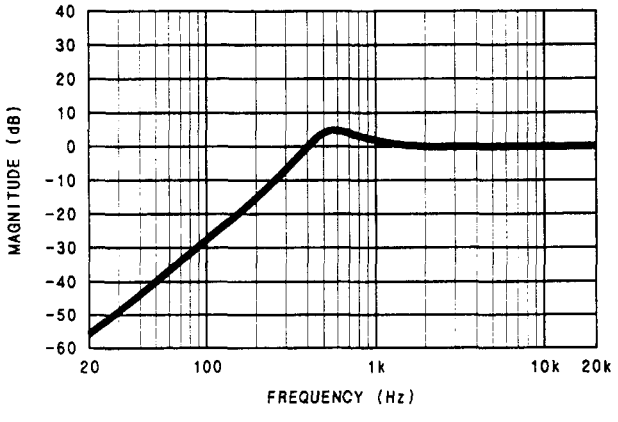


Figure 8B-4. 400 Hz High-Pass Filter, U1 Pin 6

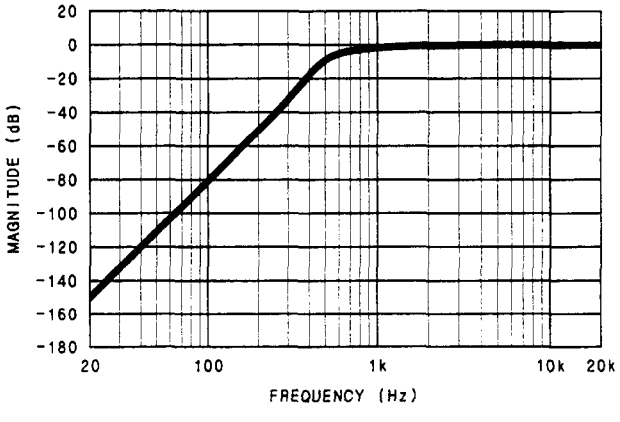


Figure 8B-5. 400 Hz High-Pass Filter, U2 Pin 6

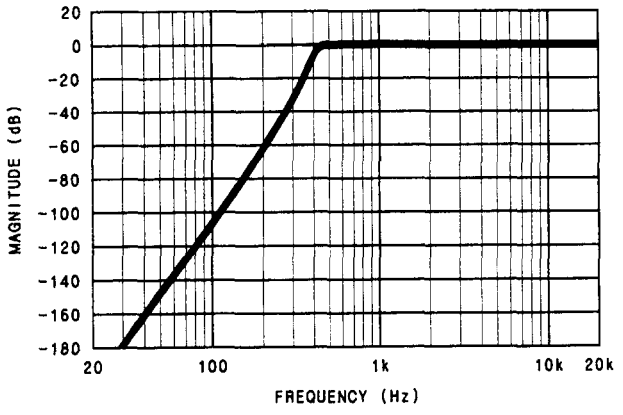


Figure 8B-6. 400 Hz High-Pass Filter, A2TP3

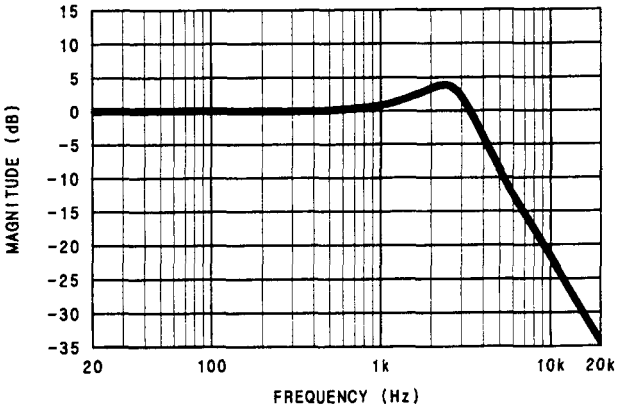


Figure 8B-7. CCITT Weighting Filter, U1 Pin 6

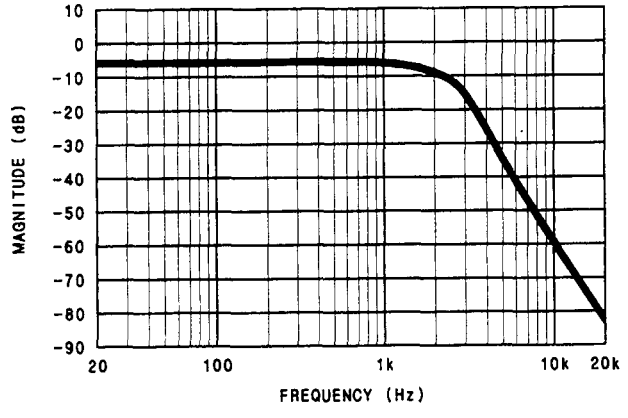


Figure 8B-8. CCITT Weighting Filter, U1 Pin 7

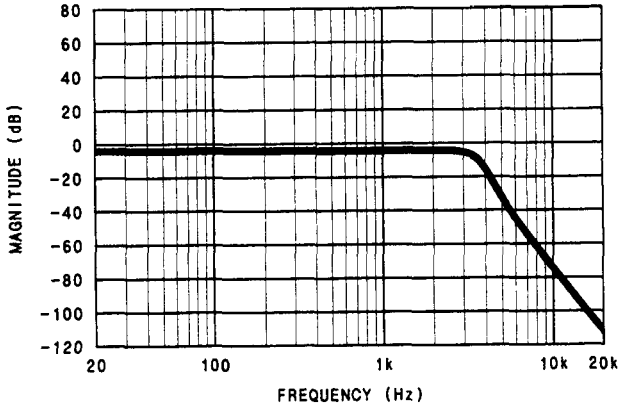


Figure 8B-9. CCITT Weighting Filter, U1 Pin 14

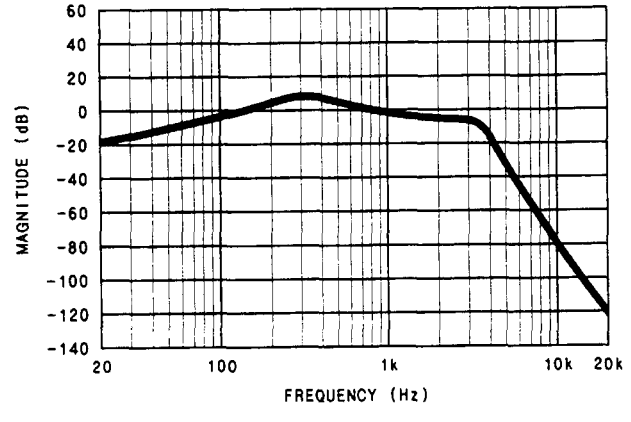


Figure 8B-10. CCITT Weighting Filter, U1 Pin 8

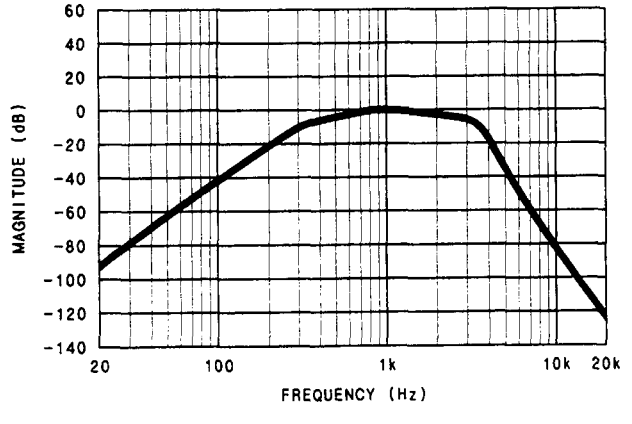


Figure 8B-11. CCITT Weighting Filter, A2TP3

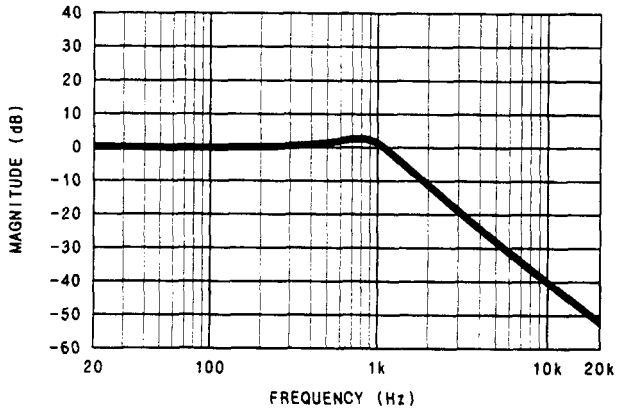


Figure 8B-12. C-Message Weighting Filter, U1 Pin 1

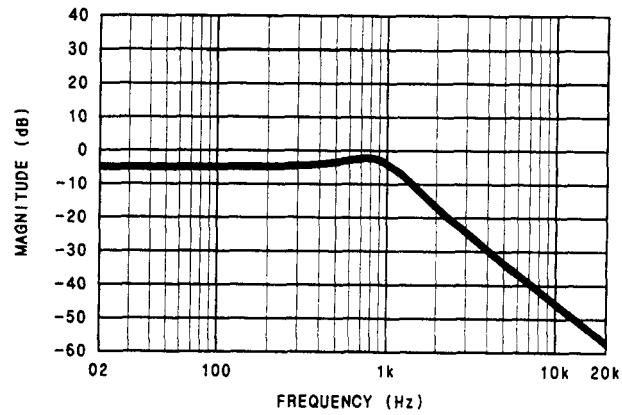


Figure 8B-13. C-Message Weighting Filter, U1 Pin 7

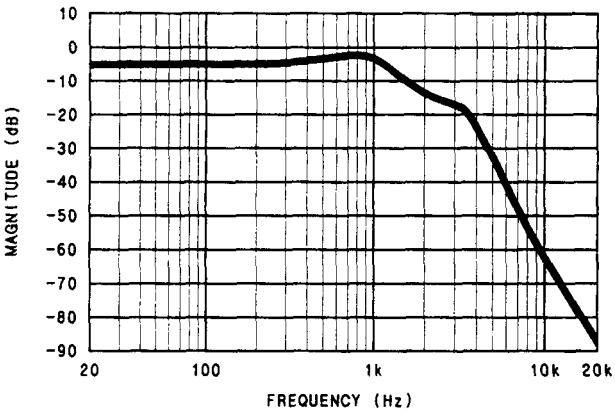


Figure 8B-14. C-Message Weighting Filter, U1 Pin 14

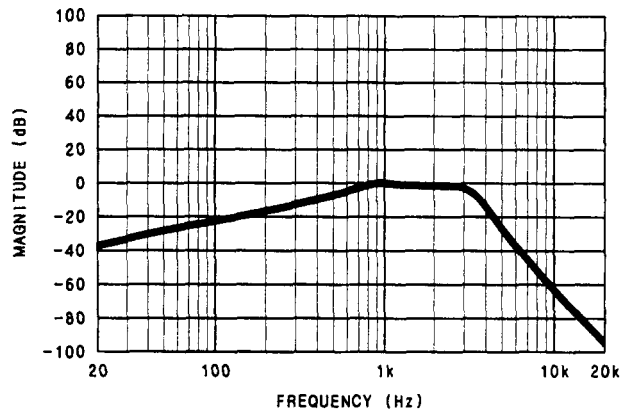


Figure 8B-15. C-Message Weighting Filter, U1 Pin 8

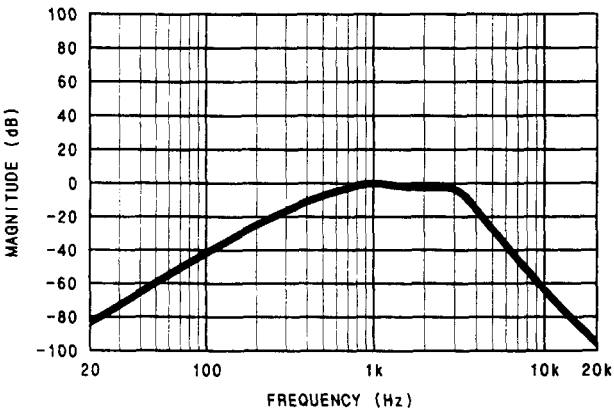


Figure 8B-16. C-Message Weighting Filter, A2TP3

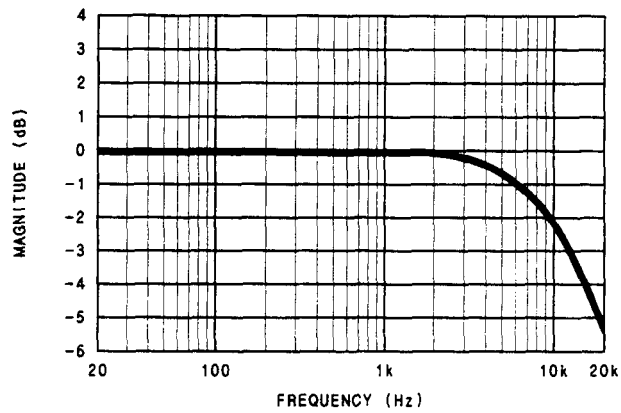


Figure 8B-17. "A" Weighting Filter, U1 Pin 3

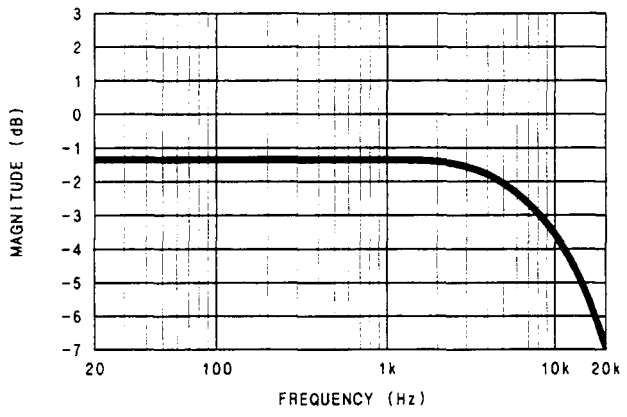


Figure 8B-18. "A" Weighting Filter, U1 Pin 7

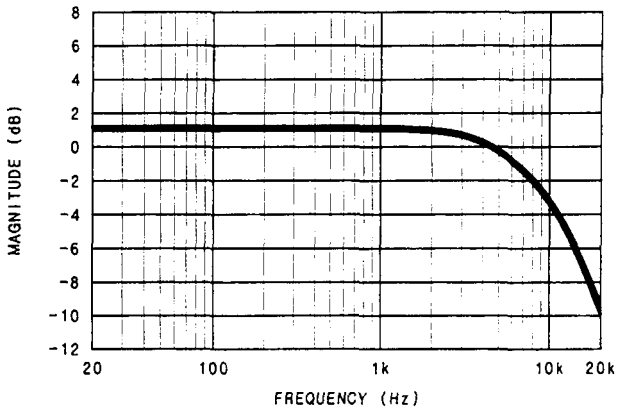


Figure 8B-19. "A" Weighting Filter, U1 Pin 14

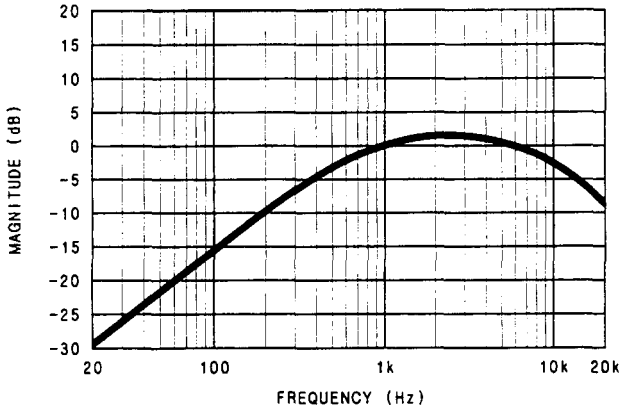


Figure 8B-20. "A" Weighting Filter, U1 Pin 8

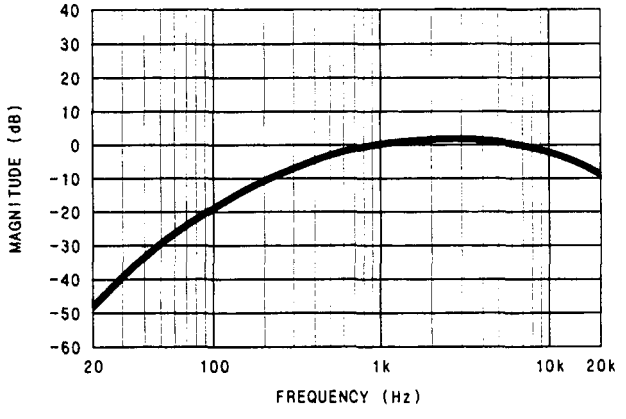


Figure 8B-21. "A" Weighting Filter, A2TP3

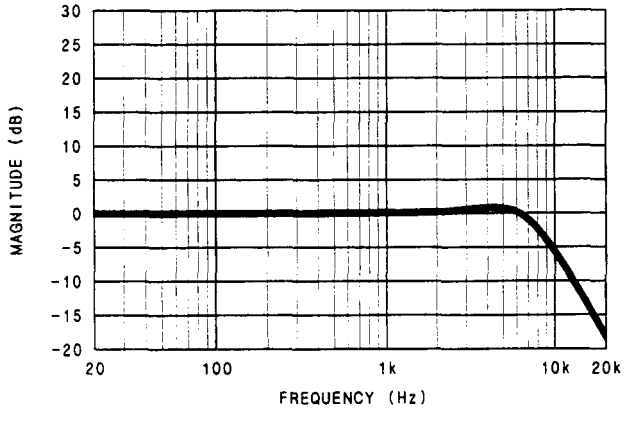


Figure 8B-22. CCIR Weighting Filter, U1 Pin 1

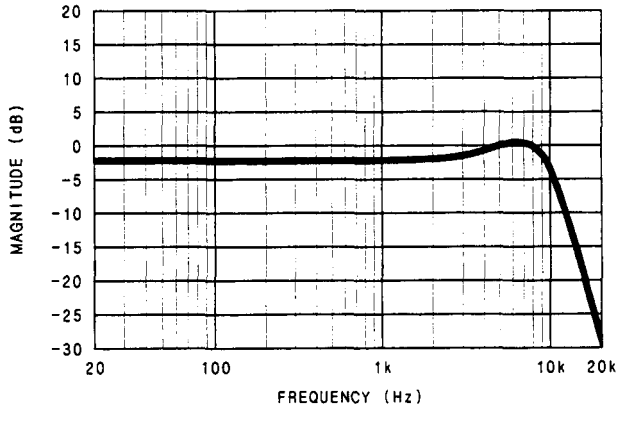


Figure 8B-23. CCIR Weighting Filter, U1 Pin 7

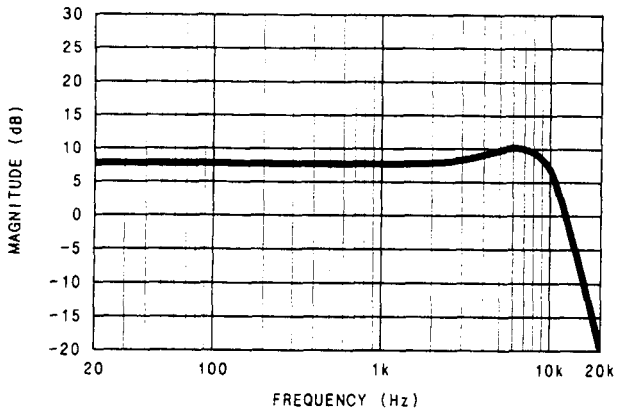


Figure 8B-24. CCIR Weighting Filter, U1 Pin 14

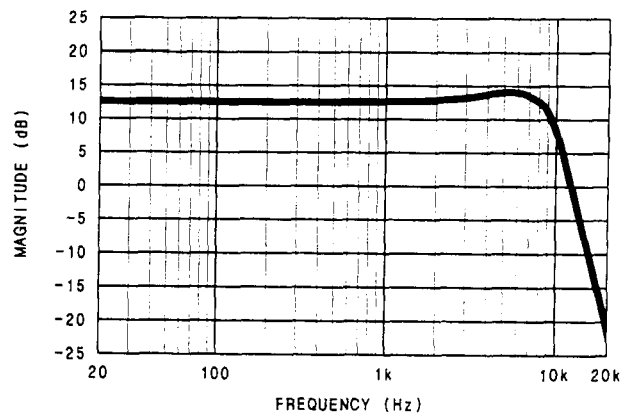


Figure 8B-25. CCIR Weighting Filter, U1 Pin 8

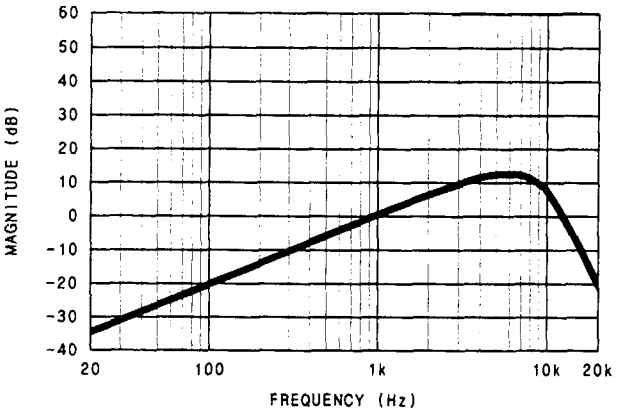


Figure 8B-26. CCIR Weighting Filter, A2TP3

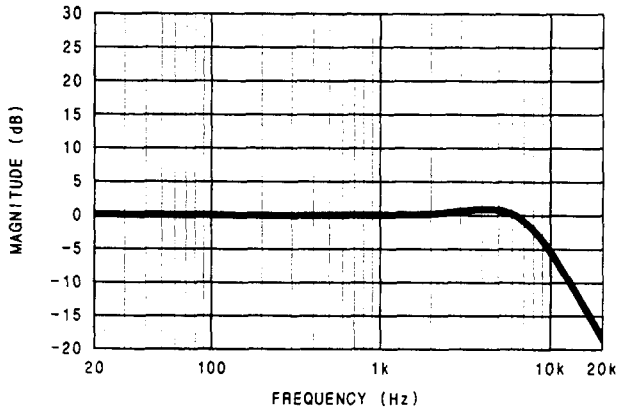


Figure 8B-27. CCIR/ARM Weighting Filter, U1 Pin 1

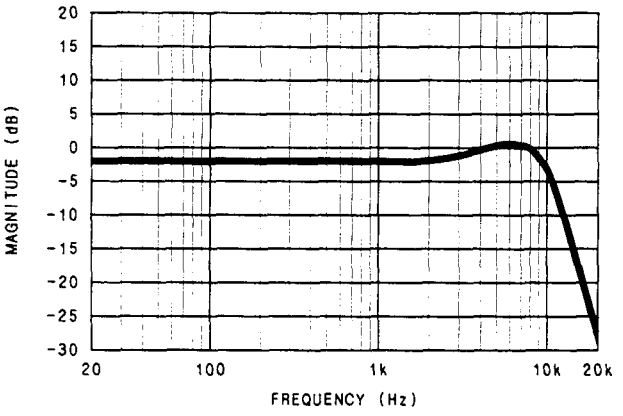


Figure 8B-28. CCIR/ARM Weighting Filter, U1 Pin 7

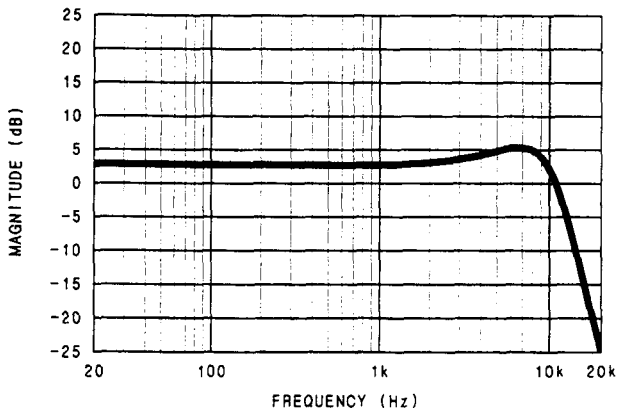


Figure 8B-29. CCIR/ARM Weighting Filter, U1 Pin 14

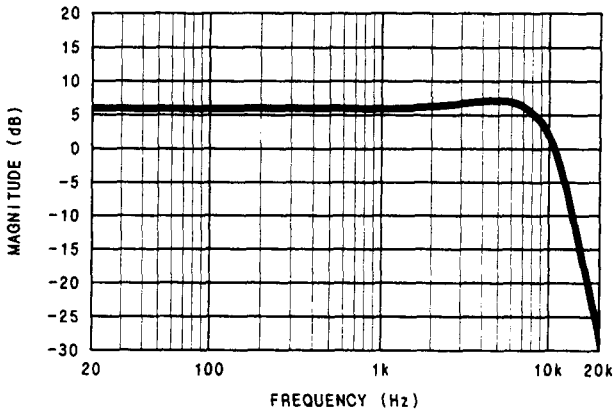


Figure 8B-30. CCIR/ARM Weighting Filter, U1 Pin 8

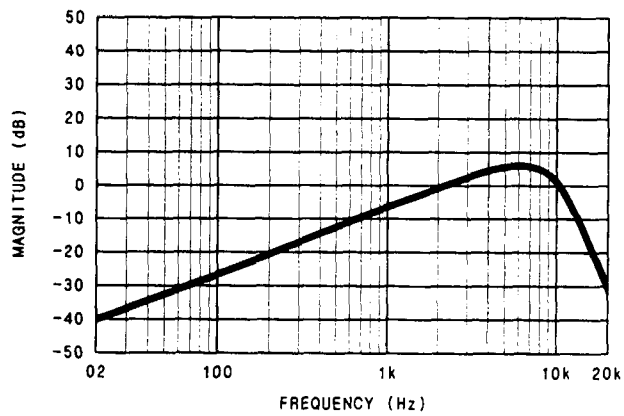


Figure 8B-31. CCIR/ARM Weighting Filter, A2TP3

SERVICE SHEET 3---A3 Notch Filter Assembly (Notch-Generating Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Notch Filter Assembly (A3) contains the basic notch-generating circuitry which includes two integrators, two sum amplifiers, and their control circuitry.

Integrators

The two integrators are nearly identical. A simplified diagram of an integrator is shown in Figure 8B-32. For Integrator 1, FETs Q30 through Q32 switch the feedback capacitors to change ranges. FETs Q14 through Q21 switch the input resistors to coarse tune the filter. The FETs are driven by the Notch Control Drivers whose control inputs come from the Controller via the Latch Assembly (see Service Sheets 12 and 13).

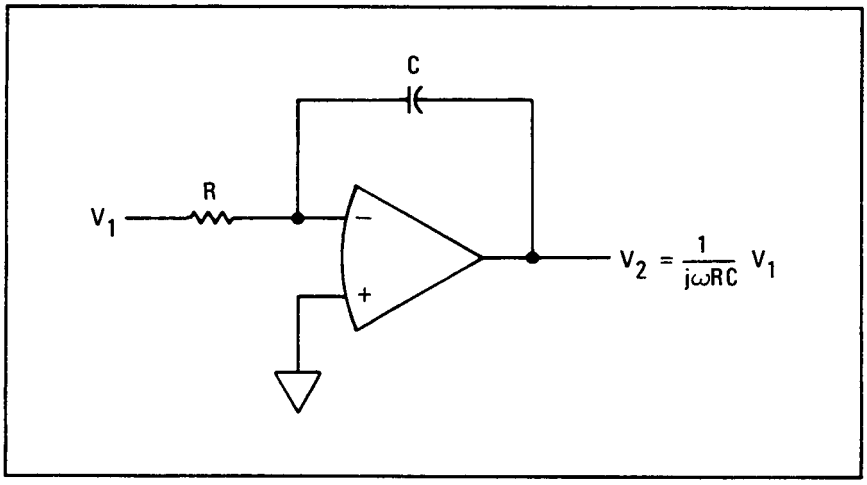


Figure 8B-32. Integrator Circuit

Sum Amplifiers

Sum Amplifiers 1 and 2 and the Sum and Output Amplifier sum various signals in the proportion and phase relationship required by the state-variable design. (See the discussion of the Notch Filter on Service Sheet BD2.) The Sum and Output Amplifier has inputs which are switched by FETs Q11 and Q12 to control the type of filter response, namely, notch, bandpass, or flat. Q13 is a resistive match for the resistance of Q11 or Q12. Sum Amplifier 2 injects the error signal from the notch Balance and Tune Multipliers to automatically fine balance and tune the Notch Filter (see Service Sheet 4). The FETs are driven by the Notch Control Drivers.

Pre-Notch RMS and Average Detectors

The Pre-Notch RMS and Average Detectors convert the ac signal at the input to the Notch Filter, but following the Weighting Bandpass and High-Pass Filters (see Service Sheet 2), to an equivalent dc voltage measured by the Voltmeter. The conversion can be either rms responding or average responding as selected by U19. U17 is the true rms converter. The Pre-Notch Average Detector is calibrated to output a dc voltage corresponding to the rms value of a sine-wave input.

The average-responding converter consists of U18A and associated components, which function as a full-wave rectifier, and U18B and associated components, which function as a low-pass filter. Full-wave rectification is produced by summing the half-wave-rectified current flowing through R100 with the un-rectified current flowing through R98. The rectified current is weighted twice as heavily as the un-rectified current since R100 is half the value of R98. Since U18A inverts as well as rectifies, the summing of currents is equivalent to a subtraction.

TROUBLESHOOTING

General

Procedures for checking the Notch Filter Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the source is working properly.

Equipment

Oscilloscope HP1740A

⟨✓1⟩ Notch Filter Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Press DISTN. Short pin 3 of U5 to A3TP1 (GND).

2. Connect a high-impedance, dc coupled oscilloscope to A3TP5 (BP OUT), A3TP6 (HP OUT), A3TP7 (OUT), and A3TP14 (LP OUT) one at a time. The dc offset level (superimposed on an ac signal) for each should be between −200 to +200 mVdc.

3. On the Audio Analyzer, remove the short at pin 3 of U5. Short A3TP3 (TUNE) and A3TP4 (BAL) both to A3TP1 (GND).

4. On the Audio Analyzer, set the INPUT and OUTPUT switches to ground. Key in AMPTD 2 V. Key in 1.11 SPCL to set the input gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

5. AC couple the oscilloscope and connect it to A2TP3 (OUT, see Service Sheet 2). Increment the Audio Analyzer's SOURCE amplitude to obtain exactly 6 Vpp on the oscilloscope.

Hint: The amplitude at A2TP3 should be approximately between 5 and 6 Vpp before adjustment. (The period should be approximately 1 ms.)

6. On the Audio Analyzer, key in the SOURCE frequency and Special Functions listed in Table 8B-20. For each setting, measure the waveforms at the test point indicated. The peak-to-peak amplitude should be within the limits indicated.

Hint: If the waveforms at A3TP14 only are faulty, check the Sum and Output Amplifier. See step 8 below.

Hint: If all waveforms are incorrect, check the Sum Amplifier, which should have a gain of 1 (from A3TP5 to pin 6 of U11) and Sum Amplifier 1.

Hint: If most of the waveforms are incorrect, check the control voltages listed in Table 8B-21. If the control signals are correct, measure the ac signal at the drains of FETs Q30 through Q35 at the corresponding SOURCE frequency (choose 1 kHz for 53.1 SPCL). The drain voltage should be 0 Vrms when the FET is on. If these signals are all correct, continue on with step 7.

7. On the Audio Analyzer, key in 53.1 SPCL. Key in the Special Functions and SOURCE frequencies listed in Table 8B-22. For each setting, measure the ac signal on the sources of FETs Q14 through Q29. A signal should appear on the source unless the FET is off; 0 Vrms should appear if the FET is on. If a signal is faulty, also check the control voltage listed in Table 8B-22.

Hint: If an attempt is made to switch on an FET which has failed to an open state, signals will usually appear on the sources of Q14 through Q21 but not Q22 through Q29.

8. On the Audio Analyzer, key in FREQ 1 kHz, 53.1 SPCL, and 54.147 SPCL. Connect the oscilloscope to A3TP7 (OUT).

Table 8B-20. Voltage at A3TP5, 6, 7, and 14, ⟨✓1⟩ Step 6

Special Functions	SOURCE Frequency (Hz)	Voltage Limits (Vpp) at			
		A3TP5	A3TP6	A3TP7	A3TP14
53.1 and 54.147	1 000	4.8 to 7.2	4.8 to 7.2	<1.2	4.8 to 7.2
	5 000	0.3 to 0.5	1.6 to 2.4	4.8 to 7.2	<0.1
	200	0.3 to 0.5	<0.1	4.8 to 7.2	1.6 to 2.4
53.0	125	4.8 to 7.2	4.8 to 7.2	<1.2	4.8 to 7.2
53.2	8 000	4.8 to 7.2	4.8 to 7.2	<1.2	4.8 to 7.2
53.3 and 54.108	47 000	4.8 to 7.2	4.8 to 7.2	<1.2	4.8 to 7.2

Table 8B-21. Voltage at A3U16, ⟨✓1⟩ Step 6 Hint

Special Function	Level (Vdc) U16 Pin			FETs On
	1	2	3	
53.0	0	−15	−15	Q31, Q34
53.1	−15	0	−15	Q30, Q33
53.2	−15	−15	0	Q32, Q35
53.3	−15	−15	−15	None

Table 8B-22. Levels at A3Q14 through A3Q29, ⟨✓1⟩ Step 7

Special Function	SOURCE Frequency (Hz)	FETs On	Level (Vdc) at U14 Pin				Level (Vdc) at U15 Pin			
			13	14	2	1	2	1	13	14
54.1	20	Q21, Q29	−15	−15	−15	−15	−15	−15	−15	0
54.2	20	Q20, Q28	−15	−15	−15	−15	−15	−15	0	−15
54.4	20	Q19, Q27	−15	−15	−15	−15	−15	0	−15	−15
54.8	50	Q18, Q26	−15	−15	−15	−15	0	−15	−15	−15
54.16	100	Q17, Q25	−15	−15	−15	0	−15	−15	−15	−15
54.32	200	Q16, Q24	−15	−15	0	−15	−15	−15	−15	−15
54.64	500	Q15, Q23	−15	0	−15	−15	−15	−15	−15	−15
54.128	1000	Q14, Q22	0	−15	−15	−15	−15	−15	−15	−15
54.255	2000	All	0	0	0	0	0	0	0	0

9. On the Audio Analyzer, key in the Special Functions listed in Table 8B-23. For each setting, the peak-to-peak amplitude, observed on the oscilloscope, should be within the limits indicated. If the signal is faulty, also check the control signals indicated.

10. See Service Sheet 4 and check the Notch Filter tune and balance.

⟨✓2⟩ Pre-Notch RMS and Average Detectors Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 1 V. Key in 1.11 SPCL to set the input gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

Table 8B-23. Voltage at A3TP7, ⟨✓1⟩ Step 9

Notch Filter Mode	Special Function	Level at A3TP7 (Vpp)	Level (Vdc) at U10 Pin	
			1	2
Notch	44.1	<2.1	0	0
Flat	44.2	5.4 to 6.6	0	−15
Bandpass	44.3	4.8 to 7.2	−15	0

2. Connect a high-impedance, ac coupled oscilloscope to A2TP3 (OUT). The waveform should be 2.7 to 2.9 Vpp. (The period of the signal should be approximately 1 ms.)

Hint: If the signal is faulty, see Service Sheet 2 and check the Programmable Gain Amplifier.

3. Use the oscilloscope's vertical gain controls to adjust the waveform amplitude for 7.1 divisions peak-to-peak.

4. Connect the oscilloscope, dc coupled, to A3TP15 (RMS2). The dc level observed on the oscilloscope should be between 2.4 and 2.6 Vdc. Grounding pin 6 of U18B should have no effect.

Hint: Pin 15 of U19 should be a TTL low.

5. On the Audio Analyzer, key in 5.2 SPCL. The dc level observed on the oscilloscope should be between 2.4 and 2.6 Vdc. Grounding pin 6 of U18B should cause the voltage to be about −15 Vdc.

Hint: Pin 15 of U19 should be a TTL high.

SERVICE SHEET 4---A3 Notch Filter Assembly (Tune and Balance Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Notch Filter Assembly (A3) contains the notch balance and tune circuitry that improves the depth and tuning accuracy of the notch.

Chopper Circuits

The Tune Comparator and Chopper are driven by the signal from Integrator 2 (see Service Sheet 3). This signal is in quadrature with the fundamental of the input to the Notch Filter. The Balance Comparator and Chopper are driven by the signal from Integrator 1. This signal is in phase with the fundamental of the input to the Notch Filter. The Tune and Balance Comparators drive the chopper FETs (Q4 and Q5) so that they switch at the zero crossings of the comparator inputs. When the outputs of the comparators go high (for example, when their open-collector outputs shut off), the FETs switch on (short circuit) because the gates are grounded through R46 or R48. When the comparators go low, putting a large negative voltage at the FET gates, the FETs switch off.

The current from the Tune (or Balance) Chopper and the Inverting Amplifier are summed together at the inverting (−) input of the Tune (or Balance) Integrator. The chopper current is weighted by a factor of two because the path resistance from the chopper is about half of the path resistance from the Inverting Amplifier. When Gain Switch Q2 is off, the Tune Chopper's path resistance is R49 in series with R54; the Inverting Amplifier's path resistance is R60. When Q2 is switched on, the current in both paths increases by about a factor of ten. R55 is now in parallel with R54, and R58 with R60. This increases the Tune Integrator gain by a factor of ten and compensates for a 20 dB reduction in attenuation when Attenuator 1 is switched out (see Service Sheet 5). The action of the Balance Chopper is similar to the Tune Chopper.

Integrators and Multipliers

The sum current from the Tune Chopper and Inverting Amplifier is integrated by the Tune Integrator. The dc value of the sum current represents the tuning error of the Notch Filter. The integrator amplifies and filters the error current and drives the Tune Multiplier. The integration capacitors are switched for different frequency ranges to compensate for the resultant gain change with frequency. When the Notch Filter range is changed, FET Q1 is momentarily switched on to discharge the integration capacitor and speed up the tuning correction. Operation of the Balance Integrator is similar to the Tune Integrator. The tune and balance offset adjustments (R62 and R63) compensate for dc offsets in the filter to maximize the depth of the notch.

The Tune Multiplier receives a dc control input (the Y input) from the Tune Integrator and an ac input (the X input) from Integrator 1 (see Service Sheet 3). The sensitivity of the X input is set by R77, the Y input by R81, and the overall multiplier by R75 and R79. The output of the Tune Multiplier is a current which is summed directly with the current from the Balance Multiplier and applied to Sum Amplifier 2 (see Service Sheet 3). The dc level into the Tune Multiplier is also measured by the DC Voltmeter to give the Controller an indication of whether or not the Notch Filter is properly tuned.

TROUBLESHOOTING

General

Procedures for checking the Notch Filter Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the source is working properly.

Equipment

Oscilloscope ..... HP 1740A

⟨✓1⟩ Notch Filter Tune and Balance Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 1 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Key in 53.1 SPCL and 54.147 SPCL to tune the Notch Filter to 1 kHz. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, ac coupled oscilloscope to A4TP8 (AMP 1, see Service Sheet 5). The waveform should be between 1.1 and 1.7 Vpp. (The period of the signal should be approximately 1 ms.)

Hint: If the signal is faulty, see Service Sheet 3 and check the Notch Filter and Service Sheet 5 and check Attenuator 1 and Amplifier 1.

3. Connect the oscilloscope to A3TP2 (NOTCH AMP). The waveform should be between 12 and 19 Vpp.

4. DC couple the oscilloscope and connect it to A3TP4 (BAL). The dc level should be between −5 and −4 Vdc.

Hint: Pin 7 of U8B should be a 0 to −15V square wave with a period of 1 ms. The source of Q4 should be a positive, half-wave-rectified sine wave. Pin 6 of U1 should be a sine wave with an amplitude of 12 to 19 Vpp. Pin 14 of U16D should be −15V; Q8 should be off.

5. On the Audio Analyzer, key in 44.3 SPCL to set the Notch Filter to the bandpass mode. The dc level should be between +4 and +5 Vdc.

Hint: A3TP2 should be a sine wave with an amplitude of 10 to 21 Vpp. If faulty, see Service Sheet 3 and check the Notch Filter.

Hint: Pin 7 of U8B should be a 0 to −15V square wave with a period of 1 ms. The source of Q4 should be a negative, half-wave-rectified sine wave.

6. Connect the oscilloscope to A3TP3 (TUNE). On the Audio Analyzer, key in 44.2 SPCL to set the Notch Filter to the flat mode. Key in FREQ 500 Hz. The dc level should be between +4 and +5 Vdc.

Hint: Pin 1 of U8A should be a 0 to −15V square wave with a period of 2 ms. The source of Q5 should be a negative, half-wave-rectified sine wave. Q1 should be off.

7. On the Audio Analyzer, key in FREQ 2 kHz. The dc level should be between −5 and −4 Vdc.

Hint: Pin 1 of U8A should be a 0 to −15V square wave with a period of 0.5 ms. The source of Q5 should be a positive, half-wave-rectified sine wave.

8. On the Audio Analyzer, key in 0.56 S (Shift) 3 SPCL to discharge the Tune and Balance Integrators. The dc level should be between −50 and +50 mVdc.

Hint: Pin 14 of U16D should be 0 Vdc; Q1 should be on.

9. Connect the oscilloscope to A3TP4. The dc level should be between −50 and +50 mVdc.

Hint: Q8 should be on.

10. On the Audio Analyzer, key in 0.565 SPCL to disable the discharge of the Tune and Balance Integrators. Connect one channel of the oscilloscope (ac coupled) to A3TP5 and the other channel to pin 2 of U9. Trigger the oscilloscope from the signal on A3TP5 (BP OUT). The two signals should be in phase. (The signal to pin 2 of U9 should have an amplitude of approximately 100 mVpp.)

11. On the Audio Analyzer, key in FREQ 500 Hz. The two signals should be approximately 180° out of phase.

12. On the Audio Analyzer, key in FREQ 1 kHz. Move the oscilloscope from A3TP5 to A3TP6 (HP OUT) and from pin 2 of U9 to pin 2 of U4. The two signals should be in phase.

13. On the Audio Analyzer, key in 44.3 SPCL. The two signals should be approximately 180° out of phase.

14. On the Audio Analyzer, key in 44.2 SPCL. Connect the oscilloscope to the source of Q2. The waveform should have an amplitude of less than 200 mVpp.

Hint: Pin 14 of U10D should be 0V. Q2 should be on.

15. On the Audio Analyzer, key in AMPTD 100 mV. Key in 3.3 SPCL to set the Gain Switch off. The waveform should be a sine wave with a phase reversal at each peak and have an amplitude of approximately 5 Vpp.

Hint: Pin 14 of U10D should be −15V. Q2 should be off.

Hint: The signal at A3TP2 should be a sine wave with an amplitude of 16 Vpp. If faulty, see Service Sheet 5 and check Attenuator 1.

16. Connect the oscilloscope to the source of Q3. The waveform should be a positive, full-wave-rectified sine wave with an amplitude of approximately 2 Vpp.

Hint: Q3 should be off.

17. On the Audio Analyzer, key in 3.1 SPCL. Key in AMPTD 1 V. The signal amplitude should be less than 500 mVpp.

Hint: Q3 should be on.

NOTE

The following steps check the overall performance of the Notch Filter at various frequencies. The notch circuitry of Service Sheet 3 is assumed to be operating properly, and the source is assumed to have less than 0.01% distortion and noise. If distortion is high on all ranges, perform the Notch Filter Tune and Balance Adjustment, *paragraph 5-12, and also check the distortion of the Output Amplifier 1, see Service Sheet 5.*

18. On the Audio Analyzer, press DISTN. Key in AMPTD 2.5 V. Key in 44.1 SPCL to set the Notch Filter to the notch mode. Key in 3.0 SPCL to set the output amplifier gain to automatic. The amplitude display should read 0.01% or less.

Hint: The gates of Q7 and Q9 should be 0V and the FETs should be on. The gates of Q6 and Q10 should be −15V and the FETs should be off. The signal at A3TP7 (OUT) should be less than 100 mVpp.

19. On the Audio Analyzer, key in 54.139 SPCL. Note the amplitude display. Key in 54.155 SPCL. Note the amplitude display. In both cases the display should be 0.01% or less.

20. On the Audio Analyzer, key in FREQ 20 Hz. Key in 53.0 SPCL and 54.23 SPCL to tune the Notch Filter to 20 Hz. The amplitude display should be 0.01% or less.

Hint: The gates of Q6 and Q10 should be 0V and the FETs should be on. The gates of Q7 and Q9 should be −15V and the FETs should be off. The signal at A3TP7 should be less than 100 mVpp.

21. On the Audio Analyzer, key in FREQ 10 kHz. Key in 53.2 SPCL and 54.184 SPCL to tune the Notch Filter to 10 kHz. The amplitude display should be 0.01% or less.

Hint: The gates of Q6, Q7, Q9, and Q10 should be −15V and the FETs should be off. The signal at A3TP7 should be less than 100 mVpp.

22. On the Audio Analyzer, key in FREQ 20 kHz. Key in 53.3 SPCL and 54.46 SPCL to tune the Notch Filter to 20 kHz. The amplitude display should be 0.01% or less.

Hint: See the hint for step 21.

SERVICE SHEET 5---A4 Output Amplifier/Voltmeter Assembly (Output Amplifier)

PRINCIPLES OF OPERATION

General

This portion of the Output Amplifier/Voltmeter (A4) contains the output amplifier circuitry. The output from the Notch Filter is amplified, attenuated, and filtered as necessary to obtain a proper output reading by the Output RMS/Average Detector (see Service Sheet 6). The ac output of the amplifier is available at the rear-panel MONITOR output connector.

Attenuators and Amplifiers

Attenuators 1 and 2 can each be set for an attenuation of 0 or 20 dB. They are switched together. The attenuator control line, OU AMP1, switches in the 0 dB path of Attenuators 1 and 2 indirectly through U21D, which acts as an isolating switch and a logic inverter. When the control input (F4) to U21D is high, U21D is off; F1 of U21A and F3 of U7C are pulled to ground via R11, and the respective switches are enabled. When F4 of U21D is low, U21D is on; resistors R2, R5, and R11 form a voltage divider which applies a logical high to F1 of U21A and F3 of U7C, and the respective switches are disabled.

Amplifier 1 has a fixed gain of 5. Amplifiers 3 and 4 each have a fixed gain of 10. The Output Clamp in Amplifiers 3 and 4 accesses the driver stage of the respective IC and prevents the output from exceeding +12 or −12V. The output from Amplifier 1 drives the Low-Pass Filters and the Notch Filter tune and balance circuitry (see Service Sheet 4). Amplifier 4 drives the MONITOR output connector and is protected against the application of reverse voltage by R53 (which acts as a fuse), CR8, and CR9. A12L1 and C1 form an RFI filter.

Filters

The three Low-Pass Filters are 30, 80, and 750 kHz, three-pole, active Butterworth filters. The passband gain of each filter is 2. The active element of the filter, U8, has an Output Clamp similar to U6 and U13. The filters are switched via U9.

The two High-Pass Filters are respectively a 0.3 Hz, single-pole, passive filter and a 13 Hz, three-pole, active filter. Switching is via K1. CR3 suppresses the inductive transient created by the coil of K1 when the current is interrupted.

TROUBLESHOOTING

General

Procedures for checking the Output Amplifier/Voltmeter Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the source in working properly.

Equipment

Oscilloscope ..... HP 1740A

⟨✓1⟩ Attenuators, Amplifiers, and Low-Pass Filters Check

1. On the Audio Anlayzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 100 mV. Key in 1.11 SPCL to set the input gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedence, ac coupled oscilloscope to A3TP7 (OUT). Increment the Audio Analyzer's SOURCE amplitude for exactly 300 mVpp on the oscilloscope.

Hint: The amplitude at A3TP7 before adjustment should be between 260 and 300 mVpp. (The period should be approximately 1 ms.) If the signal is faulty, see Service Sheet 3 and check the Notch Filter.

3. Connect the oscilloscope to A4TP8 (AMP 1). On the Audio Analyzer, key in the Special Functions listed in Table 8B-24. For each setting, the amplitude of the signal observed on the oscilloscope should be with in the limits indicated. If the signal is faulty, also check the control signals indicated.

Table 8B-24. Level at A4TP8, ⟨✓1⟩ Step 3

Special Function	Level at A4TP8 (mVpp)	Level (TTL) at U21 Pin		
		1	8	16
3.1	140 to 160	H	L	L
3.3	1400 to 1600	L	H	H

Hint: Amplifier 1 should have a gain of 5.

4. Connect the oscilloscope to A4TP6 (AMP 2). On the Audio Analyzer, set the LOW PASS FILTER to 80 kHz, 30 kHz, and all off. For each setting, the waveform should have an amplitude between 2.7 and 3.3 Vpp.

Hint: The control signals are as shown in Table 8B-25.

Table 8B-25. Levels at A4U9, ⟨✓1⟩ Step 4 Hint

LOW PASS FILTER On	Level (TTL) at U9 Pin		
	1	8	9
80 kHz	H	L	H
30 kHz	H	H	L
None	L	H	H

5. On the Audio Analyzer, key in the SOURCE frequency and LOW PASS FILTER listed below. For each setting, the waveform should be within the limits indicated in Table 8B-26.

Table 8B-26. Limits at A4TP6, ⟨J1⟩ Step 5

SOURCE Frequency (kHz)	LOW PASS FILTER On	Level at A4TP6 (Vpp)
100	None	2.5 to 3.3
80	80 kHz	1.7 to 2.6
30	30 kHz	1.7 to 2.6

Hint: See the hint for step 4.

6. On the Audio Analyzer, key in FREQ 1 kHz. Set LP FILTER to 80 kHz. Reduce the SOURCE amplitude for a waveform amplitude of 1.2 Vpp.

7. Connect the oscilloscope to A4TP5 (AMP 3). The waveform should be between 11.5 and 12.5 Vpp.

Hint: Pin 9 of U7 should be a TTL low. Pin 1 of U7 should be a TTL high. Amplifier 3 should have a gain of 10.

8. On the Audio Analyzer, key in 3.1 SPCL. The waveform should be between 110 and 130 mVpp.

Hint: Pin 9 of U7 should be a TTL high. Pin 1 of U7 should be a TTL low.

9. Connect the oscilloscope to A4TP4 (AMP 4). The waveform should be between 110 and 130 mVpp.

Hint: Pin 8 of U7 should be a TTL high. Pin 16 of U7 should be a TTL low. The Buffer (U14B) and High-Pass Filters should each have a gain of 1. Amplifier 4 should have a gain of 10.

10. On the Audio Analyzer, key in 3.2 SPCL. The waveform should be between 1.1 and 1.3 Vpp.

Hint: Pin 8 of U7 should be a TTL low. Pin 16 of U7 should be a TTL high.

11. On the Audio Analyzer, key in 55.0 SPCL, 56.15 SPCL, and 57.140 SPCL to set the SOURCE frequency to 13 Hz. The waveform should be between 1.1 and 1.3 Vpp.

Hint: Pin 1 of K1 should be a TTL low. Pins 3 and 4 of K1 should be shorted.

12. On the Audio Analyzer, key in 0.435 SPCL to insert the 13 Hz High-Pass Filter (U14A and associated components). The waveform should be between 0.7 and 1.0 Vpp.

Hint: Pin 1 of K1 should be a TTL high. Pins 3 and 5 of K1 should be shorted. The waveform at pin 1 of U14A should be between 80 and 130 mVpp.

SERVICE SHEET 6—A4 Output Amplifier/Voltmeter Assembly (Detector and Meter Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Output Amplifier/Voltmeter (A4) contains the Output RMS/Average/Quasi-peak Detector, Output Overload Detector, and SINAD meter circuitry.

Output RMS/Average/Quasi-peak Detector

The circuits on the upper half of the schematic diagram form the Output RMS/Average/Quasi-peak Detector referred to in the block diagrams. When used as a true rms converter, the Output RMS/Average/Quasi-peak Detector converts the ac input signal into a dc voltage equal to the root mean square (rms) of the input level. The circuits form an analog computer which converts the ac signal to its dc rms equivalent by a method called implicit conversion. The analog computer performs logging, antilogging, squaring, averaging, and dividing mathematical functions. When used as an average-responding converter, the Output RMS/Average/Quasi-peak Detector converts the ac input signal into a dc voltage equal to the absolute average (that is, full-wave rectified and filtered) of the input level but calibrated to the rms value of a sine wave. When used as a quasi-peak converter, the Output detector converts the ac signal to its dc quasi-peak equivalent. This type of detector has a fast rise time coupled with a slow decay time constant which "captures" impulses or other signals with a high crest factor (noise or repetitive signal bursts).

Refer to Figure 8B-33, which is a simplified diagram of the circuit showing only the components which produce the rms conversion. Since the log-antilog circuit cannot operate on a bi-directional signal, the input is full-wave rectified. Full-wave rectification is accomplished by half-wave rectifying (and inverting) the input, then summing the rectified current with a current proportional to the input voltage but weighted by one half. U5, R55, R62, and CR11 perform the half-wave rectification. The rectified signal produces a current (I_1) in R71 which is summed with the current (I_2) in R70 at the inverting (−) input to U4. R70 is twice the resistance of R71.

U4, Q2A, and Q1A form the Log Amplifier. The full-wave-rectified current ($I_3 = I_1 + I_2$) flows through transistors Q2A and Q1A and into the output of U4. (Q2A is a common-base stage; Q1A is configured as a diode.) The current (I_3) through Q2A and Q1A produces a voltage across each base-emitter junction proportional to the log of the current. The sum of the two base-emitter voltages (V_1) is the sum of two nearly identical logarithms and is proportional to the log of the square of the current ($\log {I_3}^2$) and hence the log of the square of the input voltage ($\log {V_{IN}}^2$). (The identity used here is: $\log I + \log I = \log (I \times I) = \log I^2$.)

Now consider the operation of the Filter Amplifier, which also functions as an antilog circuit. The collector current (I_4) of Q1B is filtered by U3 and the associated resistors and capacitors (R90, R91, R92, R94, C53, and C56). The dc component of this current flows through R90, R91, and R92 and produces a voltage which, when buffered by U2, is the output (V_{OUT}) of the circuit. (The effects of R93 and R95 in the schematic are being momentarily ignored.) U3 also holds the collector of Q1B at ground potential to establish the offset of the output at 0V. The collector current (I_5) of Q2B is generated by the output voltage (V_{OUT}), which appears across R98. U12 holds the collector of Q2B and one end of R98 at ground potential.

The voltage across the base-emitter junctions of Q1B and Q2B is proportional to the log of their respective collector currents. The sum of the two base-emitter voltages (V_1) is proportional to the log of the product of the two collector currents ($I_4 \times I_5$). Since the sum of the base-emitter voltages of Q1B and Q2B equals the sum of Q1A and Q2A, the products of the respective collector currents are equal (${I_3}^2 = I_4 \times I_5$). Recalling that the dc component of I_4 produced the output voltage (V_{OUT}) and that the output voltage produced I_5, it is evident that the output voltage is proportional to the square root of the product of I_4 and I_5 and thus is proportional to the input voltage (V_{IN}), which has been squared, filtered (to obtain the mean level), and the square root obtained.

Refer now to the schematic diagram, Figure 8B-117 (SS6). The switches of U23 and U25 control whether the detector functions as a true rms, average or quasi-peak responding converter. The switch modes are cataloged in Table 8B-27.

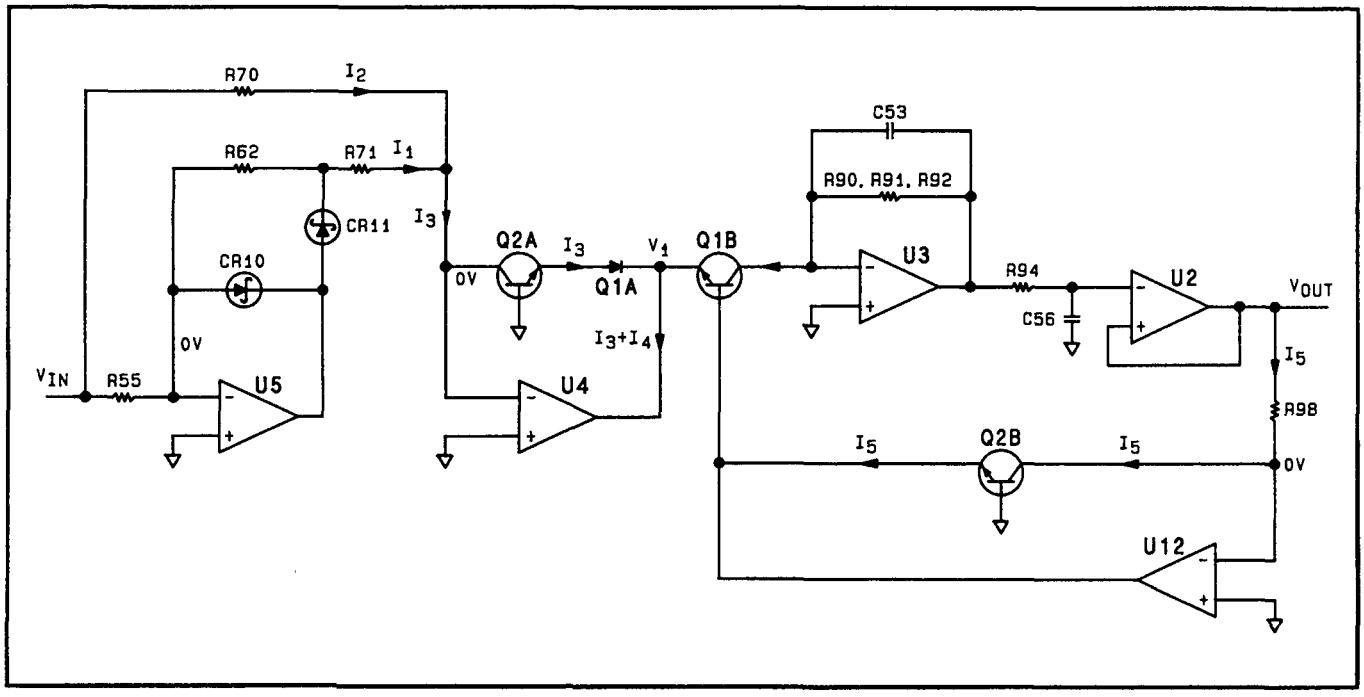


Figure 8B-33. Simplified Diagram of the Output RMS/ Detector

Table 8B-27. Detector Switching Modes

Detector Mode	State of			
	U23A, U23C, U24A, U24C	U23B, U23D, U24B, U24D	U25A, U25B, U25C	U25D
True RMS	Open	Closed	Open	Closed
Average	Closed	Open	Open	Closed
Quasi-peak	Closed	Open	Closed	Open

In the average-responding converter mode, full-wave rectification of the input signal is performed by U5 as with the true rms converter. But current summing is via R158, R157, and U22. Filtering is done via the Filter Amplifier but bypassing the antilogging function.

R143 and R144 are installed whenever the offset adjustment R85 has insufficient range. CR13 and CR16 protect the log and antilog transistors should offset voltages of opposite polarity be applied to them. CR14 provides an offset voltage in the collector of Q1B that matches the offset created by the base-emitter junction of Q2A in the collector of Q1A. R93 and R95 improve the response characteristics of the circuit to low frequency inputs while at the same time allow the circuit to respond rapidly to changes in input level. R91 permits fine adjustment of the gain of the circuit. R94 and C56 also form the first real pole in the Ripple Filter (see Service Sheet 7).

In the quasi-peak converter mode, full-wave rectification of the input signal is performed by U5 with current summing via R202 and R203. The quasi-peak converter consists of two peak detector stages in series. Stage 1, which consists of U26, U27A (Buffer) and associated components is an inverting, positive peak detector which has a charge rate of $\leq$2 ms (determined by R202 and C1) and a discharge rate of approximately 400 ms (R205, C1). Stage 2, which consists of U28, U27B (Buffer) and associated components is an inverting, negative peak detector which has a charge rate of approximately 200 ms (determined by R208 and C2), and a discharge rate of approximately 600 ms (R210, C2).

SINAD Meter Circuits

The SINAD meter displays the log of the Pre-Notch RMS/Average Detector minus the log of the Output RMS/Average/Quasi-peak Detector. The Pre-Notch RMS/Average Detector produces a current which flows through R57 and logging transistor Q4A. The voltage developed across the base-emitter junction of Q4A is proportional to the log of its collector current. Similarly, the Output RMS/Average/Quasi-peak Detector produces a current which flows through R56 and logging transistor Q4B and develops a base-emitter voltage proportional to the log of its collector current. The voltage at the base of Q4A (with respect to ground) is equal to the difference between the base-emitter voltages of Q4A and Q4B. The feedback amplifier, Q17C, amplifies this difference and produces the output. Note that the collectors and bases of both Q4A and Q4B are all biased near ground potential. Thermistor RT1 thermally compensates for the drift of the two logging transistors.

The voltage from the SINAD Log Ratio Meter Amplifier is converted to a current by the Meter Transconductance Amplifier which drives the meter. CR15 protects the meter against reverse current. R83 and C51 add heavy filtering to the often noisy SINAD measurement signal.

The Meter Peg/Off Switch receives commands from the Controller via the Latch Assembly which enable, gently peg, or switch off the meter via the Meter Transconductance amplifier, depending on the measurement being made and the SINAD measurement range. A low at the inverting (−) input of U19A or U19B switches the respective output FET (Q6 or Q5) on pulling the output connection to either ground or +2.4V.

Output Overload Detector

The Output Overload Detector compares the level from the Output RMS/Average/Quasi-peak Detector to a reference set by R60 and R61. If the level exceeds the reference, U19D switches FET Q7 on which resets the Overload Flip-Flop (see Service Sheet 12) and reduces the gain of the Output Amplifier to 0 dB.

TROUBLESHOOTING

General

Procedures for checking the Output Amplifier/Voltmeter Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨⟩ Extend the board assembly where necessary to make measurements. These procedures assume that the source is working properly.

Equipment

Digital Voltmeter ..... HP 3455A
Oscilloscope ..... HP 1740A

⟨√1⟩ Output RMS/Average/Quasi-peak Detector General Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a voltmeter to A4TP4 (AMP 4). Set the voltmeter to measure ac. Fine adjust the Audio Analyzer's SOURCE amplitude for 2.99 to 3.01 Vrms on the voltmeter.

Hint: The amplitude at A4TP4 before adjustment should be between 2.85 and 3.15 Vrms. If the signal is faulty, see Service Sheet 5 and check the Output Amplifier circuitry.

3. Connect the voltmeter to A4TP1 (DC OUT). Set the voltmeter to measure dc. The level on the voltmeter should be between +2.94 and +3.06 Vdc. Grounding pin 2 of U22 should have no effect.

Hint: Pin 10 of U23 should be a TTL low. U23B, U23D, U24B, and U24D should be on. U23A, U23C, U24A, and U24C should be off.

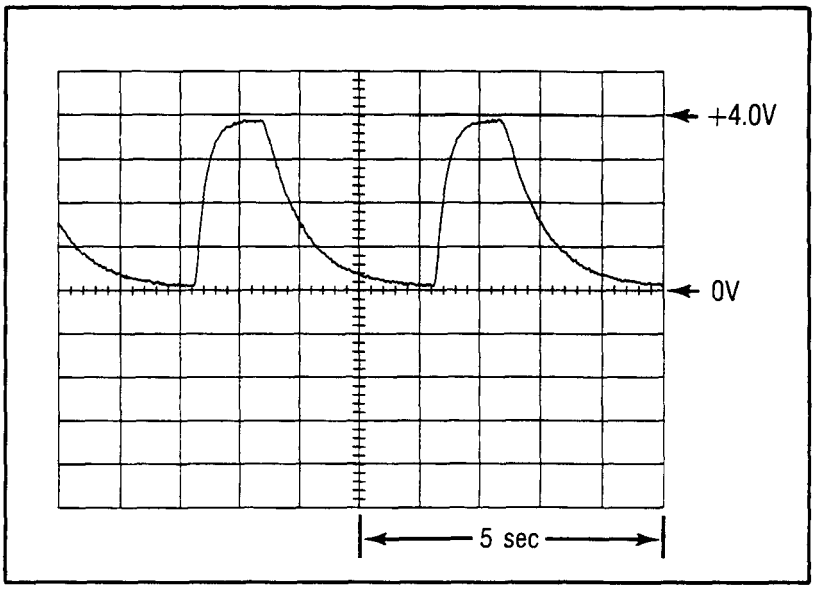


Figure 8B-33.1. Waveform at A4TP1, ⟨√1⟩ Step 12

Hint: If the signal amplitude is only slightly out of limits, perform the *Voltmeter Adjustment,* paragraph 5-13; if greatly out of limits, perform the ⟨√2⟩ *Full-Wave Rectfier Check* and the ⟨√3⟩ *Log Amplifier and Filter Amplifier Check.*

4. Key in 5.2 SPCL to switch the detector to average. The level on the voltmeter should be between +2.94 and +3.06 Vdc. Grounding pin 2 of U22 should cause the level to go to approximately -15 Vdc.

Hint: Pin 10 of U23 should be a TTL high. U23B, U23D, U24B, and U24D should be off. U23A, U23C, U24A, and U24C should be on.

5. Reconnect the voltmeter to A4TP4. Set the voltmeter to measure ac. On the Audio Analyzer, reduce the SOURCE amplitude for a reading between 299 and 301 mVrms on the voltmeter.

6. Reconnect the voltmeter to A4TP1. Set the voltmeter to measure dc. The level on the voltmeter should be between +294 and +306 mVdc.

Hint: If the signal is only slightly out of limits, perform the *Voltmeter Adjustment,* paragraph 5-13; if within limits, the detector is functioning properly under the current test conditions.

7. Key in 5.0 SPCL to switch the detector to rms. The level on the voltmeter should be between +294 and +306 mVdc.

8. Reconnect the voltmeter to A4TP4. Set the voltmeter to measure ac. On the Audio Analyzer, increase the SOURCE amplitude for a reading between 2.99 and 3.01 Vrms on the voltmeter.

9. Key in 5.7 SPCL to switch the detector to quasi-peak. Hint: Pin 3 of U29 should be a TTL low. U25A, U25B and U25C should be on, U25D should be off and U23 and U24 should be in the same state as for the average detector. See hint for step 4.

10. Reconnect the voltmeter to A4TP1. Set the voltmeter to measure dc. The level on the voltmeter should be between 2.94 and 3.06 Vdc. Hint: See the hint for step 6.

11. Disconnect the voltmeter. Connect a high-impedance, dc-coupled oscilloscope to A4TP1. Use the oscilloscope's vertical gain controls to adjust the diplay amplitude for 4 division peak deflections of the dc signal. Hint: Set the ground to the center of the display. Set sweep time to 1 sec/div. Hint: See the hint for step 6.

12. On the Audio Analyzer, press S (Shift) SIG/NOISE. The waveform should be as shown in Figure 8B-33.1. Note rise and fall times.

⟨√2⟩ Full-Wave Rectifier Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, dc coupled oscilloscope to A4TP4 (AMP 4). On the Audio Analyzer, fine adjust the SOURCE amplitude for 8.5 Vpp on the oscilloscope.

Hint: The amplitude at A4TP4 before adjustment should be approximately 8.5 Vpp. If the signal is faulty, see Service Sheet 5 and check the Output Amplifier circuitry.

3. Connect the oscilloscope to pin 6 of U5. The waveform should be as shown in Figure 8B-34. (Note: Excessive input capacitance of the oscilloscope may cause oscillation. Use a divide-by-ten probe.)

4. Connect the oscilloscope to A4TP11 (RECT). The waveform should be a negative full-wave-rectified sine wave with a peak amplitude between −4.5 and −4.0V.

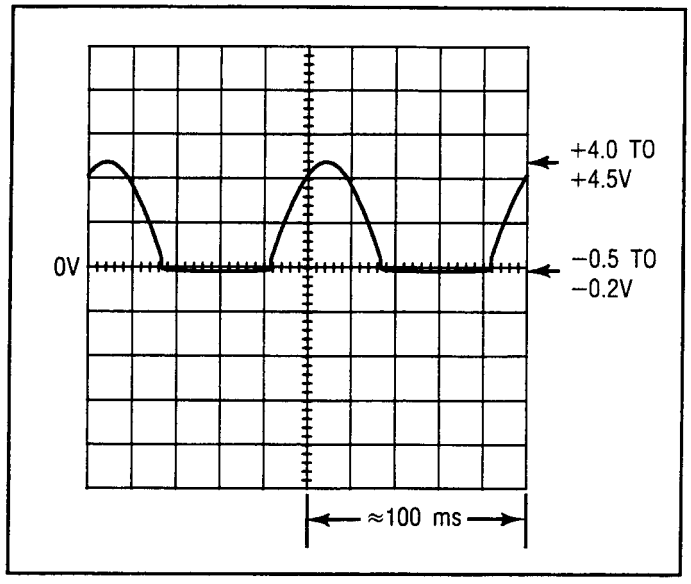


Figure 8B-34. Waveform at Pin 6 of U5, ⟨√2⟩ Step 3

⟨√3⟩ Log Amplifier and Filter Amplifier Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, dc coupled oscilloscope to the cathode of CR11. The waveform should be a half-wave-rectified sine wave with a peak amplitude between +4.0 and +4.5V. (The period should be approximately 1 ms.)

Hint: If the signal is faulty, perform the *Full-Wave Rectifier Check.*

3. Connect the voltmeter to A4TP2 (LOG AMP). Set the voltmeter to measure dc. The voltmeter should read between −1.26 and −1.21 Vdc. (This voltage is valid only at room temperature.)

4. Connect the voltmeter to pin 6 of U4. The voltage should be approximately −2.3 Vdc.

Hint: If the voltage is closer to −2.0 Vdc, the Log Amplifier is operating properly but no current is flowing in the emitter of Q1B; the fault is in the Filter Amplifier. If the voltage is closer to −3.0 Vdc, the Log Amplifier is operating properly but no current is flowing in the collector of Q1B; the fault is in the Filter Amplifier. (The fault is probably causing the output of U12 to be clamped to +0.5 Vdc, whereas, it is normally negative.)

5. On the Audio Analyzer, key in 5.2 SPCL to set the detector to average. (This isolates the Amplifier Filter from the Log Amplifier.) Connect the oscilloscope to A4TP11 (RECT). The waveform should be a negative, full-wave-rectified sine wave with a peak amplitude between −4.5 and −4.0V.

Hint: If the signal is faulty, perform the *Full-Wave Rectifier Check.*

6. Connect the voltmeter to A4TP1 (DC OUT). The voltmeter should read between +2.9 and +3.3 Vdc.

Hint: Pin 6 of U3 should also be between +2.9 and +3.3 Vdc and read the same as A4TP1.

7. Connect the voltmeter to pin 6 of U12. The voltmeter should read between −2.5 to −2.0 Vdc.

Hint: The emitter of Q2B should be approximately −640 mVdc.

Hint: At this point, operation of the Filter Amplifier has been verified except for Q1B, CR14, U23, U24, and the filtering capability of the circuit. Check U23 and U24 by performing the ⟨√1⟩ *Output RMS/Average/Quasi-peak Detector General Check.*

⟨√4⟩ SINAD Meter Circuits Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 1 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Key in 45.1 SPCL to enable the SINAD meter. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a dc voltmeter to A3TP15 (RMS2). On the Audio Analyzer, fine adjust the SOURCE amplitude for a reading of +1.00 Vdc on the voltmeter.

Hint: The voltage at A3TP15 should read approximately 1 Vdc before adjustment. If it does not, see Service Sheet 3 and check the Pre-Notch RMS Detector.

3. Connect the voltmeter to A4TP1 (DC OUT). The voltage should read between +0.99 and +1.01 Vdc.

Hint: If the voltage is out of limits, perform the *Output RMS/Average/Quasi-peak Detector General Check.*

4. Insert a 31.6 kΩ resistor in parallel with R56. This simulates a 6 dB SINAD.

5. Connect the voltmeter to pin 14 of U17C. The voltage should be between +320 and +360 mVdc.

Hint: The voltage at pins 3 and 5 of Q4 should be between −500 and −480 mVdc.

6. Connect the voltmeter to pin 5 of U17B. The voltage should be the same as in step 5 except that the loading of a 10 MΩ voltmeter input will cause the signal level to be 0.3% low. The SINAD meter should read between 5.5 and 6.5 dB.

Hint: The drains of Q5 and Q6 should read the same as pin 5 of U17B. Q5 and Q6 should be off. Pins 4 and 6 of U19 should be a TTL high.

Hint: If the meter reads only slightly out of limits, perform the *SINAD Meter Adjustment,* paragraph 5-14.

7. On the Audio Analyzer, key in 0.528 SPCL to switch the SINAD meter off. The voltage at pin 5 of U17B should read 0 to +10 mVdc. The SINAD meter should read 0.

Hint: Q6 should be on. Pin 4 of U19A should be a TTL low. Pin 6 of U19B should be a TTL high.

8. On the Audio Analyzer, key in 0.524 SPCL to peg the meter. The voltage at pin 5 of U17B should read between +1.5 and +2.5 Vdc. The SINAD meter should read slightly above full scale.

Hint: Q5 should be on. Pin 6 of U19B should be a TTL low. Pin 4 of U19A should be a TTL high.

⟨√5⟩ Overload Detector Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 4 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, dc coupled oscilloscope to the drain of Q7. The level should be a TTL high.

Hint: Pin 13 of U19D should be between −15.2 and −14.7 Vdc.

3. On the Audio Analyzer, key in AMPTD 4.2 V. The level should be a TTL low.

Hint: Pin 13 of U19D should be between 0 and +200 mVdc.

SERVICE SHEET 7---A4 Output Amplifier/Voltmeter Assembly (Ripple Filters, Voltmeter Input Selector, and Voltage-to-Time Converter)

PRINCIPLES OF OPERATION

General

This portion of the Output Amplifier/Voltmeter (A4) contains the Voltmeter Input Selector, the Voltage-to-Time Converter, and several input ripple filters.

Ripple Filters

Several of the dc inputs to the Voltage-to-Time Converter are filtered to remove ripple and noise. This gives a smoother-reading display. The line from the Differential-to-Single-Ended Amplifier (see Service Sheet 1), from which dc level is read in the dc level measurement mode, is filtered by the passive filter consisting of R118, C65, and C66. CR23 and CR24 are needed to prevent reverse voltages from damaging the electrolytic capacitors, C65 and C66, since the input voltage can be of either polarity. Passive filter R116 and C67 heavily filters the line from the Output RMS/Average Detector in the SINAD measurement.

The Ripple Filter, consisting of U10C and associated components, provides a complex impedance across the line from the Output RMS/Average Detector and gives two poles of high-frequency rolloff. The output is buffered by U1. A similar Ripple Filter (U10D and associated components) filters the line from the Input RMS or Average Detector. It is a more complex filter, having an extra real pole. The output is buffered by U10A.

Diodes CR17 through CR22 protect the inputs to the Voltmeter Input Selector against high or reverse voltages.

Voltmeter Input Selector

Multiplexer U18 forms an eight-pole, single-throw switch. The multiplexer is always enabled by the high on the EN input. The Detector Select Switches (U9B and U21C) selects between the Input Range Detector and the Input RMS/Average Detector. To change a switch setting, the Controller issues the appropriate code to the Instrument Bus. The code is decoded and latched on the Latch Assembly (see Service Sheet 12) which puts the appropriate logic level on lines VO SEL 0, 1, and 2. For a discussion of Instrument Bus control, see Service Sheet BD4.

Voltage-to-Time Converter

The dc voltage at the DC Voltmeter input is converted to a pulse, with a duration linearly related to the magnitude of the voltage, by the Voltage-to-Time Converter. The pulse length is then measured by the Counter (see Service Sheet 14). The converter consists of the Comparator, Ramp Generator, and Reference.

The Reference supplies a voltage of controlled temperature co-efficient to the input to the Ramp Generator. The basic reference is the temperature-stable, reference diode VR4. The reference is fed from the current source Q10, which itself is temperature stable because its base-emitter junction and its reference, VR3, have similar thermal behavior. The negative reference supplies current to the inverting (−) input of U15 through R125 and R127. CR25, R123, and R124 add a slight temperature coefficient to the current to cancel the effect of the temperature coefficient of C70. The DC Voltmeter sensitivity is adjusted by means of R125.

U15 (with C70) integrates the negative input current to produce an increasing ramp. The ramp is generated only when Q9 is off (for example, when RAMP GATE (L) is low). This is initiated by the Controller. When Q9 is on, the voltage across VR5 appears across C70. This clamps the output of U15 at approximately −6.2V. The current for Q9 is supplied by current source Q12. When Q9 goes off, the ramp begins, starting at −6.2V.

The ramp begins when the RAMP GATE (L) line goes low. The output of comparator U20 at this time is high because the voltage at its non-inverting (+) input is higher than the inverting (−) input. The output of U20 is inverted by FET Q8. The Counter now begins clocking the duration of the ramp. When the ramp reaches the voltage at the non-inverting input, the output of U20 goes low and (via Q8) inhibits the clocking of the Counter. R131 and R136 add a small amount of hysteresis to the Comparator to assure a complete and rapid transition of the output once it begins to change.

Since the ramp begins at a negative offset, each voltage measurement consists of clocking the duration of a pair of ramps. The first ramp is generated with the Voltmeter Input Selector set to the grounded input (input 0). The duration of this ramp is proportional to the offset. The second ramp is generated with the selector set to the input to be measured. The duration of this ramp is proportional to the input level plus the offset. The difference in duration is computed by the Controller and is proportional to the input voltages.

The large negative offset voltage permits the DC Voltmeter to measure both negative and positive voltages.

TROUBLESHOOTING

General

Procedures for checking the Output Amplifier/Voltmeter Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the source is working properly.

Equipment

Digital Voltmeter	HP 3455A
Oscilloscope	HP 1740A

⟨√1⟩ Ripple Filters Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect one channel of a high-impedance, dc coupled oscilloscope to A2TP2 (RMS). Connect the other channel to pin 1 of U10A. Both channels should read between +2.9 and +3.1 Vdc and both should read the same.

3. On the Audio Analyzer, connect and disconnect the HIGH INPUT several times and observe the two traces on the oscilloscope. The signal at pin 1 of U10A should lag in time slightly behind the signal at A2TP2 when the input is connected and disconnected.

4. On the Audio Analyzer, reconnect the HIGH INPUT. Connect one channel of the oscilloscope to A4TP1 (DC OUT). Connect the other channel to pin 7 of U18. Both channels should read between +2.9 and +3.1 Vdc and both should read the same.

Hint: If the signal at A4TP1 is faulty, see Service Sheet 6 and check the Output RMS/Average Detector.

5. On the Audio Analyzer, connect and disconnect the HIGH INPUT several times and observe the two traces on the oscilloscope. The signal at pin 7 of U18 should lag slightly behind the signal at A4TP1 when the input is connected and disconnected.

6. On the Audio Analyzer, reconnect the HIGH INPUT. Move the oscilloscope connection from pin 7 of U18 to pin 11. Both channels should read the same.

7. On the Audio Analyzer, connect and disconnect the HIGH INPUT several times and observe the two traces on the oscilloscope. The signal at pin 11 of U18 should lag behind the signal at A4TP1 when the input is connected and disconnected. (The lag will be longer than for the previous steps.)

⟨√2⟩ Voltmeter Input Selector Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Key in the Direct Control Special Functions listed in Table 8B-28. For each setting, compare the dc voltage at A4TP9 (MUX) to the pin on U18 indicated. The two voltages should be the same to within the repeatability of the voltmeter. If faulty, also check the logic level of the pins indicated.

Hint: If the selector has a failure in which one input is always connected to the output, pulses will usually appear on the faulty input when another line is slected. Use Special Function 49.N to select the lines.

⟨√3⟩ Voltage-to-Time Converter Check

1. Measure the anode of VR4 with a dc voltmeter. The voltage should be between −6.51 and −5.89 Vdc.

Table 8B-28. Voltmeter Input Selector Check, ⟨✓2⟩ Step 2

Direct Control Special Function	Check Voltage at U18 Pin	Level (TTL) at U18 Pin		
		1	16	15
0.530	4	L	L	L
0.531	5	H	L	L
0.532	6*	L	H	L
0.533	7	H	H	L
0.534	12	L	L	H
0.535	11	H	L	H
0.536	10	L	H	H
0.537	9**	H	H	H

* A 3 Vrms ac signal should appear here also.
** A 1.2 to 1.5 Vrms signal should appear here also if the SOURCE frequency is set to 20 Hz.

2. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 49.1 SPCL to set the voltmeter to measure the Input Range Detector. Connect the HIGH OUTPUT to the HIGH INPUT.

3. Connect a high-impedance, dc coupled oscilloscope to A4TP7 (RAMP). The waveform should be as shown in Figure 8B-35.

Hint: The slope of the triangles in the waveform should be approximately 1 V/ms.

Hint: Pin 14 of U19C should be as shown in Figure 8B-36. If it appears as a simple square wave, check that pin 5 of U18 is between +1.4 and +1.5 Vdc.

4. Connect the oscilloscope to A4TP10 (COMP). The waveform should be as shown in Figure 8B-37.

⟨✓4⟩ Detector Select Switches Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 1.11 SPCL to set the input gain to 0 dB. Key in 3.1 SPCL to set the output gain to 0 dB. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a dc voltmeter to pin 7 of U9B.

3. On the Audio Analyzer, key in 0.531 SPCL to select the Pre-Notch Detector. The voltage should be between 1.4 and 1.6 Vdc. Shorting out R201 should reduce the voltage to 0V.

Hint: Pin 1 of U10A should be between 2.8 and 3.2 Vdc. Pin 9 of U21C should be a TTL low. Pin 8 of U9B should be a TTL high.

4. On the Audio Analyzer, key in 0.539 SPCL to select the Input Range Detector. The voltage should be between 1.4 and 1.6 Vdc. Shorting out R201 should have no effect.

Hint: Pin 19 of connector A13XA4B should be between 2.8 and 3.2 Vdc. Pin 9 of U21C should be a TTL high. Pin 8 of U9B should be a TTL low.

