HEWLETT
PACKARD

OPERATING MANUAL

HP 71000A

SPECTRUM ANALYZER

100Hz-2.9GHz/50KHz-26.5GHz

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DOCUMENTATION DESCRIPTION

The following manuals are provided with the HP 71000A Modular Spectrum Analyzers.

System Support Manual

This is the service manual for the Modular Spectrum Analyzers. It provides installation procedures, specifications, troubleshooting information, and user documentation for the System Verification software.

Operating Manual

This manual is divided into three parts:

Manual Operation (Part I) tells how to use the instrument manually.

Remote Opertation (Part II) explains how to program and operate the instruments remotely.

Display Operation (Part III) describes features of the graphic display. It tells how to configure the display screen, obtain hardcopy outputs, examine the addresses of modules on the HP-MSIB, and receive error reports.

Remote Language Reference

This reference lists the Modular Spectrum Analyzer remote commands. Each command is described; each description contains a syntax flow chart and a definition of the command parameters including their range.

At the back of the reference is a Keyword Summary, which lists the commands by function.

CONTENTS OF OPERATING MANUAL

PART I

Manual Operation

PART II

Remote Operation

PART III

Display Operation

CONTENTS OF OPTIONAL MODULES

[ ] Tracking Generator

[ ]

[ ]

PART I

Manual Operation

CHAPTER 1

GENERAL INFORMATION

Description: *This chapter describes the various instruments in the system mainframe and shows drawings of each of the modules.*

CHAPTER 2

GETTING STARTED

Description: This chapter describes the front panel of the instrument, explains the softkey concept, and shows you how to make some typical measurements (with examples).

CHAPTER 3

USR HARDKEY

Description: This chapter explains how to use the [USR] hardkey and how to select and change softkeys. It also shows how to go from automatic to manual coupling and back using a set of softkeys.

CHAPTER 4

MNU HARDKEY

Description: This chapter provides an overview of the MNU hardkey. In addition, it shows you how to select different functions of the spectrum analyzer.

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CHAPTER 1

GENERAL INFORMATION

Description: This chapter describes the various instruments in the system mainframe, and shows drawings of each of the modules.

Introduction

This manual describes manual, remote and display operation of the HP 71000A Modular Spectrum Analyzer Systems Series. The manual is divided into three parts. Part I (Manual Operation) tells how to use the instrument manually. Part II (Remote Operation) explains how to program and operate the instruments remotely. Part III (Display Operation) focuses on the features of the graphic displays. It shows users how to configure the display screen, obtain hardcopy outputs, examine the addresses of the modules on the HP-MSIB, and receive error reports.

All three parts are organized in chapters, sections, and subsections. For example, the MNU chapter has a section on Frequency and a subsection on Center Frequency. Part I, II, and III are differentiated by blue tabs, the chapters by white tabs, the sections by annotation at the top of the pages, and the subsections by listings in the chapter contents and the index.

This chapter, General Infomation, describes the HP Modular Measurement System and includes drawings of the modules. It also lists the modules in the three different systems and summarizes their specfications.

Module Descriptions

The Modular Signal Analyzer is the first product introduced as part of the HP 70000A Modular Measurement System. This modular automatic test system is built around a powerful new mainframe and may ultimately include a wide range of test instruments such as analyzers, sources, and conditioners.

The Modular Signal Analyzer product family initially consists of two displays, eight modules and a mainframe configurable as RF, microwave and millimeter wave spectrum analyzers.

Described below are the modules which are part of the Modular Measurement System.

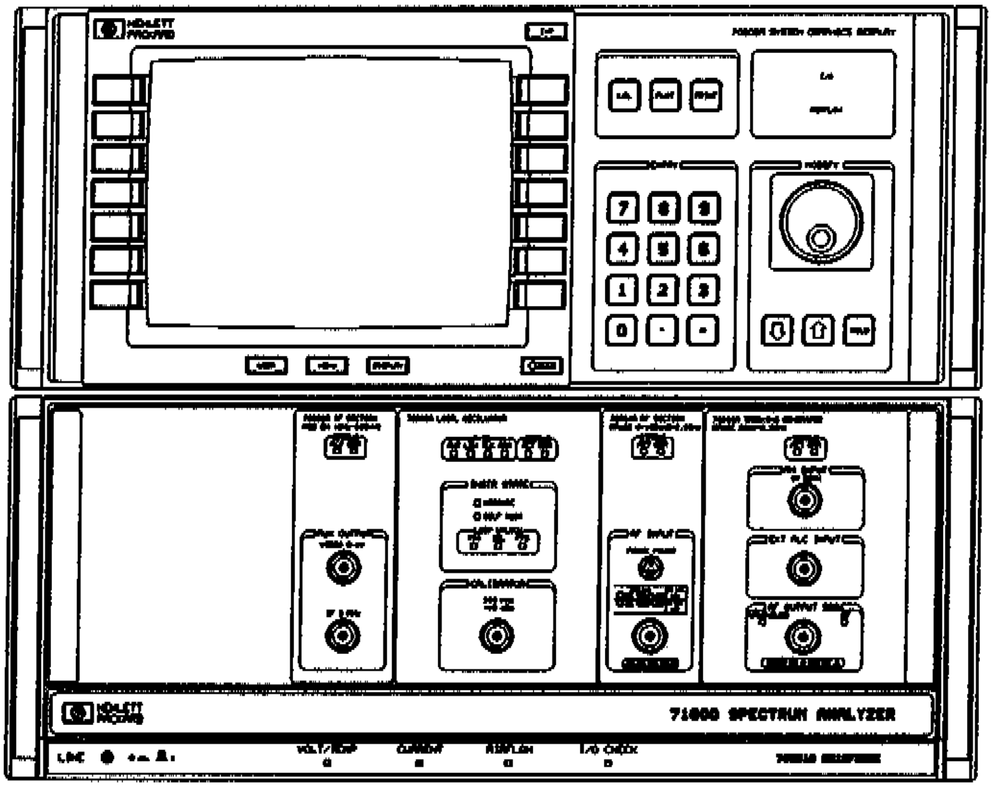


Fig. 1-1. Modular Measurement System

HP 70001A Mainframe

The HP 70000 Modular Measurement System mainframe provides the structural environment for plug-in instrument modules along with cooling, power, and digital communciation bus interface. It is compatible with 1/8, 1/4, 3/8, and 1/2 width modules and has a maximum capacity of eight one-section (1/8 width) modules. External appearance is similar to System II cabinets. Rack compatibility is provided and benchtop use is facilitated with integral bails and optional handles.

Two digital buses are provided: HP-IB remote operation, and a new high performance bus called (Module System Interface Bus) for intermodule communication. The mainframe has good EMC performance (MIL-STD 461B) and has been designed to withstand the rigors of tough, industrial environments. It provides a solid, reliable base around which Modular Signal Analyzer systems may be easily configured.

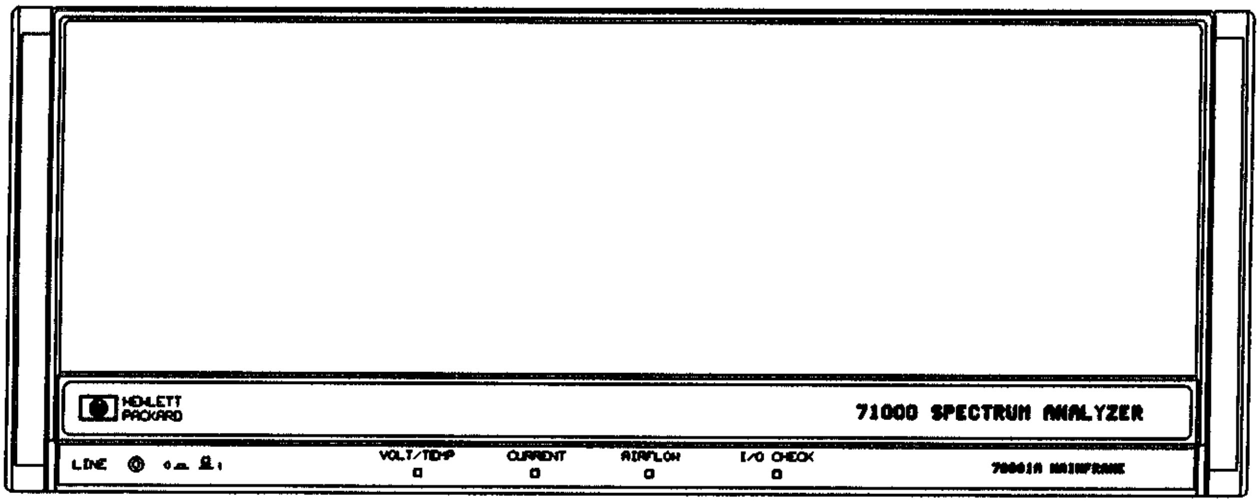


Fig. 1-2. HP 70001A Mainframe

HP 70205A Graphics Display

The Graphics Display is a 3/8 module which provides the human interface and manual control for the HP 70000 Modular Measurement System. It can display modular instrument status and measured output and has graphics, trace, text and marker capability. Controls include 14 user definable menu keys (these are referred to as Softkeys in the text), 10 data keys, 10 control keys (3 of the keys are referred to as Hardkeys in the text) and an analog control knob. Instrument control is accomplished by using the menu keys to establish an interactive front panel for the accessed instrument.

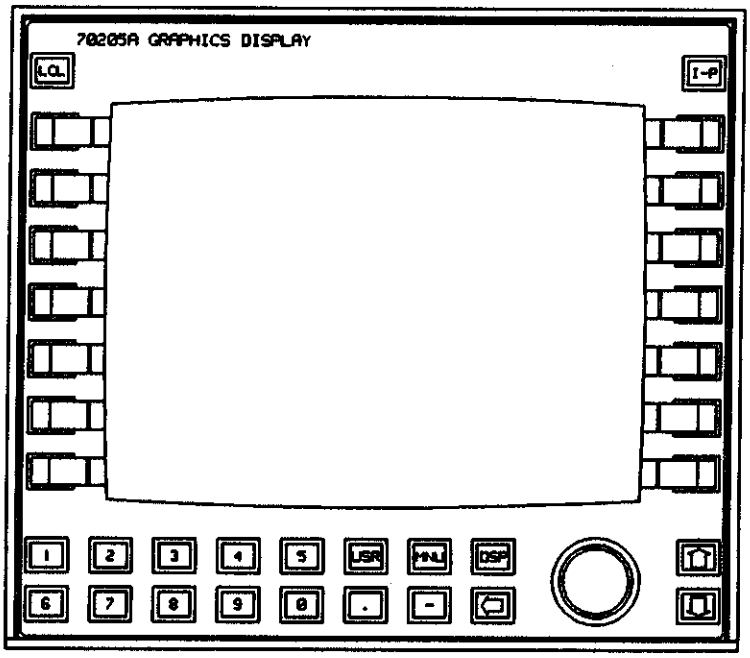


Fig. 1-3. HP 70205A Graphics Display

HP 70206A System Graphics Display

The System Graphics Display is a "stand-alone" large screen display for the HP 70000 Modular Measurement System. It uses a 9 inch raster CRT in a 7 inch, full rack System II frame and is stack compatible with the HP 70001A Mainframe and other System II instruments. It supplies the same dislay and manual control capability as the HP 70205A Graphic Display. Hardkeys on the HP 70205A slightly differ from the hardkeys on the larger HP 70206A. For example, on the HP 70206A the "display hardkey" is denoted by [DISPLAY] while on the HP 70205A the same hardkey is abbreviated to [DSP]. Although the key functions are identical, the abbreviated hardkey labels are used exclusively throughout this operating manual. The primary advantages of the HP 70206A are its large display size and the fact that when it is used in place of the Graphics Display, a 3/8 section of mainframe capacity is released for other modules.

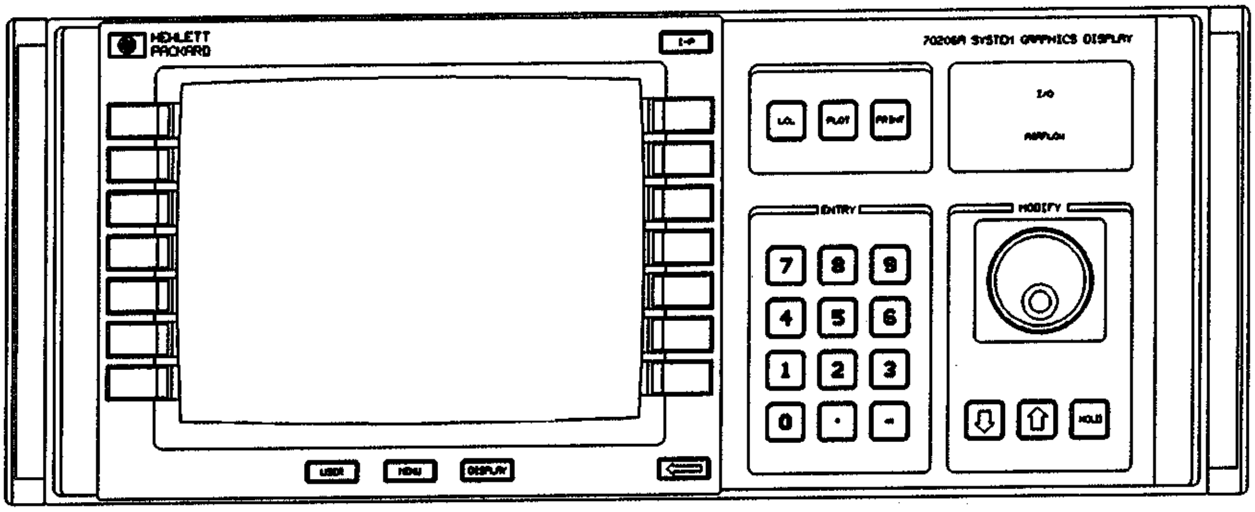


Fig. 1-4 . HP 70206A System Graphics Display

HP 70900A Local Oscillator

This 1/4 width module consists of three elements: a local oscillator (LO), a controller, and a video processor. The LO supplies a swept signal with a frequency range of 3.0 to 6.6 GHz for use by the front end modules, tracking generator, external mixer interface module or any other module or device requiring the signal. For spans ≤10 MHz the sweep is fully synthesized using fractional-N techniques while for spans > 10 MHz lock-and-roll tuning is used.

The video processor digitizes the video signal received from the IF module and processes this signal using normal (Rosenfell), positive peak, negative peak or sample detection.

The controller contains the system firmware which controls and coordinates measurements. Other system modules (Front Ends, IF, Tracking Generator, etc.) are slave modules which are controlled by the Local Oscillator module. Figure 1-5 shows the front and back view of the Local Oscillator module with the annotation included.

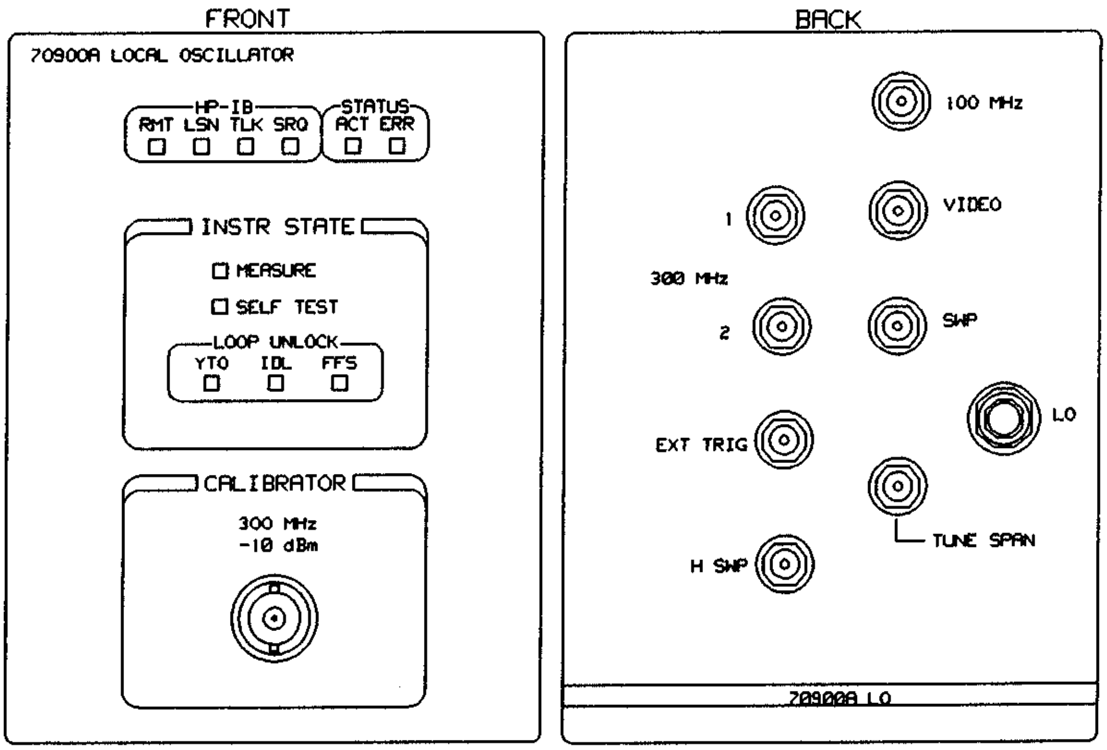


Fig. 1-5. L.O. module HP 70900A

HP 70904A RF Section (100Hz - 2.9GHz)

This 1/8 width module provides an input attenuator and converts the incoming RF signal to a 21.4 MHz IF. The RF front end (HP 70904A) has selectable input coupling with frequency ranges of 100 Hz - 2.9 GHz (DC coupled) and 100 kHz - 2.9 GHz (AC coupled). Figure 1-6 shows the front and back view of the R.F. section with the annnotation included.

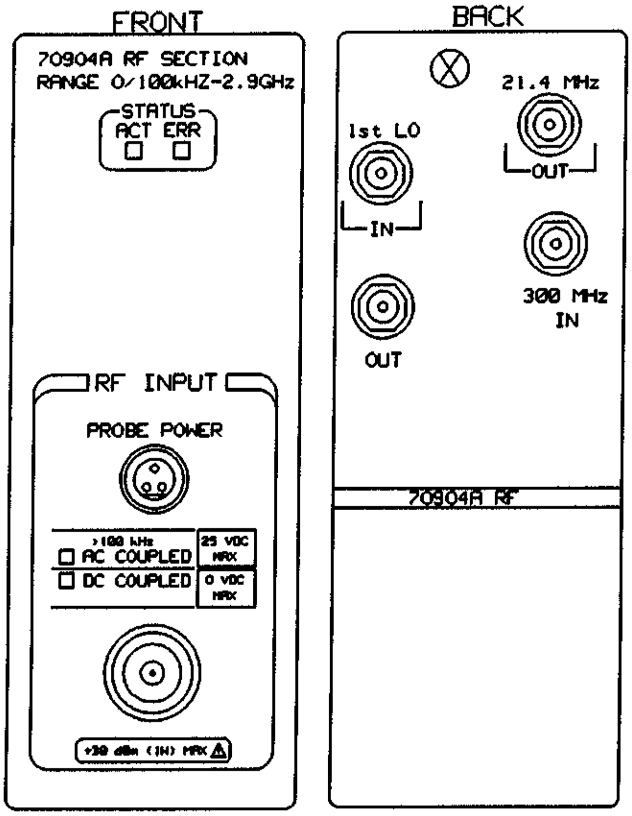


Fig. 1-6. R.F. module HP 70904A

HP 70905A RF Section (50kHz - 22GHz)

The 50 kHz - 22 GHz MW front end (HP 70905A) uses a Type N connector. Figure 1-7 shows the front and back view of the R.F. section with the annnotation included.

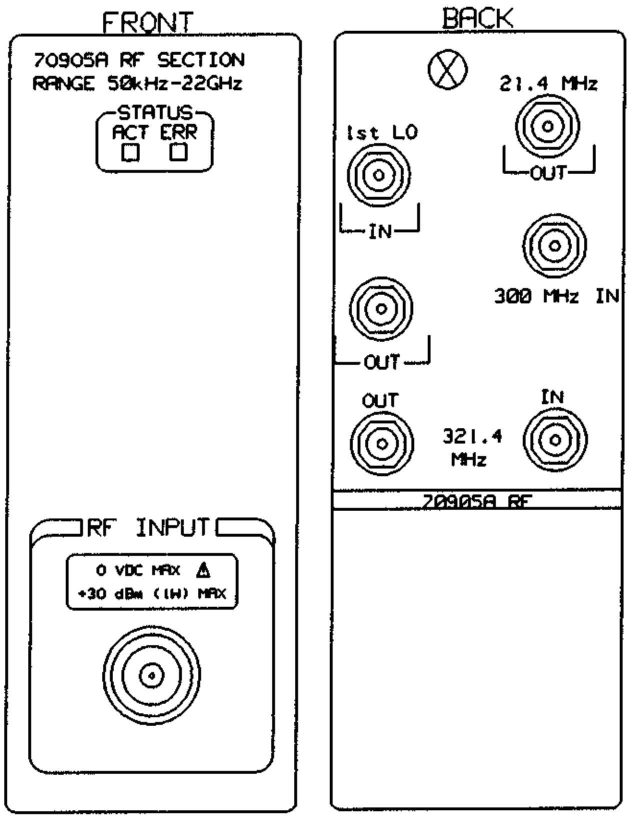


Fig. 1-7. R.F. module HP 70905A

HP 70906A RF Section (50kHz - 26.5GHz)

The 50 kHz - 26.5 GHz MW front end (HP 70906A) uses an APC-3.5 connector. Both MW front ends are unpreselected. Figure 1-9 shows the front and back view of the R.F. Section module with the annotation included.

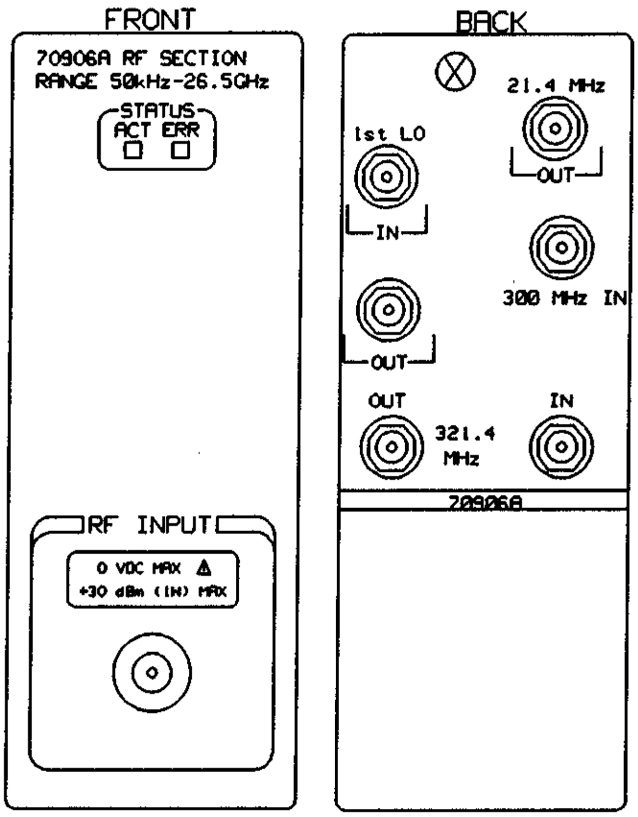


Fig. 1-9. R.F. module HP 70906A

HP 70902A IF Section (RES BW 10Hz - 300kHz)
HP 70903A IF Section (RES BW 100kHz - 3 MHz)

The 1/8 width IF modules process the 21.4 MHz signal received from the RF section or external mixer interface module. They contain resolution bandwidth filters, log amplifier, detection circuitry and video filters. Each IF module produces a detected video signal which is output to the video processor in the LO/Control module.

The HP 70902A IF contains filters ranging from 10 Hz - 300 kHz, selectable in a 1, 3, 10 sequence or in 10% increments (except from 3 kHz - 7 kHz). The HP 70903A IF offers filters from 100 kHz - 3 MHz, also selectable in a 1, 3, 10 sequence or in 10% increments (except for 3-10KHz BW). Figures 1-10 and 1-11 show the front and back views of the I.F. Section module with the annotation included.

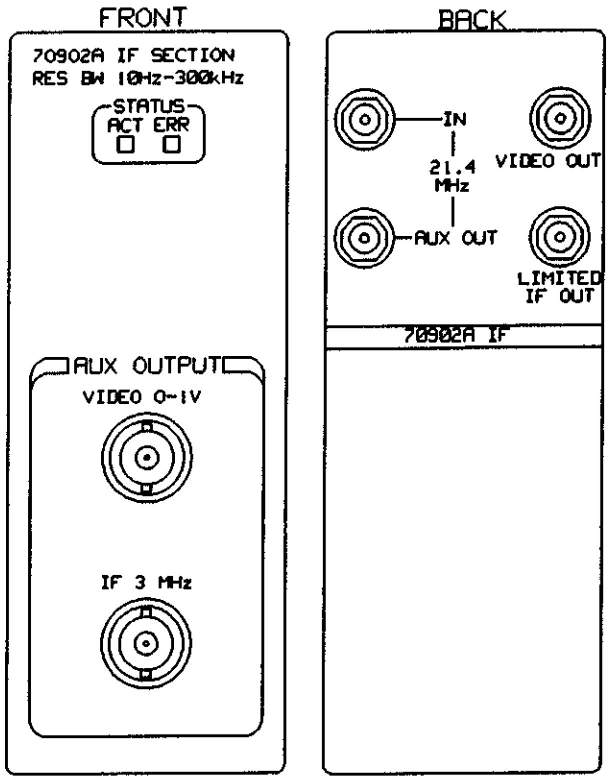


Fig. 1-10. I.F. module HP 70902A

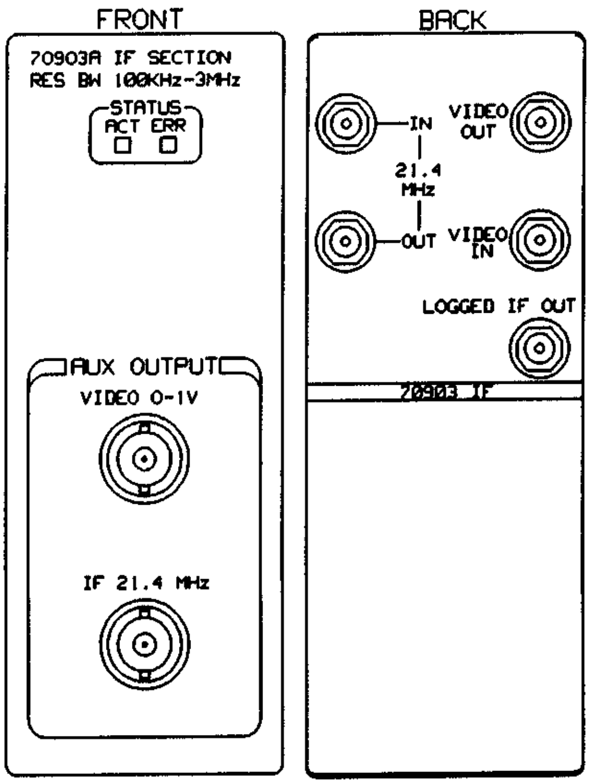


Fig. 1-11. I.F. module HP 70903A

HP 70907A External Mixer Interface

This module provides a convenient interface between external mixer and the Modular Signal Analyzer system. It contains an LO amplifier, diode bias supply, and downconversion circuitry to convert the 321.4 MHz input IF to a 21.4 MHz IF which is supplied to one of the IF modules. Modular Signal Analyzer's frequency range can be extended to 60 GHz using the HP 11970 harmonic mixer series with this module and to over 300 GHz by using mixers supplied by other manufacturers. Special applications down to 2.7 GHz can also be addressed with external mixers using this module.

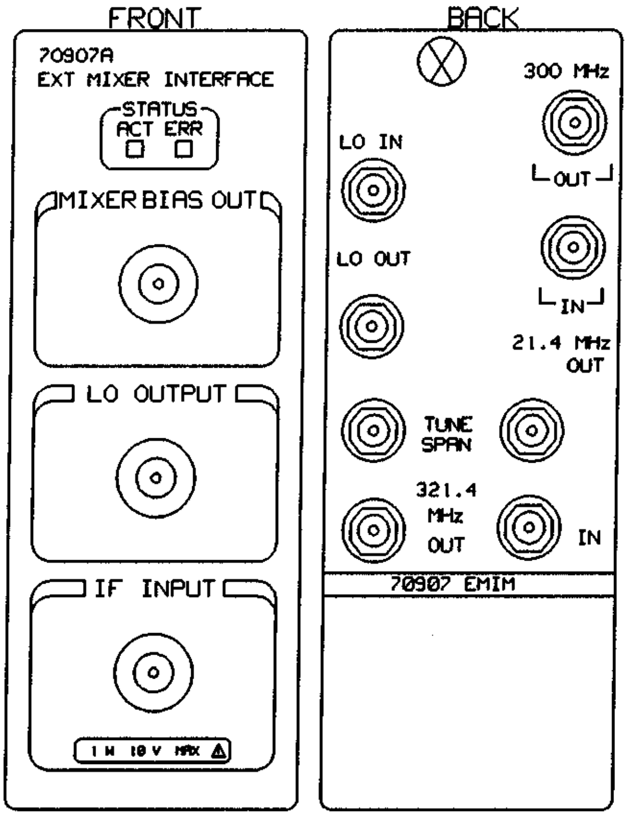


Fig. 1-12. External Mixer Interface HP 70907A

HP 70300A RF Tracking Generator

This module generates a signal which tracks the tuned frequency of the Spectrum Analyzer. Frequency range of the output is 20 Hz - 2.9 GHz with an amplitude range of -10 dBm to -20 dBm. Selection of the attenuator option increases the amplitude range to -80 dBm. A phaselocked 21.4 MHz source option allows frequency offsets of up to +/- 10 MHz. Measurement dynamic range exceeds 125 dB with the standard module and will be greater than 150 dB with an output amplifier option to be provided later. Amplitude modulation is also available and built-in firmware allows component test measurements to be made with unparalleled ease.

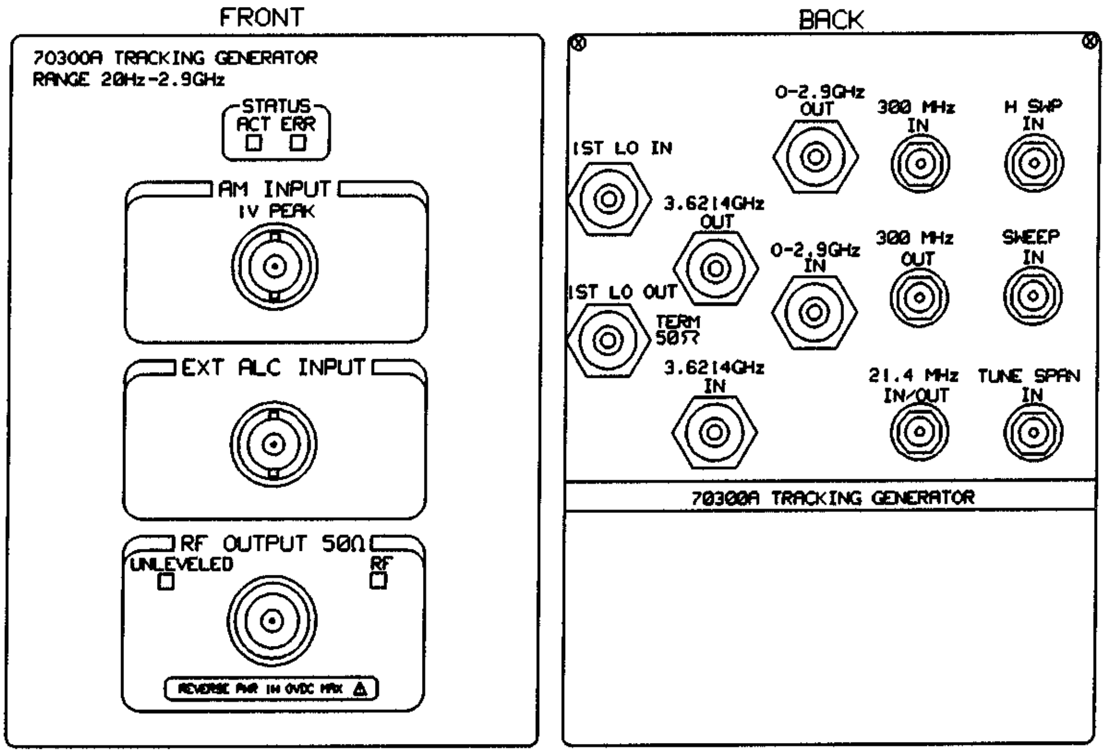


Fig. 1-12. Tracking Generator module HP 70300A

System Descriptions

Three general-purpose instrument systems will be covered in this operating manual: the HP 71100A Radio Frequency Spectrum Analyzer, the HP 71200A Microwave Spectrum Analyzer, and the HP 71300A Millimeter Wave Spectrum Analyzer. When a system is ordered, the factory will insert the required modules and blank panels into the mainframe, supply the necessary intermodule cabling, and perform a functional check on the system. A limited number of options will be available with each system to allow you the flexibility in choosing displays, IF sections, frequency ranges, and types of service. The Modular Signal Analyzer System Reference program (e.g. 71000S) will enable you to order a custom system and have it configured by the factory.

In addition to the system, you may order individual modules, blank panels, and cables from the Modular Signal Analyzer equipment list. This allows you to extend the capability of previously ordered systems, stock back-up modules, and configure your own system if one of the standard systems or the system reference program does not meet your needs. When modules are ordered individually, they will be shipped together, but will not be configured as a system and given a functional check.

These systems and options are configured and given a functional check at the factory. Required cables and blank panels are included and the System is loaded into the mainframe for shipment. A one-year return-to-HP warranty is included as a standard item with each system.

HP 71100A RF Spectrum Analyzer (100Hz-2.9GHz)

HP 70001A Mainframe
HP 70205A Graphics Display
HP 70900A Local Oscillator
HP 70902A IF Section (RES BW 10Hz-300kHz)
HP 70904A RF Section (100Hz-2.9GHz)

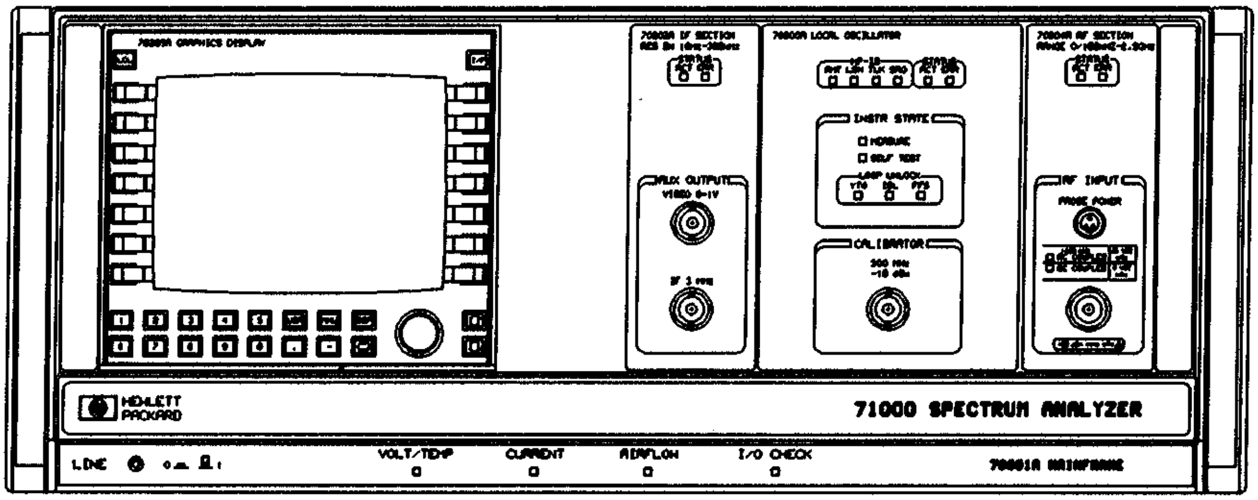


Fig. 1-13. HP 71100A Measurement System

HP 71200A Microwave S.A. (50kHz-22/26.5GHz)

HP 70001A Mainframe
HP 70205A Graphics Display
HP 70900A Local Oscillator
HP 70902A IF Section (RES BW 10Hz-300kHz)
HP 70905A RF Section (50kHz-22GHz)

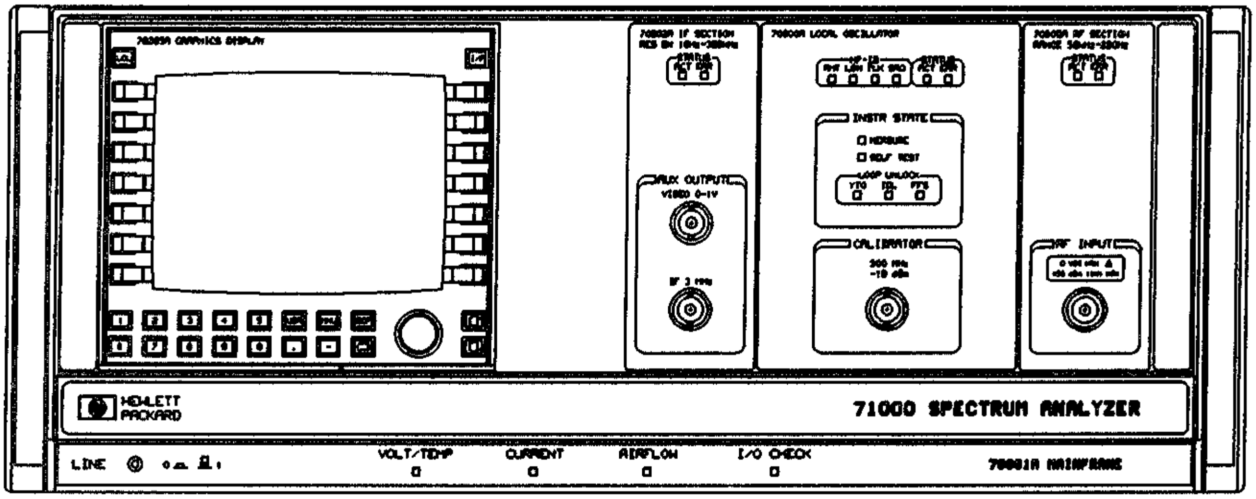


Fig. 1-14. HP 71200A Measurement System

HP 71300A Millimeter S.A.

HP 70001A Mainframe
HP 70205A Graphics Display
HP 70900A Local Oscillator
HP 70902A IF Section (RES BW 10Hz-300kHz)
HP 70907A External Mixer Interface

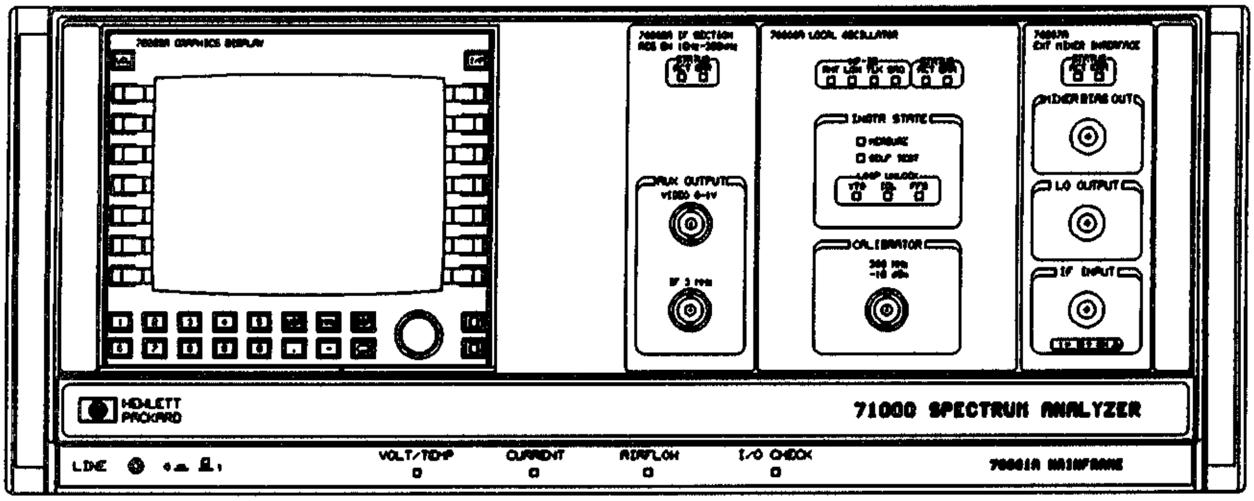


Fig. 1-15. HP 71300A Measurement System

System Options

001 Delete HP 70905A RF Section, add HP 70906A RF Section (50 kHz - 26.5 GHz), (applies to HP 71200A Microwave Spectrum Analyzer only)
002 Delete HP 70205A Graphics Display, add HP 70206A System Graphics Display (30/60 Hz Operation)
003 Delete HP 70205A Graphics Display, add HP 70206A System Graphics Display (50/60 Hz Operation)
004 Add HP 70903A IF Section (RES BW 100kHz-3MHz)
005 Delete HP 70902A IF Section, add HP 70903A IF Section (Res BW 100 kHz - 3 MHz)
908 Rack Flange Kit for mainframe or HP 70206A Display without handles
913 Rack Flange Kit for mainframe or HP 70206A Display with handles
915 Rack Mount Slide Kit for mainframe
910 Extra Manual

Support Options

The Option W30 provides, where available, an additional two years "Return-to-HP service support, commencing at the end of the standard one-year warranty.

71100 Option W30 Two (2)-Year Additional Return_to-HP Servicee
71200 Option W30 Two (2)-Year Additional Return-to-HP Service
71300 Option W30 Two (2)-Year Additional Return-to-HP Service

On-Site Service

On-site service for HP 71000 systems is available in some areas. Contact your HP sales representative for information on availability and terms.

CHAPTER 2

GETTING STARTED

Description: This chapter describes the front panel of the instrument, explains the softkey concept, and shows you how to make some typical measurements (with examples).

Introduction

This chapter is intended for both first-time and experienced spectrum analyzer users. The chapter has been partitioned into several sections and subsections. The sections describe the front panel of the instrument and the various functions of the spectrum analyzer. In addition, the sections describe how measurements are made. The subsections provide more in-depth information. At the end of this chapter are step-by-step examples for you to try.

Note: When the instrument first powers on, the set of softkeys which appears on the CRT display will contain two keys labelled ◂100/200 DIAGNST▸ and ◂71300A DIAGNST▸. See the System Support Manual for proper operation before continuing.

Front Panel Concept

The front panel of this instrument is simple and straight forward, thus allowing you to easily use this powerful instrument. When you first look at the front panel you will notice the lack of knobs and buttons. With the exception of a few "Hardkeys," softkey menus access the majority of functions. Throughout this manual, the symbol used for hardkey is [XXX]. The symbol used for softkey is ◂XXXXX▸. The following section (Softkey Concept) describes the softkey functions in greater detail.

Both key types, Hardkey ([XXX]) and Softkey (◂XXX▸), are located on the displays. There are two types of displays available with this instrument: (1) the HP 70205A Graphics Display module, which plugs into the mainframe, and (2) the HP 70206A System Graphics Display, which is a large screen stand alone display. Both units serve three main functions. In their "display" function, they show information (such as traces) from the different instruments in the system. But they provide far more than the traditional functions because they can display information from several instruments at one time on a single screen, and they update this information in real time. In their "control" function, the units control the settings and actions of instruments in the system. They provide more than the traditional control function because they can control any instrument in the system. In their "utility" function, they provide a variety of valuable aids, such as system level error reporting, system level address analysis, and direct printer and plotter output.

Fig. 2-1 below shows the HP 70205A display and keys.

There are 14 softkeys, 7 on each side of the CRT display (HP 70205A). Three hardkeys ([USR], [MNU], and [DSP]) are located underneath the CRT. Press each of the hardkeys to see its top level softkey; notice the 14 top level softkeys you will use for functional operation. There are additional softkey functions associated with some of the top level softkeys.

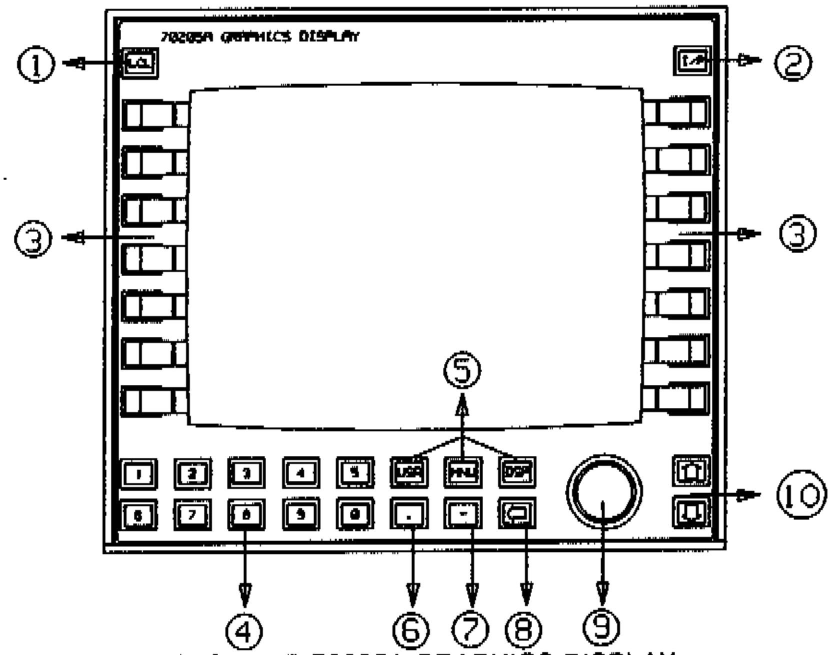


Fig.2-1. HP 70205A GRAPHICS DISPLAY

1. Local Control - This key when pressed returns the instrument to local control if it was in remote.

2. Instrument Preset - This key causes the instrument to activate all the preset conditions of the instrument.

3. Softkeys - These keys allow access to the system functions.

4. Numeric Keypad - This is the keypad for entering numeric values.

5. Hardkeys - These three keys (USR, MNU, DSP) activate the top level commands which appear on the screen next to the softkeys.

6. Decimal Pt. - This key is used for entering a decimal point when using the keypad.

7. Minus Sign - This key is used for entering negative numbers.

8. Back Space (back arrow) - This key is used to go from the lower level of softkeys to the next higher level. It is also used in programming to move the cursor to the beginning of the line.

9. Display Knob - This knob is used for changing parameter values, for selecting alpha characters and for accessing the diagnostic test.

10. Step Keys - These two keys are used for changing parameters up or down depending on which key is pressed.

Fig. 2-2 shows the location of the annotation on the CRT.

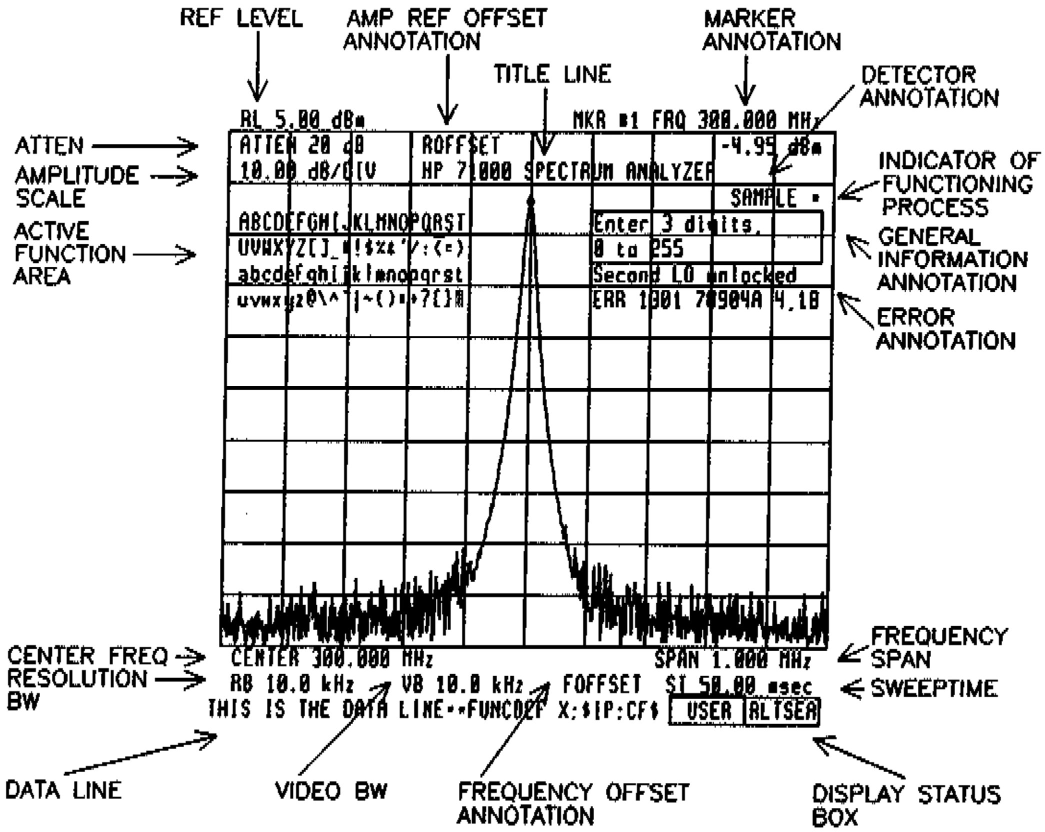


Fig.2-2. Display Annotation

Fig. 2-3 below shows the HP 70206A display and keys.