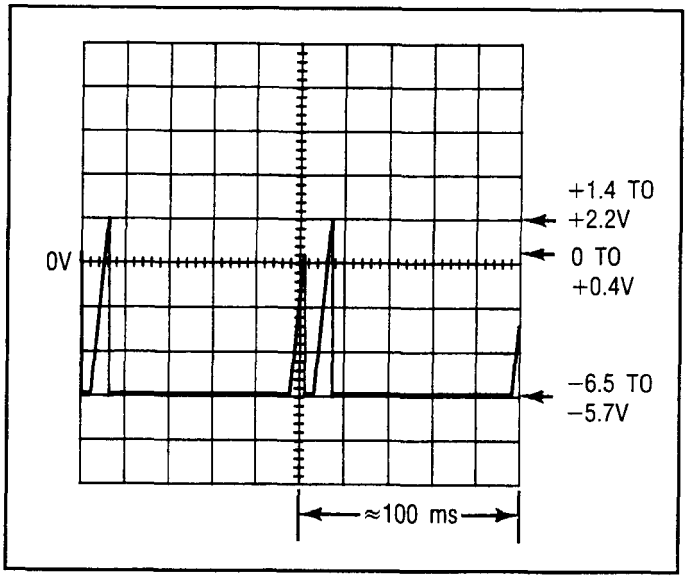


Figure 8B-35. Voltage-to-Time Converter Check, ⟨J3⟩ Step 3

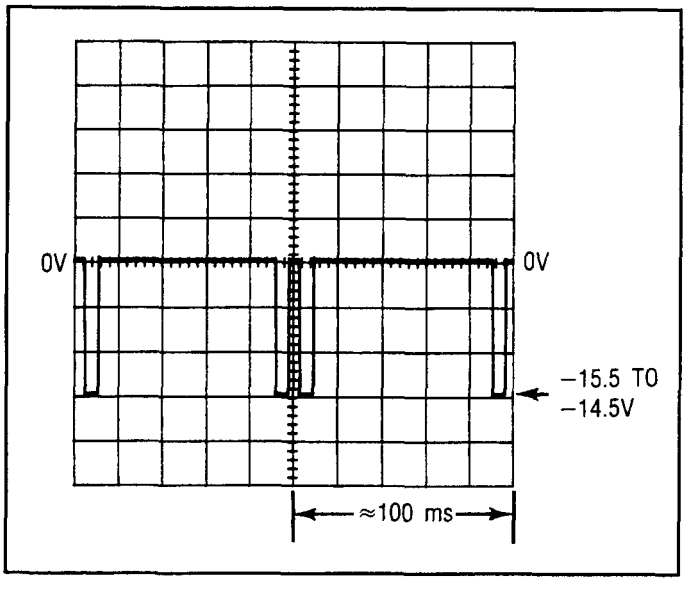


Figure 8B-36. Voltage-to-Time Converter Check, ⟨J3⟩ Step 3 Hint

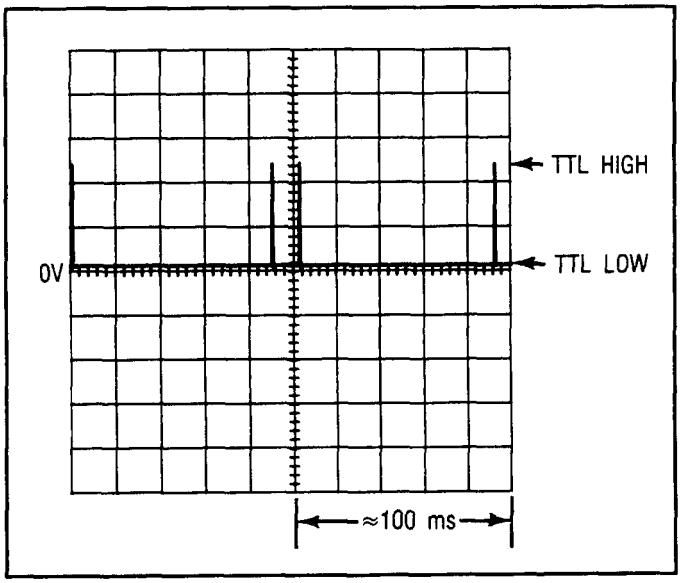
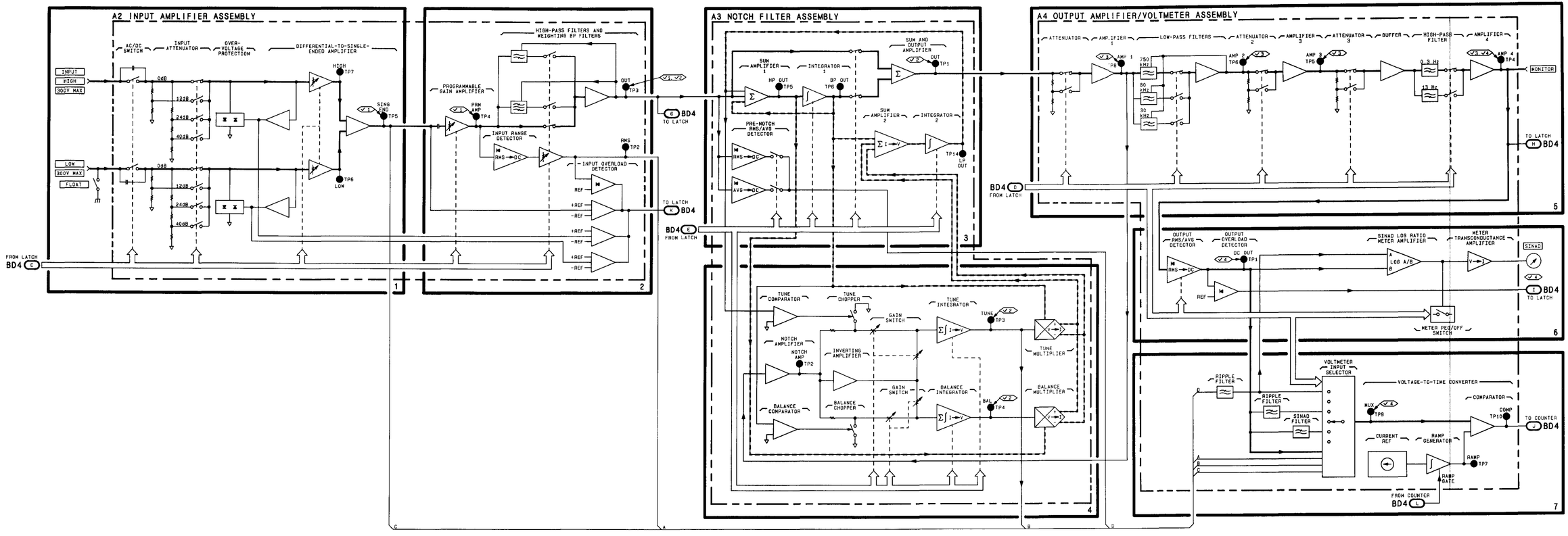


Figure 8B-37. Voltage-to-Time Converter Check, ◇3◇ Step 4

CHANGES

All serial prefixes	**On the block diagram:** • **TP1, TP5, TP6** - In the **A3 NOTCH FILTER ASSEMBLY**, change TP5 to TP6, change TP6 to TP5, and change TP1 to TP7.

BD2



BD2
Figure 8B-101
8B-101

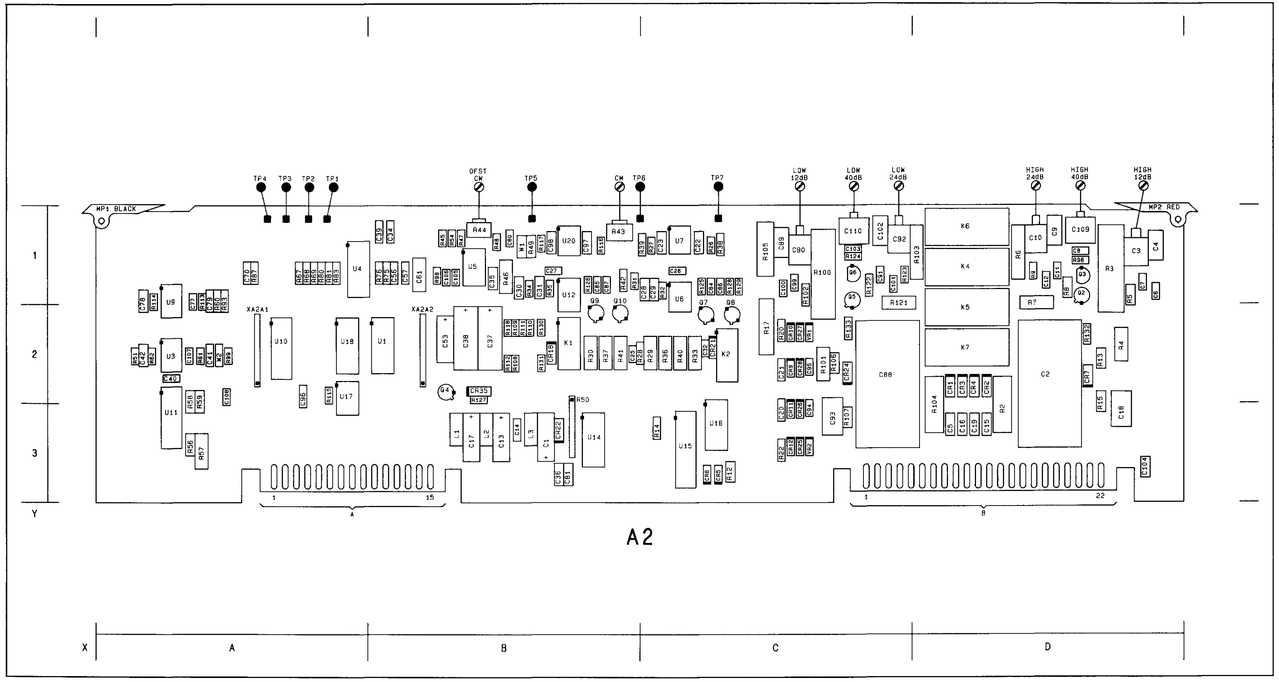


Figure 8B-102. SERVICE SHEET 1 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y
C1	B3
C2	D2
C3	D1
C4	D1
C5	D3
C6	D1
C7	D1
C8	D1
C9	D1
C10	D1
C11	D1
C12	D1
C13	B3
C14	B3
C15	D3
C16	D3
C17	B3
C18	D3
C19	D3
C20	C3
C21	C2
C22	C1
C23	C1
C25	B2
C26	C1
C27	B1
C28	C1
C29	C1
C30	B1
C31	B1
C32	C2
C34	B1
C35	B1
C39	B1
C40	B1
C84	C1
C85	B1
C86	B1
C87	B1
C88	C2
C89	C1
C90	C1
C91	C1
C92	C1
C93	C3
C94	C3
C95	C2
C97	B1
C98	B1
C99	C1
C100	C1
C101	C1
C102	C1
C103	C1
C105	B1
C106	B1
C109	D1
C110	C1
CR1	D2
CR2	D2
CR3	D2
CR4	D2
CR5	C3
CR6	C3
CR7	D2
CR9	C2
CR10	C2
CR11	C3
CR12	C3
CR18	B2
CR21	D2
CR22	B3
CR24	C2
CR25	C3
CR26	C3
CR27	C3
CR28	C2
K1	B2
K2	D2
K4	D1
K5	D2
K6	D1
K7	D2
L1	B3
L2	B3
L3	B3
MP1	A1
MP2	D1
Q2	D1
Q3	D1
Q5	C1
Q6	C1
Q7	C2
Q8	C2
Q9	B2
Q10	B2
R2	C3
R3	D1
R4	D2
R5	D1
R6	D1
R7	D1
R8	D1
R9	D1
R12	C3
R13	D2
R14	C3
R15	D2
R17	D2
R20	C2
R22	C2
R26	C1
R27	C1
R28	C2
R29	C2
R30	B2
R31	B1
R32	C1
R34	C1
R35	B1
R36	C2
R37	B2
R38	C1
R39	C1
R40	C2
R41	B2
R42	B1
R43	B1
R44	B1
R45	B1
R46	B1
R47	B1
R48	B1
R49	B1
R54	B1
R95	D1
R96	B1
R100	C1
R101	C2
R102	C1
R103	C1
R104	D2
R105	C1
R106	C2
R107	C3
R108	B2
R109	B2
R110	B2
R111	B2
R112	B2
R116	B1
R117	B1
R118	B2
R121	C1
R122	C1
R123	C1
R124	C1
R125	C1
R126	B1
R128	C1
R129	C1
R130	B2
R131	B2
R132	C2
R133	C2
TP1	A1
TP5	B1
TP6	C1
TP7	C1
U5	B1
U6	C1
U7	C1
U12	B1
U14	B3
U15	C3
U16	C3
U20	B1
VR1	C2
VR2	C3
W2	A2

Measurement Circuits Block Diagram **BD2**

SEE REVERSE SIDE

NOTES

1. Pinouts for F.E.T.s Q7,8,9, and 10.

2. RF choke inductance is 2.5 to 6 uH at 1 MHz.
3. * Asterisk indicates factory selected values.
4. FETs Q7 and Q9 (each are dual FETs) must be replaced as a matched pair. To order, use part number 08903-80035.

Schematic General Information

CHANGES

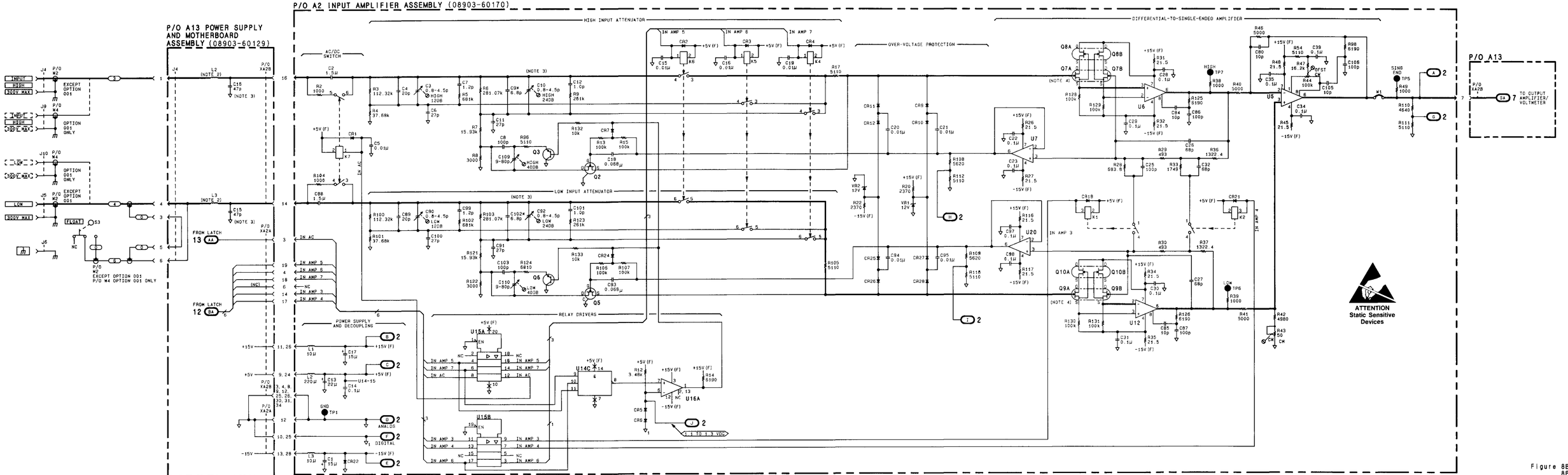
All Serial Prefixes

Under Notes:

- Note 1 - Add the following information under Note 1: "Since Q7, 8, 9, and 10 are double FET packages, they will operate correctly in the circuit if inserted with the tab either pointing up or down.

CHANGES

All serial prefixes	**Under Notes:** • **Note 1** - Add the following information under Note 1: "Since Q7, 8, 9, and 10 are double FET packages, they will operate correctly in the circuit if inserted with the tab either pointing up or down."
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.



SS1
Figure 8B-103
8B-103

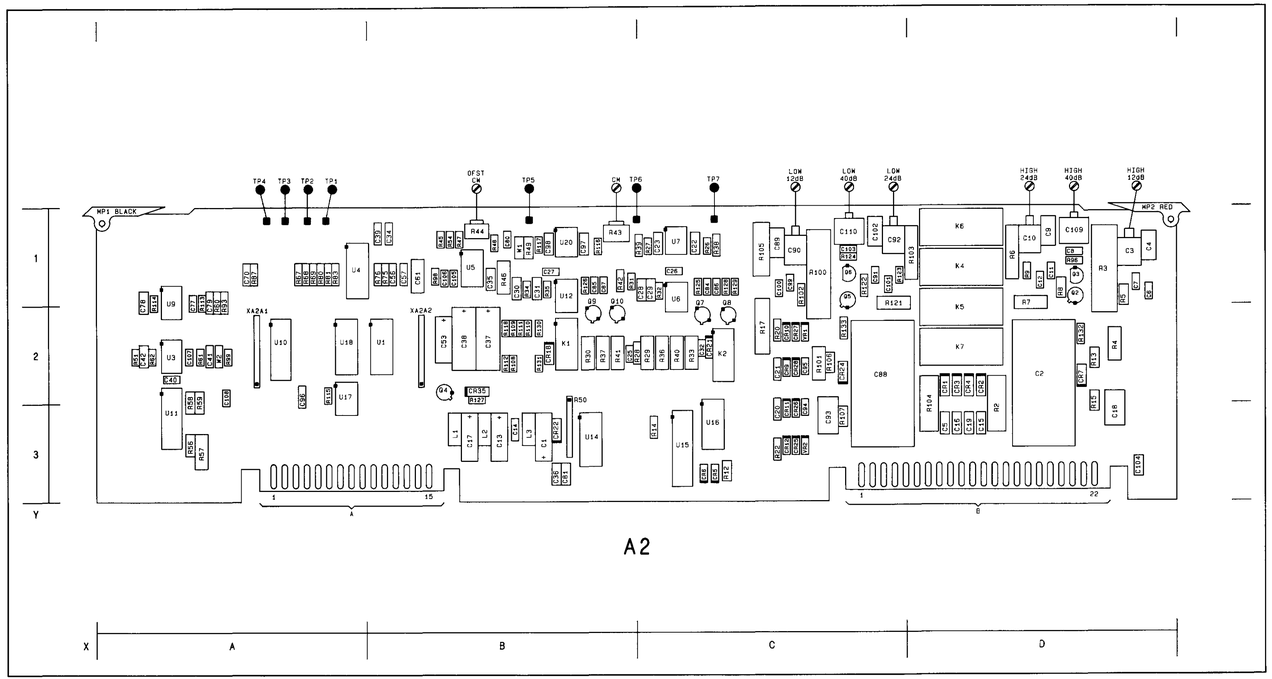


Figure 8B-104. SERVICE SHEET 2 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C36	B3						
C37	B2						
C38	B2						
C40	A2						
C41	A2						
C42	A2						
C53	B2						
C56	B1						
C57	B1						
C61	B1						
C70	A1						
C77	A1						
C78	A1						
C79	A1						
C81	B3						
C96	A2						
C104	D3						
C107	A2						
C108	A2						
CR35	B2						
Q4	B2						
R50	B3						
R51	A2						
R56	A3						
R57	A3						
R58	A3						
R59	A2						
R60	A1						
R61	A2						
R62	A2						
R67	A1						
R68	A1						
R69	A1						
R75	B1						
R76	B1						
R80	A1						
R81	A1						
R83	A1						
R87	A1						
R93	A1						
R99	A2						
R113	A1						
R114	A1						
R115	A2						
R127	B2						
TP2	A1						
TP3	A1						
TP4	A1						
U1	B2						
U3	A2						
U4	A1						
U9	A1						
U10	A2						
U11	A3						
U14	B3						
U16	C3						
U17	A2						
U18	A2						
W1	B1						
XA2A1	A2						
XA2A2	B2						

P/O A2 Input Amplifiers-Input Circuits **SS1**

SEE REVERSE SIDE

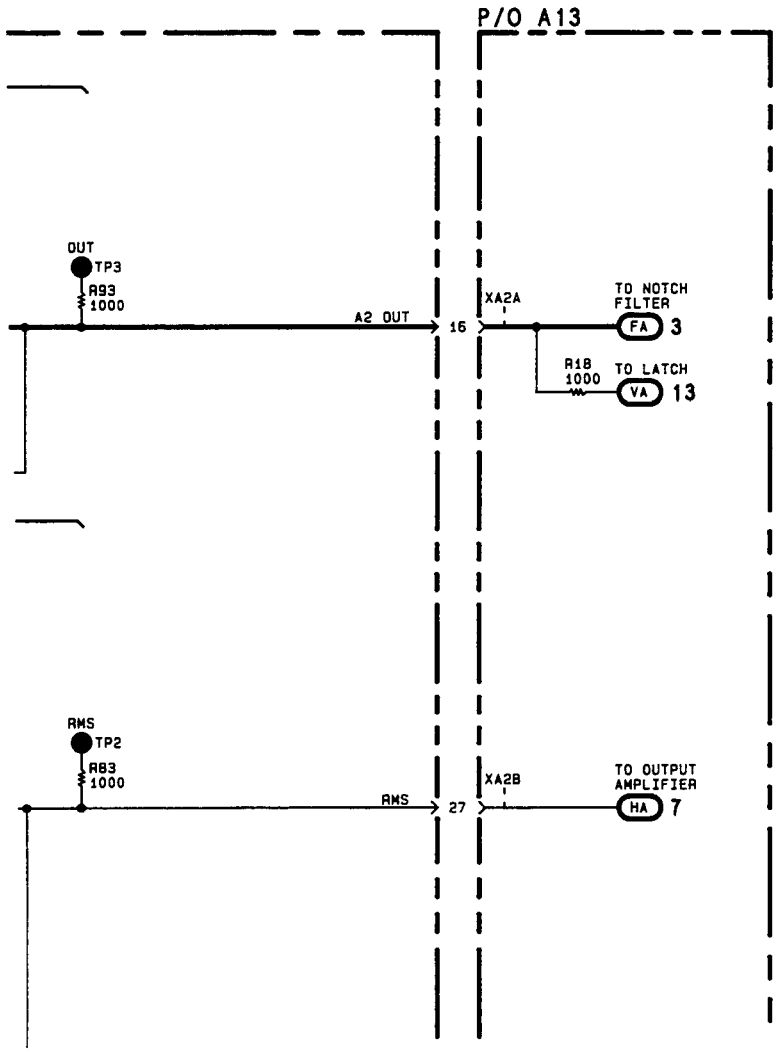
NOTES

1. Whenever an option plug-in filter is not installed, there is a jumper wire connecting pins 7 and 9 on the filter plug-in connectors. The front panel is labled to the effect that on the standard instrument there are no filters installed.

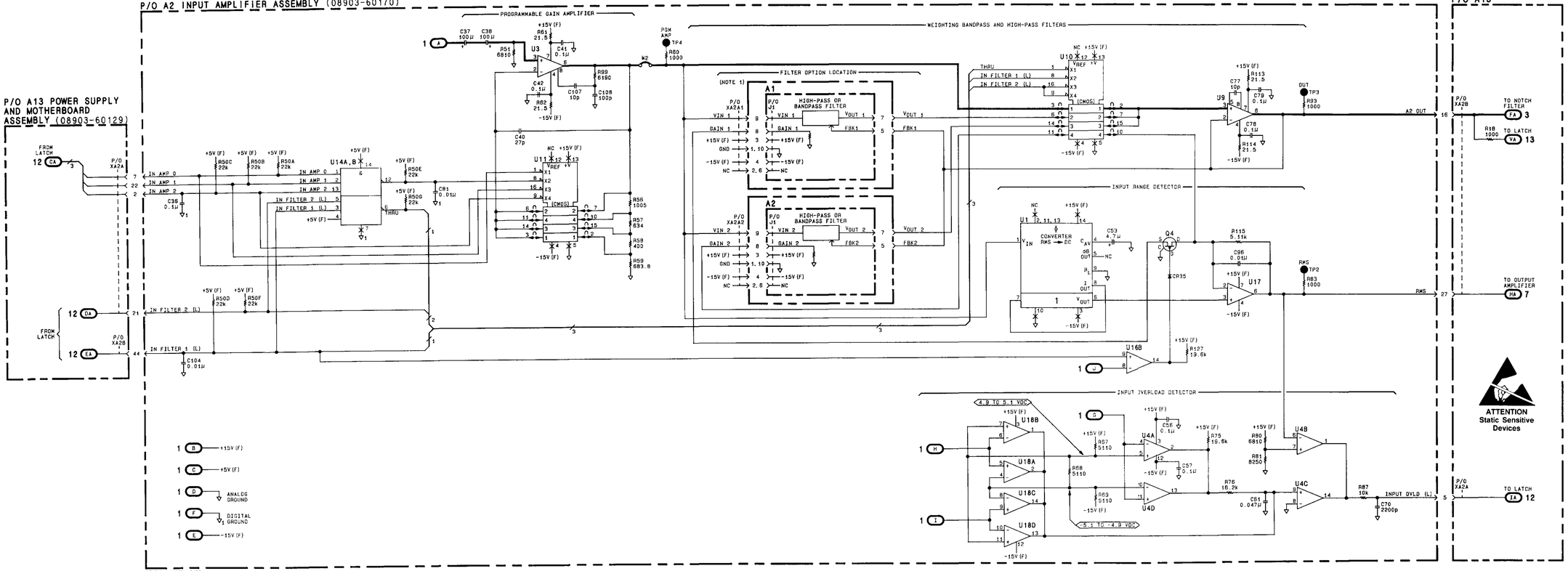
Schematic General Information

CHANGES

All serial prefixes	**On the A2 schematic:** • **08903-60170** - Use the partial schematic on page 8B-104.3. • **W2** - Delete W2 jumper and replace it with R134, 10 ohm. • **P/O XA2B** - In the P/O A13 section, delete the connection between P/O XA2B and pin 27. Delete P/O and change XA2B to XA2A. Add XA2B to the right of pin 27. **On the A13 Component Locator:** • **JP3** - Delete W2 and replace it with R134. **On the A13 Component Coordinates:** • **W2** - Delete W2 and add R134 A,2.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.



P/O A2 Input Amplifier Assembly

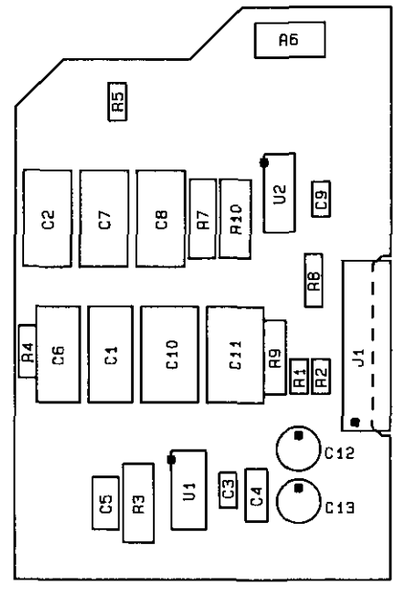


SS2
Figure 88-105
88-105

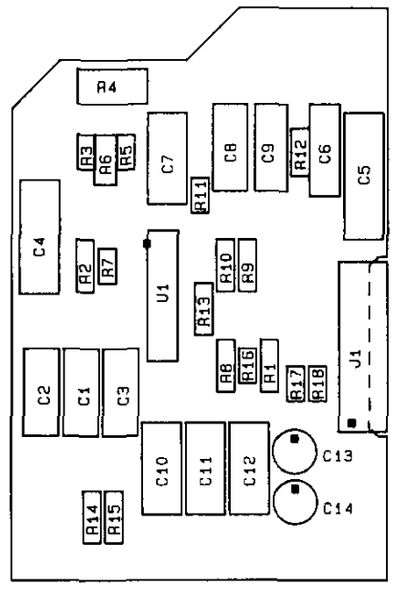
NOTES

1. When an optional plug-in filter assembly is in the left-most position (Filter 1), it is designated as assembly A2A1. When an optional plug-in filter assembly is in the right-most position (Filter 2), it is then designated as assembly A2A2.

Schematic General Information



(08903-60124)



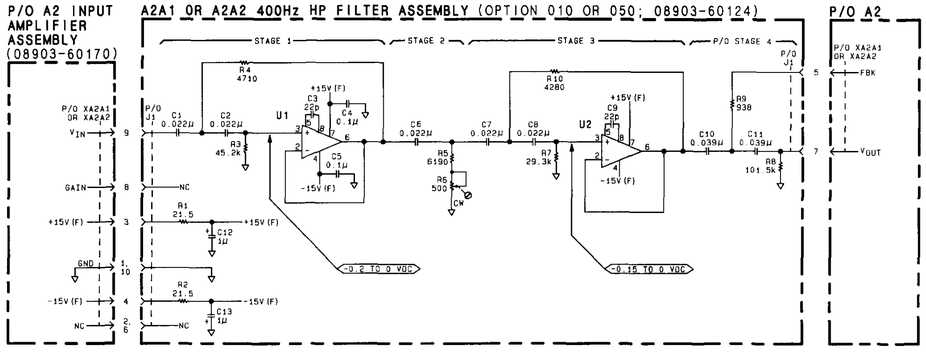
(08903-60125)

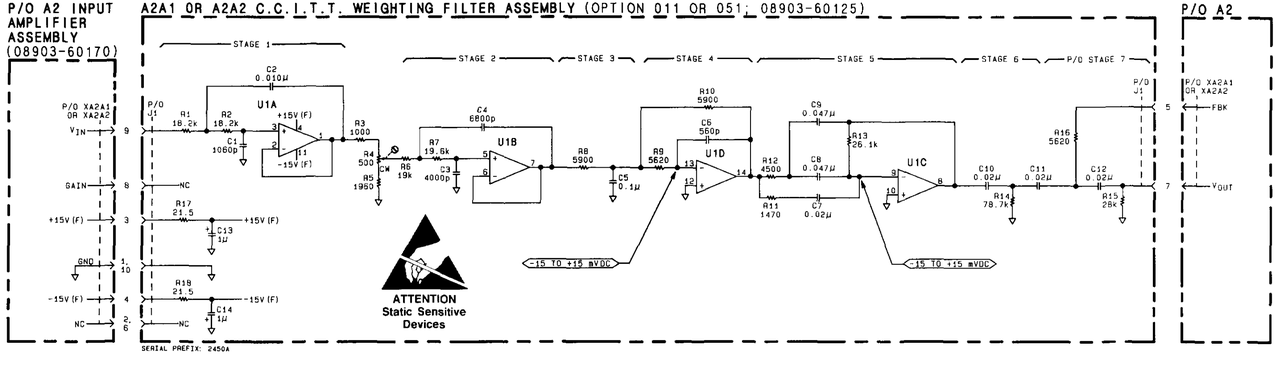
Component Locators

Figure 8B-106 SERVICE SHEET 2A INFORMATION

P/O A2 Input Amplifiers-Output Circuits SS2

SEE REVERSE SIDE


P/O A2 INPUT AMPLIFIER ASSEMBLY (08903-60170)
A2A1 OR A2A2 400Hz HP FILTER ASSEMBLY (OPTION 010 OR 050; 08903-60124)
P/O A2
STAGE 1
STAGE 2
STAGE 3
P/O STAGE 4
P/O XA2A1 OR XA2A2
VIN
GAIN
+15V (F)
GND
-15V (F)
NC
FBK
VOUT
U1
U2
-0.2 TO 0 VDC
-0.15 TO 0 VDC

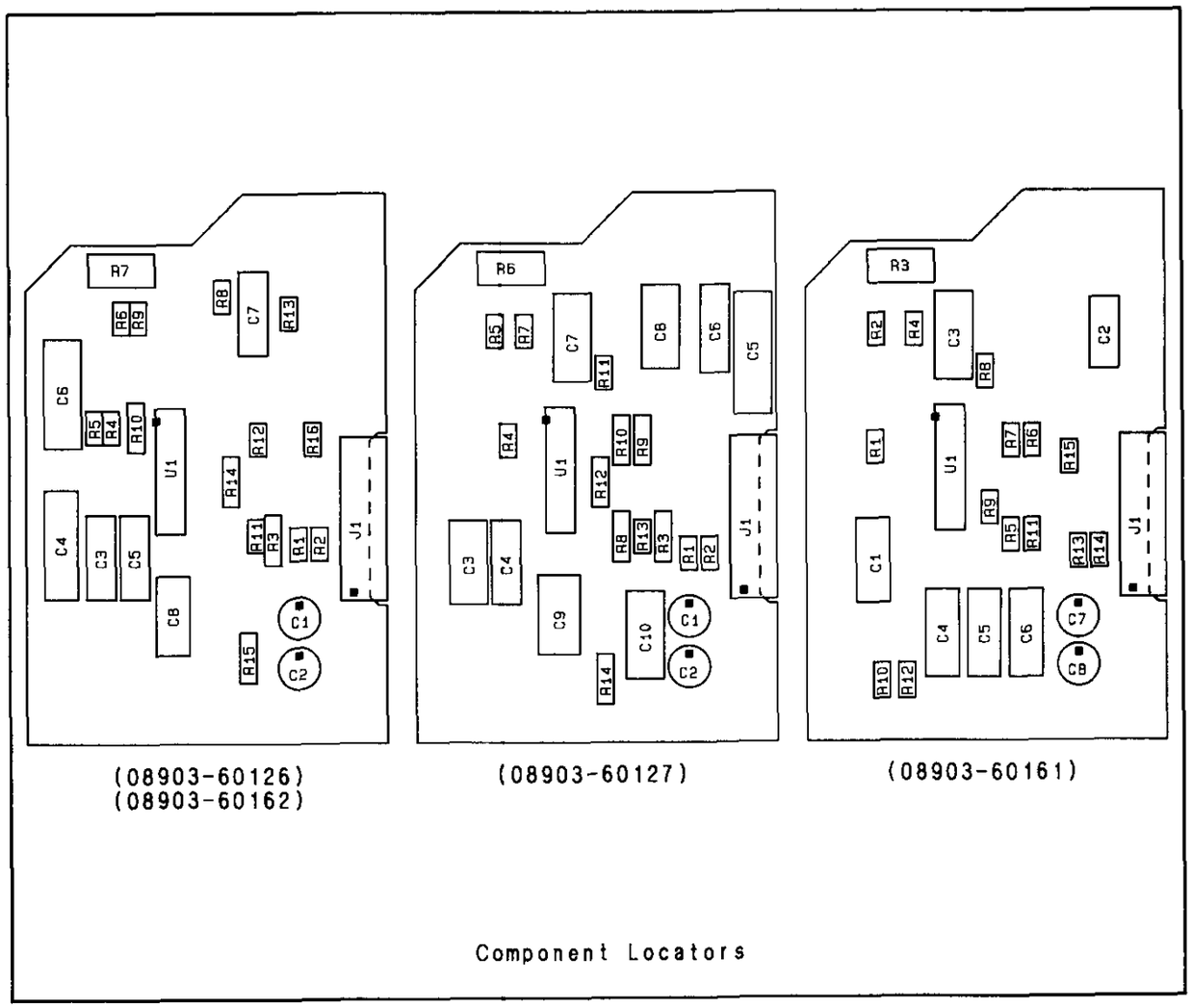

P/O A2 INPUT AMPLIFIER ASSEMBLY (08903-60170)
A2A1 OR A2A2 C.C.I.T.T. WEIGHTING FILTER ASSEMBLY (OPTION 011 OR 051; 08903-60125)
P/O A2
STAGE 1
STAGE 2
STAGE 3
STAGE 4
STAGE 5
STAGE 6
P/O STAGE 7
P/O XA2A1 OR XA2A2
VIN
GAIN
+15V (F)
GND
-15V (F)
NC
FBK
VOUT
U1A
U1B
U1C
U1D
-15 TO +15 mVDC
ATTENTION
Static Sensitive
Devices
SERIAL PREFIX: 2450A

NOTES

1. When an optional plug-in filter assembly is in the left-most position (filter 1), it is designated as assembly A2A1. When an optional plug-in filter assembly is in the right-most position (filter 2), it is then designated as assembly A2A2.
2. The only difference between the CCIR and the CCIR/ARM Weighting Bandpass Filter Assemblies is the values of R6,R11,R13 and R16, listed as follows.

FILTER ASSEMBLY	R6	R11	R13	R16
CCIR (08903-60126)	383	2370Ω	3830Ω	1520Ω
CCIR/ARM (08903-60162)	464	3480Ω	4640Ω	4640Ω

Schematic General Information

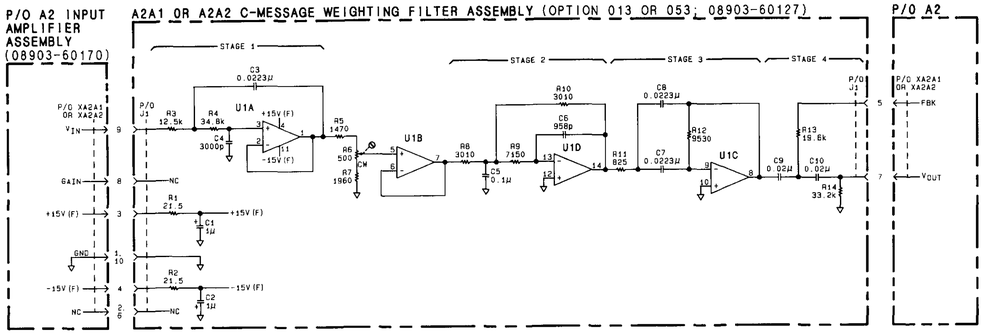


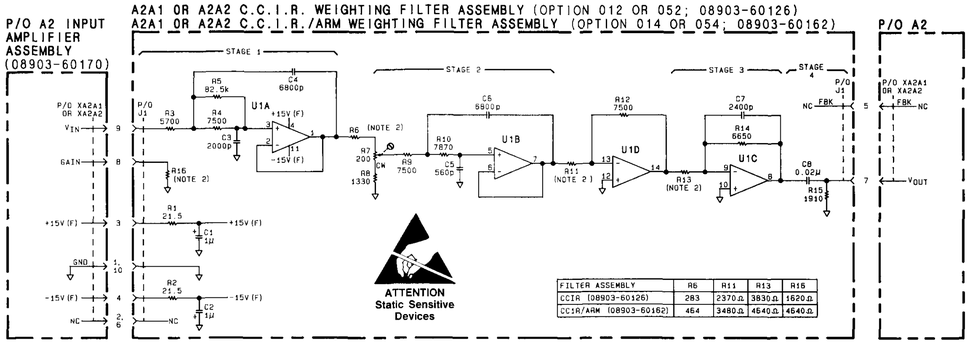
Component Locators

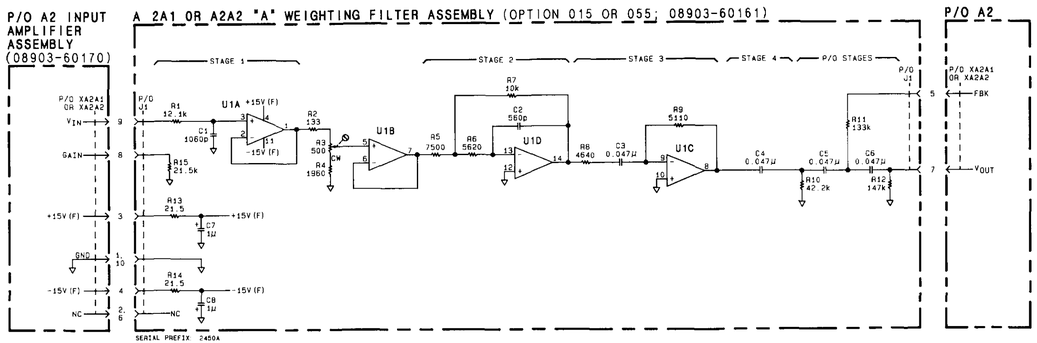
Figure 8B-108. SERVICE SHEET 2B INFORMATION

A2A1 AND/
OR A2A2
SEE REVERSE SIDE

SS2A


P/O A2 INPUT AMPLIFIER ASSEMBLY (08903-60170)
A2A1 OR A2A2 C-MESSAGE WEIGHTING FILTER ASSEMBLY (OPTION 013 OR 053; 08903-60127)
P/O A2
STAGE 1
STAGE 2
STAGE 3
STAGE 4
P/O XA2A1 OR XA2A2
VIN
GAIN
+15V (F)
GND
-15V (F)
NC
FBK
VOUT
U1A
U1B
U1C
U1D
C1 1µ
C2 1µ
C3 0.0223µ
C4 3000p
C5 0.1µ
C6 958p
C7 0.0223µ
C8 0.0223µ
C9 0.02µ
C10 0.02µ
R1 21.5
R2 21.5
R3 12.5k
R4 34.8k
R5 1470
R6 500 CW
R7 1960
R8 3010
R9 7150
R10 3010
R11 825
R12 9530
R13 19.6k
R14 33.2k


P/O A2 INPUT AMPLIFIER ASSEMBLY (08903-60170)
A2A1 OR A2A2 C.C.I.R. WEIGHTING FILTER ASSEMBLY (OPTION 012 OR 052; 08903-60126)
A2A1 OR A2A2 C.C.I.R./ARM WEIGHTING FILTER ASSEMBLY (OPTION 014 OR 054; 08903-60162)
P/O A2
STAGE 1
STAGE 2
STAGE 3
STAGE 4
P/O XA2A1 OR XA2A2
VIN
GAIN
+15V (F)
GND
-15V (F)
NC
FBK
VOUT
U1A
U1B
U1C
U1D
C1 1µ
C2 1µ
C3 2000p
C4 6800p
C5 5600p
C6 6800p
C7 2400p
C8 0.02µ
R1 21.5
R2 21.5
R3 5700
R4 7500
R5 82.5k
R6 (NOTE 2)
R7 200
R8 1330
R9 7500
R10 7870
R11 (NOTE 2)
R12 7500
R13 (NOTE 2)
R14 6650
R15 1910
R16 (NOTE 2)
ATTENTION
Static Sensitive
Devices
FILTER ASSEMBLY | R6 | R11 | R13 | R16
CCIR (08903-60126) | 283 | 2370Ω | 3830Ω | 1620Ω
CCIR/ARM (08903-60162) | 464 | 3480Ω | 4640Ω | 4640Ω


P/O A2 INPUT AMPLIFIER ASSEMBLY (08903-60170)
A 2A1 OR A2A2 "A" WEIGHTING FILTER ASSEMBLY (OPTION 015 OR 055; 08903-60161)
P/O A2
STAGE 1
STAGE 2
STAGE 3
STAGE 4
P/O STAGES
P/O XA2A1 OR XA2A2
VIN
GAIN
+15V (F)
GND
-15V (F)
NC
FBK
VOUT
U1A
U1B
U1C
U1D
C1 1060p
C2 560p
C3 0.047µ
C4 0.047µ
C5 0.047µ
C6 0.047µ
C7 1µ
C8 1µ
R1 12.1k
R2 133
R3 500 CW
R4 1960
R5 7500
R6 5620
R7 10k
R8 4640
R9 5110
R10 42.2k
R11 133k
R12 147k
R13 21.5
R14 21.5
R15 21.5k
SERIAL PREFIX 2450A

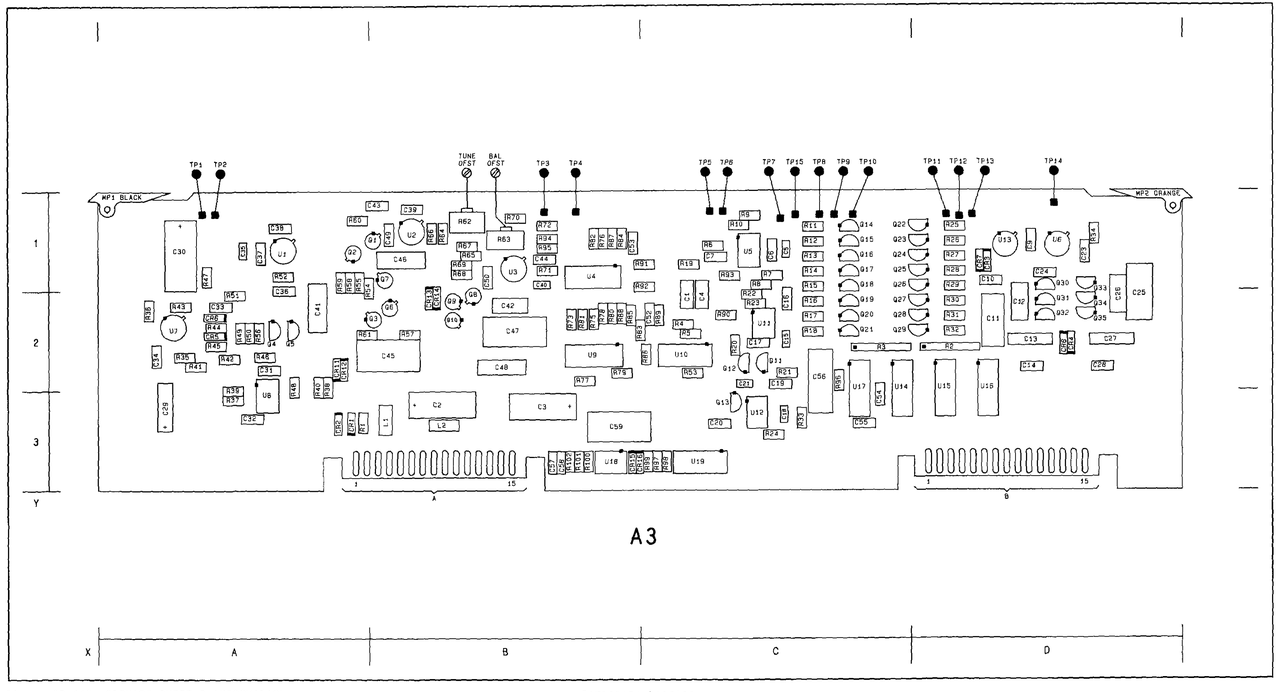


Figure 8B-110. SERVICE SHEET 3 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	C2	R18	C2				
C2	B3	R19	C1				
C3	B3	R20	C2				
C4	C2	R21	C2				
C5	C1	R22	C2				
C6	C1	R23	C2				
C7	C1	R24	C3				
C8	D1	R25	D1				
C10	D1	R26	D1				
C11	D1	R27	D1				
C12	D2	R28	D1				
C13	D2	R29	D1				
C14	D2	R30	D2				
C15	D2	R31	D2				
C16	D2	R32	C2				
C17	C2	R33	C3				
C18	C3	R34	D1				
C19	C2	R83	C1				
C20	C3	R86	C2				
C21	C2	R87	C3				
C23	D1	R88	C3				
C24	D1	R89	C3				
C25	D2	R100	B3				
C26	D2	R101	B3				
C27	D2	R102	B3				
C28	D2						
C54	C3	TP1	A1				
C55	C3	TP5	C1				
C56	C2	TP6	C1				
C57	B3	TP7	C1				
C58	B3	TP8	C1				
C59	B3	TP9	C1				
		TP10	C1				
CR1	A3	TP11	B1				
CR2	A3	TP12	B1				
CR3	D1	TP13	D1				
CR4	D2	TP14	C1				
CR7	D1	TP15	C1				
CR8	D2						
CR15	B3	U5	C1				
CR16	B3	U6	D1				
		U10	C2				
L1	B3	U11	C2				
L2	B3	U12	C3				
		U13	D1				
Q11	C2	U14	D2				
Q12	C2	U15	D2				
Q13	C3	U16	D2				
Q14	D1	U17	B3				
Q15	C1	U18	C3				
Q16	C1	U19	C3				
Q17	C1						
Q18	D1						
Q19	D2						
Q20	C2						
Q21	C2						
Q22	D1						
Q23	D1						
Q24	D1						
Q25	D1						
Q26	D1						
Q27	D2						
Q28	D2						
Q29	D2						
Q30	D2						
Q31	D2						
Q32	D2						
Q33	D1						
Q34	D2						
Q35	D2						
R1	A3						
R2	C2						
R3	C2						
R4	C2						
R5	C1						
R6	C1						
R7	C1						
R8	C1						
R9	C1						
R10	C1						
R11	C1						
R12	C1						
R13	C1						
R14	C1						
R15	C1						
R16	C2						
R17	C2						

P/O A2A1 AND/OR A2A2
SEE REVERSE SIDE

SS2B

NOTES

A3R2,R3
TOP VIEW

PIN NO	1	2	3	4	5	6	7	8
GND	A	B	C	D	E	F	H	

A3Q11-35

PLASTIC CASE, OR

TO-18 METAL CAN

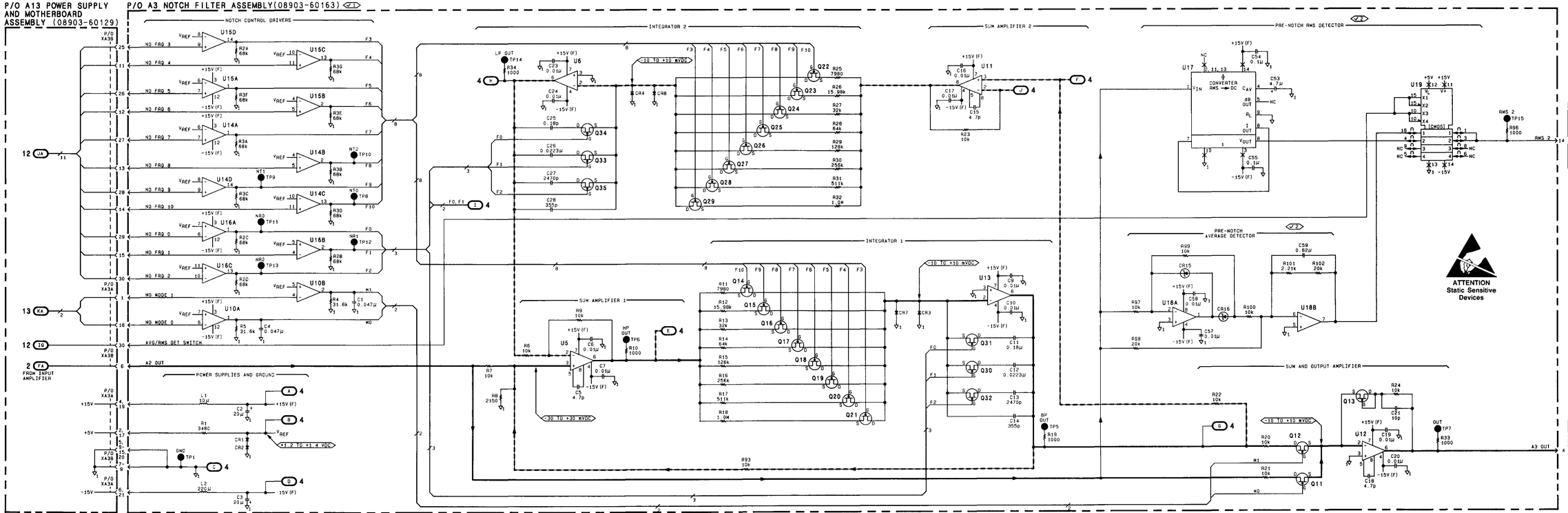
Schematic General Information

CHANGES

All serial prefixes	**On the A13 schematic:** • **C53** - Under PRE-NOTCH RMS DETECTOR, locate C53 and change it to C56 .18 uF (non-polarized). • **C25** - Under INTEGRATOR 2, change the value of C25 to .18 uF.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.

P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)

P/O A3 NOTCH FILTER ASSEMBLY(08903-60163) <J1>



SS3
Figure 8B-111
8B-111

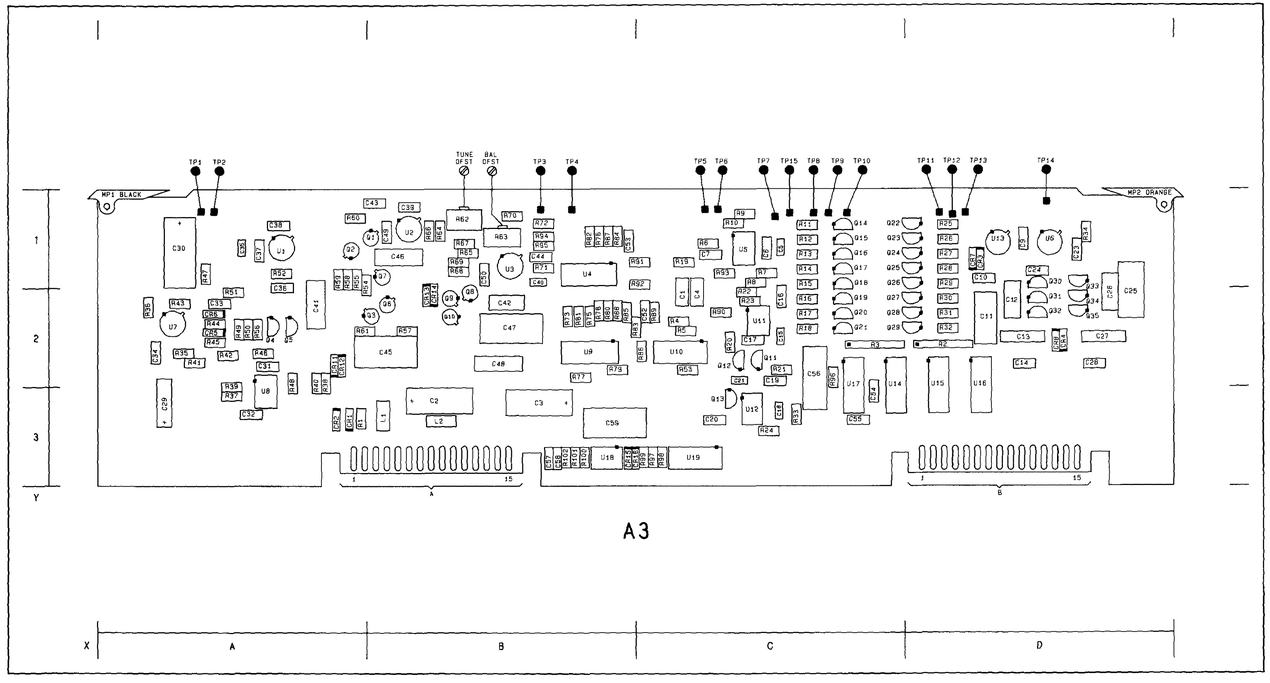


Figure 8B-112. SERVICE SHEET 4 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C29	A3	RB0	B2				
C30	A1	RB1	B2				
C31	A2	RB2	B1				
C32	A3	RB3	C2				
C33	A2	RB4	B1				
C34	A2	RB5	B2				
C35	A1	RB6	C2				
C36	A1	RB7	B1				
C37	A1	RB8	B2				
C38	A1	RB9	C2				
C39	B1	R90	C2				
C40	B1	R91	C1				
C41	A2	R92	C1				
C42	B2	R94	B1				
C43	B1	R95	B1				
C44	B1	TP2	A1				
C45	B2	TP3	B1				
C46	B1	TP4	B1				
C47	B2						
C48	B2	U1	A1				
C49	B1	U2	B1				
C50	B1	U3	B1				
C52	C1	U4	B1				
C53	B1	U7	A2				
		U8	A3				
CR5	A2	U9	B2				
CR6	A2	U10	C2				
CR11	A2	U15	D2				
CR12	A2						
CR13	B2						
CR14	B2						
Q1	B1						
Q2	A1						
Q3	B2						
Q4	A2						
Q5	A2						
Q6	B2						
Q7	B1						
Q8	B2						
Q9	B2						
Q10	B2						
R2	D2						
R35	A2						
R36	A2						
R37	A3						
R38	A2						
R39	A2						
R40	A2						
R41	A2						
R42	A2						
R43	A2						
R44	A2						
R45	A2						
R46	A2						
R47	A1						
R48	A2						
R49	A2						
R50	A2						
R51	A2						
R52	A1						
R53	C2						
R54	A1						
R55	A1						
R56	A2						
R57	B2						
R58	A1						
R59	A1						
R60	A2						
R61	A2						
R62	B1						
R63	B1						
R64	B1						
R65	B1						
R66	B1						
R67	B1						
R68	B1						
R69	B1						
R70	B1						
R71	B1						
R72	B1						
R73	B2						
R75	B2						
R76	B1						
R77	B2						
R78	B2						
R79	B2						

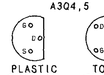
P/O A3 SEE REVERSE SIDE — **Notch Filter~ Notch Generating Circuits** — **SS3**

NOTES

A3R2
TOP VIEW

PIN NO	1	2	3	4	5	6	7	8
GND	A	B	C	D	E	F	H	

A3Q4,5



PLASTIC CASE, OR

TO-18 METAL CAN

A3Q1-3

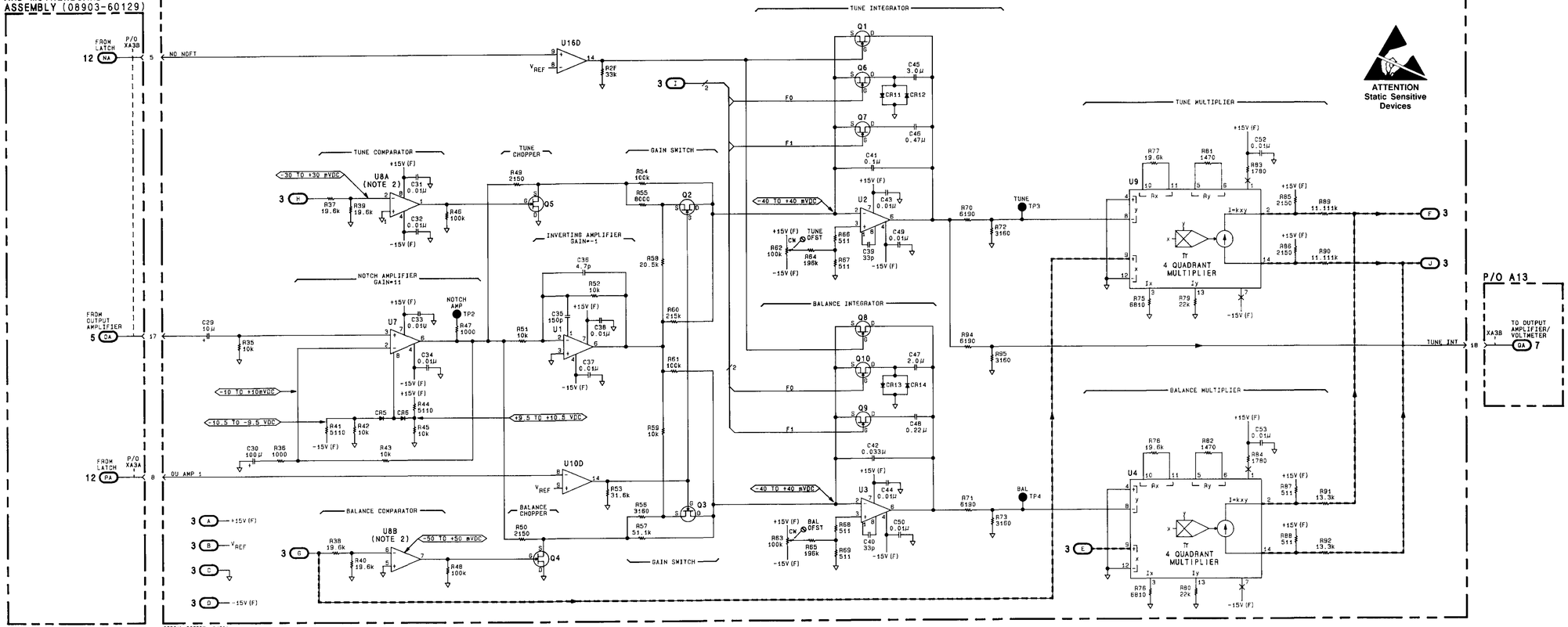
Schematic General Information

CHANGES

2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.

P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)

P/O A3 NOTCH FILTER ASSEMBLY (08903-60163) <V1>



SS4
Figure 8B-113
8B-113

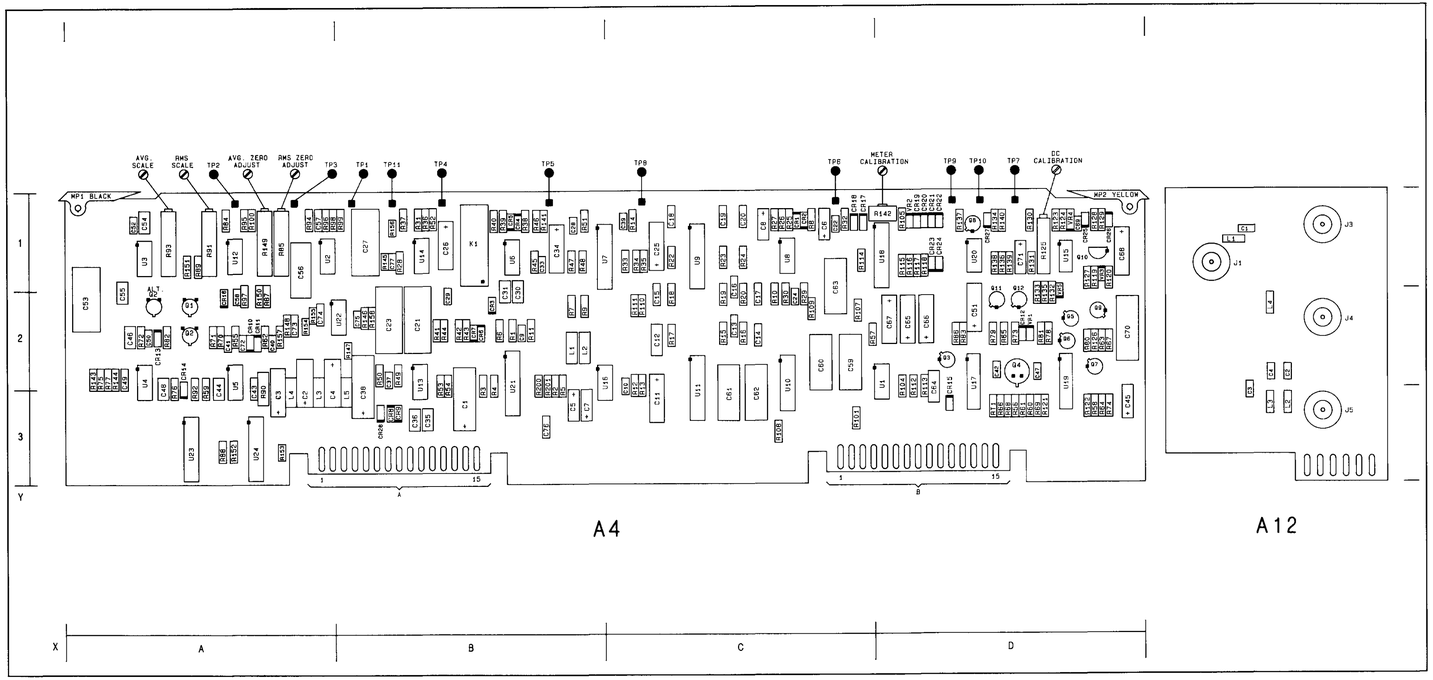


Figure 8B-114. SERVICE SHEET 5 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	B3	R31	B1				
C2	A3	R32	C1				
C3	A3	R33	C1				
C4	A3	R34	C1				
C5	B1	R35	C1				
C6	C1	R36	B1				
C7	B3	R37	B1				
C8	C1	R38	B1				
C9	B2	R39	B1				
C10	C2	R40	B3				
C11	C3	R41	B2				
C12	C2	R42	B2				
C13	C2	R43	B2				
C14	D2	R44	B2				
C15	D2	R45	B1				
C16	D1	R46	B1				
C17	C1	R47	B1				
C18	C1	R48	B1				
C19	C1	R49	B2				
C20	C1	R50	B2				
C21	B2	R51	B1				
C22	D1	R52	B3				
C23	B2	R53	B2				
C24	C2	R54	B2				
C25	C1	R141	B1				
C26	B1						
C27	B1	TP3	A1				
C28	B1	TP4	B1				
C29	B2	TP5	B1				
C30	B2	TP6	C1				
C31	B2	TP8	C1				
C33	B1						
C34	B1	U7	B1				
C35	B3	U8	C1				
C36	B3	U9	C1				
C37	B2	U11	C3				
C39	B3	U13	B2				
C39	C1	U14	B1				
C76	B1	U15	B2				
		U21	B2				
CR1	C1						
CR2	C1						
CR3	B2						
CR4	B1						
CR5	B1						
CR6	B2						
CR7	B2						
CR8	B3						
CR9	B3						
CR28	B3						
K1	B1						
L1	B2						
L2	B2						
L3	A3						
L4	A3						
L5	B3						
R1	B2						
R2	B2						
R3	B2						
R4	B2						
R5	B2						
R6	B2						
R7	B2						
R8	C1						
R9	B2						
R10	C2						
R11	B2						
R12	D2						
R13	C2						
R14	C1						
R15	C2						
R16	D2						
R17	C2						
R18	D2						
R19	C2						
R20	C2						
R22	C1						
R23	C1						
R24	C1						
R25	C1						
R26	C1						
R27	C1						
R28	B1						
R29	C2						
R30	C2						

P/O A3

SEE REVERSE SIDE

Notch Filter-Tune and Balance Circuits

SS4

NOTES

1. All the voltages shown are for no input, 1.11 SPCL and 3.1 SPCL.
2. Chassis ground is made by mechanical contact of connector to rear panel.

Schematic General Information

CHANGES

All serial prefixes	**On the A4 schematic:** • **U21A** - In the upper left hand corner locate U21A pin 13 and delete (F1) on the +15V supply line, locate U21A pin 4 and delete (F1) on the −15V supply line. • **C32** - In the upper portion of the A4 schematic under LOW-PASS FILTERS PASS BAND GAIN-2 add C32 3.3 p in parallel to A4C16. • **C18** - In the upper portion of the A4 schematic under LOW-PASS FILTERS PASS BAND GAIN-2 change the value of C18 to 91 pF. • **U9A** - In the upper portion of the A4 schematic under LOW-PASS FILTERS PASS BAND GAIN-2 locate U9A pin 13 and delete (F2) on the +15V supply line, locate U9A pin 4 and delete (F2) on the −15V supply line. **On the Component Locator:** • **U1,U2,U6,U8,U12,U13** - U1, U2, U6, U8, U12 and U13 are round cans and the tabs should be in the 2:00 o'clock position. • **R211** - On page 8B-114.4, in the lower left hand corner, add R211 between R209 and R210. **On the Component Coordinates:** • **R211** - On page 8B-114.3 add R211 A,3, to the partial component coordinates table.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2728A and below	**On the A4 schematic:** • **08903-60282** - The 08903-60128 board is obsolete, to replace this board you must order the 08903-60282 (not Quasi- Peak). **Note:** - The 08903-60282 (not Quasi-Peak) and the 08903-60283 (Quasi-Peak) are identical boards except for the positioning of W1. See partial schematic on page 8B-116.5, and the Component Locator on page 8B-114.4.

SS5

CHANGES

2730A to 2813A for HP8903B and 2730A to 2814A for HP8903E	**On the A4 schematic:** • 08903-60183 - Change the A4 board part number 08903-60128 to 08903-60183 (Quasi-Peak). **On the Component Locator:** • **08903-60183** - Use the partial component locator on page 8B-114.3. **On the Component Coordinates:** • **08903-60183** - Use the partial component coordinates on page 8B-114.3.
2813A and above	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.
2816A and above for HP8903B and 2818A and above for HP8903E	**On the A4 schematic:** • **08903-60283** - Change the board part number to 08903-60283 (Quasi-Peak). **Note:** - The 08903-60282 (not Quasi-Peak) and the 08903-60283 (Quasi-Peak) are identical boards except for the positioning of W1. See partial schematic on page 8B-116.5, and the Component Locator on page 8B-114.4. **On the Component Locator:** • **08903-60283** - Use the new component locator on page 8B-114.4 for serial prefixes 2816A and above (8903B) and 2818A and above (8903E).

COMP	X, Y
C2	A,3
C3	A,3
C4	A,3
C40	A,2
C41	A,2
C43	A,3
C44	A,2
C46	A,2
C48	A,2
C49	A,2
C50	A,2
C52	A,1
C53	A,1
C54	A,1
C55	A,2
C56	A,1
C57	A,1
C58	A,2
C72	A,2
C73	A,2
C74	A,2
C78	A,1
C79	A,3

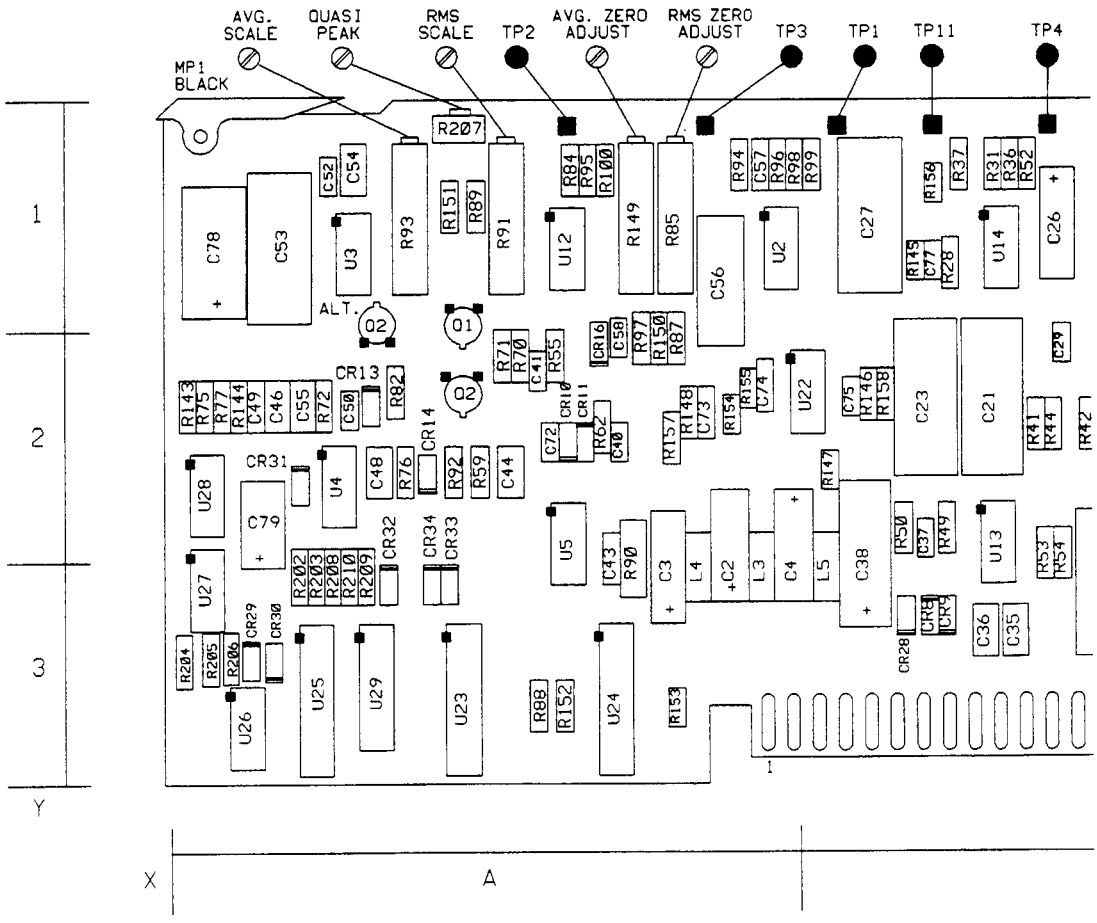
COMP	X, Y
CR10	A,2
CR11	A,2
CR13	A,2
CR14	A,2
CR16	A,2
CR29	A,3
CR30	A,3
CR31	A,2
CR32	A,3
CR33	A,3
CR34	A,3
L3	A,3
L4	A,3
MP1	A,1
Q1	A,1
Q2	A,2
Q2(ALT)	A,1
R55	A,2
R59	A,2
R62	A,2
R70	A,2
R71	A,2

COMP	X, Y
R72	A,2
R75	A,2
R76	A,2
R77	A,2
R82	A,2
R84	A,1
R85	A,1
R87	A,2
R88	A,3
R89	A,1
R90	A,3
R91	A,1
R92	A,2
R93	A,1
R94	A,1
R95	A,1
R96	A,1
R97	A,2
R98	A,1
R100	A,1
R143	A,2
R144	A,2
R148	A,2
R149	A,1
R150	A,2
R151	A,1

COMP	X, Y
R152	A,3
R153	A,3
R154	A,2
R155	A,2
R157	A,2
R202	A,3
R203	A,3
R204	A,3
R205	A,3
R206	A,3
R207	A,1
R208	A,3
R209	A,3
R210	A,3
TP2	A,1
TP3	A,1
U2	A,1
U3	A,1
U4	A,2
U5	A,2
U12	A,1
U23	A,3
U24	A,3
U25	A,3

COMP	X, Y
U26	A,3
U27	A,3
U28	A,2
U29	A,3

Partial Component Coordinates for Figures 8B-114, 8B-116, and 8B-118. (2730A to 2813A for HP8903B) and (2730A to 2814A for the HP8903E)



Partial Component Locator for Figures 8B-114, 8B-116, and 8B-118. (2730A to 2813A for HP8903B) and (2730A to 2814A for the HP8903E)

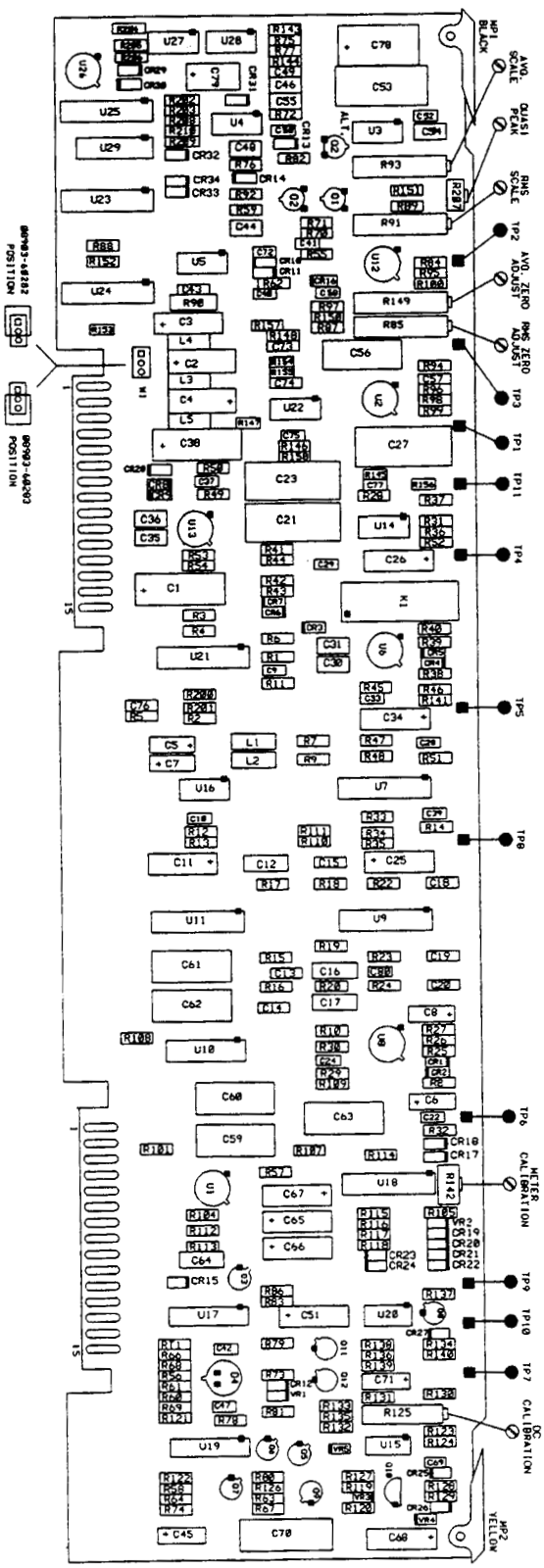
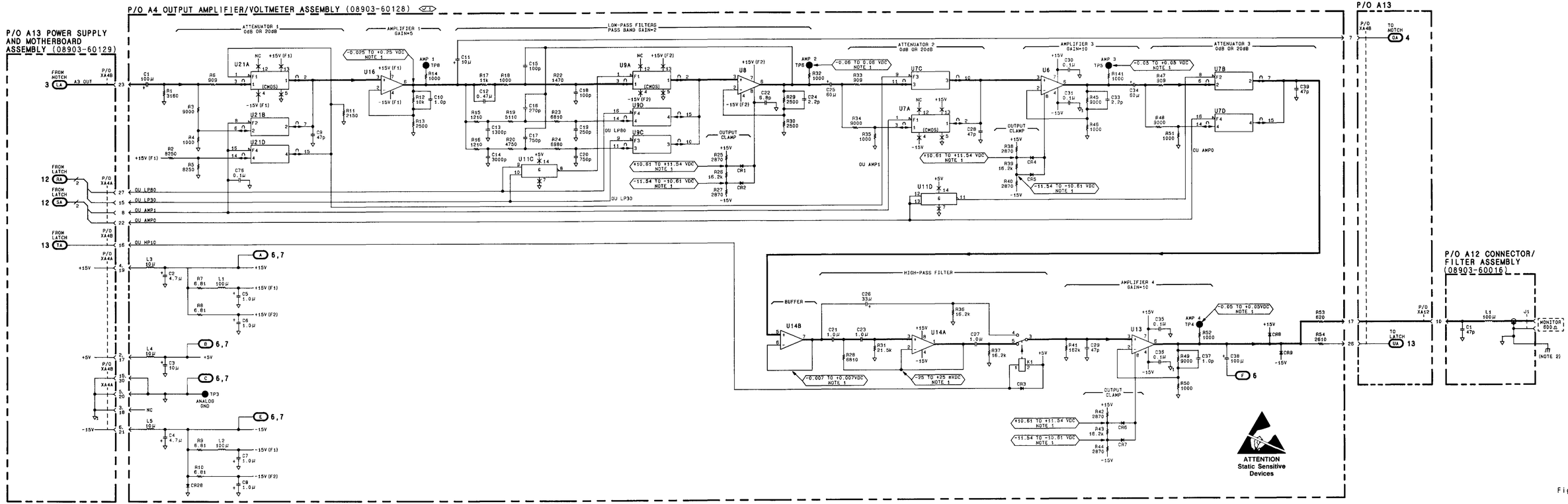


Figure 8B-114. Component Locator (8903B, 2816A and above)
Figure 8B-114. Component Locator (8903E, 2818A and above)



SS5
Figure 8B-115
8B-115

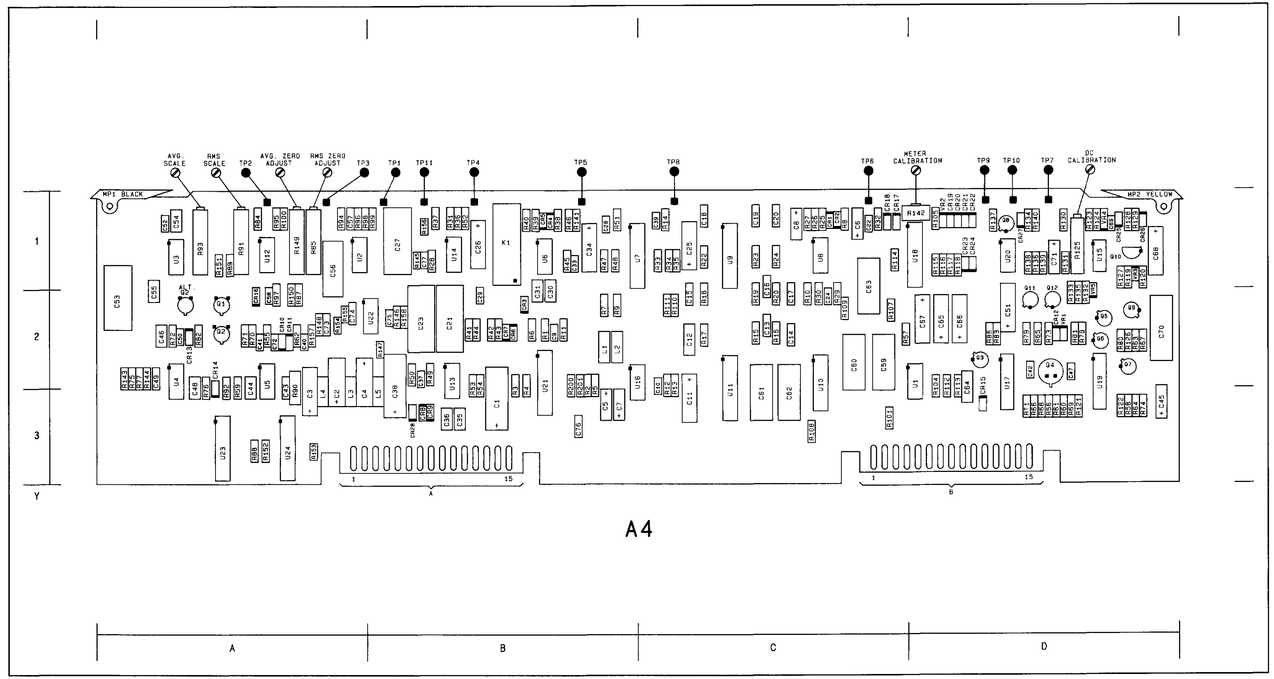


Figure 8B-116. SERVICE SHEET 6 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y
C40	A2
C41	A2
C42	D2
C43	A2
C44	A2
C45	D3
C46	A2
C47	D2
C48	A2
C49	A2
C50	A2
C51	D2
C52	A1
C53	A2
C54	A1
C55	A2
C56	A1
C57	A2
C58	A2
C72	A2
C73	A2
C74	A2
C75	B2
C77	B1
CR10	A2
CR11	A2
CR12	D2
CR13	A2
CR14	A2
CR15	D3
CR16	A2
Q1	A2
Q2	A2
Q3	A2
Q4	D2
Q5	D2
Q6	D3
Q7	D2
R55	A2
R56	D3
R57	C3
R58	D3
R59	A2
R60	D3
R61	D3
R62	A2
R63	D2
R64	D3
R65	D2
R66	D3
R67	D2
R68	D3
R69	D3
R70	A2
R71	A2
R72	A2
R73	D2
R74	D3
R75	A2
R76	A2
R77	A2
R78	D2
R79	D2
R80	D2
R81	D2
R82	A2
R83	D2
R84	A1
R85	A1
R86	D2
R87	A2
R88	A3
R89	A1
R90	A2
R91	A1
R92	A2
R93	A1
R94	A1
R95	A1
R96	A1
R97	A2
R98	A1
R99	B1
R100	A1

COMP	X,Y
R142	D1
R143	A2
R144	A2
R145	B1
R146	B2
R147	B2
R148	A2
R149	A1
R150	A2
R151	A1
R152	A3
R153	A3
R154	A2
R155	A2
R156	B1
R157	A2
R158	B2
RT1	C3
TP1	B1
TP2	A1
TP11	B1
U2	A1
U3	A1
U4	A2
U5	A2
U6	B1
U12	A1
U17	D2
U19	D2
U22	B2
U23	A3
U24	A3
VR1	D2

COMP	X,Y

COMP	X,Y

P/O A4, A12

SEE REVERSE SIDE

Output Amplifier/ Voltmeter- Output Amplifier

SS5

NOTES

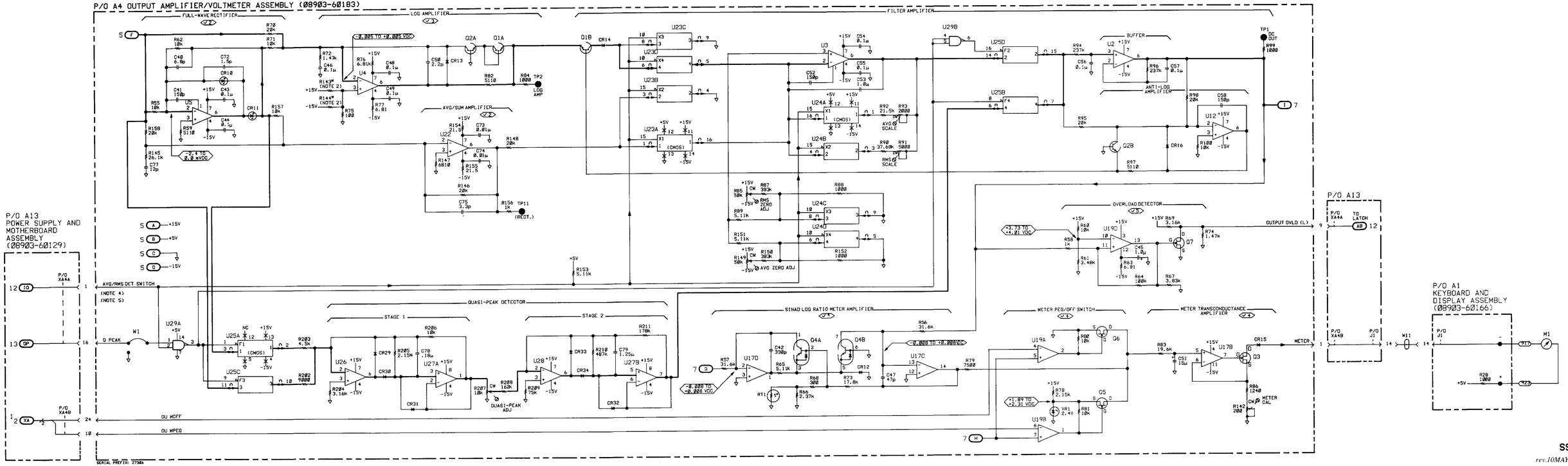
1. * Asterisk indicates factory selected values.
2. These components are not normally loaded. Refer to Section 5 under VOLTMETER ADJUSTMENTS.
3. All voltages shown are for 1-3 Vrms input at 1 kHz, with 1.11 SPCL and 3.1 SPCL.
4. If the A4 OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY (08903-60128) is to be used in an 8903A AUDIO ANALYZER as an RMS detector, pin 1 of the XA4A connector must be grounded. Otherwise, the A4 assembly will function as an AVG detector.