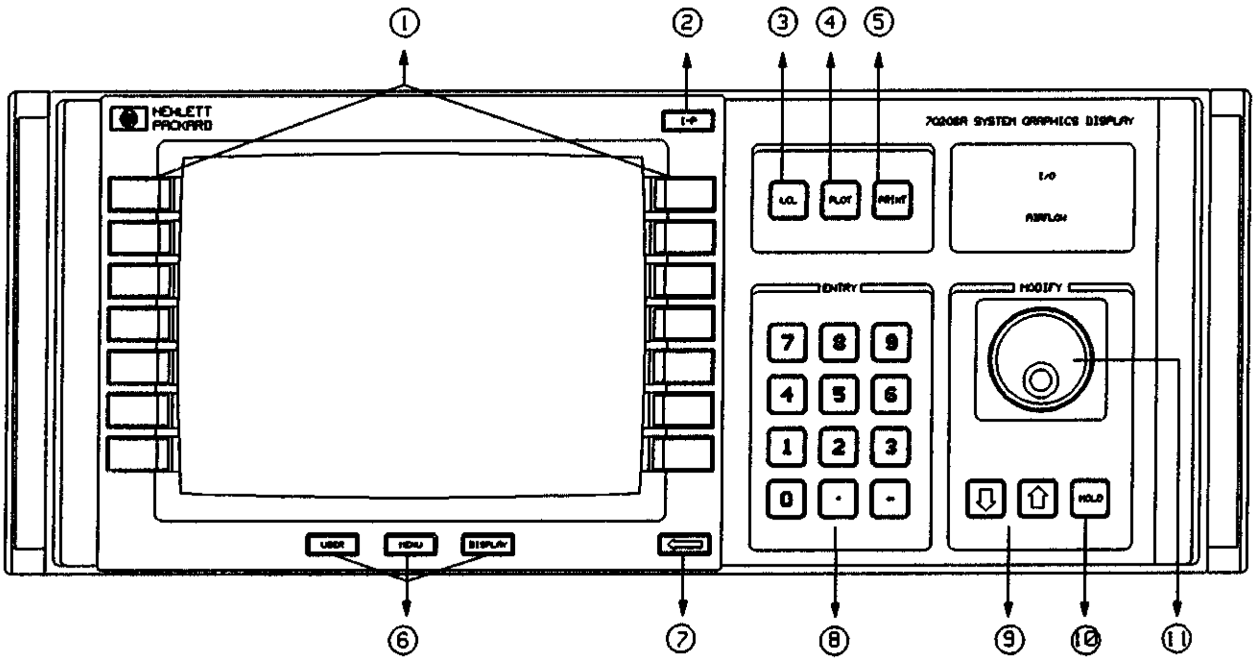


Fig. 2-3. HP 70206A SYSTEM GRAPHICS DISPLAY

1. Softkeys - These keys allow access to the system functions.

2. Instrument Preset - This key causes the instrument to activate all the preset conditions of the instrument.

3. Local Control - This key when pressed returns the instrument to local control if it was in remote.

4. Plot - This key causes the instrument to create a plot of what is on the screen.

5. Print - This key causes the instrument to print out the screen information.

6. Hardkeys - These three keys (USR, MNU, DSP) activate the top level commands which appear on the screen next to the softkeys.

7. Back Space (back arrow) - This key is used to go from the lower level of softkeys to the next higher level. It is also used in programming to move the cursor to the beginning of the line.

8. Numeric Keypad - This is the keypad for entering numeric values.

9. Step Keys - These two keys are used for changing parameters up or down depending on which key is pressed.

10. Hold - This key deactivates the function displayed in the active function area; the readout is blanked from the screen.

11. Display Knob - This knob is used for changing parameter values, for selecting alpha characters and for accessing the diagnostic test.

Fig. 2-4 shows a typical mainframe with no modules plugged in. Each of the modules were described in Chapter 1 and the display module in the previous section. The HP 70001A Mainframe is a rugged structure into which modules in varying widths can be placed. It serves two main functions. In its "life support" function, the mainframe provides power, cooling, and EMC protection for all of its modules. In its "communication" function, it manages all digital communications between modules and between mainframes. Indicators of the mainframe's condition are located on its lower part. These indicators are status LED's, and, when they are lit, report the following conditions.

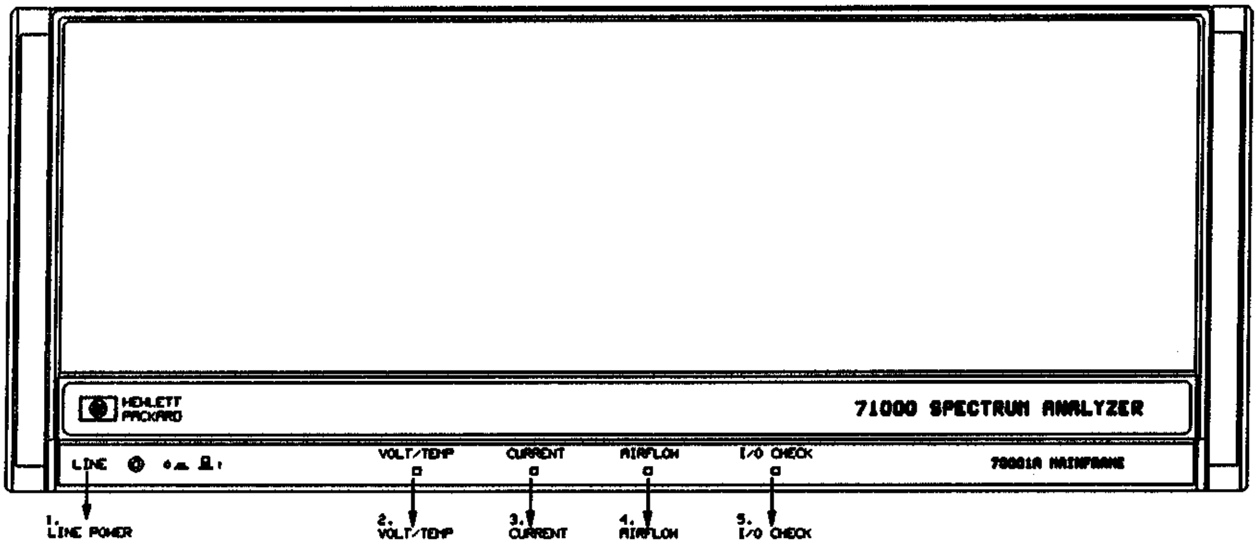


Fig. 2-4. MAINFRAME HP 70001A

1. If the power is on, the LED is lit.

2. If there is a VOLTAGE or TEMPERATURE problem, the LED is lit. (See the System Support Manual)

3. If there is a CURRENT problem, the LED is lit.

4. If there is an AIRFLOW problem, the LED is lit.

5. If there is an I/O problem, the LED is lit.

Softkey Controls

All the major functions of the spectrum analyzer are accessed through softkeys. These softkeys are accessed through hardkeys. The three hardkeys which access system level functions are labelled [USR] (USER), [MNU] (MENU) and [DSP] (DISPLAY). The [USR] and [MNU] hardkeys access functions of individual instruments (in this instance the spectrum analyzer functions). Through the [DSP] (DISPLAY) menu, you can select and control instruments which are in the system. Separate chapters discuss each of the three hardkeys.

When the instrument is first turned on, the [USR] set of softkeys appears on the CRT display. This set of softkeys, a subset of the [MNU] softkeys, is factory preset and can be changed by you (see USER chapter).

In the three chapters MENU, USER, and DISPLAY, you will find a diagram which functionally shows the top level menu and any of the associated lower level commands below it. For example, in the MENU chapter you will find a label at the top of the page which says, THE MENU SOFTKEYS; under this label are 14 softkey boxes labelled FREQ, AMP, ..., EXT MIXER representing the 14 softkeys that appear when the hardkey [MNU] is pressed. Under these 14 softkeys are many branches, representing deeper levels of softkeys. The number beside the command indicates the set of termination softkeys which appear when the command is pressed. This format is also used for the diagrams in the USER and DISPLAY chapters.

Making Measurements

The purpose of this section is to introduce you to some of the main features of the spectrum analyzer. In addition, you will be shown how easily measurements are made with this system. Follow the step-by-step instructions through TUNE, ZOOM, and MEASURE. The softkeys to be pressed will be listed in the left column. In the right column is an explanation of the softkey you selected. The figures are samples of the displays that you will see.

Connect the Cal signal to the RF input. (The figures below where taken using a RF spectrum analyzer and could look different (wider span) on other analyzers).

SOFTKEYS:	**EXPLANATION/FIGURES:**
1. TUNE	
SELECT ◀CENTER FREQ▶	This softkey allows you to change the center frequency of the analyzer.

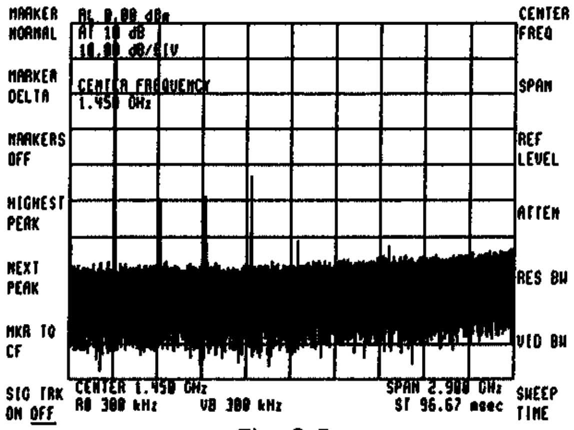


Fig. 2-5

SELECT [3], [0], [0] and ◀MHz▶	These keys select 300 MHz as the center frequency of the analyzer.

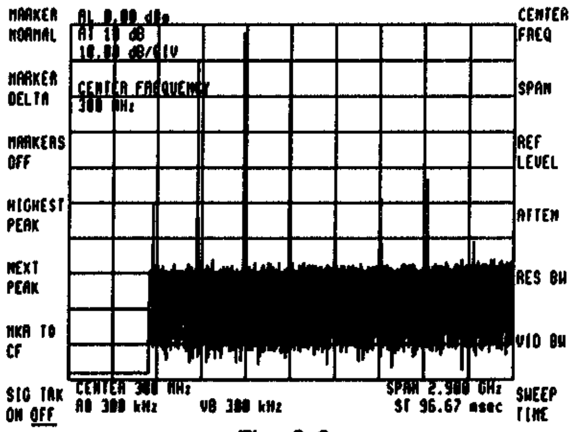


Fig. 2-6

SOFTKEYS: | **EXPLANATION/FIGURES:**

2. ZOOM

SELECT ◀SPAN▶

This softkey allows you to change the span of the analyzer.

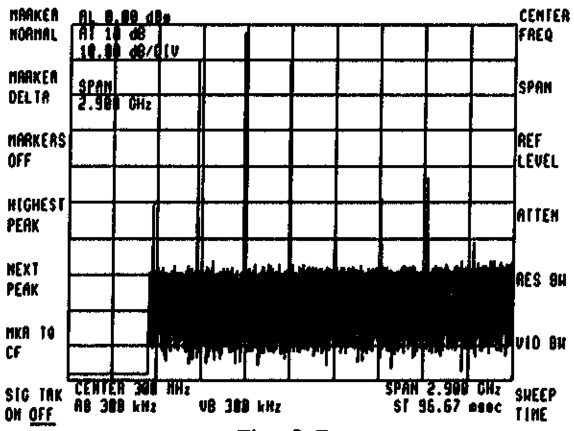


Fig. 2-7

SELECT [1] and ◀MHz▶

These keys select 1 MHz as the span. In other words, the start frequency is 299.5MHz and the stop frequency is 300.5MHz.

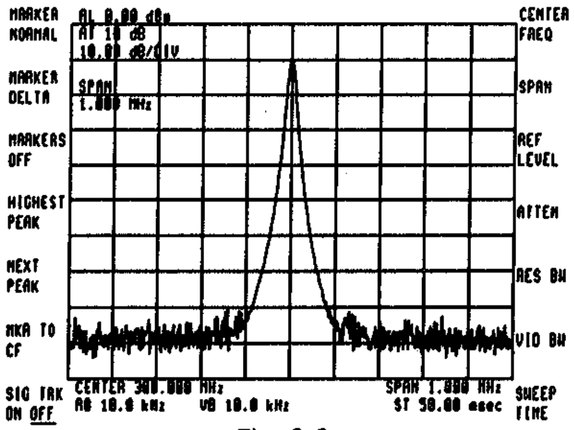


Fig. 2-8

SOFTKEYS:	EXPLANATION/FIGURES:
3. MEASURE	
SELECT ◀HIGHEST PEAK▶	This softkey places a marker at the highest peak. Then the frequency and amplitude can be read directly from the annotation.

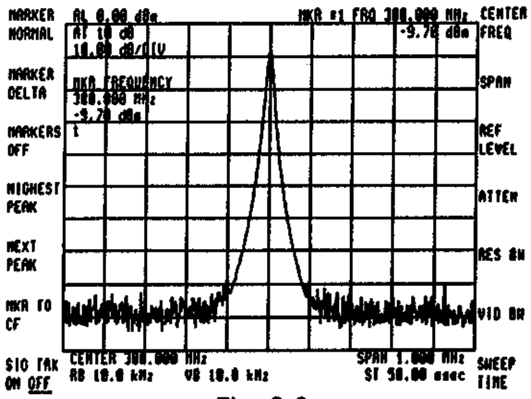


Fig. 2-9

All secondary analyzer functions (resolution bandwidth, video bandwidth, sweep time and attenuation) were automatically adjusted (coupled) to maintain a fully calibrated display. These coupled functions can also be uncoupled to allow manual operation.

Auto to Manual Example:

To manually control the different functions or to uncouple them you select the function and enter the value. Notice the asterisk beside the annotation to indicate the function is uncoupled. See the example below

Select ◀RES BW▶ and then turn the display KNOB and notice the BW changing. It changes in 10% increments.

This causes the resolution bandwidth to be fixed. It is no longer automatically determined.

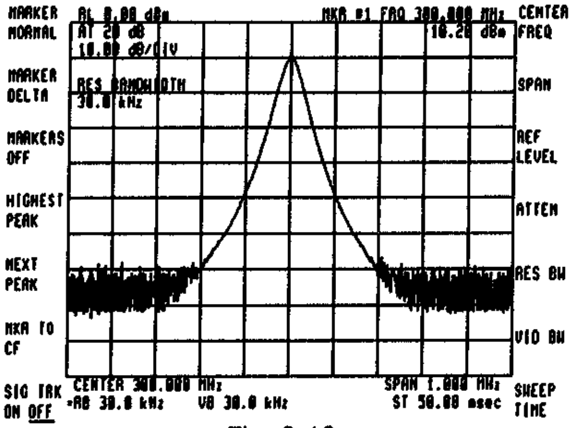


Fig. 2-10

SELECT [1] and then ◀AUTO▶.

This puts the function resolution bandwidth back into the coupled mode and back to 10kHz, the preset value.

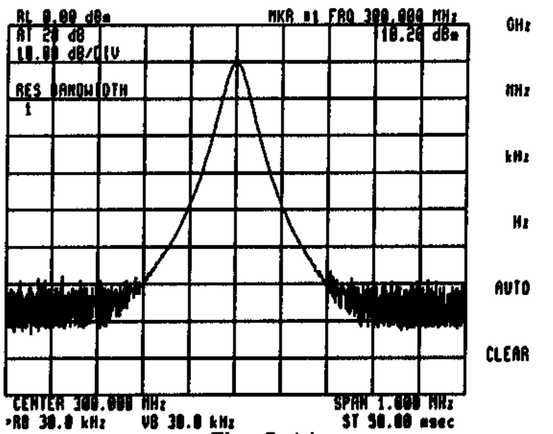


Fig. 2-11

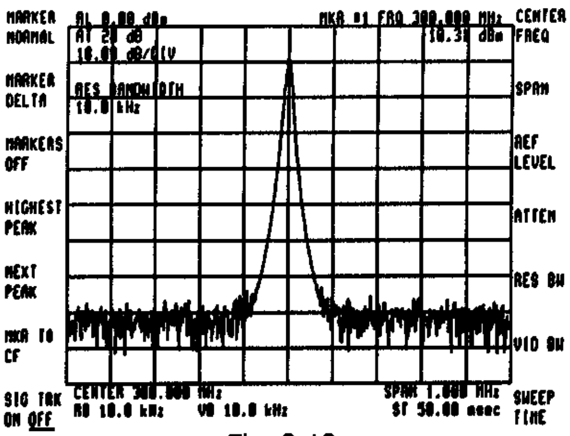


Fig. 2-12

Marker Examples:

Markers can be used to quickly identify signal frequency and amplitudes. The delta markers are available to measure signal separation or amplitude differences.

SOFTKEYS: / EXPLANATION/FIGURES:

SELECT ◀MARKERS OFF▶, ◀SPAN▶

This turns off the markers and brings span to the active function area of the analyzer.

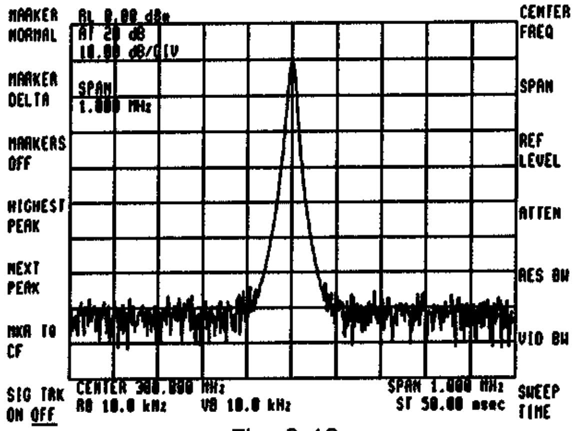


Fig. 2-13

SELECT [6], [0], [0] and ◀MHz▶

These keys select 600 MHz as the span.

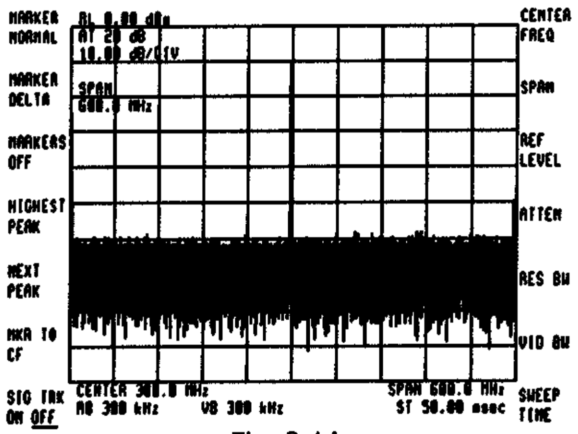


Fig. 2-14

SOFTKEYS: | **EXPLANATION/FIGURES:**

SELECT ◀CENTER FREQ▶ and then [4], [5], [0] and ◀MHz▶

This softkey allows you to change the center frequency of the analyzer. These keys select 450 MHz as the center frequency of the analyzer. It also shows the second harmonic of the Cal signal.

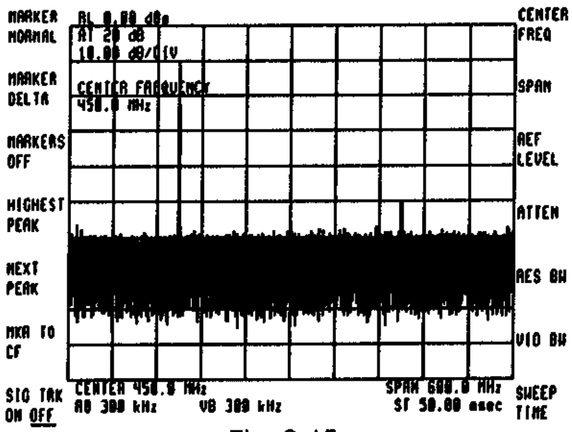


Fig. 2-15

SELECT ◀HIGHEST PEAK▶

Selecting highest peak places a marker on the highest peak signal and you can measure frequency and amplitude directly.

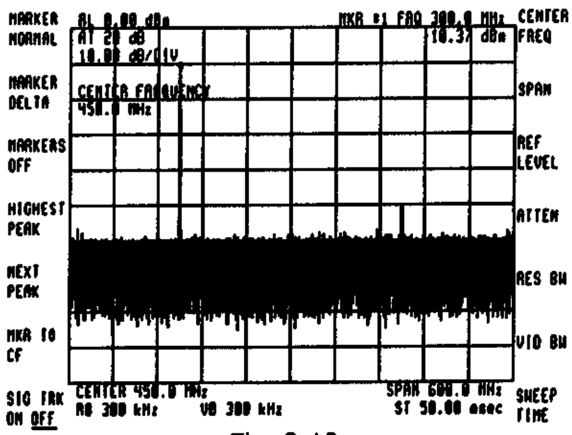


Fig. 2-16

SOFTKEYS: | **EXPLANATION/FIGURES:**

SELECT ◀MARKER DELTA▶

This places a second marker at the same place as the normal marker. The second marker can be moved by several methods; step keys, display knob, or key pad enter, finally, by select a marker function as below.

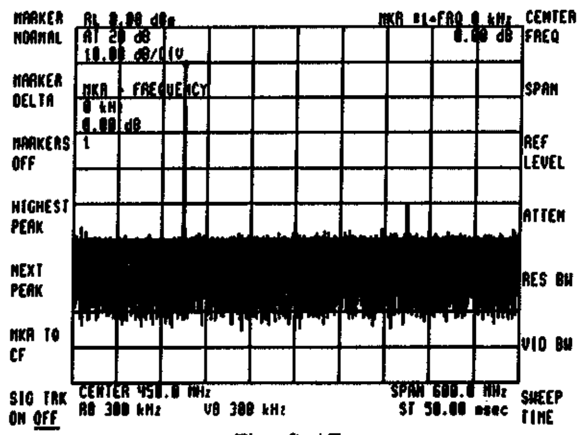


Fig. 2-17

SELECT ◀NEXT PEAK▶

This places the Delta Marker on the second harmonic of the Cal signal and the amplitude and frequency can be read from the annotation.

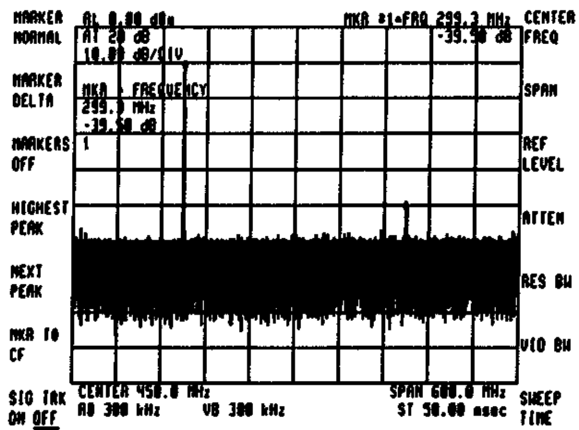


Fig. 2-18

These last examples show some of the capabilities of the markers for making fast and accurate measurements. Refer to the Marker section under MNU Hardkey for more details.

CHAPTER 3

USR HARDKEY

Description: This chapter explains how to use the [USR] (hardkey) and how to select and change softkeys. It also shows how to go from automatic to manual coupling and back using a set of softkeys.