A4Q1,Q2

A4Q3,5-7
TOP VIEW

A4Q4

Schematic General Information


P/O A4 OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY (08903-60183)
FULL-WAVE RECTIFIER
LOG AMPLIFIER
FILTER AMPLIFIER
AVG/SUM AMPLIFIER
QUASI-PEAK DETECTOR
STAGE 1
STAGE 2
SINAD LOG RATIO METER AMPLIFIER
METER PEG/OFF SWITCH
METER TRANSCONDUCTANCE AMPLIFIER
BUFFER
ANTI-LOG AMPLIFIER
OVERLOAD DETECTOR
-0.005 TO +0.005 VDC
-2.4 TO -0.9 mVDC
-0.008 TO +0.008 VDC
+3.73 TO +4.01 VDC
+1.89 TO +2.31 VDC
AVG/RMS DET SWITCH
(NOTE 4)
(NOTE 5)
Q PEAK
OU MOFF
OU MPEG
QUASI-PEAK ADJ
RMS ZERO ADJ
AVG ZERO ADJ
RMS SCALE
AVG SCALE
METER CAL
OUTPUT OVLD (L)
METER
TP1 DC OUT
TP2 LOG AMP
TP11 (RECT.)
P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)
P/O A13
P/O XA4A
TO LATCH A8
P/O XA4B
P/O J1
P/O A1 KEYBOARD AND DISPLAY ASSEMBLY (08903-60166)
SERIAL PREFIX: 2730A

CHANGES

All serial prefixes	**On the Component Locator:** • **U1,U2,U6,U8,U12,U13** - U1, U2, U6, U8, U12 and U13 are round cans and the tabs should be in the 2:00 o'clock position. • **U29A** - On the left hand side of the new A4 OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY (08903-60183), locate U29A and change pin 1 to 2 and pin 2 to 1. • Delete the page number (8B-116.3) on the schematic foldout that is tied to serial prefix 2730A and replace it with a revision date of *rev.10MAY87.* • **R211** - On page 8B-114.4, in the lower left hand corner of the component locator, add R211 between R209 and R210. **On the Component Coordinates:** • **R211** - On page 8B-114.3, add R211 A,3, to the partial coordinates table.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY from 08903-60129 to 08903-60192.
2728A and below	**On the A4 schematic:** • **SS6** - The 08903-60128 board is obsolete, to replace this board you must order the 08903-60282 (not Quasi-Peak). **Note:** - The 08903-60282 (not Quasi-Peak) and the 08903-60283 (Quasi-Peak) are identical boards except for the positioning of W1. See partial schematic on page 8B-116.5, and the Component Locator on page 8B-116.6.

SS6

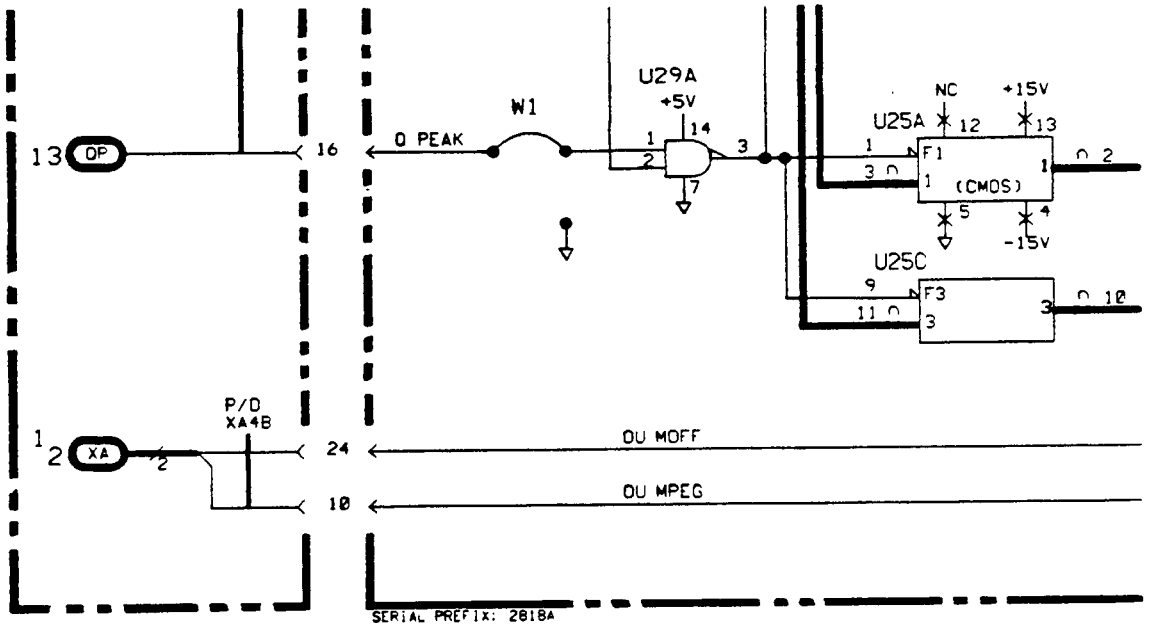
CHANGES

2730A to 2813A for HP8903B and 2730A to 2814A for HP8903E	**On the A4 schematic:** • A4 - Use the new schematic foldout on page 8B-116.3. Delete the page number (8B-116.3) and replace it with a revision date of *rev.10MAY87.* **On the Component Locator:** • **A4** - Use the partial component locator on page 8B-114.3. **On the Component Coordinates:** • **A4** - Use the partial component coordinates on page 8B-114.3. **Under "Notes":** • Add the following notes; NOTE 5. When in 5.7 Special (Quasi) the AVG/RMS line is high. NOTE 6. Unused gates U29C and U29D have their inputs and outputs grounded. **On the A13 schematic:** • **SS6**- Add the new schematic on page 8B-116.3, *rev.10MAY87,* (keep the original schematic.)
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY from 08903-60192 to 08903-60292.

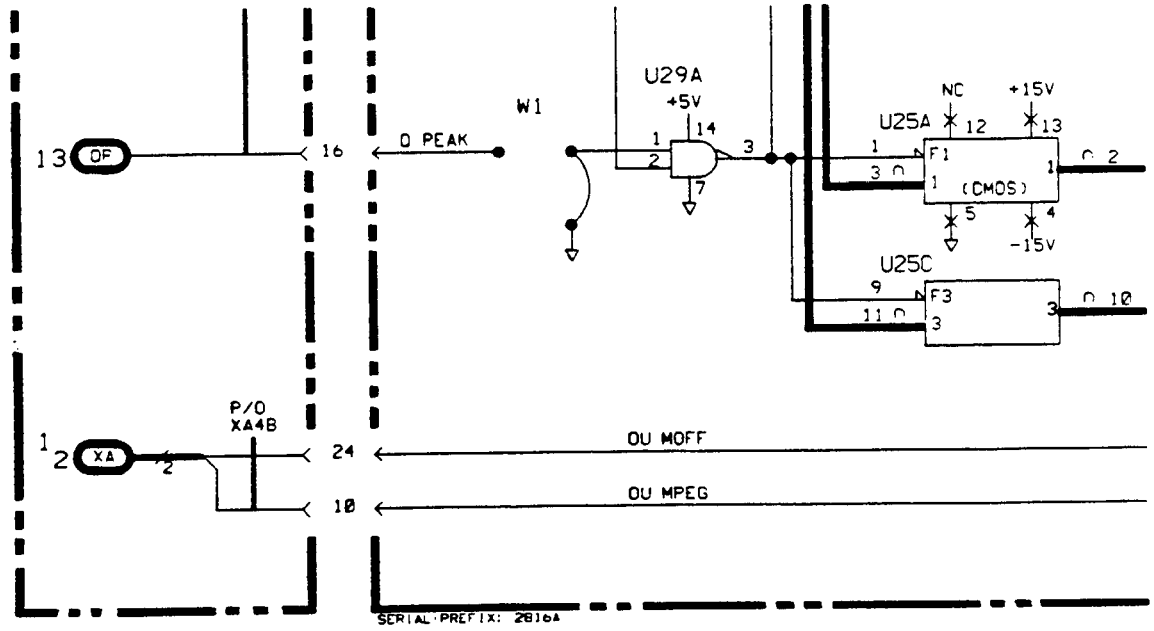
CHANGES

2816A and above for HP8903B and 2818A and above for HP8903E	**Under "Notes":** • Add the following notes; Note 7. The 08903-60183 does not have a W1 jumper wire. Note 8. The 08903-60283 and the 08903-60282 are identical boards except for the position of the W1 jumper wire. See the partial schematic on page 8B-116.5, and the Component Locator on page 8B-116.6. **On the A4 schematic:** • **A4** - In the upper left hand corner of the schematic change the board part number to 08903-60283. **Note:** The 08903-60282 and 08903-60283 are identical boards except for the positioning of W1. See the partial schematic on page 8B-116.5, and the Component Locator on page 8B-116.6. • **SS6** - Use the schematic partial on page 8B-116.5. **On the Component Locator:** • **A4** - Use the component locator on page 8B-116.6 for serial prefixes 2816A and above (8903B) and 2818A and above (8903E).

Reserved for future changes.



W1 Jumper in the 08903-60283 position.



W1 Jumper in the 08903-60282 position.

Changes to Figure 8B-116.3 (8903E, 2818A and above)
Changes to Figure 8B-116.3 (8903B, 2816A and above)

SS6

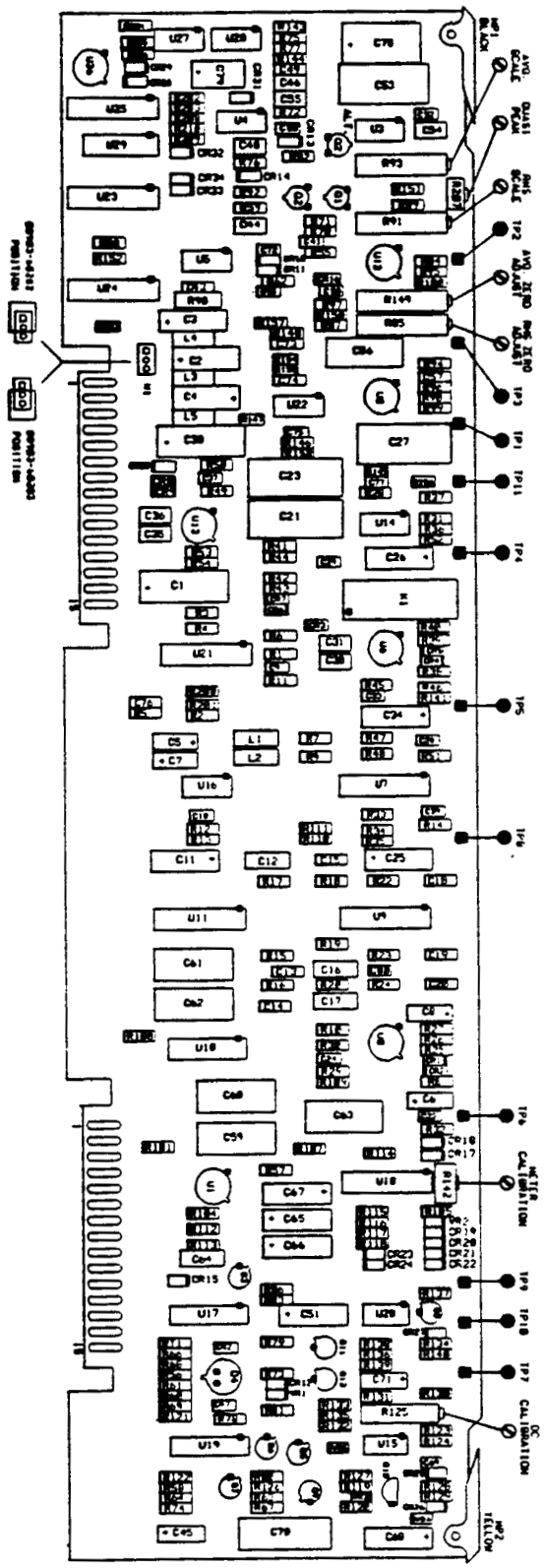
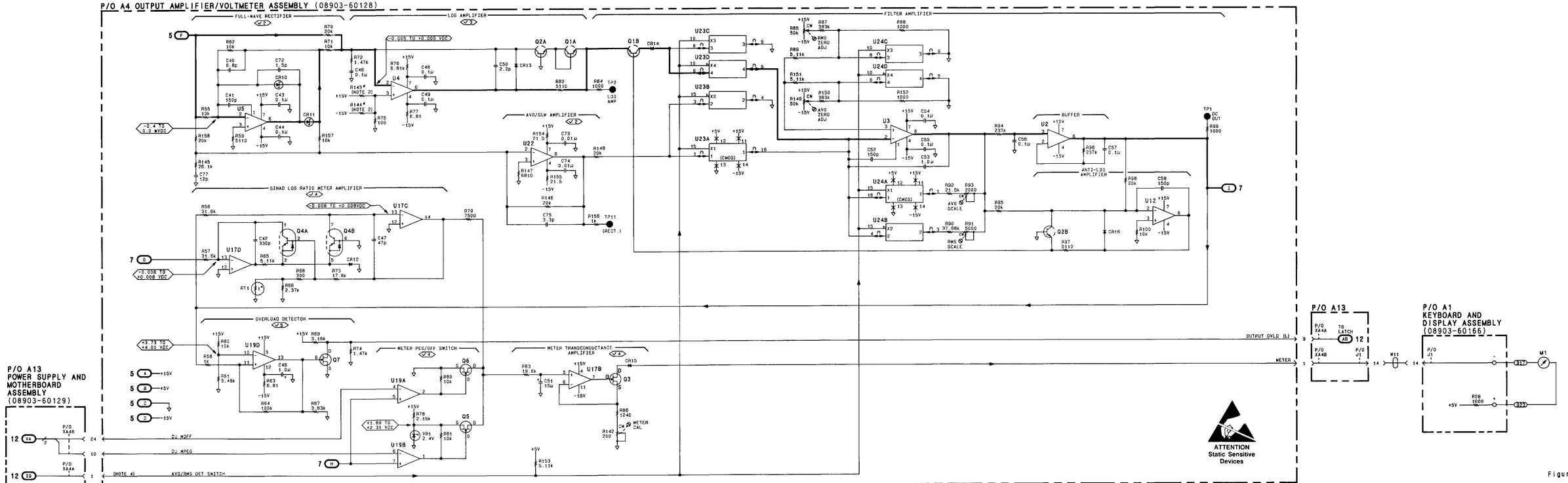


Figure 8B-116. Component Locator (8903E, 2818A and above)
Figure 8B-116. Component Locator (8903B, 2816A and above)


P/O A4 OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY (08903-60128)
FULL-WAVE RECTIFIER
LOG AMPLIFIER
FILTER AMPLIFIER
AVG/SUM AMPLIFIER
SINAD LOG RATIO METER AMPLIFIER
OVERLOAD DETECTOR
METER PEG/OFF SWITCH
METER TRANSCONDUCTANCE AMPLIFIER
BUFFER
ANTI-LOG AMPLIFIER
-2.4 TO 0.0 VDC
-0.005 TO +0.005 VDC
-0.008 TO +0.008VDC
+3.73 TO +4.01 VDC
+1.89 TO +2.31 VDC
OUTPUT OVLD (L)
METER
OV MOFF
OV MPEG
AVG/RMS DET SWITCH
(NOTE 4)
ATTENTION Static Sensitive Devices
P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)
P/O A13
P/O A1 KEYBOARD AND DISPLAY ASSEMBLY (08903-60166)
SERIAL PREFIX: 2450A

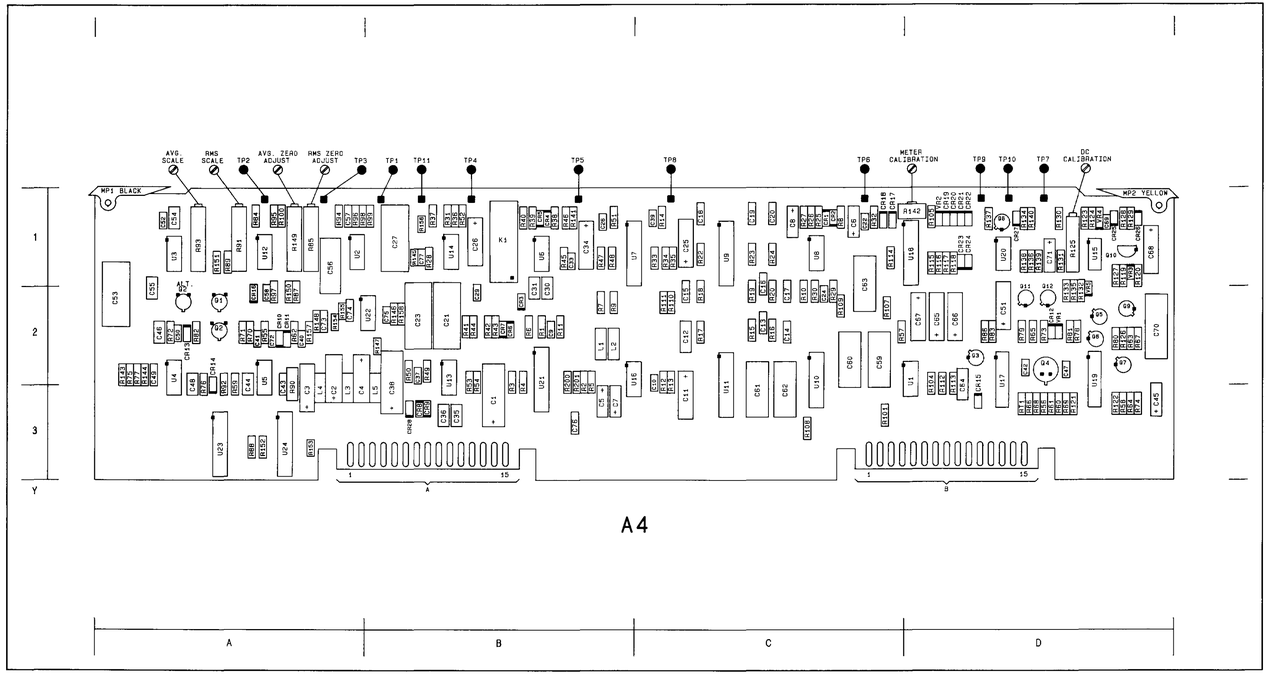


Figure 8B-118. SERVICE SHEET 7 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C59	C2	VR2	D1				
C60	C2	VR3	D1				
C61	C3	VR4	D1				
C62	C3	VR5	D2				
C63	C1						
C64	D2						
C65	D2						
C66	B2						
C67	D1						
C68	D1						
C69	D1						
C70	D2						
C71	D1						
CR17	C1						
CR18	C1						
CR19	D1						
CR20	D1						
CR21	D1						
CR22	D1						
CR23	D1						
CR24	D1						
CR25	D1						
CR26	D1						
CR27	D1						
Q8	D1						
Q9	D2						
Q10	D1						
Q11	D2						
Q12	D2						
R101	C3						
R104	D2						
R105	D1						
R107	C2						
R108	C3						
R109	C2						
R110	C2						
R111	C2						
R112	D2						
R113	D2						
R114	C1						
R115	D1						
R116	D1						
R117	D1						
R118	D1						
R119	D1						
R120	D1						
R121	D3						
R122	D3						
R123	D1						
R124	D1						
R125	D1						
R126	D2						
R127	D1						
R128	D1						
R129	D1						
R130	D1						
R131	D1						
R132	D2						
R133	D2						
R134	D2						
R135	D2						
R136	D1						
R137	D1						
R138	D1						
R139	D1						
R140	D1						
R200	B2						
R201	B2						
TP7	D1						
TP9	D1						
TP10	D1						
U5	D2						
U9	C1						
U16	C2						
U11	C3						
U15	D1						
U18	D1						
U19	D2						
U20	D1						
U21	B2						

P/O A1, A4 SEE REVERSE SIDE — Output Amplifier/ Voltmeter-Detector and Meter Circuits — **SS6**

NOTES

1. Decouple probe with a 10k ohm resistor when measuring this voltage.
2. Measured with respect to the +15 VDC supply.
3. THE A4 OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY (08903-60128) may retrofit to analyzers with serial prefixes 2306A or lower, having A3 NOTCH FILTER ASSEMBLY (08903-60105). To retrofit, carefully unsolder A4R101 and resolder this resister between points A and B as shown on this schematic (SS7). Unsolder A4R200 and resolder this resistor between points C and D (on SS7). Solder pads and mounting holes are proVIDED on the circuit board.
4. If the A4 OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY (08903-60128) is to be used in an 8903A AUDIO ANALYZER as an RMS detector, pin 1 of the XA4A connector must be grounded. Otherwise, the A4 assembly will function as an AVG detector.

A4Q8,9
TOP VIEW

Schematic General Information

CHANGES

All serial prefixes	**On the Component Locator:** • **U1,U2,U6,U8,U12,U13** - U1, U2, U6, U8, U12 and U13 are round cans and the tabs should be in the 2:00 o'clock position • **R211** - On page 8B-118.3, in the lower right hand corner of the component locator, add R211 between R209 and R210. **On the Component Coordinates:** • **R211** - Add R211 A,3, to the partial component coordinate table on page 8B-114.3.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY from 08903-60129 to 08903-60192.
2728A and below	**On the A4 schematic:** • **SS7** - The 08903-60128 board is obsolete, to replace this board you must order the 08903-60282 (not Quasi- Peak). • **Note:** - The 08903-60282 (not Quasi-Peak) and the 08903-60283 (Quasi-Peak) are identical boards except for the positioning of W1. See partial schematic on page 8B-116.5, and the Component Locator on page 8B-118.3.
2730A to 2813A for HP8903B and 2730A to 2814A for HP8903E	**On the A4 schematic:** • **SS7** - Change the A4 board part number 08903-60128 to 08903-60183 (Quasi-Peak). **On the Component Locator:** • **A4** - Use the partial component locator on page 8B-114.3. **In General Information:** • **Add the following notes;** • **NOTE 5:** When in 5.7 Special (Quasi) the AVG/RMS line is high. • **NOTE 6:** Unused gates U29C and U29D have their inputs and outputs grounded. **On the Component Coordinates:** • **R211** - Use the partial component coordinates on page 8B-114.3.

SS7

CHANGES

2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY from 08903-60192 to 08903-60292.
2816A and above for HP8903B and 2818A and above for HP8903E	**On the A4 schematic:** • In the upper left hand corner of the schematic change the A4 board part number 08903-60183 to 08903-60283. **Note**: The 08903-60282 is a direct replacement for the 08901-60128 for CPC. The 08903-60282 and the 08903-60283 are identical except for the positioning of W1 (see schematic partial on page 8B-116.5, and the Component Locator on page 8B-118.3). **On the Component Locator:** • **A4** - Use the new component locator on page 8B-118.3 for serial prefixes 2816A and above (8903B) and 2818A and above (8903E).

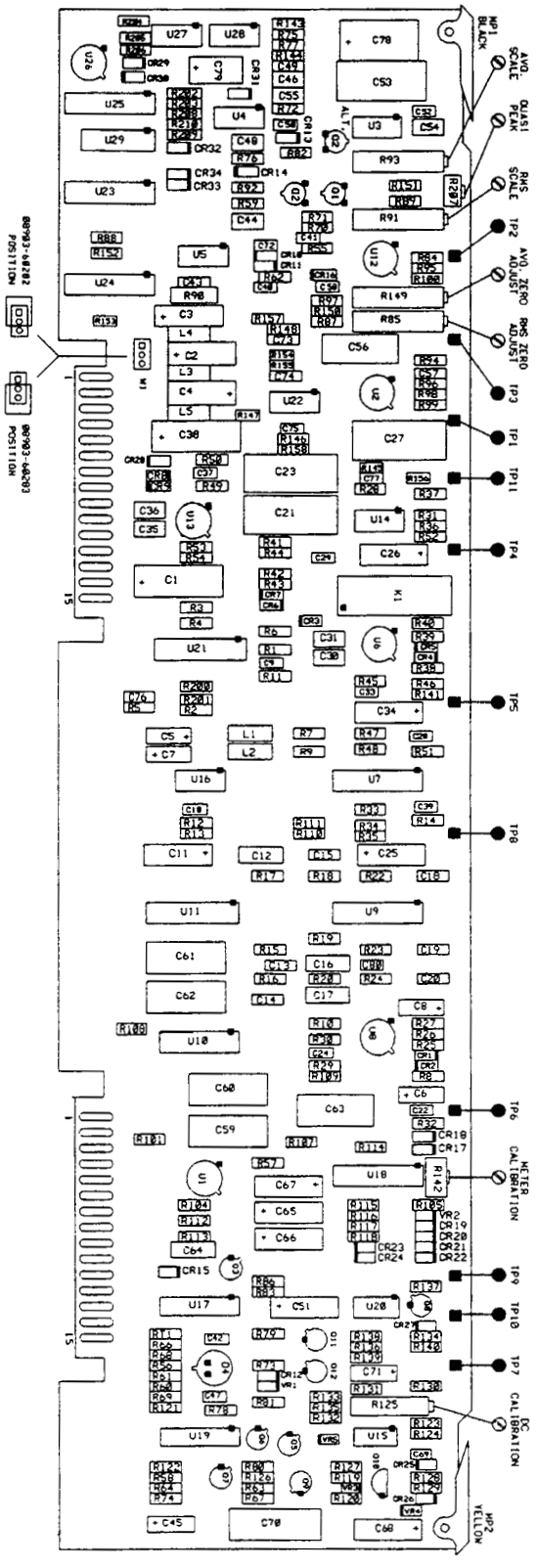
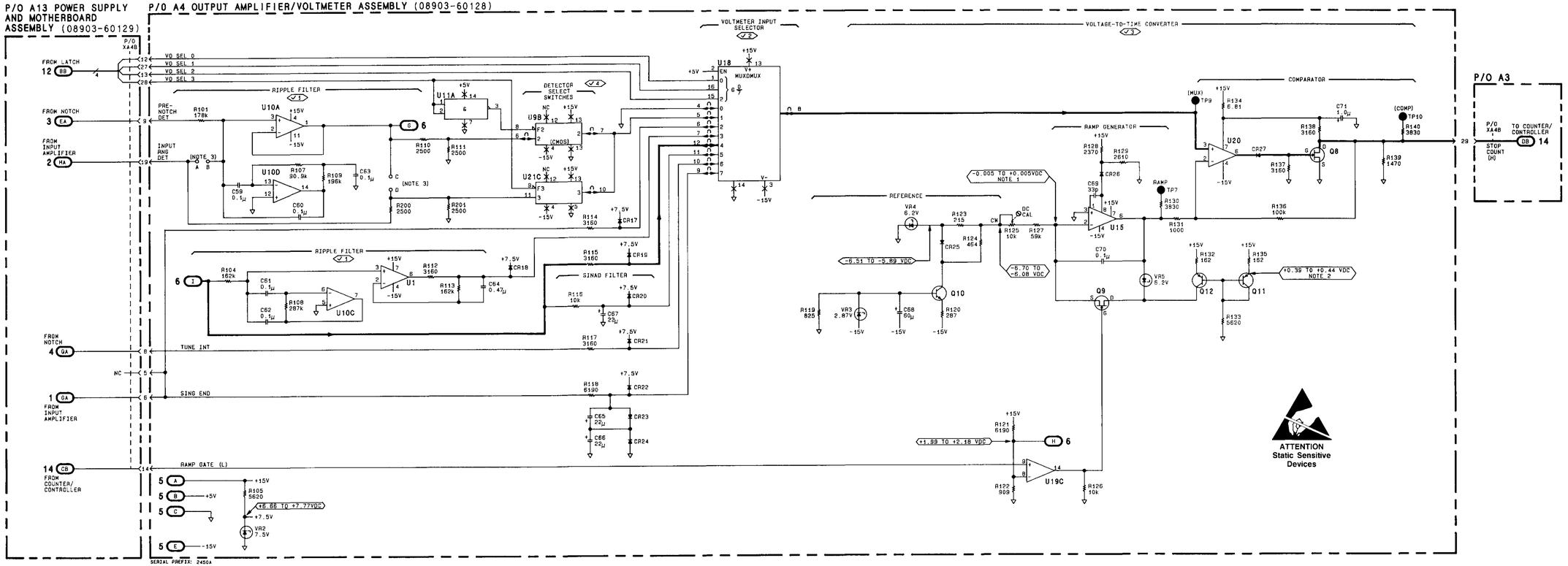


Figure 8B-118. Component Locator (8903B, 2816A and above)
Figure 8B-118. Component Locator (8903E, 2818A and above)

P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)

P/O A4 OUTPUT AMPLIFIER/VOLTMETER ASSEMBLY (08903-60128)



SS7
Figure 8B-119
8B-119

Table 8-3. Key Scan Programs

HP 9825A (HPL)	HP 85A (BASIC)
0: fxd 0	10 FIXED 0
1: rem 728; llo 7	20 REMOTE 728
2: wrt 728, "60.SP"	30 LOCAL LOCKOUT 7
3: red 728,A	40 OUTPUT 728; "60.SP"
4: dsp A; jmp −1	50 ENTER 728; A
5: end	60 DISP A
	70 GOTO 50
	80 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 19 for troubleshooting and a complete list of HP-IB mnemonics.

NOTE

Binary representations of the information in pointed brackets appear on the Audio Analyzer's displays.

N=0 Displays <0> in the left display and <Addressed to Talk>.<Addressed to Listen> in the right display. This function reads back and displays the present state of the Talk and Listen Address Flip-Flops (A9U1A and U1B). For example, if the displays show 1 and 0, the Audio Analyzer is addressed to talk (and is unaddressed to listen). This means the Talk Address Flip-Flop is set (and the Listen Address Flip-Flop is reset).

N=1 Displays <0> in the left display and <DAV>.<RFD><DAC> in the right display. 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 Audio Analyzer (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 Displays <0> in the left display and <ATN>.<REN> in the right display. 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 Displays <0> in the left display and <SPM>.<SRQ> in the right display. 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 Audio Analyzer. A 1 for either <SPM> or <SRQ> indicates the Audio Analyzer is in serial-poll mode (SPM) or that it is presently driving the SRQ bus control line.

N=4 Displays PIO Port A with the most-significant bits in the left display and the least-significant bits in the right display. This function inputs and displays (without modifying) the data at PIO port A (A9U18). Leading zeros in both displays are blanked. The display is interpreted as shown in Table 8-4.

N=5 Displays PIO Port B with the most-significant bits in the left display and the least-significant bits in the right display. This function is similar to Special Function 61.4 except PIO port B is displayed. The display is interpreted as shown in Table 8-5.

N=6 Displays the HP-IB Status Register with <SPM> <STSO> <SRQ> <LLO> in the left display and <REM> <ADRSD> <TRIG> <HOLD/DELAY> in the right display. The status register is contained in RAM.

SERVICE SHEET BD3---Source Circuits Block Diagram

PRINCIPLES OF OPERATION

General

Service Sheet BD3 covers the source circuits which consist of the oscillator and its output circuits.

Oscillator (A5)

The Oscillator is conceptually similar to the Notch Filter in that it is a state-variable design; that is, it is formed by combining various circuit blocks which perform simple mathematical functions (amplification, inversion, summation, and integration). A simplified diagram of the basic oscillator is shown in Figure 8C-1. Each integrator causes 270° phase shift (that is, 90° plus an inversion) and the Sum Amplifier and Fine Tune circuits cause an inversion. Thus, there are 720° total phase shift around the loop which gives rise to positive feedback—a necessary condition for oscillation. The output of the circuit (not shown on the simplified diagram) is taken from Integrator 1.

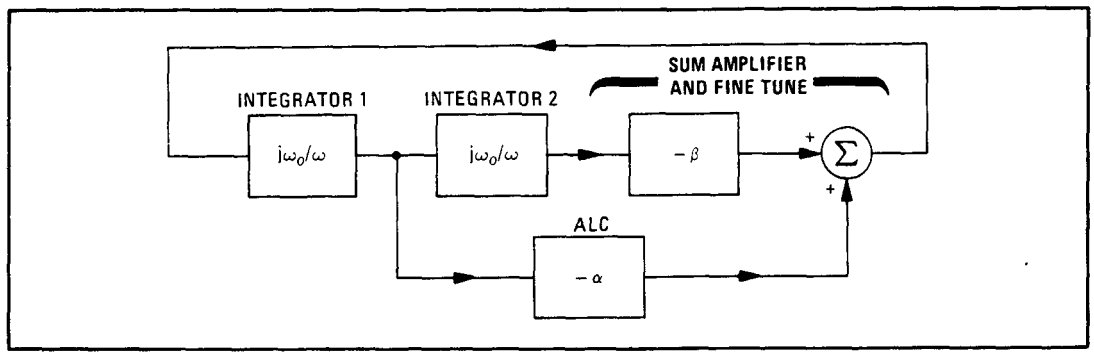


Figure 8C-1. Simplified Diagram of the Basic Oscillator

The equation governing the frequency of oscillation for the circuit is

$$s = \tfrac{1}{2}\omega_0(\alpha \pm \sqrt{\alpha^2 - 4\beta}),$$

where s is the complex frequency.

Assume for a moment that $\alpha = 0$. The radian frequency of oscillation consists only of the imaginary term and is

$$s = j\omega = j\omega_0\sqrt{\beta} = j2\pi f_0\sqrt{\beta}.$$

The frequency is coarse tuned by adjusting ω_0 in the simplified diagram (Rs and Cs in Integrators 1 and 2). Fine tuning is accomplished by adjustment of β. Tuning is done by the Controller which uses the Counter to check frequency. Special Functions 55, 56, and 57 can be used to manually set the tuning of the Oscillator.

To obtain stable, low-distortion oscillation at the prescribed frequency and level (3 Vrms) requires exact adjustment of gain α to obtain a purely imaginary term for s. If s contains a positive term, the amplitude of oscillation grows; if it contains a negative term, oscillation decays. Adjustment of α is done through the use of negative feedback in an automatic leveling control (ALC) circuit. The ALC circuit must correct for an amplitude disturbance (such as during a frequency change) within a few cycles of oscillation and yet introduce no distortion.

Refer now to Figure 8C-101. The leveling circuit consists of two Sample and Hold amplifiers, two error amplifiers, and a Level Setting Multiplier. Some of the important waveforms in the circuit are shown in Figure 8C-2. The figure shows the situation that occurs when the level suddenly decreases.

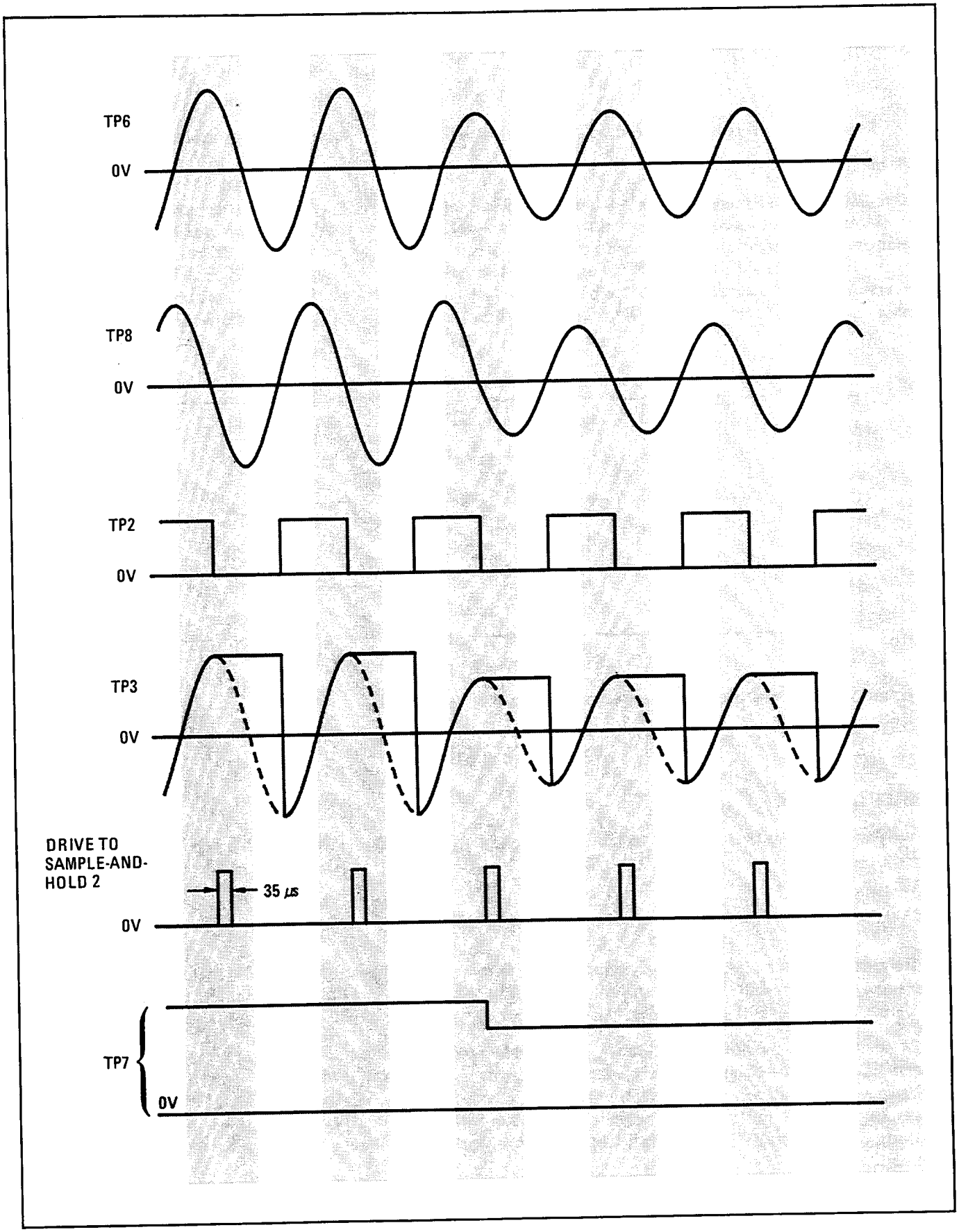


Figure 8C-2. Oscillator ALC Waveforms

The signal from Integrator 1 (at TP6) is buffered then sampled by Sample and Hold 1. The sampling switch is driven by a signal which is in phase with the output from Integrator 2 (at TP8) which lags the output of Integrator 1 by 90°. The sample switch drive voltage appears at TP2. When sampling begins (TP2 goes high), the output of Integrator 1 is at its negative peak. Sampling continues until the positive peak is reached (the negative-going zero crossing of Integrator 2) then the sampling switch opens and the peak voltage is held on a storage capacitor. (The circuit is thus a track-and-hold circuit.) The sampled signal, which has been buffered, appears at TP3. (In actuality, the buffer clips the negative peaks, but this is of little consequence.)

The negative going edge of the sample switch drive signal also triggers a 35 μs monostable multivibrator which closes the sample switch of Sample and Hold 2. The voltage from Sample and Hold 1 is then transferred to the storage capacitor of Sample and Hold 2 and then held. This signal, after being buffered, appears at TP7 and is a dc voltage equal to the peak of the signal from Integrator 1. (At high frequencies, the OR gate that drives the sampler switch holds the duty cycle at 50% even though the pulse width is less than 35 μs.)

This peak signal is compared against a very stable dc reference by the Proportional Error Amplifier. The amplified level error drives one input to the Level Setting Multiplier. The multiplier can be visualized as a variable-gain amplifier with an ac input from Integrator 1. The dc control input from the Proportional Error Amplifier controls the gain and polarity of this "amplifier". The output of the multiplier drives and input to the sum amplifier which injects a signal of the proper magnitude and phase to bring the output of Integrator 1 to the correct level.

The Proportional Error Amplifier provides coarse, fast-responding ALC action. The amplifier's output is also applied to the Error Integrator through a switch which is also driven by the 35 μs monostable multivibrator. The Error Integrator drives a second dc control input of the Level Setting Multiplier and provides exact ALC correction.

The complete loss of oscillation is sensed by the 200 ms Oscillator Restart monostable multivibrator. It is always retriggered by the signal from Integrator 2 unless the signal ceases. At that time a switch is momentarily closed to force a large restart error in the Proportional Error Amplifier. Normally, the oscillator will restart by the normal action of the ALC circuit, this circuit, however, provides a backup.

The ALC Loop Gain Adjust keeps the loop gain relatively constant regardless of signal level by adjusting the sensitivity of the multiplier to its control voltages. Thus the ALC loop reacts equally well for large or small signals which are produced momentarily during tuning.

Output Attenuator (A6)

The Oscillator is always on and outputs a constant level. The Output Attenuator circuits provide a controllable level to the OUTPUT connectors and also allow the signal to be effectively turned off.

Amplifier 1 is used for fine setting of the output level. Its gain can be programed from approximately −12 to 0 dB. The equation that governs the gain of Amplifier 1 is:

$$\text{gain} = (1 - 0.5M)\frac{N + 256}{511},$$

where N is an integer between 0 and 255 and M is either 0 or 1. In practice N is usually kept between 100 and 255 for a range of approximately 3 dB. M is set to 1 when the output is set to the "off" condition. The gain of Amplifier 1 can be manually programed by Special Functions 58 (which sets the value of N) and 59 (which sets the value of M).

Amplifier 2 is programed from approximately −17.5 to 0 dB gain in 2.5 dB steps. In the "off" condition, the gain is set to approximately −60 dB. The gain of Amplifier 2 can be manually controlled by Special Function 59.

Attenuator A is a programmable, passive voltage divider with an attenuation of 0, 20, or 40 dB and an "off" state (a short to ground). The attenuation can be manually controlled by Special Function 59.

The Output Amplifier Driver has a fixed gain of 1.9 (+5.58 dB). It prevents the Floating Output Amplifier from loading Attenuator A.

The Floating Output Amplifier has a gain of 1.12 and has differential outputs. The LOW OUTPUT connector can be conveniently grounded or floated by a front-panel switch. The output impedance of the amplifier itself is 50Ω.

Attenuator B is a floating, 50Ω attenuator which can be programed to 0 or 20 dB. The attenuation of Attenuator B can be manually controlled by Special Function 59. The impedance of the source can be set to either 50Ω or 600Ω. For instruments with serial prefix 2730A and below, this is implemented with a non-programmable front panel switch. For instruments with serial prefix 2742A and above, Special Function 47.X is used to select the output impedence. This feature enables the user to program the output impedence of the source via HP-IB as well as from the front panel.

If an external voltage exceeding +12 or −12V is applied to the HIGH or LOW OUTPUT connector, the Over-Voltage Detector opens the two relays in the output paths. The Relay Drive-One Shot holds the relays open for 1s after the over-voltage condition has been removed to prevent relay chatter if the overload signal is pulsing. The Voltage Clamp protects the output circuits from the initial overvoltage transient until the relays open.

TROUBLESHOOTING

General

Procedures for checking the source circuits of the instrument are given below. The blocks or points to check are marked on the bolck diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. The procedures assume that the measurement circuits of the instrument (for example, AC Level and Frequency) are working properly. A second Audio Analyzer is needed only if distortion is out of specification and it cannot be determined whether the instrument's source or distortion measurement is at fault. Before performing any check, perform all the checks on Service Sheet BD1.

Equipment

Audio Analyzer ..... HP 8903B or HP 339A
Oscilloscope ..... HP 1740A
Power Supply ..... HP 6215A

⟨✓1⟩ Oscillator Tuning Check

NOTE

This check assumes that the internal reference frequency is properly adjusted; see paragraph 5-7.

1. Key in 41.0 SPCL to initialize the instrument. Set the INPUT switch to ground. Set the 80 kHz LOW PASS filter off. Connect A5TP6 (OSC 1) to the HIGH INPUT with a short cable.

2. Key in 55.3 SPCL, 56.128 SPCL, and 57.128 SPCL to set the Oscillator frequency to its highest range, middle coarse tune, and middle fine tune settings. The frequency should be between 55.3 and 57.3 kHz. The amplitude should be between 2.65 and 3.05 Vrms.

Hint: If there is no signal, short A5TP9 (ALC) to A5TP6 (OSC 1). If a signal now appears with the frequency approximately correct but the amplitude is about 2 Vrms, perform ⟨✓2⟩ *Oscillator Leveling Check.* If there still is no signal, the fault probably lies with the frequency range and coarse tune circuits; continue on with the following steps to determine which tuning circuits are not responding properly.

Hint: If the signal is present at approximately the correct frequency but the level is incorrect, perform ⟨✓2⟩ *Oscillator Leveling Check* or if only slightly out of limits perform the *Oscillator and Output Attenuator Adjustment,* paragraph 5-15.

Hint: If the signal level is correct but the frequency is incorrect, continue with the following steps to determine which tuning circuits are not responding properly.

3. Key in the following Special Functions and observe the frequency. The frequency should be within the limits shown in Table 8C-1.

Table 8C-1. Frequency Limits at A5TP6, ⟨✓1⟩ Step 3

Special Functions	Frequency Limits (Hz)	
	Minimum	Maximum
55.2	6930	7810
55.1	856	887
55.0	108.7	112.7

Hint: If the frequencies for Special Functions 55.0 to 55.3 are all out of limits, continue with the following steps to determine which tuning circuits are not responding properly. If at least one frequency, but not all

frequencies, for Special Functions 55.0 to 55.3 are correct, see Service Sheet 8 and check the range switching circuits.

4. Key in 55.2 SPCL. Key in the pairs of Special Functions shown in Table 8C-2 and observe the frequency for each Special Function. Calculate the percent change in frequency between the first and second Special Function. For example, if the frequency for 56.128 SPCL is 7040.5 Hz and for 56.127 SPCL is 6994.3 Hz the percent change frequency is

$$\text{Frequency Change} = \frac{6994.3 - 7040.5}{7040.5} \times 100\% = -0.66\%.$$

The frequency change should be within the limits shown. If faulty, see Service Sheet 8 and check the coarse tune switching circuits.

Table 8C-2. Limits of Frequency Change at A5TP6, ⟨✓1⟩ Step 4

Special Functions	Limits of Frequency Change (%)	
	Minimum	Maximum
56.128, 56.127	−1.37	−0.14
56.64, 56.63	−2.13	−0.88
56.32, 56.31	−3.67	−2.38
56.16, 56.15	−6.77	−5.38
56.8, 56.7	−12.9	−11.3
56.4, 56.3	−25.8	−22.7
56.2, 56.1	−49.9	−47.9

5. Key in 56.128 SPCL. Key in 57.255 SPCL and note the frequency, then key in 57.0 SPCL and note the frequency. Calculate the ratio: (frequency for 57.255 SPCL) ÷ (frequency for 57.0 SPCL). The ratio should be between 1.105 and 1.113. If faulty, see Service Sheet 8 and check the fine tune switching circuits.

6. Key in the following pairs of Spcial Functions and check that the frequency for the second entry is higher than the frequency for the first entry. If faulty, see Service Sheet 8 and check the fine tune switching circuits.

Special Functions	Special Functions
57.254, 57.255	57.239, 57.240
57.253, 57.254	57.223, 57.224
57.251, 57.252	57.191, 57.192
57.247, 57.248	57.127, 57.128

7. Key in FREQ 20 Hz. The frequency should read between 19.94 and 20.6 Hz. If faulty, see Service Sheet 8.

8. Key in FREQ 100 kHz. The frequency should read between 99.7 and 100.3 kHz. If faulty, see Service Sheet 8.

⟨✓2⟩ Oscillator Leveling Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Connect a high-impedance, dc coupled oscilloscope to A5TP6 (OSC 1). The waveform should be an undistorted sine wave with an amplitude between 7 and 9 Vpp and a period of approximately 1 ms.

Hint: If no signal is present, short A5TP9 (ALC) to A5TP6 (OSC 1). The waveform should be a distorted sine wave with an amplitude between 6 and 8 Vpp and a period of approximately 1 ms. If there is now a signal, continue on with step 2. If there still is no signal, see Service Sheet 8 and check the analog ICs.

Hint: If the signal is proper, continue on with step 9.

2. Connect the oscilloscope to A5TP2 (S/H GATE). The waveform should be a TTL square wave with a period of approximately 1 ms. If faulty, see Service Sheet 9 and check the Zero Crossing Detector.

3. Connect the oscilloscope to A5TP3 (S/H). The waveform should be as shown in Figure 8C-3. If faulty, see Service Sheet 9 and check Sample and Hold 1.

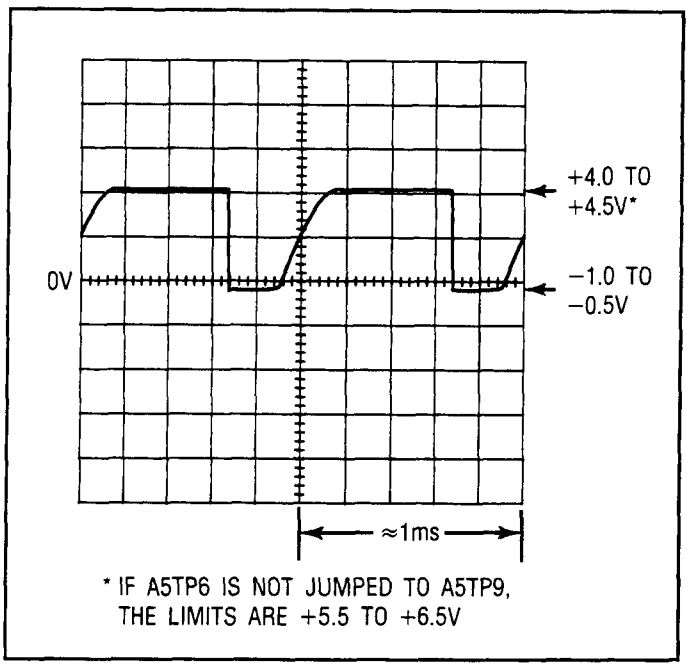


Figure 8C-3. Oscilloscope Waveform at A5TP3, ⟨J2⟩ Step 3

4. Connect the oscilloscope to A5TP7 (V PEAK). The waveform should be a dc level equal to the peak voltage noted in step 1. If faulty, see Service Sheet 9 and check Sample and Hold 2.

5. Short A5TP9 (ALC) to A5TP6 (OSC 1) if not already shorted. Connect the oscilloscope to A5TP5 (PROP ERROR). The waveform should be a dc level greater than +2 Vdc. If faulty, see Service Sheet 9 and check the Proportional Error Amplifier.

6. Short A5TP9 (ALC) to ground. The waveform should be a dc level less than −2 Vdc. If faulty, see Service Sheet 9 and check the Proportional Error Amplifier.

7. Connect the oscilloscope to A5TP11 (INT ERROR). The waveform should go to about +1 Vdc then drift slowly to 0 Vdc. If faulty, see Service Sheet 9 and check the Error Integrator.

Hint: If the signal in step 6 is correct, but the signal of step 1 was either at an incorrect level or required the jumper between A5TP6 adn A5TP9, see Service Sheet 9 and check the Level Setting Multiplier and Reference.

8. Remove the short on A5TP9. Jumper A5TP6 to A5TP9. The waveform should be less than −1 Vdc (and will have some 1 kHz ripple). If faulty, see Service Sheet 9 and check the Error Integrator. (See also the hint under step 7.)

9. Remove the jumper between A5TP6 and A5TP9, if present. Connect the oscilloscope to A5TP6. Key in FREQ 20 Hz. The waveform should be an undistorted sine wave with an amplitude of 7.5 to 9.5 Vpp and a period of approximately 50 ms. If faulty, see Service Sheet 9.

10. Key in FREQ 100 kHz. The waveform should be an undistorted sine wave with an amplitude of 7.5 to 9.5 Vpp and a period of approximately 10 μs. If faulty, see Service Sheet 9.

⟨✓3⟩ Output Attenuator Check

1. Key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Set IMPEDANCE to 600Ω.

NOTE

In the following checks the limits of the levels measured assume a source loading of 100 kΩ (the impedance of the HIGH INPUT). Use of a high-impedance ac voltmeter may give erroneous readings.

2. Connect A5TP6 (OSC 1) to the HIGH INPUT. The amplitude should be between 2.7 and 3.0 Vrms and the frequency should be approximately 1 kHz. If the frequency is faulty, see Oscillator Tuning. If the amplitude is faulty, see ⟨✓2⟩ *Oscillator Leveling Check.*

3. Press RATIO. Connect A6TP6 (AMP 1) to the HIGH INPUT. Key in 59.0 SPCL and the Special Functions listed in Table 8C-3. For each setting, the amplitude ratio should be within the limits indicated. If faulty, see Service Sheet 10 and check Amplifier 1.

Table 8C-3. Amplitude Ratio Limits at A6TP6, ⟨✓3⟩ Step 3

Special Function	Amplitude Ratio Limits (%)	
	Minimum	Maximum
58.255	100.40	101.40
58.127	75.25	76.00
58.63	62.67	63.30
58.31	56.39	56.95
58.15	53.24	53.78
58.7	51.67	52.19
58.3	50.89	51.40
58.1	50.49	51.00
58.0	50.30	50.80

4. Key in 58.255 SPCL and 59.32 SPCL to activate the "off" state. The relative amplitude should be between 50.2 and 50.7%.

5. Key in 59.0 SPCL. Press RATIO twice to establish a new reference. Connect A6TP5 (AMP 2) to the HIGH INPUT.

6. Key in the Special Functions listed in Table 8C-4. For each setting, the amplitude ratio should be within the limits indicated. If faulty, see Service Sheet 10 and check Amplifier 2.

7. Key in 59.0 SPCL. Press RATIO twice. Connect A6TP4 (AMP 3) to the HIGH INPUT.

8. Key in the Special Functions listed in Table 8C-5. For each setting, the amplitude ratio should be with in the limits indicated. If faulty, see Service Sheet 10 and check Attenuator A and the Output Amplifier Driver.

9. Key in 59.0 SPCL. Press RATIO twice. Connect A6TP3 (FLT HI) to the HIGH INPUT. The relative amplitude should be between 111 and 113%. If faulty, see Service Sheet 11 and check the Floating Amplifier.

10. Connect the HIGH OUTPUT to the HIGH INPUT. The relative amplitude should remain between 111 and 112%. If faulty, see Service Sheet 11 and check Attenuator B.

11. Press RATIO twice. Key in 59.8 SPCL. The relative amplitude should be between 9.9 and 10.1%. If faulty, see Service Sheet 11 and check Attenuator B.

Table 8C-4. Amplitude Ratio Limits at A6TP5, ⟨✓3⟩ Step 6

Special Function	Amplitude Ratio Limits (%)	
	Minimum	Maximum
59.0	98.33	99.32
59.1	73.75	74.49
59.2	55.29	55.84
59.3	41.49	41.91
59.4	31.09	31.41
59.5	23.32	23.55
59.6	17.49	17.67
59.7	13.12	13.25
59.32	–	0.10

Table 8C-5. Amplitude Ratio Limits at A6TP4, ⟨✓3⟩ Step 8

Special Function	Amplitude Ratio Limits (%)	
	Minimum	Maximum
59.0	188	192
59.16	18.8	19.2
59.24	1.88	1.92
59.32	–	0.01

12. Key in 59.0 SPCL. Set IMPEDANCE to 50Ω. The relative amplitude should raise by 0.6% (to a nominal 100.6%). If faulty, see Service Sheet 11 and check the impedance switch relay.

13. Press RATIO twice. Connect the HIGH INPUT to the LOW OUTPUT. Set the LOW OUTPUT switch to FLOAT. Short the center conductor of the HIGH OUTPUT connector to ground. The right display should read between 94.7 and 95.7%. If faulty, see Service Sheet 11 and check the Floating Output Amplifier.

14. Disconnect the short from the HIGH OUTPUT connector. Press S (Shift) DC LEVEL. Connect a dc power supply to the HIGH INPUT. Set the supply to +12.5 to +13.5 Vdc.

15. Connect the power supply to the HIGH OUTPUT then the LOW OUTPUT. For each connection relay K2 should audibly click when the supply is connected then click again 1s after it is removed. If faulty, see Service Sheet 11 and check the Over-Voltage Protect circuits.

16. Connect the power supply again to the HIGH INPUT. Set the supply to −13.5 and −12.5 Vdc.

17. Repeat step 15.

⟨✓4⟩ Source Distortion Check

NOTE

This check is used to pinpoint the source of distortion when it is slightly out of specification. Use an external distortion analyzer unless it is known that the internal distortion analyzer is operating properly.

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 6 V.

2. Connect a distortion analyzer to the test points listed in Table 8C-6 and measure the distortion. Set the low-pass filter of the distortion analyzer to 30 kHz. The distortion should be less than 0.01% in each case. If faulty, see the service sheet and check the circuits listed in Table 8C-6.

Table 8C-6. Source Distortion Troubleshooting, ⟨J4⟩ Step 2

Test Point	Service Sheet	Most Probable Cause
A5TP6 (OSC 1)	9	Oscillator Leveling
A6TP6 (AMP 1)	10	Amplifier 1
A6TP5 (AMP 2)	10	Amplifier 2
A6TP4 (AMP 3)	10	Output Amplifier Driver
HIGH OUTPUT	11	Floating Output Amplifier

SERVICE SHEET 8---A5 Oscillator Assembly (State-Variable Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Oscillator Assembly (A5) contains the basic state-variable circuitry which generates a signal at a specific frequency. (See the discussion of the Oscillator on Service Sheet BD3.) It includes two integrators, a fine tune circuit, a sum amplifier, and their control circuitry.

Integrators

The two integrators are nearly identical. A simplified diagram of an integrator is shown in Figure 8B-32 (in the discussion of the Notch Filter). For Integrator 1, FETs Q12 through Q14 switch the feedback capacitors to change ranges. FETs Q4 through Q11 switch the input resistors to coarse tune the oscillator. The FETs are driven by the Oscillator Control Drivers whose control inputs come from the Controller via the Latch Assembly (see Service Sheet 12).

Fine Tune

Fine tuning is accomplished by varying the total amount of input current from Integrator 2 into the Sum Amplifier U5. The Fine Tune circuit inverts the output from Integrator 2. Its gain is determined by the closing of FETs Q28 to Q31 and the switches of U19. The output of U12B produces a current in R60 of opposite polarity to the current in R57.

Sum Amplifier

The Sum Amplifier sums the currents from Integrator 2 and the Fine Tune via R57 and R60 and the current from the ALC circuit (see Service Sheet 9). The currents from Integrator 2 affect the Oscillator frequency, and the current from the ALC circuit affects the level.

TROUBLESHOOTING

General

Procedures for checking the Oscillator Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the measurement circuits of the instrument (for example, ac level and frequency) are working properly.

Equipment

Oscilloscope ..... HP 1740A

⟨✓1⟩ Tuning Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in AMPTD 3 V. Key in 55.3 SPCL, 56.255 SPCL, and 57.255 SPCL to set the Oscillator frequency to its highest range, coarse tune, and fine tune settings. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, dc coupled oscilloscope to A5TP6 (OSC 1), A5TP8 (OSC 2), then A5TP4 (OSC 3). Use a low-capacitance 10:1 divider probe. The dc level should be between −50 and +50 mVdc at A5TP6 and A5TP4 and between −250 and +250 mVdc at A5TP8. The ac level at A5TP6 and A5TP8 should be between 8.3 and 8.7 Vpp. The frequency should be between 110 and 130 kHz.

Hint: If the dc level is out of limits, check U4, U5, and U11. The amplifiers are connected in a negative dc feedback loop; a failure in one amplifier will upset the bias of the others. Check that the output voltages have the proper sense. (For example, a positive offset at pin 2 of U4 should result in a negative output at pin 6. It should approach −15V.)

Hint: If the dc level is correct but there is no ac signal, short A5TP9 (ALC) to A5TP6. If a signal now appears with the frequency approximately correct but an amplitude of about 5.5 Vpp, see Service Sheet 9 and check the Oscillator leveling circuits. The signal will be distorted.

Hint: If the dc and ac levels are correct but the frequency is incorrect, continue with the following steps to determine which tuning circuits are not responding properly.

3. On the Audio Analyzer, key in the Special Functions listed in Table 8C-7. For each setting, connect the oscilloscope to the drains of the FETs indicated. (Use a probe.) A signal of several volts should be present when 55.3 SPCL is keyed in, but not when the Special Function listed is keyed in. If the signal is faulty, also check the control line indicated. (All control lines should be −15V for 55.3 SPCL.)

Table 8C-7. Check of FET Drains, ⟨✓1⟩ Step 3

Special Function	Drains to Check	Level (Vdc) at U18 Pin		
		1	2	14
55.2	Q12, Q25	0	−15	−15
55.1	Q13, Q26	−15	0	−15
55.0	Q14, Q27	−15	−15	0

4. On the Audio Analyzer, key in 55.2 SPCL. Key in the Special Functions listed in Table 8C-8. For each setting, connect the oscilloscope to the drains of the FETs indicated. A signal of several volts should be present when the Special Function is keyed in, but not when 56.255 is keyed in. If the signal is faulty, also check the control lines indicated. (All control lines should be 0 Vdc for 56.255 SPCL.)

Table 8C-8. Check of FET Drains, ⟨√1⟩ Step 4

Special Function	Drains to Check	Level (Vdc) at U17 Pin				Level (Vdc) at U16 Pin			
		2	14	13	1	2	1	13	14
56.254	Q6, Q19	0	0	0	0	0	0	0	−15
56.253	Q7, Q20	0	0	0	0	0	0	−15	0
56.251	Q4, Q17	0	0	0	0	0	−15	0	0
56.247	Q5, Q18	0	0	0	0	−15	0	0	0
56.239	Q8, Q21	0	0	0	−15	0	0	0	0
56.223	Q11, Q24	0	0	−15	0	0	0	0	0
56.191	Q10, Q23	0	−15	0	0	0	0	0	0
56.127	Q9, Q22	−15	0	0	0	0	0	0	0

5. On the Audio Analyzer, key in 56.255 SPCL. Key in the Special Functions listed in Table 8C-9. For each setting, connect the oscilloscope to the drain of the FET indicated. A signal of several volts should be present when the Special Function is keyed in, but not when 57.0 is keyed in. If the signal is faulty, also check the control lines indicated. (All control lines should be 0 Vdc for 57.0 SPCL.)

Table 8C-9. Check of FET Drains, ⟨√1⟩ Step 5

Special Function	Drain to Check	Level (Vdc) at U20 Pin			
		2	1	14	13
57.128	Q31	0	0	0	−15
57.64	Q30	0	0	−15	0
57.32	Q29	0	−15	0	0
57.16	Q28	−15	0	0	0

6. On the Audio Analyzer, key in the Special Functions listed in Table 8C-10. For each setting, connect the oscilloscope to the pin of U19 indicated. A signal of several volts should be present when the Special Function is keyed in, but not when 57.15 is keyed in. If the signal is faulty, also check the control lines indicated. (All control lines should be a TTL high for 57.15 SPCL.)

Table 8C-10. TTL Levels at A5U19, ⟨√1⟩ Step 6

Special Function	Pin On U19 to Check	Level (TTL) at U19 Pin			
		1	8	9	16
57.7	15	H	H	H	L
57.11	10	H	H	L	H
57.13	7	H	L	H	H
57.14	2	L	H	H	H

Hint: This step concludes a check of the functioning of the tuning circuits. If the fault is excessive distortion (particularly at low frequencies), the cause may be a leaky FET switch. The particular FET can be ascertained by observing which switch is on when the distortion goes away. If the fault is a frequency error as observed in the *Oscillator Tuning Check* of Service Sheet BD3, the faulty resistor or FET switch can be ascertained by noting which Special Functions give correct readings and which do not. Table 8C-11 should assist in correlating the Special Functions and range switches.

Table 8C-11. Special Function 55.N Vs. Range Switches Closed, ⟨J1⟩ Step 6 Hint

Special Function	Switches Closed
55.3	None
55.2	Q12, Q25
55.1	Q13, Q26
55.0	Q14, Q27

Table 8C-12 should assist in correlating the Special Functions and the coarse-tune switches.

NOTE

For Special Function 56.N, let N=N8+N7+N6+N5+N4+N3+N2+N1. The value of N determines which switches are closed. For example, 56.18 SPCL will close Q8, Q21, Q7, and Q20. N5+N2=16+2=18.

Table 8C-12. Special Function 56.N Vs. Coarse-Tune Switches Closed, ⟨J1⟩ Step 6 Hint

Component of N	Value	Switches Closed
N8	128	Q9, Q22
N7	64	Q10, Q23
N6	32	Q11, Q24
N5	16	Q8, Q21
N4	8	Q5, Q18
N3	4	Q4, Q17
N2	2	Q7, Q20
N1	1	Q6, Q19

Table 8C-13 should assist in correlating the Special Functions and the fine-tune switches.

NOTE

For Special Function 57.N, let N=255-(N8+N7+N6+N5+N4+N3+N2+N1). The value of N determines which switches are closed as follows. For example, 57.237 SPCL closes switches U19D and U19B. 255-N5-N2=255-16-2=237.

Table 8C-13. Special Function 57.N Vs. Fine-Tune Switches Closed, ⟨J1⟩ Step 6 Hint

Component of N	Value	Switch Closed
N8	128	Q31
N7	64	Q30
N6	32	Q29
N5	16	Q28
N4	8	U19D
N3	4	U19C
N2	2	U19B
N1	1	U19A

7. On the Audio Analyzer, ground A5TP9 (ALC). Key in 55.3 SPCL, 56.1 SPCL, and 57.0 SPCL. Connect the oscilloscope to A5TP6. The waveform should be less than 2 mVpp and between −50 and +50 mVdc.

Hint: If the signal is too large, an FET switch is leaking. A leaking FET will cause excessive distortion at 20 Hz.

SERVICE SHEET 9---A5 Oscillator Assembly (ALC Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Oscillator Assembly (A5) contains the ALC circuitry which senses the level of the output and injects into the oscillator circuitry a signal of proper phase and amplitude to correct for any error in the Oscillator output level.

Sample-and-Hold Circuits

The output of the sample-and-hold circuits is a dc voltage equal to the positive peak of the Oscillator output. The sample switch, FET Q16, of Sample-and-Hold 1 is driven in quadrature with the signal which is to be sampled. The quadrature drive comes from Integrator 2 of the Oscillator (see Service Sheet 8) via the Zero-Crossing Detector. The Zero-Crossing Detector produces a low output whenever its input is less than 0V. R67 and R70 provide a small amount of hysteresis to assure a rapid and complete output transition once it begins. The output is inverted by NOR gate U1B and translated to a level compatible with Q16 by U8D. A low on the output of U8D (−15V) turns Q16 off; a high (output off) permits Q16 to be turned on by the low gate-to-source resistance of R84.

The signal to be sampled comes from Integrator 1 of the Oscillator. It is buffered by a unity-gain amplifier, U9 and Q2. Q2 boosts the current-drive capability of the amplifier since it must drive a capacitor, C39, when Q16 is on. Sampling begins at the negative peak of the input signal and continues to the positive peak when Q16 shuts off—holding the signal peak on C39. (CR5 actually clamps the negative level to −0.6V.) The circuit thus performs a track-and-hold function. The peak dc voltage is buffered by a high-impedance, unity-gain amplifier, U13.

The sampled peak is further sampled by Sample-and-Hold 2. The sample-and-hold switch, FET Q15, is also driven by the quadrature signal, but the length of the drive pulse is shortened to 35 μs or less by U1C. Monostable multivibrator U7A is triggered by the quadrature signal. Its duration is 35 μs. Its low-true output is combined with the quadrature signal in NOR gate U1C. Should the half-period of the quadrature signal be less than 35 μs, U7A is retriggered before its timeout is completed. The output pulses of U1C, then, have a duration less than 35 μs.

The output from U1C is translated to a level compatible with Q15 by U8C (similar to U8D). A signal out of phase with the output to the gate of Q15 is fed through C46 to cancel the turn-on spikes created by the junction capacitances of Q15. The guard traces surrounding the ungrounded nodes of C39 and C45 hold the surrounding printed circuit board area at a potential that is approximately equal to the level being held on the capacitors. Leakage currents, caused by potential differences near the capacitors, thus flow to the guard trace and to the output of U13 or U14 rather than to the capacitor. The sampled output is buffered by U14.

Level Error Amplifiers and Level Setting Multiplier

The ac signal from the Oscillator is fed into one input (−X) of the Level Setting Multiplier (U6, U12A, and associated components). The multiplier, U6, acts as a variable-gain amplifier. The gain of the multiplier is proportional to the difference in voltage between the two Y inputs. The sense of the gain (that is, inverting or non-inverting) is determined by the sign of the difference in the two voltages.

The dc output of the sampler, which is equal to the peak of the ac signal from the Oscillator, is compared to a Reference. The difference between the dc level and the Reference is amplified by the Proportional Error Amplifier, U10B, and is fed into the −Y input of the multiplier. U10B has a gain of 2. (The ALC circuit is designed to react to a change in level in less than one cycle of the input signal.)

The level error voltage from U10B is also integrated and inverted by the Error Integrator, U15, and fed into the +Y input of the multiplier. This integrator gives the ALC loop high gain for long-term level accuracy. It, however, reacts slowly to level errors. The input to the Error Integrator is applied only briefly (for 35 μs or less) each cycle by FET Q3. This provides an integration function over most of the frequency range of the Oscillator.

The overall gain of the multiplier is further controlled by the current into the IX input. This current is produced by common-base stage Q1. The current is proportional to the voltage at the output of U14. The additional control holds the gain of the ALC loop more nearly constant as a function of level. This is particularly important when large amplitude perturbations occur such as when the Oscillator range is changed.

The output of the multiplier is a current. U12A forms a transresistance amplifier which converts the differential current to a single-ended voltage. The output drives the Sum Amplifier of the Oscillator (see Service Sheet 8).

Reference

The Reference produces a temperature-stable voltage which the Proportional Error Amplifier compares with the dc voltage from Sample-and-Hold 2. The voltage is derived from voltage reference diode VR5. The voltage across R98 and R102 is the same as across VR5. The current produced in these resistors flows into R97 and produces a constant voltage. The voltage at the output of U10A is equal to the voltage across R97, R98, and R102 and is set (by adjustment of R102) to equal twice the desired peak voltage of the Oscillator.

Oscillator Restart

Monostable multivibrator U7B is normally retriggered by the signal from the Oscillator (via the Zero-Crossing Detector). If the input frequency drops below 5 Hz (corresponding to a period of 200 ms), U7B times out and switches on FET Q34 (via Q33 and Q32). This pulls the non-inverting (+) input of U10B down to approximately 2.4V minus the voltage across VR3. The abnormally low voltage at U10B creates a large error which, by the action of the ALC loop, restarts the Oscillator. (The Oscillator is assumed to be stopped if the frequency is below 5 Hz.)

TROUBLESHOOTING

General

Procedures for checking the Oscillator Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the measurement circuits of the instrument (for example, ac level and frequency) are working properly.

Equipment

Oscilloscope ..... HP 1740A

⟨✓1⟩ Oscillator Leveling Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Short A5TP9 (ALC) to A5TP6 (OSC 1).

2. Connect a high-impedance, dc coupled oscilloscope to A5TP2 (S/H GATE). The waveform should be a TTL square wave with a period of approximately 1 ms.

Hint: If no signal is present, check A5TP8 (OSC 2). The waveform should be a sine wave with an amplitude between 12 and 13 Vpp. If no signal is present, see Service Sheet 8 and check Oscillator tuning. If signal is present at A5TP8 but at the wrong level, continue on with the following steps.

Hint: If signal is present but at the wrong frequency, see Service Sheet 8 and check Oscillator tuning.

3. Connect the oscilloscope to pin 2 of U9. The waveform should be as shown in Figure 8C-4.

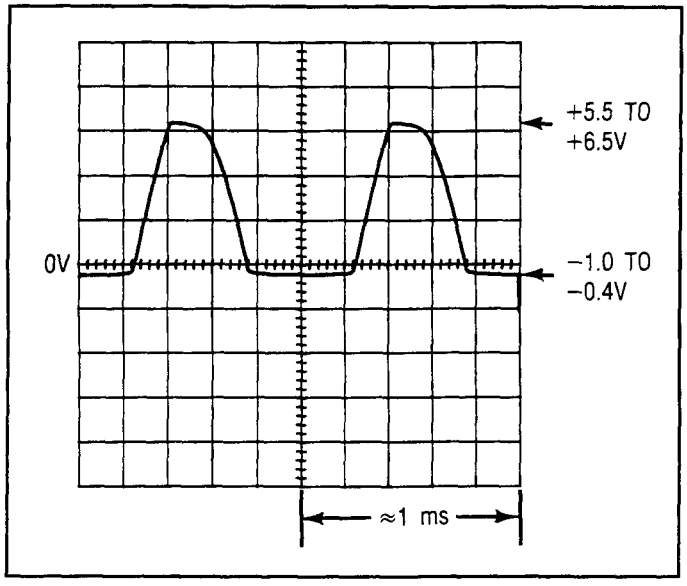


Figure 8C-4. Waveform at Pin 2 of U9, ⟨✓1⟩ Step 3

4. Connect the oscilloscope to pin 14 of U8D. The waveform should be as shown in Figure 8C-5.

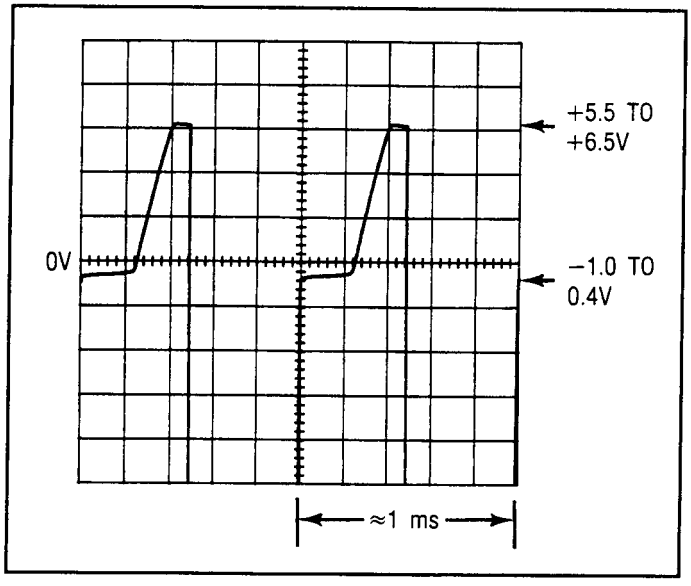


Figure 8C-5. Waveform at Pin 14 of U8D, ⟨✓1⟩ *Step 4*

5. Connect the oscilloscope to A5TP3 (S/H). The waveform should be as shown in Figure 8C-6.

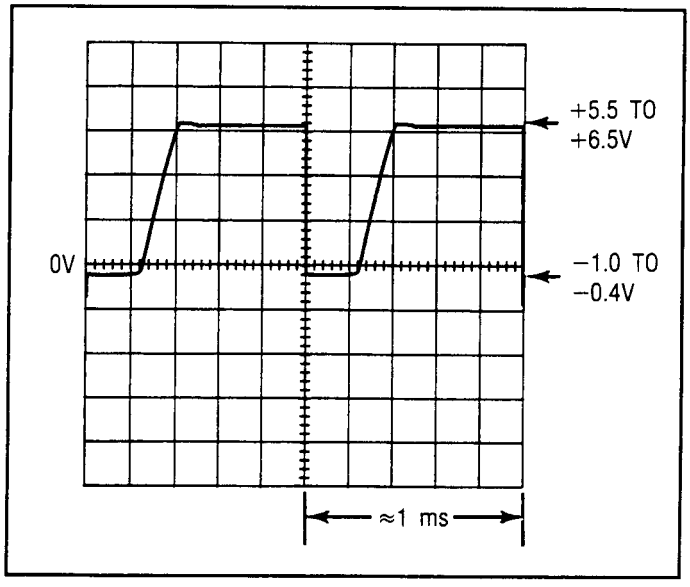


Figure 8C-6. Waveform at A5TP3, ⟨✓1⟩ *Step 5*

6. Connect the oscilloscope to pin 13 of U8C. The waveform should be as shown in Figure 8C-7.

7. Connect the oscilloscope to A5TP7 (V PEAK). The waveform should be a dc signal with a level equal to the peak level of the signal at A5TP3 (see step 5).

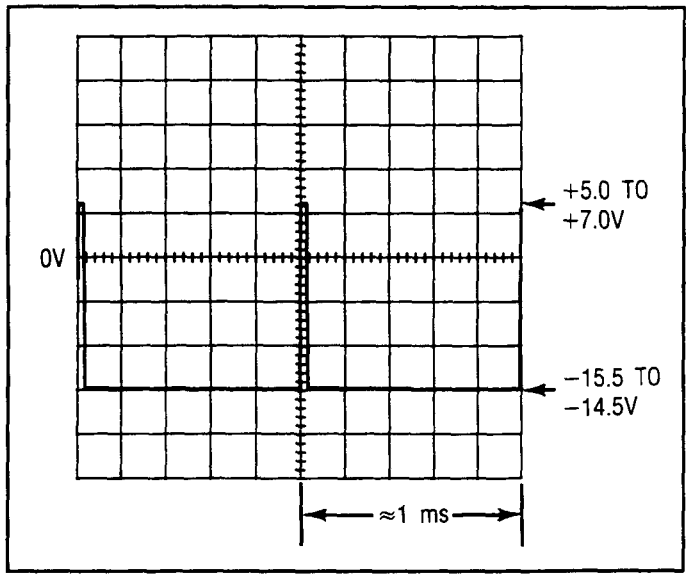


Figure 8C-7. Waveform at Pin 13 of U8C, ⟨J1⟩ Step 6

8. Connect the oscilloscope to pin 1 of U10A. The dc level should be between +7.8 and +8.2 Vdc.

Hint: If the level is only slightly out of limits, perform the *Oscillator and Output Attenuator Adjustment*, paragraph 5-15.

9. Connect the oscilloscope to A5TP5 (PROP ERROR). The dc level should be between +3.2 and +3.7 Vdc.

Hint: If the level is faulty, measure the voltage at pin 5 of U10B. It should be the same as that observed in step 8. If it is not, also check pin 5 of U7B; it should be a TTL high; Q32 and Q33 should be on; and Q34 should be off. (If Q34 is on, pin 5 of U10B will be approximately +2.3 Vdc and the output of U10B, if working properly, will be approximately −3.7 Vdc.)

10. Connect the oscilloscope to A5TP11 (INT ERROR). The waveform should be as shown in Figure 8C-8.

Hint: The waveform at pin 2 of U8B should be pulses with a 1 ms period, width approximately 35 μs, upper peak approximately +3V, and lower peak approximately −15V.

11. Connect the oscilloscope to pin 1 of U12A. The waveform should be as shown in Figure 8C-9.

Hint: The voltage at pin 2 of U6 should be approximately +10 Vdc with an ac waveform superimposed having an amplitude of 0.8 Vpp. (The shape of the waveform should be the same as shown above.) The voltage at pin 14 of U6 should be approximately +10 Vdc with an ac waveform superimposed having an amplitude of 1.7 Vpp. The output of U12A should equal 2.6 times the difference in voltage between pin 14 and pin 2 of U6. (Note that the ac waveform at pins 14 and 2 of U6 are out of phase with each other; thus the ac output of U12A is 2.6 times the sum of the peak-to-peak voltages at pin 14 and pin 2 of U6.)

Hint: The voltage drop across R119 should be 2.9 Vdc.

Hint: This step concludes a check of the function of the leveling circuits with the leveling loop open. The following steps check the closed-loop performance.

12. Remove the short between A5TP9 and A5TP6. Connect the oscilloscope to A5TP6. The waveform should be an undistorted sine wave with an amplitude between 7.8 and 8.2 Vpp.

Hint: If the steps up to 11 give positive results, but step 12 is out of limits, the problem may lie with the loop dynamics. Look for RF oscillations in the amplifiers of the loop. If distortion is excesive, check U6.

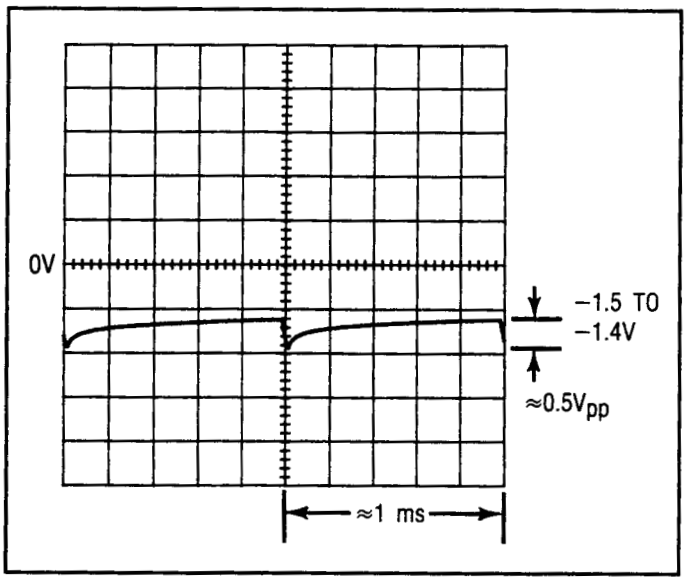


Figure 8C-8. Waveform at A5TP11, √1 Step 10

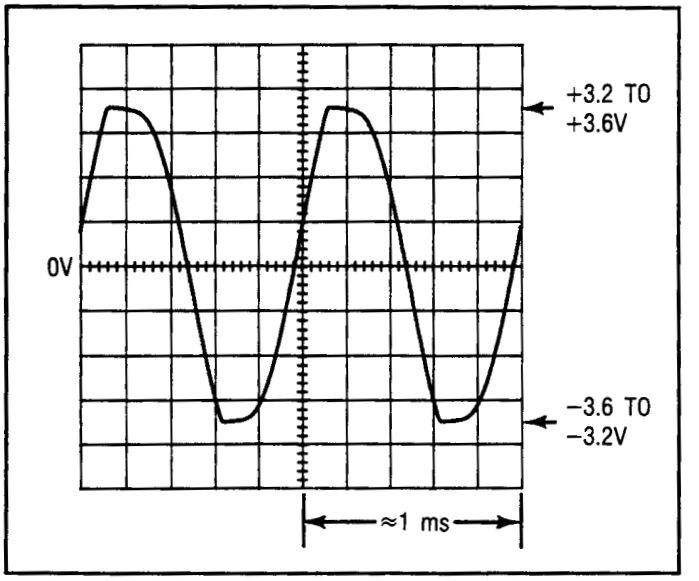


Figure 8C-9. Waveform at Pin 1 of U12A, √1 Step 11

13. Set the oscilloscope to a slow sweep rate. Short pin 3 of U10A to ground rapidly several times in succession and observe the oscilloscope. When the pin is grounded, the amplitude should drop to about 6 Vpp. When the waveform changes level (either higher or lower), the change should appear to be instantaneous and have less than 0.5V overshoot or undershoot.

SERVICE SHEET 10---A6 Output Attenuator Assembly (Input Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Output Attenuator Assembly (A6) contains two programmable-gain amplifiers, a programmable attenuator, and a fixed-gain amplifier. The input to the circuits comes from the output of the Oscillator.

Amplifier 1

Amplifier 1 provides gain programmable in fine steps. U9 is configured as an inverting operation amplifier; the amplifier's maximum gain is 1. The gain is determined by the setting of DAC U13 which controls the feedback of the high-gain, differential amplifier U9. Refer to Figure 8C-10, which shows the interaction of U13 and U9 in a simplified form. The DAC is programed by lines AT AMP 0 through AT AMP 7 and AT OFF. When AT OFF is high, the gain setting is reduced an additional 6 dB. CR1 and CR2 protect U13 from static discharge. C11 frequency compensates the amplifier.

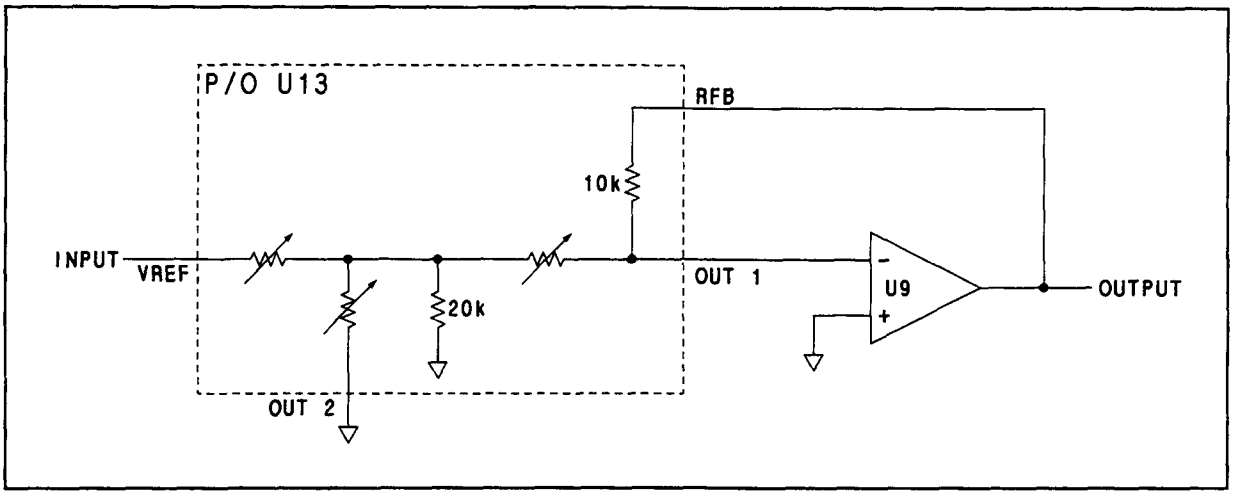


Figure 8C-10. Simplified Diagram of Amplifier 1

Amplifier 2

Amplifier 2 provides gain programmable in 2.5 dB steps from approximately −17.5 to 0 dB. Operation of Amplifier 2 is similar to Amplifier 1. The DAC (U10) is programed by lines AT AMP 8 through AT AMP 11 and AT OFF. These control lines, however, are further decoded by two ROMS (U11 and U12) to introduce a slight gain offset to compensate a quantization error in the 2.5 dB gain steps. When AT OFF is high, the gain of Amplifier 2 becomes approximately −60 dB.

Attenuator A

Attenuator A is a programmable 0, 20, and 40 dB voltage divider. It is programed by lines AT AMP 8 through AT AMP 12 and AT OFF as decoded by ROM U11 and the NAND gates of U14. When AT OFF is high, switch U15D shorts the attenuator output to ground.

Output Amplifier Driver

The amplifier formed by Q5 and U3 has a gain of 1.9. The high input impedance of the FETs of Q5 prevents loading of Attenuator A. Variable resistor (OUTPUT OFFSET ADJ) R32 adjusts the overall, dc coupled output chain for 0 Vdc offset.

TROUBLESHOOTING

General

Procedures for checking the Output Attenuator Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the measurement circuits of the instrument (for example, ac level and frequency) are working properly.

Equipment

Oscilloscope ..... HP 1740A

⟨✓1⟩ Amplifier and Attenuator Check

1. Key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground.

NOTE

In the following checks the limits of the levels measured assume a source loading of 100 kΩ (the impedance of the HIGH INPUT). Use of a high-impedance ac voltmeter may give erroneous readings.

2. Connect A5TP6 (OSC 1) to the HIGH INPUT. The amplitude should be between 2.67 and 2.95 Vrms and the frequency should be approximately 1 kHz.

Hint: If the signal is faulty, see Service Sheet 8 and check the Oscillator tuning.

3. Press RATIO. Connect A6TP6 (AMP 1) to the HIGH INPUT. Key in 59.0 SPCL and the Special Functions listed in Table 8C-14. For each setting, the amplitude ratio should be within the limits indicated. If the signal is faulty, also check the control lines indicated.

Table 8C-14. Amplitude at A6TP6, ⟨✓1⟩ Step 3

Special Function	Amplitude Ratio Limits (%)		Level (TTL) at U13 Pin								
	Minimum	Maximum	12	11	10	9	8	7	6	5	4
58.255	100.40	101.40	H	H	H	H	H	H	H	H	H
58.127	75.25	76.00	H	H	H	H	H	H	H	L	H
58.63	62.67	63.30	H	H	H	H	H	H	L	L	H
58.31	56.39	56.95	H	H	H	H	H	L	L	L	H
58.15	53.24	53.78	H	H	H	H	L	L	L	L	H
58.7	51.67	52.19	H	H	H	L	L	L	L	L	H
58.3	50.89	51.40	H	H	L	L	L	L	L	L	H
58.1	50.49	51.00	H	L	L	L	L	L	L	L	H
58.0	50.30	50.80	L	L	L	L	L	L	L	L	H

4. Key in 58.255 SPCL and 59.32 SPCL to activate the "off" state. The right display should read between 50.2 and 50.7%.

Hint: Pin 4 of U13 should be a TTL low. Pins 5 through 12 of U13 should be TTL highs.

5. Key in 59.0 SPCL. Press RATIO twice to establish a new reference. Connect A6TP5 (AMP 2) to the HIGH INPUT.

6. Key in the Special Functions listed in Table 8C-15. For each setting, the amplitude ratio should be within the limits indicated. If the signal is faulty, also check the control lines indicated.

Table 8C-15. Amplitude at A6TP5, ⟨✓1⟩ Step 6

Special Function	Amplitude Ratio Limits (%)		Level (TTL) at U12 Pin											Level (TTL) at U11 Pin			
	Minimum	Maximum	10	11	12	13	14	9	7	6	5	4	1	9	7	6	5
59.0	98.33	99.32	L	L	H	H	H	H	H	H	H	H	H	L	H	L	L
59.1	73.75	74.49	H	L	H	H	H	H	L	H	H	H	H	L	H	H	H
59.2	55.29	55.84	L	H	H	H	H	H	L	L	L	H	H	H	L	L	H
59.3	41.49	41.91	H	H	H	H	H	L	H	H	L	H	L	H	L	H	H
59.4	31.09	31.41	L	L	L	H	H	L	H	L	H	L	L	L	L	L	L
59.5	23.32	23.55	H	L	L	H	H	L	L	H	H	H	H	L	L	L	L
59.6	17.49	17.67	L	H	L	H	H	L	L	H	L	H	H	L	H	L	L
59.7	13.12	13.25	H	H	L	H	H	L	L	H	L	L	L	L	H	H	H
59.32	–	0.10	L	L	H	H	L	L	L	L	L	L	L	L	L	L	L

7. Key in 59.0 SPCL. Press RATIO twice. Connect A6TP4 (AMP 3) to the HIGH INPUT.

8. Key in the Special Functions listed in Table 8C-16. For each setting, the amplitude ratio should be with in the limits indicated. If the signal is faulty, also check the control lines indicated.

Table 8C-16. Amplitude at A6TP4, ⟨✓1⟩ Step 8

Special Function	Amplitude Ratio Limits (%)		Level (TTL) at IC Pin							
			U14							U5
	Minimum	Maximum	13	12	10	4	11	8	6	16
59.0	188	192	H	H	H	L	L	H	H	H
59.16	18.8	19.2	L	H	H	L	H	L	H	H
59.24	1.88	1.92	L	H	L	H	H	H	L	H
59.32	–	0.01	H	L	L	L	H	H	H	L

Hint: The gain of the Output Amplifier Driver should be 1.9.

SERVICE SHEET 11---A6 Output Attenuator Assembly (Output Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Output Attenuator Assembly (A6) contains the Floating Output Amplifier, Attenuator B, and Over-Voltage Protection. The output is floating (that is, not referenced to ground) unless chassis-mounted switch S2 is closed.

Floating Output Amplifier

The Floating Output Amplifier is a single-ended-to-differential converter. Conversion is accomplished by a precise combination of negative feedback, positive feedback, and cross-coupling which yields a symmetrical differential output with high common-mode rejection and a well-defined output impedance of 50Ω. The complexity of the circuit makes detailed analysis difficult. (For a more detailed discussion, see *Hewlett-Packard Journal,* August 1980, pp. 12, 13.)

Output transistors Q1 through Q4 boost the current drive capability of differential amplifiers (U1 and U2). Constant-current sources CR23 through CR26 provide bias current for diodes CR4 through CR7 and the bases of Q1 through Q4. CR4 through CR7 thermally compensate the base-emitter junctions of Q1 through Q4.

When relay K4 is open, R103 adds another 550Ω to the output impedance to the amplifier's output to bring the total impedance to 600Ω. R89 references the amplifier at ground when the output connectors are floating. Diodes CR8 through CR11 and CR19 through CR22 protect the Floating Output Amplifier from reverse-voltage transients while the over-voltage protection relays deactivate. The diodes are referenced to −12 or +12V generated by VR2 and VR1 respectively. C25 (HF BALANCE) is adjusted for optimum common-mode rejection at 100 kHz where the RFI rejection components (C29, A13C13, and A13C14) and stray circuit capacitance upset the circuit balance.

Attenuator B

Output Attenuator B is a 20 dB, pi-section pad switched by relay K1.

Over-Voltage Protection

The instantaneous voltage across the HIGH and LOW OUTPUT connectors is monitored by the Over-Voltage Detector. If the instantaneous differential voltage exceeds approximately −12 or +12V (usually due to an inadvertent application of a signal to the output), the Over-Voltage Detector causes relays K2 and K3 to open the two signal paths to prevent damage to the output circuits.

The two 12V thresholds are derived from two 0.42V references (voltage dividers R94 and R96 and R95 and R97) and two voltage dividers on the output lines (R90 through R93). The detector consists of four, wired-OR comparators (U8A, U8B, U8C, and U8D). Comparators U8D and U8C compare the HIGH and LOW outputs, respectively, against the +0.42V reference; U8A and U8B compare the HIGH and LOW outputs, respectively, against the −0.42V reference. Whenever either reference level is exceeded, the associated comparator goes low and triggers the Relay Drive One Shot (U7), which deactivates K2 and K3 by outputting a TTL high. The duration of the high output is 1s unless U7 is retriggered by the presence of the reverse voltage. Thus, a repetative overload (one with a period less than 1s) will hold the relay open until the overload is removed.

The two voltage dividers formed by R90 through R93 limit the current flow to the Over-Voltage Detector inputs for large overvoltage situations.

TROUBLESHOOTING

General

Procedures for checking the Output Attenuator Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Extend the board assembly where necessary to make measurements. These procedures assume that the measurement circuits of the instrument (for example, ac level and frequency) are working properly.

Equipment

Oscilloscope ..... HP 1740A

⟨✓1⟩ Floating Output Amplifier Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Set IMPEDANCE to 600Ω. Key in FREQ 100 Hz. Key in 58.127 SPCL and 59.7 SPCL to preset the SOURCE amplitude. Connect the HIGH INPUT to A6TP4 (AMP 3). The left display should read approximately 100 Hz, and the right display should read between 0.525 and 0.546 Vrms.

Hint: If the signal is faulty, see Service Sheet 10 and check Amplifier 3.

2. On the Audio Analyzer, press RATIO. Connect the HIGH INPUT to A6TP3 (FLT HI). The relative amplitude display should read between 111 and 113%.

Hint: If no signal is present, check U1, U2, and Q1 through Q4. If signal is present but at the wrong level, continue with the following steps. If the signal is correct, continue on at step 10.

3. On the Audio Analyzer, ground A6TP2 (FLT LO) and A6TP3 (FLT HI). Connect the HIGH INPUT to the junction of R68 and R69. The relative amplitude should read between 57.2 and 57.8%.

Hint: If the signal is faulty, check R48 and R61. (The amplifier gain is the ratio R61/R48 expressed in %.)

4. Connect the HIGH INPUT to pin 3 of U1. The right display should read between 35.6 and 36.0%.

Hint: If the signal is faulty, check R47, R55, and R56. (The amplifier gain is the ratio R/(R+R72) expressed in %, where R is the parallel combination of R55, R56, and the 100 kΩ input resistance.)

5. Connect the HIGH INPUT to the junction of R66 and R67. The relative amplitude should read between 56.3 and 57.5%.

Hint: If the signal is faulty, check R46 and R64. (The amplifier gain is the ratio of step 4, excluding the loading of the 100 kΩ input resistance, times 1+R54/R46 expressed in %.)

6. Remove the ground from A6TP3. Place a short across R70. Connect the HIGH INPUT to A6TP3. On the Audio Analyzer, press RATIO twice to establish a new reference.

7. Connect the HIGH INPUT to pin 3 of U2. The right display should read between 31.4 and 31.8%.

Hint: If the signal if faulty, check R49, R57, and R58. (The amplifier gain is R/(R+R57) expressed in %, where R is the parallel combination of R49, R58, and the 100 kΩ input resistance.)

8. Remove the short from R70. Connect the HIGH INPUT to A6TP4. On the Audio Analyzer, press RATIO twice to establish a new reference.

9. Connect the HIGH INPUT to the HIGH OUTPUT. The right display should read between 111 and 113%.

Hint: If the signal is faulty, check R70 and any component in series or parallel with the path from A6TP3 to the HIGH OUTPUT connector, such as K1, K2, K3, R103, etc.

10. On the Audio Analyzer, set the LOW OUTPUT to FLOAT. Remove the ground from A6TP2. Ground A6TP3. Connect the HIGH INPUT to the LOW OUTPUT. The right display should read between 106 and 108%.

Hint: If the signal is faulty, check R71, R89, K2, and K3.

⟨J2⟩ Attenuator B Check

1. Key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Key in 58.255 SPCL and 59.0 SPCL to preset the source amplitude to 6V. Set IMPEDANCE to 600Ω. Connect the HIGH INPUT to A6TP3 (FLT HI). The left display should read approximately 1000 Hz, and the right display should read between 5.9 and 6.1 Vrms.

Hint: If the signal is faulty, see ⟨J1⟩ *Floating Output Amplifier Check.*

2. Press RATIO. Connect the HIGH INPUT to the HIGH OUTPUT. The right display should read between 99.3 and 99.5%.

Hint: Relay K1 should be in the through-path position. Pins 1, 2, and 3 of U4 should be TTL high.

Hint: The two pairs of contacts of K2 and K3 should be closed.

Hint: If the reading is 100%, check K4.

3. Press RATIO twice to establish a new reference. Key in 59.8 SPCL to switch in Attenuator B. The right display should read between 9.95 and 10.05%.

Hint: Pin 1 of U4 should be a TTL high; pins 2 and 3 of U4 should be a TTL low.

⟨J3⟩ Over-Voltage Detector Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Key in AMPTD 1 V. Set the OUTPUT switch to ground. Set IMPEDANCE to 600Ω.

2. Connect a high-impedance, dc coupled oscilloscope through a tee to the HIGH OUTPUT. Connect a BNC-to-cliplead adapter to the tee. Set the oscilloscope to 5V per division and adjust the oscilloscope to observe the 1 kHz, 1 Vrms sine wave.

Hint: If the signal is faulty, see ⟨J1⟩ *Floating Output Amplifier Check.*

3. Momentarily touch the center-conductor cliplead (but not the ground lead) to the +15V power supply on the A6 assembly. (The + end of C1 is a convenient place to touch the clip lead.) The signal observed on the oscilloscope should jump to +15V with no ac present, then return to normal after about 1s.

4. Momentarily touch the clip lead to the −15V power supply. (The − end of C3 is a convenient place to touch the cliplead.) The signal should jump to −15V with no ac present, then return to normal after about 1s.

5. On the Audio Analyzer, set the LOW OUTPUT switch to FLOAT. Connect the oscilloscope to the LOW OUTPUT. Short the HIGH OUTPUT to ground. (A 50Ω load can also be used for this.) Repeat steps 3 and 4. The results should be the same.

⟨J4⟩ Impedance Switch Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Key in AMPTD 1 V. Set the INPUT and OUTPUT switches to ground. Set IMPEDANCE to 600Ω. Connect the HIGH INPUT to A6TP3 (FLT HI). The left display should read approximately 1 kHz, and the right display should read approximately 1 Vrms.

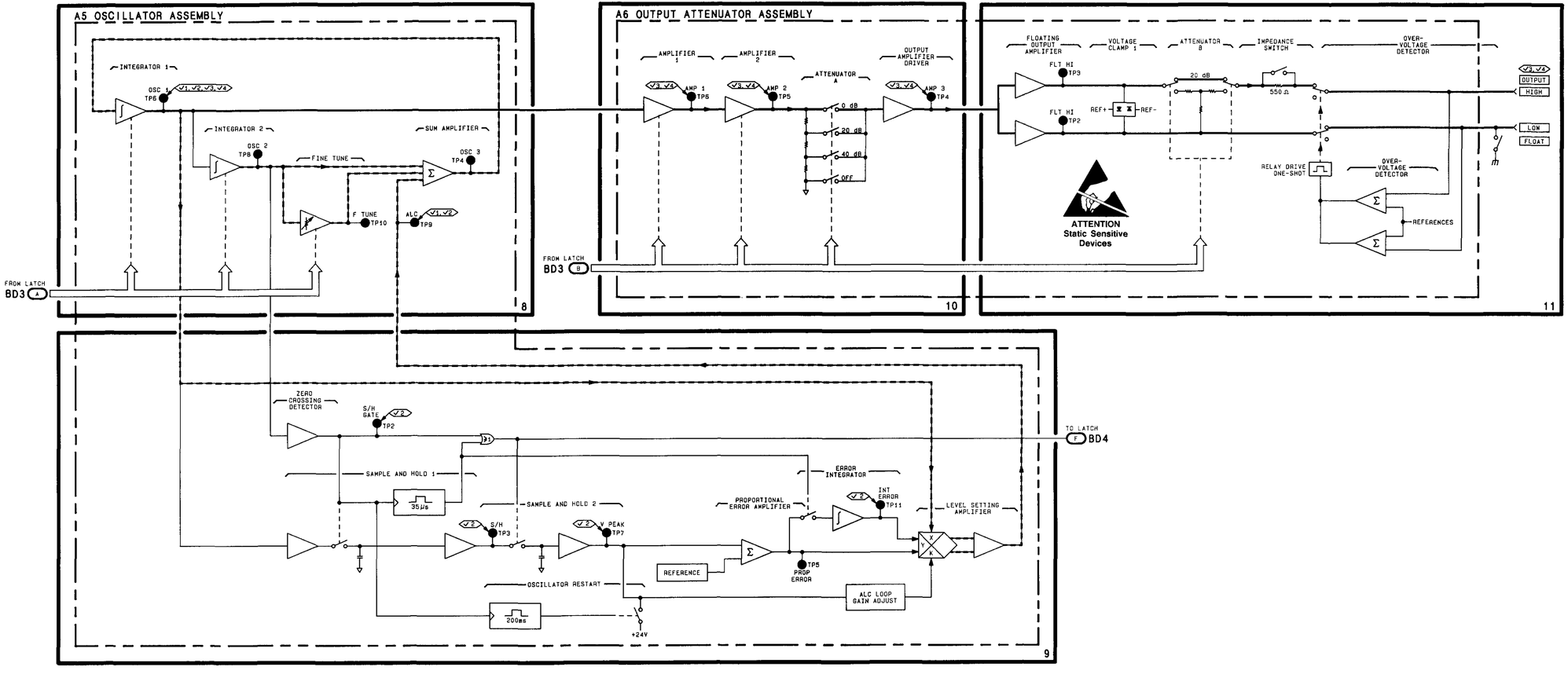
Hint: If the signal is faulty, see ⟨J1⟩ *Floating Output Amplifier Check.*

2. Press RATIO. Short the HIGH OUTPUT to ground. The right display should read between 90.6 and 92.6%.

Hint: If the signal is faulty, check K4. A6TP7 (50/600Ω) should be a TTL high.

3. Set IMPEDANCE to 50Ω. The right display should read less than 1%.

Hint: If the signal is faulty, check K4. A6TP7 (50/600Ω) should be a TTL low.



BD3
Figure 8C-101
8C-101

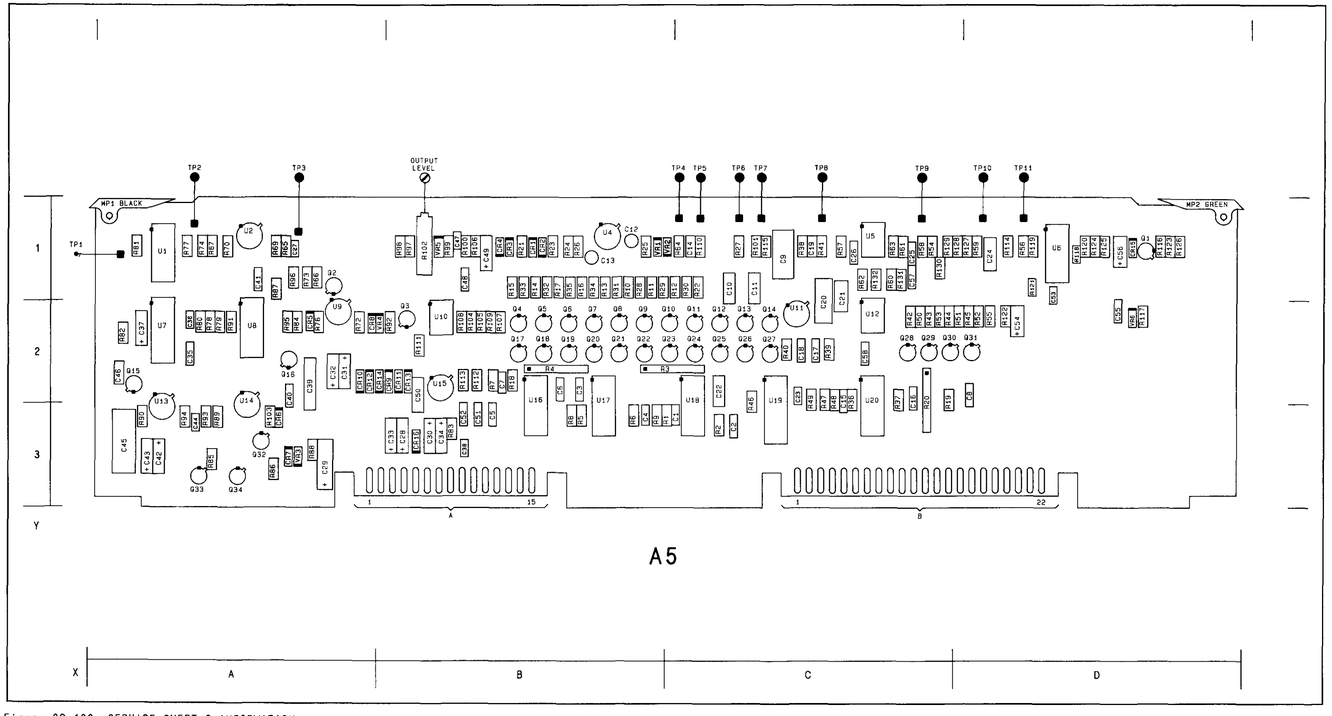


Figure 8C-102. SERVICE SHEET 8 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y
C1	C3
C2	C3
C3	B2
C4	B3
C5	B3
C6	B2
C7	B2
C8	D2
C9	C1
C10	C1
C11	C1
C12	B1
C13	B1
C14	C1
C15	C2
C16	D2
C17	D2
C18	D2
C19	C1
C20	C1
C21	C1
C22	C2
C23	C2
C24	D1
C25	C1
C26	C1
CR1	B1
CR2	B1
CR3	B1
CR4	B1
CR16	B3
Q4	B2
Q5	B2
Q6	B2
Q7	B2
Q8	B2
Q9	B2
Q10	B2
Q11	C2
Q12	C2
Q13	C2
Q14	C2
Q17	B2
Q18	B2
Q19	B2
Q20	B3
Q21	B2
Q22	B2
Q23	B2
Q24	C2
Q25	C2
Q26	C2
Q27	C2
Q28	C2
Q29	C2
Q30	C2
Q31	D2
R1	B3
R2	C3
R3	B2
R4	B2
R5	B3
R6	B3
R7	B2
R8	B3
R9	B3
R10	B1
R11	B1
R12	C1
R13	B1
R14	B1
R15	B1
R16	B1
R17	B1
R18	B2
R19	C2
R20	C2
R21	B1
R22	C1
R23	B1
R24	B1
R25	B1
R26	B1
R27	C1
R28	B1
R29	B1
R30	C1
R31	B1
R32	B1
R33	B1
R34	B1
R35	B1
R36	C2
R37	C2
R38	C1
R39	C2
R40	C2
R41	C1
R42	C2
R43	C2
R44	C2
R45	B2
R46	C2
R47	C2
R48	C2
R49	C2
R50	C2
R51	C2
R52	D2
R53	C2
R54	C1
R55	D2
R56	D1
R57	C1
R58	C1
R59	D1
R60	C1
R61	C1
R62	C1
R63	C1
R64	C1
TP1	C1
TP6	C1
TP8	C1
TP9	C1
TP10	D1
U4	B1
U5	C1
U11	C2
U12	C2
U16	B2
U17	B2
U18	C2
U19	C2
U20	C2
VR1	B1
VR2	B1

Source Circuits Block Diagram **BD3**

SEE REVERSE SIDE

NOTES

1. Decouple probe with 10k ohm resister when measuring this voltage.
2. Ground TP9 to stop oscillator when measuring this voltage.
3. Measure with 57.255 SPCL.

A5Q4-14 TOP VIEW

A5U4,5,11,12 TOP VIEW

A5R3,4,20 TOP VIEW

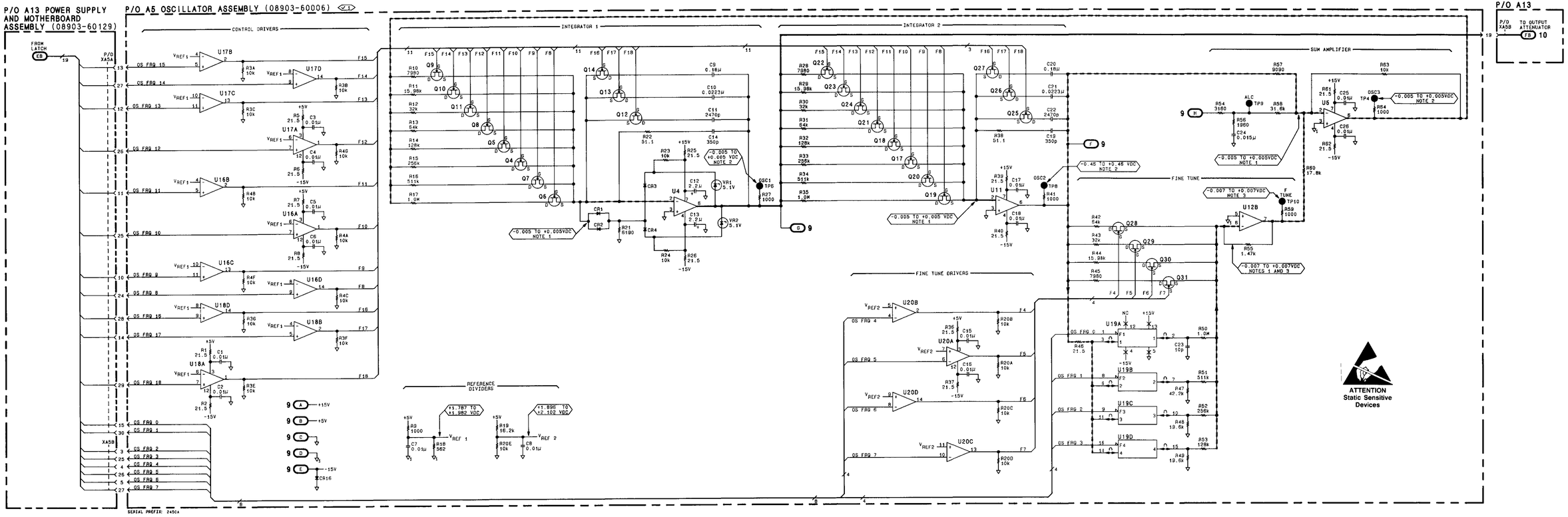
PIN NO.

COMMON	1	GND
A	2	
B	3	
C	4	
D	5	
E	6	
F	7	
G	8	

Schematic General Information

CHANGES

2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2723A and above	**On the A5 schematic:** • **C59, C60** - Under INTEGRATOR 1, add pin 8 (compensation) between pins 4 and 6 of U4. To pin 8, add C59, 1.5pF to ground. Under INTEGRATOR 2, add pin 8 (compensation) between pins 4 and 6 of U11. To pin 8 add C60 1.5pF to ground. **On the A5 Component Locator:** • **C59, C60** - Add C59 to the backside of the board between pins 3 and 8 of U4. Add C60 to the backside of the board between pins 3 and 8 of U11. **On the A5 Component Coordinates:** • **C59, C60** - Add C59 B,1 and C60 C,2 to the coordinates table.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.



SS8
Figure 8C-103
8C-103

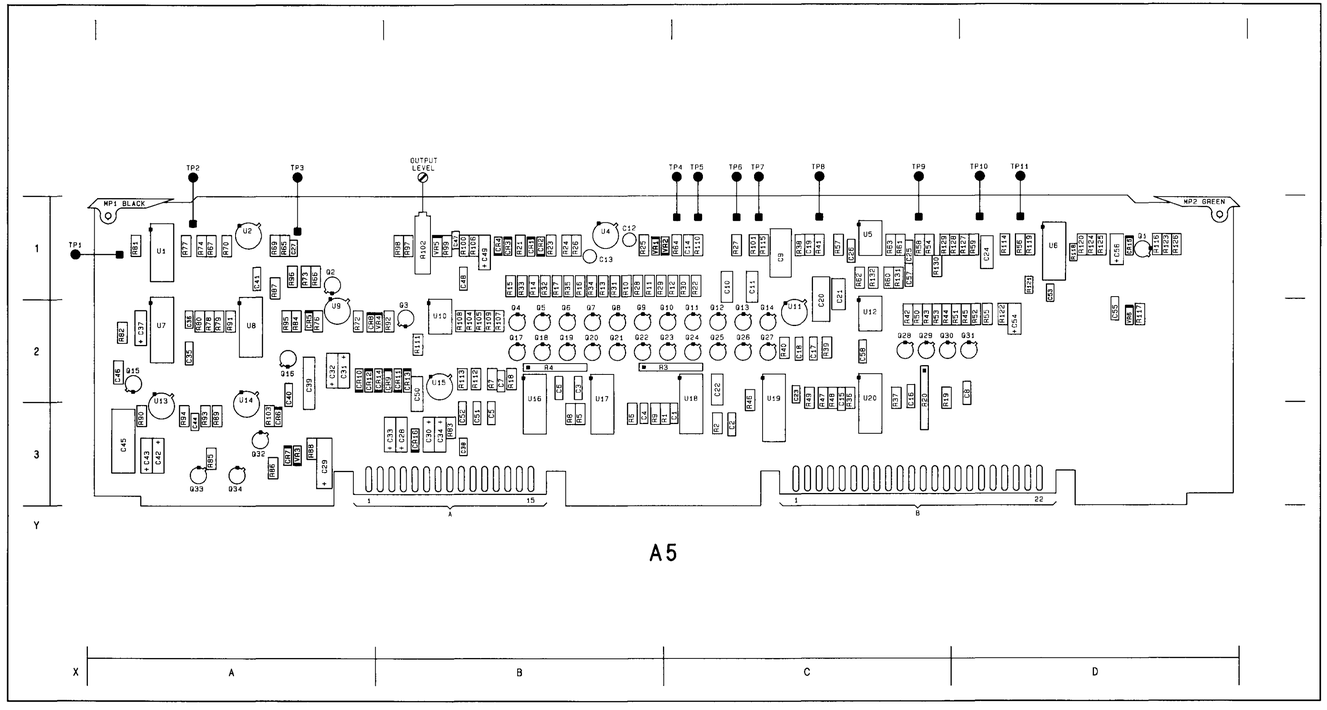


Figure 8C-104. SERVICE SHEET 9 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C27	A1	R102	B1				
C28	B3	R103	A3				
C29	A3	R104	B2				
C30	B3	R105	B2				
C31	A2	R106	B1				
C32	A2	R107	B2				
C33	B3	R108	B2				
C34	B3	R109	B2				
C35	A2	R110	C1				
C36	A2	R111	B2				
C37	A2	R112	B2				
C38	B3	R113	B2				
C39	A2	R114	D1				
C40	A2	R115	C1				
C41	A1	R116	D1				
C42	A3	R117	D2				
C43	A3	R118	D1				
C44	A3	R119	D1				
C45	A3	R120	D1				
C46	A2	R121	D1				
C47	B1	R122	D2				
C48	B1	R123	D1				
C49	B1	R124	D1				
C50	B2	R125	D1				
C51	B3	R126	D1				
C52	B3	R127	D1				
C53	D1	R128	C1				
C54	D2	R129	C1				
C55	D2	R130	C1				
C56	D1	R131	C1				
C57	C1	R132	C1				
C58	C2						
		TP1	A1				
CR5	A2	TP2	A1				
CR6	A3	TP3	A1				
CR7	A3	TP5	C1				
CR8	A2	TP7	C1				
CR9	B2	TP11	D1				
CR10	A2						
CR11	B2	U1	A1				
CR12	A2	U2	A1				
CR13	B2	U6	D1				
CR14	A2	U7	A2				
CR15	D1	U8	A2				
		U9	A2				
Q1	D1	U10	B2				
Q2	A1	U12	C2				
Q3	B2	U13	A2				
Q15	A2	U14	A2				
Q16	A2	U15	B2				
Q30	A3						
Q33	A3	VR3	A3				
Q34	A3	VR4	A2				
		VR5	B1				
R65	A1	VR6	D2				
R66	A1						
R67	A1						
R68	A1						
R70	A1						
R72	A2						
R73	A1						
R74	A1						
R76	A2						
R77	A1						
R78	A2						
R79	A2						
R80	A2						
R81	A1						
R82	A2						
R83	B3						
R84	A2						
R85	A3						
R86	A3						
R87	A1						
R88	A3						
R89	A3						
R90	A3						
R91	A2						
R92	B2						
R93	A3						
R94	A3						
R95	A2						
R96	A1						
R97	B1						
R98	B1						
R99	B1						
R100	B1						
R101	C1						

P/O A5 — Oscillator-State-Variable Circuits — SS8

SEE REVERSE SIDE

NOTES

1. Decouple probe with 10k ohm resister when measuring this voltage.
2. Ground TP9 to stop oscillator when measuring this voltage.

A5Q3,15, 16,34 TOP VIEW

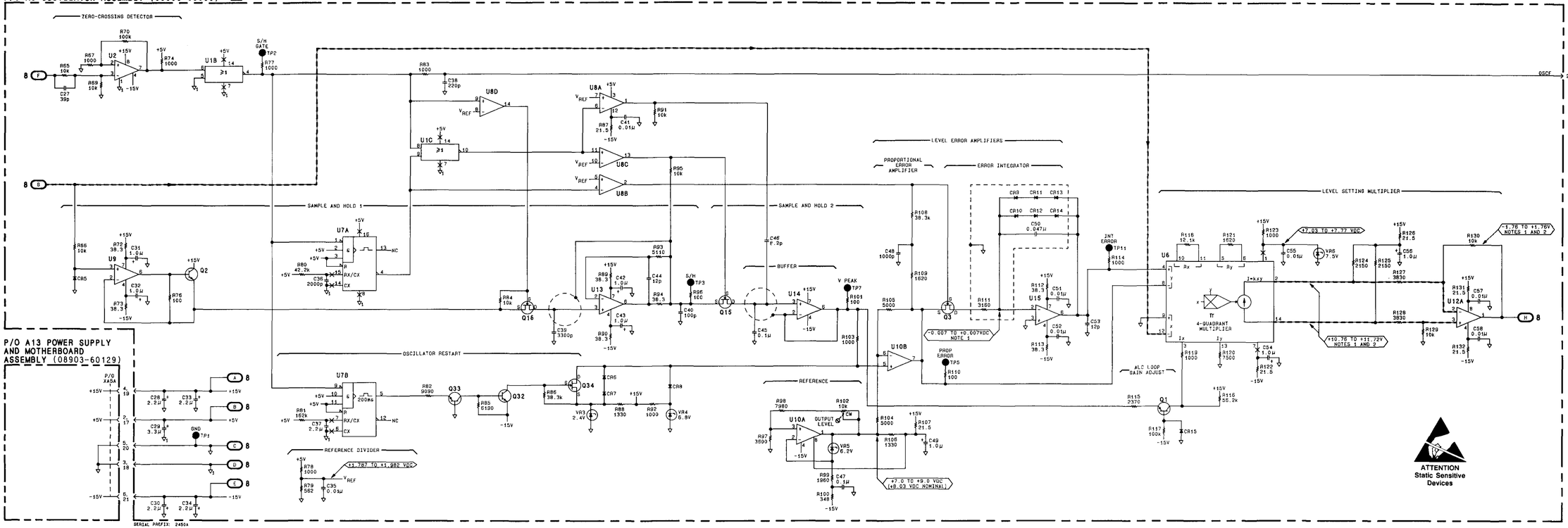
A5U2,3,9,10, 12-15 TOP VIEW

Schematic General Information

CHANGES

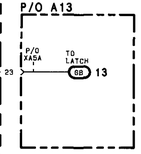
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.

P/O A5 OSCILLATOR ASSEMBLY (08903-60006) ⚠1



P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)

P/O A13



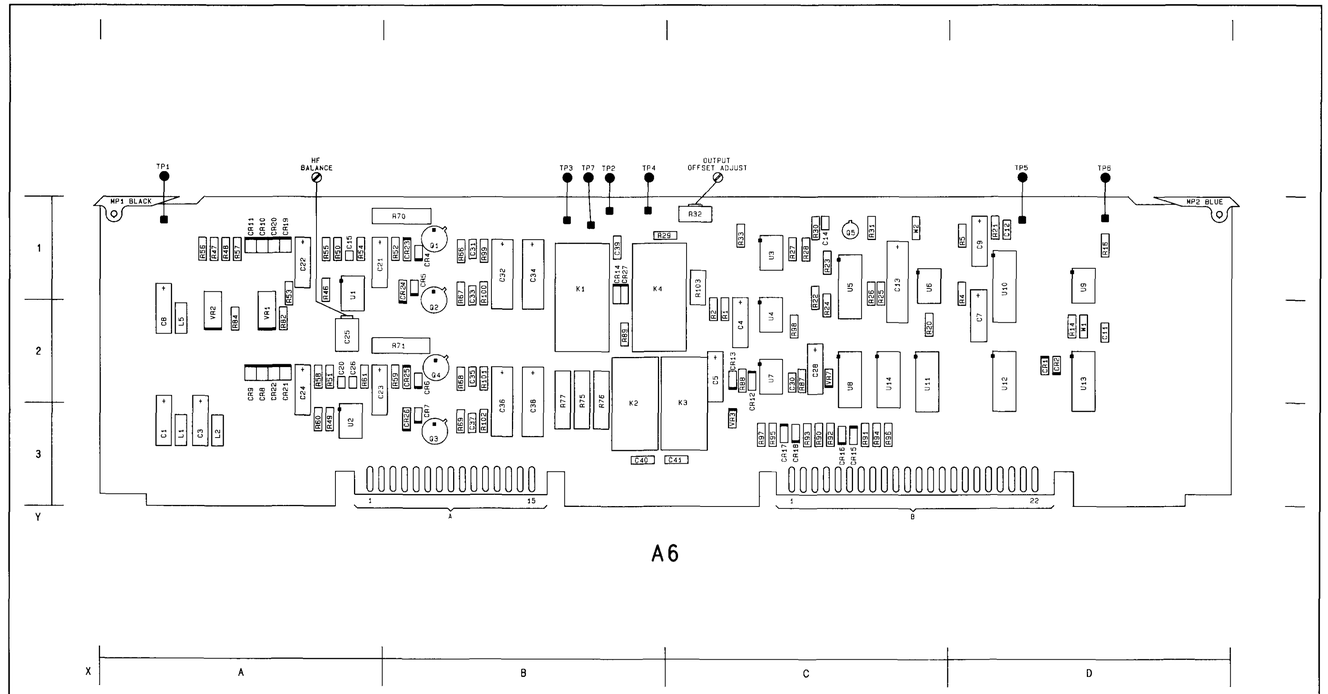


Figure 8C-106. SERVICE SHEET 10 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	A3						
C3	A3						
C4	C2						
C5	C2						
C7	D2						
C8	A2						
C9	D1						
C11	D2						
C12	D1						
C13	C1						
C14	C1						
CR1	D2						
CR2	D2						
L1	A3						
L2	A3						
L5	A2						
Q5	C1						
R1	C2						
R2	C2						
R4	D1						
R5	D1						
R14	D1						
R16	D1						
R20	C2						
R21	D1						
R22	C1						
R23	C1						
R24	C2						
R25	C1						
R26	C1						
R27	C1						
R28	C1						
R29	B1						
R30	C1						
R31	C1						
R32	C1						
R33	C1						
TP4	B1						
TP5	D1						
TP6	D1						
U3	C1						
U5	C1						
U6	C1						
U9	B1						
U10	D1						
U11	C2						
U12	D2						
U13	D2						
U14	C2						
W1	D2						
W2	C1						

P/O A5 Oscillator-ALC Circuits **SS9**

SEE REVERSE SIDE

NOTES

1. ↓V2 indicates a second analog ground trace used for certain capacitors on the floating output amplifier located on service sheet 11.

Q5 TOP VIEW

LOGIC LEVELS

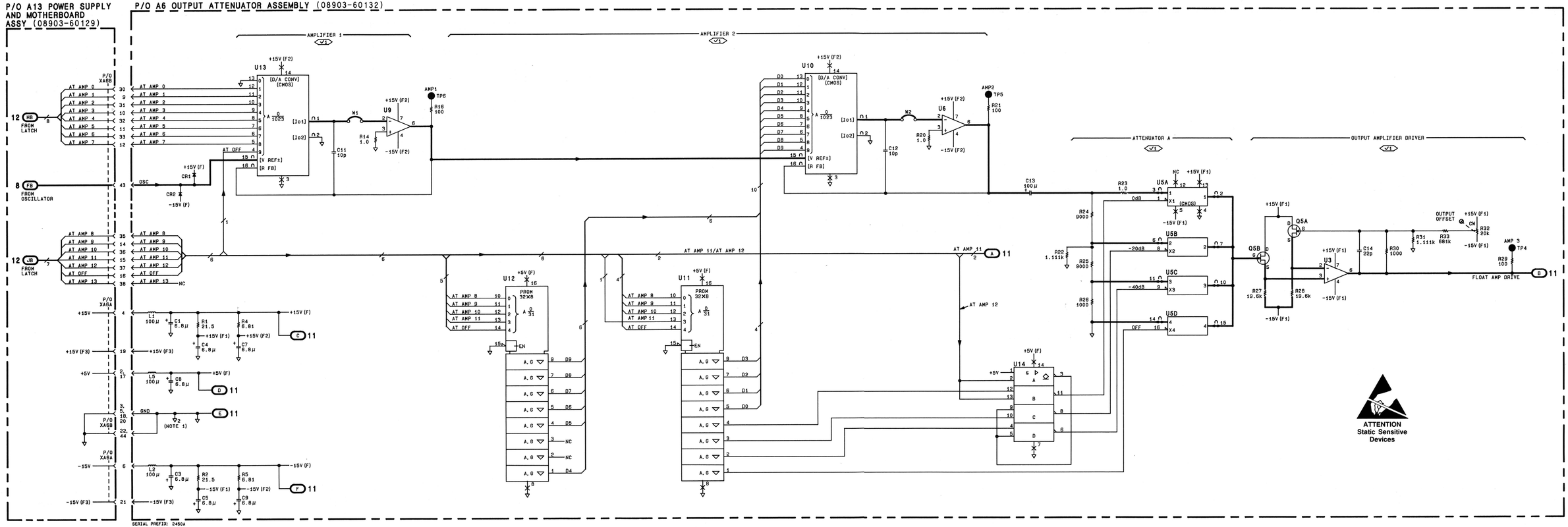
	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

K1 AND K4 BOTTOM VIEW

Schematic General Information

CHANGES

2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.



SS10
Figure 8C-107
8C-107

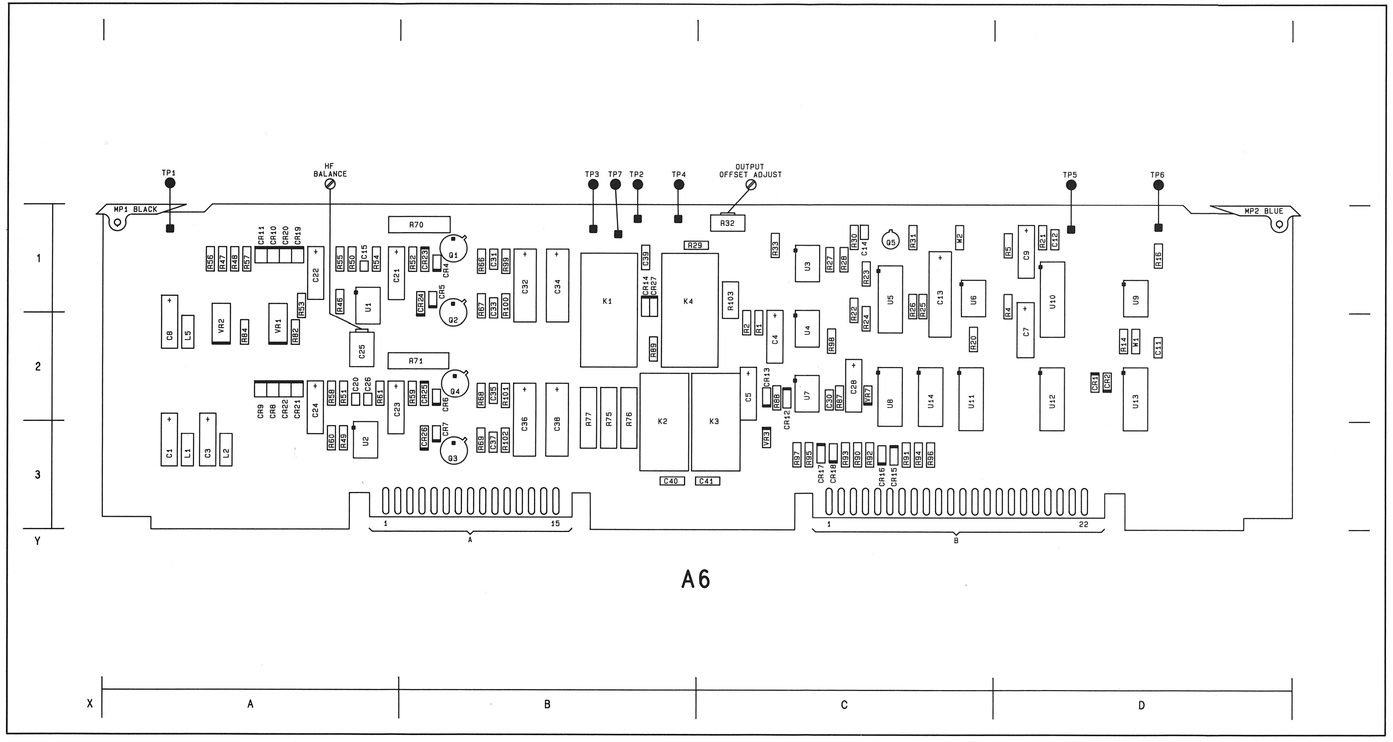


Figure 8C-108. SERVICE SHEET 11 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C15	A1	R91	C3				
C20	A2	R92	C3				
C21	A1	R93	C3				
C22	A1	R94	C3				
C23	A2	R95	C3				
C24	A2	R96	C3				
C25	A2	R97	C3				
C26	A2	R98	C2				
C28	C2	R99	B1				
C30	C2	R100	B1				
C31	B1	R101	B2				
C32	B1	R102	B3				
C33	B1	R103	C1				
C34	B1						
C35	B2	TP1	A1				
C36	B3	TP2	B1				
C37	B3	TP3	B1				
C38	B3	TP7	B1				
C39	B1						
C40	B3	U1	A1				
C41	C3	U2	A3				
		U4	C2				
CR4	B1	U7	C2				
CR5	B1	U8	C2				
CR6	B2						
CR7	B3	VR1	A2				
CR8	A2	VR2	A2				
CR9	A2	VR3	C3				
CR10	A1	VR7	C2				
CR11	A1						
CR12	C2						
CR13	C2						
CR14	B1						
CR15	C3						
CR16	C3						
CR17	C3						
CR18	C3						
CR19	A1						
CR20	A1						
CR21	A2						
CR22	A2						
CR23	B1						
CR24	B1						
CR25	B2						
CR26	B3						
CR27	B1						
K1	B1						
K2	B2						
K3	C3						
K4	B1						
Q1	B1						
Q2	B1						
Q3	B3						
Q4	B2						
R46	A1						
R47	A1						
R48	A1						
R49	A3						
R50	A1						
R51	A2						
R52	B1						
R53	A1						
R54	A1						
R55	A1						
R56	A1						
R57	A1						
R58	A2						
R59	B2						
R60	A3						
R61	A2						
R66	B1						
R67	B1						
R68	B2						
R69	B3						
R70	B1						
R71	B2						
R75	B3						
R76	B3						
R77	B3						
R82	A2						
R84	A2						
R87	C2						
R88	C2						
R89	B2						
R90	C3						

P/O A6 Output Attenuator-Input Circuits **SS10**

SEE REVERSE SIDE

NOTES

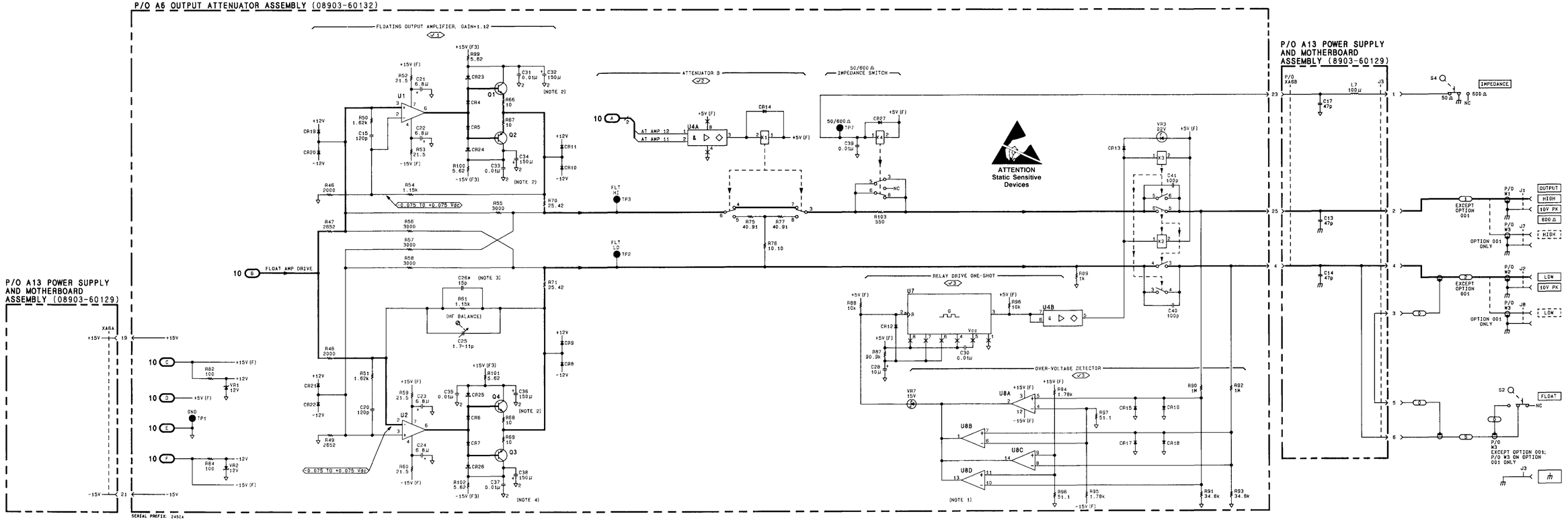
1. Comparator A6U8 has open collector.
2. ∇_2 indicates a second analog ground trace used for these capacitors on the floating output amplifier for improved current isolation. This second ground trace connects into common ground on the mother-board.
3. * Asterisk indicates factory selected values.

K2,3
BOTTOM VIEW

Schematic General Information

CHANGES

2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2742A and above	**On the A6 schematic:** • **P/O A13** - In the upper right portion of the schematic delete the circuitry for the impedance switch.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.
2818A and above	**On the A6 schematic:** • **R91, R93, R94, R95** - In the lower right hand corner of the schematic under OVER-VOLTAGE DETECTOR, change the values of R91 and R93 to 21.5K ohms, and change the component values of R94 and R95 to 2.61K ohms.



SS11
Figure 8C-109
8C-109

CHANGES

2742A and above On the schematic:

- P/O A13 - In the upper right portion of the schematic delete the circuitry for the impedance switch.

SERVICE SHEET BD4---Digital Circuits Block Diagram

PRINCIPLES OF OPERATION

General

Service Sheet BD4 covers the Counter, Keyboard and Display, Latches, Controller, and Remote Interface; that is, it covers most of the digital circuits of the instrument.

Counter (P/O A8)

The Counter consists of the input switching, Clock Counter, Cycle Counter, and counter control circuits. The Counter is used in two modes: (1) to measure frequency (from either the input circuits, the output circuits, or the Oscillator) or (2) to measure the duration of the dc voltmeter Stop Count pulse. The Clock and Cycle Counters are both utilized for the frequency measurement; however, only the Clock Counter is used for the voltage measurement. The Cycle Counter counts the number of cycles of the input frequency (FMUX) and has two stages, giving a total division ratio of 32. The Clock Counter counts the 2 MHz Clock Out (Φ) signal, which originates at the Crystal Oscillator of the CPU. The Clock Counter has three stages, giving a total division ratio of 2048.

To select the frequency-count mode, the Voltmeter Gate switch is opened and the Clock Counter Gate set to route the path from the Frequency Gate into the Clock Counter. The Controller then clears (resets) the counters and at the same time arms the Mode Select. At the beginning of the next Cycle of the input signal (FMUX), the Mode Select closes both the Frequency Gate and Cycle Counter Gate switches. After a short period, carries are generated at the outputs of both the Clock and Cycle Counters. The Controller counts the carries via the Carry Gating circuit which is now enabled. When a predetermined number of carries from the Clock Counter has been counted, the Controller disarms the Mode Select. At the beginning of the next cycle of the input signal, the Mode Select opens both the Frequency Gate and Cycle Counter Gates switches. This guarantees that at least one cycle of the input signal is counted.

The Count Transfer Logic then transfers the count of the individual stages of both counters in parallel to the Controller via the Counter Output Gating. First, the output from Stage 1 of the Cycle Counter is transferred. Then the output from Stage 2 of the Cycle Counter and Stage 3 of the Clock Counter is loaded into Stage 1 of the Cycle Counter and the output is again transferred. This process is again repeated with Stage 2 of the Clock Counter loading into Stage 1 of the Cycle Counter via Stage 3 of the Clock Counter and Stage 2 of the Cycle Counter and transferring. Finally, Stage 1 of the Clock Counter is loaded into Stage 1 of the Cycle Counter via the intermediate stages and transferred.

To make a voltage measurement, the Controller first sets the Clock Counter Gate to receive the signal from the Voltmeter Gate. The Stop Count Gate was closed after completing the previous measurement. The Controller then arms the Voltmeter Gate and initiates the ramp in the Voltage-to-Time Converter (via the Ramp Gate line). The first pulse on the Clock Out (Φ) line closes the Voltmeter Gate. The Clock Counter now begins counting the 2 MHz clock pulses. After an interval determined by the dc level being measured, the Voltage-to-Time Converter generates a Stop Count pulse which opens the Stop Count Gate. The Count accumulated in the Clock Counter is thus proportional to the input voltage. (Note that the Cycle Counter is not used in this measurement.) The count is transferred to the Controller in the same manner as for a frequency measurement.

Controller (P/O A8)

The Controller consists of a Microprocessor, Read-Only Memory (ROM), Random-Access Memory (RAM), a Memory Select Decoder, and input/output interface circuitry. The Microprocessor is divided into two devices: the Central Processing Unit (CPU) and a Static Memory Interface (SMI). A third device, a Peripheral Input/Output (PIO on A9), is also included when the Microprocessor interfaces with the Remote Interface Assembly.

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. Four of the sixteen address bits are decoded by the Memory Select Decoder to enable one of the ROM devices. Eleven 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. Information in ROM may be either a program instruction or data. In a similar manner temporary information is written to or read from the RAM. The RAM, however, is addressed by only eight of the eleven address bits, and inputs or outputs only four data bits. The RAM is enabled by Address 15 (A15). **Serial Prefix 2652A and Above**: Fifteen address bits are used to address the ROM. The enabled ROM then outputs eight bits of data onto the Data Bus from the location corresponding to the input address.

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 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 location 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 does data manipulation (arithmetic and logic computations) and contains the clocking and control circuitry. The 2 MHz clock comes from the Crystal Oscillator and is also used as the Counter time-base reference. The SMI interfaces with the ROMs and RAM.

The CPU also contains bidirectional input/output (I/O) ports for communicating with the instrument hardware. This is done via the Instrument Bus discussed in the next paragraph. Four of the Instrument I/O bits, however, are reserved for servicing 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. Refer to *Controller LEDs and Test Points,* paragraph 8-28.

Latches (A7) and Instrument Bus

Figure 8D-1 shows a typical hookup on the Instrument Bus. The Instrument Bus lines are broken into three groups: enable (e), select (s), and data (d). The enable code (e0 to e3) comes from I/O lines 10 through 13 of the CPU (A8U5). Three of the lines are decoded by the Enable Code Decoder (A8U22) to activate one of eight unique enable lines (e=0 to e=7). The fourth line enables the decoder itself. The enable lines run to the Keyboard, Remote Interface, and Latch Assemblies and to the Counter on the Controller/Counter Assembly. Typically, each line is dedicated to a specific operational function; for example, enable line e=6 controls Oscillator tuning.

The select (s0 to s3) and data codes (d0 to d3) come from I/O lines 00 to 07. The eight lines also run to the Keyboard, Remote Interface, and Latch Assemblies and to the Counter where they are decoded. The Latch Assembly decodes the Instrument Bus for all of the measurement and source assemblies. 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 and the data code selects the specific function or configuration. For a given function, the select codes are decoded only while the corresponding enable line is active. The data codes are 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 line 02. The "s" indicates a select code, "2" indicates that it is the third least significant bit of the un-decoded 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 data back to the I/O ports.

PRINCIPLES OF OPERATION—SERVICE SHEET BD4

The example of Figure 8D-1 will be used to illustrate how the 8 dB gain setting is selected for the Programmable Gain Amplifier on the Input Amplifier Assembly. The amplifier (not shown) is set for 8 dB gain when the output line labeled 8 dB(L) of Data Latch A7U11 goes low. A7U11 is on the Latch Assembly. Register U11 is simply

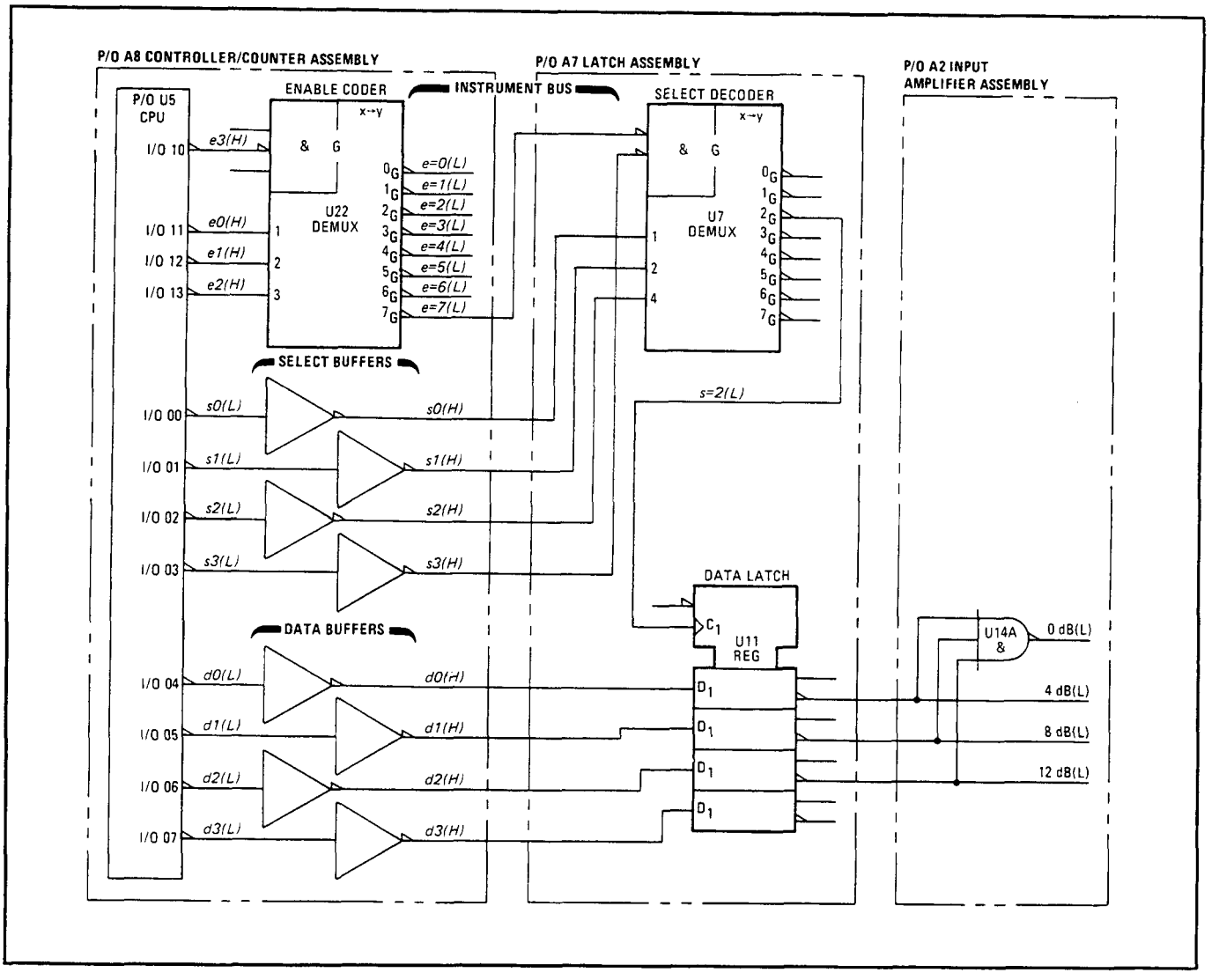


Figure 8D-1. Example Showing Instrument Bus Hookup

a latch; it does not decode the data. To set the amplifier gain to 8 dB, the CPU sends out the binary enable code 0111 (hexadecimal 7), select code 0010 (hexadecimal 2), and data code 0010 (hexadecimal 2). The Enable Decoder activates the line e=7(L). (The decoder was enabled because e3(H) was low.) Since s3(H) is low, and since e=7(L) is also low, the Select Decoder (A7U7) is enabled. The three least significant bits of the select code are decoded and activate the s=2(L) line out of the decoder. This line clocks the data into the Data Latch A7U11. Since the d1(H) line is high, the 8 dB(L) line goes low. This sets the amplifier gain to 8 dB. (NAND gate A2U14A decodes the three least significant bits of A7U11. It causes the 0 dB(L) line to go low when e=7, s=2, d0=0, d1=0, and d2=0.)

There is a direct relationship between the codes output on the Instrument Bus and the Direct Control Special Functions discussed in paragraph 8-22. If the enable, select, and data codes are combined into a hexadecimal number "*esd*", this becomes the Direct Control suffix. In the example here it is 722, corresponding to Direct Control code 0.722 discussed in the example there. 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*=727 were issued, the 4 dB, 8 dB, and 12 dB lines 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*, paragraph 8-22.

In addition to the Instrument Control Latches which interface the communication between the Controller and the measurement and source circuits, the Latch Assembly also contains the Counter input conditioning circuits and plotter control circuits.

The Parity Check latch is used on power-up to check the integrity of the Data lines of the Instrument Bus. Overload conditions from either the Input Overload Detector of the Overload Detector on the output amplifier circuit (see Service Sheet BD2) are read back to the Instrument Bus through the Overload Readback latch.

The Counter Input Switch selects whether the input to the Counter Schmitt Trigger is from the Input Amplifier or Output Amplifier. The Counter Input Schmitt Trigger conditions the analog input signal to make it compatible with the TTL logic of the Counter. It has self-setting upper and lower references. Input peak detectors set the two references at one-half the level of the positive peak. This gives excellent noise immunity over a wide range of input levels. The FMUX Select switch selects the input to the Counter from either the Counter Input Schmitt Trigger or the Oscillator.

The X Axis and Y Axis DACs provide X and Y outputs to the rear panel for plotting during a frequency sweep. The DACs themselves output current which is converted to a voltage by transresistance amplifiers at their outputs. (The amplifiers also filter the signal.) Each DAC amplifier can output 0 to +10V in 255 steps. They are programed by the Controller via the Plotter Control and Input Latches, which also control the Pen Lift line.

Keyboard and Display (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 is accomplished by driving the rows in sequence with the select decoder and reading the state of the columns with the data readback lines (unbuffered data lines). If no key closure is found after 50 ms, the Microprocessor leaves this routine and begins making a new measurement.

Lighting of the key and annunciator lights and display digits and decimal points is by a straight-forward decoding of the Instrument Bus. The segments of the displays are lighted (and latched) one segment at a time. Note that the lights in the keys do not light as a direct result of a key closure. This is done by the Microprocessor, having recognized a key closure, sending the command out on the Instrument Bus to light the key light.

Remote Interface (A9)

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 an output peripheral to the Controller.

As an input peripheral, it 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 or not the byte is a command (for example, Device Clear), address, or data (for example, "M1"). If it is an address or command, the byte is processed. If it is data, the routine first checks whether or not 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, the 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 Audio Analyzer has been addressed to talk. The Require Service message (SRQ) is also output via the Remote Interface.

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. The Handshake Logic controls the asynchronous transfer of bytes over the HP-IB. It does this without interruption of the Microprocessor whenever the byte is data but the Audio Analyzer is not addressed to listen or whenever the byte is not an interrupting bus command. It also provides the means for the Microprocessor to complete the handshake if the byte is an interrupting type.

When the Audio Analyzer is accepting bytes, the Handshake Logic monitors the Microprocessor and HP-IB and signals the HP-IB talker or bus controller when the Audio Analyzer is ready to receive, tells the Microprocessor when valid data is on the HP-IB, and tells the HP-IB talker when the Microprocessor has accepted the data. When the Audio Analyzer is outputting data or status bytes, the Handshake Logic tells the Microprocessor when the HP-IB listener is ready to receive, provides the Microprocessor with logic to tell the listener when data is valid, and tells the Microprocessor when the listener has accepted data.

The HP-IB Input/Output transceivers act as HP-IB buffers and send/receive switches. They are 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 Handshake 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 Audio Analyzer'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 input bits 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 Gates output the address from the Address Switches onto the Instrument Bus data lines when Special Function 21 (HP-IB Address) is selected. This is how the Controller reads the HP-IB address. (See *HP-IB Address* in the *Detailed Operating Instructions* in Section 3.)

The portion of the Microprocessor that directly handles the HP-IB input/output resides on the Remote Interface Assembly. This is 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, 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 and the other to the handshake and control logic.

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=3. The decoded select lines enable or disable parts of the Remote Interface Assembly.

TROUBLESHOOTING

General

Procedures for checking the digital circuits of the instrument are given below. The blocks or points to check are marked on the block diagram with a check mark and a number inside, for example, ⟨✓3⟩. Before performing any check, perform all the checks on Service Sheet BD1.

Equipment

Digital Test/Extender Board	HP 08903-60018
Oscilloscope	HP 1740A
Signature Analyzer	HP 5005A
Voltmeter	HP 3455A

⟨✓1⟩ Counter (Including Counter Input) Check

NOTE

For this check, the Audio Analyzer's Source is assumed to be working properly.

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches to ground. Set the 80 kHz LOW PASS filter off. Set FREQ to 100 kHz and AMPTD to 1V. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a high-impedance, dc coupled oscilloscope to A7TP2 (FMUX).

3. On the Audio Analyzer, key in 46.0 SPCL to set the Counter to measure the Oscillator frequency. The waveform on the oscilloscope should be a TTL square wave with a period of approximately 10 μs. If faulty, see Service Sheet 13 and check the FMUX Select.

4. Disconnect the cable to the Audio Analyzer's INPUT. The waveform on the oscilloscope should remain unchanged. If faulty, see Service Sheet 13 and check the FMUX Select.

5. Reconnect the cable to the Audio Analyzer's INPUT. Key in 46.1 SPCL to set the Counter to measure the input frequency. The waveform should remain unchanged. If faulty, see Service Sheet 13 and check the Input Select, Counter Input Schmitt Trigger, and the FMUX Select.

6. Disconnect the cable to the Audio Analyzer's INPUT. The waveform on the oscilloscope should be a steady TTL high or low. If faulty, see Service Sheet 13 and check the Input Select and Counter Input Schmitt Trigger.

7. Reconnect the cable to the Audio Analyzer's INPUT. Key in 46.3 SPCL to set the Counter to measure the frequency at the output amplifier. The waveform on the oscilloscope should again be a TTL square wave with a period of approximately 10 μs. If faulty, see Service Sheet 13 and check the Input Select.

8. Disconnect the cable to the Audio Analyzer's INPUT. The waveform on the oscilloscope should become a steady TTL high or low. If faulty, see Service Sheet 13 and check the Input Select.

9. Reconnect the cable to the Audio Analyzer's INPUT. Connect the oscilloscope to A8TP5 (CYC). The waveform on the oscilloscope should be bursts of TTL square waves where the period of the pulses in the bursts is approximately 10 μs and the bursts, although difficult to measure, are approximately 170 ms apart. If faulty, see Service Sheet 14 and check the Mode Select and Cycle Counter Gate.

10. Connect the oscilloscope to A8TP6 (CLK). The waveform on the oscilloscope should be bursts of TTL square waves where the period of the pulses in the bursts is 500 ns and the bursts, although difficult to measure, are approximately 170 ms apart. If faulty, see Service Sheet 14 and check the Mode Select and Frequency Gate.

11. Connect the oscilloscope to A8TP2 (CLK CRY). The waveform on the oscilloscope should be bursts of TTL square waves where the period of the pulses in the bursts is 1 ms and the bursts, although difficult to measure, are approximately 170 ms apart. If faulty, see Service Sheet 14 and check the Clock Counter.

12. Connect the oscilloscope to A8TP1 (CYC CRY). The waveform on the oscilloscope should be bursts of TTL square waves where the period of the pulses in the bursts is 320 μs and the bursts, although difficult to measure, are approximately 170 ms apart. If faulty, see Service Sheet 14 and check the Cycle Counter.

Hint: If all steps above give positive results but the Counter is still suspected to be faulty, see Service Sheet 14 and check the Carry Gating and the Counter Output Gating.

⟨√2⟩ Controller Kernel Check

CAUTION

MOS and CMOS ICs can be damaged by static charges and circuit transients. Do not remove the A8 Controller/Counter 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 HP 4208-0094.) When unplugging ICs, place the board on a conductive pad. When the IC is unplugged, insert it into the foam also.

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 LINE to OFF. Extend the A8 Controller/Counter Assembly with the Digital Test/Extender Board. Connect the ribbon cable on the extender board to the empty socket A8J1 (ADR BUS). Switch LINE to ON.

2. Check A8TP14 (+12V) with dc voltmeter. The voltage should be between +11.4 and +12.6 Vdc. If faulty, see Service Sheet 20 and check the +12V Regulator.

3. Short A8TP4 (RES) to A8TP3 (GND). This resets the Controller and forces a short write (instruction) cycle. Connect a high-impedance, dc coupled oscilloscope to A8TP13 (WRT). The waveform should be TTL pulses with a period of 2 μs. If faulty, see Service Sheet 15 and check the clock circuit and Φ line.

4. Set the switches labeled ROMC on the extender board to CLOSED. This forces the SMI to step through its addresses.

5. On the A8 Controller/Counter Assembly, connect the signature analyzer clipleads as follows:

Clock	A8TP13 (WRT)
Ground	A8TP3 (GND)

On the extender board, connect the signature analyzer clipleads as follows:

Start	ADDRESS 15
Stop	ADDRESS 15

6. Set the signature analyzer's start, stop, and clock to trigger as follows:

Start	Falling Edge
Stop	Falling Edge
Clock	Rising Edge

7. Check the following test points listed in Table 8D-1 on the extender board or on A8 with the signature analyzer probe. If all signatures are bad except GND, see Service Sheet 15 and replace the SMI. If only one ADDRESS line is faulty, see Service Sheets 15 and 16 and check the SMI and the address line.

8. Check A8TP17 (RAM write) and A8TP18 (CPU read) with a dc coupled oscilloscope. RAM write should be a TTL high, CPU read should be a TTL square wave with a period of 2 μs. If faulty, see Service Sheet 15 and check the SMI and the load on the two lines.

TROUBLESHOOTING—SERVICE SHEET BD4

Table 8D-1. Signatures for Address Lines, √2 Step 7

Test Point	Signature	Test Point	Signature
A8TP16 (+5V)	0001	ADDRESS 8	HC89
A8TP3 (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

8. Check A8TP17 (RAM write) and A8TP18 (CPU read) with a dc coupled oscilloscope. RAM write should be a TTL high, CPU read should be a TTL square wave with a period of 2 μs. If faulty, see Service Sheet 15 and check the SMI and the load on the two lines.

9. Switch LINE to OFF. Remove A8U30 (CPU External Register or RAM) from its socket.

10. Switch LINE to ON. Check the CONTROL BUS test points listed in Table 8D-2 on the extender board with the signature analyzer probe. If signatures are faulty, see Service Sheet 15 and check the Decoders and ROMs. **Serial Prefix 2652A and Above**: If signatures are faulty, replace the ROM.

Serial Prefix 2450A to 2520A:

NOTE

The signatures listed in Table 8D-2 are valid only for the software with the specified date (or ROM part numbers) listed in Table 8D-3.

Table 8D-2. Signatures for Data Lines, √2 Step 10

Test Point	Signature	Test Point	Signature
DATA 0	6AF2	DATA 4	HP04
DATA 1	6PH9	DATA 5	57A4
DATA 2	1AAH	DATA 6	FF71
DATA 3	C317	DATA 7	C96A

Table 8D-3. Valid ROM Part Numbers, √2 Step 10 Note*

ROM Number	Part Number	ROM Number	Part Number
1	08903-80016	6	08903-80021
2	08903-80017	7	08903-80022
3	08903-80018	8	08903-80023
4	08903-80019	9	08903-80024
5	08903-80020		
* Valid software date 11.15 1984.			

TROUBLESHOOTING—SERVICE SHEET BD4

NOTE

The signatures listed in Tables 8D-2a and 8D-2b are valid only for the software with the specified date (or ROM part numbers) listed in Tables 8D-3a or 8D-3b.

Serial Prefix 2520A to 2614A:

Table 8D-2a. Signatures for Data Lines, √2 Step 10

Test Point	Signature	Test Point	Signature
DATA 0	5F7C	DATA 4	FU4U
DATA 1	5427	DATA 5	9A27
DATA 2	508A	DATA 6	9C65
DATA 3	0487	DATA 7	6074

Table 8D-3a. Valid ROM Part Numbers, √2 Step 10 Note*

ROM Number	Part Number	ROM Number	Part Number
1	1818-3741	6	1818-3746
2	1818-3742	7	1818-3747
3	1818-3743	8	1818-3748
4	1818-3744	9	1818-3749
5	1818-3745		
* Valid software date 2.11 1985.			

Serial Prefix 2652A and Above

Table 8D-2b. Signatures for Data Lines, √2 Step 10

Test Point	Signature	Test Point	Signature
DATA 0	UU90	DATA 4	860U
DATA 1	3FHU	DATA 5	UCC0
DATA 2	9HCP	DATA 6	AU5P
DATA 3	6498	DATA 7	2207

Table 8D-3b. Valid ROM Part Number, √2 Step 10 Note*

ROM Number	Part Number
10	08903-80036
* Valid software date 8.22 1986.	

√3 CPU External Register (RAM) Check

1. Perform the *Power-Up Checks on Service Sheet BD1.*

√4 CPU I/O Port Check

1. Switch LINE to OFF. Extend the A8 Controller/Counter Assembly with the Digital Test/Extender Board. Switch LINE to ON.

NOTE

Check that the switches labeled ROMC on the extender board are set to OPEN.

2. Key in 0.0 SPCL. Check the Instrument Bus test points listed in Table 8D-4 on the extender board with an oscilloscope or signature analyzer probe (used as a logic probe). If faulty, see Service Sheet 15 and check the CPU and I/O port decoders and buffers.

Table 8D-4. Levels on Instrument Bus, ⟨✓4⟩ Step 2

Test Point	Measured Signal
ENABLE 0	Low-Going TTL Pulses, Period ≈30 ms
SELECT 0 to 3	TTL Low
DATA (H) 0 to 3	TTL Low
DATA (L) 0 to 3	TTL High

3. Key in 0.0 S (Shift) 5 S 5 SPCL. Recheck the test points listed in Table 8D-5. If faulty, see Service Sheet 15 and check the CPU and I/O port decoders and buffers.

Table 8D-5. Levels on Instrument Bus, ⟨✓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-6. For each entry, the indicated ENABLE test point on the extender board should show low-going TTL pulses with a period of approximately 30 ms. All other ENABLE test points should be TTL highs. If faulty, see Service Sheet 15 and check the Enable Decoder and CPU.

Table 8D-6. Pulses, ⟨✓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

⟨✓5⟩ 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⟩ *Front-Panel LED Check.* While pressing the SPCL key, 33 should appear in the display. After the SPCL key is released, 99 should appear. If other numbers appear, continue on.

2. Jumper pin 7 of A8U6 (EXT INT) to A8TP3 (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-2. 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 17. If a wrong code appears for one or more keys, check the corresponding key and decoder; see Service Sheet 20.

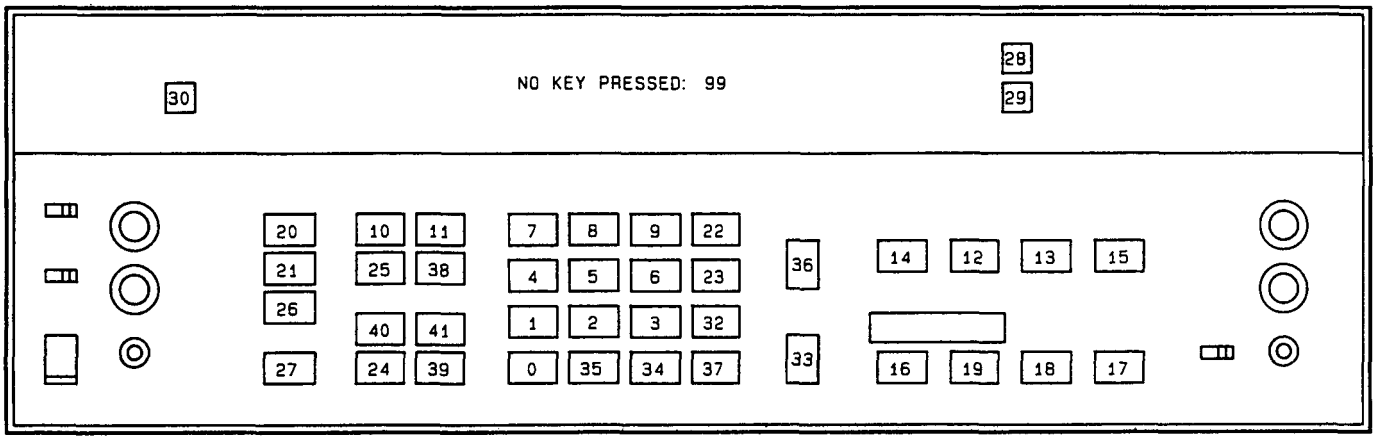


Figure 8D-2. Key Codes for Special Function 60.0, ⟨✓5⟩ Step 3

⟨✓6⟩ Keyboard Interrupt Check

1. Connect high-impedance, dc coupled oscilloscope to pin 7 of A8U6 (EXT 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 17 and check the Keystroke Detector.