Introduction

This chapter describes the [USR] hardkey (or fixed- label key). The softkeys associated with this key appear when the instrument is first turned on. These softkeys allow access to the spectrum analyzer functions most often used. Typical measurements (such as reading frequency and amplitude of signals) can be set up and made with this set of softkey functions.

These softkeys can be replaced or changed by the user in two ways:

1. By using the "DEFINE UDK" function described in this chapter.

2. By programming the softkey using the downloadable feature (keydef) described in Part II Remote Operation.

Figure 3-1 shows the softkeys which appear when [USR] (hardkey) is pressed.

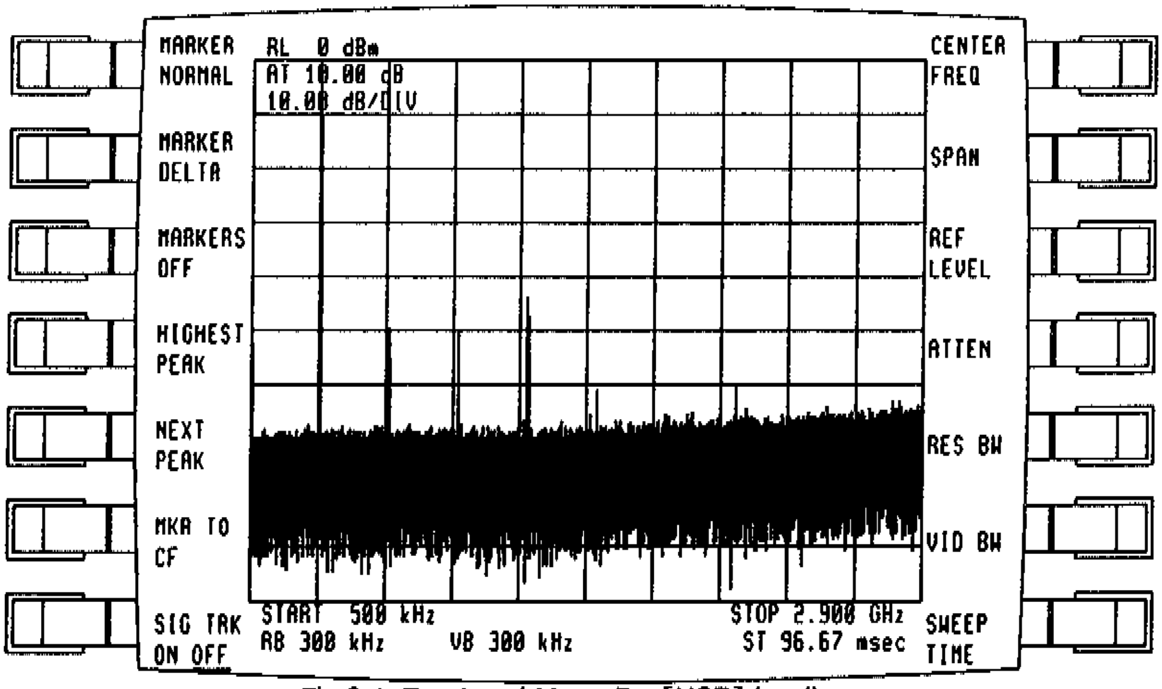
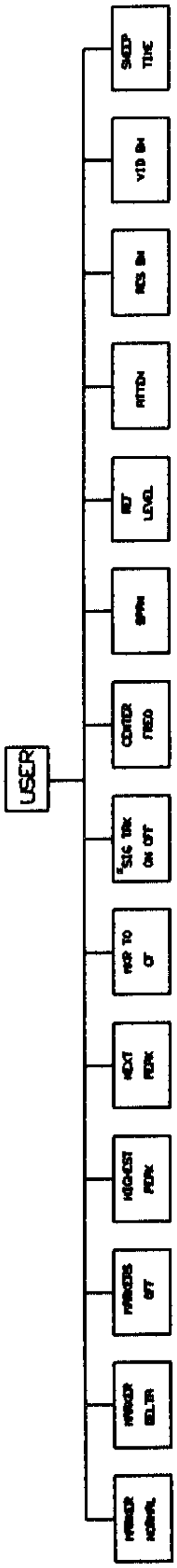


Fig.3-1. Top Level Menu For [USR] hardkey

Figure 3-2 shows the softkeys in a menu tree format.



*When instrument is first shipped from the factory, <100/200 DIAGNST> and <71300A DIAGNST> will appear. See System Support Manual for details.

Fig. 3-2

Using [USR] hardkey

The [USR] hardkey selects a set of frequently used spectrum analyzer functions. Fourteen softkeys that access these functions appear when the instrument is first turned on, when instrument preset is pressed, or when the [USR] key is pressed.

To activate any one of them, press the softkey and enter the value wanted.

Defining Your Own Softkey Function

To define your own softkey function, you must use the ◀DEFINE UDK▶ function. To do this, select [MNU], then ◀SPECIAL FUNCTION▶, and then ◀DEFINE UDK▶. The example below shows how to make START FREQ one of the "USER" softkeys.

Select [MNU] and then ◀SPECIAL FUNCTIONS▶.

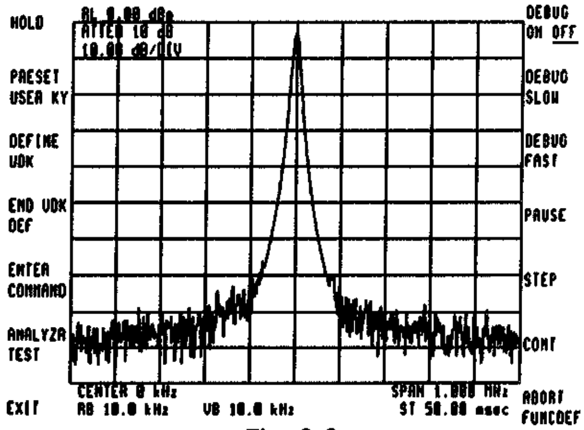


Fig. 3-3

Select ◀DEFINE UDK▶. Notice that the softkeys change back to the MENU set, and the annotation asks you to select a function.

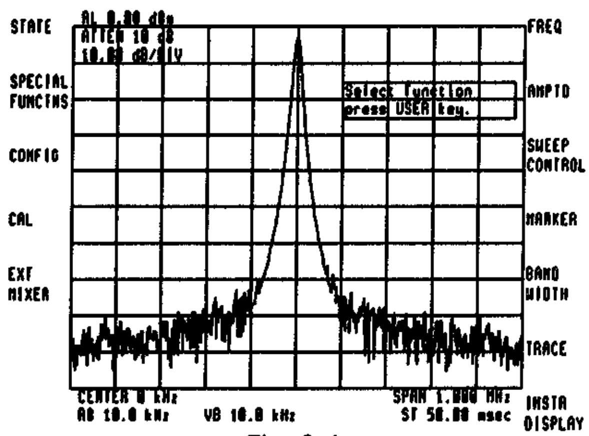


Fig. 3-4

Select ◀FREQ▶, then select ◀START FREQ▶. The annotation asks you to select [USR] then the softkey that you want to redefine.

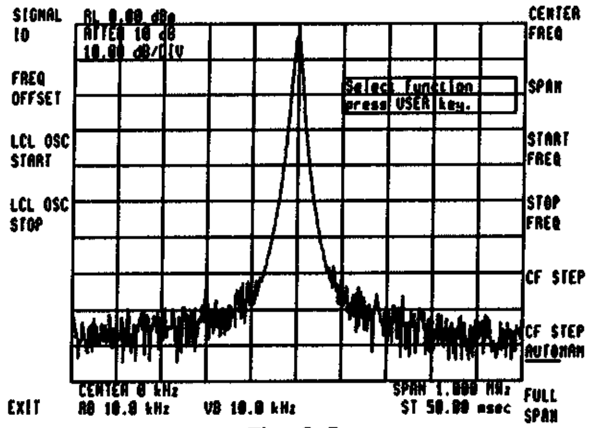


Fig. 3-5

Select ◀CENTER FREQ▶. Notice that the softkey now changes to ◀START FREQ▶ instead of ◀CENTER FREQ▶.

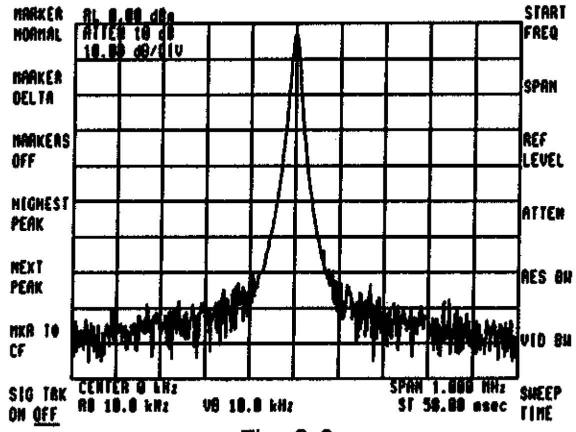


Fig. 3-6

Selecting Auto Function

To return to an Auto (or coupled) function from the User menu, select the function you want and then enter any number on the keyboard. A set of terminator softkeys will appear, one of which is ◀Auto▶. Press this key and the function will return to auto if it had been in the manual mode previously.

In the example below, the resolution bandwidth softkey ◀RES BW▶ was selected and the number 1 was entered on the keypad.

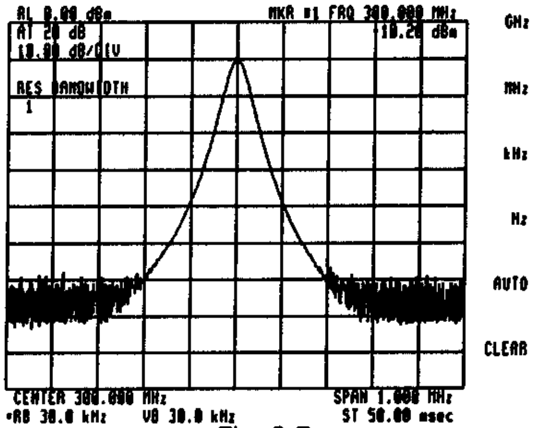


Fig. 3-7

CHAPTER 4

MNU HARDKEY

DESCRIPTION: This chapter provides an overview of the "MNU" hardkey. In addition, it shows you how to select different functions of the spectrum analyzer.

Introduction

This chapter describes in detail the functions accessed by pressing [MNU] (hardkey). This includes the major spectrum analyzer functions.

Top Level Softkeys

Figure 4-1 shows the 14 softkeys which appear when [MNU] is pressed.

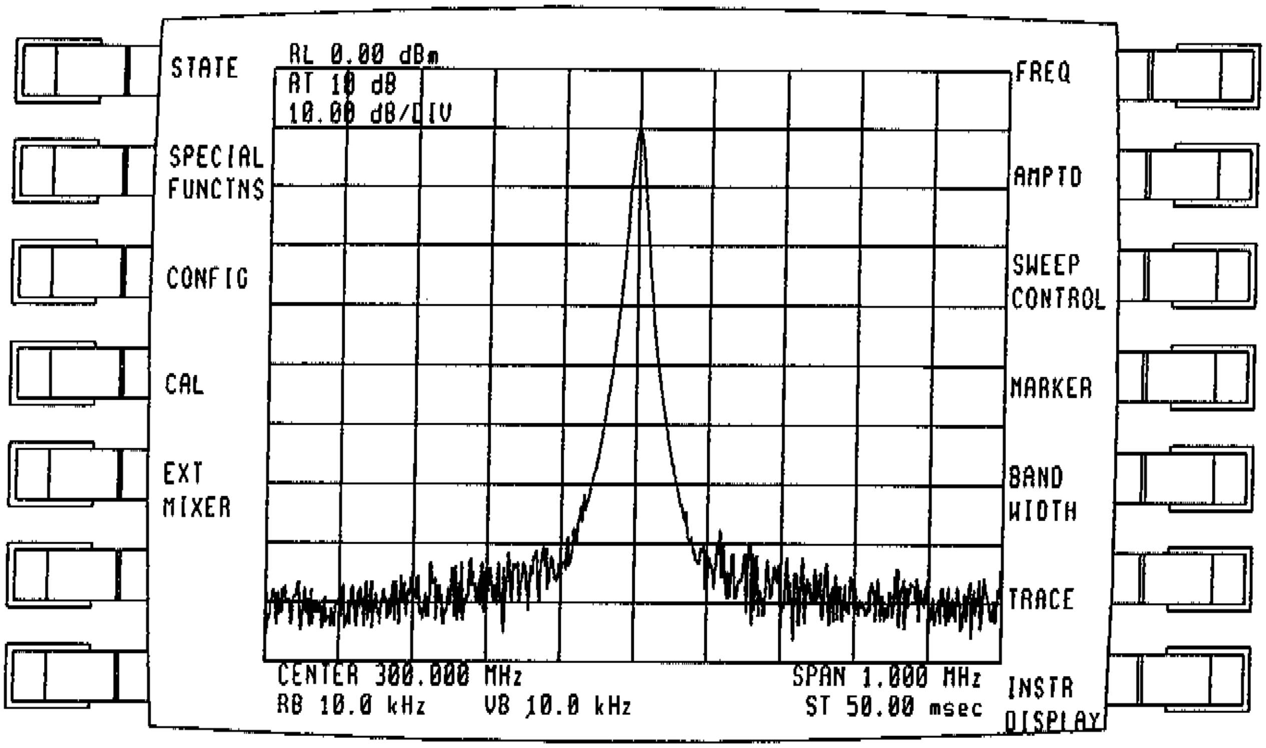


Fig.4-1. Top level menu for [MNU] hardkey

At the top of figure 4-2 is a label THE MENU SOFTKEYS, representing the [MNU] hardkey. Under this label are 14 boxes labelled FREQ, AMPL ..., EXT MIXER, representing the 14 softkeys which appear when [MNU] is pressed. If a tracking generator is in the system and activated, the softkey SOURCE will appear after EXT MIXER. Under these 14 softkeys are many branches, representing deeper levels of softkeys.