⟨✓7⟩ Front-Panel LED Check

1. Perform the *Front-Panel LED Check* on Service Sheet BD1.

⟨✓8⟩ HP-IB Check

1. See Service Sheet 19.

⟨✓9⟩ Instrument Control Latches and Parity Check and Overload Readback Check

1. See Service Sheet 12.

⟨✓10⟩ Plotter Control Circuits Check

NOTE

The following procedure assumes that the instrument is capable of making a swept ac level measurement.

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the OUTPUT and INPUT switches to ground. Set AMPTD to 1V. Connect the HIGH OUTPUT to the HIGH INPUT.

2. Connect a dc voltmeter to the rear-panel X AXIS, Y AXIS, and PEN LIFT outputs and observe the voltage as the keys indicated in Table 8D-7 are pressed.

Hint: If the upper limits of the X AXIS or Y AXIS outputs are only slightly out of limits, consult Table 5-1, *Factory Selected Components*, for A7R8 and A7R10.

Table 8D-7. Plotter Control Circuits Check, ⟨✓10⟩ Step 2

Key Pressed	X AXIS	Y AXIS	PEN LIFT
START FREQ	−10 to +10 mVdc	−10 to +10 mVdc	TTL High
STOP FREQ	+9.7 to +10.3 Vdc	+9.7 to +10.3 Vdc	TTL High
SWEEP	Slow increase from ≈0 to ≈ +10 Vdc	Steady at ≈ +5 Vdc	TTL Low

SERVICE SHEET 12---A7 Latch Assembly (Data Latches)

PRINCIPLES OF OPERATION

NOTE

The following discussions require an understanding of the operation of the Instrument Bus (see Instrument Bus, *Service Sheet BD4) and of the Instrument Bus readback (see* Direct Control Special Functions, *paragraph 8-22).*

General

This portion of the Latch Assembly (A7) contains many of the select decoders and data latches which decode the Instrument Bus and drive the digital-to-analog devices in the instrument hardware. The circuit also includes two overload flip-flops and a Parity Check.

Data Latches and Select Decoder

The Data Latches are of two types. One type (for example, register U9) decodes and latches all four data lines of the Instrument Bus when enabled by a unique select code (for example, U9 is enabled by s=3(L) from Select Decoder U7). Continuing the example, U7 is enabled when e=7(L) is low (that is, true) and s3(H) is low (that is, false, in other words, *s* is between 0 and 7). Thus, U9 responds to *esd*=73*d*, where *d* is the arbitrary data input.

The other type (for example, register U22) is enabled by a unique enable code (for example, *e*=6). The three least significant bits of the select code (*s*0, *s*1 and *s*2) are then decoded, and the input (for example, d0(H)) is loaded and latched into the output enabled by the decoding of the select inputs. Thus for example, if *esd*=631, a high is loaded into OS FRQ4. Note that d0(H) is high since *d*=1 (binary 0001). The other outputs of the data latch are unaffected. Also note that more than one data latch can be activated with a single Direct Control Special Function (for example, if *esd*=633, a high is loaded into both OS FRQ5 of U23 and OS FRQ4 of U22).

Overload Flip-Flops

When an input overload is detected (see Service Sheet 2), Input Overload Flip-Flop U14 is reset. Pin 5 of U14A resets Data Latches U9, U11, and U12 which sets the gain of the input circuits to minimum. The state of U14A is read by the Controller via U15B. To read U14A, the Controller issues *esd*=700 to the Instrument Bus. If d0(L) is low, the Input Overload Flip-Flop is known to be reset. To set U14A, the Controller issues *esd*=772 to the Instrument Bus. Since d1(H) is high, pin 8 of U14B is low, which sets U14A.

The Output Overload Flip-Flop, U13, operates in a manner similar to U14. When an overload is detected (see Service Sheet 6), U10 is reset which sets the gain of the Output Amplifier to minimum. The state of U10 is read when the Controller issues *esd*=740 to the Instrument Bus. The code *esd*=760 sets the flip-flop.

Parity Check

The Parity Check circuit allows the Controller to test the integrity of the data lines of the Instrument Bus. To check parity, the Controller sends out the sixteen codes *esd*=740 to *esd*=74F. For each code, the output of exclusive-OR gate U8C is read back by the Controller. The output of U8C is low when *d*0+*d*1+*d*2+*d*3 is even, or high when it is odd. Parity is checked only during instrument power up (see *Power-Up Checks,* paragraph 8-27).

TROUBLESHOOTING

General

Procedures for checking the Latch Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. The A8 Controller/Counter Assembly must be extended using the extender board (HP 08903-60018). The A7 Latch Assembly must be extended using three 44 pin extender boards.

Equipment

Digital Test/Extender Board	HP 08903-60018
Oscilloscope	HP 1740A
Signature Analyzer	HP 5005A
44 Pin Extender Boards (3)	HP 08901-60084

⟨✓1⟩ Latches Check---Using Signature Analysis

1. Switch LINE to OFF. Extend the A8 Controller/Counter Assembly using the digital test/extender board (HP 08903-60018) and the A7 Latch Assembly using the three 44 pin extender boards (HP 08901-60084).

2. Interconnect the Controller/Counter Assembly, the Latch Assembly, the extender boards, and the signature analyzer as shown in Figure 8D-3. Set the switches on the digital test/extender board to the OPEN position.

3. Unplug assemblies A2 through A6. (They do not need to be completely removed.)

4. Set the signature analyzer's start, stop, and clock to trigger as follows:

Start	Falling Edge
Stop	Falling Edge
Clock	Rising Edge

5. Connect A8TP9 (TEST C) to A8TP3 (GND).

NOTE

Disregard the front-panel indications when performing signature analysis.

6. Set LINE switch to ON. Verify that Test LEDs A, B, and D light and remain lit.

7. Remove the ground from A8TP9. Verify that Test LED C lights and remains lit.

8. Check the pins on the ICs indicated in Table 8D-8 with the signature analyzer.

NOTE

In addition to the signatures shown in Table 8D-8, Service Sheet 13 contains signatures that can be checked using the current test setup.

Hint: If nearly all signatures are faulty, see Service Sheet BD4 and check the CPU I/O port.

⟨✓2⟩ Latches Check---Using Direct Control Special Functions

NOTE

If the keyboard is operating properly, the latches can be checked using Direct Control Special Functions and a logic probe. A signature analyzer is not needed. Extend the Latch Assembly when performing this check.

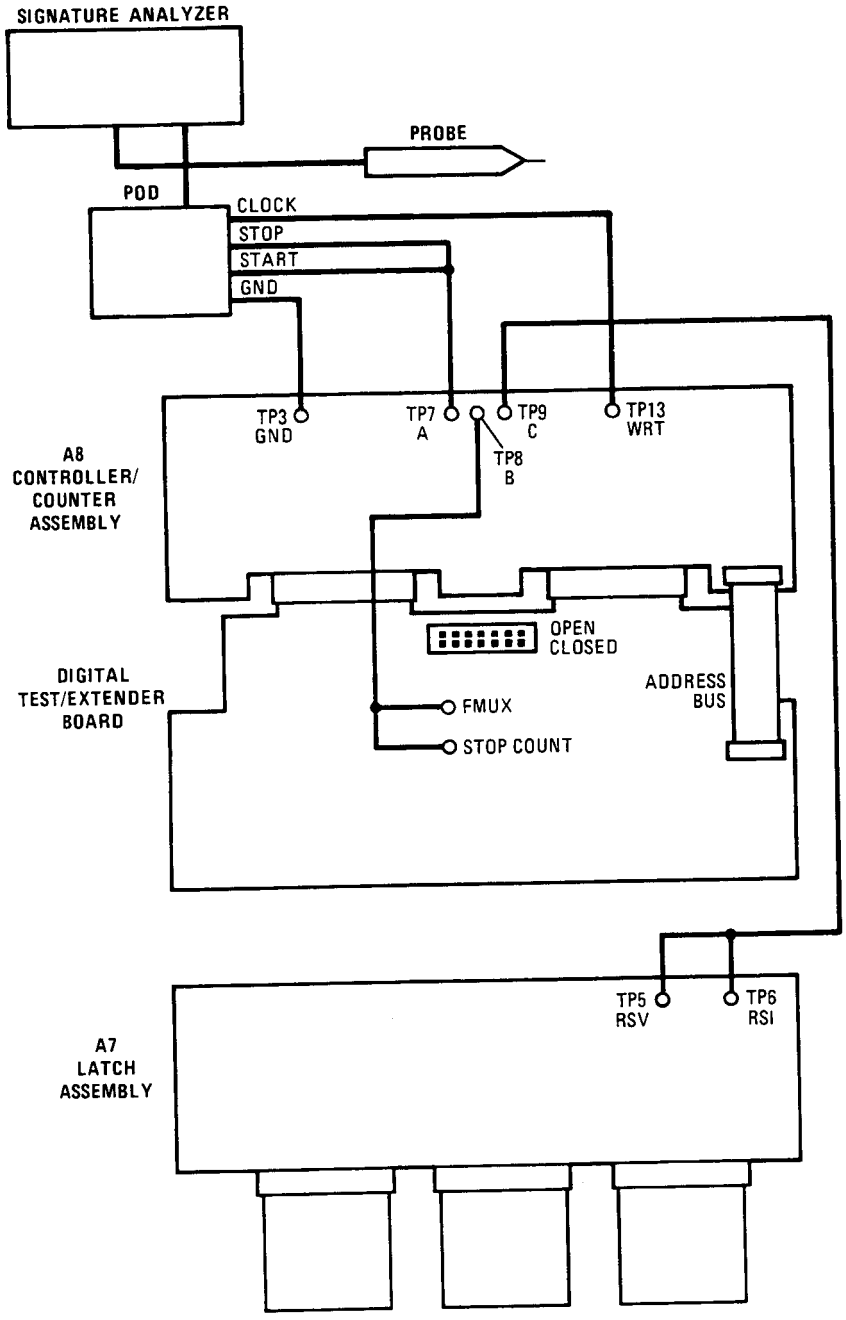


Figure 8D-3. Latch Assembly Troubleshooting Setup, ⟨J1⟩ *Step 2*

Table 8D-8. Signatures for ⟨J1⟩ Step 8

Pin	U7	U8	U9	U10	U11	U12	U13	U14	U15	Pin
1	600A	2941	801H	AA99	801H	801H	4824	40AA	0000	1
2	9CU7	2941	78A1	C393	8U6U	57H5	57H5	4824	72UC	2
3	7PAA	0000	3085	UCC7	F74C	A345	0A07	HP9P	1UU1	3
4	PH3H	2941	57H5	57H5	57H5	4824	4824	8160	96CA	4
5	35F6	2941	F4F9	F4F9	F4F9	8P2C	F944	801H	F839	5
6	4824	0000	3085	UCC7	F74C	F60U	8160	F839	1UU1	6
7	0A07	0000	78A1	C393	8U6U	0000	0000	0000	0000	7
8	0000	0000	0000	0000	0000	F60U	P2CH	8160	1UU1	8
9	P1A9	0000	H4AA	2308	A5AP	8P2C	AA99	F944	P2CH	9
10	2308	0000	78A1	C393	8U6U	4824	8160	–	A98H	10
11	3AHU	0000	3085	UCC7	F74C	A345	P1A9	0A07	–	11
12	H4AA	–	5C95	5C95	5C95	F4F9	4824	F4F9	–	12
13	A5AP	–	7FC0	7FC0	7FC0	801H	40AA	–	–	13
14	A345	4824	3085	UCC7	F74C	4824	4824	4824	4824	14
15	HP9P		78A1	C393	8U6U					15
16	4824		4824	4824	4824					16

Pin	U22	U23	U24	U25	U26	U27	U28	U29	U30	Pin
1	600A	600A	600A	600A	600A	600A	600A	600A	HP9P	1
2	9CU7	9CU7	9CU7	9CU7	9CU7	9CU7	9CU7	9CU7	96CA	2
3	7PAA	7PAA	7PAA	7PAA	7PAA	7PAA	7PAA	7PAA	3AHU	3
4	26U7	26U7	26U7	26U7	54UP	54UP	54UP	54UP	72UC	4
5	H3HU	H3HU	H3HU	H3HU	P322	P322	P322	P322	–	5
6	7255	7255	7255	7255	H3CF	H3CF	H3CF	H3CF	–	6
7	9C3C	9C3C	9C3C	9C3C	68U6	68U6	68U6	68U6	0000	7
8	0000	0000	0000	0000	0000	0000	0000	0000	–	8
9	3F58	3F58	3F58	3F58	U12F	U12F	U12F	U12F	–	9
10	HA3H	HA3H	HA3H	HA3H	404F	404F	404F	404F	–	10
11	10U4	10U4	10U4	10U4	F798	F798	F798	F798	–	11
12	2941	2941	2941	2941	6A46	6A46	6A46	6A46	A98H	12
13	57H5	F4F9	5C95	7FC0	57H5	F4F9	5C95	7FC0	P1A9	13
14	77F6	77F6	77F6	77F6	F9P1	F9P1	F9P1	F9P1	4824	14
15	4824	4824	4824	4824	4824	4824	4824	4824		15
16	4824	4824	4824	4824	4824	4824	4824	4824		16

Note: The signature for a high or +5V is 4824. The signature for a low or ground is 0000. The "–" indicates that there is no valid signature for the pin. A blank indicates no pin on the IC.

Select Decoder

1. Key in the Direct Control Special Functions indicated in Table 8D-9. For each setting, check the pins on U7 indicated.

Data Latches U9, U10, and U11

2. Key in the Direct Control Special Functions indicated in Table 8D-10. For each setting, check the pins on the IC indicated.

Hint: Pin 1 on the ICs should be high.

Table 8D-9. Select Decoder Check, ⟨✓2⟩ Step 1

Direct Control Special Function	Level (TTL) at U7 Pin							
	15	14	13	12	11	10	9	7
0.700	*	H	H	H	H	H	H	H
0.710	H	*	H	H	H	H	H	H
0.720	H	H	*	H	H	H	H	H
0.730	H	H	H	*	H	H	H	H
0.740	H	H	H	H	*	H	H	H
0.750	H	H	H	H	H	*	H	H
0.760	H	H	H	H	H	H	*	H
0.770	H	H	H	H	H	H	H	*
* Low-going TTL pulses, approximately 30 ms period.								

Table 8D-10. Data Latches Check, ⟨✓2⟩ Step 2

Direct Control Special Function	IC to Check	Level (TTL) at Pin							
		2	3	7	6	10	11	15	14
0.720	U11	L	H	L	H	L	H	L	H
0.72F	U11	H	L	H	L	H	L	H	L
0.730	U9	L	H	L	H	L	H	L	H
0.73F	U9	H	L	H	L	H	L	H	L
0.750	U10	L	H	L	H	L	H	L	H
0.75F	U10	H	L	H	L	H	L	H	L

Data Latch U12

3. Key in 0.710 SPCL. Pins 6 and 8 of U12 should be low.

4. Key in 0.71F SPCL. Pins 6 and 8 of U12 should be high.

Overload Flip-Flops

5. Momentarily ground A7TP6 (RSI). Pin 5 of U14 should be low; pin 6 should be high.

6. Key in 0.700 SPCL. Pin 5 of U14 should be high; pin 6 should be low.

7. Key in 0.770 SPCL. Momentarily ground A7TP6 again. Key in 0.772 SPCL. Pin 5 of U14 should be high; pin 6 should be low.

8. Momentarily ground A7TP5 (RSV). Pin 9 of U13 should be low; pin 8 should be high.

9. Key in 0.760 SPCL. Pin 9 of U13 should be high; pin 8 should be low.

10. Key in 0.770 SPCL. Momentarily ground A7TP5 again. Key in 0.771 SPCL. Pin 9 of U13 should be high; pin 8 should be low.

Data Latches U22 through U29

11. Key in the Direct Control Special Functions indicated in Table 8D-11. For each setting, check the pin on the ICs indicated. For the special function code 0.6*s*0, the pin should be low, for 0.6*s*F it should be high.

12. Key in the Direct Control Special Functions indicated in Table 8D-12. For each setting, check the pin on the ICs indicated. For the special function code 0.6*s*0, the pin should be low, for 0.6*s*F it should be high.

Table 8D-11. Data Latches Check, ⟨✓2⟩ Step 11

Direct Control Special Function	Pin to Check on U22, U23, U24, and U25
0.600, 0.60F	4
0.610, 0.61F	5
0.620, 0.62F	6
0.630, 0.63F	7
0.640, 0.64F	9
0.650, 0.65F	10
0.660, 0.66F	11
0.670, 0.67F	12

Table 8D-12. Data Latches Check, ⟨✓2⟩ Step 12

Direct Control Special Function	Pin to Check on U26, U27, U28, and U29
0.500, 0.50F	4
0.510, 0.51F	5
0.520, 0.52F	6
0.530, 0.53F	7
0.540, 0.54F	9
0.550, 0.55F	10
0.560, 0.56F	11
0.570, 0.57F	12

Parity Check

13. Key in the Direct Control Special Functions indicated in Table 8D-13. For each setting, check the pins of U8 indicated.

Table 8D-13. Parity Check, ⟨✓2⟩ Step 13

Direct Control Special Function	Level (TTL) at U8 Pin		
	3	6	8
0.670	L	L	L
0.671	H	L	H
0.674	L	H	H
0.675	H	H	L

Readback Check

14. Key in 0.670 SPCL then 0.740 SPCL. The displays should read 0000 0000.

15. Key in 0.671 SPCL then 0.740 SPCL. The displays should read 0001 0000.

16. Key in 0.770 SPCL then 0.700 SPCL. Note the displays as A7TP6 (RSI) is momentarily grounded. The displays should read 0000 0000 when A7TP6 is ungrounded and 0001 0000 when grounded.

17. Key in 0.760 SPCL. Note the displays as A7TP5 (RSV) is momentarily grounded. The displays should read 0000 0000 when A7TP5 is ungrounded and 0001 0000 when grounded.

SERVICE SHEET 13---A7 Latch Assembly (DAC and Counter Trigger Circuits)

PRINCIPLES OF OPERATION

General

This portion of the Latch Assembly (A7) contains some of the data latches, the Counter Input Schmitt Trigger, and the X- and Y-Axis DACs.

Data Latches

The data latches are discussed in the *Principles of Operation* for Service Sheet 12.

Counter Input Schmitt Trigger

The Counter Input Schmitt Trigger converts the analog signal from the Input Amplifier (see Service Sheet 2) or the Output Amplifier (see Service Sheet 5) into a TTL-compatible signal which drives the Counter. Switching of the two signals is via the Input Switch, U18. The switch also grounds the unused input to minimize cross-talk.

U17 is a buffer amplifier which drives two peak detector diodes, CR7B and CR8B. CR7A and CR8A cancel the error in the peak detectors caused by the drop across the diodes. R17 to R20 divide the detected voltages by two. U2C and U2D are comparators that are referenced by the peak detectors. U2C trips at one-half the level of the positive peak of the input, U2D trips at one-half the negative peak. R22 and R23 add a small amount of hysteresis to the comparators. The outputs of U2C and U2D are applied to two inputs of set-reset flip-flop U1C and U1B. The output of U2D, however, is first inverted by U1D. The output of U1C drives NAND gate U16B, which acts as a switch.

Consider the action of the Schmitt trigger on an input signal. Assume that the signal is periodic but at the moment is at 0V and increasing. Also assume that the flip-flop is reset (U1C low). The output of U2C is high because the signal has not yet reached half the level of the positive peak. U2D is low because the signal is more positive than half the negative peak. U1D is high. When the signal reaches one-half the positive peak, U2C goes low and the flip-flop sets (U1C high), but when the signal returns below one-half the positive peak and U2C goes high again, the flip-flop remains set. When the signal goes below one-half the negative peak, U2D goes high and resets the flip-flop, but when the signal returns to above one-half the negative peak and U2D returns low again, the flip-flop remains reset. The action of the Schmitt trigger is depicted in Figure 8D-4.

The Counter Input Schmitt Trigger thus self-biases its upper and lower references to one-half the respective positive and negative peaks. The result is excellent immunity to noisy signals whether large or small. U16 forms an output switch to route the signal from either the Counter Input Schmitt Trigger or the Oscillator to the Counter.

X- and Y-Axis DACs

The X- and Y-Axis DACs are programed by the Controller via the Instrument Bus and Latch Assembly. The DACs output a current proportional to the binary weighting of the inputs. The current is converted to a voltage by transconductance amplifiers U3C and U3D. C23 and C24 provide heavy filtering. The outputs are applied to the rear-panel X AXIS and Y AXIS output connectors. The pen lift function is controlled by the Controller via the Instrument Bus and U6. (A high is issued to lift the pen.)

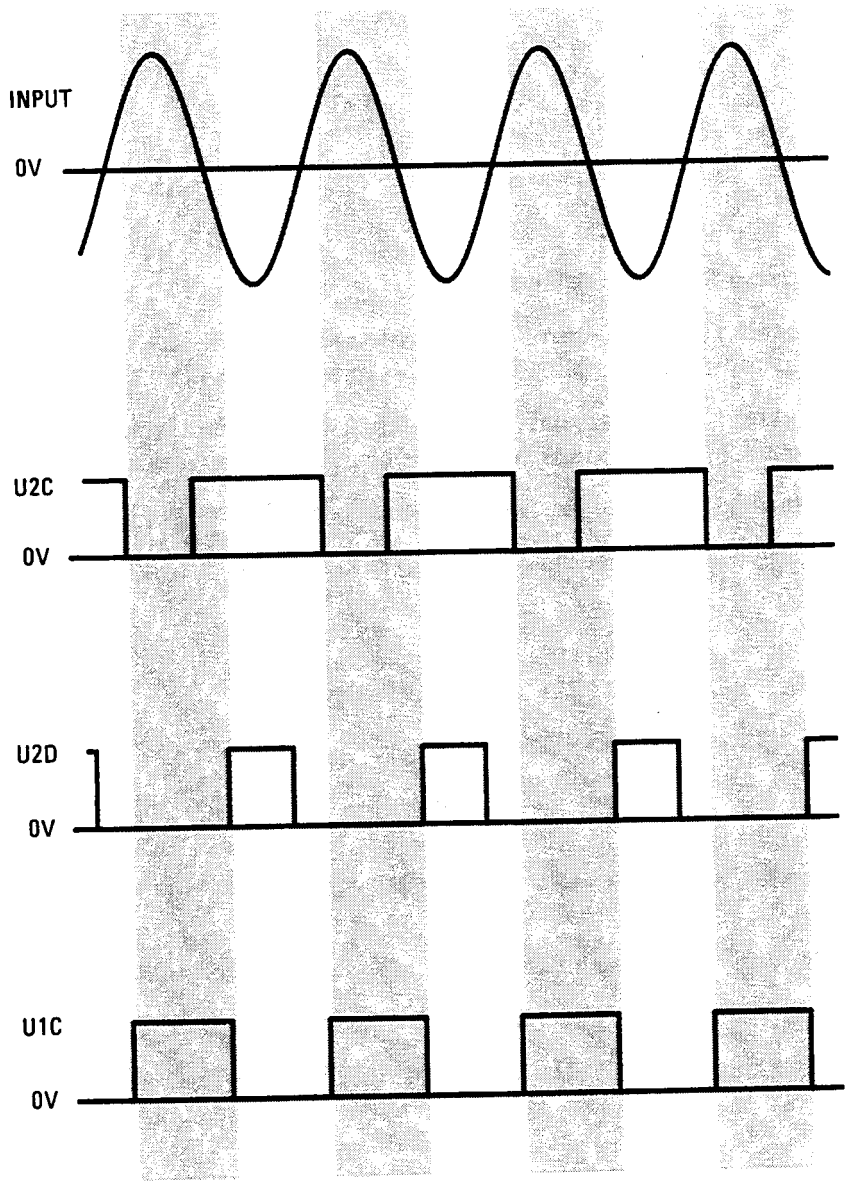


Figure 8D-4. Action of the Counter Input Schmitt Trigger for a Sine Wave Input

TROUBLESHOOTING

General

Procedures for checking the Latch Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. When troubleshooting the latches, the A8 Controller/Counter Assembly must be extended using the extender board (HP 08903-60018). The A7 Latch Assembly must be extended using three 44 pin extender boards.

Equipment

Digital Test/Extender Board	HP 08903-60018
Digital Voltmeter	HP 3455A
Oscilloscope	HP 1740A
Signature Analyzer	HP 5005A
44 Pin Extender Boards (3)	HP 08901-60084

⟨✓1⟩ Latches Check---Using Signature Analysis

1. Switch LINE to OFF. Extend the A8 Controller/Counter Assembly using the digital test/extender board (HP 08903-60018) and the A7 Latch Assembly using the three 44 pin extender boards (HP 08901-60084).

2. Interconnect the Controller/Counter Assembly, the Latch Assembly, the extender boards, and the signature analyzer as shown in Figure 8D-5. Set the switches on the digital test/extender board to the OPEN position.

3. Unplug assemblies A2 through A6. (They do not need to be completely removed.)

4. Set the signature analyzer's start, stop, and clock to trigger as follows:

Start	Falling Edge
Stop	Falling Edge
Clock	Rising Edge

5. Connect A8TP9 (TEST C) to A8TP3 (GND).

NOTE

Disregard the front-panel indications when performing signature analysis.

6. Set LINE switch to ON. Verify that Test LEDs A, B, and D light and remain lit.

7. Remove the ground from A8TP9. Verify that Test LED C lights and remains lit.

8. Check the pins on the ICs indicated in Table 8D-14 with the signature analyzer.

NOTE

In addition to the signatures shown in Table 8D-14, Service Sheet 12 contains signatures that can be checked using the current test setup.

Hint: If nearly all signatures are faulty, see Service Sheet BD4 and check the CPU I/O port.

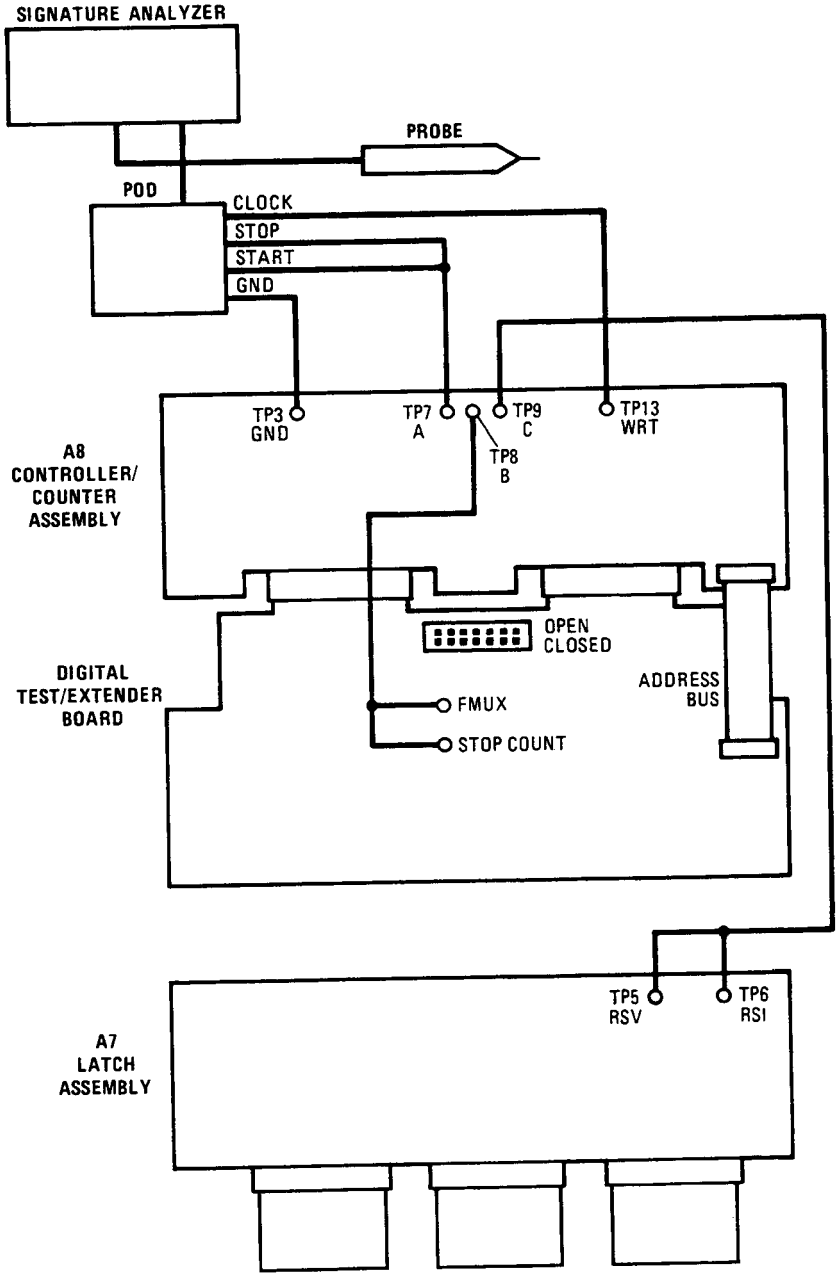


Figure 8D-5. Latch Assembly Troubleshooting Setup

Table 8D-14. Signatures for ⟨√1⟩ Step 8

Pin	U5	U6	U20	U21	Pin
1	600A	600A	600A	600A	1
2	9CU7	9CU7	9CU7	9CU7	2
3	7PAA	7PAA	7PAA	7PAA	3
4	2199	2199	2199	2199	4
5	C551	C551	C551	C551	5
6	6380	6380	6380	6380	6
7	44P4	44P4	44P4	44P4	7
8	0000	0000	0000	0000	8
9	F043	F043	F043	F043	9
10	6PA2	6PA2	6PA2	6PA2	10
11	9C44	9C44	9C44	9C44	11
12	1P0U	1P0U	1P0U	1P0U	12
13	F4F9	57H5	7FC0	5C95	13
14	6420	6420	6420	6420	14
15	4824	4824	4824	4824	15
16	4824	4824	4824	4824	16

Note: The signature for a high or +5V is 4824.
The signature for a low or ground is 0000.

⟨√2⟩ Latches Check—Using Direct Control Special Functions

NOTE

If the keyboard is operating properly, the latches can be checked using Direct Control Special Functions and a logic probe. A signature analyzer is not needed.

1. Key in the Direct Control Special Functions indicated in Table 8D-15. For each setting, check the pin on the ICs indicated. For special function code 0.4*s*0, the pin should be low, for 0.4*s*F it should be high.

Table 8D-15. Data Latches Check, ⟨√2⟩ Step 1

Direct Control Special Function	Pin to Check on U5, U6, U20, and U21
0.400, 0.40F	4
0.410, 0.41F	5
0.420, 0.42F	6
0.430, 0.43F	7
0.440, 0.44F	9
0.450, 0.45F	10
0.460, 0.46F	11
0.470, 0.47F	12

⟨√3⟩ X- and Y-Axis DACs and Pen Lift Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT switch to ground. Connect the rear-panel X AXIS output to the INPUT or to the input of a dc voltmeter.

2. Key in the Special Functions listed in Table 8D-16. For each setting, key in S (Shift) DC LEVEL or note the

level on the external voltmeter. The dc level should be as indicated. If the level is faulty, also check the pins on U4 indicated.

Table 8D-16. X-Axis Output Level Check, ⟨J3⟩ Step 2

Direct Control Special Function	Level (Vdc) at X AXIS Output	Level (TTL) at U4 Pin							
		5	6	7	8	9	10	11	12
0.450, 0.440	−0.002 to 0.002	L	L	L	L	L	L	L	L
0.448	0.03 to 0.05	L	L	L	L	L	L	L	H
0.444	0.07 to 0.09	L	L	L	L	L	L	H	L
0.442	0.14 to 0.17	L	L	L	L	L	H	L	L
0.441	0.29 to 0.33	L	L	L	L	H	L	L	L
0.440, 0.458	0.59 to 0.66	L	L	L	H	L	L	L	L
0.454	1.2 to 1.3	L	L	H	L	L	L	L	L
0.452	2.4 to 2.6	L	H	L	L	L	L	L	L
0.451	4.8 to 5.2	H	L	L	L	L	L	L	L

Hint: If the dc levels are all uniformly high or low, replace A7R10 with a value selected on the basis described in Table 5-1.

3. Connect the rear-panel Y AXIS output to the INPUT or to the input of a dc voltmeter. Key in the Special Functions listed in Table 8D-17. For each setting, key in S (shift) DC LEVEL or note the level on the external voltmeter. The dc level should be as indicated. If the level is faulty, also check the pins on U5, U6, U20, and U21 indicated.

Table 8D-17. Y-Axis Output Level Check, ⟨J3⟩ Step 3

Direct Control Special Function	Level (Vdc) at Y AXIS Output	Level (TTL) at U19 Pin							
		5	6	7	8	9	10	11	12
0.470, 0.460	−0.002 to 0.002	L	L	L	L	L	L	L	L
0.468	0.03 to 0.05	L	L	L	L	L	L	L	H
0.464	0.07 to 0.09	L	L	L	L	L	L	H	L
0.462	0.14 to 0.17	L	L	L	L	L	H	L	L
0.461	0.29 to 0.33	L	L	L	L	H	L	L	L
0.460, 0.478	0.59 to 0.66	L	L	L	H	L	L	L	L
0.474	1.2 to 1.3	L	L	H	L	L	L	L	L
0.472	2.4 to 2.6	L	H	L	L	L	L	L	L
0.471	4.8 to 5.2	H	L	L	L	L	L	L	L

Hint: If the dc levels are all uniformly high or low, replace A7R8 with a value selected on the basis described in Table 5-1.

4. Connect a dc voltmeter to the rear panel PEN LIFT output. Key in 0.421 SPCL (pen up). The voltage should read a TTL high.

5. Key in 0.420 SPCL (pen down). The voltage should read a TTL low.

⟨J4⟩ Counter Input Check

1. On the Audio Analyzer, key in 41.0 SPCL to initialize the instrument. Set the INPUT and OUTPUT switches both to ground. Set AMPTD to 1V. Key in 46.3 SPCL to set the counter to read the output amplifier signal. Connect the HIGH INPUT to the HIGH OUTPUT.

2. Connect a high-impedance, dc coupled oscilloscope to pin 3 of U18. The signal should be approximately 6 Vpp.

Hint: Pin 8 of U18 should be a TTL low, pin 1 a high. The signal at pin 10 of U18 should also be 6 Vpp; if it is not, see Service Sheet 5 and check Amplifier 4.

3. Key in 46.1 SPCL to set the counter to read the input frequency. The signal at pin 3 of U18 should be approximately 6 Vpp.

Hint: Pin 1 of U18 should be a TTL low, pin 8 a high. The signal at pin 2 of U18 should also be 6 Vpp; if it is not, see Service Sheet 2 and check the Weighting Bandpass and High-Pass Filters.

4. Connect the oscilloscope to pin 2 of U2 then to pin 13 of U2. The waveforms should be pulses with a period of 1 ms. The pulses at pin 2 of U2 should be +5V for 0.65 ms and −15V for 0.35 ms. The pulses at pin 13 should be the complement of those at pin 2.

Hint: The level at pin 5 of U2 should be approximately one half the level of the positive peak of the signal at pin 3 of U17. The level at pin 11 of U2 should be approximately one half the level of the negative peak of the signal at pin 3 of U17.

5. Connect the oscilloscope to pin 8 of U1. The waveform should be a TTL square wave.

6. Connect the oscilloscope to A7TP2 (FMUX). The waveform should be a TTL square wave which should become either high, low, or intermittent if the HIGH OUTPUT is disconnected.

Hint: Pins 4 and 9 of U16 should be a TTL high.

7. Key in 46.0 SPCL to set the counter to read the oscillator signal. The waveform should be a TTL square wave which should persist if the HIGH OUTPUT is disconnected.

Hint: Pin 4 of U16 should be a TTL low. Pin 10 of U16 should be a TTL high.

SERVICE SHEET 14---A8 Controller/Counter Assembly (Counter Circuits)

PRINCIPLES OF OPERATION

NOTE

The following discussions require an understanding of the operation of the Instrument Bus (see Instrument Bus, *Service Sheet BD4) and of the Instrument Bus readback (see* Direct Control Special Functions, *paragraph 8-22).*

General

The Counter consists of the Clock Counter, the Cycle Counter, gating circuits, and the Count Transfer Logic. The final stages of the Clock and Cycle Counters are in the Controller itself. The Clock Counter counts the 2 MHz clock (Φ) signal. The Cycle Counter counts the input or Oscillator signal (FMUX) and is not used when measuring voltage.

Clock Counter

The Clock Counter has three stages (U1, U2, and U14A) which form a divide-by-2048. The input to the counter, when enabled, is 2 MHz, and the output is 976.5625 Hz.

When the Counter is making a frequency measurement, the Frequency Gate (U19B) is armed by the Controller and gated by the input signal (FMUX). To arm the Frequency Gate, the Controller sends *esd*=7F0 out on the Instrument Bus which sets U29A (and also clears the Clock Counter). NAND gate U19B is thus high. Next, the Controller issues *esd*=7E0. This puts a high on the output of U4B, a high on U20C, and thus a low on U4A and the D1 input to U29A. The next falling edge of FMUX clocks the low into U29A and gates U19B, which routes the 2 MHz (Φ) signal into the Clock Counter. (U29B had previously been reset, putting a high on pin 5 of U19B and causing U19C to go high.)

As the count progresses, carries from flip-flop 4 of U14A are output to Instrument Bus line d2(L) via U17D and are counted by the Controller. U17D was enabled by the same signal from the Controller that armed U4A.

After a predetermined number of clock carries have been counted by the Controller, the Controller issues *esd*=7E1 to the Instrument Bus. U20C now goes low which puts a high on the D1 input of U29A. The next falling edge of FMUX clocks the high into U29A and inhibits U19B. If FMUX should be interrupted during the count, the Controller program terminates the count sequence after 16 more clock carries.

When voltage is being measured, the Voltmeter Gate performs functions similar to the Frequency Gate. To make a voltage measurement, the Controller issues *esd*=7E0 to the Instrument Bus. This puts a high on both inputs of NAND gate U4A. The low at the output of U4A enables the Voltmeter Gate U19C. (Mode Select flip-flop U29B had previously been set.) At this point the Stop Count(H) line from the Voltage-to-Time Converter is low. Thus the 2 MHz clock (Φ) signal is gated into the counter via the Stop Count and Voltmeter Gates. After an interval determined by the dc voltage at the input to the Voltage-to-Time Converter, Stop Count(H) goes high which disables the clock signal. The accumulated count is, then, a function of the dc voltage.

Cycle Counter

The Cycle Counter has two stages (U15 and U14B) which form a divide-by-32. The input to the counter, when enabled, is FMUX, the signal from the input or Oscillator. The counter is enabled and disabled by the same signal that enables and disables the Frequency Gate; it is cleared at the same time as the Clock Counter. Carries from the Cycle Counter are output to Instrument Bus line d3(L) via U17B and are counted by the Controller. U17B is enabled at the same time as U17D.

Counter Output Gating

To read back the outputs of the Clock and Cycle Counters after completion of a count sequence, the Controller issues *esd*=7D0 to the Instrument Bus. The output of U4D (which had been low) goes high and enables Counter Output Gates U7B, U7D, U17C, and U17A. The outputs of U15 are inverted and placed on the readback data

lines of the Instrument Bus. Next, the Controller issues *esd*=7C0 to the Instrument Bus. U3C goes low. This causes U15 to be loaded with the output of U14 and also enables the Counter Output Gates since the output of U4D is high. The output of U15 is thus placed on the Instrument Bus through U14. In a similar manner the Controller issues *esd*=7B0 and *esd*=7A0 to copy the outputs of U1 and U2 into the subsequent stages and onto the Instrument Bus.

Select Decoder

For a general discussion of operation and decoding of the Instrument Bus, see *Instrument Bus*, Service Sheet BD4. For a discussion of the readback operation, see *Direct Control Special Functions*, paragraph 8-22.

TROUBLESHOOTING

General

Procedures for checking the Controller/Counter Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩. The A8 Controller/Counter Assembly must be extended using the extender board (HP 08903-60018).

CAUTION

MOS and CMOS ICs can be damaged by static charges and circuit transients. Do not remove this 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 HP 4208-0094.) When unplugging ICs, place the board on a conductive pad. When the IC is unplugged, insert it into the pad also.

Several ICs on this assembly 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 slowly pry up the IC one pair of pins at a time.

Equipment

Digital Test/Extender Board ..... HP 08903-60018
Signature Analyzer ..... HP 5005A

⟨√1⟩ Counter Check

1. Set LINE to OFF. Extend the A8 Controller/Counter Assembly using the digital test/extender board (HP 08903-60018).

NOTE

It is not necessary to place the A7 Latch Assembly on extender boards for this procedure.

2. Interconnect the Controller/Counter Assembly, the Latch Assembly, the extender board, and the signature analyzer as shown in Figure 8D-6. Set the switches on the digital test/extender board to the OPEN position.

3. Unplug assemblies A2 through A6. (They do not need to be completely removed.)

4. Set the signature analyzer's start, stop, and clock to trigger follows:

Start ..... Falling Edge
Stop ..... Falling Edge
Clock ..... Rising Edge

5. Connect A8TP9 (TEST C) to A8TP3 (GND).

NOTE

Disregard the front-panel indications when performing signature analysis.

6. Set LINE switch to ON. Verify that Test LEDs A, B, and D on the A8 Counter/Controller Assembly light and remain lit.

7. Remove the ground from A8TP9. Verify that Test LED C lights and remains lit.

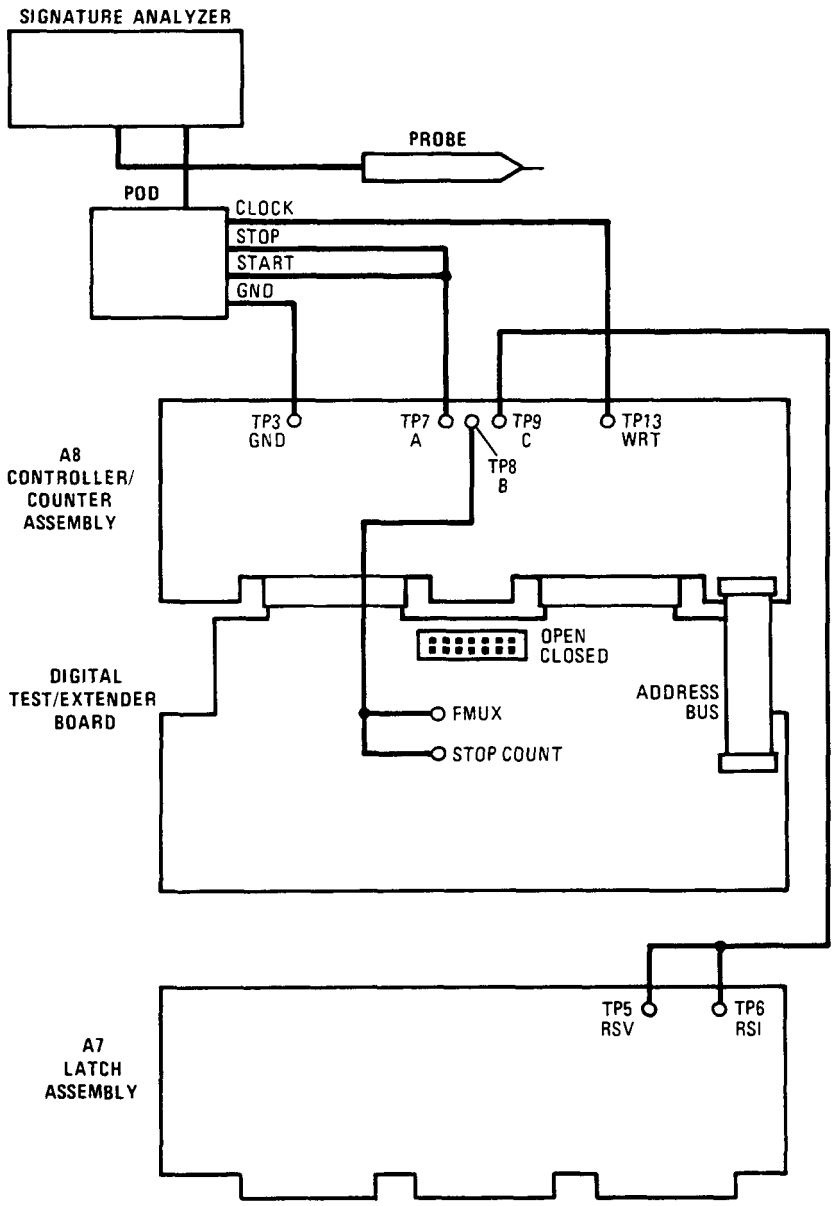


Figure 8D-6. Controller/Counter Assembly Troubleshooting Setup, ⟨J1⟩ Step 2

Table 8D-18. Signatures for ⟨√1⟩ Step 8

Description	Location	Signature
+5V	A8TP16 (+5V)	4824
d0(L)	A8U7 pin 6	1UU1
d1(L)	A8U7 pin 11	8FPH
d2(L)	A8U17 pin 8	13C1
d3(L)	A8U17 pin 3	3494

8. Check the points in Table 8D-18 with the signature analyzer probe.

Hint: If a data line is suspected (for example, if the signature for d2(L) only is faulty), the line itself may be faulty; see the CPU I/O Port Check on Service Sheet BD4. Otherwise, continue with step 9. If no signatures are faulty, perform the Counter Input Check on Service Sheet 13.

9. Remove A8U7 and A8U17 from their sockets.

CAUTION

The IC sockets are a high-grip type. Their lifetime is limited to only a few insertions. Use caution when removing or inserting ICs to avoid damage to the socket or IC.

10. Check the points in Table 8D-19 with the signature analyzer probe (the pin numbers for A8U7 and A17U17 are the socket pin numbers).

Table 8D-19. Signatures for ⟨√1⟩ Step 10

Description	Location	Signature
+5V	A8TP16 (+5V)	4824
d0(L)	A8U7 pin 6	104H
d1(L)	A8U7 pin 11	581P
d2(L)	A8U17 pin 8	UA92
d3(L)	A8U17 pin 3	581P

Hint: If faulty, the problem is with the data line itself; see the CPU I/O Port Check on Service Sheet BD4.

11. Check the points in Table 8D-20 with the signature analyzer probe.

12. Plug in A8U17. Check the pins on A8U17 with the signature analyzer probe as indicated in Table 8D-21.

Hint: A faulty signature indicates a fault in A8U17. If none of the signatures is faulty, A8U7 is probably faulty.

Hint: If the counter is operating properly, only three signatures are different with A8U7 and A8U17 installed. The signatures that differ from Table 8D-21 are:

1. U4, pin 1 is 1UU1 instead of 104H.
2. U20, pin 5 is 57H5 instead of 5869.
3. U20, pin 6 is 1UU1 instead of 104H.

Table 8D-20. Signatures for ⟨J1⟩ Step 11

Pin	U1	U2	U3	U4	U14	U15	U19	U20	U21	U29	Pin
1	U282	4824	5543	104H	8PU6	PF02	4824*	1H67	600A	4824	1
2	A885	A25C	0000*	5A9U	FFC1	1247	4824*	5543	9CU7	P522	2
3	A25C	–	0000*	P522	A1F9	4HF1	0000*	5543	7PAA	5543	3
4	F119	–	U282	12CC	6412	2PCA	U93H	1H67	PH3H	5AF7	4
5	U5U1	F119	3450	12CC	5A7H	HA42	C7A5	5869	0000	C119	5
6	U5U1	F119	8PU6	5A9U	6412	HA42	4824*	104H	35F6	U93H	6
7	0000	0000	0000	0000	0000	0000	0000	0000	5AF7	0000	7
8	42C1	0000*	PF02	–	A8P9	PF85	4824*	5543	0000	C7A5	8
9	A1F9	PUP6	8PU6	–	2PCA	4CPU	0000*	1H67	12CC	UU81	9
10	PUP6	–	2AH0	–	U5U1	FFC1	UU81	5543	PCP3	2F7H	10
11	42C1	–	PF85	07P1	A885	5A7H	AH06	1H67	2AH0	0000	11
12	6412	42C1	U93H	PF02	4HF1	A8P9	0000*	AH06	3450	–	12
13	5AF7	5AF7	5543	PCP3	5AF7	5AF7	4824*	P522	U282	385U	13
14	4824	4824	4824	4824	4824	4824	4824	4824	2F7H	4824	14
15									385U		15
16									4824		16

* Flashing light on test probe.
Note: The signature for a high or +5V is 48824. The signature for a low or ground is 0000. The "–" indicates that there is no valid signature for the pin. A blank indicates no pin on the IC.

Table 8D-21. Signatures on A8U17, ⟨J1⟩ Step 12

Pin	U17	Pin	U17
1	07P1	8	13C1
2	A8P9	9	07P1
3	3494	10	1247
4	5A9U	11	13C1
5	5A7H	12	4HF1
6	3494	13	5A9U
7	0000	14	4824

Note: The signature for a high or +5V is 4824. The signature for a low or ground is 0000.

SERVICE SHEET 15—A8 Controller/Counter Assembly (Controller)

PRINCIPLES OF OPERATION

General

The Controller/Counter Assembly (A8) controls the entire automated portion of the operation of the instrument. The Controller consists of a Microprocessor, ROMs, a RAM, and input/output (I/O) circuits. The Microprocessor, RAM, and I/O circuits are shown on Service Sheet 15, the ROMs on Service Sheet 16. For a general discussion of how the Controller and the Instrument Bus control the operations of the instrument, see *Principles of Operation* for Service Sheet BD4. **Serial Prefix 2652A and Above**: ROMs 1–9 have been consolidated into one ROM (ROM 10), which is located on SS15.

Microprocessor

The Microprocessor is divided into two ICs, the Central Processing Unit (CPU) and the Static Memory Interface (SMI). In addition a third IC, the Peripheral Input/Output (PIO) located on the Remote Interface Assembly (Service Sheet 19), is considered a part of the Microprocessor. The PIO is used when it is necessary to interface the CPU with the HP-IB. The CPU (U5) is an eight-bit parallel processor. Crystal Y1 and capacitors C25, C26, and C27 determine the frequency (2 MHz) of the CPU's internal clock. This clock also serves as the time base reference for the Counter. The CPU inputs and outputs are described in Table 8D-22.

Table 8D-22. Inputs and Outputs of the CPU (U5)

Pin Name	Description	Type
I/O00 thru I/O07	I/O Port Zero	Input/Output
I/O10 thru I/O17	I/O Port One	Input/Output
DB0 thru DB7	Data Bus Lines	Bi-directional (3-state)
ROMC0 thru ROMC4	Control Lines	Output
Φ, WRITE	Clock Lines	Output
EXT RES	External Reset	Input
INT REQ	Interrupt Request	Input
ICB	Interrupt Control Bit	Output
RC	RC Network	Input
XTLX	Crystal Clock Line	Output
XTLY	External Clock Line	Input

The SMI provides most of the interface logic needed to address up to 65 536 bytes of memory in the microprocessor system. In response to control signals from the CPU, the SMI generates the address and control signals needed by the memory devices. The SMI inputs and outputs are described in Table 8D-23.

Table 8D-23. Inputs and Outputs of the SMI (U6)

Pin Name	Description	Type
DB0 thru DB7	Data Bus Lines	Bi-Directional (3-state)
ADDR0 thru ADDR15	Address Lines	Output
ROMC0 thru ROMC4	Control Lines	Input
Φ, WRITE	Clock Lines	Input
INT REQ	Interrupt Request	Output
PRI IN	Priority In Line	Input
RAM WRITE	Write Line	Output
EXT INT	External Interrupt Line	Input
REGDR	Register Drive Line	Input/Output
CPU READ	CPU Read Line	Output

The PIO provides most of the interface logic needed to interface the CPU with the HP-IB. The PIO is described in Service Sheet 19.

Memory

The instrument's memory consists of nine 2048-bit ROMs, a RAM, and some small memory capability within the CPU itself. The RAM is the CPU External Register (U30) and is a 256-address, four-bit scratch pad memory used to read and write four bits (DB0-DB3) to and from the CPU. The Memory Select Decoder (U24) controls which memory IC on the Controller Assembly is enabled. Address line 15 enables the RAM.
Serial Prefix 2652A and Above: The instrument's memory consists of one 256K ROM, a RAM, and some small memory capability within the CPU itself.

To illustrate how a ROM address is accessed for data, assume that the CPU wants to read information from address 255 of ROM 3 (U10). First, the CPU places the necessary information on the ROM Control (ROMC) and the data lines of the Control Bus. The SMI decodes this information from the CPU and outputs the required address information on lines A0(H) through A15(H) and then sets CPU READ(H) high. CPU READ(H) is inverted by U23E and pulls one of the enable inputs low on each ROM and the RAM.

Serial Prefix 2652A and Above: To illustrate how a ROM address is accessed for Data, assume that the CPU wants to read information from a location in the ROM. First, the CPU places the necessary information on the ROM Control (ROMC) and the Data lines of the control Bus. The SMI decodes this information from the CPU and outputs the required address information on lines AO (H) through A15 (H), then sets CPU Read (H) high. CPU Read (H) is inverted by U23E and pulls the Enable line (Pin 22) low on the ROM. The data from that location in ROM is then placed on Data Lines DBO (H) through DB7 (H). The RAM Read and Write functions are similiar to the ROM function. Address lines A13 (H) through A15 (H) are decoded by Address Decoder U34 to enable U30.

Note that this is a read operation and the RAM WRITE(L) line from the SMI is high. Of address lines A11(H) through A15(H), only A12(H) will be high. Memory Select Decoder U24 decodes lines A11(H) through A14(H). Since only line A12(H) is high, output 2—ROM3(L)—of U24 goes low. Since A15(H) is low, the RAM (U30) is not enabled (A15(H) is inverted by U23F). Since CPU READ(L) and ROM3(L) are both low, ROM3 (U10) is enabled.

Since A0(H) through A7(H) are high and A8(H) through A10(H) are low, the data at address 255 is read out of the ROM. The eight bits of information are placed on lines DB0(H) through DB7(H). This information is then read into the CPU (U5).

The RAM read and write functions are similar to the ROM function. The CPU READ(H) and RAM WRITE(L) lines are used to determine which function of the CPU External Register (U30) is activated. Address line A15(H) is used to enable U30.

TEST LEDs and Test Points

The TEST LEDS DS1 through DS4 are controlled by the CPU as described in *Controller Test LEDs and Test Points*, paragraph 8-28. The test points (TP7 through TP10) are used to modify the power-up routine and are also used when performing signature analysis.
Serial Prefix 2652A and Above: Instruments with this serial break have the test points located on a single row connector.

Select and Data Buffers

The Select and Data Buffers (U16 and U23) invert and buffer the I/O 00 through I/O 07 input/output lines from the CPU to the Instrument Bus. For a general discussion of the Instrument Bus, see Service Sheet BD4. In addition, data lines d0(L) through d3(L) are input to the CPU from the Instrument Bus.

Enable Decoder

The Enable Decoder (U22) decodes the e0(H) through e3(H) lines from the CPU into the eight individual enable lines e=0(L) through e=7(L). These are distributed through several assemblies of the instrument to enable the desired select decoder.

Power On Reset

The Power On Reset circuit (Q1 and associated components) applies a momentary low on the EXT RES line of the CPU when power is applied to the instrument. When EXT RES is pulled low and then released, a program originating at memory address 0 is executed.

TROUBLESHOOTING

General

Procedures for checking the Controller/Counter Assembly are given below. The circuits to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Extend the board assembly where necessary to make measurements.

CAUTION

MOS and CMOS ICs can be damaged by static charges and circuit transients. Do not remove this 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 HP 4208-0094.) When unplugging ICs, place the board on a conductive pad. When the IC is unplugged, insert it into the pad also.

Several ICs on this assembly 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.

If the Audio Analyzer powers up correctly, it is a strong indication that the Controller circuits are operating properly. In most cases, the two most common indications of a Controller fault are that the instrument fails to complete even the first phase of the power-up routine or that it behaves very erratically. However, be very careful about assuming a Controller failure when the instrument behaves erratically. Because of the close interrelationship of the circuit components, the data feedback loops, and the software, a failure that is occuring in one section of the instrument can affect other areas. For example, many types of malfunctions will prevent the Audio Analyzer from tuning properly.

In addition, keep the following points in mind when troubleshooting the Controller:

1. It is important to understand the structure of the Controller's buses. Data on these buses is often unstable or meaningless because of multiplexing, switching transients, and open-collector circuits. These conditions cause no problems for the Controller itself since it is synchronous and knows when the bus lines contain stable signals. (This is also true for the signature analyzer.) However, this is not true of other instruments testing the Controller such as a logic probe or oscilloscope. These test instruments, though, can still be used to examine qualitative factors such as general activity, logic levels, waveform timing, and bus conflicts.

2. Since bus structures also make it possible for many devices to be connected together on a single node, finding the one bad device on such a node can be difficult. A current tracer is useful for this purpose.

3. The Controller is a sequential processor. Program flow depends on a long sequence of instructions and events. If even a single bit of information is incorrect, the entire sequence can be changed. Bad memory bits are the most common source of single-bit errors.

4. The proper operation of the clock circuits is critical.

5. An improper reset can cause the Controller to appear to be running, but it may be incorrectly initialized or running the wrong sequence of software.

6. Interrupts are edge triggered. A stuck interrupt will interrupt once and then never again. An intermittent interrupt will keep interrupting. When the Controller is interrupted, the measurement is aborted, and the complete measurement cycle restarts at the beginning. Therefore, if the intermittent interrupt occurs frequently, it will completely prevent the instrument from operating.

TROUBLESHOOTING—SERVICE SHEET 15

Equipment

Digital Test/Extender Board ..... HP 08903-60018
Signature Analyzer ..... HP 5005A

Serial Prefix 2450A to 2614A

⟨J1⟩ Memory Select Decoders and ROM Check

NOTE

This check is a continuation of the Controller Kernel Check of Service Sheet BD4.

1. Switch LINE to OFF. Remove A8U30 (CPU External Register—RAM) from its socket. Extend the A8 Controller/Counter Assembly with the Digital Test/Extender Board. Connect the ribbon cable on the extender board to the empty socket A8J1 (ADR BUS). Switch LINE to ON.

2. Short A8TP4 (RES) to A8TP3 (GND). (Keep this jumper on for all subsequent tests.) Set the switches labeled ROMC on the extender board to CLOSED.

3. On the A8 Controller/Counter Assembly, connect the signature analyzer clipleads as follows:

Clock ..... A8TP13 (WRT)
Ground ..... A8TP3 (GND)

On the extender board, connect the signature analyzer clipleads as follows:

Start ..... ADDRESS 15
Stop ..... ADDRESS 15

4. Set the signature analyzer's start, stop, and clock to trigger as follows:

Start ..... Falling Edge
Stop ..... Rising Edge
Clock ..... Rising Edge

5. Check the pins listed in Table 8D-24 with the signature analyzer probe.

Table 8D-24. Signatures on A8U24, ⟨J1⟩ Step 5

Selected ROM	Pin on U24	Signature	Selected ROM	Pin on U24	Signature
1	1	4CP2	6	6	2F25
2	2	U1U2	7	7	F615
3	3	P352	8	9	6F7P
4	4	340A	9	10	048A
5	5	8UH9			

Hint: If faulty, check U24 and its output lines.

6. Connect the signature analyzer start and stop to the pin on U24 listed in Table 8D-25. Then check the indicated CONTROL BUS test points on the extender board with the signature analyzer probe.

TROUBLESHOOTING—SERVICE SHEET 15

NOTE

The signatures in Table 8D-25 are valid only for the ROMs with the part number listed in Table 8D-26. Consult the Manual Updates packet for signatures corresponding to ROMs with other part numbers.

Table 8D-25. Control Bus Test Point Signatures, √1 Step 6

ROM	Start/Stop to Pin on U24	Signature on CONTROL BUS DATA Test Point							
		0	1	2	3	4	5	6	7
1	1	18C9	305A	09PH	A9AP	P14P	1U96	PPH8	PC3C
2	2	PUC0	5641	4065	U966	2CF8	255F	F8CP	17PF
3	3	82U3	A0A4	44A6	F2FU	6348	7137	UHPH	95C5
4	4	5066	F387	C042	0H72	2494	8562	CFA1	7PPP
5	5	2HP5	A123	80AP	UP9H	8A56	321A	H482	924P
6	6	0439	6AC2	HHU2	A8H1	6858	962A	045F	P643
7	7	76CF	6533	U7U9	58A3	24HA	8H64	384C	36A0
8	9	8P2P	58U5	9337	PU72	6P3U	0813	3454	7C1F
9	10	F5FP	62AP	FHU8	CCPU	HA27	85P6	UA82	2H35

*Table 8D-26. Valid ROM Part Numbers**

ROM Number	Part Number	ROM Number	Part Number
1	08903-80016	6	08903-80021
2	08903-80017	7	08903-80022
3	08903-80018	8	08903-80023
4	08903-80019	9	08903-80024
5	08903-80020		

* Valid software date 11.15 1984.

Hint: A faulty signature indicates a faulty ROM.

Serial Prefix 2652A and above:

√1 Memory Select Decoders and ROM Check

This step is not valid for instruments with prefixes of 2652A and above.

√2 Enable Decoder Check

1. Key in the Direct Control Special Functions indicated in Table 8D-27. For each setting, check the pins on U22 indicated.

Hint: If "enable=2" is bad, these special functions cannot be keyed into the instrument (perform the *Front-Panel Keys and Scanners Check—Using Signature Analysis* on Service Sheet 17).

⟨√3⟩ Select and Data Buffers Check

1. Key in the Direct Control Special Functions indicated in Tables 8D-28 and 8D-29. For each setting, check the pins indicated.

Table 8D-28. Levels at A8U23, ⟨√3⟩ Step 1

Direct Control Special Function	Level (TTL) at U23 Pin							
	9	8	5	6	3	4	1	2
0.000	H	L	H	L	H	L	H	L
0.0FF	L	H	L	H	L	H	L	H

Table 8D-29. Levels at A8U16, ⟨√3⟩ Step 1

Direct Control Special Function	Level (TTL) at U16 Pin							
	12	11	9	8	1	3	5	6
0.000	H	L	H	L	H	L	H	L
0.0FF	L	H	L	H	L	H	L	H

SERVICE SHEET 16---A8 Controller/Counter Assembly (Read Only Memory)

PRINCIPLES OF OPERATION

The read-only memory (ROM) circuits are included in the *Principles of Operation* for Service Sheet 15.

TROUBLESHOOTING

Procedures for checking the ROMs are given in the *Memory Select Decoders and ROM Check* on Service Sheet 15.

SERVICE SHEET 17---A1 Keyboard and Display Assembly (Keyboard)

PRINCIPLES OF OPERATION

NOTE

The following discussion requires an understanding of the operation of the Instrument Bus (see Instrument Bus, *Service Sheet BD4) and of the Instrument Bus readback (see* Direct Control Special Functions, *paragraph 8-22).*

General

The Keyboard and Display Assembly (A1) interrupts the Controller when a key has been pressed and provides the circuitry that enables the Controller to determine which key was pressed.

Keystroke Detector

The Keystroke Detector pulses the External Interrupt line low when a key is pressed. When no key is down (that is, key switches S1 through S41 open), the inverting (−) input to U22B is pulled low by R6C and R6D. The outputs of the Key Row Scanner U30 are normally in the high or off state (the outputs are open-collector). The non-inverting (+) input of U22B is biased at approximately +1.4V. Thus for the condition when no key is pressed, the output of U22B is high, the output of U22A is low, and the output of U23A is high (that is, no interrupt; see Service Sheet 15).

Pressing any key (for example, the SINAD key S20) pulls the inverting input of U22B above +1.4V (via R5G and R2E for the SINAD key). This causes U23A to go low and creates a Controller interrupt. U22B has an open-collector output. When U22B goes low, C3 is rapidly discharged to produce a low on the input to U22A. However, when U22B goes high, C3 can only charge via R9. This action holds the input to U22A low for at least 50 ms regardless of key bounce. R11 adds hysteresis to U22A to improve noise immunity and shorten the transition time of the input to U23A.

Key Scanner and Front-Panel Keys

When the Controller receives an interrupt, it immediately initiates a key scan routine. The scan must identify the pressed key before the key has been released even in the presence of key bounce. Consider the example of pressing the SINAD key (S20). The scan begins by the Controller issuing *esd*=2F0 to the Instrument Bus. This puts an active low on pin 4 of demultiplexer U30. More specifically, *e*=2 and *s*=F. Both 0 and 1 inputs are high since *s*0=1 and *s*1=1. A 3 is demultiplexed. The 4 input is enabled since *s*2=1; the 5 input is disabled. e=2(L) is low and enables input G4. (Input G5 is not enabled because input 5 is not enabled.) Thus only the 3 output of the lower half of the demultiplexer (U30), enabled by input 4, is low.

The same Instrument Bus code enables the readback gates U24A, U25A, U24B, and U25B but not U24D, U25D, U24C, and U25C. Specifically, *s*3=1. Thus, the input to U23C is high. The two inputs to U23D are low. The NAND gates U24A, U25A, U24B, and U25B are enabled and function as inverters. U23B is low and the outputs of the NAND gates U24D, U25D, U24C, and U25C are high, that is, off. The Controller reads back the data (*d*) lines and scans the data giving priority to the highest number decoded. Since all columns are held high by pull-up resistors, the Controller reads *d*=F. The SINAD key has no effect because the output at pin 7 of U30 is off at this time.

The Controller next issues *esd*=2E0. Pin 5 of U30 is now low. U24A, U25A, U24B, and U25B are still enabled and U24D, U25D, U24C, and U25C are still disabled. *d*=F is read back. The sequence then continues with the issuance of *esd*=2D0 and 2C0 with the result that *d*=F is read back each time until *esd*=2C0 when *d*=B will be read back; that is, *d*2=0 (d2(L) is high). The Controller has now learned that the SINAD key was pressed.

If no key had been found in the first four columns, the sequence continues until the issuance of *esd*=270. With this code, the s3(H) input to U23B and U23C goes low. Now U24A, U25A, U24B, and U25B are disabled, and U24D, U25D, U24C, and U25C are enabled. The Controller now starts reading the data lines from U24D, U25D, U24C, and U25C to determine if one of the keys in the second four columns is closed.

If no key was found (that is, d=F always) due to key bounce, the scan repeats until 50 ms have elapsed and then the instrument reverts back to its previous mode of operation. Whether the key was found or not, the measurement cycle that was interrupted is aborted and a new software cycle is initiated.

Key-Light Circuits

The key-light circuits are discussed on Service Sheet 18.

TROUBLESHOOTING

General

Procedures for checking the Keyboard and Display Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩. Remove the front-panel assembly to gain access to the circuit side of the keyboard. Note that the troubleshooting for the Enable Code e=0 Select Decoders (U29 and U29) shown on this service sheet is covered on Service Sheet 18.

Equipment

Digital Test/Extender Board ..... HP 08903-60018
Oscilloscope ..... HP 1740A
Signal Analyzer ..... HP 5005A
Voltmeter ..... HP 3455A

⟨✓1⟩ Keystroke Detector Check

1. Press any key and observe Test LED C on the A8 Controller/Counter Assembly. Each time the key is pressed the LED should toggle, that is, change state. If it does, the Controller is being properly interrupted.

2. Remove the ribbon cable W11.

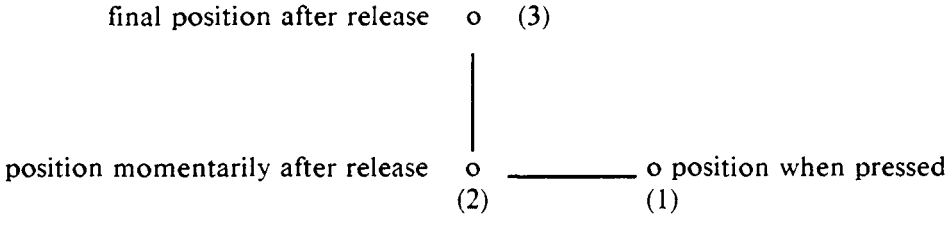
3. Check the voltages in Table 8D-30.

Table 8D-30. Keystroke Detector Check, ⟨✓1⟩ Step 3

Keys Down	Voltage Limits (Vdc) on A1U22				Level (TTL) at U23 Pin 1
	Pin 2	Pin 5	Pin 6	Pin 7	
None	−0.01 to 0.01	0.6 to 1.1	4.5 to 5.5	0 to 0.5	H
One	2.5 to 4.5	3.0 to 4.3	0 to 0.3	4.0 to 5.5	L

Hint: Any key should give the same voltage readings. The voltage at U22 pin 2 will be higher for the condition of one key down if more than one key is down.

4. Connect a high-impedance, dc coupled oscilloscope to U23 pin 1. Connect the oscilloscope's dc coupled external horizontal input to U22 pin 2. Press then release any key. The dot on the oscilloscope should move as follows:



Hint: The dot should dwell at the intermediate position (2) momentarily after release of the key for 40 to 60 ms.

⟨✓2⟩ Front-Panel Keys and Scanners Check---from Keyboard

NOTE

This check assumes proper operation of the following keys: Shift, SPCL, decimal, and all numeric. Otherwise, use ⟨✓3⟩ below which requires a signature analyzer. It also assumes that the Keystroke Detector works properly (see ⟨✓1⟩ above).

1. From Table 8D-31, determine the row of the key to be checked and enter the Direct Control Special Function for that row. (The display should now show 1111.0000.)

2. Disable keyboard interrupts by shorting A8TP3 (GND) to A8U6 pin 7 (EXT IN) on the A8 Controller/Counter Assembly. Extend the A8 Controller/Counter Assembly to make this connection.

3. Pressing any key in the appropriate row of Table 8D-31 should give the display shown. (No key down gives the display 1111.0000. Pressing a key not in the given row gives this display also.)

NOTE

To repeat step 1 above, it is first necessary to remove the jumper from A8TP3.

Table 8D-31. Front-Panel Keys and Scanners Check (Keyboard), ⟨✓1⟩ Step 1

Direct Control Special Function	Display vs. Key Pressed			
	0111.0000	1011.0000	1101.0000	1110.0000
0.250	(None)	(None)	⇑	⇓
0.260	×10	AMPTD INCR	−	AUTO OPERERATION
0.270		CLEAR	SPCL	dBV dB
0.280	(None)	LCL	LOG LIN	RATIO
0.290	SWEEP	PLOT LIMIT	FREQ INCR	÷
0.2A0	Hz mV	kHz V	STOP FREQ	START FREQ
0.2B0	(Right Filter)	30 kHz	80 kHz	(Left Filter)
0.2C0	DISTN	S	SINAD	AC LEVEL
0.2D0	AMPTD	FREQ	9	8
0.2E0	7	6	5	4
0.2F0	3	2	1	0

⟨✓3⟩ Front-Panel Keys and Scanners Check---Using Signature Analysis

1. Ground A8TP10 (TEST D) on the A8 Controller/Counter Assembly.

2. Connect signature analyzer start and stop to A8TP7 (TEST A). Connect signature analyzer clock to A8TP13 (WRT).

3. Set the signature analyzer's start, stop, and clock to trigger as follows:

Start ..... Falling Edge
Stop..... Falling Edge
Clock ..... Rising Edge

4. Set Audio Analyzer's LINE switch to OFF and back to ON. Disregard the front-panel display readouts.

5. Connect the signature analyzer's probe to A8TP8 (TEST B).

6. Press the front-panel keys and note the signature. The signatures are documented in Figure 8D-7.

Hint: Pressing keys simultaneously alters the signatures. If no meaningful results can be obtained, continue on with step 7.

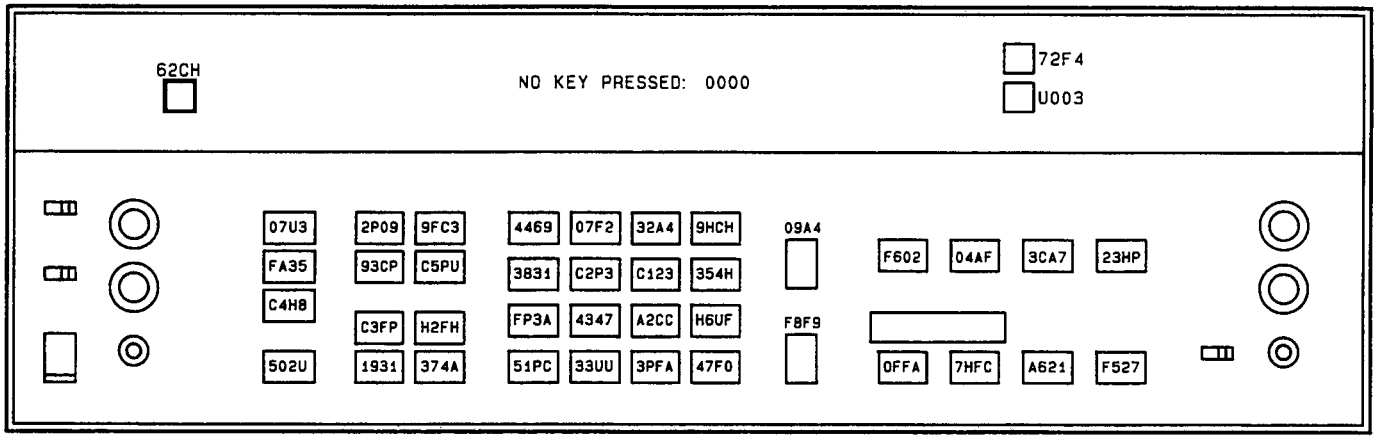


Figure 8D-7. Signatures for the Front-Panel Keys and Scanners Check, ⟨✓3⟩ Step 6

7. Connect the signature analyzer's probe to the points indicated in Table 8D-32 and check the signatures. (No keys should be pressed.)

Table 8D-32. Front-Panel Keys and Scanners Check (Signatures), ⟨✓3⟩ Step 7

Pin	U23	U24	U25	U30	Pin
1	938F	938F	938F	62AU	1
2	0000	U005	U005	7008	2
3	0000	7008	7008	1999	3
4	1381	938F	938F	0000	4
5	7008	U005	U005	0000	5
6	AA4P	7008	7008	0000	6
7	0000	0000	0000	0000	7
8	AA4P	7008	7008	0000	8
9	AA4P	1381	1381	0000	9
10	39F2	938F	938F	0000	10
11	39F2	7008	7008	0000	11
12	7008	1381	1381	0000	12
13	U005	938F	938F	7FC5	13
14	938F	938F	938F	7008	14
15				62AU	15
16				938F	16

Note: The signature for a high or +5V is 938F.
The signature for a low or ground is 0000.

⟨✓4⟩ Key Light Check

1. Key in the Direct Control Special Functions listed in Table 8D-33 to turn on the desired key light.

Table 8D-33. Key Light Check, ◇4◇ Step 1

Direct Control Special Function	Title
0.010	(Left Filter)
0.011	(Right Filter)
0.012	30 kHz
0.013	80 kHz
0.014	AC LEVEL
0.015	SINAD
0.016	DISTN
0.017	S (Shift)

SERVICE SHEET 18—A1 Keyboard and Display Assembly (Display)

PRINCIPLES OF OPERATION

The Keyboard and Display Assembly (A1) contains the front-panel displays, decimal points, annunciators, and key lights and the decoders and latches that control them. Lighting of a display is accomplished by straightforward decoding of the Instrument Bus with one code sent out for each of the seven segments of the display. For example, to display the digit "3" in display U9, the Controller issues *esd*=031, 032, 033, 034, 03D, 03E, and 037 in succession. Register U18 decodes the Instrument Bus code and successively outputs and latches the data present on the Z9 input (that is, d3(H), the most significant bit of the *d* code) to its internal flip-flops. A low on an output of U18 turns on a segment, a high turns it off. Thus, a low appears on the output of flip-flops 1, 2, 3, 4, and 7 (corresponding to *esd*=031, 032, 033, 034, and 037) and turns on the LEDs in segments a, b, c, d, and g respectively in U9. A high appears on the output of flip-flops 5 and 6 (corresponding to *esd*=03D and 03E) and turns off segments e and f. This results in a "3" being displayed.

Lighting of the minus sign (segment g of U8), decimal points, annunciators, and key lights is similar. For example, to light the % annunciator, the Controller issues *esd*=0A3 to the Instrument Bus. This is decoded by register U13 which latches a low into its internal flip-flop 3. The low turns on DS16.

The select decoders and the circuits for lighting the key lights are shown on Service Sheet 17. For a discussion of the Instrument Bus, see the *Principles of Operation* for Service Sheet BD4.

For instruments with serial prefix 2742A and above, an LED is used to indicate which impedence the source has been selected to by the user (50 or 600 Ω). The LED is lit when the source impedence has been set to 50 Ω. The LED (A1DS20) is found on Service Sheet 17.

TROUBLESHOOTING

General

The procedure for checking the Keyboard and Display Assembly is given below. The circuits are set to a desired (static) state using Direct Control Special Functions, and then the logic levels are checked.

Equipment

Voltmeter ..... HP 3455A

⟨✓1⟩ Annunciator and Key Light Check

1. Key in the Direct Control Special Functions listed in Table 8D-34 to turn on the desired annunciator or key light.

Table 8D-34. Annunciator and Key Light Check, ⟨✓1⟩ Step 1

Direct Control Special Function	Title	Light Type
0.024	ADDRESSED	Annunciator
0.025	REMOTE	Annunciator
0.026	kHz	Annunciator
0.027	Hz	Annunciator
0.0A0	mV	Annunciator
0.0A1	V	Annunciator
0.0A2	dB	Annunciator
0.0A3	%	Annunciator
0.090	SPCL	Key Light
0.091	RATIO	Key Light
0.095	SWEEP	Key Light

Hint: With the exception of the ADDRESSED and REMOTE lights, the lights go off when a new Direct Control Special Function is entered. To turn off the ADDRESSED light enter 0.02C and to turn off the REMOTE light enter 0.02D.

⟨✓2⟩ Decimal Point Check

1. Key in the Direct Control Special Functions listed in Table 8D-35 to turn on the desired decimal point. The digit number is the number on the display window directly below the digit.

⟨✓3⟩ Display Check

1. Key in the Direct Control Special Functions listed in Table 8D-36 to turn on the desired digit segment in the desired position. The digit number is the number on the display window directly below the digit.

Table 8D-35. Decimal Point Check, ⟨✓2⟩ Step 1

Direct Control Special Function	Number of Following Digit
Left Display	
0.023	1
0.022	2
0.021	3
0.020	4
Right Display	
0.093	Upper Left Corner
0.0A7	5
0.0A6	6
0.0A5	7
0.0A4	8

Table 8D-36. Display Check, ⟨✓3⟩ Step 1

Digit Number	Direct Control Special Function	Digit Number	Direct Control Special Function
Left Display		**Right Display**	
Digit Before 1	0.0B*d*	Digit Before 5	0.092*
1	0.0C*d*	5	0.03*d*
2	0.0D*d*	6	0.04*d*
3	0.0E*d*	7	0.05*d*
4	0.0F*d*	8	0.06*d*
* *d*=2 only (g is the only segment controlled with this special function.)			

Segment Displayed*	*d*
(None)	0
a	1
b	2
c	3
d	4
e	5
f	6
g	7
* See schematic diagram for identification of segments a through g.	

SERVICE SHEET 19---A9 Remote Interface Assembly

PRINCIPLES OF OPERATION

General

The Remote Interface Assembly (A9) interfaces the Controller with the HP-IB. It performs the necessary handshake operation, interprets the HP-IB control lines, and is both an input and output peripheral to the Controller. The Remote Interface Assembly consists of three basic elements: the HP-IB I/O, the Handshake Logic, and the Interface Control circuits. In addition, other miscellaneous circuits are used on the assembly. The operation of the three basic elements is explained first. Then, a detailed explanation of how the bus controller (for example, a computing controller) addresses the instrument to talk or to listen is presented. The miscellaneous circuits are then briefly discussed. Table 8D-37 lists and identifies the mnemonics used in the Remote Interface and should be referred to while reading the principles of operation.

Table 8D-37. Mnemonics for Remote Interface

Mnemonic	Signal Name
AAD	Acceptor Accepted Data
ACD	Accepted Data
ADS	Addressed
AFC	Address Flip-Flop Clock
ARD	Accepted Received Data
ATL	Addressed to Listen
ATN	Attention
ATT	Addressed to Talk
AVD	Accept Valid Data
CLF	Clear Listen Flip-Flop
CTF	Clear Talk Flip-Flop
DAR	Disable ROM
DAV	Data Valid
DIO1	Data Input/Output 1
DIO8	Data Input/Output 8
DFC	Data Accepted Flip-Flop Clock
EAH	Enable Acceptor Handshake
EIC	Enable Interface Control
ENR	Enable ROM
EOI	End or Identify
ICP	Interrupt CPU

Mnemonic	Signal Name
IFC	Interface Clear
LAD	Listener Accepted Data
LRD	Listener Ready for Data
NDAC	Not Data Accepted
NRFD	Not Ready for Data
RAS	Read Address Selector
RAT	Read Addressing Type
RDR	Reset DAC/RFD
REN	Remote Enable
RFC	REN Flip-Flop Clock
RNL	REN Flip-Flop Latched
RSL	Read Switch Lower
RSU	Read Switch Upper
RTR	Ready to Receive
RVD	Receive Valid Data
SDA	Set Data Accepted
SDV	Set Data Valid
SLF	Set Listen Flip-Flop
SRQ	Service Request
STF	Set Talk Flip-Flop
UUA	Universal Unlisten Address

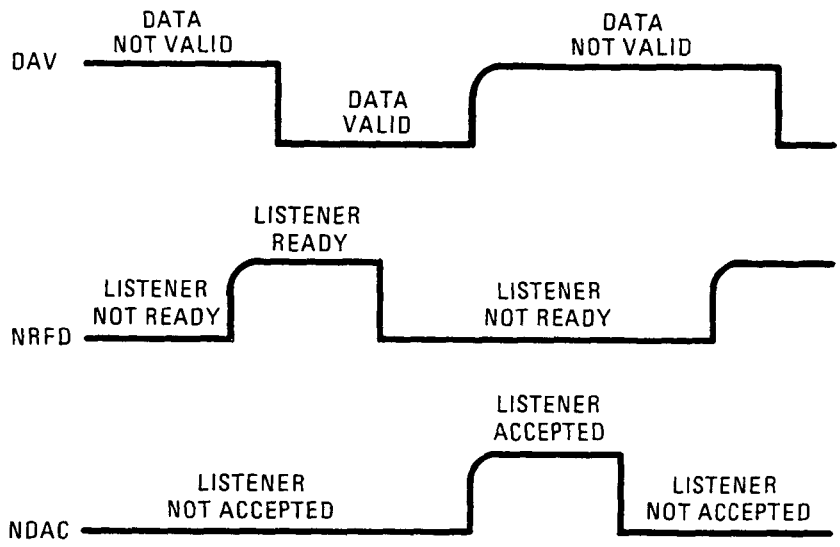
HP-IB I/O Circuits

The HP-IB I/O circuits provide bidirectional interface between the Remote Interface Assembly and the HP-IB. The circuit consists of U7, U8, U9, and U10. When the TALK(L) line is low, the interface is configured to send data to the HP-IB. In this state, U7 and U9 are disabled, and since they are open-collector devices, they are essentially out of the circuit. U8 and U10 provide a direct path from the Peripheral Input/Output (U18) to the HP-IB. When the TALK(L) line is high, the Remote Interface is configured to receive data from the HP-IB. In this mode, U7 and U9 are enabled, and the path through U8 and U10 is reversed. This allows data from the HP-IB to be applied to the Peripheral Input/Output (U18), the Address Decoder (U5), and the Interface Control ROM (U2). Depending upon the function being performed, this data is either sent to the Controller or used to decode the talk or listen address.

Handshake Logic Circuits

Information is communicated over the HP-IB by means of handshakes between instruments. It is assumed in this discussion that the reader is familiar with the use of the DAV, NDAC, and NRFD signals as they are used

on the HP-IB. (Figure 8D-8 illustrates the HP-IB handshake.) The instrument can operate as either a talker or a listener when so directed by the bus controller. The primary control circuits in the Handshake Logic are the DAC Flip-Flop (U3B) and gates U20A, U20B, and U15B.



Start with the talker waiting for the listener to release NRFD (not ready for data) indicating it is ready.

When the listener is ready, NRFD goes high (false). The talker then places valid data on DIO1 through DIO8 and sets DAV (data valid) low (true).

NRFD then goes low (true) and the talker waits for the listener to indicate it has accepted the data (or ignored it) by releasing the NDAC (not data accepted) to a high (false, i.e., data is accepted).

The talker sets DAV high (false) and again waits for the listener to release NRFD.

(NOTE that if ATN is true, all instruments on the bus must handshake regardless of whether they are talkers, listeners, or bystanders. Being in remote or local has nothing to do with handshaking.) If ATN is false, they only handshake if addressed.

Figure 8D-8. Simplified HP-IB Handshake Between a Talker and One Listener

When the instrument is a listener, the ATL(L) line is low, and the high output from U15B enables U20A and U20B. This condition is also true when ATN(L) goes low and is discussed in detail later. In either case, the DAC Flip-Flop (U3B) controls the handshake. If U3B is set, the RTR(L) line from the reset output is low, and the NRFD(L) line from U20B is high indicating that the instrument is ready to receive data. The ACD(L) line from the active-high output of U3B is high, and (since the other input to U20A is also high), the NDAC(L) line is low. When the bus controller sees all of the required NRFD(L) lines high (more than one instrument can be addressed to listen), it sets DAV(L) low. When DAV(L) goes low (indicating the data on the HP-IB is valid), the Interface Control ROM either sets EXT INT low or resets U3B by setting SDA(L) low, depending on whether or not the CPU must be interrupted. (See Table 8D-38 for a complete list of the Interface Control ROM input and output signals.) If the CPU is interrupted, it will reset U3B using the DFC(L) line. In either case, ACD(L) goes low and the NDAC(L) line from U20A goes high. When the bus controller sees all of NDAC(L) lines go high, it sets DAV(L) high. The DAV(L) signal is applied through gates U19B, U14B, and U13B to set the DAC Flip-Flop (U3B). Gates U14B and U13B are used to slow down the handshake and prevent a possible race condition. When the DAC Flip-Flop is set, the instrument is returned to a ready-for-data condition.

When the instrument is a talker, the output from U15B is low because both the ATL(L) and the ATN(L) lines are high. The low output from U15B disables U20A and U20B. This prevents the DAC Flip-Flop from driving

the NDAC(L) and NRFD(L) HP-IB lines. The Controller (A8) now reads the NDAC(L) line through U19C and U13C and the NRFD(L) line through U19D and U13D. Both of these signals are routed to the Controller through the Peripheral Input/Output (U18). The DAV(L) signal is driven by the Controller through U18 and U20C by the SDV(H) line. U20C is enabled by U14A when the TALK(L) line is low. In the talk mode, the handshaking is entirely controlled by the instrument's firmware and Controller.

Interface Control Circuits

The primary control element in the Interface Control circuits is the Interface Control ROM (U2). U2 is enabled when all the following conditions are satisfied:

1. RTR(L) is low. This indicates the instrument is ready to receive data or commands.

2. EAH(L) is low. This enables an acceptor handshake. It is decoded from the ATL and ATN lines by U14D. Therefore, if the instrument is addressed to listen or if attention is true, the gate is enabled.

3. U15C pin 8 is low. This indicates that the Controller (A8) has enabled the interface to receive data. This state is latched by the flip-flop consisting of U15C and U15D. This flip-flop is also used to disable the Interface Control ROM (U2) when the Remote Interface is preparing to talk. U2 is disabled so that its control circuits do not respond to the data that the instrument itself is sending.

4. AVD(L) is low. This indicates that the bus controller is asserting that the data on the HP-IB is valid by putting DAV(L) low.

When all of these conditions are true, U2 is enabled by setting the EIC(L) line from U14C low. The outputs of U2 are then dependent upon the decoded address line inputs. Depending upon the selected output, the Interface Control ROM will set or clear the appropriate flip-flops, complete a handshake, or interrupt the Controller. The 32 possible states of the output lines are listed and defined in Table 8D-38.

How the Remote Interface Handshakes with the HP-IB

The Remote Interface circuits control the asynchronous transfer of bytes over the HP-IB. The following three conditions require that the instrument complete the handshake requirements:

1. When it is a bystander.

2. When the ATN(L) line is low (true). For example, when the bus controller is addressing the instrument to set it to the talk or listen modes. There are also universal commands that can be sent when ATN(L) is low.

3. When it is already addressed to talk or listen.

The instrument handshakes as a bystander whenever ATN(L) is high and it is not addressed to listen. Actually, this handshake is not an interchange of information because under these conditions the instrument never pulls the NRFD(L) and NDAC(L) output lines low. These lines are held high because ATL(L) and the ATN(L) inputs to U15B remain high. ATL(L) remains high because the instrument is not currently addressed to listen. ATN(L) remains high because it is high at the HP-IB and the signal is applied through two inverters (U19E and U13A) to the input of U15B. The resulting low output is applied to U20A and U20B and the NRFD(L) and NDAC(L) lines are always high. In this mode, the Audio Analyzer is essentially "off the bus". Note that the DAC Flip-Flop (U3B) is also applied to these gates and depending upon its output state would also hold one of the gate outputs high if ATN were true or ATL were true.

When the bus controller wants to address the instrument to talk, ATN(L) is set low. The output of U15B goes high and the status of the NRFD(L) line (U20B) and the status of the NDAC(L) line are controlled by the DAC Flip-Flop (U3B). (The DAC Flip-Flop is already set by DAV(L) being high through U19B, U14B, and U13B.) This causes the RTR(L) line from the DAC Flip-Flop to set NRFD(L) high. The bus controller has already placed the instrument's talk address on the bus and it now pulls DAV(L) low indicating that it is valid data.

Since the instrument is not yet addressed to talk, the TALK(L) input to the HP-IB I/O circuits (U7, U8, U9, and U10) is high. The talk address on lines DIO1(L) through DIO5(L) is applied through U7 and U9 to the Address Decoder comparator U5. U5 compares the incoming address with the setting of the first five address switches (S1). If they are the instrument's correct address, the M=N output of U5 goes high. The data on DIO7(L) and

Table 8D-38. Inputs and Outputs of Interface Control ROM

Address						Data								Remarks**
Binary Bit Value						Bit								
16	8	4	2	1	Hex	7	6	5	4	3	2	1	0	
Pin Number						Pin Number								
14	13	12	11	10	x	9	7	6	5	4	3	2	1	
L	L	L	L	L	00	H	•	H	H	H	H	*	L	SCG so AHS only.
L	L	L	L	H	01	H	*	L	H	H	H	•	L	OTA so CTF and AHS.
L	L	L	H	L	02	H	•	H	H	H	H	*	L	OLA so AHS only.
L	L	L	H	H	03	L	*	H	H	H	H	*	H	UBC so INT only.
L	L	H	L	L	04	H	*	H	H	H	H	*	L	SCG so AHS only.
L	L	H	L	H	05	H	*	L	H	H	H	*	L	UNT so CTF and AHS.
L	L	H	H	L	06	H	•	H	H	L	H	•	L	UNL so CLF and AHS.
L	L	H	H	H	07	H	*	H	H	H	H	*	L	NRC so AHS only.
L	H	L	L	L	08	H	•	H	H	H	H	*	L	SCG so AHS only.
L	H	L	L	H	09	H	*	H	L	L	H	•	L	MTA so STF, CLF, and AHS.
L	H	L	H	L	0A	L	•	L	H	H	L	•	H	MLA so SLF, CTF, and AHS.
L	H	L	H	H	0B	L	•	H	H	H	H	•	H	UBC so INT only.
L	H	H	L	L	0C	H	•	H	H	H	H	*	L	SCG so AHS only.
L	H	H	L	H	0D	H	•	L	H	H	H	•	L	UNT so CTF and AHS.
L	H	H	H	L	0E	H	•	H	H	L	H	*	L	UNL so CLF and AHS.
L	H	H	H	H	0F	H	•	H	H	H	H	•	L	NRC so AHS only.
H	L	L	L	L	10	L	•	H	H	H	H	•	H	DATA so INT only.
H	L	L	L	H	11	L	•	H	H	H	H	•	H	DATA so INT only.
H	L	L	H	L	12	L	*	H	H	H	H	•	H	DATA so INT only.
H	L	L	H	H	13	H	•	H	H	H	H	•	L	CDATA so AHS only.
H	L	H	L	L	14	L	•	H	H	H	H	*	H	DATA so INT only.
H	L	H	L	H	15	L	*	H	H	H	H	•	H	DATA so INT only.
H	L	H	H	L	16	L	*	H	H	H	H	*	H	DATA so INT only.
H	L	H	H	H	17	H	*	H	H	H	H	*	L	CDATA so AHS only.
H	H	L	L	L	18	L	•	H	H	H	H	*	H	DATA so INT only.
H	H	L	L	H	19	L	•	H	H	H	H	•	H	DATA so INT only.
H	H	L	H	L	1A	L	*	H	H	H	H	*	H	DATA so INT only.
H	H	L	H	H	1B	H	*	H	H	H	H	•	L	CDATA so AHS only.
H	H	H	L	L	1C	L	*	H	H	H	H	*	H	DATA so INT only.
H	H	H	L	H	1D	L	•	H	H	H	H	*	H	DATA so INT only.
H	H	H	H	L	1E	L	•	H	H	H	H	•	H	DATA so INT only.
H	H	H	H	H	1F	H	*	H	H	H	H	*	L	CDATA so AHS only.

* Don't care condition.

** The outputs are active low. The functions of each output are:

Bit 7: INT, interrupts CPU.
Bit 6: Don't care (NC).
Bit 5: CTF, clear Talk Flip-Flop.
Bit 4: STF, set Talk Flip-Flop.
Bit 3: CLF, clear Listen Flip-Flop.
Bit 2: SLF, set Listen Flip-Flop.
Bit 1: Don't care (NC).
Bit 0: AHS, automatic handshake.

Mnemonics used:

CDATA: DATA from Control group
DATA: DATA (interface responds)
MLA: My Listen Address
MTA: My Talk Address
NRC: Non-Recognized Command
OLA: Other Listen Address
OTA: Other Talk Address
SCG: Secondary Command Group
UBC: Universal Bus Command
UNL: Un-Listen
UNT: Un-Talk

DIO6(L) is applied to the Interface Control ROM (U2) to determine whether the instrument is being addressed to talk or to listen. If it is being addressed to talk, DIO7(L) is low and DIO6(L) is high (that is, 10). If it is being addressed to listen, DIO7(L) is high and DIO6(L) is low (that is, 01). These two bits are the only difference between the DIO inputs from the bus controller to the instrument when it is being set to talk or listen.

The EIC(L) from U14C is low to enable U2 and the other inputs to the address lines of U2 select the memory locations that will set output pin 5 to low. The STF(L) line sets the Talk flip-flop U1A. At the same time, the SDA(L) output at pin 1 of U2 is low and resets the DAC Flip-Flop (U3B). The low output from pin 9 of U3B is applied to U20A and the NDAC(L) line goes high, indicating that the handshake is complete. Note that the CPU did not need to be interrupted.

Remote Enable Flip-Flop

When the instrument is addressed to listen, the CPU is interrupted and must determine whether or not it has been enabled to the remote mode (or whether it is already in the remote mode). The Controller does this by attempting to set the Remote Enable Flip-Flop (U3A). If the REN(L) line on the HP-IB is low (true), it is inverted by U19F and the reset input to U3A pin 1 is high. In this case U3A can be set by the Controller. Conversely, if REN(L) is high, the reset input is low and U3A is held reset. The Controller checks the set output of U3A RNL(H) through inverter U11A and the Peripheral Input/Output (U18). If the instrument receives its listen address and if the output of U3A is high, it enters remote mode and lights the REMOTE annunciator on the front panel.

Serial Poll Enable Flip-Flop

When the Controller recognizes the SPE (Serial Poll Enable) bus command, the CPU is interrupted and attempts to set the Serial Poll Flip-Flop (U12B). IFC(L) from the HP-IB is applied through U19A and U11D to the reset input of U12B. If IFC(L) is high, the Serial Poll Flip-Flop can be set; if it is low U12B is held reset. If U12B is set, the instrument enters the serial poll mode, and this information is read back via the Instrument Bus to the Controller through U4D. When the instrument is subsequently addressed to talk, it again reads back the output of U12B to determine what information to output to the HP-IB: measurement results or the status byte. If it is still in the serial poll mode, the status byte is output. When the SPD (Serial Poll Disable) bus command is received, the Controller resets U12B.

Other Control Lines

The remaining HP-IB control lines to the instrument are EOI(L), SRQ(L), and IFC(L). EOI(L) is not used by the instrument and is terminated in R6N and R6P. SRQ(L) is output to the HP-IB under Controller direction through U18. IFC(L) is used to clear all talkers and listeners off the HP-IB. IFC(L) is buffered into four lines. At the output of U19A, after CR1, one line is applies to the Address Comparator (U5) to disable it. This keeps the Interface Control ROM (U2) from affecting either the Talk or Listen Flip-Flop while IFC is true. Two additional lines (from U12E and U13F) clear the Talk and Listen Flip-Flops (U1A and U1B). The fourth line (from U11D) clears the Serial Poll Flip-Flop.

Address Readback Circuit

When so directed by the operator, the Controller sequentially reads back the status of the Address Switches (S1A through S1E) and the talk-only and listen-only switches (S1G and S1F). This information is processed through gates U4 and U17 under control of the RSU(L) and RSL(L) lines from the Select Decoder (U16). The Controller's internal RAM is also read for service request (SRQ) status. The front-panel display shows not only the HP-IB address and the talk-only or listen-only status, but also whether or not it is issuing a service request (SRQ). (See Special Functions 21.0 and 21.1 in the *Detailed Operating Information* in Section 3.)

Peripheral Input/Output

The Peripheral Input/Output (U18) provides the required I/O interface between the Controller and the HP-IB. Refer to Table 8D-39 for a description of inputs and outputs of U18.

Select Decoder

For a general discussion of instrument control, see *Latches (A7) and Instrument Bus* in the *Principles of Operation* for Service Sheet BD4.

Table 8D-39. Inputs and Outputs of the PIO (U18)

Pin Name	Description	Type
I/O A0 thru I/O A7	I/O Port A	Input/Output
I/O B0 thru I/O B7	I/O Port B	Input/Output
DB0 thru DB7	Data Bus Lines	Bi-Directional (3 state)
ROMC0 thru ROMC4	Control Lines	Input
Φ, WRITE	Clock Lines	Input
EXT INT	External Interrupt	Input
PRI IN	Priority In	Input
PRI OUT	Priority Out	Output
INT REQ	Interrupt Request	Output
DBDR	Data Bus Drive	Output

TROUBLESHOOTING

General

Procedures for checking the Remote Interface Assembly are given below. The circuits to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨✓3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Extend the board assembly where necessary to make measurements.

CAUTION

MOS and CMOS ICs can be damaged by static charges and circuit transients. Do not remove this 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 HP 4208-0094.) When unplugging ICs, place the board on a conductive pad. When the IC is unplugged, insert it into the pad also.

Several ICs on this assembly 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.

The following checks use the *HP-IB Functional Checks* in the Operating Section (refer to paragraph 3-11) as a basis for troubleshooting the Remote Interface Assembly. It is assumed in the following procedures that the failure was detected during the functional checks. Therefore, it is only necessary to perform the troubleshooting procedures starting with the equivalent functional check in which the failure occured. During the procedures, the 61.N Service Special Functions are also used to help locate the failure.

When using the troubleshooting flowcharts, it is important that the associated notes be read. These notes help clarify the steps that are flagged. The troubleshooting procedures assume that the bus controller and the bus controller's HP-IB interface are operating properly. Therefore, it is assumed that the required inputs are present at the interface to the Audio Analyzer. Always perform all of the HP-IB Functional Checks after any repair to the Remote Interface Assembly.

When using the flowcharts, refer to the principles of operation to clarify the sequence of troubleshooting. Refer to Figure 8D-8 for an explanation of the HP-IB handshake. If replacement of a probably defective part does not correct the Remote Interface problem, check any related circuits that are connected to the faulty area. For example, some bus controllers simultaneously function as both talker and listener. As a result, they may mask a failure of the Remote Interface handshaking capabilities. This can happen when either the NRFD or NDAC output driver on the bus fails in a high state. This type of failure is a very subtle problem. The quickest way to determine what is happening is to monitor the driver outputs while activating both output levels of the individual drivers.

Equipment

Digital Test/Extender Board	HP 08903-60018
Logic Probe	HP 5005A
Oscilloscope	HP 1740A

NOTE

The following are the notes for Figures 8D-9 through 8D-12.

1. The Run indicator shows the status of the handshake between the bus controller and the Audio Analyzer. If it is still on, the handshake was not completed.

2. This Special Function reads back and displays the present state of the Talk and Listen Flip-Flops. (See 61.N Display HP-IB Status *in paragraph 8-23.)*

3. This Special Function reads back and displays the present state of the ATN bus control line and the state of the Remote Enable Flip-Flop.

4. X equals "don't care".

5. If TP4 is low, the handshake logic has satisfied the initial requirements to input address data into the Interface Control ROM. If TP4 is high, this requirement is not complete.

6. Displays HP-IB address set on the Address Switches.

7. Remember that the checkout procedure assumes that the Audio Analyzer is set to address 28. If the instrument has been set for a different address, modify the HP-IB Functional Checks *procedure and the troubleshooting information to match the new address.*

8. Indicated IC is the most likely malfunction. However, if replacement does not fix the problem, check the circuits that drive or are driven by the specified IC and all wiring and components that are connected to the same signals.

9. See Figure 8D-8 for a simplified explanation of the HP-IB Handshake.

⟨√1⟩ Address Recognition Check

1. Perform the steps shown in the *Address Recognition Troubleshooting Flowchart,* Figure 8D-9.

⟨√2⟩ Remote and Local Messages and the LCL Key Check

1. Perform the steps shown in the *Remote and Local Messages and the LCL Key Troubleshooting Flowchart,* Figure 8D-10.

⟨√3⟩ Sending the Data Message Check

1. Perform the steps shown in the *Data Message Troubleshooting Flowchart,* Figure 8D-11.

⟨√4⟩ Receiving the Data Message Check

1. Perform the *Receiving the Data Message* portion of the *HP-IB Functional Checks.*

Hint: Most of the circuits that are used in this check were used in previous checks. Check the inputs and outputs of gates U8 and U10. if they are good, the problem could be U18 (PIO), the Controller (see Service Sheet 15), or the annunciators (see Service Sheet 18).

⟨√5⟩ Local Lockout and Clear Lockout/Set Local Messages Check

1. Perform the *Local Lockout and Clear Lockout/Set Local Messages* portion of the *HP-IB Functional Checks.*

Hint: Most of the circuits that are used in this check were used in previous checks. If the instrument fails this check, the problem is probably in the Controller (see Service Sheet 15) or the front-panel keyboard circuits (see Service Sheet 17).

⟨√6⟩ Clear Message Check

1. Perform the *Clear Message* portion of the *HP-IB Functional Checks.*

Hint: The circuits that are used in this check were used in previous checks. If a problem occurs during the check, repeat the previous checks starting at ⟨√1⟩ *Address Recognition Check.*

⟨√7⟩ Abort Message Check

1. Perform the *Abort Message* portion of the *HP-IB Functional Checks.*

Hint: Most of the circuits that are used in this check were used in previous checks. The flowchart (Figure 8D-12) is primarily used to check the IFC and serial-poll circuits.

⟨✓8⟩ Status Byte Message Check

1. Perform the *Status Byte Message* portion of the *HP-IB Functional Checks.*

Hint: Most of the circuits that are used in this check were used in previous checks. The most important difference is that the Controller must recognize that the Serial Poll Flip-Flop is set and send the status byte when addressed to talk.

⟨✓9⟩ Require Service Message

1. Perform the *Require Service Message* portion of the *HP-IB Functional Checks.*

Hint: Most of the circuits that are used in this check were used in previous checks. The most important difference is that the Controller must drive the SRQ(L) line low. It does this through gate U20D and the PIO (U18). Repeat the check and monitor the input and output of U20D.

⟨✓10⟩ Trigger Message and Clear Key Triggering

1. Perform the *Trigger Message and Clear Key Triggering* portion of the *HP-IB Funtional Checks.*

Hint: Most of the circuits that are used in this check were used in previous checks. The most important difference is that the Controller must recognize that the CLEAR key can be used to trigger the instrument. The problem is probably in the Controller (see Service Sheet 15) or the CLEAR key circuit (see Service Sheet 17).

⟨✓11⟩ Select Decoder and Address Switches Check

1. Key in the Direct Control Special Functions indicated in Table 8D-40. For each setting, check the pins on U16 indicated.

Table 8D-40. Select Decoder Outputs, ⟨✓11⟩ Step 1

Direct Control Special Function	Level (TTL) at U16 Pin							
	15	14	13	12	11	10	9	7
0.300	*	H	H	H	H	H	H	H
0.310	H	*	H	H	H	H	H	H
0.320	H	H	*	H	H	H	H	H
0.330	H	H	H	*	H	H	H	H
0.340	H	H	H	H	*	H	H	H
0.350	H	H	H	H	H	*	H	H
0.360	H	H	H	H	H	H	*	H
0.370	H	H	H	H	H	H	H	*

2. Key in 0.350 SPCL to read back part of S1. The left display should be of the form *abcd* where

a=1 if S1D is open;
b=1 if S1C is open;
c=1 if S1B is open;
d=1 if S1A is open.

3. Key in 0.360 SPCL to read back the rest of S1 and U12B. The left display should be of the form *abcd* where

a=1 if U12B is set;
b=1 if S1G is open;
c=1 if S1F is open;
d=1 if S1E is open.

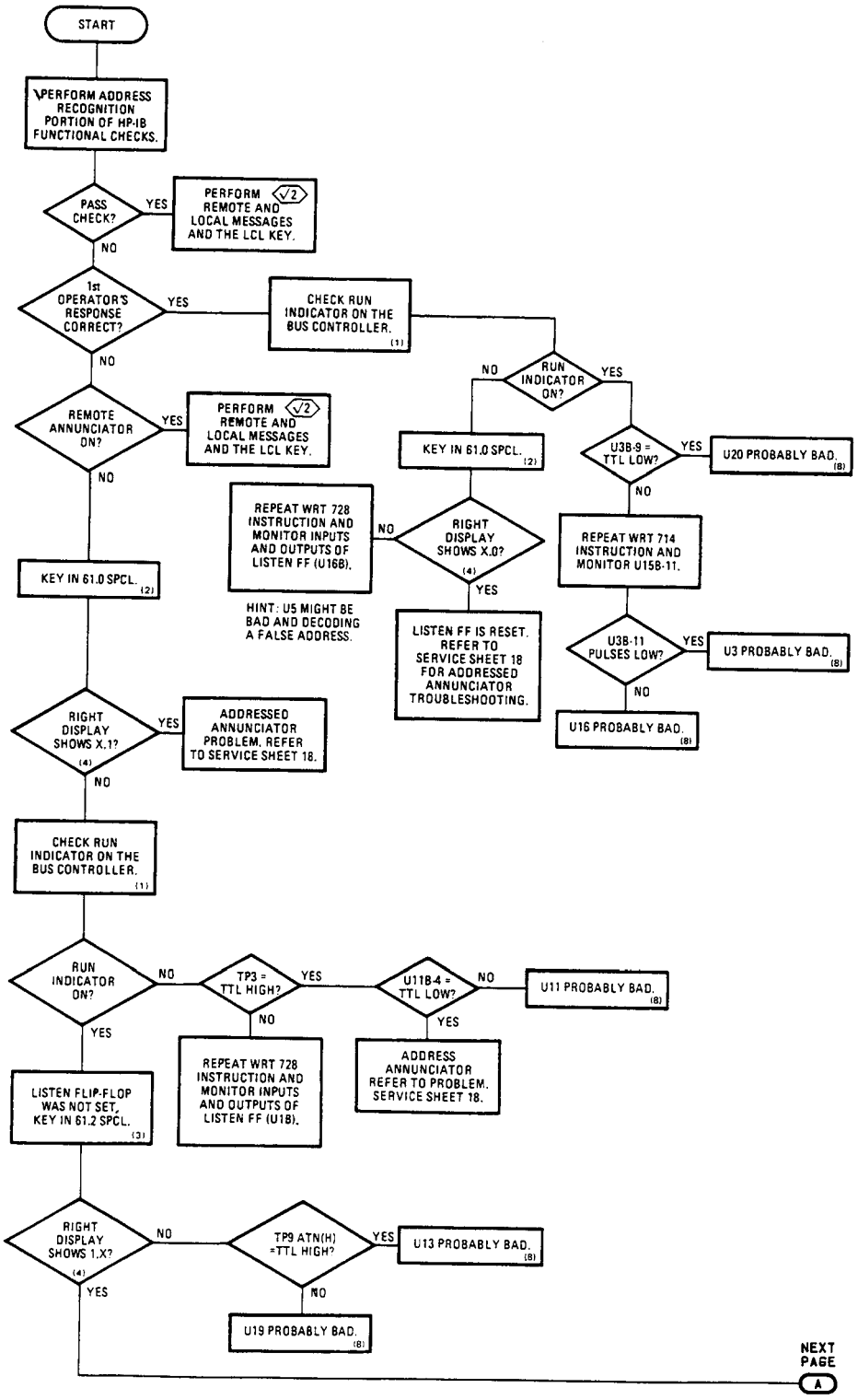


Figure 8D-9. Address Recognition Check Troubleshooting Flowchart, √1 (1 of 2)

TROUBLESHOOTING---SERVICE SHEET 19

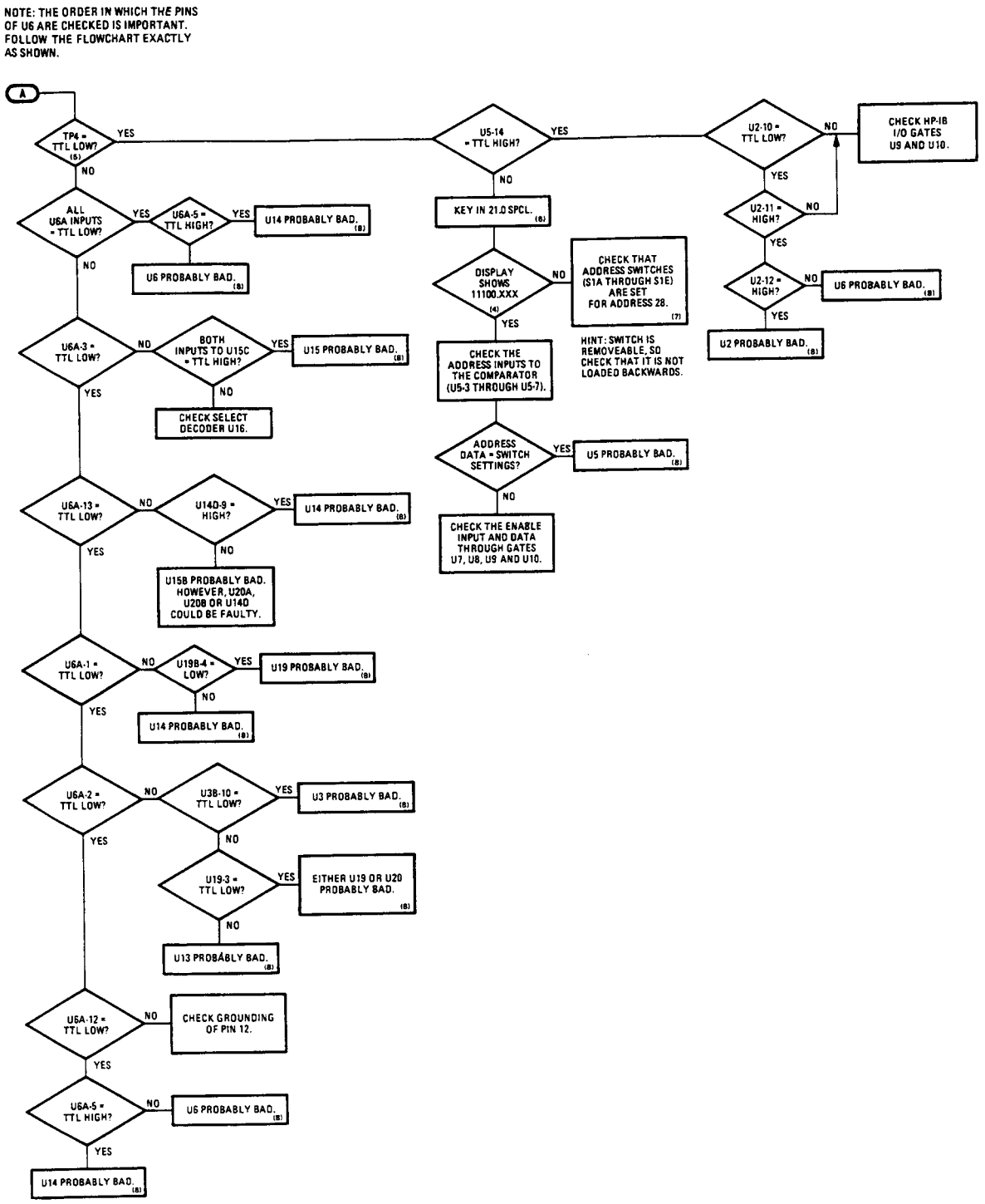


Figure 8D-9. Address Recognition Check Troubleshooting Flowchart, J1 *(2 of 2)*

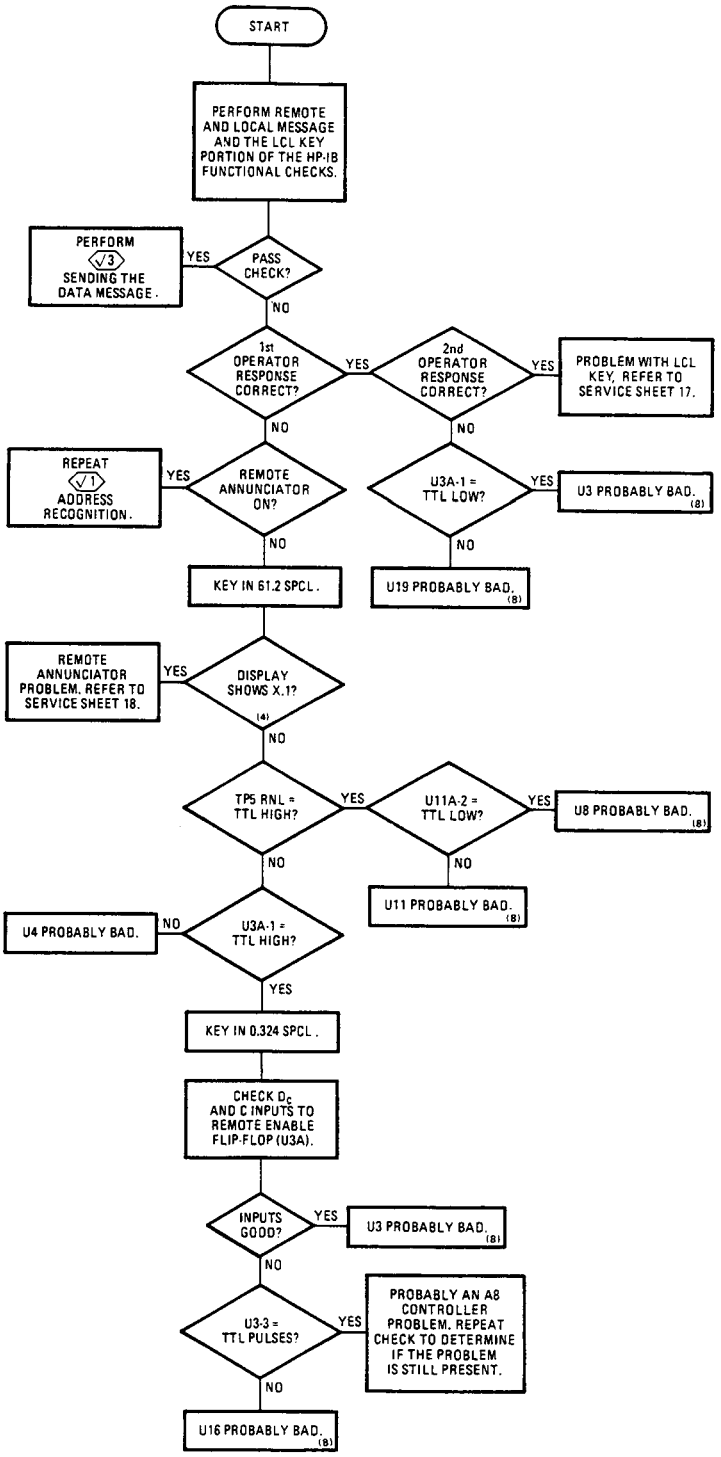


Figure 8D-10. Remote and Local Message and the LCL Key Check Troubleshooting Flowchart, √2

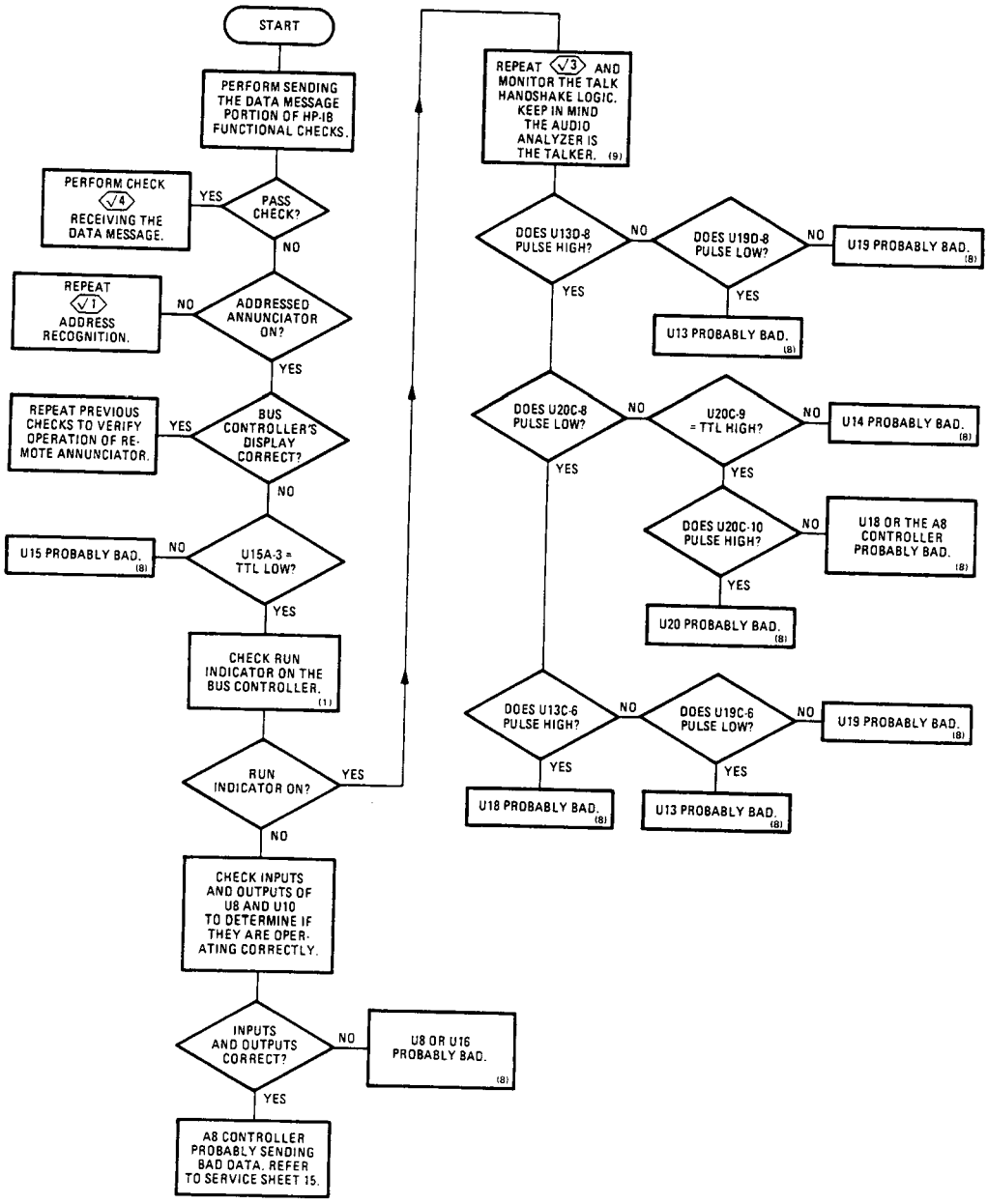


Figure 8D-11. Sending the Data Message Check Troubleshooting Flowchart, √3

TROUBLESHOOTING---SERVICE SHEET 19

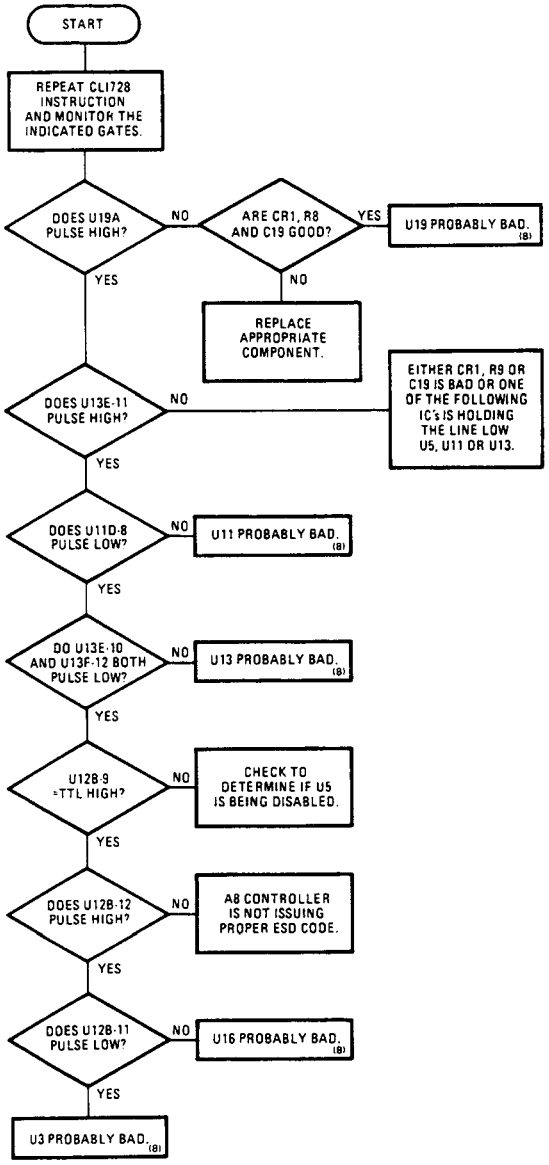
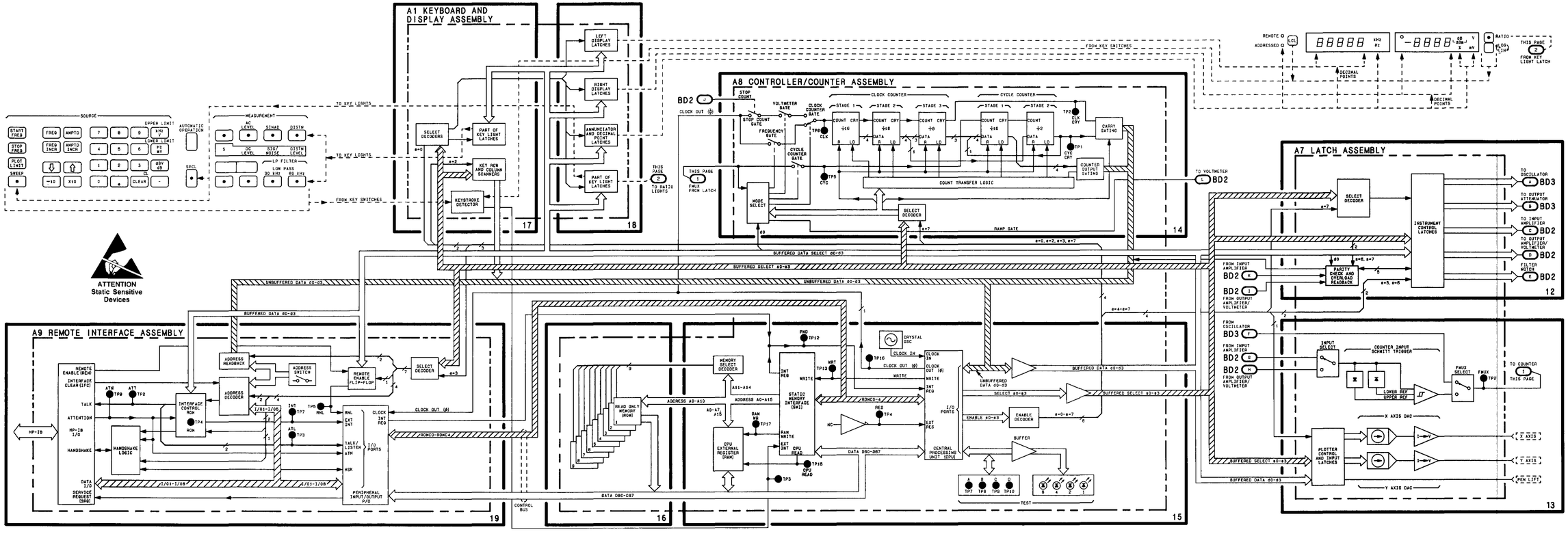


Figure 8D-12. Abort Message Check Troubleshooting Flowchart, ⟨J7⟩



BD4
Figure 8D-101
8D-101

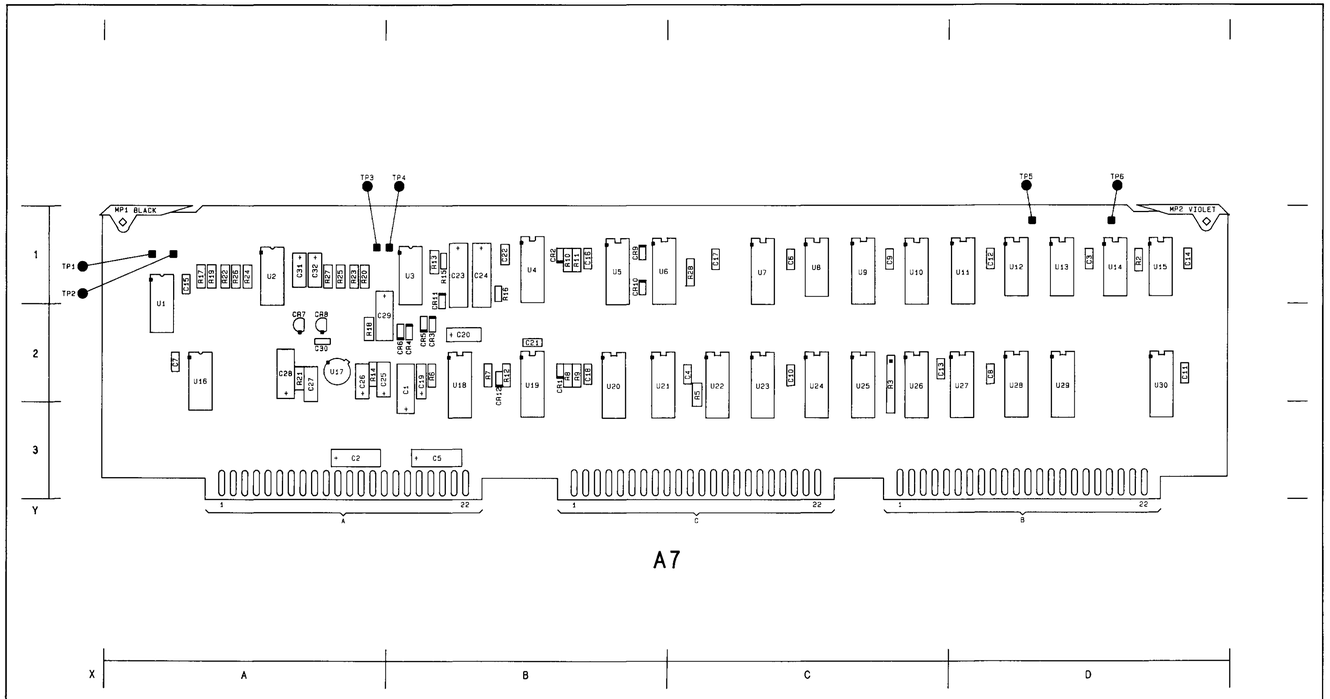


Figure 8D-102. SERVICE SHEET 12 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	B2						
C2	A3						
C3	D1						
C4	C2						
C5	B3						
C6	C1						
C7	A2						
C8	D2						
C9	C1						
C10	C2						
C11	D2						
C12	D1						
C13	C2						
C14	D1						
R2	D1						
R3	C2						
R5	C2						
TP1	A1						
TP5	D1						
TP6	D1						
U7	C1						
U8	C1						
U9	C1						
U10	C1						
U11	D1						
U12	D1						
U13	D1						
U14	D1						
U15	D1						
U23	C2						
U24	C2						
U25	C2						
U26	C2						
U27	D2						
U28	D2						
U29	D2						
U30	D2						

Digital Circuits Block Diagram **BD4**

SEE REVERSE SIDE

NOTES

LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

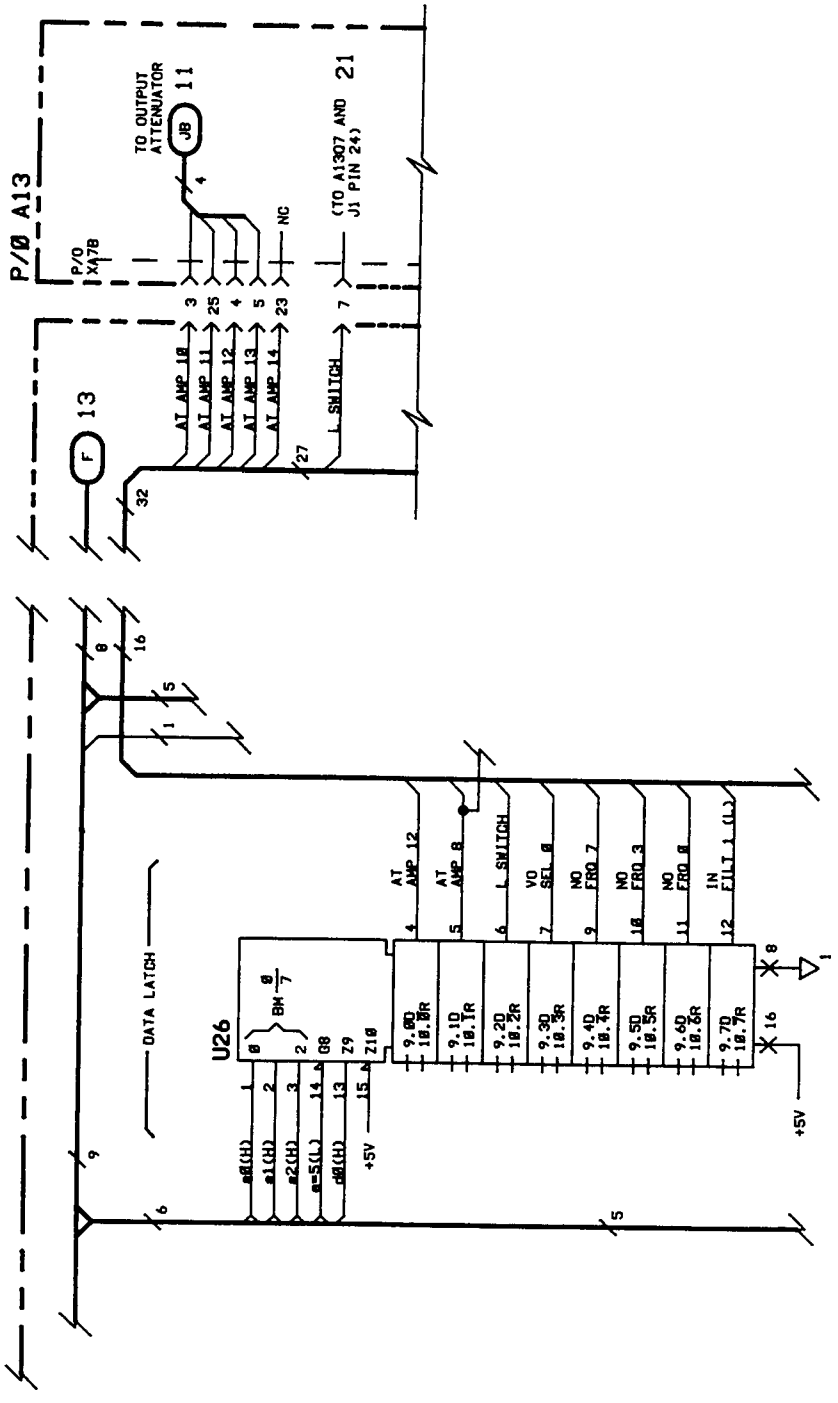
A7R3
TOP VIEW

PIN NO.	1	2	3	4	6	6	7	8
	GND	A	B	C	D	E	F	G

Schematic General Information

CHANGES

All serial prefixes	**On the A13 schematic:** • **U24** - On U24 pin 10 change AT AMP 5 to AT AMP 6 and on U24 pin 11 change AT AMP 1 to AT AMP 2.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2742A and above	**On the A7 schematic:** • **08903-60130** - Use the schematic with the schematic partial on page 8D-102.3. **On the A7 Component Locator:** • **C27** - Mark C27 positive on the end closest to C2.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.


P/Ø A13
P/O XA7B
TO OUTPUT ATTENUATOR
J8
11
21
(TO A1307 AND J1 PIN 24)
NC
AT AMP 10
AT AMP 11
AT AMP 12
AT AMP 13
AT AMP 14
L SWITCH
27
32
13
DATA LATCH
U26
BM 8/7
AT AMP 12
AT AMP 8
L SWITCH
VO SEL 8
NO FRQ 7
NO FRQ 3
NO FRQ 8
IN FILT 1 (L)
+5V

P/O A13
POWER SUPPLY
AND MOTHERBOARD
ASSEMBLY
(08903-60129)

P/O A7 LATCH ASSEMBLY (08903-60130)

SERIAL PREFIX: 2450A

ATTENTION
Static Sensitive
Devices

SS12
Figure 8D-103
8D-103

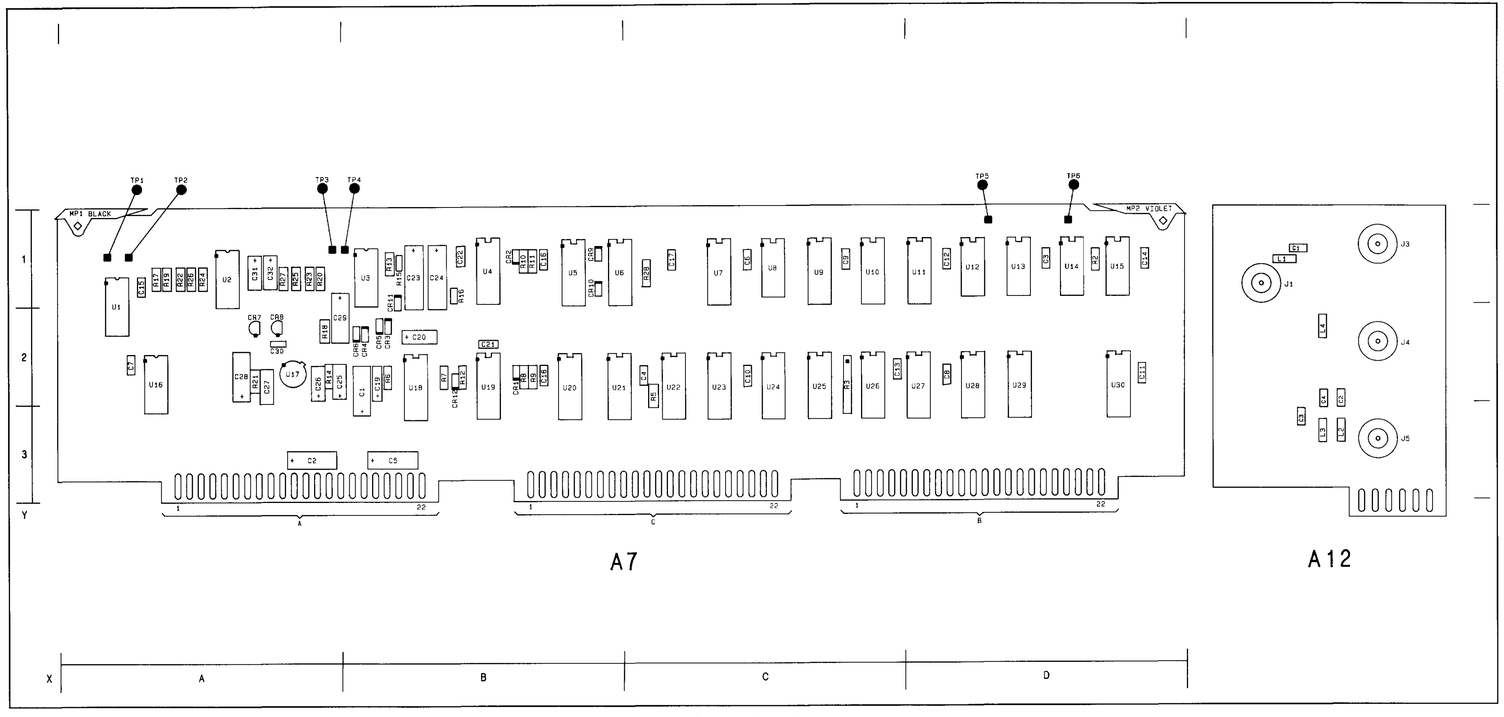


Figure 8D-104. SERVICE SHEET 13 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C15	A1						
C16	B1						
C17	C1						
C18	B2						
C19	B2						
C20	B2						
C21	B2						
C22	B1						
C23	B1						
C24	B1						
C25	A2						
C26	A2						
C27	A2						
C28	A2						
C29	A2						
C30	A2						
C31	A1						
C32	A1						
CR1	B2						
CR2	B1						
CR3	B2						
CR4	B2						
CR5	B2						
CR6	B2						
CR7	A2						
CR8	A2						
CR9	B1						
CR10	B1						
CR11	B1						
CR12	B2						
R6	B2						
R7	B2						
R8	B2						
R9	B2						
R10	B1						
R11	B1						
R12	B2						
R13	B1						
R14	A2						
R15	B1						
R16	B1						
R17	A1						
R18	A2						
R19	A1						
R20	A2						
R21	A2						
R22	A1						
R23	A1						
R24	A1						
R25	A1						
R26	A1						
R27	A1						
R28	C1						
TP2	A1						
TP3	A1						
TP4	B1						
U1	A1						
U2	A1						
U3	B1						
U4	B1						
U5	B1						
U6	B1						
U16	A2						
U17	A2						
U18	B2						
U19	B2						
U20	B2						
U21	B2						

P/O A7 Latch-Data Latches **SS12**

SEE REVERSE SIDE

NOTES

1. Chassis ground is made by mechanical contact of connector with rear panel.
2. * Asterisk indicates factory selected values.

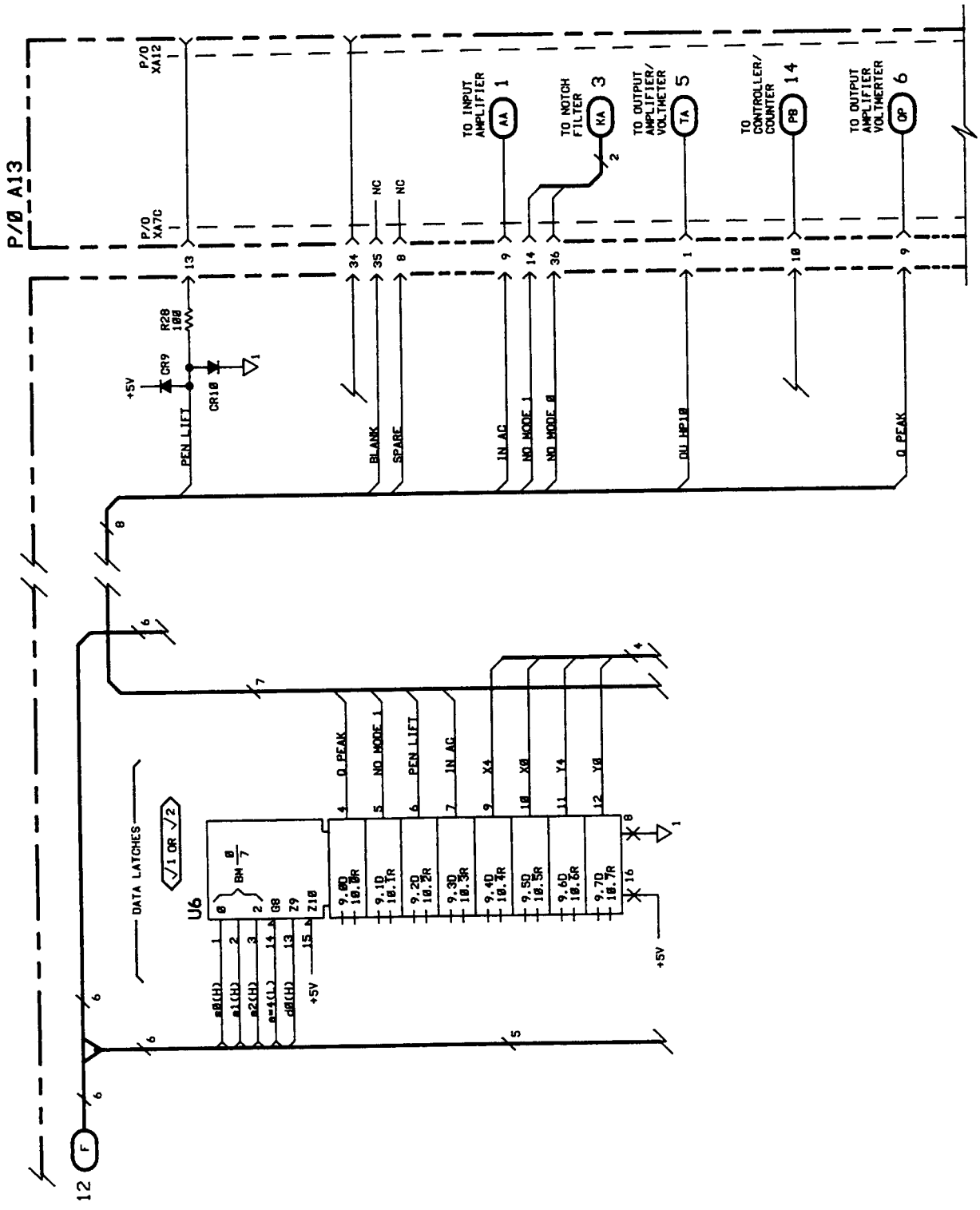
LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

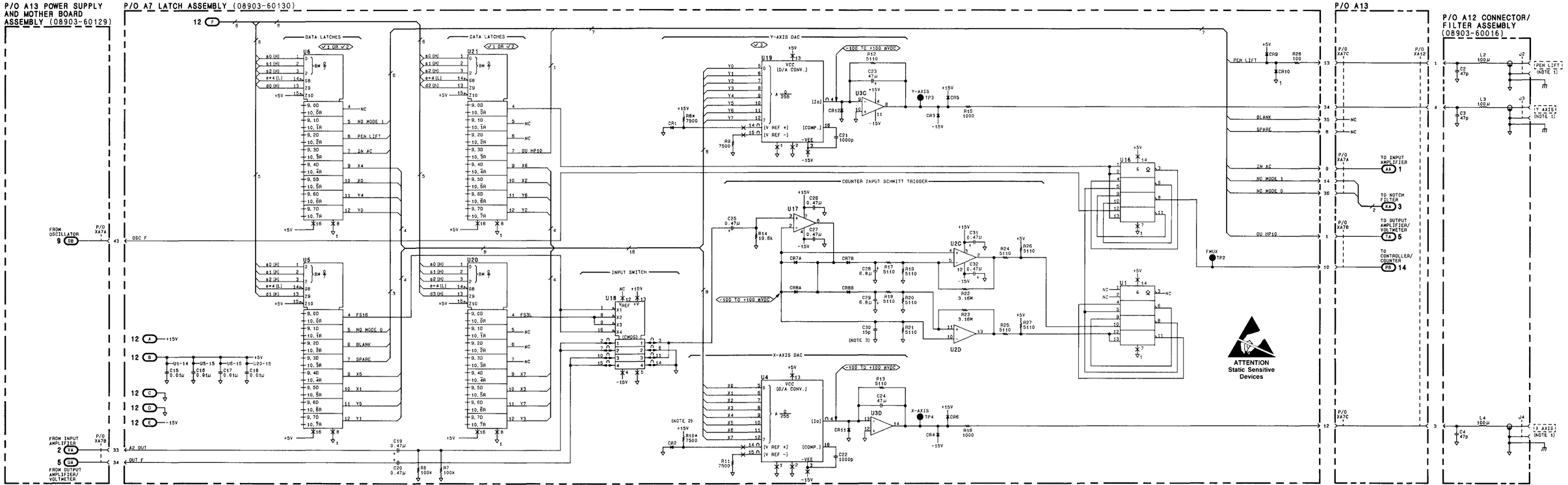
Schematic General Information

CHANGES

All serial prefixes	**On the A12 Component Locator:** • **J3, J4, J5** - Change J3 to J4, J4 to J3, and, J5 to J2.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2742A and above	**On the A7 schematic:** • **R12, R13** - In the center of the P/O A7 LATCH ASSEMBLY, under Y-AXIS DAC, change the value of R12 to 5K and under X-AXIS DAC, change the value of R13 to 5K. • **08903-60130** - Use the schematic with the schematic partial on page 8D-104.3.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.



P/O A7 LATCH ASSEMBLY (2742A and above)


P/O A13 POWER SUPPLY AND MOTHER BOARD ASSEMBLY (08903-60129)
P/O A7 LATCH ASSEMBLY (08903-60130)
P/O A13
P/O A12 CONNECTOR/ FILTER ASSEMBLY (08903-60016)
DATA LATCHES
Y-AXIS DAC
COUNTER INPUT SCHMITT TRIGGER
INPUT SWITCH
X-AXIS DAC
FROM OSCILLATOR
FROM INPUT AMPLIFIER
FROM OUTPUT AMPLIFIER/ VOLTMETER
OSC F
A2 OUT
OUT F
PEN LIFT
BLANK
SPARE
IN AC
NC MODE 1
NC MODE 0
QU HP10
FMUX
TO INPUT AMPLIFIER
TO NOTCH FILTER
TO OUTPUT AMPLIFIER/ VOLTMETER
TO CONTROLLER/ COUNTER
ATTENTION Static Sensitive Devices
SERIAL PREFIX: 2450A

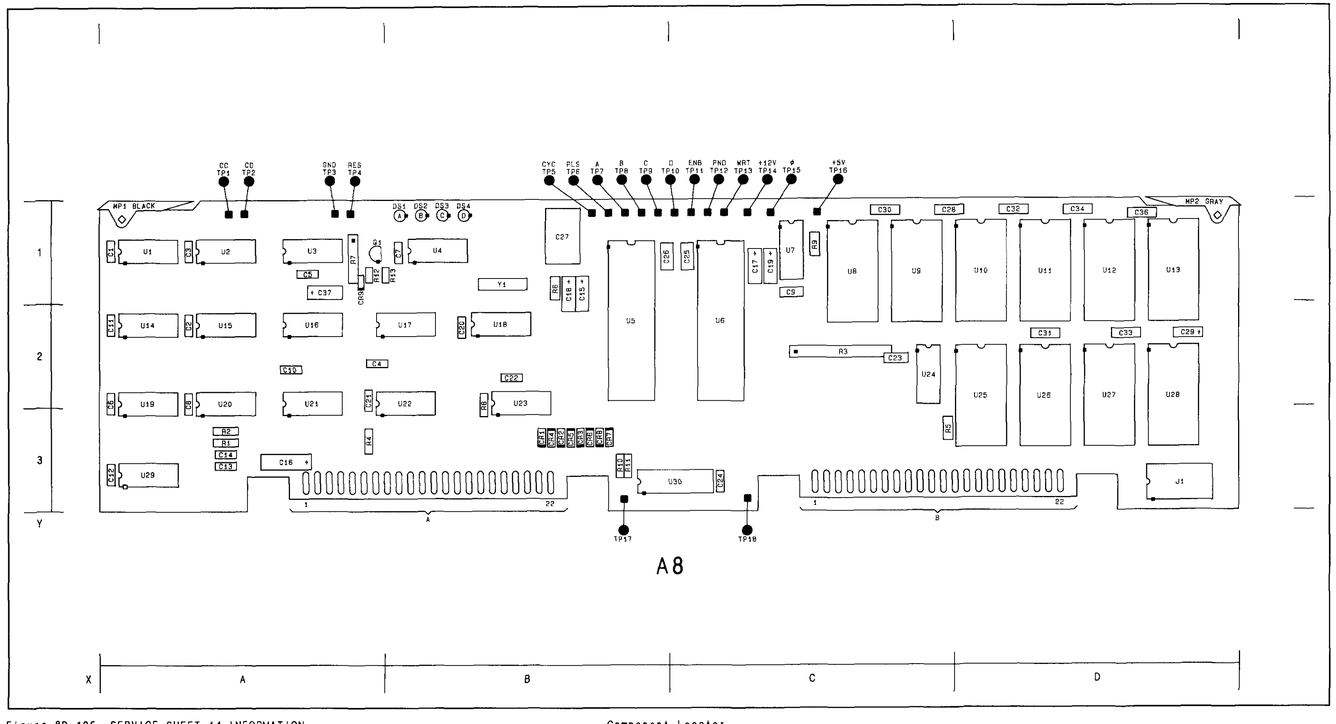


Figure 8D-106. SERVICE SHEET 14 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	A1						
C2	A2						
C3	A1						
C4	A2						
C5	A1						
C6	A2						
C7	B1						
C8	A2						
C9	C1						
C10	A2						
C11	A2						
C12	A3						
C13	A3						
C14	A3						
R1	A3						
R2	A3						
TP1	A1						
TP2	A1						
TP5	B1						
TP6	B1						
U1	A1						
U2	A1						
U3	A1						
U4	B1						
U7	C1						
U14	A2						
U15	A2						
U17	B2						
U19	A3						
U20	A3						
U21	A2						
U29	A3						

P/O A7, P/O A12
SEE REVERSE SIDE

Latch-DAC and Counter Trigger Circuits

SS13

NOTES

LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

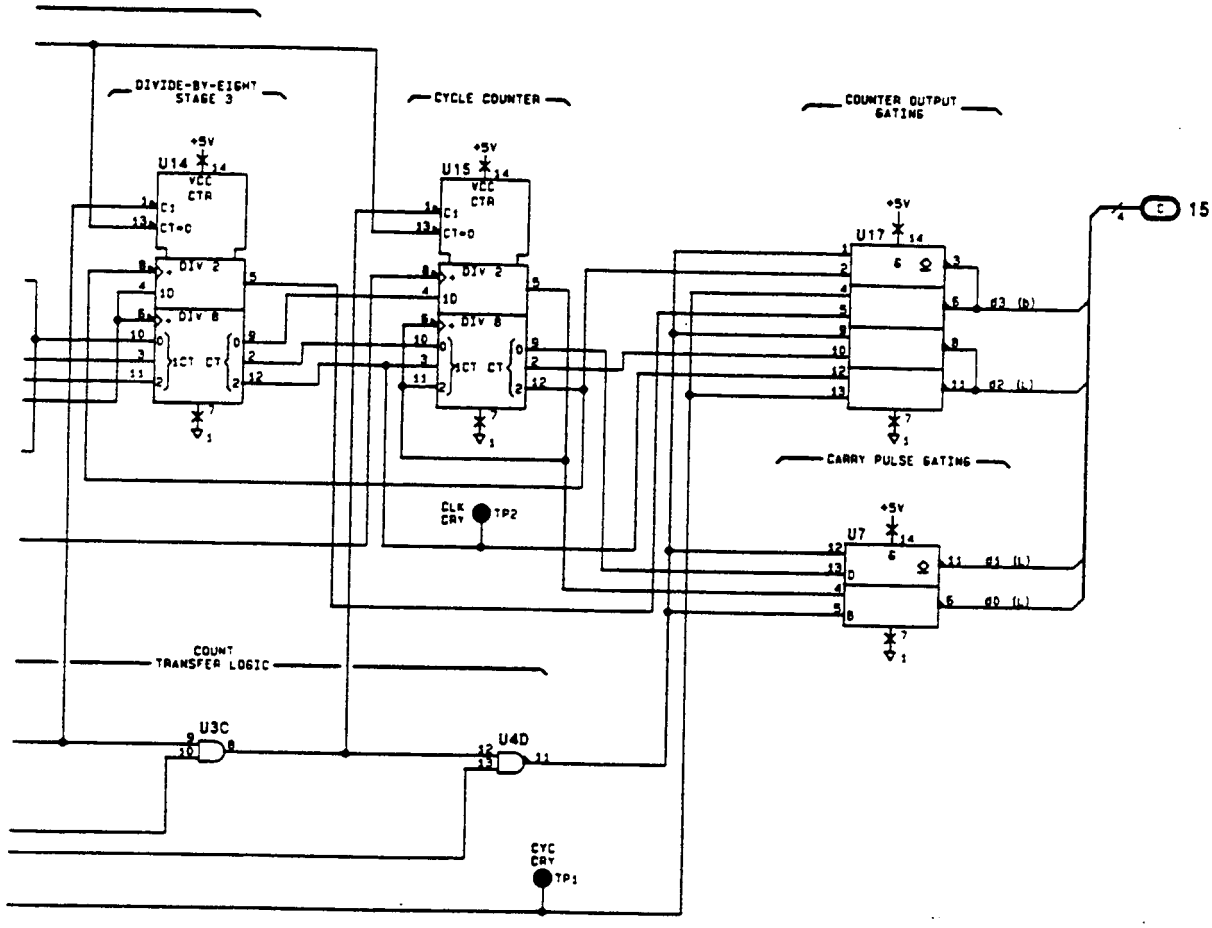
Schematic General Information

CHANGES

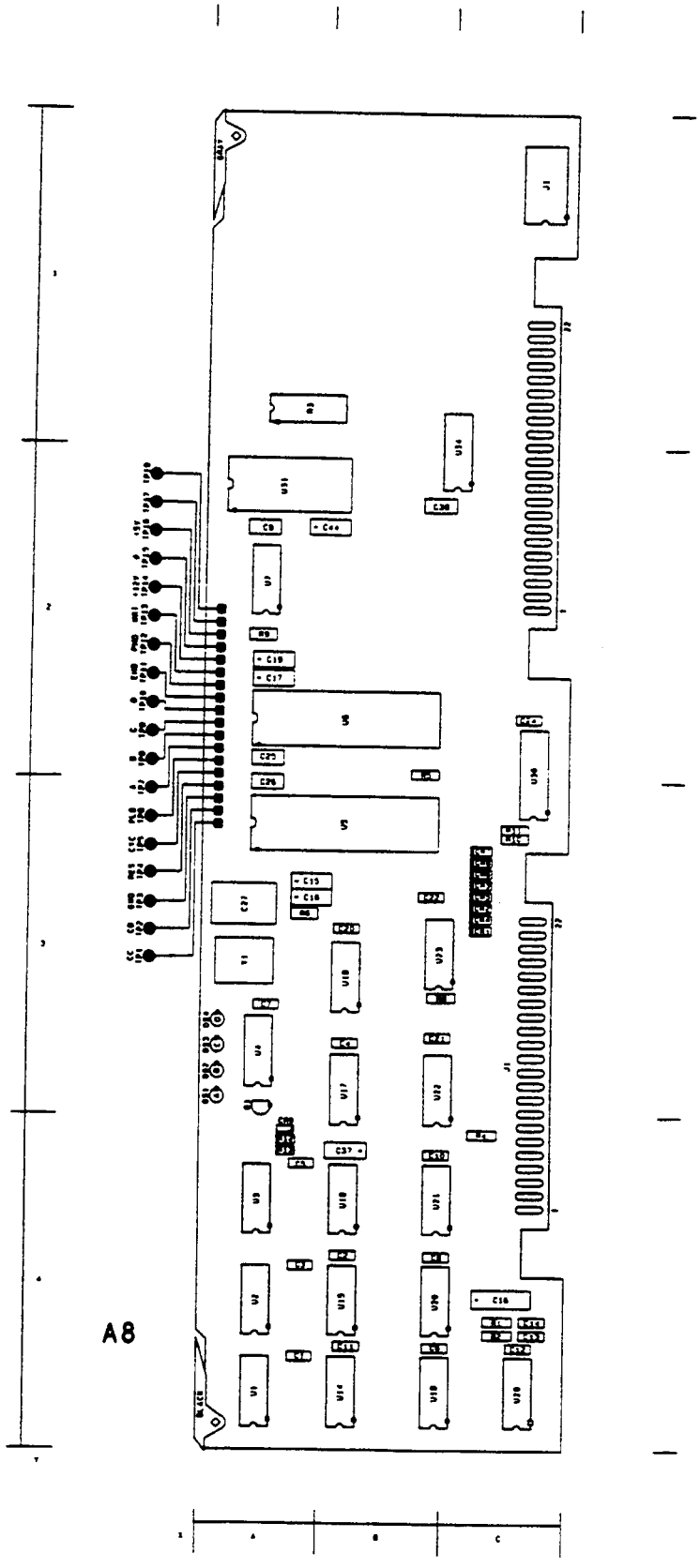
All serial prefixes	**On the A8 schematic:** • **08903-60134** - Modify Service Sheet 14 by adding the new partial schematic P/O SS14, P/O A8 CONTROLLER/COUNTER ASSEMBLY on page 8D-106.3.
2652A only	**On the A8 schematic:** • **08903-60184** - Change the part number of the A8 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60184. **On the A8 Component Locator:** • **08903-60184** - Use the new A8 component locator on page 8D-106.4. **On the A8 Component Coordinates:** • **08903-60184** - Use the new A8 component coodinates on page 8D-106.5.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A to 2922A	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.
2944A and above	**On the A8 schematic:** • **08903-60300** - Use the new schematic foldout on page 8D-106.11. SS14 with the revision date of rev.01OCT89. **On the A8 Component Locator:** • **08903-60300** - Use the new A8 Component Locator on page 8D-106.8 with the revision date of rev.01OCT89. **On the A8 Component Coordinates:** • **08903-60300** - Use the new A8 Component Coordinates on page 8D-106.9 with the revision date of rev.01OCT89.

CHANGES

2948A and above	**On the A13 schematic:** • **08903-60392** - Use the new schematic foldout on page 8D-106.11. SS14 with the revision date of rev.01OCT89.