FIG. 4-2
Sht 1 of 4

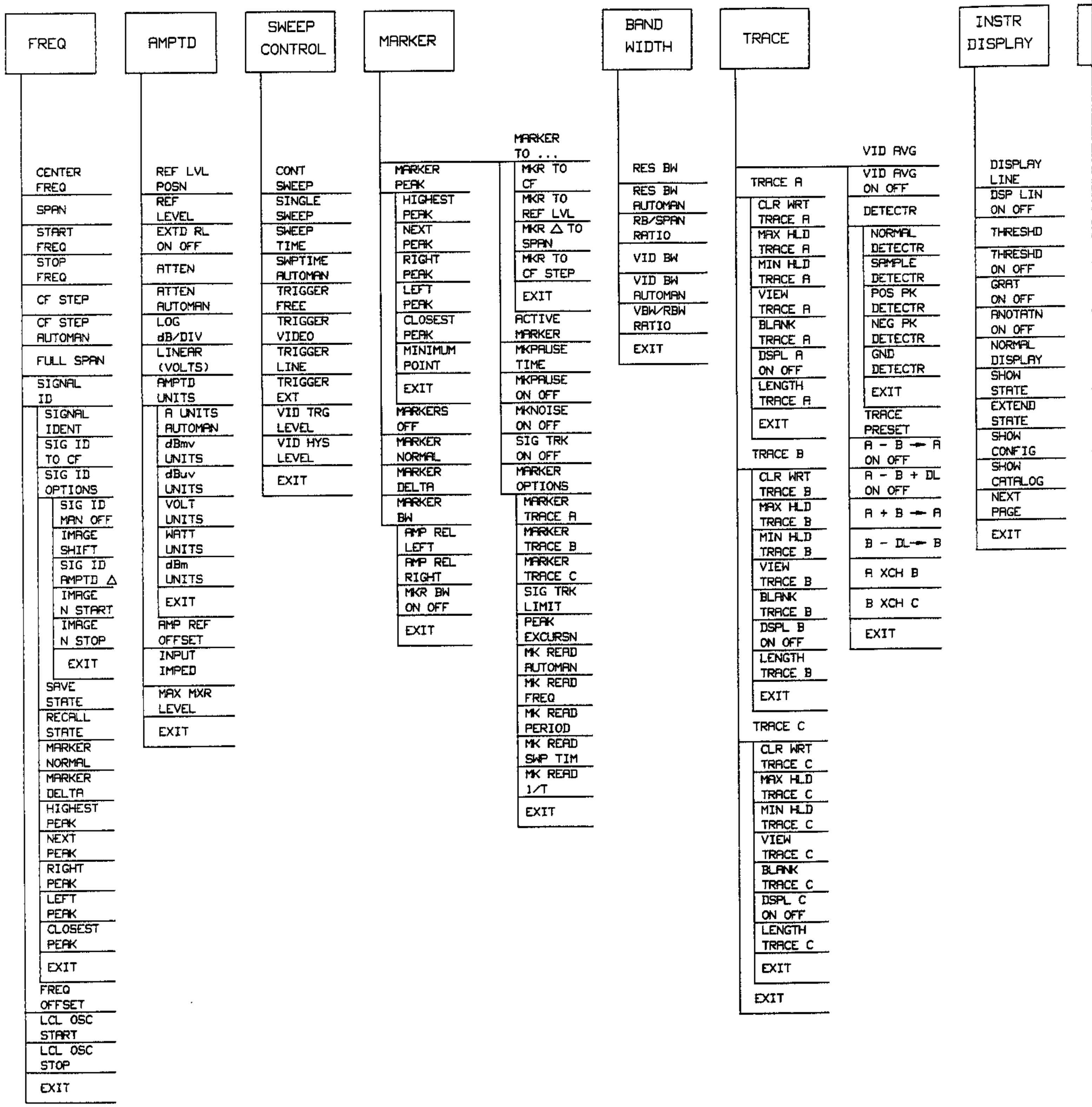


FIG. 4-2
Sht 2 of 4

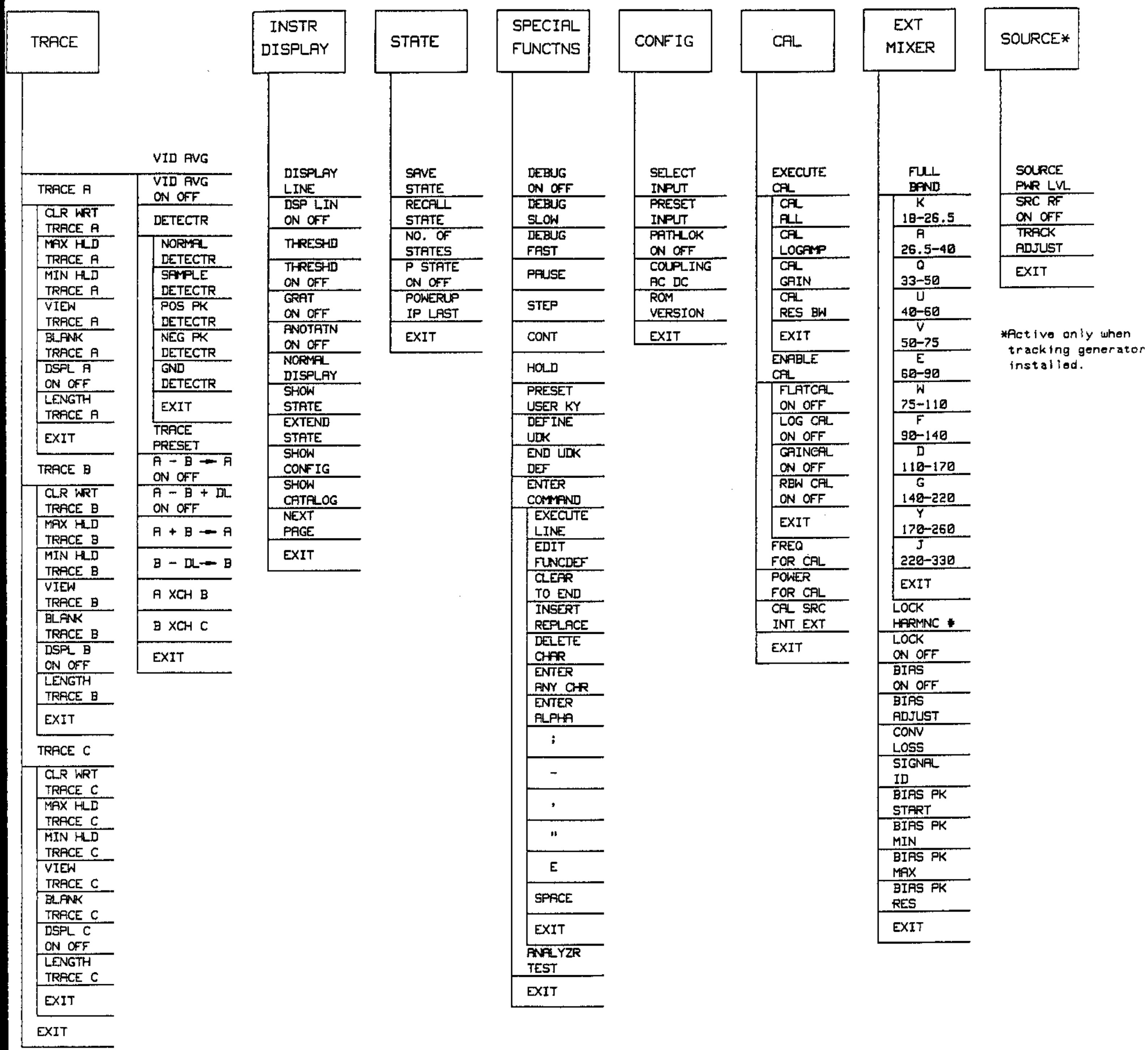


Figure 4-2. The MENU Softkeys

FIG. 4-2
Sht 3 of 4

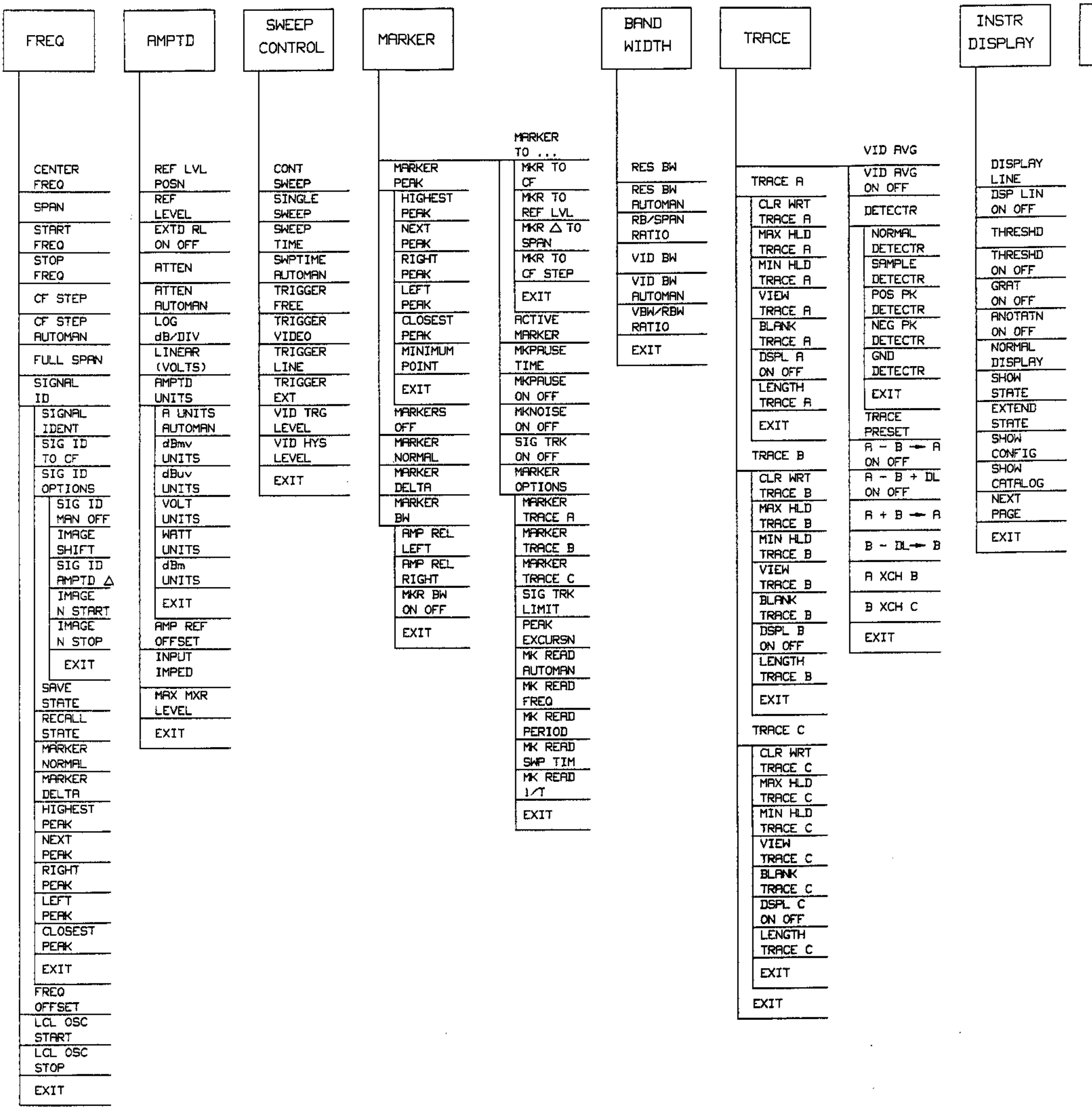
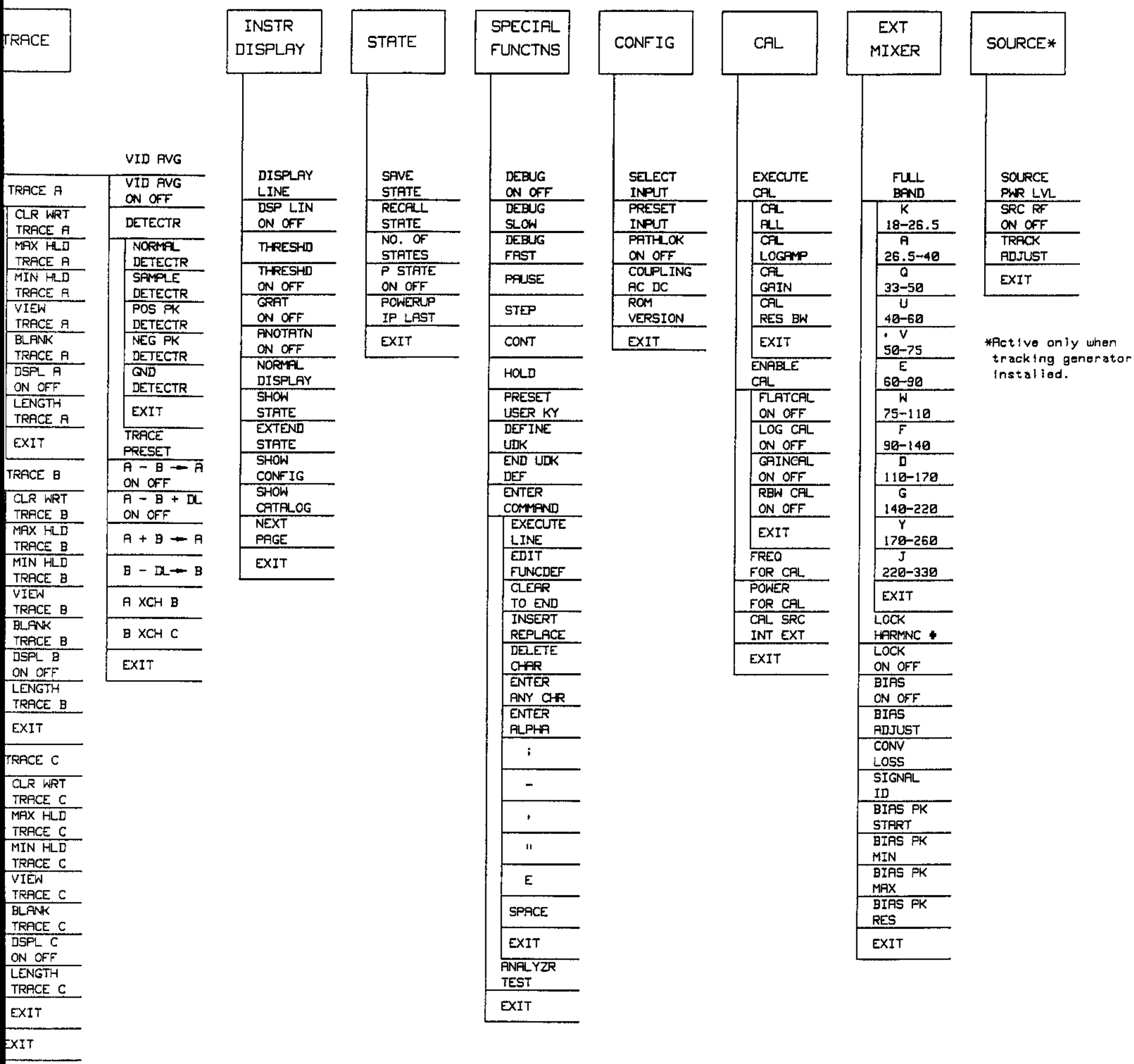


FIG. 4-2
Sht 4 of 4



The sections in Part I are organized in the following manner:

Frequency

This section describes softkeys that change frequency settings or identify signals.

Amplitude

This section describes softkeys that change amplitude reference or attenuator settings and display scale setting functions.

Sweep Control

This section describes softkeys that change trigger mode settings or sweep time settings. It also describes softkeys that change sweep mode settings.

Marker

This section describes softkeys that use markers to make faster and more accurate measurements.

Bandwidth

This section describes softkeys that change resolution bandwidth settings.

Trace

This section describes softkeys that use the TRACE functions for writing, storing, and manipulating trace data. It also describes the softkeys used to select the detector functions.

Instrument Display

This section describes softkeys that change instrument display settings or annotation settings.

State

This section describes softkeys for saving or recalling trace displays. It also describes how to set up the spectrum analyzer's power-up state.

Special Function

This section describes softkeys you will use to select the memory display function and to re-label your own softkeys. It describes how to write, execute, and debug your own programs from the front panel. It also describes the softkeys you will use to perform an analyzer self test.

Configuration

This section describes softkeys that select the input source or the coupling mode. It also describes how to find the version of firmware in the instrument and how to lock the path of measurement into the instrument.

Calibration

This section describes softkeys used to calibrate the amplitude, the resolution, the bandwidth, the frequency, and the log amplifier. It also describes how correction features are set.

External Mixer

This section explains how to set up an external mixer using softkeys. It also describes the Bias circuitry set up.

Frequency

This section describes softkeys which change frequency settings or identify signals. Figure 4-3 shows the softkeys which appear when ◀FREQ▶ (softkey) is pressed.

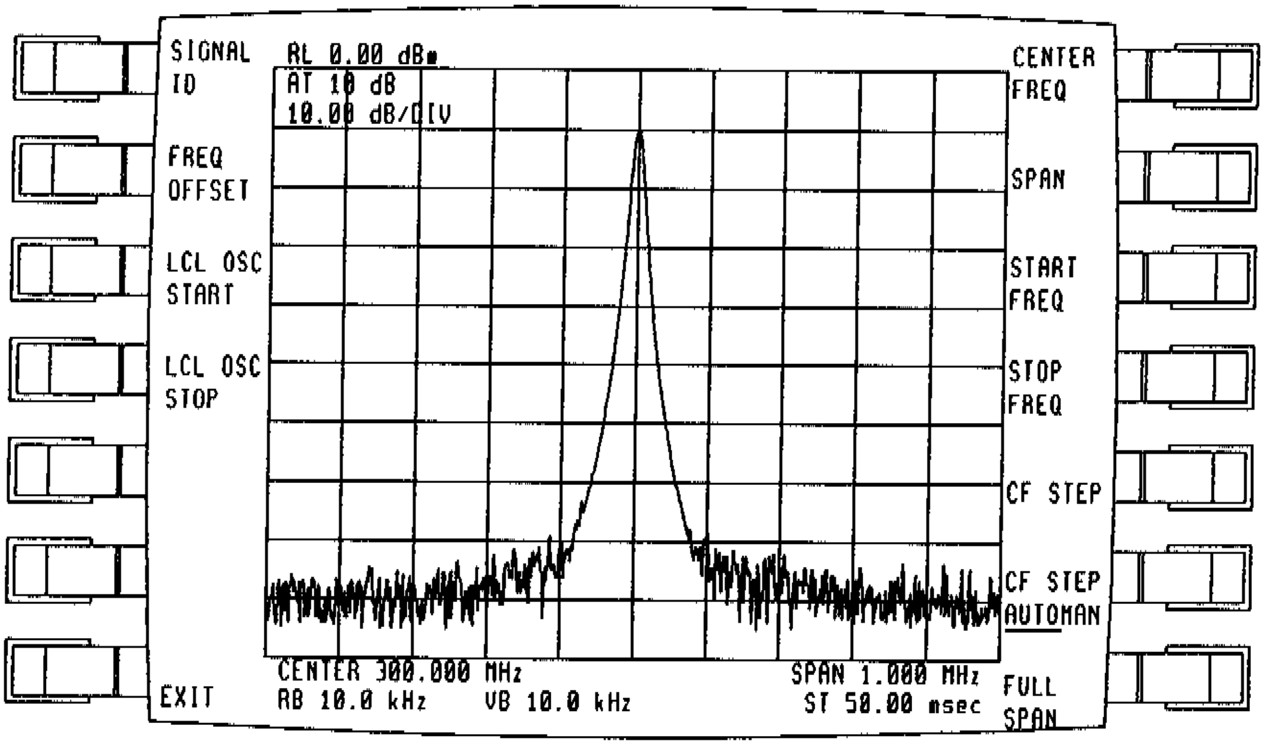
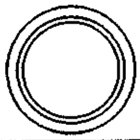
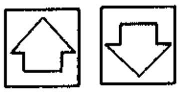


Fig.4-3. Top level menu for ◀FREQ▶

Center Frequency

To adjust center frequency select the ◀FREQ▶ softkey and then select the ◀CENTER FREQ▶ softkey. The center frequency can be tuned continuously from 0-2.9 GHz (0-26.5 GHz for the microwave spectrum analyzer). The center frequency can be set with 1 Hz resolution. Readout resolution is for span greater than 0 it is 1 divided by trace-length times frequency of span; for span equal to 0 it is 1 divided by 10 times RBW, hence the highest readout resolution is obtained with narrow frequency spans. Data entered, however, is stored to a resolution of 1 Hz even though the center frequency readout may display less resolution.

Three methods of setting CENTER FREQUENCY are shown below:

KNOB		Changes the center frequency by an amount dependent on how fast or slow the knob is turned. Turning faster causes a larger change vs slow for a small change.
STEP KEYS		Changes the center frequency by one tenth of the frequency span, i.e., by one division. ◀CF STEP▶ can be used to change this step size.
KEY PAD	0 1 2 3 4 5 6 7 8 9	Allows direct center frequency entry. The analyzer will accept a center frequency with 1 Hz resolution. Even though the readout may show a fewer number of digits (due to wide frequency span), as the span is narrowed, the full entry will be readout. Abbreviated readouts are rounded.

Example:

A signal can be tuned to the center of the display by pressing ◀CENTER FREQ▶, then turning the display knob, pressing the step keys, or using the numeric key pad. The frequency of the center of the display can be read from the active function at the center left of the display or from the center frequency annotation at the lower left of the display.

Connect CAL OUTPUT to RF INPUT, then press [I/P] for a full span display.

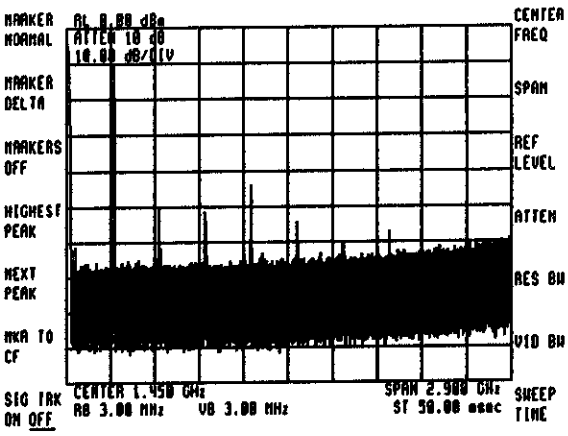


Fig.4-4. This display is for a 2.9 GHz RF section. The display will look different (wider span) for a 22 or 26.5 GHz RF section.

Select [MNU] and then select ◀FREQ▶; finally, select ◀CENTER FREQ▶. Tune signal to center of display with the knob.

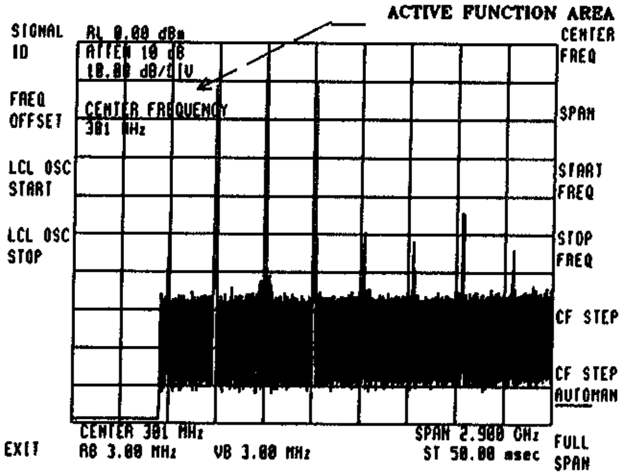


Fig.4-5

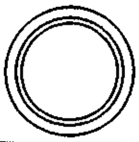
Span

The frequency span changes the total display frequency range symmetrically about the center frequency. Note that the frequency span readout refers to the total display frequency range; to determine frequency span per division, divide by 10.

As the frequency span is changed, resolution bandwidth and video bandwidth automatically change to provide a predetermined level of resolution and noise averaging respectively. Sweep time also changes automatically to maintain a calibrated display.

The analyzer's span can be adjusted from 0 to 2.9 GHz in the low band and 0 to 26.5 GHz in the microwave band. The zero span enables the analyzer to function as a fixed-tuned receiver and the zero span can display modulation waveforms in the time domain.

Three methods of setting SPAN are shown below:

KNOB		Changes the frequency span continuously.
STEP KEYS		Changes the frequency span to the next value in a 1,2,5,10 sequence.
KEY PAD	0 1 2 3 4 5 6 7 8 9	Enters an exact value depending on span. Resolution is read to less than 1 Hz.

Example:

◀SPAN▶ to zoom-in on signals.

Connect CAL OUTPUT to RF INPUT, then press [I/P]. This selects a convenient full span display from 0 to 2.9GHz (0-26.5 GHz microwave spectrum analyzer).

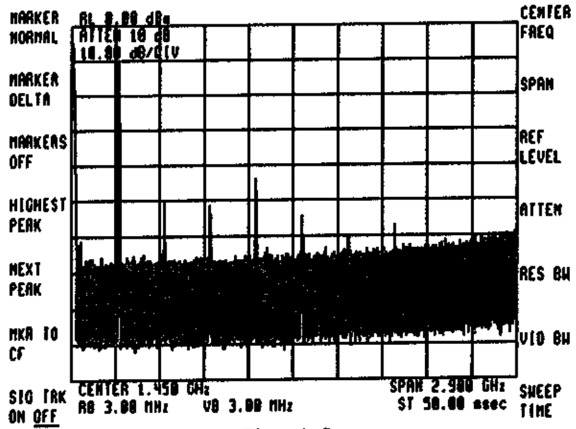


Fig. 4-6

Select [MNU] and then select ◀FREQ▶. Tune center frequency to 300 MHz by pressing ◀CENTER FREQ▶, then enter [3], [0], [0], ◀MHz▶.

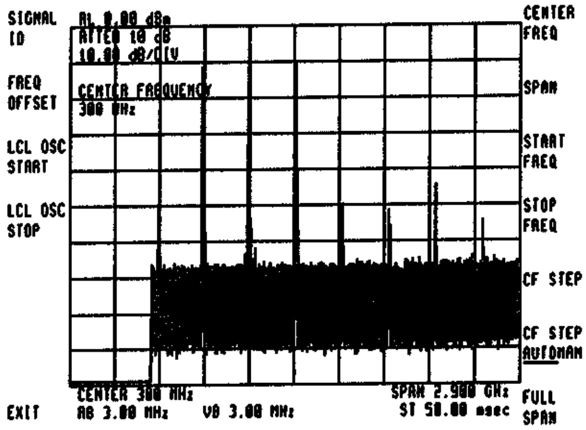


Fig. 4-7

To reduce the span press ◀SPAN▶, then select the step keys or the knob. The desired span can also be selected with the numeric keyboard. Note that narrow frequency spans provide increased center frequency resolution.

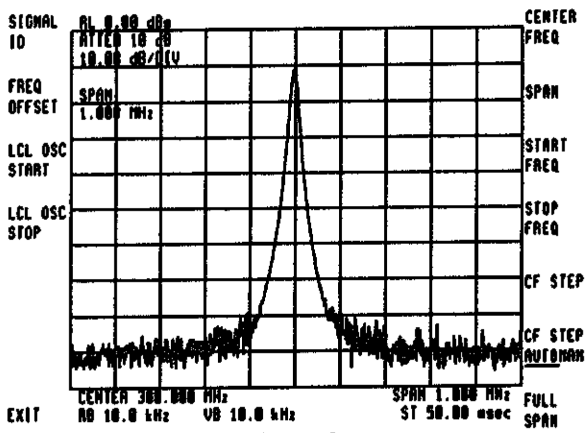


Fig. 4-8

Example:

By operating the spectrum analyzer in zero span the modulation waveform of an AM signal can be displayed in the time domain.

In the frequency domain, the analyzer can accurately determine the modulation frequency and level.

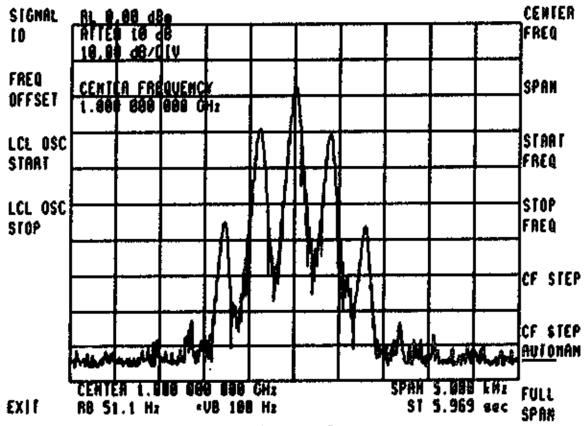


Fig. 4-9

To demodulate the AM, increase the resolution bandwidth to include both sidebands within the IF passband. Press ◀BANDWIDTH▶, then ◀RES BW▶ and then use the step keys.

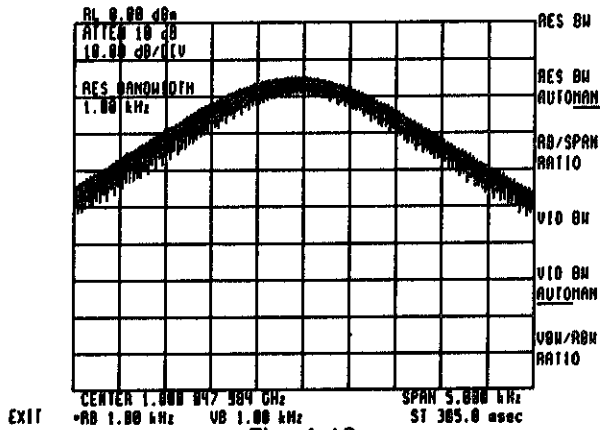


Fig. 4-10

Position the signal at the reference level and select a linear voltage display. Press ◀AMPTD▶, then ◀REF LEVEL▶, and then use the knob. Press ◀LINEAR▶.

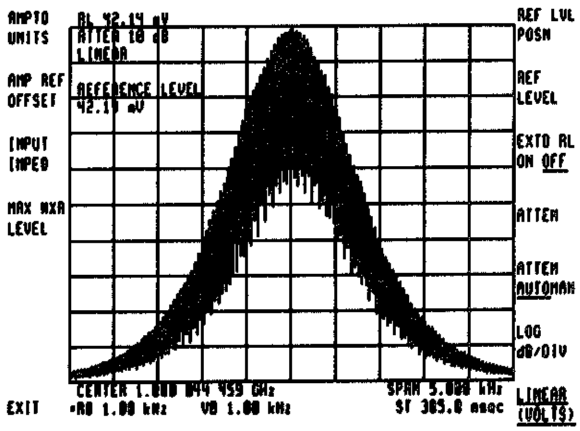


Fig. 4-11

To select zero span, press ◀FREQ▶, ◀SPAN▶, and then enter 0 Hz. Video Trigger can be used to trigger on the waveform. The sweep time control can be adjusted to change the horizontal scale.

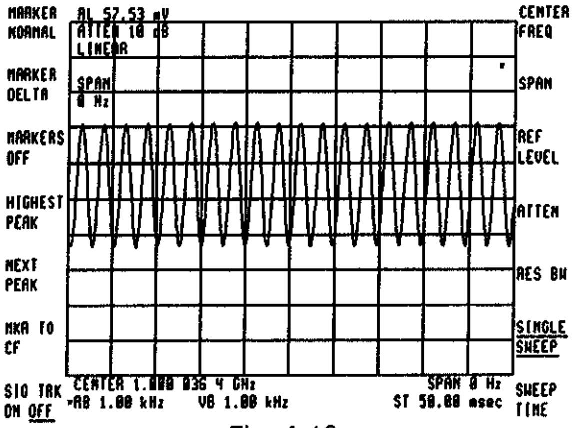


Fig. 4-12

Start/Stop Frequency

Another way to adjust the frequency range is by using ◀START FREQ▶ and ◀STOP FREQ▶ instead of ◀CENTER FREQ▶ and ◀SPAN▶. Activating ◀START FREQ▶ or ◀STOP FREQ▶ causes both to read out in place of ◀CENTER FREQ▶ and ◀SPAN▶ on the CRT. ◀START FREQ▶ sets the left graticule frequency and ◀STOP FREQ▶ sets the right graticule frequency; both are mutually exclusive with ◀CENTER FREQ▶ and ◀SPAN▶.

The instrument's [I/P] or ◀FULL SPAN▶ selects a start/stop frequency from 0-2.9 GHz (0-26.5 GHz for mircowave spectrum analyzers). The maximum start/stop frequency span allowable is 26.5 GHz. The minimum span is 0 Hz (Start Freq = Stop Freq).

Start/Stop frequency readout resolution is for span greater than 0 it is 1 divided by trace-length times frequency of span; for span = 0 it is 1 divided by 10 times RBW (span= stop frequency - start frequency).

Three methods of setting START FREQ and STOP FREQ are shown below:

KNOB	Changes the start or stop frequency. The amount of change is dependent upon the rate of change of the knob. Turning faster causes a larger change vs slow for a small change.
STEP KEYS	Changes the frequency by one tenth of the total frequency span.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Exact start or stop frequencies can be entered. The number of digits readout depends upon the frequency span.

Example:

Set start/stop frequency to monitor the FM broadcast band. The input signal is from an FM antenna.

Press [I/P], [MNU], then press ◂FREQ▸, then ◂START FREQ▸, and enter [8], [8], ◂MHz▸ on the keyboard. Press ◂ STOP FREQ▸ and enter [1], [0], [8], ◂MHz▸ on the keyboard.

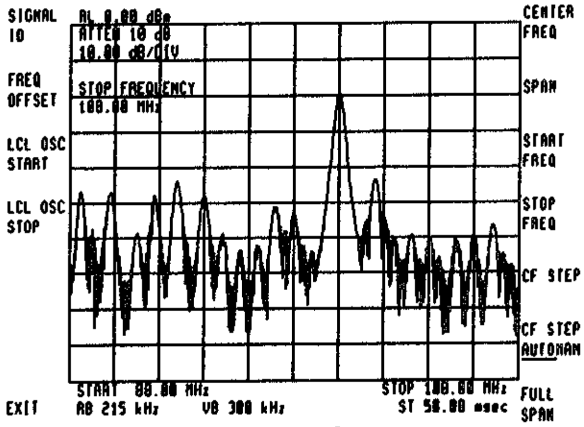


Fig. 4-13

Press ◂CENTER FREQ▸. Note that horizontal scaling is unchanged although the Start/Stop frequency readouts are replaced by center frequency and span (108 - 88 = 20 MHz).