P/O SS14 A8 Controller/Counter Assembly

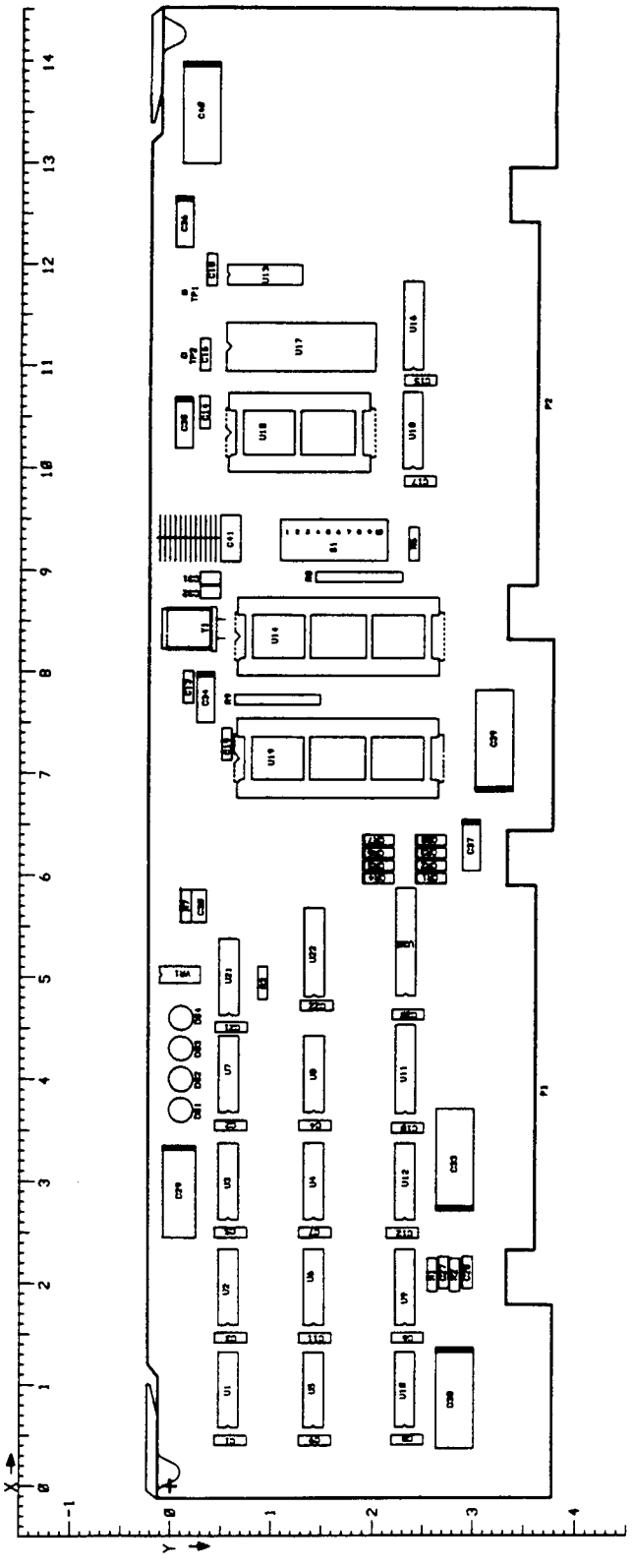


A8 Component Locator (2652A only)

A8 Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	A,4	R1	C,4	U20	B,4				
C2	B,4	R3	A,1	U21	B,4				
C3	A,4	R4	C,4	U22	B,1				
C4	B,1	R5	B,2	U23	B,1				
C5	A,4	R6	A,3	U30	C,2				
C6	B,4	R8	B,1	U31	A,2				
C7	A,3	R9	A,2	U34	C,2				
C8	B,4	R10	C,3						
C9	A,2	R11	C,3	Y1	A,3				
C10	B,4	R12	A,4						
C11	B,4	R13	A,4						
C15	A,3								
C17	A,2	TP1	A,3						
C18	A,3	TP2	A,3						
C19	A,2	TP3	A,3						
C20	B,1	TP4	A,3						
C21	B,1	TP5	A,2						
C22	B,1	TP6	A,2						
C24	C,2	TP7	A,2						
C25	A,2	TP8	A,2						
C26	A,3	TP9	A,2						
C27	A,3	TP10	A,2						
C37	B,4	TP11	A,2						
C38	B,2	TP12	A,2						
C44	B,2	TP13	A,2						
		TP14	A,2						
CR1	C,3	TP15	A,2						
CR2	C,3	TP16	A,2						
CR3	C,3	TP17	A,2						
CR4	C,3	TP18	A,2						
CR5	C,3								
CR6	C,3	U1	A,4						
CR7	C,3	U2	A,4						
CR8	C,3	U3	A,4						
CR9	A,4	U4	A,3						
		U5	B,1						
DS1	A,3	U6	B,2						
DS2	A,3	U7	A,2						
DS3	A,3	U14	B,4						
DS4	A,3	U15	B,4						
		U16	B,4						
J1	C,1	U17	B,1						
		U18	B,1						
Q1	A,3	U19	B,4						

A8 Component Coordinates (2652A only)



A8 Component Locator
2948A (HP8903B)
2946A (HP8903E)

SS14

COMP	X	Y	COMP	X	Y	COMP	X	Y
C1	0.5	0.4	DS1	3.7	0.1			
C2	3.6	0.4	DS2	4.0	0.1			
C3	1.5	0.4	DS3	4.3	0.1			
C4	3.6	1.2	DS4	4.6	0.1	VR1	4.9	-0.1
C5	2.5	0.4						
C6	1.5	2.1	P1	4.1	3.6	Y1	8.3	0.5
C7	2.5	1.2	P2	10.6	3.6			
C8	0.5	2.1						
C9	0.5	1.2	R1	1.8	2.6			
C10	3.5	2.1	R2	1.8	2.8			
C11	1.5	1.2	R3	4.7	0.9			
C12	2.5	2.1						
C13	7.6	0.2						
C14	10.3	0.3	R6	9.0	2.4			
C15	10.9	2.2	R7	5.5	0.1			
C16	10.9	0.3	R8	8.9	1.5			
C17	9.9	2.2	R9	7.7	0.7			
C18	11.7	0.4						
C19	7.1	0.6						
C20	4.6	2.1	S1	9.2	1.2			
C21	4.5	0.4						
C22	4.7	1.2						
			TP1	11.7	0.1			
			TP2	11.1	0.1			
C27	1.9	2.7	U1	0.7	0.7			
C28	1.9	3.0	U2	1.7	0.7			
C29	3.4	0.1	U3	2.7	0.7			
C30	5.5	0.3	U4	2.7	1.6			
C31	8.9	0.4	U5	0.7	1.6			
C32	8.8	0.4	U6	1.7	1.6			
C33	2.6	2.8	U7	3.8	0.7			
C34	8.1	0.3	U8	3.8	1.6			
C35	10.8	0.1	U9	1.7	2.5			
C36	12.8	0.1	U10	0.7	2.5			
C37	6.6	3.0	U11	3.8	2.5			
C38	1.4	2.8	U12	2.7	2.5			
C39	6.8	3.2	U13	11.8	0.6			
C40	14.1	0.3	U14	8.1	0.7			
C41	9.3	0.6	U15	10.1	0.6			
			U16	11.1	2.5			
CR1	6.0	2.4	U17	10.9	0.6			
CR2	6.1	2.4	U18	10.1	2.5			
CR3	6.2	2.4	U19	6.9	0.7			
CR4	6.0	1.9	U20	4.9	2.5			
CR5	6.1	1.9	U21	4.7	0.7			
CR6	6.2	1.9	U22	4.9	1.6			
CR7	6.4	1.9						
CR8	6.4	2.4						

A8 Component Coordinates
2948A (HP8903B)
2946A (HP8903E)

P/O A8 CONTROLLER/COUNTER ASSEMBLY (08903-60300 FOR HP8903B / 8903-60301 FOR HP8903E)

P/O A13 POWER SUPPLY AND MOTHER BOARD ASSEMBLY (08903-60129 FOR HP8903B/ 08903-60395 FOR HP8903E)

FROM OUTPUT AMPLIFIER/ VOLTMETER

7 DB

P/O XA8A

P1(39)

STOP_COUNT_(H)

FROM LATCH

13 P8

P1(12)

FMUX

DB(H)

SS16 H

STOP COUNT GATE

VOLTMETER GATE

MODE SELECT

FREQUENCY GATE

SS15, 16 C(H) K

SELECT DECODER

SS16 J S0-S3(H)

SS16 E E7(L)

CLOCK COUNTER GATE

CYCLE COUNTER GATE

CLOCK COUNTER

DIVIDE-BY-SIXTEEN STAGE 1

DIVIDE-BY-SIXTEEN STAGE 2

DIVIDE-BY-EIGHT STAGE 3

CYCLE COUNTER

COUNTER OUTPUT GATING

COUNT TRANSFER LOGIC

RAMP GATE (L)

P1(9)

P/O A13

P/O XA8A

CB SS7

TO OUTPUT AMPLIFIER/ VOLTMETER

DB-D3(L) C SS16

D3(L)

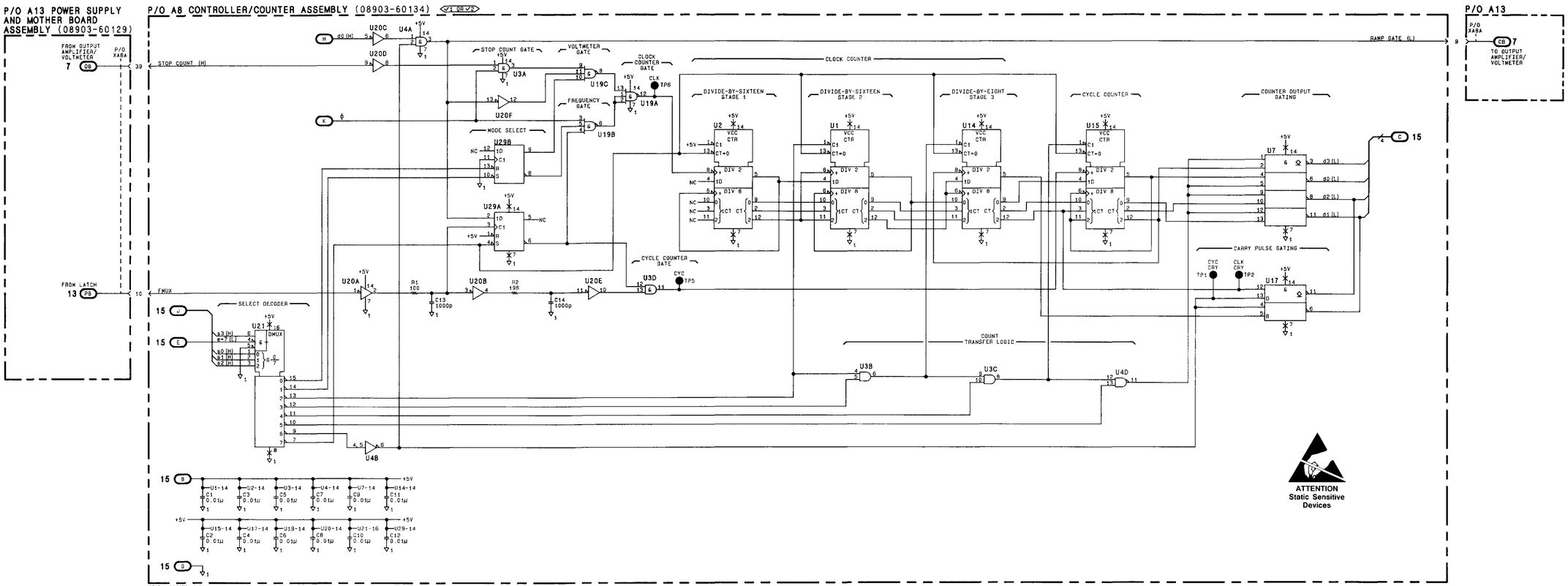
D2(L)

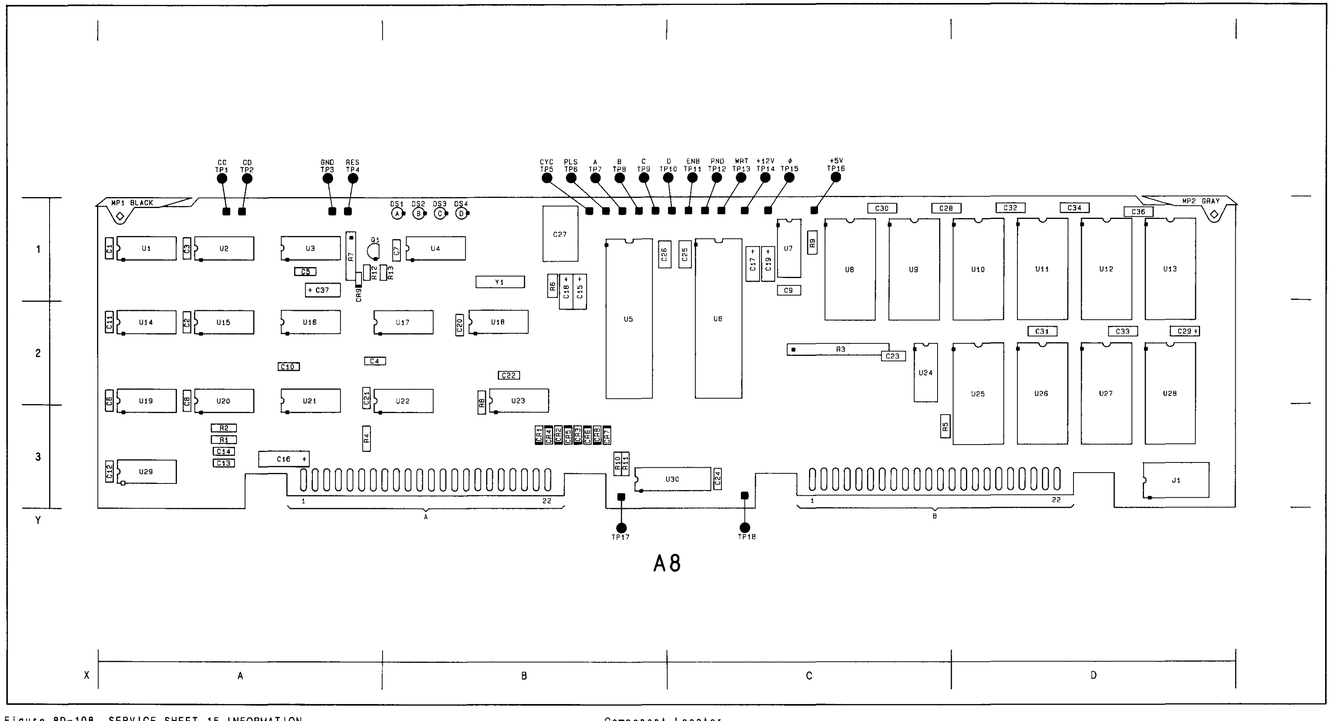
D0(L)

D1(L)

SS14

Figure 8D-106.11
(rev 01OCT89)


P/O A13 POWER SUPPLY AND MOTHER BOARD ASSEMBLY (08903-60129)
FROM OUTPUT AMPLIFIER/ VOLTMETER
7 CB
P/O XABA 1
39
STOP COUNT (H)
FROM LATCH
13 PB
10
FMUX
P/O A8 CONTROLLER/COUNTER ASSEMBLY (08903-60134) 1 OF 2
P/O A13
P/O XABA 1
CB 7
TO OUTPUT AMPLIFIER/ VOLTMETER
RAMP GATE (L)
STOP COUNT GATE
VOLTMETER GATE
FREQUENCY GATE
MODE SELECT
CLOCK COUNTER GATE
CYCLE COUNTER GATE
CLOCK COUNTER
DIVIDE-BY-SIXTEEN STAGE 1
DIVIDE-BY-SIXTEEN STAGE 2
DIVIDE-BY-EIGHT STAGE 3
CYCLE COUNTER
COUNTER OUTPUT GATING
CARRY PULSE GATING
SELECT DECODER
COUNT TRANSFER LOGIC
U20C
U20D
U4A
U3A
U19C
U19A
U20F
U19B
U29B
U29A
U2
U1
U14
U15
U7
U17
U20A
U20B
U20E
U3D
U21
U4B
U3B
U3C
U4D
R1 100
R2 196
C13 1000p
C14 1000p
TP1
TP2
TP5
TP6
CYC CRY
CLK CRY
ATTENTION Static Sensitive Devices
SERIAL PREFIX: 2450A



A8

Figure 8D-108. SERVICE SHEET 15 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C15	B1						
C16	A3						
C17	C1						
C18	B1						
C19	C1						
C20	B2						
C21	A2						
C22	B2						
C23	C2						
C24	C3						
C25	C1						
C26	B1						
C27	B1						
C37	A1						
CR1	B3						
CR2	B3						
CR3	B3						
CR4	B3						
CR5	B3						
CR6	B3						
CR7	B3						
CR8	B3						
CR9	A1						
DS1	B1						
DS2	B1						
DS3	B1						
DS4	B1						
J1	D3						
Q1	A1						
R3	C2						
R4	A3						
R5	C3						
R6	B1						
R7	A1						
R8	B2						
R9	C1						
R10	B3						
R11	B3						
R12	A1						
R13	B1						
TP3	A1						
TP4	A1						
TP7	B1						
TP8	B1						
TP9	B1						
TP10	C1						
TP11	C1						
TP12	C1						
TP13	C1						
TP14	C2						
TP15	C1						
TP16	C1						
TP17	B3						
TP18	C3						
U5	B2						
U6	C2						
U16	A2						
U18	B2						
U22	B2						
U23	B2						
U24	C2						
U30	C3						
Y1	B1						

P/O A8 Controller/Counter-Counter Circuits **SS14**

SEE REVERSE SIDE

NOTES

LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

A8R7
TOP VIEW

PIN NO.	1	2	3	4	5	6	7	8
	+5V	A	B	C	D	E	F	G

A8R3
TOP VIEW

PIN NO.	1	2	3	4	5	6	7	8	9
	A	B	C	D	E	F	G	H	+5V

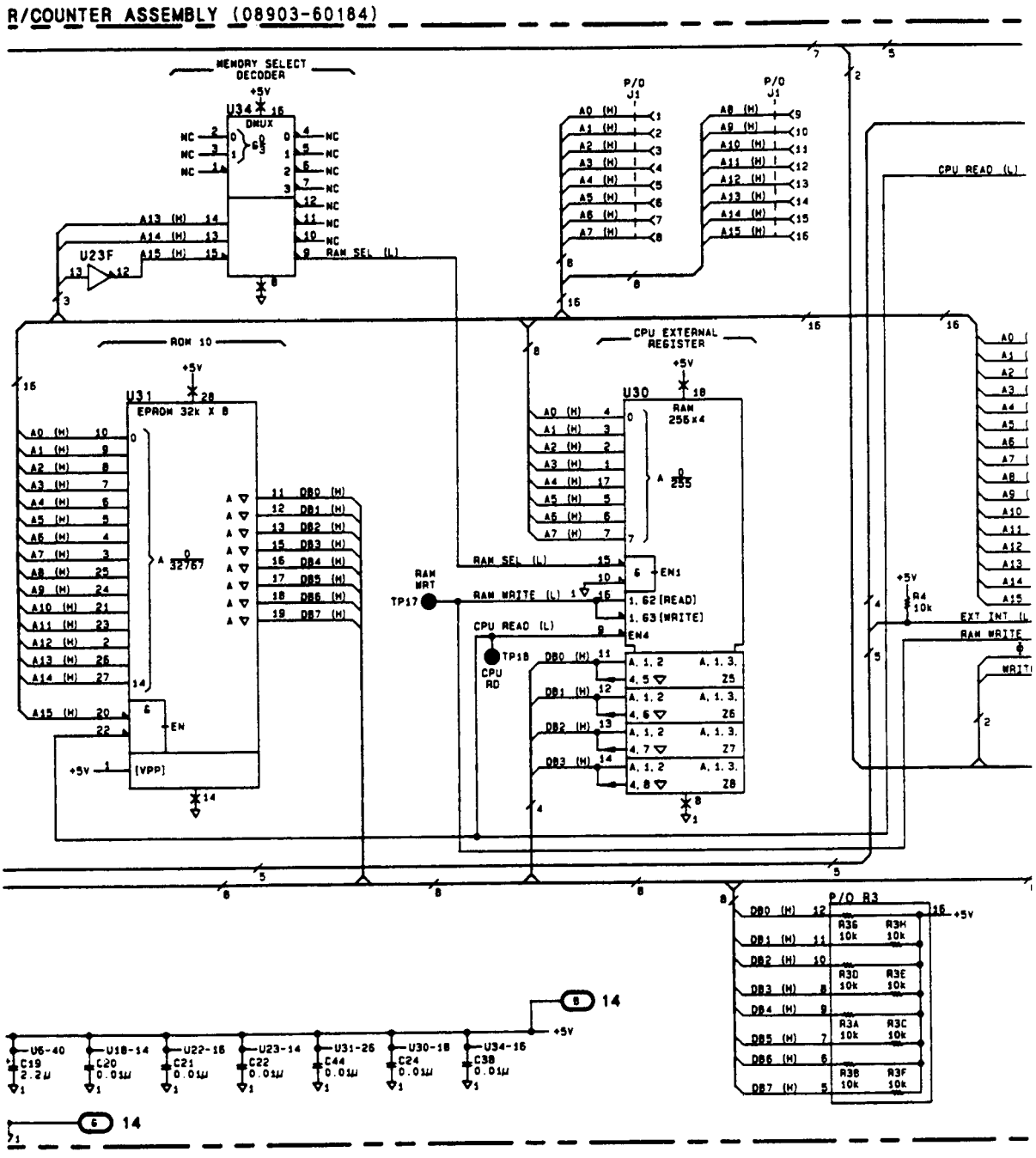
Schematic General Information

CHANGES

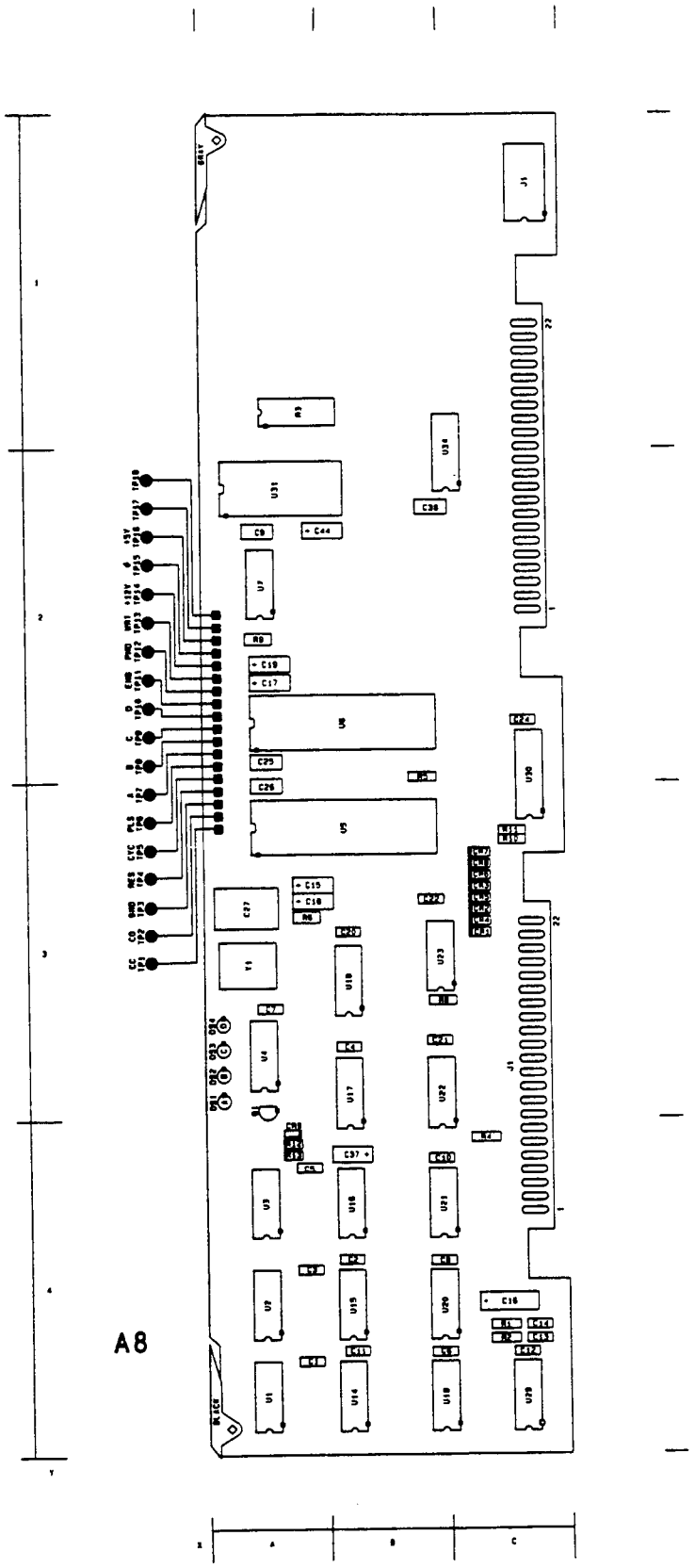
2652A only	**On the A8 schematic:** • **08903-60184** - Use the new partial schematic, P/O SS15 A8 CONTROLLER/COUNTER ASSEMBLY (2652A) on page 8D-108.3. • **R7A, R7B, R7C, R7D**- Under TEST, delete R7A through R7D. • **C44** - In the bottom left portion of the schematic change the value of C44 to 2.2uF. **On the A8 Component Locator:** • **08903-60184** - Use the new A8 component locator (2652A only) on page 8D-108.4. **On the A8 Component Coordinates:** • **08903-60184** - Use the new A8 component coordinates (2652A only) on page 8D-108.5.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2813A to 2922A	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.
2948A and above	**On the A8 schematic:** • **08903-60300** - Use the new schematic foldout on page 8D-108.11, SS15 with the revision date of rev.01OCT89. **On the A8 Component Locator:** • **08903-60300** - Use the new A8 Component Locator on page 8D-108.8 with the revision date of rev.01OCT89. **On the A8 Component Coordinates:** • **08903-60300** - Use the new A8 Component Coordinates on page 8D-108.9 with the revision date of rev.01OCT89.

CHANGES

2948A and above	**On the A13 schematic:** • **08903-60392** - Use the new schematic foldout on page 8D-108.11, SS15 with the revision date of rev.01OCT89.



P/O SS15, A8 Controller/Counter Assembly (2652A only)

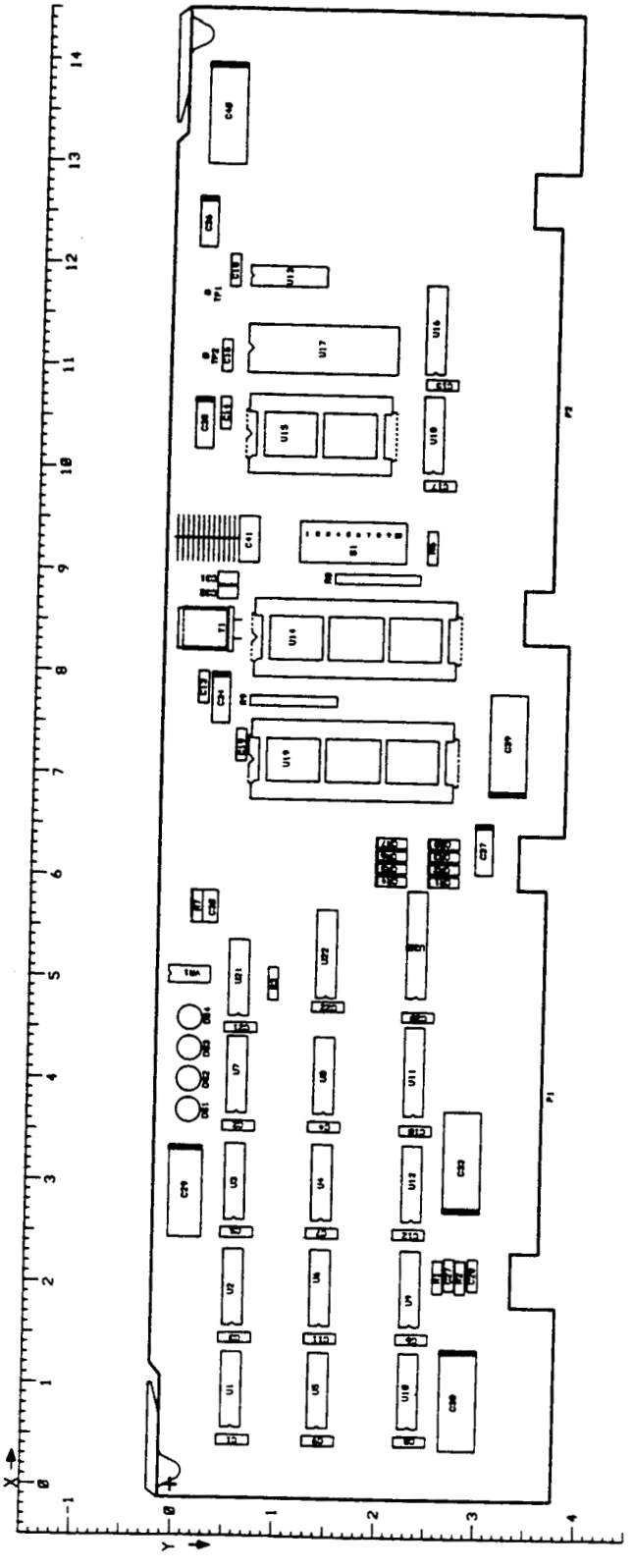


A8 Component Locator (2652A only)

A8 Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	A,4	R1	C,4	U20	B,4				
C2	B,4	R3	A,1	U21	B,4				
C3	A,4	R4	C,4	U22	B,1				
C4	B,1	R5	B,2	U23	B,1				
C5	A,4	R6	A,3	U30	C,2				
C6	B,4	R8	B,1	U31	A,2				
C7	A,3	R9	A,2	U34	C,2				
C8	B,4	R10	C,3						
C9	A,2	R11	C,3	Y1	A,3				
C10	B,4	R12	A,4						
C11	B,4	R13	A,4						
C15	A,3								
C17	A,2	TP1	A,3						
C18	A,3	TP2	A,3						
C19	A,2	TP3	A,3						
C20	B,1	TP4	A,3						
C21	B,1	TP5	A,2						
C22	B,1	TP6	A,2						
C24	C,2	TP7	A,2						
C25	A,2	TP8	A,2						
C26	A,3	TP9	A,2						
C27	A,3	TP10	A,2						
C37	B,4	TP11	A,2						
C38	B,2	TP12	A,2						
C44	B,2	TP13	A,2						
		TP14	A,2						
CR1	C,3	TP15	A,2						
CR2	C,3	TP16	A,2						
CR3	C,3	TP17	A,2						
CR4	C,3	TP18	A,2						
CR5	C,3								
CR6	C,3	U1	A,4						
CR7	C,3	U2	A,4						
CR8	C,3	U3	A,4						
CR9	A,4	U4	A,3						
		U5	B,1						
DS1	A,3	U6	B,2						
DS2	A,3	U7	A,2						
DS3	A,3	U14	B,4						
DS4	A,3	U15	B,4						
		U16	B,4						
J1	C,1	U17	B,1						
		U18	B,1						
Q1	A,3	U19	B,4						

A8 Component Coordinates (2652A only)



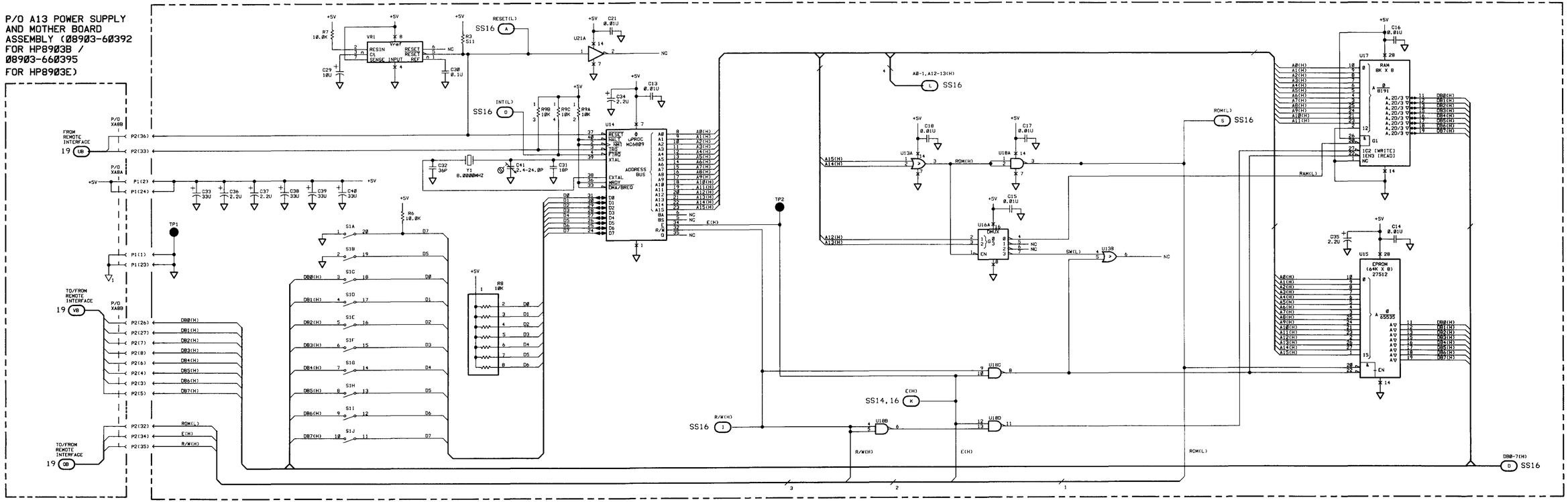
A8 Component Locator
2948A (HP8903B)
2946A (HP8903E)

COMP	X	Y	COMP	X	Y	COMP	X	Y
C1	0.5	0.4	DS1	3.7	0.1			
C2	3.6	0.4	DS2	4.0	0.1			
C3	1.5	0.4	DS3	4.3	0.1			
C4	3.6	1.2	DS4	4.6	0.1	VR1	4.9	-0.1
C5	2.5	0.4						
C6	1.5	2.1	P1	4.1	3.6	Y1	8.3	0.5
C7	2.5	1.2	P2	10.6	3.6			
C8	0.5	2.1						
C9	0.5	1.2	R1	1.8	2.6			
C10	3.5	2.1	R2	1.8	2.8			
C11	1.5	1.2	R3	4.7	0.9			
C12	2.5	2.1						
C13	7.6	0.2						
C14	10.3	0.3	R6	9.0	2.4			
C15	10.9	2.2	R7	5.5	0.1			
C16	10.9	0.3	R8	8.9	1.5			
C17	9.9	2.2	R9	7.7	0.7			
C18	11.7	0.4						
C19	7.1	0.6						
C20	4.6	2.1	S1	9.2	1.2			
C21	4.5	0.4						
C22	4.7	1.2						
			TP1	11.7	0.1			
			TP2	11.1	0.1			
C27	1.9	2.7	U1	0.7	0.7			
C28	1.9	3.0	U2	1.7	0.7			
C29	3.4	0.1	U3	2.7	0.7			
C30	5.5	0.3	U4	2.7	1.6			
C31	8.9	0.4	U5	0.7	1.6			
C32	8.8	0.4	U6	1.7	1.6			
C33	2.6	2.8	U7	3.8	0.7			
C34	8.1	0.3	U8	3.8	1.6			
C35	10.8	0.1	U9	1.7	2.5			
C36	12.8	0.1	U10	0.7	2.5			
C37	6.6	3.0	U11	3.8	2.5			
C38	1.4	2.8	U12	2.7	2.5			
C39	6.8	3.2	U13	11.8	0.6			
C40	14.1	0.3	U14	8.1	0.7			
C41	9.3	0.6	U15	10.1	0.6			
			U16	11.1	2.5			
CR1	6.0	2.4	U17	10.9	0.6			
CR2	6.1	2.4	U18	10.1	2.5			
CR3	6.2	2.4	U19	6.9	0.7			
CR4	6.0	1.9	U20	4.9	2.5			
CR5	6.1	1.9	U21	4.7	0.7			
CR6	6.2	1.9	U22	4.9	1.6			
CR7	6.4	1.9						
CR8	6.4	2.4						

A8 Component Coordinates
2948A (HP8903B)
2946A (HP8903E)

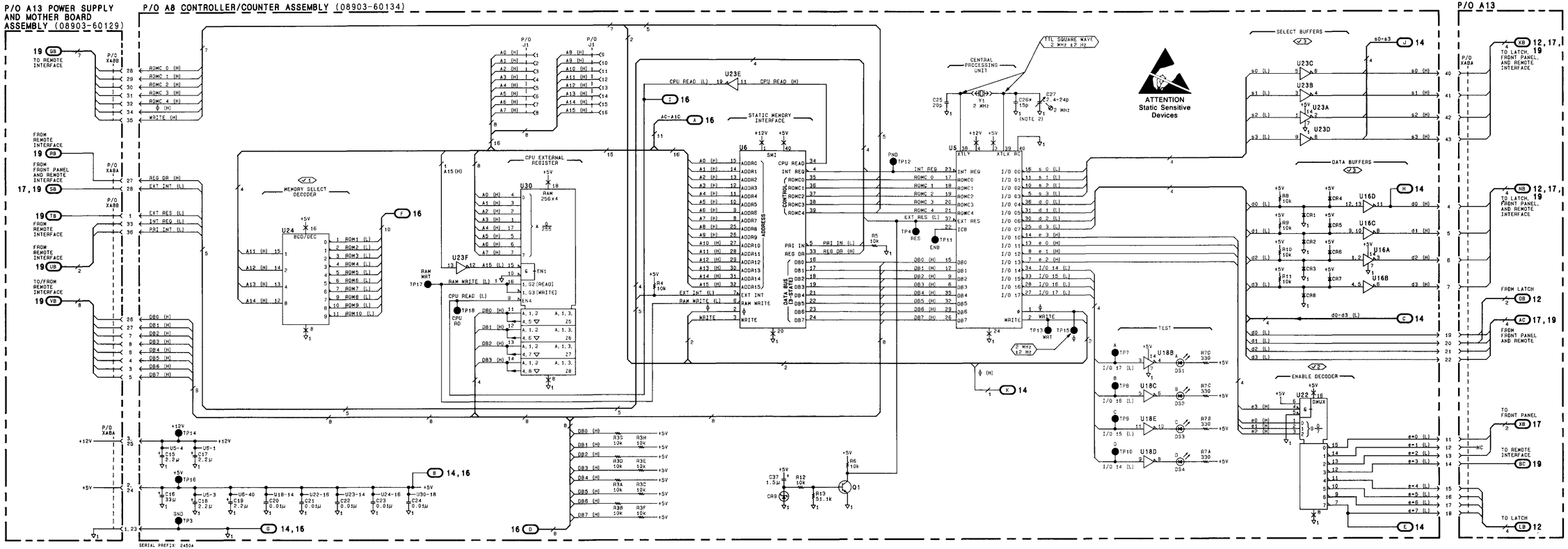
P/O A8 CONTROLLER/COUNTER ASSEMBLY (08903-60300 FOR HP8903B / 08903-60301 FOR HP8903E)

P/O A13 POWER SUPPLY AND MOTHER BOARD ASSEMBLY (08903-60392 FOR HP8903B / 08903-660395 FOR HP8903E)



SS15

Figure 8D-108.11
(rev 01OCT89)



SS15
Figure 8D-109
8D-109

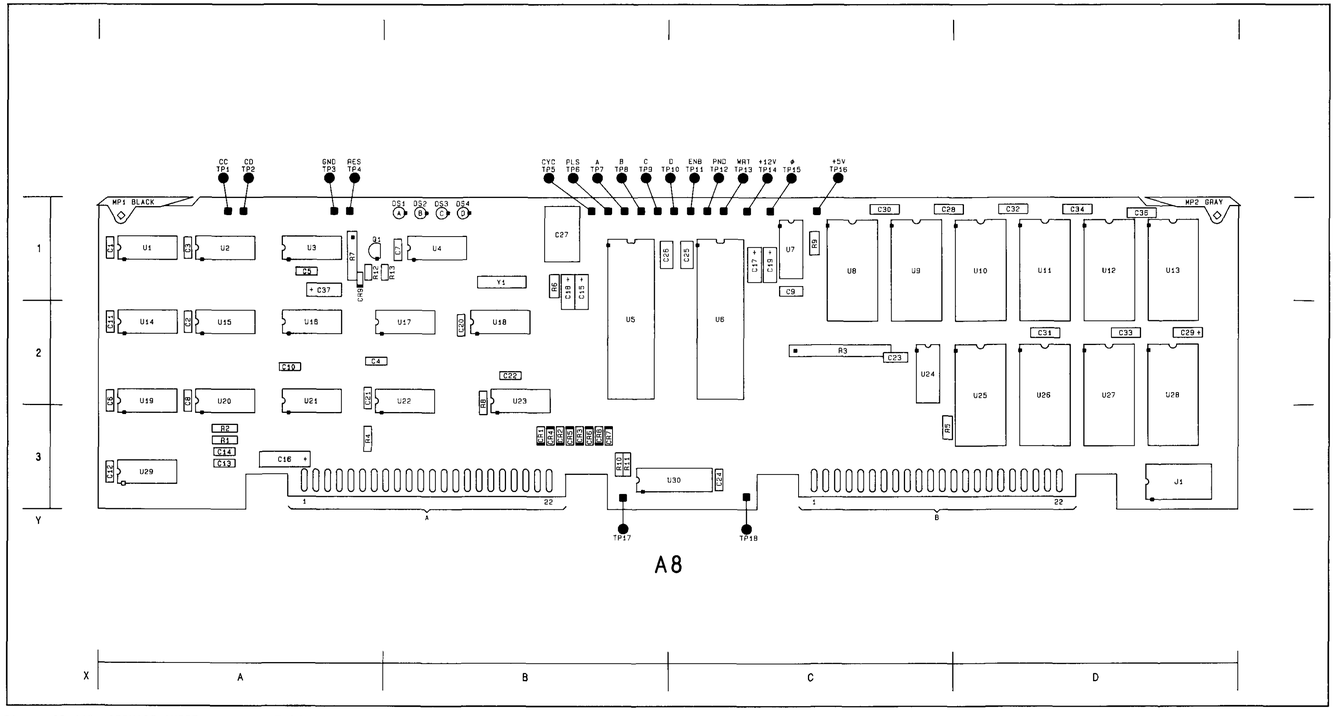


Figure 8D-110. SERVICE SHEET 16 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C28	C1						
C29	D2						
C30	C1						
C31	D2						
C32	C1						
C33	D2						
C34	C1						
C36	D1						
U8	C1						
U9	C1						
U10	B1						
U11	B1						
U12	B1						
U13	C1						
U26	D2						
U27	D2						
U28	D2						

P/O A8 SEE REVERSE SIDE

Controller/ Counter- Controller

SS15

NOTES

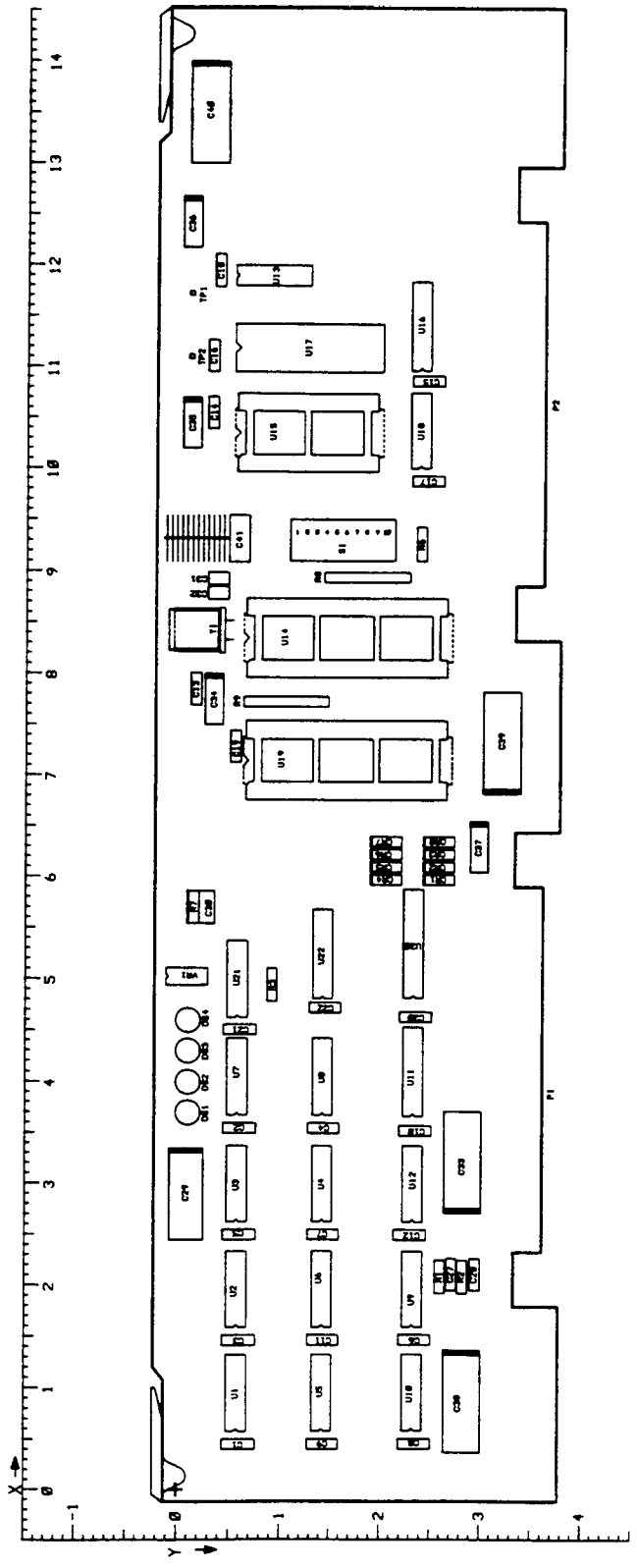
LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

Schematic General Information

CHANGES

2450A to 2614A	**On the A8 schematic:** • **08903-60134** - This Service Sheet 16 applies only to the A8 CONTROLLER/COUNTER BOARD ASSEMBLY, part number 08903-60134. **On the A8 Component Locator:** • **08903-60134** - This component locator applies only to the A8 CONTROLLER/COUNTER BOARD ASSEMBLY, part number 08903-60134. **On the A8 Component Coordinates:** • **08903-60134** - This component coordinates applies only to the A8 CONTROLLER/COUNTER BOARD ASSEMBLY, part number 08903-60134.
2652A to 2922A	**On the A8 schematic:** • **08903-60184** - This Service Sheet 16 does not apply to the A8 CONTROLLER/COUNTER BOARD ASSEMBLY, part number 08903-60184.
2948A and above	**On the A8 schematic:** • **08903-60300** - Use the new schematic foldout on page 8D-110.7, SS16 with the revision date of rev.01OCT89. **On the A8 Component Locator:** • **08903-60300** - Use the new A8 component locator on page 8D-110.4 with the revision date of rev.01OCT89. **On the A8 Component Coordinates:** • **08903-60300** - Use the new A8 component coordinates on page 8D-110.5 with the revision date of rev.01OCT89. **On the A13 schematic:** • **08903-60392** - Use the new schematic foldout on page 8D-110.7, SS16 with the revision date of rev.01OCT89.



A8 Component Locator
2948A (HP8903B)
2946A (HP8903E)

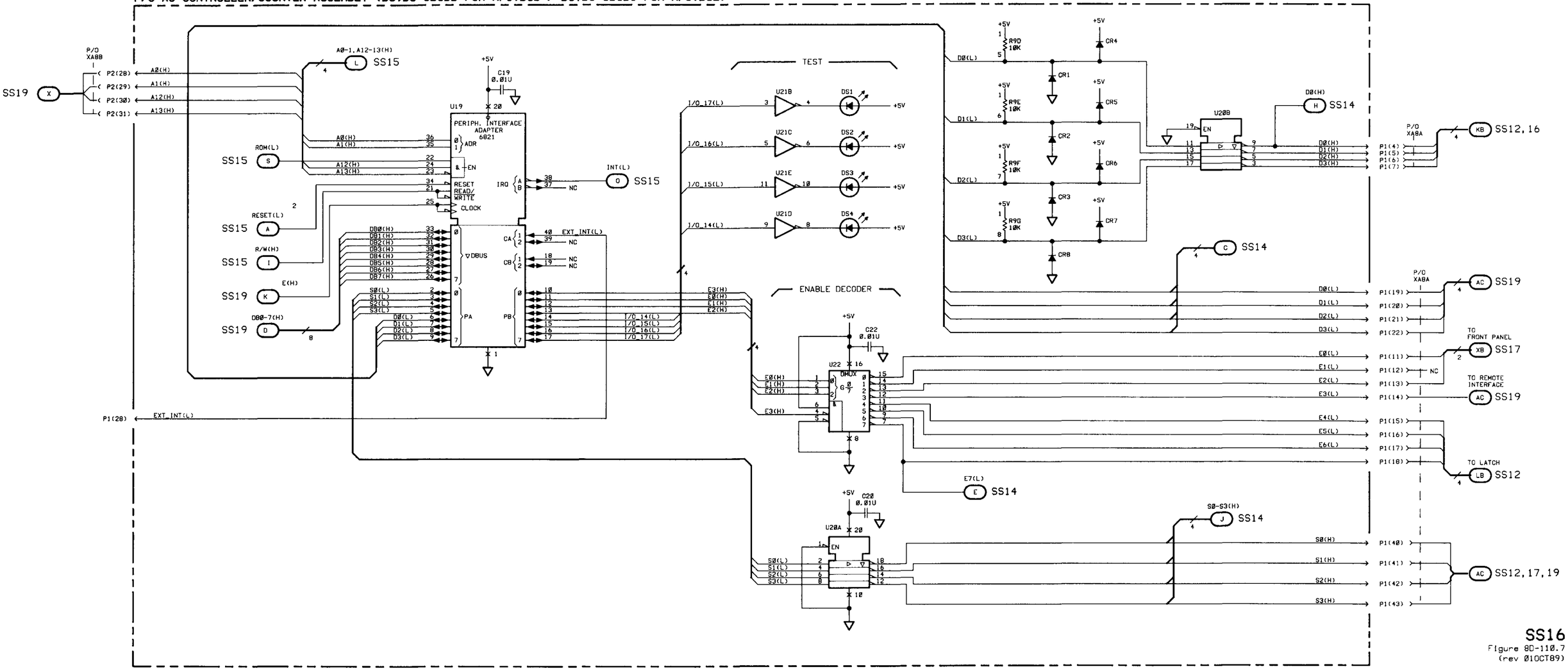
COMP	X	Y
C1	0.5	0.4
C2	3.6	0.4
C3	1.5	0.4
C4	3.6	1.2
C5	2.5	0.4
C6	1.5	2.1
C7	2.5	1.2
C8	0.5	2.1
C9	0.5	1.2
C10	3.5	2.1
C11	1.5	1.2
C12	2.5	2.1
C13	7.6	0.2
C14	10.3	0.3
C15	10.9	2.2
C16	10.9	0.3
C17	9.9	2.2
C18	11.7	0.4
C19	7.1	0.6
C20	4.6	2.1
C21	4.5	0.4
C22	4.7	1.2
C27	1.9	2.7
C28	1.9	3.0
C29	3.4	0.1
C30	5.5	0.3
C31	8.9	0.4
C32	8.8	0.4
C33	2.6	2.8
C34	8.1	0.3
C35	10.8	0.1
C36	12.8	0.1
C37	6.6	3.0
C38	1.4	2.8
C39	6.8	3.2
C40	14.1	0.3
C41	9.3	0.6
CR1	6.0	2.4
CR2	6.1	2.4
CR3	6.2	2.4
CR4	6.0	1.9
CR5	6.1	1.9
CR6	6.2	1.9
CR7	6.4	1.9
CR8	6.4	2.4

COMP	X	Y
DS1	3.7	0.1
DS2	4.0	0.1
DS3	4.3	0.1
DS4	4.6	0.1
P1	4.1	3.6
P2	10.6	3.6
R1	1.8	2.6
R2	1.8	2.8
R3	4.7	0.9
R6	9.0	2.4
R7	5.5	0.1
R8	8.9	1.5
R9	7.7	0.7
S1	9.2	1.2
TP1	11.7	0.1
TP2	11.1	0.1
U1	0.7	0.7
U2	1.7	0.7
U3	2.7	0.7
U4	2.7	1.6
U5	0.7	1.6
U6	1.7	1.6
U7	3.8	0.7
U8	3.8	1.6
U9	1.7	2.5
U10	0.7	2.5
U11	3.8	2.5
U12	2.7	2.5
U13	11.8	0.6
U14	8.1	0.7
U15	10.1	0.6
U16	11.1	2.5
U17	10.9	0.6
U18	10.1	2.5
U19	6.9	0.7
U20	4.9	2.5
U21	4.7	0.7
U22	4.9	1.6

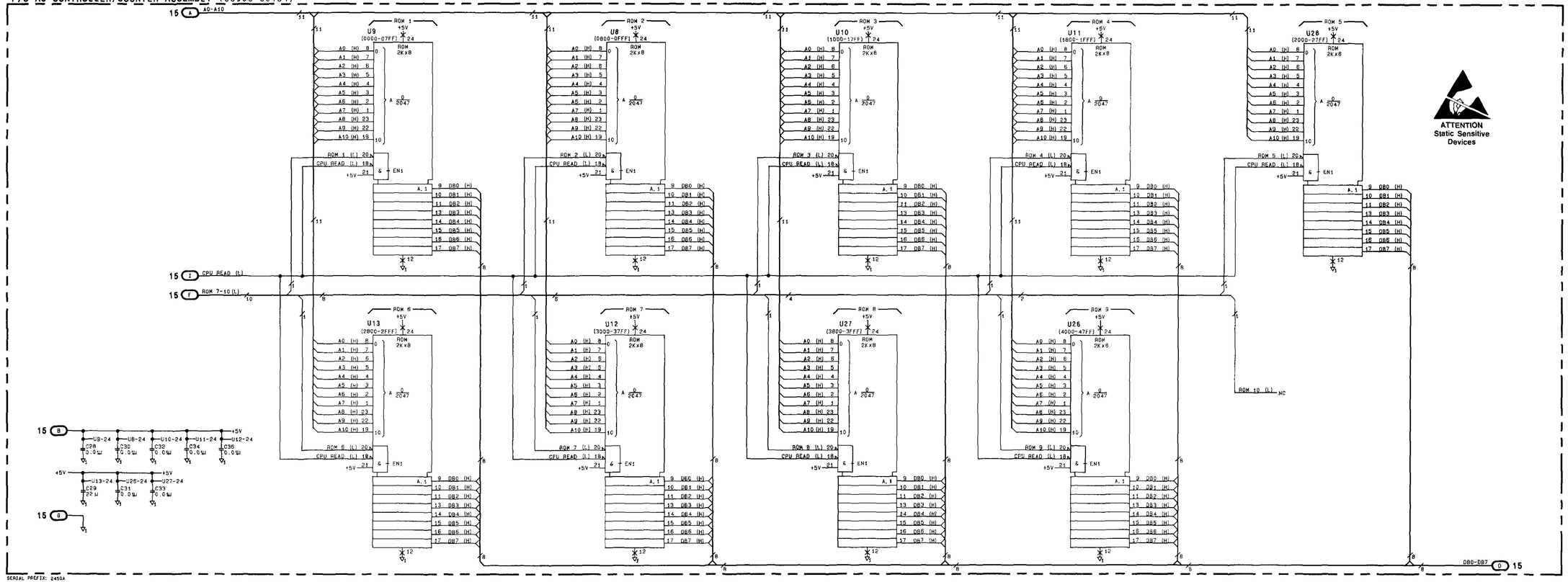
COMP	X	Y
VR1	4.9	-0.1
Y1	8.3	0.5

A8 Component Coordinates
2948A (HP8903B)
2946A (HP8903E)

P/O A8 CONTROLLER/COUNTER ASSEMBLY (08903-60300 FOR HP8903B / 08903-60301 FOR HP8903E)



SS16
Figure 8D-110.7
(rev 010CT89)



SERIAL PREFIX: 2450A

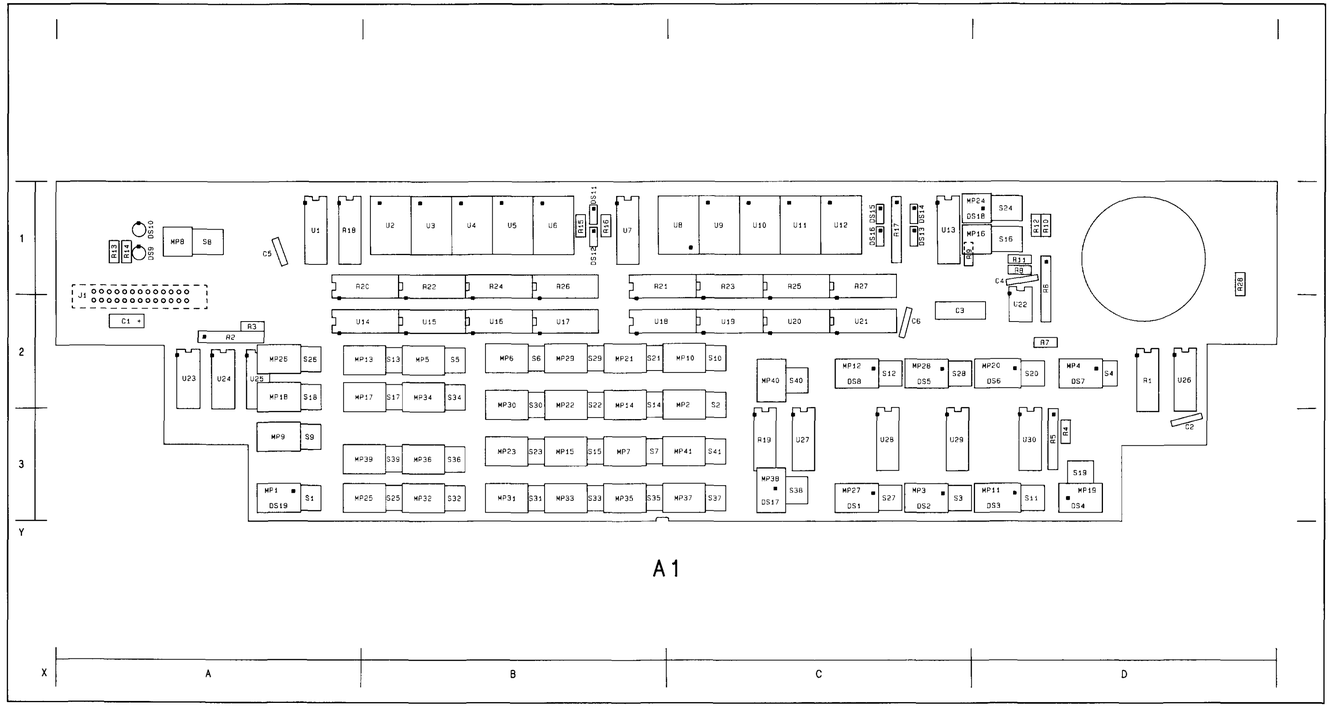


Figure 8D-112. SERVICE SHEET 17 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	A2	S18	A2				
C2	D3	S19	D3				
C3	E2	S20	D2				
C4	D1	S21	B2				
		S22	B2				
DS1	C3	S23	B3				
DS2	C3	S24	D1				
DS3	D3	S25	B3				
DS4	D3	S26	A2				
DS5	C2	S27	C3				
DS6	D2	S28	C2				
DS7	D2	S29	B2				
DS8	C2	S30	B2				
		S31	B3				
J1	A2	S32	B3				
		S33	B3				
MP1	A3	S34	B2				
MP2	C3	S35	B3				
MP3	C3	S36	B3				
MP4	D2	S37	C3				
MP5	B2	S38	C3				
MP6	B2	S39	B3				
MP7	B3	S40	C2				
MP8	A1	S41	C3				
MP9	A3						
MP10	C2	U22	D2				
MP11	D3	U23	A2				
MP12	C2	U24	A2				
MP13	B2	U25	A2				
MP14	B2	U26	D2				
MP15	B3	U28	C3				
MP16	D1	U29	C3				
MP17	A2	U30	D3				
MP18	A2						
MP19	D3						
MP20	D2						
MP21	B2						
MP22	B2						
MP23	B3						
MP24	D1						
MP25	B3						
MP26	A2						
MP27	C3						
MP28	C2						
MP29	B2						
MP30	B2						
MP31	B3						
MP32	B3						
MP33	B3						
MP34	B2						
MP35	B3						
MP36	B3						
MP37	C3						
MP38	C3						
MP39	B3						
MP40	C2						
MP41	C3						
R1	D2						
R2	A2						
R3	A2						
R4	D3						
R5	D3						
R6	D1						
R7	D2						
R8	D1						
R9	C1						
R10	D1						
R11	D1						
R12	D1						
S1	A3						
S2	C2						
S3	C3						
S4	D2						
S5	B2						
S6	B2						
S7	B3						
S8	A1						
S9	A3						
S10	C2						
S11	D3						
S12	C2						
S13	B2						
S14	B2						
S15	B3						
S16	D1						
S17	B2						

P/O A8 SEE REVERSE SIDE

Controller/ Counter-Read -Only Memory

SS16

NOTES

1. Switches S3 and S27 control the right and left HP/BP filters, respectively.

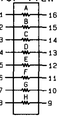
LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

A1R2,5,6
TOP VIEW

PIN NO.	1	2	3	4	5	6	7	8
	GND	A	B	C	D	E	F	G

A1U22
TOP VIEW

A1R1
TOP VIEW

Schematic General Information

CHANGES

All serial prefixes	**On the A1 schematic:** • **Line Labels** - In the center of the schematic to the left of U30 pin 14 and pin 15 change the line label "s2 (H)" to "e=2 (L)", and, "s=2 (L)" to "s2 (H)". To the left of U23C pin 8 locate "s=3 (H)" and change it to "s3 (H)".
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192.
2742A and above	**On the A1 schematic:** • **08903-60166** - Use the partial schematic on page 8D-112.4. **On the A1 Component Locator:** • **08903-60166** - Use the partial component locator on page 8D-112.3. **On the A1 Component Coordinates:** • **DS20, R29** - Add DS20 A,2, and R29 A,2 to the coordinates table.
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.

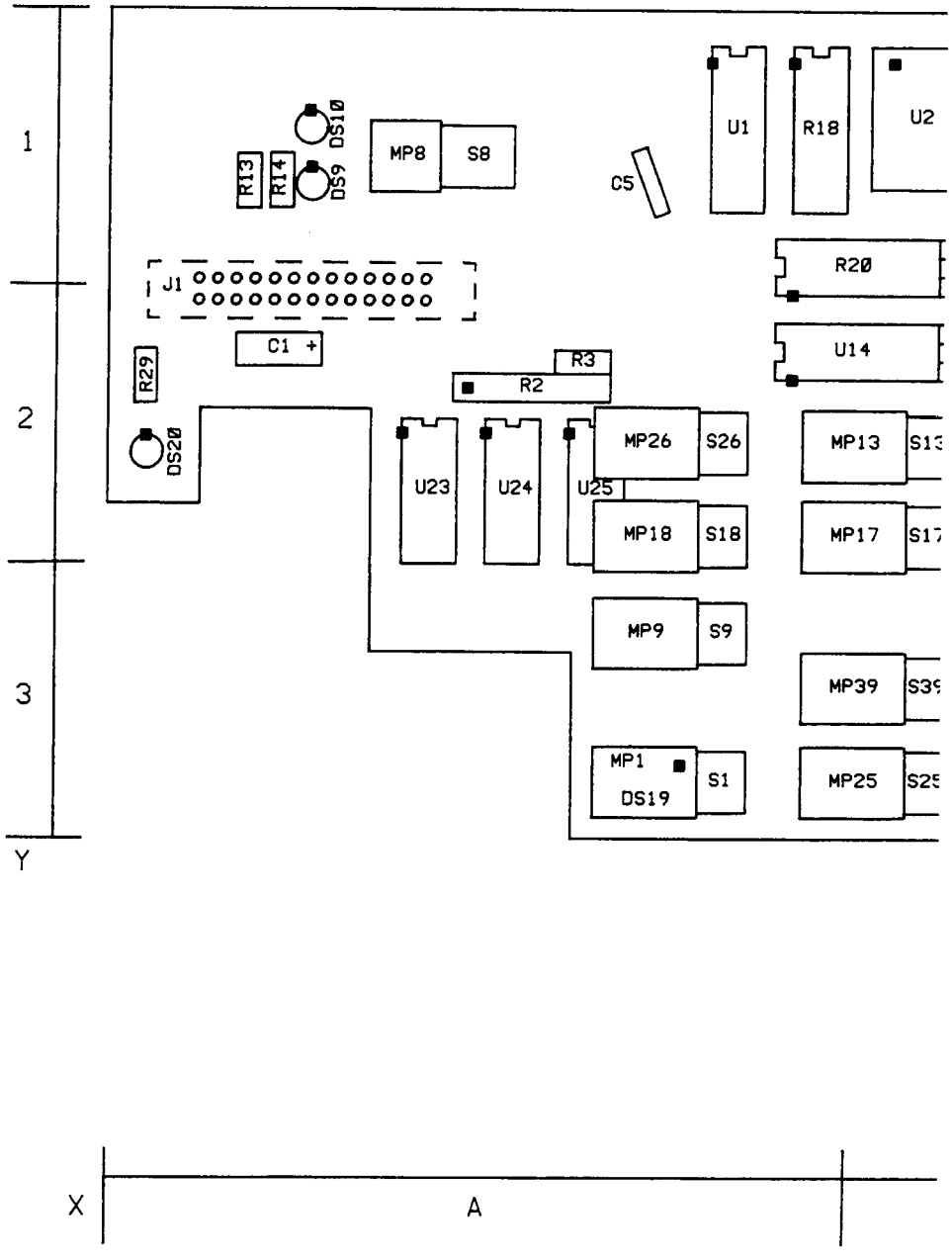


Figure 8D-112. SERVICE SHEET 17 INFORMATION

Figure 8D-112. Component Locator (2742A and above)

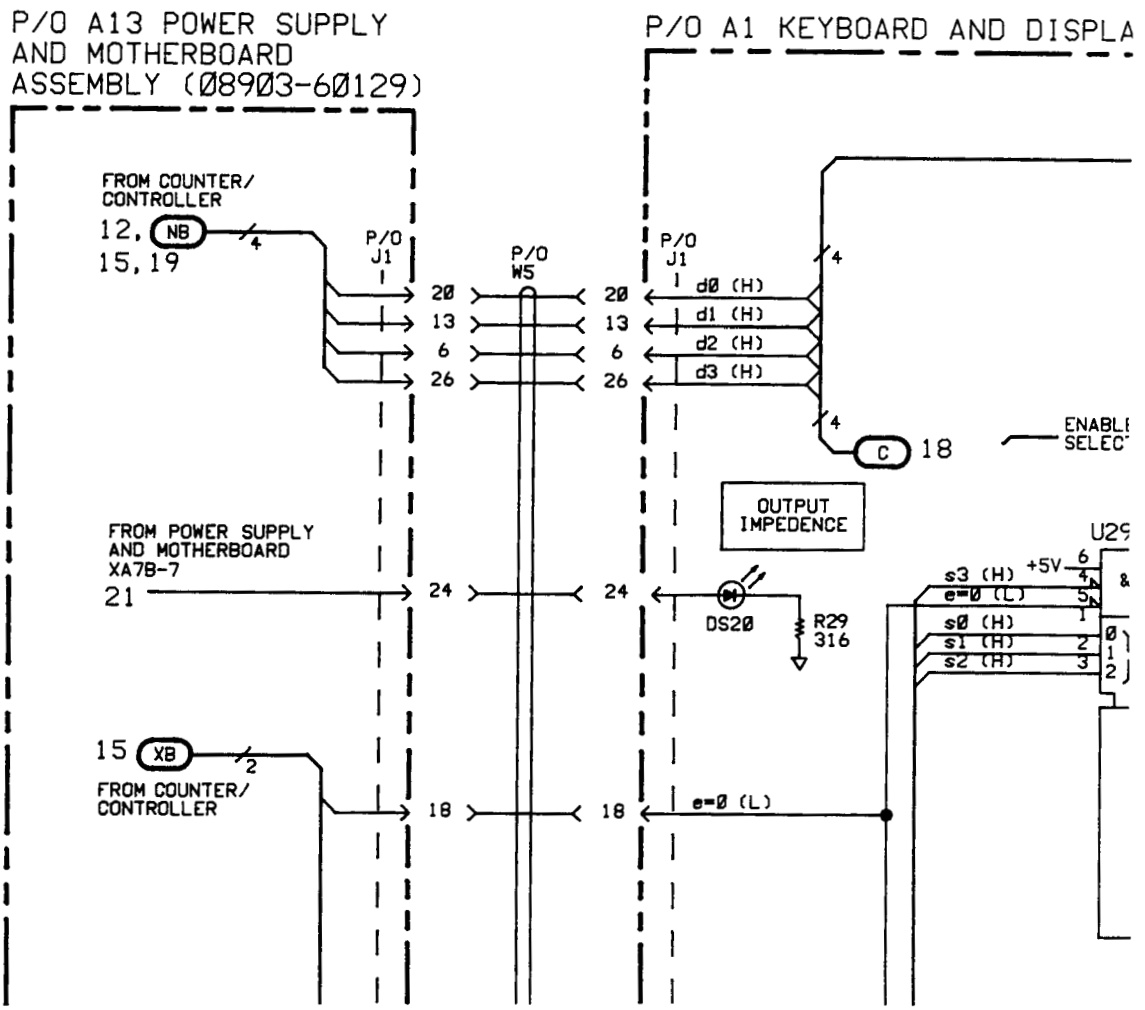
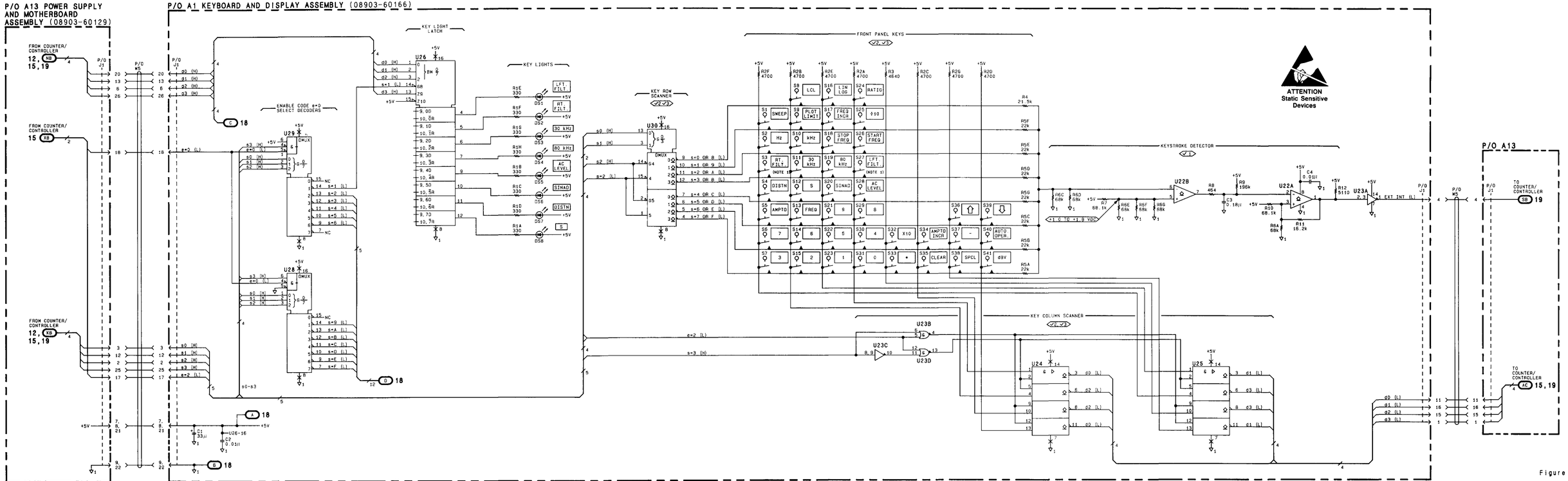


Figure 8D-112. (2742A and above)



SS17
Figure 8D-113
8D-113

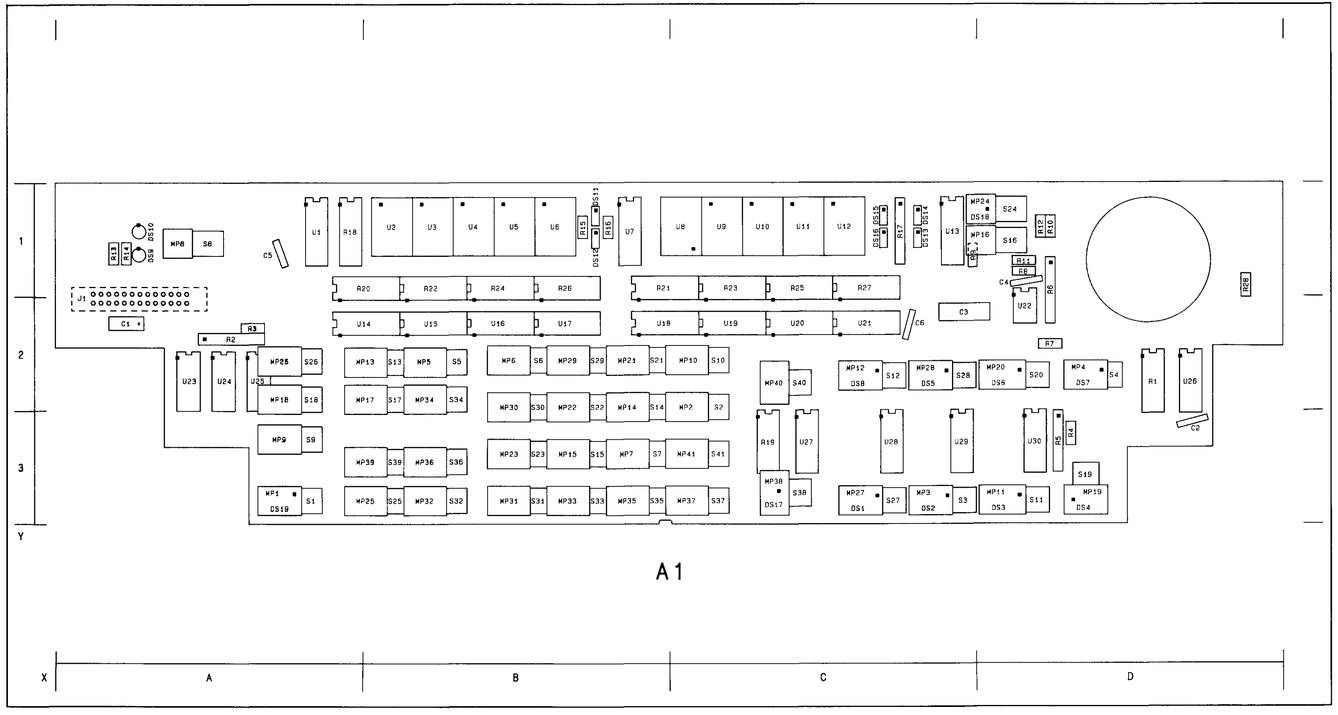


Figure 8D-114. SERVICE SHEET 18 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C5	A1						
C6	C2						
DS9	A1						
DS10	A1						
DS11	B1						
DS12	B1						
DS13	C1						
DS14	C1						
DS15	C1						
DS16	C1						
DS17	C3						
DS18	C1						
DS19	A3						
R13	A1						
R14	A1						
R15	B1						
R16	B1						
R17	C1						
R18	A1						
R19	C3						
R20	B1						
R21	B1						
R22	B1						
R23	C1						
R24	B1						
R25	C1						
R26	B1						
R27	C1						
R28	D1						
U1	A1						
U2	B1						
U3	B1						
U4	B1						
U5	B1						
U6	B1						
U7	B1						
U8	C1						
U9	C1						
U10	C1						
U11	C1						
U12	C1						
U13	C1						
U14	B2						
U15	B2						
U16	B2						
U17	B2						
U18	B2						
U19	C2						
U20	C2						
U21	C2						
U27	C3						

P/O A1 SEE REVERSE SIDE — Keyboard and Display-Keyboard Circuits — SS17

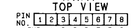
NOTES

1. Socket for U8 is upside down.

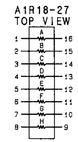
LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN	
> IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

A1R17 TOP VIEW



A1R18-27 TOP VIEW



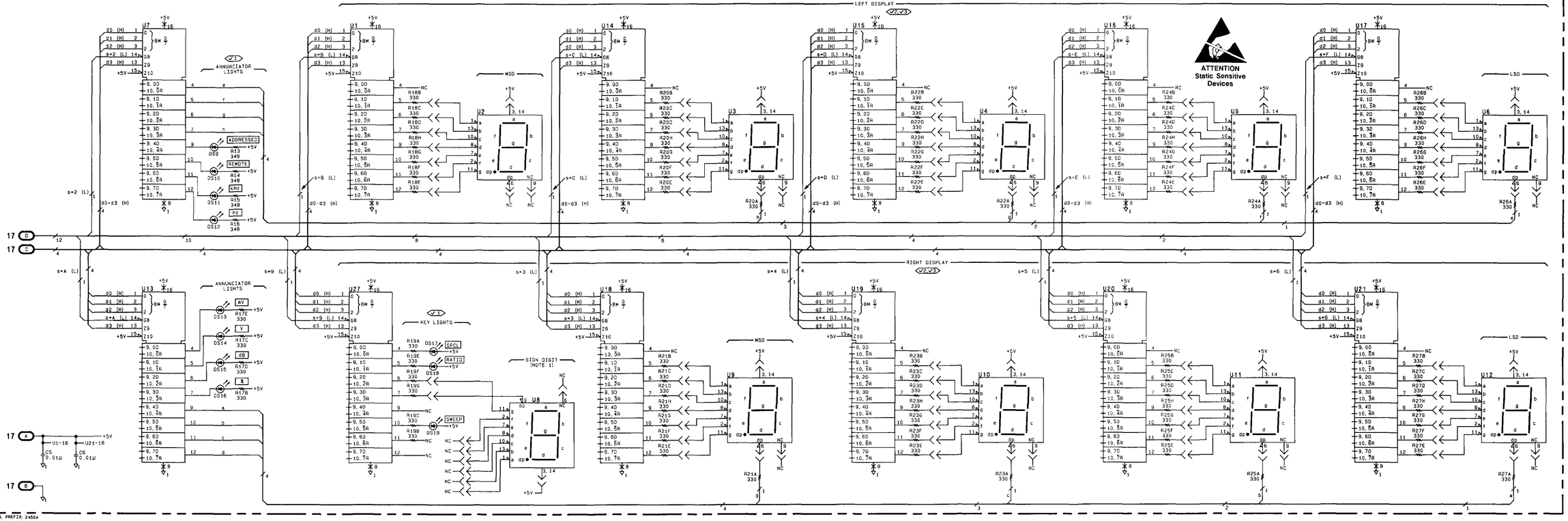
Schematic General Information

CHANGES

All Serial Prefixes

Schematic General Information:

- **Notes** - On page 8D-114, Change Note 1 to read: "Display Orientation: A1U8 (HP part 5082-7651) is part of a matched display set HP part 1990-0753. It is mounted upside down (relative to displays U2-U6 and U9-U12) with the two decimal points oriented towards the top edge of A1."


LEFT DISPLAY
RIGHT DISPLAY
ANNUNCIATOR LIGHTS
KEY LIGHTS
MSD
LSD
SIGN DIGIT (NOTE 1)
ATTENTION
Static Sensitive
Devices
ADDRESSED
REMOTE
kHz
Hz
mV
V
dB
%
SPCL
RATIO
SWEEP

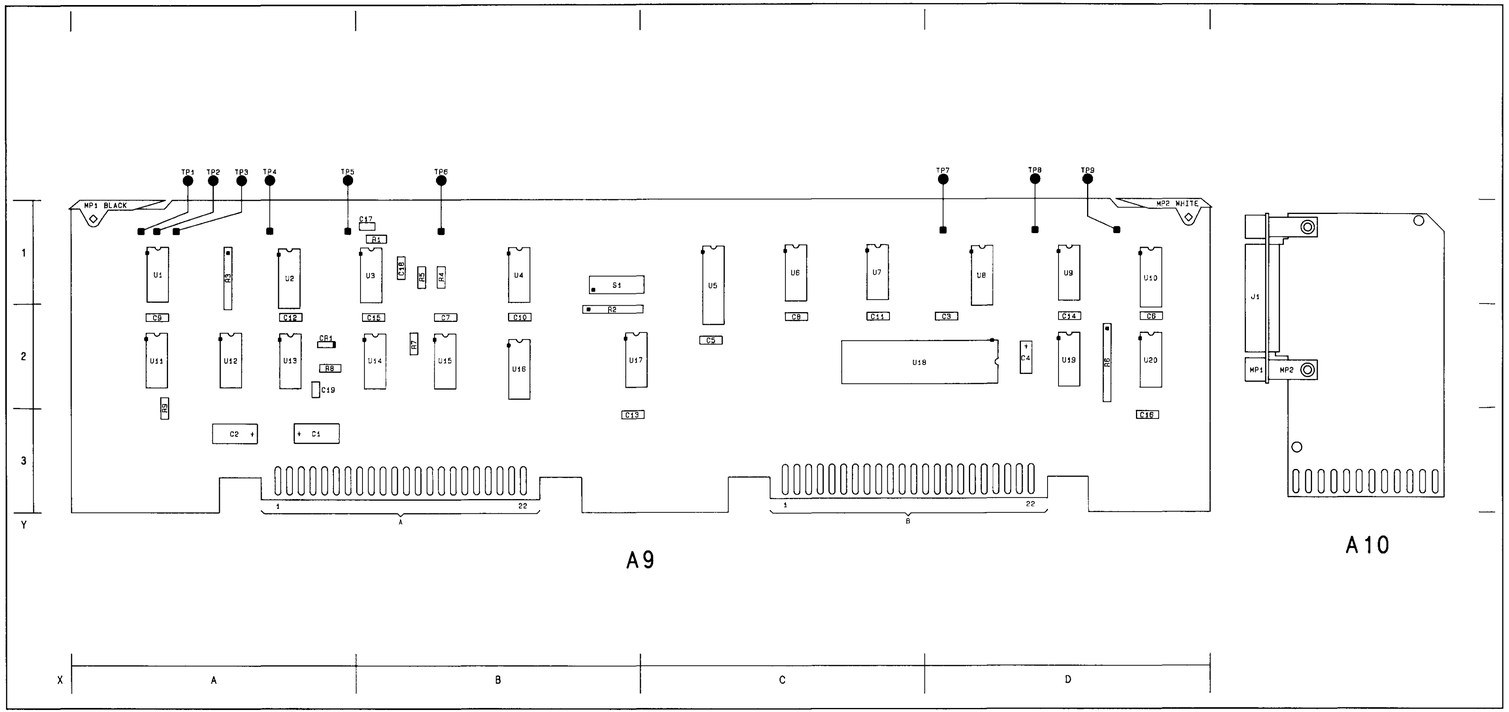


Figure 8D-116. SERVICE SHEET 19 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	A3						
C2	A3						
C3	D2						
C4	D2						
C5	C2						
C6	D2						
C7	B2						
C8	C2						
C9	A2						
C10	B2						
C11	C2						
C12	A2						
C13	B3						
C14	D2						
C15	B2						
C16	D3						
C17	B1						
C18	B1						
C19	A2						
CR1	A2						
R1	B1						
R2	B2						
R3	A1						
R4	B1						
R5	B1						
R6	D2						
R7	B2						
R8	A2						
R9	A2						
S1	B1						
TP1	A1						
TP2	A1						
TP3	A1						
TP4	A1						
TP5	A1						
TP6	B1						
TP7	D1						
TP8	D1						
TP9	D1						
U1	A1						
U2	A1						
U3	B1						
U4	B1						
U5	C1						
U6	C1						
U7	C1						
U8	D1						
U9	D1						
U10	D1						
U11	A2						
U12	A2						
U13	A2						
U14	B2						
U15	B2						
U16	B2						
U17	B2						
U18	C2						
U19	D2						
U20	D2						

P/O A1 Keyboard and Display-Display Circuits **SS18**

SEE REVERSE SIDE

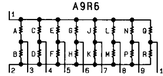
NOTES

1. Chassis ground is achieved by mechanical contact through screws holding the pc boards.

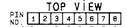
LOGIC LEVELS

	TTL
HIGH	>2V
LOW	<0.8V
< IS MORE NEG. THAN > IS MORE POS. THAN	
OPEN	HIGH
GROUND	LOW

A9R6



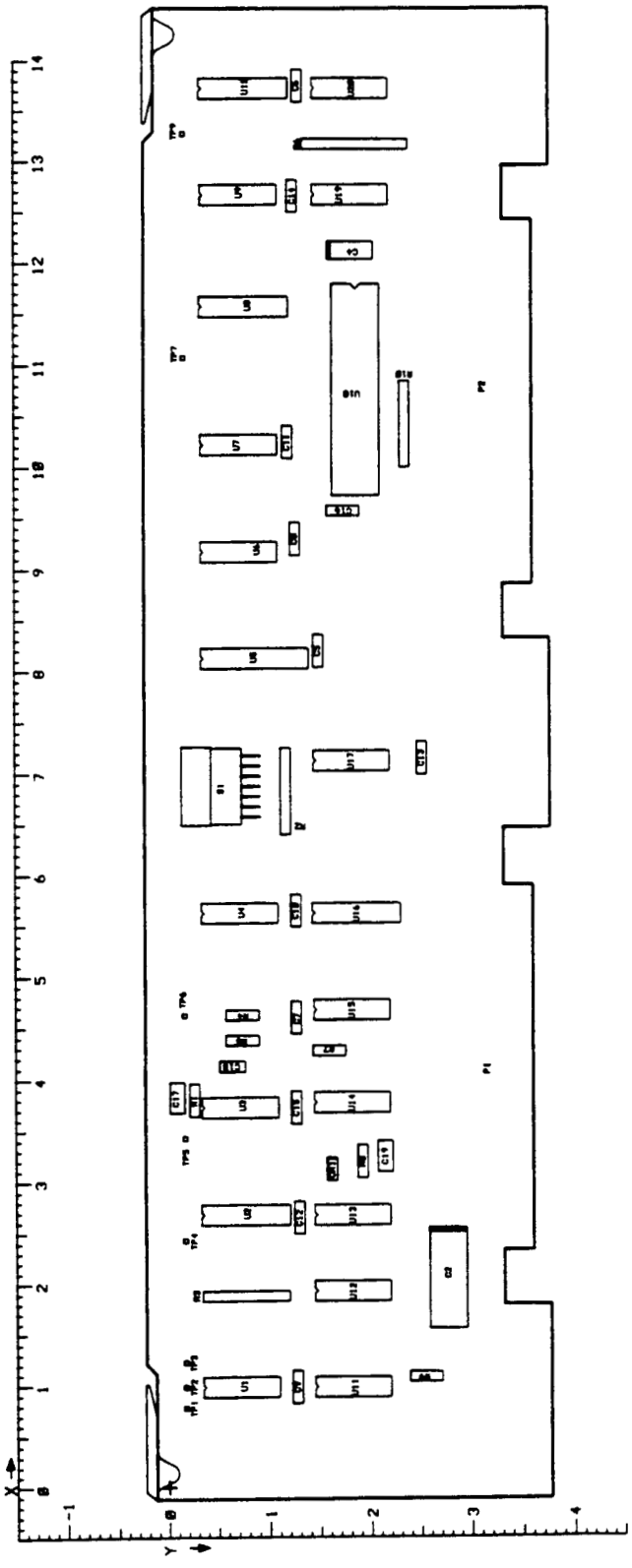
A9R2,3 TOP VIEW



Schematic General Information

CHANGES

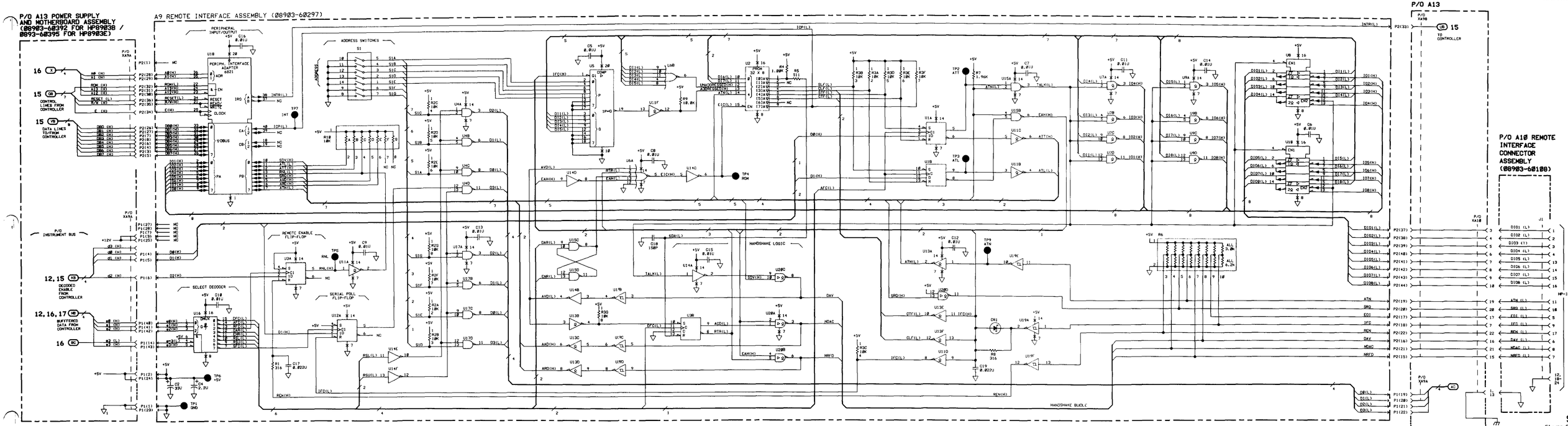
2948A and above	**On the A9 schematic:** • **08903-60297** - Use the new schematic foldout on page 8D-116.7, SS19 with the revision date of rev.01OCT89. **On the A9 Component Locator:** • **08903-60297** - Use the new A9 Component Locator on page 8D-116.4 with the revision date of rev.01OCT89. **On the A9 Component Coordinates:** • **08903-60297** - Use the new A9 Component Coordinates on page 8D-116.5 with the revision date of rev.01OCT89.