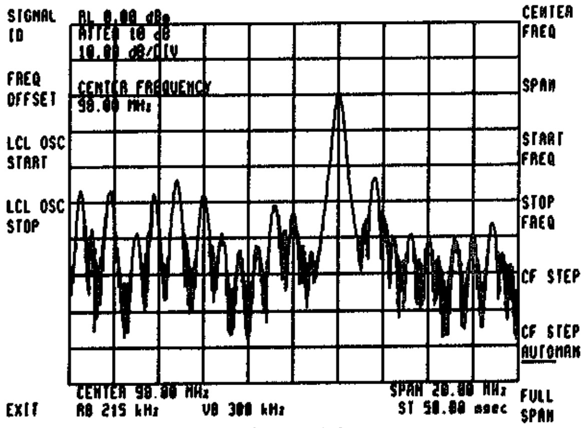


Fig. 4-14

CF Step

Pressing ◂CF STEP▸ sets step size to manual, changes and stores the step size entered into a register. This also causes the underline in the ◂CF STEP AUTOMAN▸ to change from auto to manual ◂CF STEP AUTOMAN▸. (It is only changed to manual if a value is entered.) By pressing ◂CF STEP AUTOMAN▸, the analyzer will go to the auto position again. While ◂CF STEP AUTOMAN▸ is in manual, press ◂CENTER FREQ▸ and the down step key changes center frequency by the step size value stored in the register. Several functions can be used to enter step size values to the register. When a ◂CF STEP AUTOMAN▸ is auto, the center frequency steps will be 10% of the frequency span. When in AUTO, the cf-step (register) will always contain 10% of span.

The step size can be varied from 0 Hz to greater than 20 GHz with 1 Hz resolution. It is displayed with the same resolution as center frequency. See the figure below. Notice the step size is 10% (2 MHz) of the span (20 MHz).

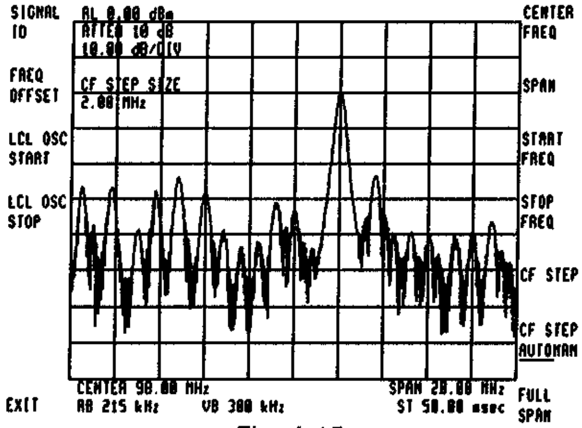


Fig. 4-15

Three methods of setting CF STEP SIZE are shown below:

KNOB	Changes the step size in display unit increments.
STEP KEYS	Changes the step size to the next step value in 1, 2, 5, 10 sequence.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Selects a specific step size to a resolution equal to the current center frequency readout.

Example:

Surveillance of a wide frequency span sometimes requires high resolution. One fast way to achieve this is to take the span in sequential pieces using a tailored center frequency step. This example looks from 0 Hz to 2.5 GHz in 50 MHz spans.

First set the span and center frequency. For a span of 50 MHz press ◀FREQ▶ then ◀SPAN▶ then enter 50 MHz on the keyboard. Set the center frequency to 25 MHz by pressing ◀CENTER FREQ▶ then entering 25 MHz on the keyboard.

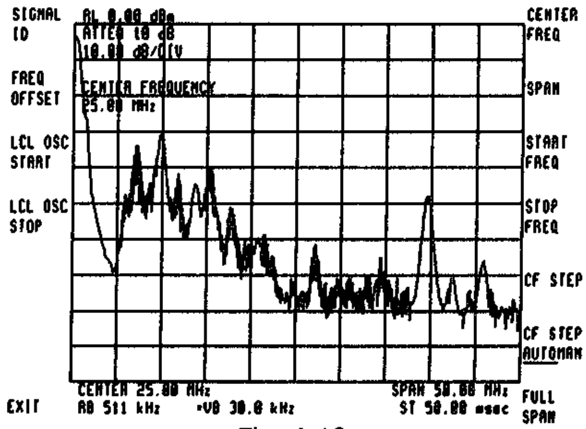


Fig. 4-16

Set the step size to 50 MHz by entering ◀CF STEP▶ then entering 50 MHz on the keyboard; reactivate center frequency with ◀CENTER FREQ▶ and step to 175 MHz.

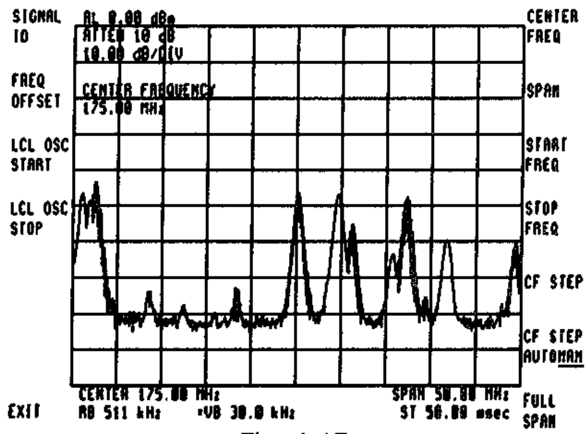


Fig. 4-17

Now each time you press the up step key you set the center frequency to the next 50 MHz span (Center frequency = 25 MHz, 75 MHz, 125 MHz, etc.). Thus, you are able to survey the spectrum span by span. Center frequency step size can also be defined by the marker (See MARKER section).

CF Step Automan

To select different step sizes press ◀CF STEP AUTOMAN▶ notice the underline changes from the auto to manual position. To go back to auto press ◀CF STEP AUTOMAN▶ and it will toggle back.

The other way to change the step size is to press ◀CF STEP▶ and then enter the change. Notice that the ◀CF STEP AUTOMAN▶ will automatically change to the manual position.

Full Span

◀FULL SPAN▶ provides a convenient starting point for making most measurements. That is, it calls for a full 0-2.9 GHz span (0-26.5 GHz for microwave spectrum analyzers), it sets the center frequency and span. Switching on line power automatically calls for an instrument preset.

[I/P] resets all the front panel functions to their preset condition.

Frequency Offset

The CRT display frequency readout can be offset. Entering an offset does not affect the trace. Press ◀FREQ OFFSET▶ and then enter the value of offset wanted.

Offset entries are added to all the frequency readouts on the CRT display including marker, start frequency, stop frequency, and others.

To eliminate an offset, activate the ◀FREQ OFFSET▶ and enter zero. An [I/P] key also sets the offsets to zero. Offsets are stored with the save functions and recalled by selecting the recall function. When an offset is entered its value is displayed on the CRT in the active function area and also at the bottom of the screen. Only a signal that FOFFSET <> 0 is turned on at the bottom of screen - its value is not displayed.

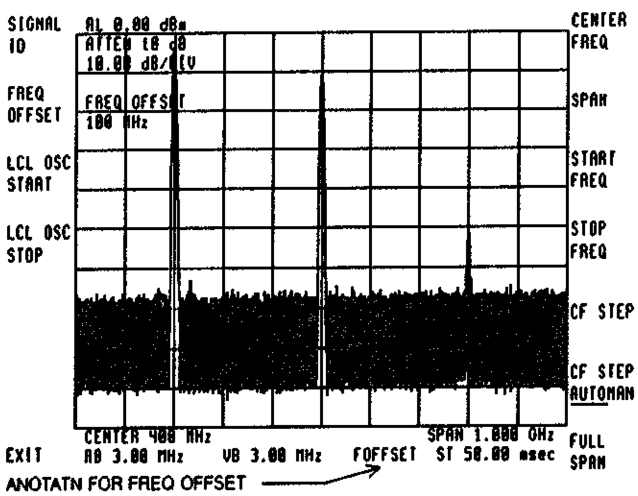


Fig. 4-18

Data entry from the keyboard can be in Hz, kHz, MHz or GHz for frequency. The offset range for frequency is +/- 1000 GHz in 1 Hz steps are kept.

Example:

The 300 MHz CAL signal is used as the input signal. The frequency offset can be set positive or negative. The example below shows a negative (-50MHz) offset. The example above shows a positive 100 MHz offset.

Press ◀FREQ OFFSET▶, then enter [-], [5], [0], ◀MHz▶.

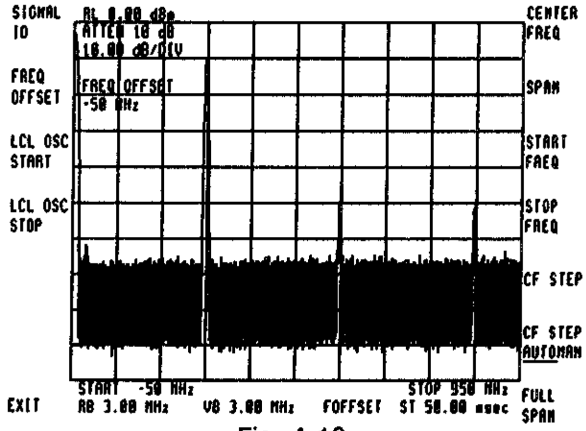


Fig. 4-19

Signal Ident

To use this function place a marker on the signal which is to be identifed, and select the band (N State) of interest. (The narrower the span the higher the probability of identifying the signal). Then press ◀SIGNAL IDENT▶. The instrument will automatically save the current state of the instrument and returns when finished. The identified signal will be indicated on the CRT display. If it can't identify the signal, this will be indicated also.

The analyzer defaults to the Automatic image mode. A detailed description can be found at the end of this section.

Signal ID to CF

Pressing ◀SIGNAL ID TO CF▶ causes the identified signal to be brought to the center frequency.

Signal ID Options

Pressing ◀SIGNAL ID OPTIONS▶ brings a new set of softkeys to the display. This set of softkeys allows the selection of manual vs automatic signal identification. It allows the selection of Image vs Shift function. The amplitude difference of the signal and image can be set. Finally, the harmonic number of start and stop can be set.

SIG ID MAN OFF

Pressing ◀SIG ID MAN OFF▶ allows the manual selection of signal indentifications. The description can be found at the end of this section.

IMAGE/SHIFT

Pressing ◀IMAGE/SHIFT▶ allows the selection of either signal identification using shift method vs image method. At the end of this section is a detailed description of these two methods.

Signal ID Amplitude delta

Pressing ◀SIG ID AMPTD DELTA▶ allows the selection of the difference in amplitude between the signal identified and the image signal. The default value is 10 dB. This softkey allows the desired value to be set. The range is from 0 dB to 300 dB.

Image N Start

Pressing ◀IMAGE N START▶ allows the selection of the start harmonic number. Selecting the correct harmonic number will reduce the time in identifying true signals.

Image N Stop

Pressing ◀IMAGE N STOP▶ allows the selection of the stop harmonic number. Selecting the correct harmonic number will reduce the time in identifying true signals.

Signal Ident

Detail description of Signal Identification function.

The analyzer provides two modes of signal identification, shift and image. Image signal identification involves searching a harmonic range for a response which has an image at twice the IF frequency. Shift signal identification involves shifting the IF frequency and the LO frequency and measuring the change in frequency of the response. For each mode, the analyzer offers both automatic and manual signal identification.

Shift Signal Identification----Automatic

The analyzer saves the current state, so that it can be recalled at the end of the signal identification process. If there is no active marker, the analyzer activates a marker and places it on the highest peak. The analyzer locates the frequency and amplitude of the response at the marker (this is the "marked" response).

Now the analyzer searches for a path from the input which uses the same mixer, but which has a different IF frequency. It tunes the analyzer so that if the marked response is a true signal, it does not move. If the marked response is a harmonic response, it shifts by N times the difference in IF frequency. The analyzer takes a sweep, and locates the shifted response. To locate the shifted response, it must appear on screen and the amplitude must be within the specified amount of the marked response set in the SIGDEL command.

If the shifted response is not found, the signal identification displays that the signal identification failed. If the shifted response is found, the difference in frequency from the marked response is divided by the IF shift to determine the harmonic number, and the true frequency of the signal is computed and displayed on the screen.

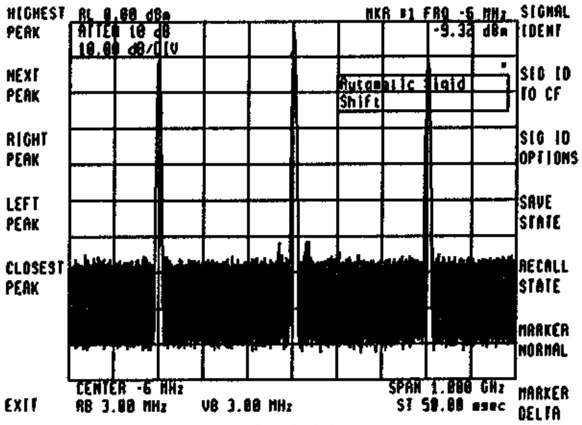


Fig.4-20

At the end of the signal identification routine, the analyzer is returned to its previous state. The SIG ID TO CF command may be used to tune the analyzer center frequency to the identified frequency (unless the signal is identified out of band and the analyzer is band locked).

Shift Signal Identification ----Manual

Manual shift signal identification works on the same principle as automatic shift signal identification, except the result is displayed differently. Instead of computing and displaying the frequency of the identified signal, the analyzer alternates sweeping between the marked response, and the shifted response, to allow you to determine the difference in frequency. During the shifted sweep, an annunciator on the display indicates that the sweep is a Manual Shift Signal Identification sweep.

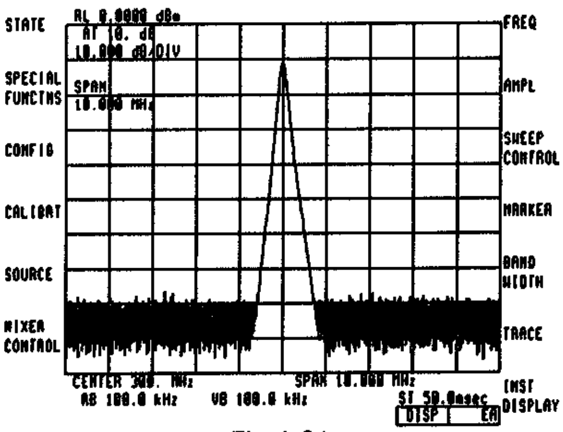


Fig.4-21

Image Signal Identification ----Automatic

To operate this mode place a marker on the response to be identified and initiate the image signal id routine. The analyzer saves the current state so that it can be recalled at the end of the signal identification process. If there is no active marker, the analyzer activates a marker and places it on the highest peak. The analyzer locates the frequency and amplitude of the response at the marker (this is the marker response).

Now the analyzer searches a range of bands for a response at any frequency, Fs, that could have produced the marked response. The range of bands may be specified by using the NSTART and NSTOP commands. For each Fs it takes a sweep, and looks for a response at Fs that is within Xdb of the marked response. You can set X by using the SIG ID AMP DELTA command. If a response is present, it looks for its image at Fs+2*IF. If the image response is present, the signal identification routines ends, displaying the frequency of the signal on the display. If the image response is not found, it checks the next Fs. After all possible frequencies have been checked, if the signal was not identified, the analyzer displays that it failed in identifying the signal.

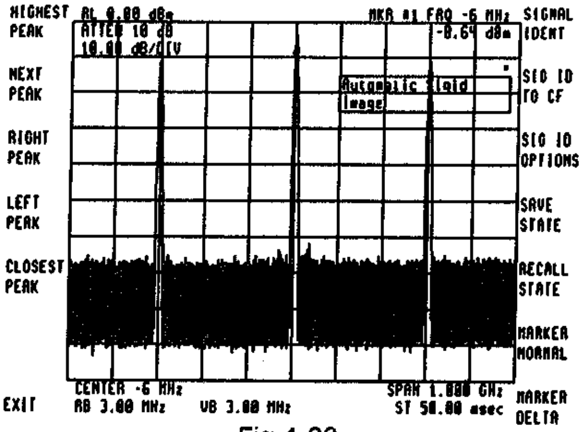


Fig.4-22

At the end of the signal identification routine, the analyzer is returned to its previous state. The SIG ID TO CF command many be used to tune the analyzer center frequency to the identified frequency (unless the signal is identified out of band and the analyzer is band locked).

Image Signal Identification ----Manual

Manual image signal identification works on the same principle as automatic image signal identification, except the result is displayed differently. Instead of searching all possible frequencies, the analyzer assumes the marked response is the signal. The analyzer alternates sweeping between the marked response and the image to allow you to compare the two.

Lcl Osc Start

Selecting ◀LCL OSC START▶ allows the selection of the local oscillator start frequency. The value can be entered on the keyboard or by using the step key or by using the display knob. In microwave analyzers the above is true if you are within a specific band.

Lcl Osc Stop

Select ◀LCL OSC STOP▶ allows the selection of the local oscillator stop frequency. The value can be entered on the keyboard or by using the step key or by using the display knob. In microwave analyzers the above is true if you are within a specific band.

Amplitude

This section describes softkeys which change amplitude reference settings or attenuator settings and also display scale setting functions.

Figure 4-23 shows the softkeys which appear when ◀AMPTD▶ is pressed.

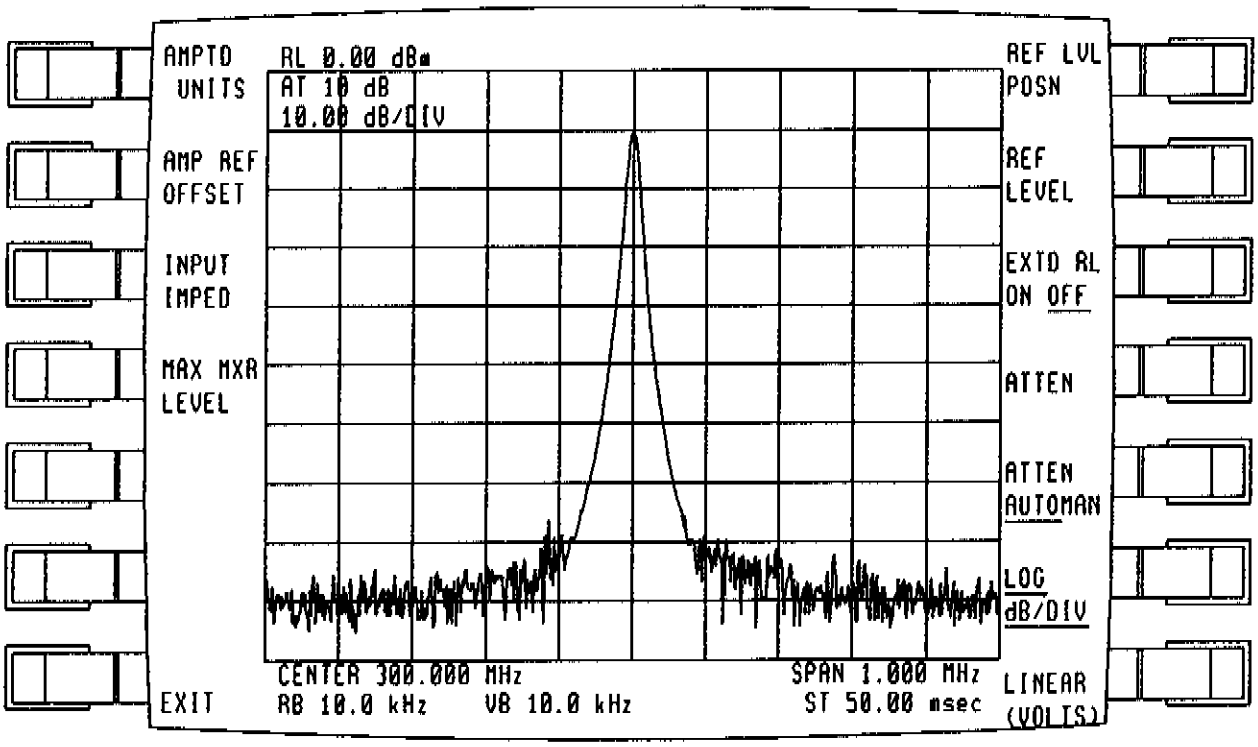


Fig.4-23. Top level menu for ◀AMPTD▶

Ref Lvl Postn

Selecting ◀REF LVL POSTN▶ causes the analyzer to set the reference level position. The position is set in terms of graticule units from top of screen (10 = top of screen, 0 = bottom of screen). Reference level position applies only to log display scale. In linear display, top of screen is used for the reference level. The preset condition is 10. The range is 0 to 10.

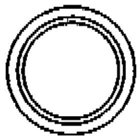
The position of the reference level is indicated on the display with small arrows at the far right and far left of the screen depending on where the reference is located. If the position is changed from the default state, the arrows will appear and indicate the reference position.

Ref Level

The reference level is the amplitude value that corresponds to the reference position (typically top of screen) as set by the reference position command. Values for the reference level are limited such that a signal at the top of the screen does not exceed the maximum power limit of the hardware input. For pulse power measurements, the EXTENDED REFERENCE LEVEL (ON/OFF) can increase the upper limit of the reference level.

When the attenuator is in the manual mode, the reference level will be set to a lower value if the attenuator setting would cause the mixer level corresponding to the top of the screen to exceed the maximum mixer level. The top of the screen level ≤ ML + AT.

Three methods of setting REF LEVEL are shown below:

KNOB		The amount of change is dependent on how fast of slow the knob is rotated.
STEP KEYS		The step keys always step RL one division (log mode 7 dB/div the step is 7 dB, linear mode (Ref Level = 300 mV) the step would be 30 uV).
KEY PAD	0 1 2 3 4 5 6 7 8 9	The key pad allows entry of exact reference levels. Digits entered beyond the displayed number of digits are deleted.

Example:

Measure the amplitude of calibration signal.

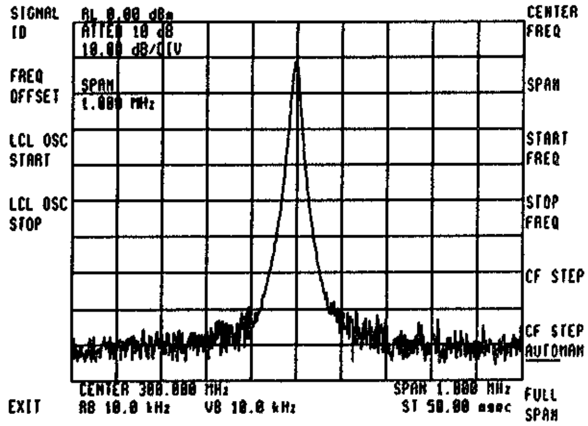


Fig. 4-24

Press [I/P], [MNU], ◀FREQ▶, ◀CENTER FREQ▶, and enter [3], [0], [0], ◀MHz▶. Then press ◀SPAN▶ and enter [1], ◀MHz▶.

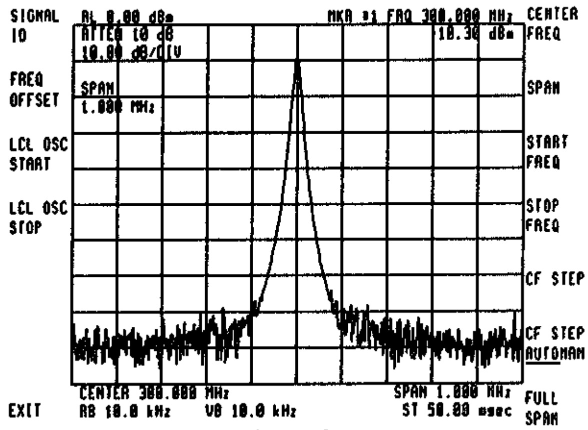


Fig. 4-25

To measure signal amplitude, press [MNU], ◀MARKER▶, ◀MARKER PEAK▶, ◀HIGHEST PEAK▶ and read the amplitude from the marker annotation.

Extd Rl On Off

Selecting ◀EXTD RL ON OFF▶ allows you to extend the reference level beyond its normal continuous power limit. The maximum value for reference level is now limited such that the top of the screen value does not exceed the maximum mixer level. The preset condition is off.

When the extended reference level is on ◀EXTD RL ON OFF ▶, the minimum value for the setting is -300 dBm (as is the normal reference level). The maximum setting depends upon the values selected for the mixer level, the value of the reference position, and the display scale (LOG/LINEAR). This setting is not a function of the maximum hardware input power level (as in normal reference level) but can be extended. The instrument preset will turn this function off.

Atten

Pressing ◀ATTEN▶ allows the selection of RF input attenuation from 0 dB to 70 dB in 10 dB steps. To select a particular attenuation setting, you press ◀ATTEN▶. Notice that the ◀ATTEN AUTOMAN▶ will change to the manual position (◀ATTEN AUTOMAN▶). Next, the desired value of attenuation is entered either by the knob, the step keys, or the keyboard. Generally the reference level does not change with attenuator settings. Notice the asterisk next to atten.

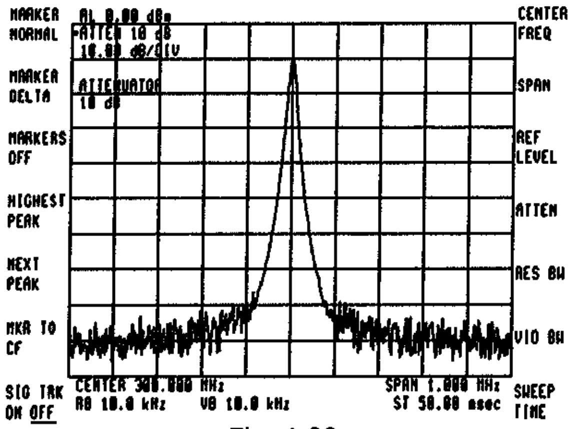


Fig. 4-26

When the RF input attenuator is in auto, the value selected assures that the level at the input mixer is less -10 dBm (the 1 dB compression point) for on-screen signals. For example, if the reference level is +28 dBm, the input attenuator will be set to 40 dBm: +28 dBm-40 dBm = -12 dBm at the mixer. The input mixer level can be changed to assure maximum dynamic range.

MAXIMUM SAFE INPUT POWER

PARAMETER	**71100A**	**71200A**	**71300A**
AC AVERAGE CONTINUOUS POWER	+30dBm	+15 dBm (0 dB Attn.) +25 dBm (10 dB Attn.) +30 dBm (>10 dB Attn.)	+20 dBm with HP 11970 Mixers
PULSE POWER	100 Watts 10 usec Pulse ≥ 20 dB Attn.	100 Watts 10 usec Pulse ≥ 40 dB Attn.	250 mW Peak Pulse Power With <1 usec Pulse (+20 dBm Average Power) With HP 11970 Mixers
DC	0 Volts (DC Coupled) ± 25 Volts (AC Coupled)	0 Volts	N/A

ZERO ATTENUATION

To protect the spectrum analyzer's input mixer, 0 dB RF attenuation can be selected only from the number/units keyboard. Press ◀ATTEN▶ and enter 0 dB on the keyboard. Notice the reference level changes to -10dBm.

Determining Distortion Products

If the total power to the analyzer is overloading the input mixer, distortion products of the input signals can be displayed as real signals. The RF attenuator can be used to determine which signals, if any, are internally generated distortion products.

Using Attenuation Function

If the signal level is very close to the noise floor and the input level does not exceed the maximum power level, then 0 dB attenuation can be used to make the signal more visible (see example below). If the power level is above the maximum, then the RF input attenuator can be used.

Example: How to use the Attenuator and how to select 0 dB of attenuation.

Press [I/P] then ◀CENTER FREQ▶. Select 2700 MHz (for the 9th harmonic of the CAL signal). Press ◀SPAN▶; enter 100 kHz on the keyboard.

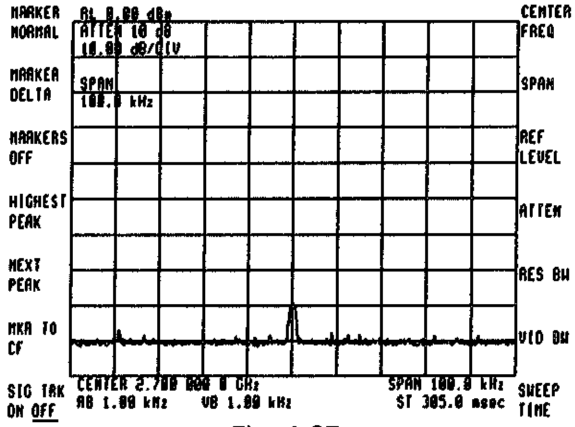


Fig. 4-27

Press ◀ATTEN▶. Press the up step key once to get 20 dB input attenuation. Notice the signal is closer to the noise floor.

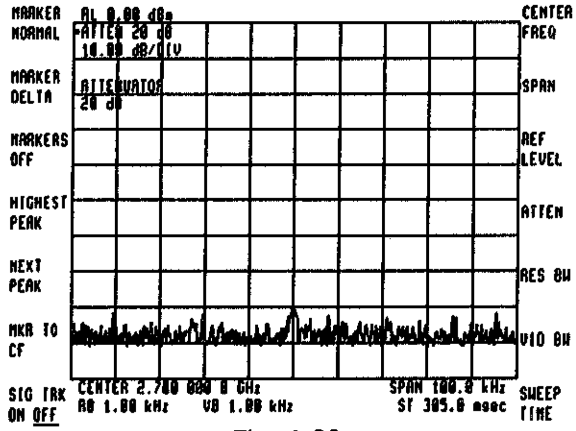


Fig. 4-28

Enter [0], ◀dB▶ notice the signal appears more clearly above the noise floor at the same absolute power level.

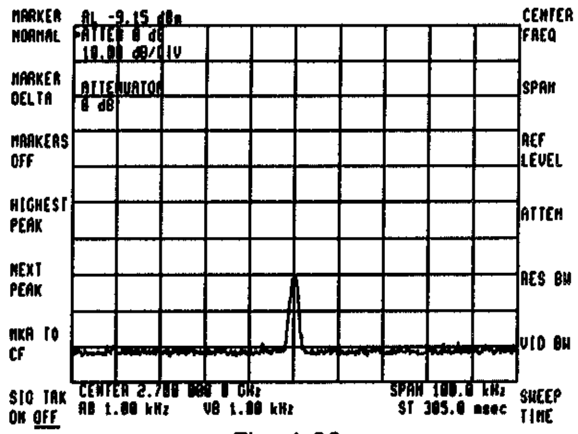


Fig. 4-29

Atten Automan

Selecting ◀ATTEN AUTOMAN▶ switches the analyzer to the manual mode of attenuation (◀ATTEN AUTOMAN▶). This function becomes active by entering an attenuation value. Using one of the three standard methods: step key, knob, or keyboard entry. Notice that the underline does not toggle to manual position until the entry is completed. The preset condition is Auto.

Log/Div

The scale keys ◀LOG DB/DIV▶ and ◀LINEAR▶ allow the scaling of the vertical graticule divisions in logarithmic or linear units without changing the reference level value. Pressing ◀LOG DB/DIV▶ scales the amplitude between 0.01 and 20 dB per division.

Press ◀I/P▶ then ◀CENTER FREQ▶, [3], [0], [0], and ◀MHz▶. Press [MNU], ◀AMPTD▶, ◀LOG DB/DIV▶. Enter [5] and ◀DB▶. Notice how the LOG SCALE dB/DIV 5.00dB appears in the active function area.

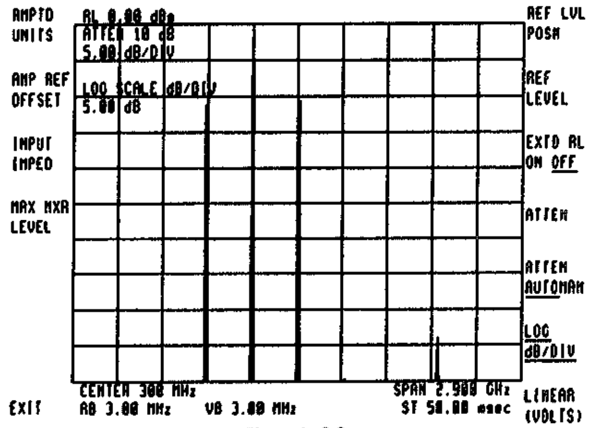


Fig. 4-30

Linear Volts

Pressing ◀LINEAR VOLTS▶ immediately scales the amplitude proportional to the input voltage. The top graticule remains the reference level; the bottom graticule becomes zero voltage. Reference level and all other amplitudes are read out in voltage. However, other units may be selected. See the Amplitude Units subsection.

If ◀LINEAR VOLTS▶ is pressed, the millivolt value will automatically be entered.

Press ◀LINEAR VOLTS▶.

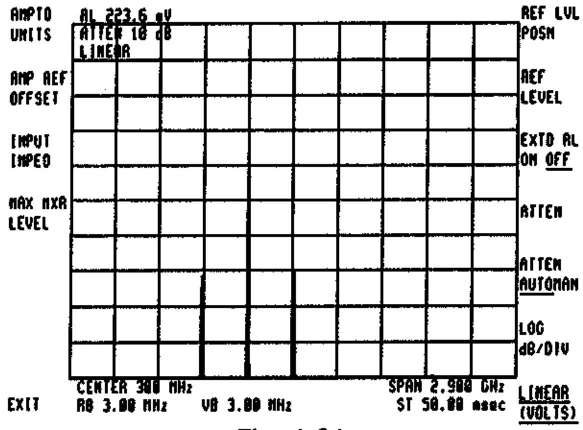


Fig. 4-31

In linear, a specific voltage per division scale can be set by entering a voltage reference level value. For example, to set the scale to 30 mV/division, press ◀REF LEVEL▶, then enter 300mV on the keyboard.

Three methods of setting the SCALE are shown below:

KNOB	Changes scale in allowable increments which are continuously variable between .01 & 20 dB per division.
STEP KEYS	Changes scale in allowable increments (0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10 dB per division).
KEY PAD 0 1 2 3 4 5 6 7 8 9	Enables direct scale selection.

Amptd Units

The choice of units is accessed by pressing ◀AMPTD UNITS▶. The following softkeys are the available choices:

1. ◀A UNITS AUTOMAN▶

2. ◀dBmV UNITS▶

3. ◀dBµV UNITS▶

4. ◀VOLT UNITS▶

5. ◀WATT UNITS▶

6. ◀dB UNITS▶

7. ◀dBm UNITS▶

The default condition, which is factory set, is ◀A UNITS AUTOMAN▶, auto unit selection and ◀dBm UNITS▶

Amp Ref Offset

The CRT display amplitude readout can be offset. Entering an offset does not affect the trace. Press ◀AMP REF OFFSET▶ and then enter the desired value.

Offset entries are added to all the amplitude readouts on the CRT display including marker, display line, and threshold, others are Ref Level, CALPWR, VTL, AMPU, MEASU.

To eliminate an offset, activate the ◀AMP REF OFFSET▶ and enter zero. An [I/P] key also sets the offsets to zero. Offsets are stored with the SAVE functions and recalled by selecting the RECALL function. See STATE section. When an offset is entered, an indicator showing that its value is <> zero is displayed on the CRT.

Press [I/P] then ◀CENTER FREQ▶ and enter [3] [0], [0], and ◀MHz▶. Press ◀SPAN ▶ and enter [1], and ◀GHz▶. Press [MNU], ◀AMPTD▶, ◀AMP REF OFFSET▶ and enter [-], [1], [0], and ◀dB▶.

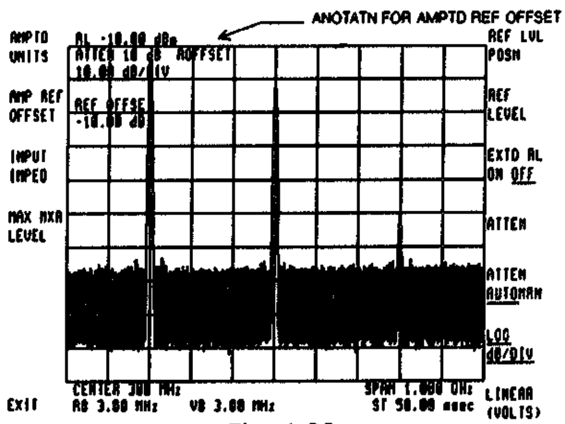


Fig. 4-32

Data entry from the keyboard can be in dB for amplitude. The amplitude offset range is greater than ±100dB in 0.01dB steps. Least significant digits will be truncated for amplitude offset entries. Notice the annotation at the top left-hand side of the display which shows that an offset has been selected.

Example:

The 300 MHz CAL signal is used as the input signal. The amplitude reference offset can be set positive or negative. The example below shows a +10dBm offset. The figure above shows a negative (-10dBm) offset.

This examples shows an Amplitude offset as a positive value.

Press ◀AMP REF OFFSET▶ then enter on keyboard 10.0 dB. Note that the original ref level of 0 dBm is now changed to 10.0 dBm also.

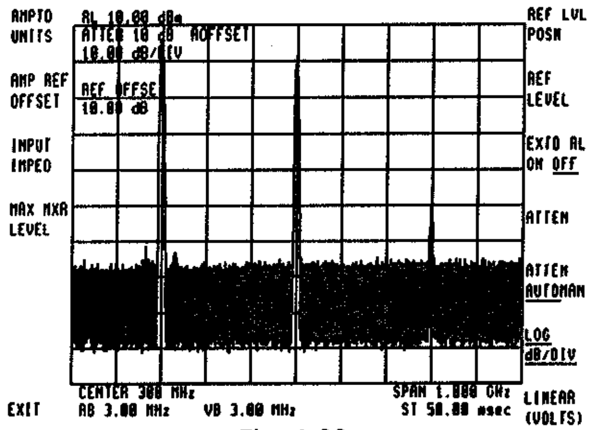


Fig. 4-33

Input Imped

The input impedence can be set by selecting the ◀INPUT IMPED▶ and then entering the desired value. The input impedance is used for power voltage conversions. This is for computational purposes only, as the actual impedance is set by hardware external to the instrument. The preset value is 50 ohms. The range of values is from 1 ohm to 100 million ohms.

The three methods of setting the INPUT IMPED is shown below:

KNOB	Changes the INPUT IMPEDANCE continuously from 1 ohm up to 100 million ohms.
STEP KEYS	Changes the INPUT IMPEDANCE to the next value in a 1,2,5,10 sequence.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Allows entry of exact INPUT IMPEDANCE. Digits entered beyond the displayed number of digits are deleted.

Max Mxr Level

Pressing ◀MAX MXR LEVEL▶ displays the preset value of -7dBm on the middle left-hand side of the display (active function area). This is the maximum level into the mixer. The Reference Level and Attenuator functions are coupled together and follow the equation below:

MAXIMUM MIXER LEVEL = REFERENCE - ATTENTUATION
(Assuming all signals are on screen)

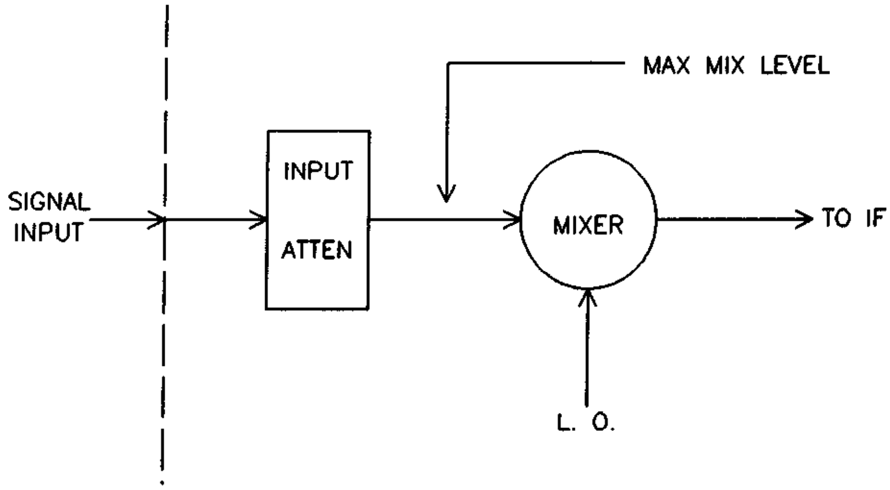


Fig.4-34.Location of Maximum Mixer Level.

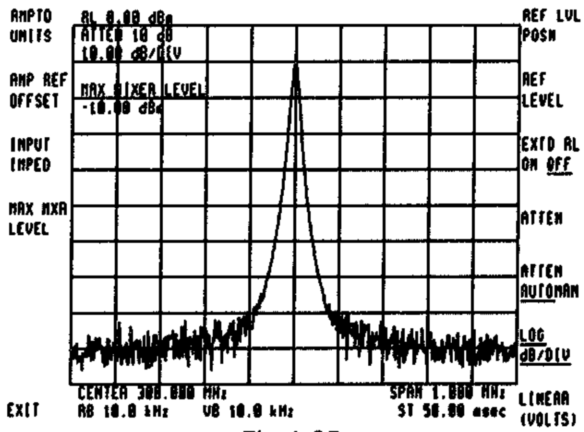


Fig.4-35

The three methods of setting MAX MXR LEVEL are shown below:

KNOB	The setting of MAX MXR LEVEL is determined by how fast or slow the knob is turned.
STEP KEYS	One step changes the MAX MXR LEVEL in 1 vertical division of the graticule.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Allows an exact value to be entered within the allowable range. -7 dBm is the maximum positive level. There is no negative restriction.

As the analyzer's REFERENCE LEVEL is changed, the coupled input attenuator will automatically change. This feature will maintain the maximum signal level at the mixer at the value you have entered or will default to a preset value.

Sweep Control

This section describes softkeys which change trigger mode settings or sweep time settings. It also describes softkeys which change sweep mode settings.

Figure 4-36 shows the softkeys that appear when ◀SWEEP CONTROL▶ is pressed.

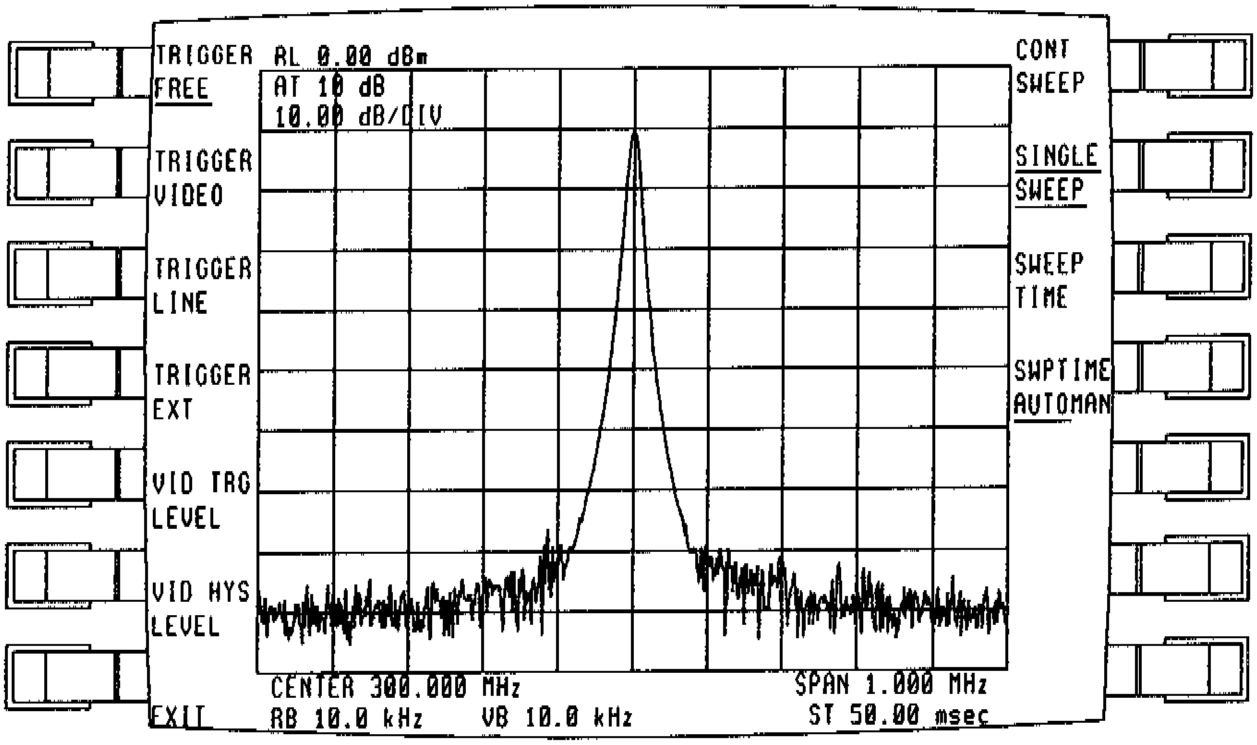


Fig.4-36. Top level menu for ◀SWEEP CONTROL▶

Continuous Sweep

To have the display sweep continuously, press ◀CONTINUOUS SWEEP▶. CONTINUOUS SWEEP is the preset factory setting. This function allows another sweep at the completion of the current sweep once the trigger conditions are met. Upon executing this command, the analyzer return immediately to its start frequency.

Single Sweep

For a single sweep of the display, press ◀SINGLE SWEEP▶. To sweep again, press the soft-key again.

Sweep Time

Pressing ◀SWEEP TIME▶ sets the sweep time selection to manual and changes the rate at which the analyzer sweeps the displayed frequency or time span.

In all frequency spans, the sweep time varies continuously from 50 msec to 1000 sec. Sweep times can be by made faster by changing the TRACE LENGTH to less than 800 points. (see Trace section)

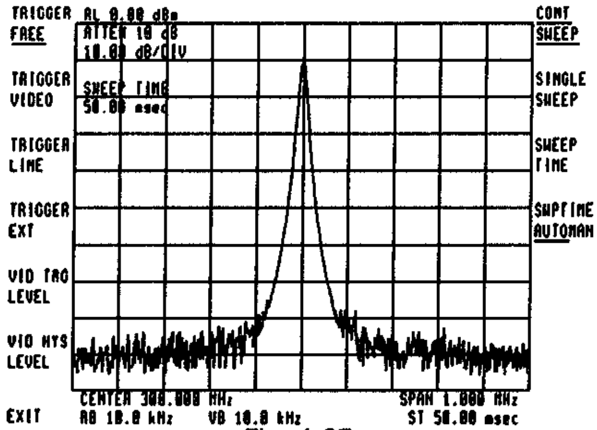


Fig. 4-37

Example:

To identify signals quickly in a very narrow frequency span (where the resolution bandwidth would be narrow) the sweep time can be temporarily reduced. (For example:speed up sweep rate.)

A frequency span of 10 kHz will have a selected resolution bandwidth of 100 Hz and a sweep time of 3 seconds.

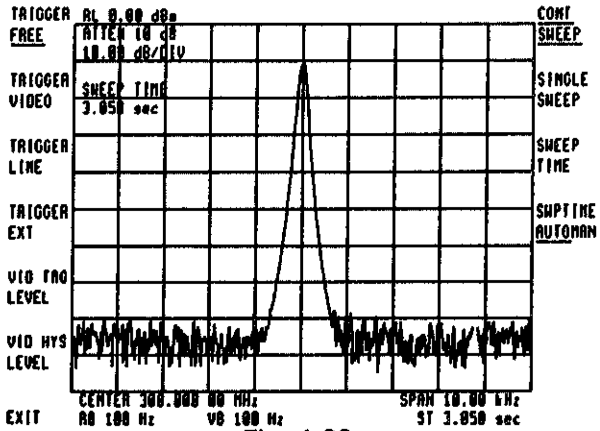


Fig. 4-38

To view quickly signals present in the span, press ◀SWEEP TIME▶ and the down step key several times. When the sweep completes its span, select ◀SWEEP TIME AUTOMAN▶ again. Note that the "Uncal" message appears automatically as the faster sweep time causes some distortion of the spectral response.

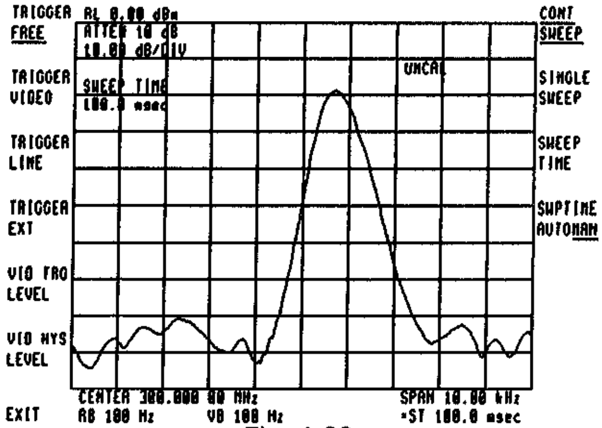


Fig. 4-39

Sweep Time Automan

To select different sweep times press ◀SWEEP TIME AUTOMAN▶ and you will notice the underline changes from the auto to manual position (◀SWEEP TIME AUTOMAN▶). To return to auto press ◀SWEEP TIME AUTOMAN▶ and it will toggle back.