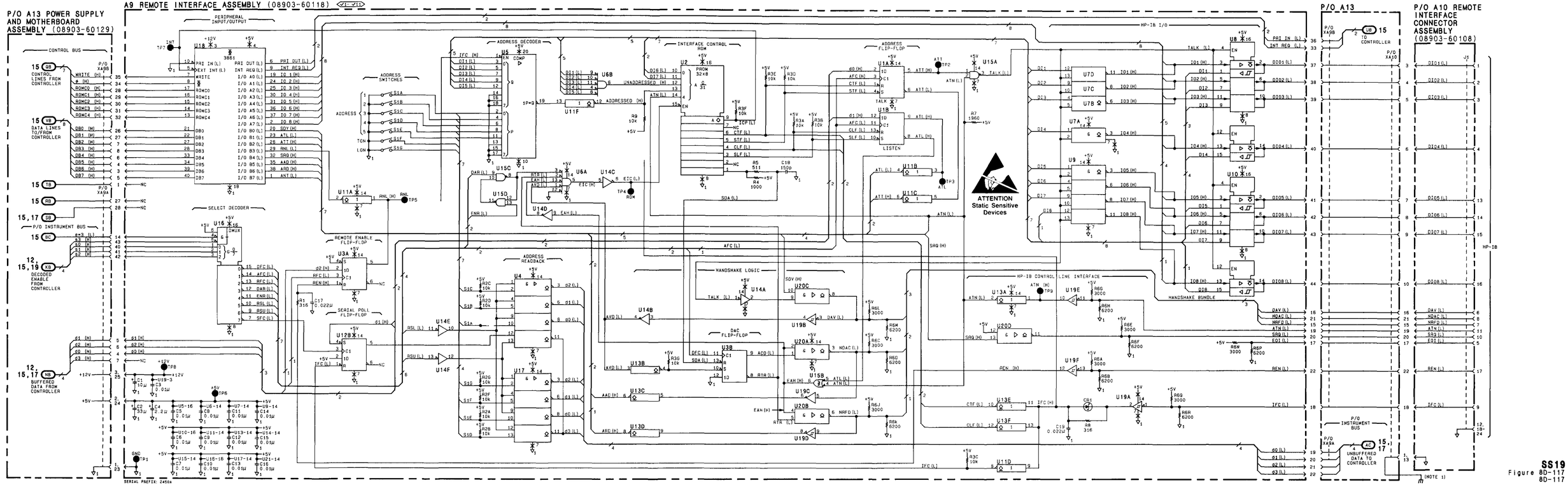
A9 Component Locator
2948A (HP8903B)
2946A (HP8903E)

COMP	X	Y	COMP	X	Y	COMP	X	Y
C2	2.6	2.8	U6	9.0	0.4			
C4	12.1	1.5	U7	10.1	0.4			
C5	8.0	1.5	U8	11.4	0.4			
C6	14.0	1.3	U9	12.5	0.4			
C7	4.8	1.3	U10	13.6	0.4			
C8	9.1	1.3	U11	0.8	1.5			
C9	0.8	1.3	U12	1.8	1.5			
C10	5.4	1.3	U13	2.5	1.5			
C11	10.0	1.2	U14	3.6	1.5			
C12	2.4	1.3	U15	4.5	1.5			
C13	6.9	2.5	U16	5.5	1.5			
C14	12.4	1.3	U17	7.0	1.5			
C15	4.0	1.3	U18	11.7	1.6			
C16	9.6	2.0	U19	12.5	1.5			
C17	3.6	0.1	U20	13.6	1.5			
C18	4.1	0.8						
C19	3.0	2.1						
CR1	3.3	1.6						
P1	4.1	3.6						
P2	10.6	3.6						
R1	3.6	0.3						
R2	6.5	1.2						
R3	1.9	0.4						
R4	4.6	0.5						
R5	4.4	0.5						
R6	13.2	1.4						
R7	4.3	1.4						
R8	3.0	1.9						
R9	1.1	2.3						
R10	10.8	2.4						
S1	6.6	0.9						
TP1	0.8	0.2						
TP2	1.0	0.2						
TP3	1.2	0.2						
TP4	2.4	0.2						
TP5	3.4	0.2						
TP6	4.6	0.2						
TP7	11.1	0.2						
TP9	13.3	0.2						
U1	0.8	0.4						
U2	2.5	0.4						
U3	3.6	0.4						
U4	5.5	0.4						
U5	8.0	0.4						

A9 Component Coordinates
2948A (HP8903B)
2946A (HP8903E)



SS19
Figure 80-116.7
(rev 010CT89)


P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)
A9 REMOTE INTERFACE ASSEMBLY (08903-60118)
P/O A13
P/O A10 REMOTE INTERFACE CONNECTOR ASSEMBLY (08903-60108)
CONTROL BUS
DATA LINES TO/FROM CONTROLLER
P/O INSTRUMENT BUS
BUFFERED DATA FROM CONTROLLER
DECODED ENABLE FROM CONTROLLER
CONTROL LINES FROM CONTROLLER
UNBUFFERED DATA TO CONTROLLER
HP-IB I/O
HP-IB CONTROL LINE INTERFACE
HANDSHAKE BUNDLE
PERIPHERAL INPUT/OUTPUT
ADDRESS DECODER
INTERFACE CONTROL ROM
ADDRESS FLIP-FLOP
ADDRESS SWITCHES
SELECT DECODER
REMOTE ENABLE FLIP-FLOP
SERIAL POLL FLIP-FLOP
ADDRESS READBACK
HANDSHAKE LOGIC
DAC FLIP-FLOP
TALKER
LISTENER
ATTENTION Static Sensitive Devices
SERIAL PREFIX: 2450A
SS19
Figure 8D-117
8D-117

SERVICE SHEET BD5---Power Supplies Block Diagram

PRINCIPLES OF OPERATION

Power Supplies (A11 and A13)

The four regulated supplies are: +15V, −15V, +12V, and +5V. The +15V and −15V supplies are used primarily to power the analog circuits. The +5V supply is used to power most of the relays and digital circuits. The +12V supply powers the main Controller ICs. The inputs for the +15V, −15V, and +12V supplies are obtained from one secondary winding of the power transformer, and the +5V supply (the supply drawing the most current) is obtained from another. The supplies are independently referenced except the +5V supply, which is referenced from the +15V supply and also requires the −15V supply to operate properly. Each supply has an indicator LED.

TROUBLESHOOTING

General

A procedure for checking the power supplies follows. Before performing the check, perform all the checks on Service Sheet BD1.

⟨√1⟩ Power Supply Check

1. Key in 41.0 SPCL to initialize the instrument. Key in S (Shift) DC LEVEL. Set the INPUT switch to ground. Observe the four green power supply LEDs on the A13 Power Supply and Motherboard Assembly. The LEDs should be on. If faulty, see Service Sheet 20.

CAUTION

MOS and CMOS ICs can be damaged by static charges and circuit transients. Do not remove the A8 Controller/Counter Assembly or the A9 Remote Control Interface Assembly while power is applied to the instrument.

NOTE

When removing assemblies to check for shorts, switch the instrument off before removing the assembly and back on when testing the supply. This will unlatch any crowbar SCRs that may have fired.

Hint: If a short is suspected, remove assemblies one at a time and observe the four power supply LEDs. An extinguished LED will light when the short is removed from the supply. The A1 Keyboard and Display Assembly can be disconnected by unplugging the wide ribbon cable plugged into it.

Hint: The +5V supply is referenced from the +15V supply and also depends on the −15V supply. The +15V supply and +12V supply share a common transformer and secondary fuse.

2. Connect the HIGH INPUT to A13TP3 through TP6. The amplitude display for each test point should be within the limits shown in Figure 8E-101. If faulty, see Service Sheet 20.

SERVICE SHEET 20---A13 Power Supply and Motherboard Assembly

PRINCIPLES OF OPERATION

General

The Power Supply has four outputs: +15V, −15V, +12V, and +5V. The +15V and −15V supplies are used to run all operational amplifiers and most other analog circuits. The +12V supply is used by the three microprocessor ICs (A8U5, A8U6, and A9U18). The +5V supply powers most of the digital circuits, all of the relays, and some of the analog circuits.

Transformer Primary Circuits

The input to the primary of the power transformer (chassis part T1) is through the four-voltage, filtered Line Power Module (A14) which permits operation from nominal line voltages of 100, 120, 200, and 240V at 48 to 66 Hz. (400 Hz is also permitted for 100 and 120V.) Matching of the primary winding to the input line voltage is accomplished by positioning of the printed circuit card A14TB1.

Regulators and Protection Circuits

A single, center-tapped secondary of the power transformer supplies the +15V, −15V, and +12V Regulators. The secondary is full-wave rectified and filtered by CR1, CR2, and C1 for the +15V and +12V Regulators and by CR3, CR4, and C2 for the −15V Regulator.

The Input Over-Voltage Protection circuit, consisting primarily of VR1, VR2, and Q3, protects the Power Supply and, indeed the rest of the instrument when the power line is connected to 200 or 220V and the power line printed circuit board is set for 100 or 120V. In that case VR1 and VR2 conduct, triac Q3 fires, and the primary fuse (chassis part F1) blows. C12 prevents Q3 from firing on short-duration line transients.

An independent, center-tapped secondary of the transformer supplies the +5V Regulator. The secondary is full-wave rectified and filtered by CR5A, CR5B, and C3.

All regulators are series-pass types. The +15V, −15V, and +12V Regulators (U2 and chassis parts U1 and U2) are three-terminal ICs with internal short-circuit, over-voltage, and reverse-voltage protection. All regulators, however, are further protected with input fuses. Capacitors at the inputs and outputs of the regulators (C4, C5, A11C1, A11C2, A11C3, and A11C4) prevent spurious oscillations.

The +5V Regulator is a discrete regulator. Chassis part Q1 is a Darlington, series-pass transistor pair driven by Q1. The output of the regulator is sensed by U1B and compared to a 5.2V reference derived from the +15V supply through voltage divider R12 and R13. Hence, operation of the +5V supply depends on the +15V supply. U1B drives Q1 which drives the series-pass transistor to maintain a constant +5.2V at the regulator's output.

U1A senses both the output current (through R5) and voltage for the +5V supply and folds back the supply during a fault. Foldback begins at about 4A. Short-circuit current is about 1A. C6 and R8 frequency compensate the regulator during foldback, and C7 and R11 during normal operation.

At the output of each supply is a reverse-voltage protection diode (CR11 through CR14), a supply status indicator, and an over-voltage protection circuit. The supply status indicators (DS1 through DS4) light when the voltage on the supply is high enough to cause the series reference diodes (VR3 through VR6) to conduct. Excessive output voltage will cause a reference diode (VR7 through VR10) to conduct and fire its respective SCR (Q2, Q4, Q5, or Q6). The SCR shorts the supply and initiates current foldback.

Impedence Selection Circuits

Serial prefixes 2742A and above: Special Function 47.X is used to select the output impedence of the source. When 47.0 SPCL is entered (this is the default condition at instrument turn-on or initialization via 40.0 or 41.0 SPCL) the output impedence is 600 Ω. Latch A7U26 pin 6 is low (approximately 0 Vdc) which turns off front panel LED A1DS20 (Service Sheet 17) causing the collector of A13Q7 to rise up to approximately +5 Vdc which turns off A6K4 (Service Sheet 11) adding 550 Ω to the output impedence of 50 Ω. When 47.1 SPCL is entered the output impedence is set to 50 Ω. Latch A7U26 pin 6 goes high (approximately +5 Vdc) which turns on front panel LED A1DS20 (Service Sheet 17) causing the collector of A13Q7 to go to approximately +0 Vdc which turns on A6K4 (Service Sheet 11) shorting out the 550 Ω in series with the output impedence of 50 Ω.

TROUBLESHOOTING

General

Procedures for checking the Power Supply and Motherboard Assembly are given below. The circuits or points to check are marked on the schematic diagram by a hexagon with a check mark and a number inside, for example, ⟨√3⟩. In addition, any points outside the labeled circuit area that must be checked are also identified. Fixed signals are shown on the schematic also inside a hexagon, for example, ⟨+1.9 TO +2.1 VDC⟩.

Equipment

Digital Multimeter	HP 3455A
Oscilloscope	HP 1740A

⟨√1⟩ Power Supply Check—Blown Line Fuse

1. Check that the line voltage selection card (A14TB1) and line fuse (F1) are matched to the power source.

2. With LINE set to OFF, unplug the plug on the secondary of T1 which plugs into A13J2. Replace the blown fuse. Set LINE to ON. If the fuse blows, check the A14 Line Power Assembly, S1, and T1.

3. Switch LINE to OFF. Measure the resistance between pins 4 and 5 of A13J2. The resistance should be greater than 100 kΩ.

4. Measure the resistance between pins 2 and 3 of A13J2. The resistance should be greater than 100 kΩ.

5. Measure the resistance across A13C1, C2, and C3. After allowing the capacitors to be charged by the ohmmeter, the resistance should be greater than 2 kΩ in each case.

Hint: If the resistance is correct but the F1 still blows when the instrument is powered up, the fault is probably in the Input Over-Voltage Protection circuit. Check A13VR1, VR2, and Q3.

⟨√2⟩ Power Supply Check—Blown Regulator Fuses

1. With LINE set to OFF, unplug all board assemblies (including the Keyboard and Display Assembly). Replace the blown fuse. Switch LINE to ON. If the fuse (A11F1, F2, or F3) blows, the problem lies with the power supply itself.

Hint: A short on the output of the +5V, +15V, or −15V supply will blow a fuse.

Hint: If the +15V and −15V supplies work but A11F2 blows, the problem is likely caused by a fault in the Over-Current Protection circuit or shorted transistors.

2. Switch LINE to OFF. Measure the resistance from A13TP3 (+5V), A13TP4 (+12V), A13TP5 (+15V), and A13TP6 (−15V) to A13TP2 (GND A). The resistance should be greater than 3 kΩ.

⟨√3⟩ Power Supply Check—General Integrity

1. With the LINE switch ON, check the dc voltages on A13TP3 (+5V), A13TP4 (+12V), A13TP5 (+15V), and A13TP6 (−15V). The voltage should be within the limits shown on the schematic diagram.

Hint: If the +5V supply is out of limits, check pin 5 of U1B. Check that pin 1 of U1A is between +12 and +15 Vdc (over-current protection unactivated).

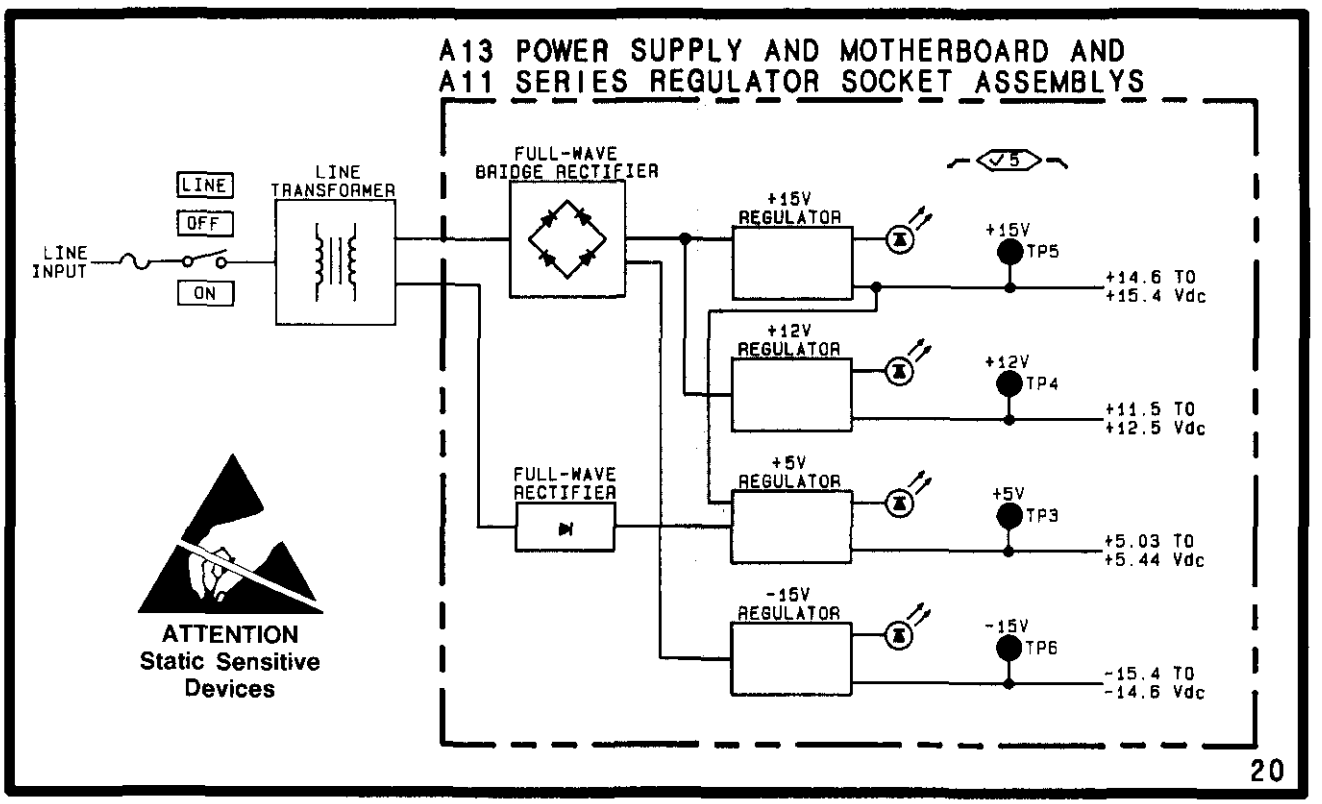
2. With an oscilloscope, measure the ripple at the outputs of the Full-Wave Rectifier. (Fuses A11F1, F2, and F3 provide convenient test points.) Ripple should be less than 1.5V and should be at double the line frequency.

Hint: For reference, typical dc level and ripple is as shown in Table 8E-1.

Table 8E-1. Typical DC Level and Ripple, ⟨√3⟩ *Step 2*

Unregulated Input	Typical Level (Vdc)	Typical Ripple (Vpp)
+15V	+23	0.6
+5V	+8	0.8
−15V	−23	0.6

3. Measure the ripple at the supply outputs. Ripple should be less than 2 mVpp.



BD5
Figure 8E-101
8E-101

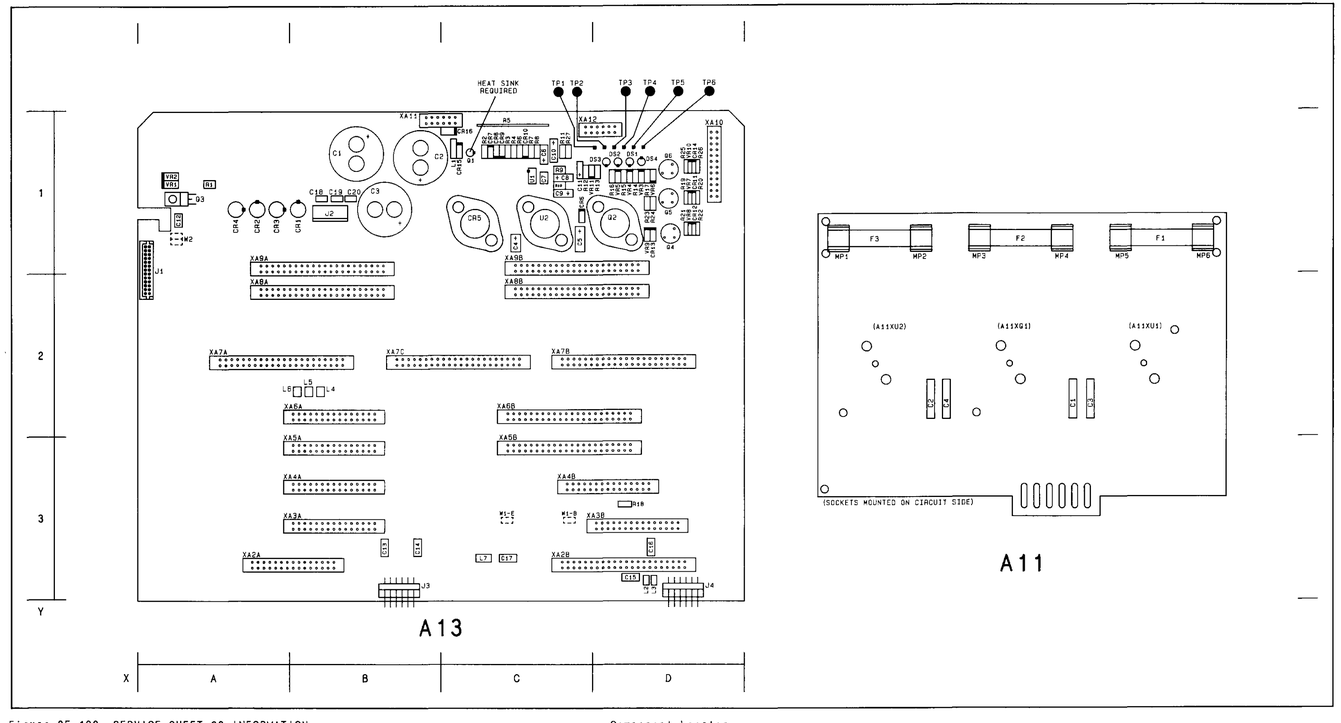


Figure 8E-102. SERVICE SHEET 20 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C1	B1	VR1	A1				
C2	B1	VR2	A1				
C3	B1	VR3	D1				
C4	C1	VR4	D1				
C5	C1	VR5	D1				
C6	C1	VR6	D1				
C7	C1	VR7	D1				
C8	C1	VR8	D1				
C9	C1	VR9	D1				
C10	C1	VR10	D1				
C11	C1	VR11	C1				
C12	A1						
C18	B1	XA10	D1				
C19	B1	XA11	B1				
C20	B1	XA12	C1				
CR1	B1						
CR2	A1						
CR3	A1						
CR4	A1						
CR5	C1						
CR6	C1						
CR7	C1						
CR8	C1						
CR9	C1						
CR10	C1						
CR11	D1						
CR12	D1						
CR13	D1						
CR14	D1						
CR15	C1						
CR16	C1						
DS1	D1						
DS2	D1						
DS3	D1						
DS4	D1						
J2	B1						
L1	C1						
Q1	C1						
Q2	D1						
Q3	A1						
Q4	D1						
Q5	D1						
Q6	D1						
R1	A1						
R2	C1						
R3	C1						
R4	C1						
R5	C1						
R6	C1						
R7	C1						
R8	C1						
R9	C1						
R10	C1						
R11	C1						
R12	C1						
R13	D1						
R14	D1						
R15	D1						
R16	D1						
R17	D1						
R18	D1						
R19	D1						
R20	D1						
R21	D1						
R22	D1						
R23	D1						
R24	D1						
R25	D1						
R26	D1						
R27	C1						
TP1	D1						
TP2	D1						
TP3	D1						
TP4	D1						
TP5	D1						
TP6	D1						
U1	C1						
U2	C1						

Power Supply

BD5

SEE REVERSE SIDE

NOTES

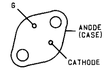
1. Value of F1 is 1.50A for 110/120V, and 0.75A for 220/240V.
2. Chassis ground is achieved through mechanical contact of the frame holding screws connected to the PC board.
3. A13R5 is a 4.8 cm (1.9 in.) strip of nickle copper.
4. Q4,5 and 6 do not have the square pad (cathode) on the actual PC motherboard. Refer to the component diagrams below.

A13Q3

U1,2,A13CR5,U2
BOTTEM VIEW

Q4,5,6
TOP VIEW

A13Q2

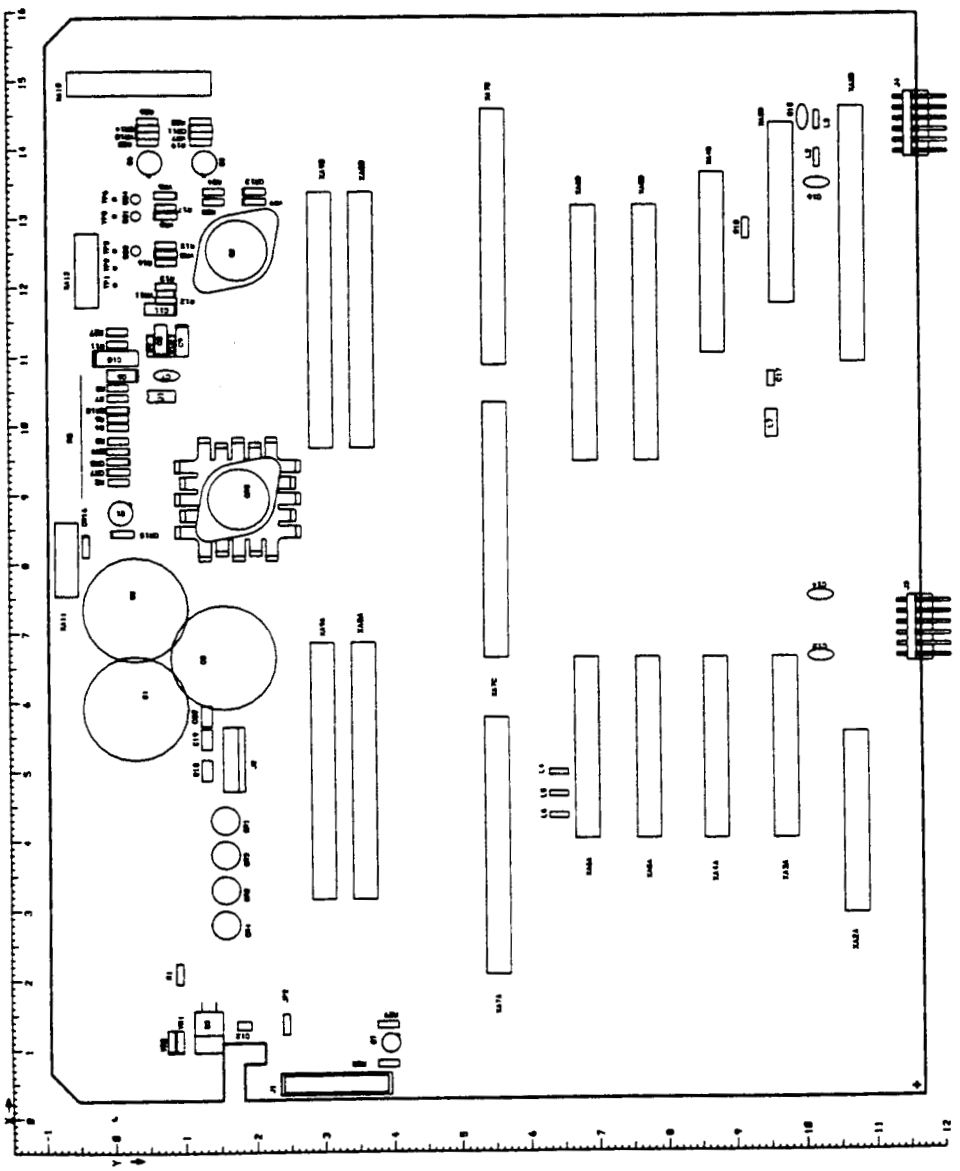


A13CR5

Schematic General Information

CHANGES

All serial prefixes	**On the A13 Component Locator:** • **C1** - Mark C1 positive on the end closest to MP4. Mark C2, C3, and, C4 positive on the end closest to the fingers of the board.
2717A to 2742A	**On the A13 schematic:** • **08903-60192** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60192. **On the A13 Component Locator:** • **J1** - In the upper left section of the component locator locate J1, then at the lower right of J1 add in order: R28, Q7, and, R29. • **JP1-B, JP1-E** - In the lower center of the component locator locate C14, then between C14 and L7 add JP1-B and JP1-E in order. **On the A13 Component Coordinates:** • **08903-60192** - In alpha numeric order add JP1-B (B-3), JP1-E (C,3), Q7 (2,A), R28 (2,A), and, R29 (2,A).
2813A and above	**On the A13 schematic:** • **08903-60292** - Change the part number of the A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY to 08903-60292.
2922A and above	**On the A13 schematic:** • **R20, R22, R26** - On the far right hand side of the schematic locate and change the value of R20, R26 to 133 ohms, and, R22 to 100 ohms.



A13 Component Locator
2948A (HP8903B)
2946A (HP8903E)

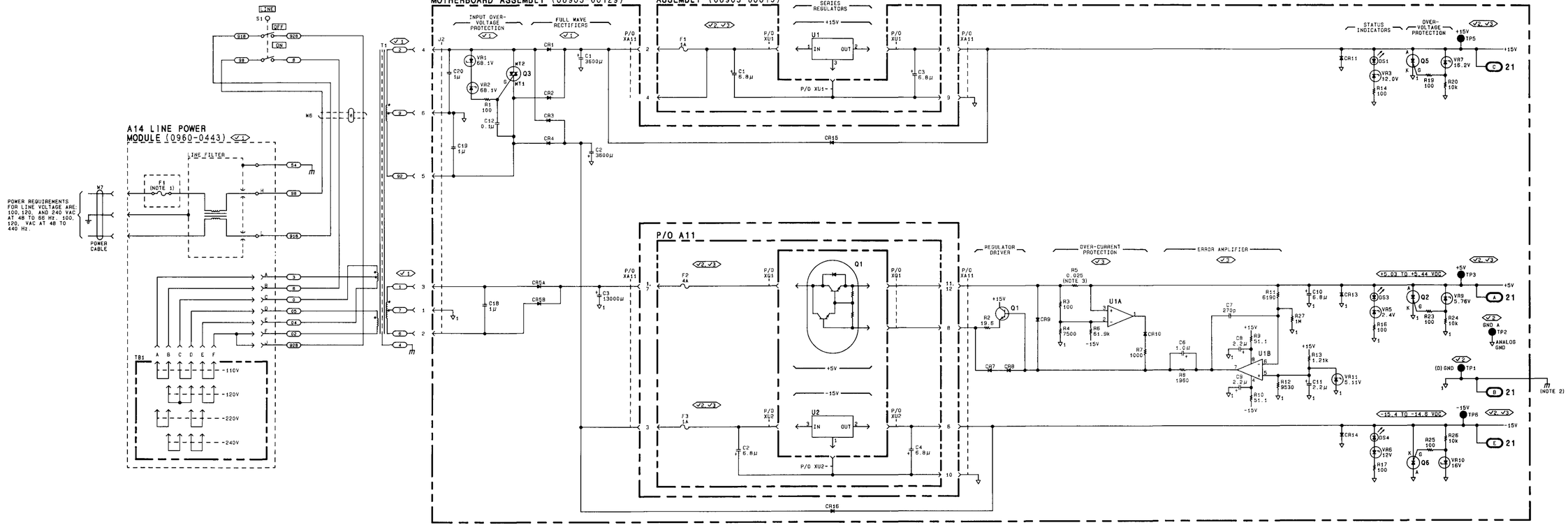
COMP	X	Y
C1	5.5	-11.5
C2	7.0	-11.0
C3	6.5	-10.0
C4	9.7	-9.6
C5	11.2	-9.8
C6	10.3	-11.1
C7	10.3	-10.7
C8	10.6	-10.8
C9	11.2	-10.6
C10	10.6	-11.9
C11	11.3	-10.6
C12	1.0	-9.8
C13	6.2	-1.2
C14	7.1	-1.2
C15	13.9	-1.5
C16	13.1	-1.2
C17	10.1	-2.0
C18	4.6	-10.3
C19	5.1	-10.3
C20	5.4	-10.3
CR1	3.9	-10.0
CR2	2.9	-10.0
CR3	3.4	-10.0
CR4	2.4	-10.0
CR5	9.0	-9.4
CR6	11.4	-10.2
CR7	9.0	-11.7
CR8	9.1	-11.3
CR9	9.3	-11.3
CR10	9.8	-11.3
CR11	13.9	-10.5
CR12	13.9	-9.8
CR13	13.0	-9.7
CR14	13.9	-11.3
CR15	8.1	-11.7
CR16	8.1	-12.0
DS1	12.7	-11.2
DS2	12.4	-11.2
DS3	12.2	-11.2
DS4	12.9	-11.2
J1	0.1	-9.0
J2	4.4	-9.9
J3	6.2	-0.2
J4	13.5	-0.2

COMP	X	Y
L1	7.9	-11.8
L2	13.4	-1.3
L3	14.0	-1.3
L4	4.6	-5.1
L5	4.3	-5.1
L6	4.0	-5.1
L7	9.3	-2.0
Q1	8.3	-11.5
Q2	12.6	-9.4
Q3	1.3	-10.2
Q4	13.4	-9.5
Q5	13.4	-10.2
Q6	13.4	-11.0
Q7	0.7	-7.6
R1	1.5	-10.7
R2	8.8	-11.7
R3	9.4	-11.7
R4	9.6	-11.7
R6	9.7	-11.7
R7	10.0	-11.7
R8	10.2	-11.7
R9	10.6	-11.0
R10	10.6	-10.7
R11	10.8	-11.7
R12	11.4	-10.6
R13	11.6	-10.6
R14	12.5	-11.0
R15	12.2	-11.0
R16	12.0	-11.0
R17	12.8	-11.0
R18	12.2	-2.4
R19	13.7	-10.1
R20	14.0	-10.1
R21	13.7	-9.8
R22	14.0	-9.8
R23	12.9	-10.3
R24	13.0	-10.3
R25	13.7	-11.3
R26	14.0	-11.3
R27	11.0	-11.7
R28	0.4	-7.9
R29	1.0	-7.9

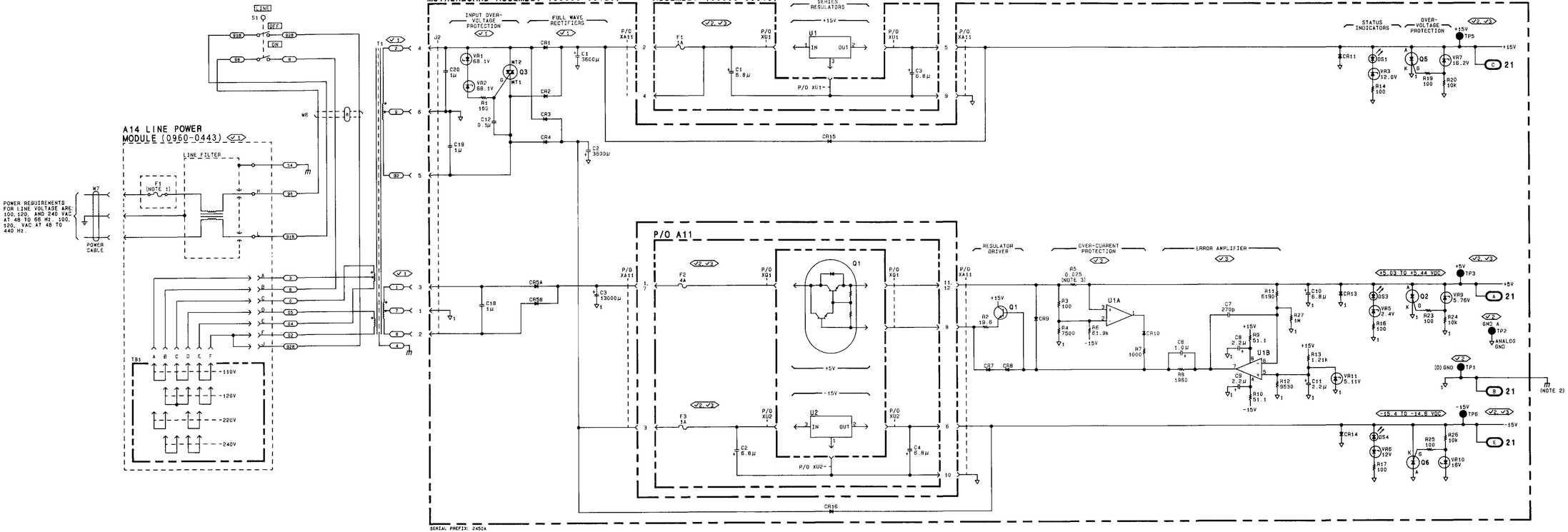
COMP	X	Y
TP1	11.7	-11.5
TP2	11.9	-11.5
TP3	12.2	-11.5
TP4	12.4	-11.5
TP5	12.7	-11.5
TP6	12.9	-11.5
U1	9.9	-11.0
U2	9.9	-10.2
VR1	0.5	-10.7
VR2	0.5	-10.8
VR3	12.7	-11.0
VR4	12.3	-11.0
VR5	12.1	-11.0
VR6	13.0	-10.6
VR7	13.8	-10.5
VR8	13.8	-9.8
VR9	12.9	-9.7
VR10	13.8	-11.3
VR11	11.5	-10.6

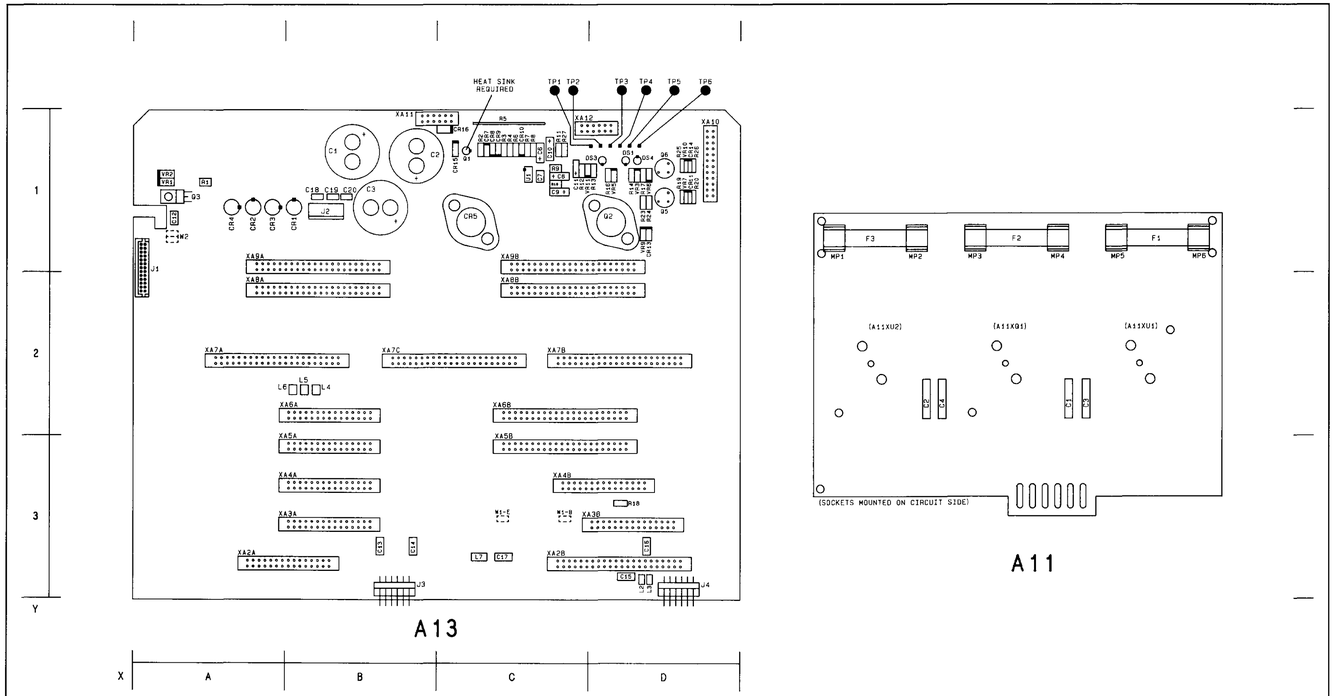
A13 Component Coordinates
2948A (HP8903B)
2946A (HP8903E)

SS20



SS20
Figure 8E-102.7
(rev 01OCT89)


P/O A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129)
P/O A11 SERIES REGULATOR SOCKET ASSEMBLY (08903-60015)
P/O A11
A14 LINE POWER MODULE (0960-0443)
LINE
OFF
ON
LINE FILTER
POWER REQUIREMENTS FOR LINE VOLTAGE ARE: 100, 120, AND 240 VAC AT 48 TO 66 HZ. 100, 120, VAC AT 48 TO 440 HZ.
POWER CABLE
TB1
-110V
-120V
-220V
-240V
INPUT OVER-VOLTAGE PROTECTION
FULL WAVE RECTIFIERS
SERIES REGULATORS
REGULATOR DRIVER
OVER-CURRENT PROTECTION
ERROR AMPLIFIER
STATUS INDICATORS
OVER-VOLTAGE PROTECTION
+5.03 TO +5.44 VDC
-15.4 TO -14.6 VDC
ANALOG GND
(NOTE 2)
SERIAL PREFIX: 2450A



A13

A11

Figure 8E-104. SERVICE SHEET 21 INFORMATION

Component Locator

Component Coordinates

COMP	X,Y	COMP	X,Y	COMP	X,Y	COMP	X,Y
C13	B3						
C14	B3						
C15	D3						
C16	D3						
C17	C3						
J1	A1						
J3	B3						
J4	D3						
L2	D3						
L3	D3						
L4	B3						
L5	B2						
L6	B2						
L7	C3						
R18	D3						
W1	C3						
W2	A1						
XA2A	A3						
XA2B	C3						
XA3A	B3						
XA3B	D3						
XA4A	B3						
XA4B	C3						
XA5A	B3						
XA5B	C3						
XA6A	B2						
XA6B	C2						
XA7A	A2						
XA7B	C2						
XA7C	B2						
XA8A	A2						
XA8B	C2						
XA9A	A1						
XA9B	C1						
XA10	D1						

A11,P/O A13,A14 SEE REVERSE SIDE — Power Supply and Mother Board-Power Supply — **SS20**

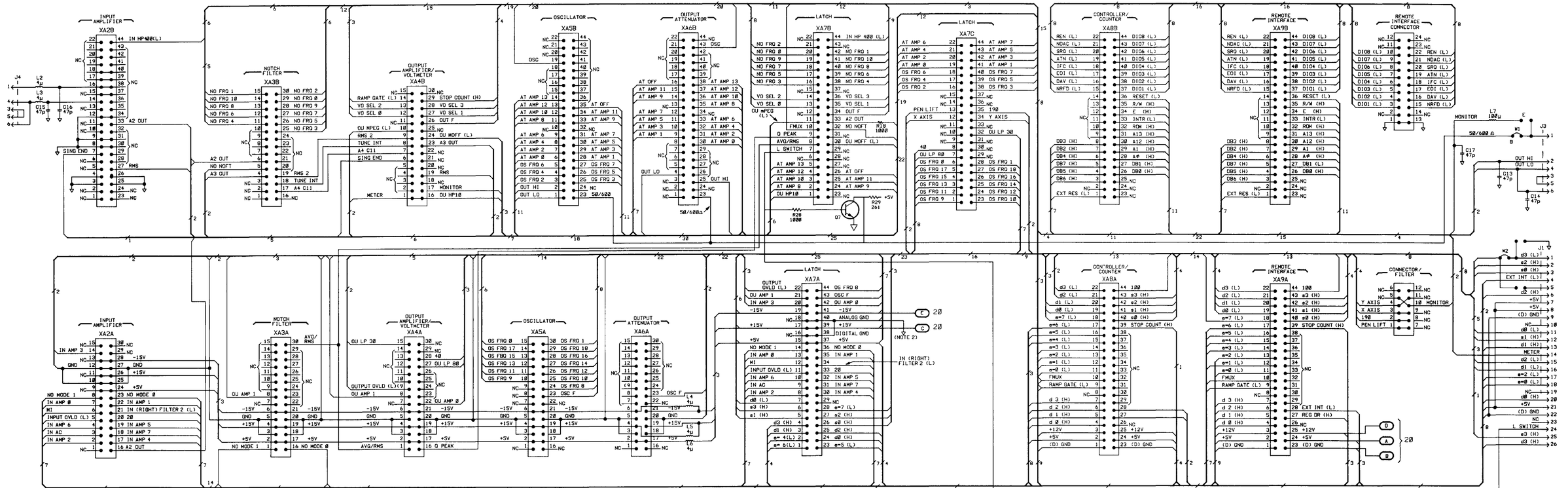
NOTES

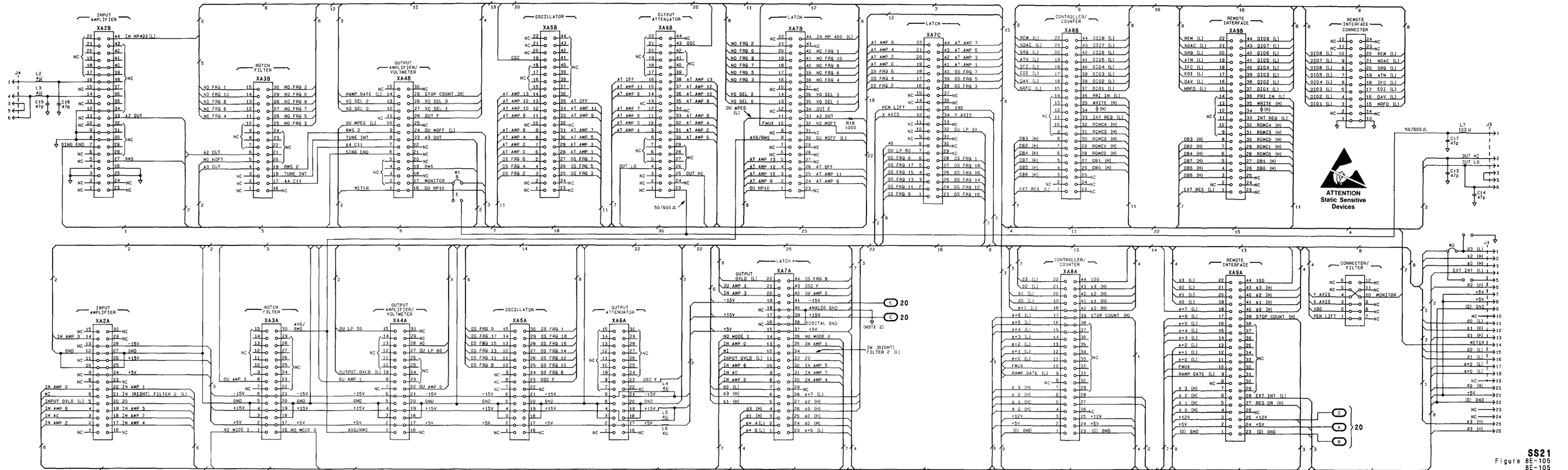
1. This wiring diagram is for (P/O) A13 POWER SUPPLY AND MOTHERBOARD ASSEMBLY (08903-60129).
2. Analog and digital ground are common to chassis ground between XA2A and XA7A.

Schematic General Information

CHANGES

2450A to 2922A	**On the A13 schematic:** • **XA4A, XA7C** - Draw a connection from XA4A pin 30 to XA7C pin 10. • **XA8A** - On the lower right half of the schematic, locate Controller/Counter XA8A and delete the connections between pins 18 and 40, 17 and 39, 16 and 38, and 15 and 37. On the line extending from pin 28 add EXT INT (L) and on the line extending from pin 27 add REG DR (H).
2717A to 2922A	**On the A13 schematic:** • **A13** - Use the new SS21, FIGURE 8E-104.3 in conjunction with SS21 on page 8E-105. • **L SWITCH** - Locate L SWITCH under XA7B and change it to Z SWITCH. Locate L SWITCH in the lower right hand corner of the schematic and change it to Z SWITCH. **On the A13 Component Locator:** • **J1** - In the upper left section of the comoponent locator, locate J1, then to the lower right of J1 add in order: R28, Q7, and R29. • **JP1-B, JP1-E** - In the lower center of the component locator locate C14, then between C14 and L7 add in order, JP1-B and JP1-E. **On the A13 Component Coordinates:** • **SS20** - In alpha numeric order add JP1-B (B,3), JP1-E (C,3), Q7 (2,A), R28 (2,A) and R29 (2,A).
2948A and above	**On the A13 Schematic:** • **SS21** - Use the new schematic foldout on page 8E-104.3, SS21 with the revision date of rev.01OCT89.


INPUT AMPLIFIER
XA2B
IN HP400(L)
NOTCH FILTER
XA3B
OUTPUT AMPLIFIER/ VOLTMETER
XA4B
OSCILLATOR
XA5B
OUTPUT ATTENUATOR
XA6B
LATCH
XA7B
LATCH
XA7C
CONTROLLER/ COUNTER
XA8B
REMOTE INTERFACE
XA9B
REMOTE INTERFACE CONNECTOR
MONITOR
50/600Ω
OUT HI
OUT LO
INPUT AMPLIFIER
XA2A
NOTCH FILTER
XA3A
AVG/ RMS
OUTPUT AMPLIFIER/ VOLTMETER
XA4A
OSCILLATOR
XA5A
OUTPUT ATTENUATOR
XA6A
LATCH
XA7A
CONTROLLER/ COUNTER
XA8A
REMOTE INTERFACE
XA9A
CONNECTOR/ FILTER
IN (RIGHT) FILTER 2 (L)
(NOTE 2)
SS21
Figure 8E-104.3
(rev 01OCT89)



SS21
Figure 8E-105
8E-105

SERVICE SHEET A---General Removal Procedures

GENERAL REMOVAL PROCEDURES

Top Cover Removal

1. Remove the two top plastic standoffs on the rear-panel by removing the Pozidriv screw 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 bottom plastic standoffs on the rear-panel by removing the Pozidriv screw 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-Panel 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 toward the rear of the instrument and then pull it off.

Information Card Removal

1. Turn the instrument upside down.

2. Remove the bottom cover. (Refer to *Bottom Cover Removal* procedure above.)

3. Grasp the information cards firmly with thumb and index finger and withdraw the information cards from the information card tray.

FRONT-PANEL DISASSEMBLY PROCEDURE

Refer to Figure 8F-101.

Front-Panel Assembly Removal

1. Remove the top and bottom covers and the side-panels of the instrument. (Refer to *General Removal Procedures* above.)

2. Pry up the trim strip on the top of the instrument just above the front-panel with a small screwdriver.

3. Remove the three screws in the channel covered by the trim strip.

4. Remove the three screws from the bottom channel.

5. Pull the front-panel assembly outward.

6. Disconnect ribbon cable W5 (17) from connector A1J1 on the Keyboard and Display Assembly (16).

NOTE

Steps 7, 8 and 9 do not apply to instruments which include Option 001.

7. Remove the two screws with lock washers which secure two cable clamps MP25 to the card cage MP24 (not shown).

8. Disconnect the connector for cable W1 (13) from connector A13J3 on the motherboard.

9. Disconnect the connector for cables W4 and W5 (24) from connector A13J4 on the motherboard.

NOTE

Parts called out in steps 10, 11 and 12 are shown in Figure 8F-103, Service Sheet B.

10. Remove the two hex nuts with lock washers (21) and separate cover (22) from the transformer (18).

11. Detach the two crimp-on wire connectors (part of W6—not shown) to the line switch S1 at the Line Power Module (29) as follows:

Wire	Contact
Gray	B
White/Red/Gray	J

12. Unsolder the two wires from the Line Power Module (29) (line filter output—not shown) as follows:

Wire	Terminal
White/Gray	Front Lug
White/Brown/Gray	Rear Lug

13. Separate the front-panel assembly from the instrument by pulling the loose end of cable assembly W6 through the cut-out in the motherboard and the two polyethylene cable straps which secure W6 to the motherboard.

Separation of the A1 Keyboard and Display Assembly from the Front-Dress Panel and Sub-Panel

1. Perform steps 1 through 6 of the *Front-Panel Assembly Removal* procedure.

2. Remove the eight screws with lock washers (18), and separate the Keyboard and Display Assembly (16) from the sub-panel (6).

Meter M1 Removal

1. Perform steps 1 through 6 of the *Front-Panel Assembly Removal* procedure.

2. Remove the eight screws with lock washers (18), and separate the Keyboard and Display Assembly (16) from the sub-panel (6).

3. Remove two hex nuts on the terminals of the meter (21), and separate the white/red/orange wire and the white/brown/violet wire from the meter terminals.

4. Remove the four nuts (19) and separate the meter (21) and four spacers (20) from the Keyboard and Display Assembly (16).

Separation of the Front-Dress Panel and Display Window from the Sub-Panel

1. Remove the front-panel assembly from the instrument (refer to *Front-Panel Assembly Removal* procedure).

2. Remove the eight screws with lock washers (18), and separate the Keyboard and Display Assembly (16) from the sub-panel (6).

3. Remove the three retainers (7) from the studs on the front-dress panel (3).

NOTE

Step 4 does not apply to instruments which include Option 001.

4. Remove the four hex nuts (2 and 29) and separate the four connectors on cables W1 (15) and W2 (14) and the 12 lock washers (12) from the sub-panel (6).

5. Separate the front-dress panel (3) from the sub-panel (6) by removing two hex nuts and lock washers (10 and 9) and by separating the two binding-post terminals (1 and 30) from the sub-panel (6).

REPLACEMENT OF PUSHBUTTON KEYS AND ANNUNCIATOR LEDS

Key Cap Replacement

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 the *Front-Panel Assembly Removal* procedure) or carefully use a pair of pliers to remove the key cap.

To remove the pushbutton key cap, you will have to pull hard. Use your free hand to hold the board down as you pull.

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 tear out the switch. To replace a key cap LED, use the following procedure:

1. Place the Audio Analyzer on a table top. Lower the front-panel so that it is facing downward (steps 1 through 6 of the *Front-Panel Assembly Removal* procedure). Remove the pushbutton key cap (refer to *Key Cap Replacement* 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.

2. Clear the solder from the LED mounting holes.

3. Insert a new LED. Make sure the polarity is right. Push the leads through the circuit board and solder.

4. 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.

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. Lower the front-panel (steps 1 through 6 of the *Front-Panel Assembly Removal* procedure).

2. Remove the pushbutton key cap. You will have to pull hard. Use your free hand to hold the board down as you pull.

3. Remove the switch by chipping away or melting off the melted plastic tabs on the circuit side of the Keyboard which hold the switch in place. Refer to Figure 8F-1.

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. Refer to Figure 8F-2.

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, which may be slightly toxic.

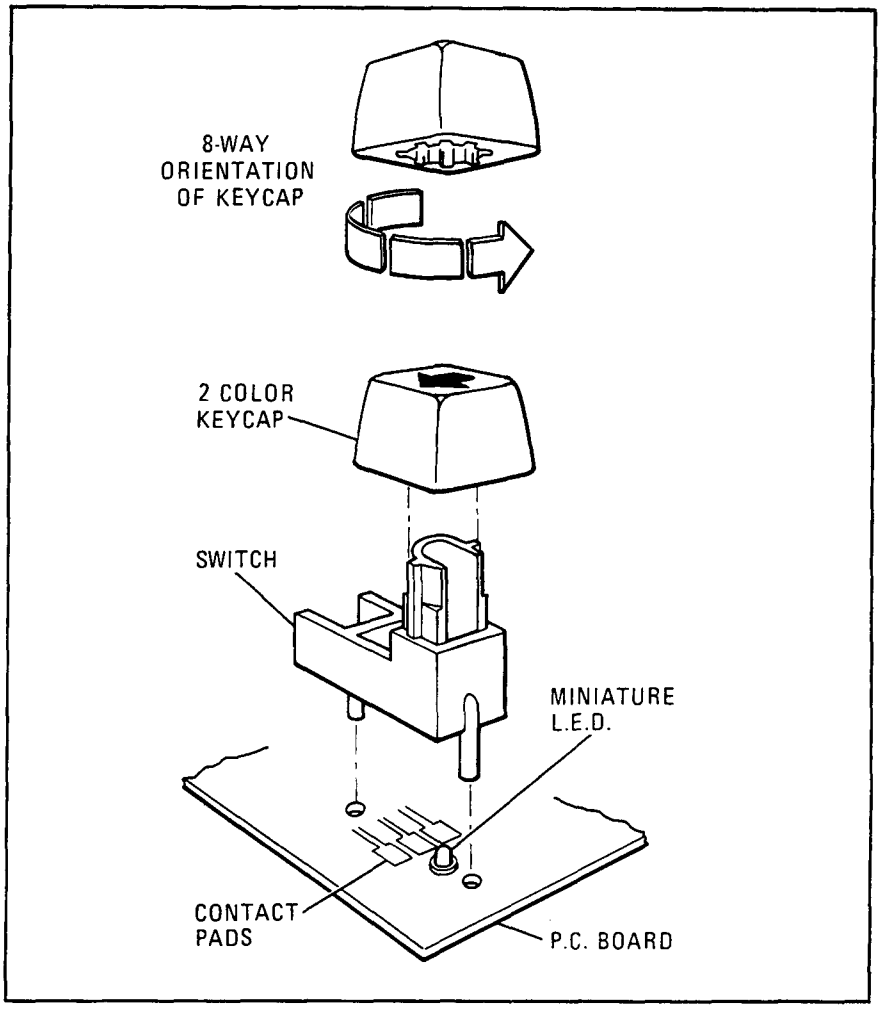


Figure 8F-1. Front-Panel Pushbutton Key Assembly

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.

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, as shown in Figure 8F-3.

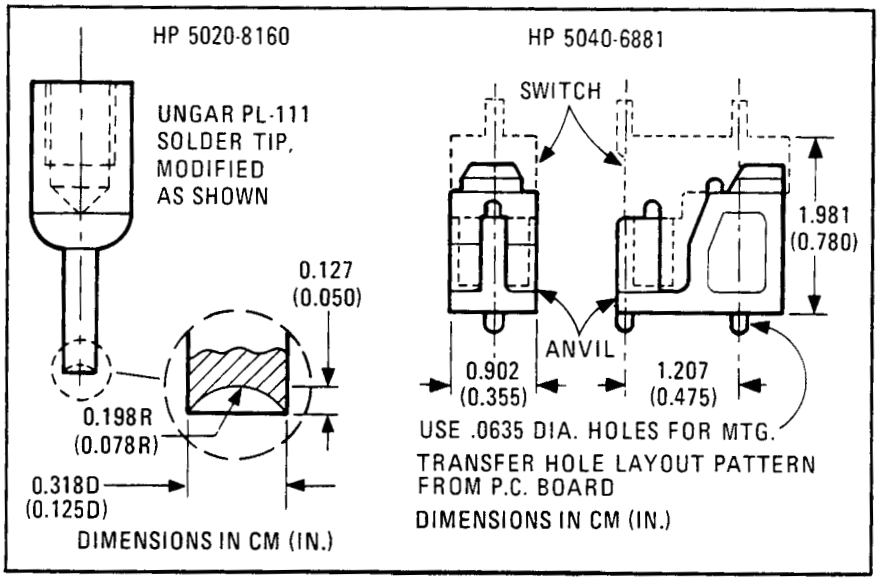


Figure 8F-2. Heat Staking Tip and Assembly Anvil

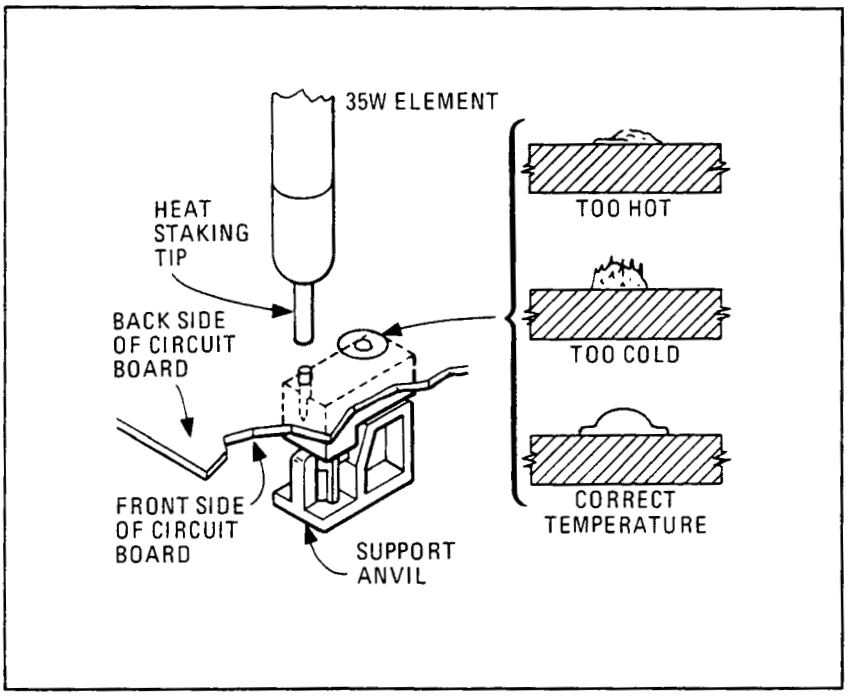


Figure 8F-3. Typical Assembly for Heat Staking Operation

SERVICE SHEET B---Rear-Panel Disassembly Procedures

REAR-PANEL DISASSEMBLY PROCEDURES

In order to remove the Power Transformer Assembly (T1) or the Connector/Filter Assembly (A12), the heatsink panel must be separated from the instrument. Refer to Figure 8F-103.

Heatsink Panel Removal

1. Remove the top cover of the instrument (refer to *General Removal Procedures,* Service Sheet A).

2. Remove the six screws and lock washers (36 and 35) and separate heatsink cover (34) from the heatsink panel (8).

3. Remove the six screws and lock washers (1 and 2) and separate the two voltage regulators (3 and 5), transistor (4), and three transistor insulators (6) from the heatsink panel (8).

4. Remove the two screws and lock washers (39 and 38) and separate rear label plate (37 or 40) if Option 001 is included.

5. Remove the four screws and lock washers (33 and 32) and separate heatsink panel (8) from rear-panel (13).

6. Separate the six insulators (7) from heatsink panel (8).

Power Transformer Assembly (T1) Removal

1. Remove the top cover and side-panels of the instrument (refer to *General Removal Procedures,* Service Sheet A).

2. Remove the instrument heatsink panel (refer to *Heatsink Panel Removal* procedure).

3. Remove the two hex nuts with lock washers (21) and separate cover (22) from the transformer (18).

4. Detach the transformer output connector (17) from connector A13J2 (not shown) in the motherboard.

5. Detach the five crimp-on wire connectors (23) from the primary side of the transformer at the Line Power Module (29) as follows:

Wire	Contact
Orange	A
Black	C
Black/Green	D
Black/Yellow	E
Black/Red	F

6. Unsolder the yellow wire (24) from ground lug on the rear panel (13).

7. Remove the four screws (27 and 28), four washers (19), and four lock nuts (20) and separate the transformer (18) and four washers (26) from the rear panel (13).

Remote Interface Connector Assembly (A10) Removal

1. Remove the top and bottom covers of the instrument (refer to *General Removal Procedures,* Service Sheet A).

2. Remove the two metric hex-head standoffs and lock washers (11 and 12) securing the HP-IB connector (14) to the rear panel (13).

3. Remove the seven screws (6-32 x 0.312) and lock washers which secure the motherboard to the chassis at the right-hand rear corner of the instrument: three from the rear edge of the motherboard and four from the right-hand edge of the motherboard.

4. Carefully move the right-hand rear corner of the motherboard no more than 0.187 inches away from instrument chassis, and remove the Remote Interface Connector Assembly (14) from its connector (A13XA10) in the motherboard.

Series Regulator Socket Assembly (A11) Removal

1. Remove the top cover of the instrument (refer to *General Removal Procedures*, Service Sheet A).

2. Remove the six screws and lock washers (36 and 35) and separate heatsink cover (34) from the heatsink panel (8).

3. Remove the six screws and lock washers (1 and 2) and separate two voltage regulators (3 and 5) and transistor (4) from the heatsink panel (8).

4. Detach the Series Regulator Socket Assembly (16) from connector A13XA11 in the motherboard.

Connector/Filter Assembly (A12) Removal

1. Remove the top and bottom covers and the side-panels of the instrument (refer to *General Removal Procedures*, Service Sheet A).

2. Remove the instrument heatsink panel (refer to *Heatsink Panel Removal* procedure).

3. Remove the two metric hex-head standoffs and lock washers (11 and 12) securing the HP-IB connector (14) to the rear panel (13).

4. Remove the two flat head screws from the rear end of each of the four corner struts (MP2, shown in Figure 6-3).

5. Remove the four screws and lock washers which secure the mother board to the rear panel (13).

NOTE

Step 6 applies only to instruments which include Option 001.

6. Remove the four hex nuts and lock washers (9 and 10) which secure connectors J7 (41), J8 (42), J9 (43), and J10 (44) to the rear panel (13).

7. Remove the four hex nuts and lock washers (9 and 10) which secure the Connector/Filter Assembly (15) to the rear-panel (13).

8. Carefully move the rear panel away from the motherboard and the corner struts until the four connectors on the Connector/Filter Assembly (15) clear the rear panel.

9. Disengage the Connector/Filter Assembly (15) from connector A13XA12 in the motherboard.

Line Power Module (A14) Removal

1. Remove the top and bottom covers and the left-hand side-panel of the instrument (refer to *General Removal Procedures*, Service Sheet A).

2. Remove the two hex nuts with lock washers (21) and separate cover (22) from the transformer (18).

3. Remove the four flat head screws and four screws and lock washers and separate lower left-hand corner strut (MP2, shown in Figure 6-2) from the instrument.

4. Remove the three screws and lock washers and separate the left frame support MP24 (not shown) from the motherboard.

5. Detach the five crimp-on wire connectors (23) from the primary side of the transformer at the Line Power Module (29) as follows:

Wire	Contact
Orange	A
Black	C
Black/Green	D
Black/Yellow	E
Black/Red	F

6. Detach the two crimp-on wire connectors (part of W6—not shown) to the line switch S1 at the Line Power Module (29) as follows:

Wire	Contact
Gray	B
White/Red/Gray	J

7. Unsolder the two wires from the Line Power Module (29) (line filter output—not shown) as follows:

Wire	Terminal
White/Gray	H
White/Brown	L

8. Unsolder the green/yellow ground wire (25) from the Line Power Module (29).

9. Depress the tabs on the top and bottom of the Line Power Module (29) and push it out through the rear panel (13).

Item Number	Reference Designator	Description
1	J3	Binding Post
2	MP40	Hex Nut
3	MP8	Front-Dress Panel
4	MP21	Not Assigned
5	See W6	Screw (4-40 x 4.6 mm)
6	MP9	Front Sub-Panel
7	S4	Not Assigned
8	W6	Line Switch Cable
9	See J3 and J6.	Lock Washer
10	See J3 and J6.	Hex Nut
11	S2	Output Float Switch
12	MP41	Lock Washer
13	P/O W1 and W2	Connector
14	W2	Output Low Cable (except Option 001)
15	W1	Output High Cable (except Option 001)
16	A1	Keyboard and Display Assembly
17	W5	Ribbon Cable
18	See MP9.	Screw (4-40 x 9.5 mm)
19	See M1.	Hex Nut with Lock Washer
20	See M1.	Spacer
21	M1	Meter
22	W4	Input High Cable (except Option 001)
23	W5	Input Low Cable (except Option 001)
24	P/O W2	Connector
25	See S2, S3, and S4.	Screw
26	See S2, S3, and S4.	Lock Washer
27	S3	Input Float Switch
28	See S2, S3, and S4.	Float Switch Lever
29	J6	Binding Post
30	A1DS20	Impedance LED

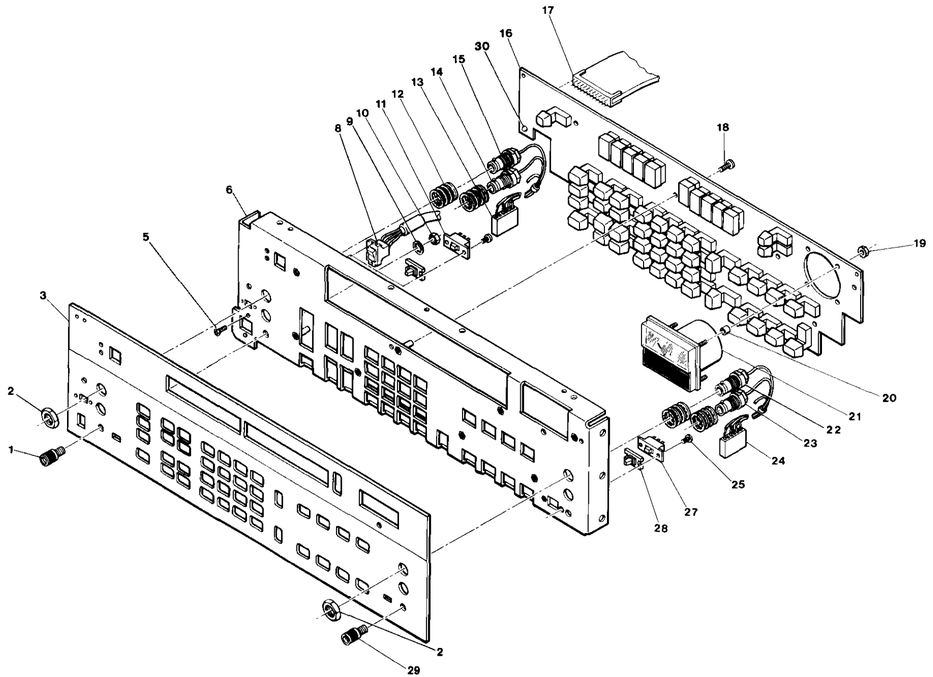


Figure 8F-101. Front-Panel Illustrated Parts Breakdown (2742A and Above)

Item Number	Reference Designator	Description
1	See Q1, U1, U2.	Tapping Screw (6-20 x 0.75)
2	See Q1, U1, U2.	Lock Washer
3	U1	Voltage Regulator 7815KC
4	Q1	Power Transistor 2N6057
5	U2	Voltage Regulator LM320K-15
6	See Q1, U1, U2	Insulator, Transistor
7	See Q1, U1, U2	Insulator, Mounting Screw
8	MP28	Heatsink Panel
9	MP42	Hex Nut
10	MP43	Lock Washer
11	See A10.	Hex Standoff
12	See A10.	Lock Washer
13	MP3	Rear Panel
14	A10	Remote Interface Connector
15	A12	Connector/Filter
16	A11	Series Regulator Socket
17	P/O T1	6-Pin Connector
18	T1	Power Transformer Assembly
19	See T1	Washer
20	See T1	Lock Nut
21	See MP30.	Hex Nut with Lock Washer
22	MP30	Cover
23	P/O T1	Primary Input Connections (5)
24	P/O T1	Primary Ground Connection
25	P/O A14	Ground Connection
26	See T1	Washer
27	See T1	Machine Screw (8-32 x 63.5 mm)
28	See T1	Machine Screw (8-32 x 57.2 mm)
29	A14	Line Power Module
30	F1	1.25 Amp Fuse (120 Vac) 0.5 Amp Fuse (220 Vac)
31	A14TB1	Line Voltage Selection Card
32	See MP28.	Lock Washer
33	See MP28.	Machine Screw (4-40 x 0.438)
34	MP29	Heatsink Cover
35	See MP29.	Lock Washer
36	See MP29.	Machine Screw (6-32 x 0.25)
37	MP31	Rear Label Plate (Except Option 001)
38	See MP31.	Lock Washer
39	See MP31.	Machine Screw (4-40 x 0.438)
40	MP31	Rear Label Plate (Option 001 Only)
41	J7	Connector (Output, High) (Option 001 Only)
42	J8	Connector (Output, Low) (Option 001 Only)
43	J9	Connector (Input, High) (Option 001 Only)
44	J10	Connector (Input, Low) (Option 001 Only)

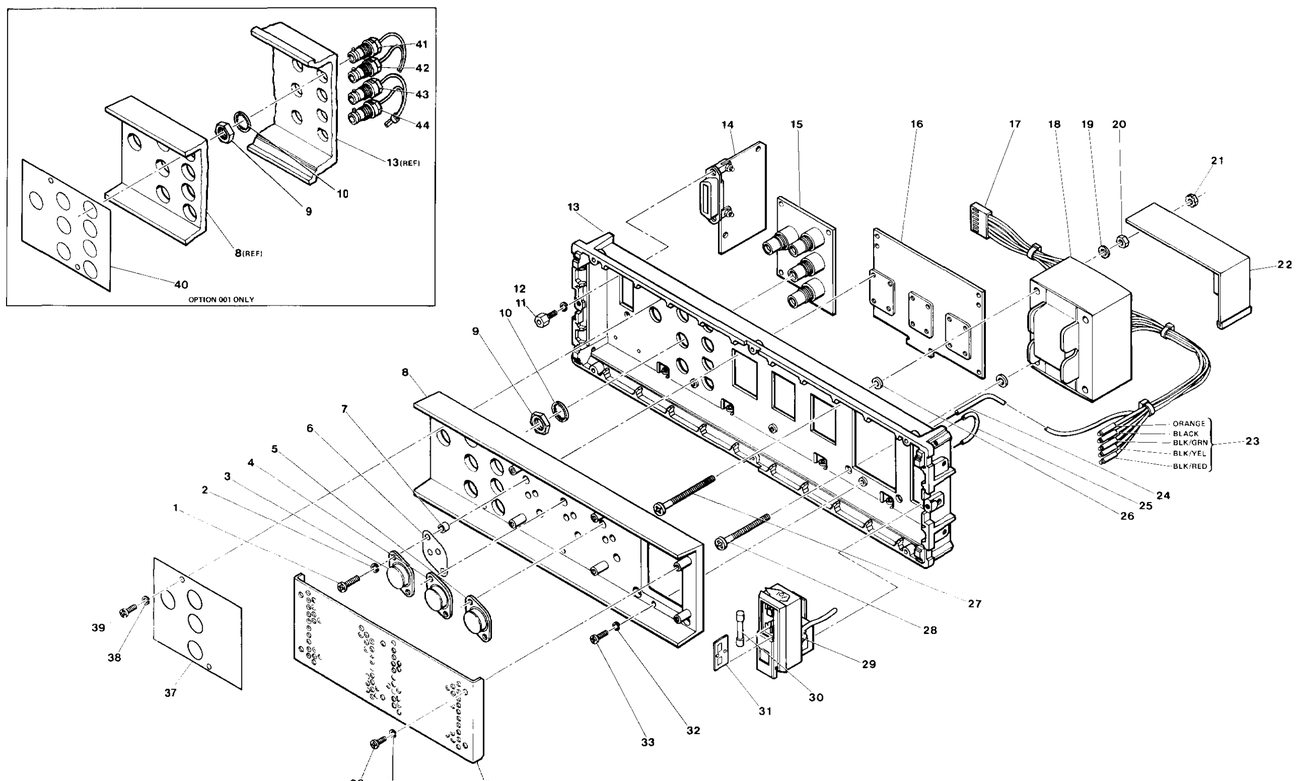


Figure 8F-103. Rear-Panel Illustrated Parts Breakdown

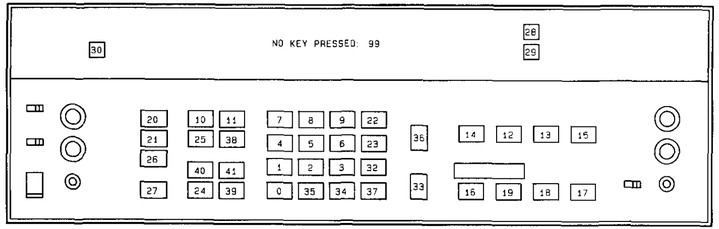


Figure 8F-105. Key Scan Codes

SERVICE SHEET C
SERVICE SPECIAL FUNCTIONS

40.0 Controller Reset

41.0 Controller Clear

42.0 Display Software Date

43.N Service Error Display Control
N=0 Disable Display of Service Errors
N=1 Enable Display of Service Errors
N=65 to N=95: Enables display of only the Service Error specified by N

44.N Notch Filter Mode Select
N=0 Notch Filter mode selected automatically as required by the measurement mode
N=1 Notch Filter in notch mode
N=2 Notch Filter in flat mode
N=3 Notch Filter in bandpass mode

45.N SINAD Meter Enable
N=0 SINAD meter enabled normally
N=1 SINAD meter enabled in all measurement modes except DC level

46.N Count Internal Signals
N=0 Oscillator Frequency
N=1 Input Frequency
N=3 Output Amplifier Frequency

48.N Defeat Output Amplifier Overdrive Protection
N=0 Output Amplifier gain determined normally
N=1 Output Amplifier gain determined by the Output RMS (Avg) Detector

49.N Display Internal Voltages
N=0 Ground
N=1 Input RMS Detector with Ripple Filter
N=2 DC Input Voltage without Filter
N=3 Output RMS (Avg) Detector with Ripple Filter
N=4 Output RMS (Avg) Detector
N=5 Output RMS (Avg) Detector with SINAD Filter
N=6 Notch Tune Voltage
N=7 DC Input Voltage with Filter

50.N Display Oscillator Frequency
N=0 Display frequency as normal
N=1 Display Oscillator frequency

52.N Read Only Memory Verification (N=ROM Number)
<Actual Checksum> . <Expected Checksum>

53.N Notch Filter Frequency Range

54.N Notch Filter Coarse Tune

55.N Oscillator Frequency Range

56.N Oscillator Coarse Tune

57.N Oscillator Fine Tune

58.N Source Fine Level

59.N Source Coarse Level

60.N Key Scan (Jumper A8U6P7 to A8TP3)
(See Figure 8F-105 for key scan codes.)

SERVICE SHEET C (Cont'd)

61.N Display HP-IB Status
N=0 <Addressed to Talk> . <Addressed to Listen> (True=1)
N=1 <DAV> . <RFD> <DAC> (True=1)
N=2 <ATN> . <REN> (True=1)
N=3 <SPM> . <SRQ> (True=1)
N=4 PIO Port A (True=1)

Display Digit	1	2	3	4	5	6	7	8
Mnemonic	IO8	IO7	IO6	IO5	IO4	IO3	IO2	IO1

N=5 PIO Port B (True=1)

Display Digit	1	2	3	4	5	6	7	8
Mnemonic	ATN	ARD	AAD	SRQ	RNL	ATT	ATL	SDV

ERROR MESSAGE SUMMARY

The error messages are grouped by error code as follows:

a. Error 10 through Error 39 and Error 90 through Error 99: these are Operating and Entry errors.

b. Error 65 through Error 89: these are Service errors.

Refer to the Error Message Summary in Section III for additional information.

NOTE

Not all of the available error message numbers are used.

Operating Errors

Error 10 — Reading too large for display.
Error 11 — Calculated value out of range.
Error 13 — Notch cannot tune to output.
Error 14 — Input level exceeds instrument specifications.

NOTE

Although error codes 17, 18 and 19 are listed as Operating Errors, they should be considered rather as diagnostic indications.

Error 17 — Internal voltmeter cannot make measurement.
Error 18 — Source cannot tune as requested.
Error 19 — Cannot confirm source frequency.
Error 25 — Top and bottom plotter limits are identical.
Error 26 — RATIO not allowed in present mode.
Error 30 — Input overload detector tripped in range hold.
Error 31 — Cannot make measurement.
Error 32 — More than 255 points total in a sweep.
Error 96 — (HP-IB only) No signal sensed at input.

SERVICE SHEET C (Cont'd)

Entry Errors

Error 20 — Entered value out of range.
Error 21 — Invalid key sequence.
Error 22 — Invalid Special Function prefix.
Error 23 — Invalid Special Function suffix.
Error 24 — Invalid HP-IB code.

Service Errors

Error 65 — Decimal point fixed too far to the left.
Error 70 — Cannot count oscillator frequency.
Error 71 — Oscillator tune abort.
Error 72 — AC input overload with input range hold.
Error 73 — Input ac level abort.
Error 74 — Output amplifier overload with output amplifier at 0 dB gain.
Error 75 — DC input overload with input range hold.
Error 76 — Too much ac for dc level measurement.
Error 77 — Output amplifier gain too high after leveling once.
Error 78 — Output amplifier overload after leveling once.
Error 79 — Output amplifier overload with no post-notch gain hold.
Error 80 — Cannot count oscillator frequency in SINAD.
Error 81 — Cannot count input frequency.
Error 82 — Notch filter does not null.
Error 83 — Cannot count input frequency (count=0).
Error 84 — Output amplifier overvoltage with no overload.
Error 85 — Period of the voltage-to-time converter 0.
Error 86 — Frequency count greater than 200 kHz.
Error 87 — Output amplifier overload with post-notch gain hold.
Error 88 — Attempt to take log of negative ratio.
Error 89 — Attempt to take log of negative number.
Error 90 — Decimal point fixed and exponent too large.
Error 91 — Decimal point fixed too far to the left (same as Error 65).
Error 92 — Decimal point fixed and unable to display.
Error 93 — Number to be displayed greater than 9999.
Error 94 — Attempt to divide by zero in ratio.
Error 95 — Signal-to-noise ratio too large to calculate.