The other way to change the sweep time is to press ◀SWEEP TIME▶ and then enter the change; you will see the ◀SWEEP TIME AUTOMAN▶ automatically change to manual position.

Trigger Function

The analyzer sweep is triggered by one of the following four modes.

* ◀TRIGGER FREE▶ allows the next sweep to start as soon as possible after the last sweep.

* ◀TRIGGER VIDEO▶ allows the next sweep to start if the detected RF envelope voltage rises or falls through the default level. The level can be specified or entered by the keyboard.

* ◀TRIGGER LINE▶ triggers on the same position of the line voltage.

* ◀TRIGGER EXT▶ allows the next sweep to start when an external voltage level passes through 1.5 volts, becoming positive.

The external trigger signal level must be between 0V and +5V.

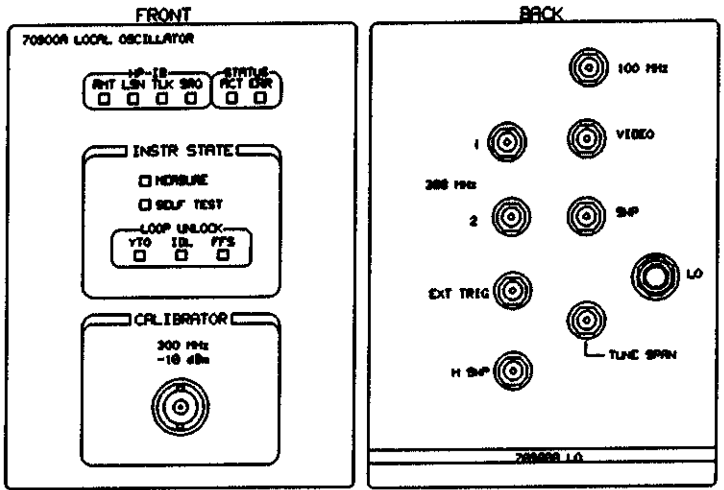


Fig. 4-40. Exteral trigger input

An RF envelope will trigger the sweep only if it is capable of being traced on the CRT display and the resolution bandwidth and video bandwidth are wide enough to pass the modulation waveform of an input signal.

Vid Trg Level

This command is used to set the video trigger level when using the ◀TRIGGER VIDEO▶ function. The default value is -100dBm. (Bottom of the screen)

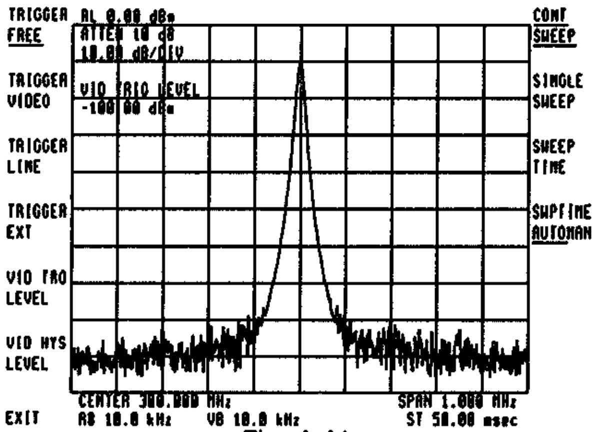


Fig. 4-41

The three methods of setting the VIDEO TRIGGER LEVEL are shown below:

KNOB	The VID TRG LEVEL value is determined by how fast or slow the knob is rotated.
STEP KEYS	One step changes the VID TRG LEVEL by 1 vertical scale division increments.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Allows an exact value of VID TRG LEVEL to be entered.

Vid Hys Level

The hysteresis and direction of the video trigger is specified by selecting ◀VID HYS LEVEL▶. If video trigger hysteresis is positive, the video trigger will be on the rising edge of the signal. The signal must come from below the trigger level set by the ◀VID TRY LEVEL▶ command and the magnitude specified by the ◀VID HYS LEVEL▶ command. The opposite is true for negative video trigger hysteresis; that is, the video trigger will be on the declining edge of the signal. The preset value is 3 dB and the range is ±300 dB.

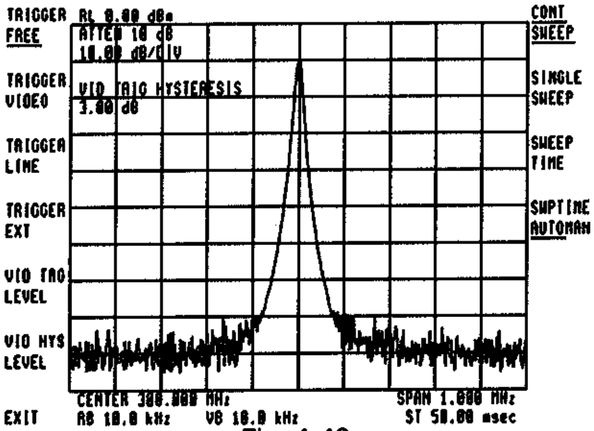


Fig. 4-42

The three methods of setting the VIDEO HYSTERESIS LEVEL are shown below:

KNOB	The VID HYS LEVEL value is determined by how fast or slow the knob is rotated.
STEP KEYS	One step changes the VID HYS LEVEL by 1 vertical scale division increments.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Allows an exact value of VID HYS LEVEL to be entered.

Marker

This section describes softkeys which use markers to make faster and more accurate measurements. Figure 4-43 shows the softkeys that appear when ◀MARKER▶ is pressed.

There are two categories of marker functions: marker functions which activate or disable markers and their related functions; marker functions which allow the scaling of the display frequency and amplitude using marker information.

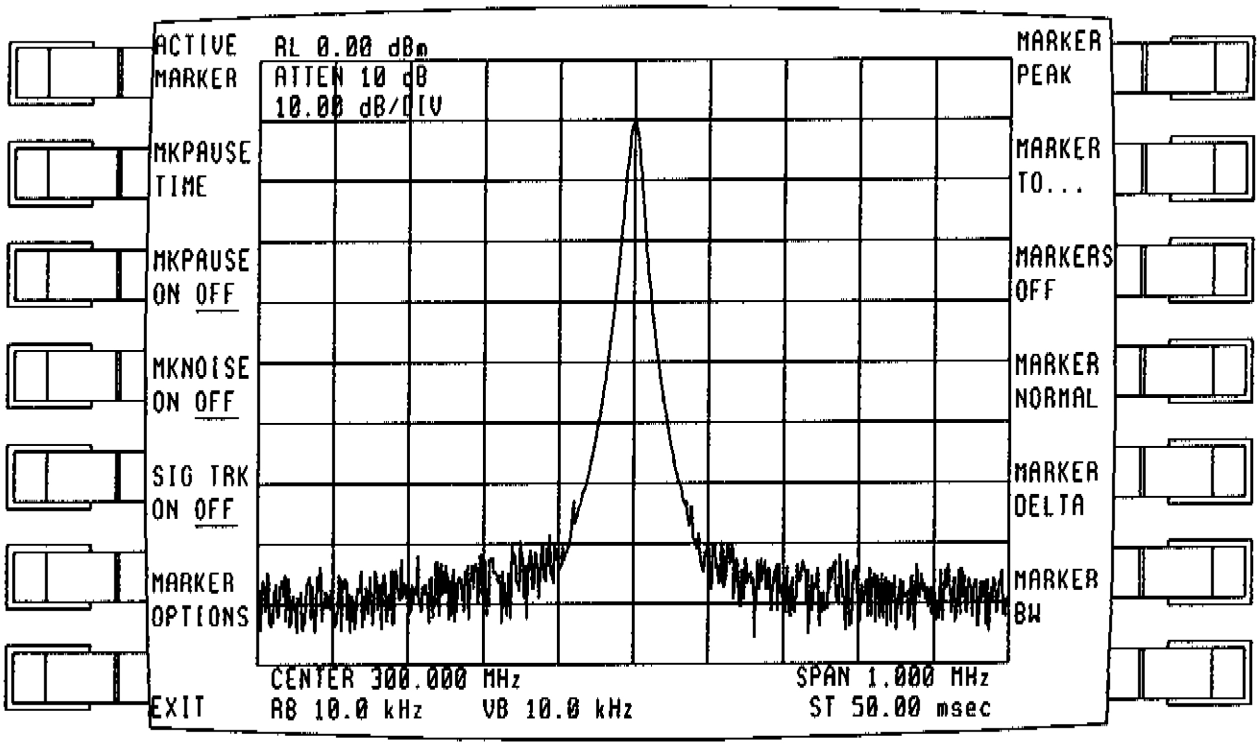


Fig.4-43. Top level menu for ◀MARKER▶

Markers are diamond shaped characters lying directly on the display trace. Up to 5 markers can be on the display at once, although only 1 can be controlled at a time; this is called the "ACTIVE" marker. It will be intensified. The horizontal position of an activated marker is controlled by the step keys, the knob, or the keyboard. The marker can be positioned at a specific frequency with the numeric keyboard.

Readout of the active marker amplitude and frequency appears in the upper right of the display. When a marker is being controlled from the front panel, its amplitude and frequency readout appears in the active function area of the graticule as well. The marker number also appears in both places.

Markers can be displayed on Trace A, Trace B and Trace C.

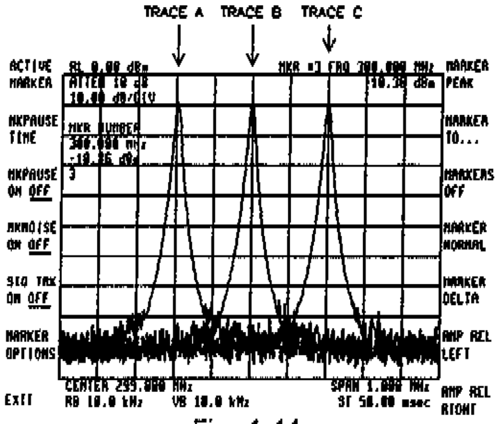


Fig. 4-44

Marker Overview

	FUNCTION
* Placing a single marker at the highest response.	◀MARKER PEAK▶
* Amplitude and frequency display.	◀MARKER TO...▶
* Direct readout of the amplitude and frequency of a point along the trace	◀MARKER NORMAL▶
* Direct readout of amplitude and frequency differences between points on the trace.	◀MARKER DELTA▶
* Direct noise level readout normalized to 1 Hz bandwidth.	◀MKNOISE ON OFF▶
* Expansion of the span about a specific frequency.	◀MKR DELTA TO SPAN▶

Marker Peak

The Marker Peak function allows you to place a marker conveniently at the following positions:

1. Highest Peak
   The highest peak function locates the absolute highest measured point.
2. Next Peak
   The next highest peak function locates the next absolute highest measured point with respect to the point where it is at.
3. Right Peak
   The right peak function locates the peak to the right of the current marker value.
4. Left Peak
   The left peak function locates the peak to the left current marker value.
5. Closest Peak
   The closest peak function locates the peak closest to the current marker value.
6. Minimum Point
   The minimum point function locates the absolute minimum measured point.

Example:

Setting the expected printer address to HP-IB Talk/Listen 01.

Press [DSP], ◀DEFINE HARDCPY▶, and ◀PRINTER IS▶.

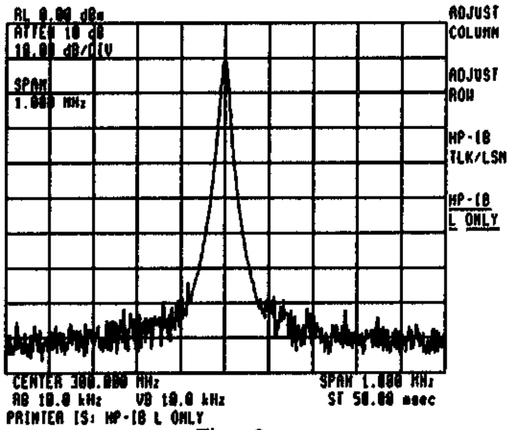


Fig. 2-44.

Select ◀HP-IB TLK/LSN▶ and enter the address 1 (printers are typically addressed at "01").

Next press ◀ENTER▶. The address should change immediately, as in the lower left corner of Figure 2-45.

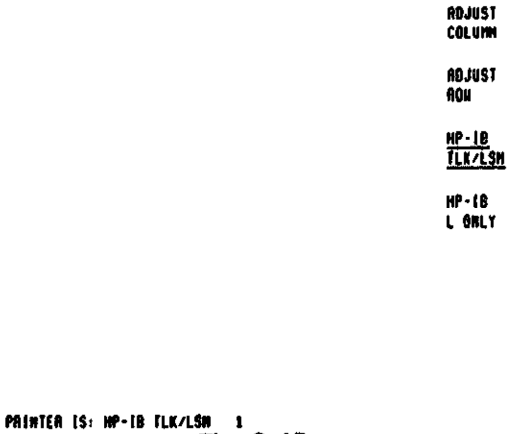


Fig. 2-45.

MARKER to Next Peak

The marker can also be placed at the next highest peaks by successively pressing ◀Next Peak▶.

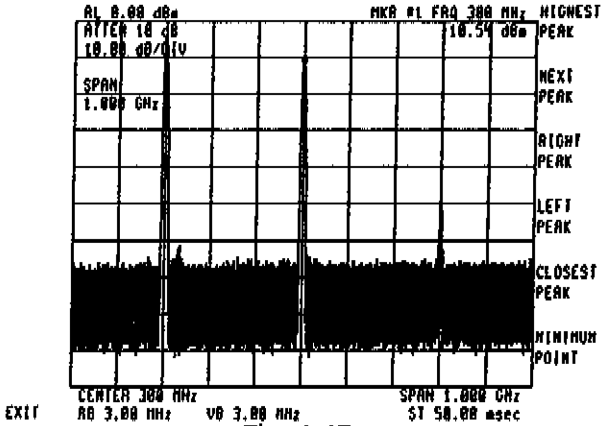


Fig. 4-47

MARKER to Minimum

The minimum trace value can be located by pressing ◀MINIMUM POINT▶.

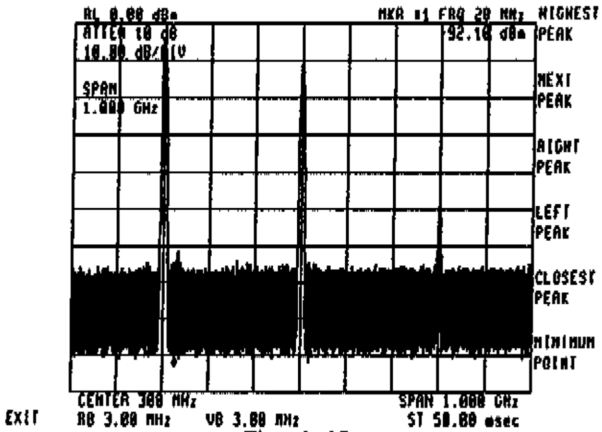


Fig. 4-48

Marker To ...

Selecting ◀MARKER TO ...▶ gives access to four helpful functions. Access a function by pressing the particular softkey associated with the function. Following a list of these functions is a detailed description of what each does.

1. ◀MKR TO CF▶ -MARKER TO CENTER FREQUENCY

2. ◀MKR TO REF LVL▶ -MARKER TO REFERENCE LEVEL

3. ◀MKR DELTA TO SPAN▶ -MARKER DELTA TO SPAN

4. ◀MKR TO CF STEP▶ -MARKER TO CENTER FREQUENCY STEP

Selecting ◀MKR TO CF▶ causes the analyzer to set the the center frequency to the frequency (absolute) of the active marker.

Selecting ◀MKR TO REF▶ causes the analyzer to set the reference level to the amplitude (absolute) of the active marker.

Selecting ◀MKR DELTA TO SPAN▶ sets the start and stop frequencies of the analyzer. If the active marker type is ◀AMP REL LEFT▶, ◀AMP REL RIGHT▶, or ◀MARKER DELTA▶, the delta reference and active marker determine the start and stop frequenies. The far left marker indicates start frequency and the far right marker indicates stop frequency. If marker delta is off, the analyzer will not operate.

Selecting ◀MKR TO CF STEP▶ assigns the value of the active to center frequency step size. If the delta function is on, the absolute difference between the delta reference and the active marker is assigned to center frequency step size.

Example:

A fast, convenient way to bring a signal to the center of the display is by using ◀MKR TO CF▶.

Activate a single marker and tune it to the desired signal by pressing ◀MARKER NORMAL▶, then use the display knob to tune to the desired signal. (Approximately 300MHz)

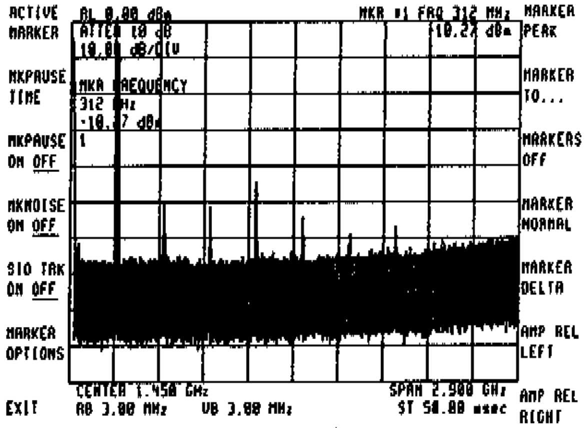


Fig. 4-49

Change the center frequency to the marker frequency by Pressing ◀MKR TO CF▶. Notice the signal with the marker now becomes the center frequency of the display.

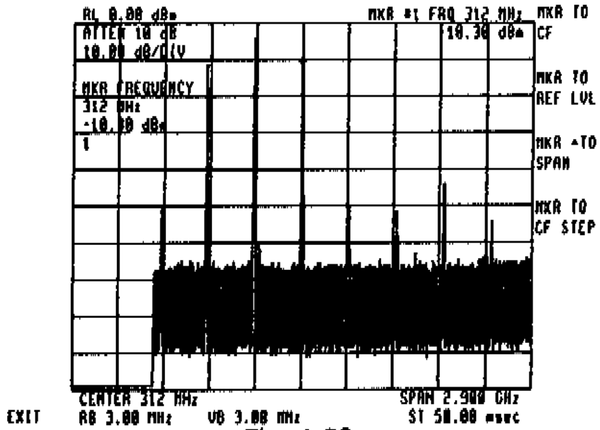


Fig. 4-50

◀MKR to CF▶ will also work if start/stop frequencies are read out.

Example:

One way to tune to a particular portion of a displayed spectrum is to use the ◀MKR DELTA TO SPAN▶ function.

Press ◀I/P▶, [MNU], ◀MARKER▶, ◀MARKER PEAK▶,◀HIGHEST PEAK▶. Then press ◀EXIT▶ and select ◀MARKER DELTA▶. Tune the display knob to place the marker at the desired span. (approximately 1.06 GHz)

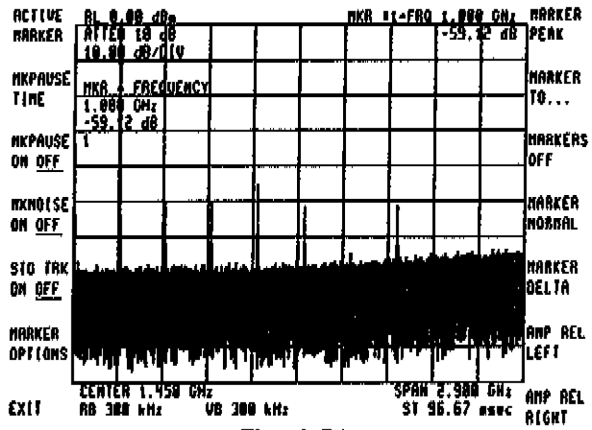


Fig. 4-51

Select ◀MARKER TO...▶ and press ◀MKR DELTA to SPAN▶. Notice the span is approximately 1 GHz and the fundamental and its two harmonics are shown.

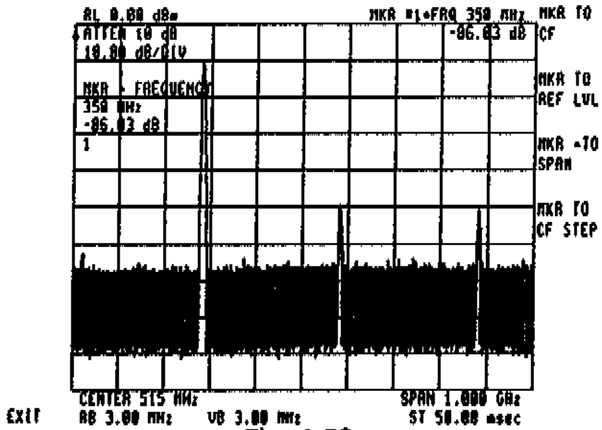


Fig. 4-52

Example:

Here is a technique for viewing a fundamental and its harmonics (or any evenly spaced portion of the spectrum) with high resolution.

Narrow the span about the fundamental to center the carrier as necessary. Place a marker on the peak.

Set the center frequency step size with ◂MKR TO CF STEP▸.

Now activate ◂center frequency▸. With each up step key, successive harmonics will be displayed.

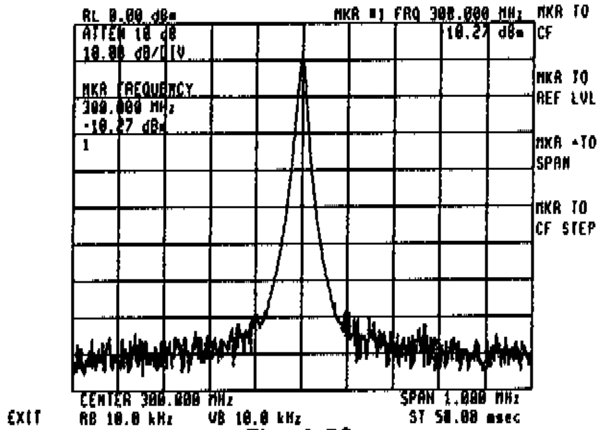
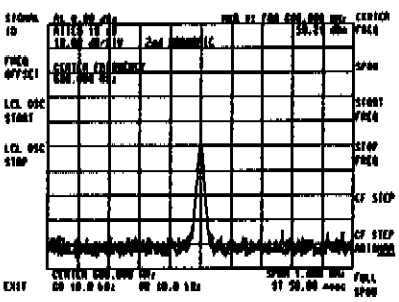
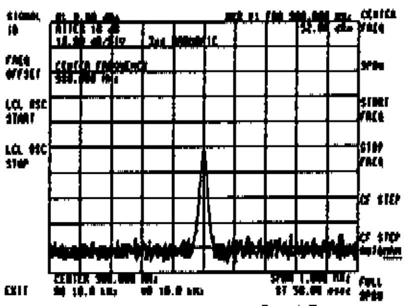
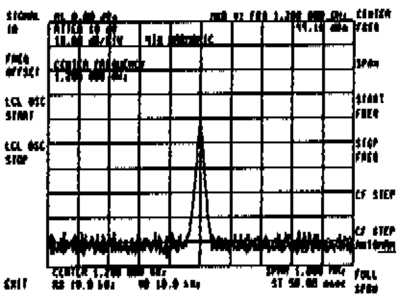


Fig. 4-53


SECOND HARMONIC


THIRD HARMONIC


FOURTH HARMONIC

Similar stepping can be accomplished using ◂MKR TO CF STEP ▸ in step size for intermodulation products or other evenly spaced signals, (such as communication channels).

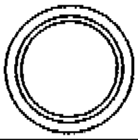
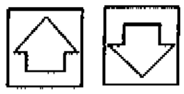
Markers Off

Selecting ◂MARKERS OFF▸ disables any marker mode and blanks the marker readout from the CRT display.

Normal Marker

Selecting ◂MARKER NORMAL▸ activates a single marker at the center of the display on the trace of highest priority. Trace priority is defined in the trace section. The marker will not activate blank A, blank B, view C, or blank C on the TRACE modes.

The three methods of setting MARKERS are shown below:

KNOB 	Moves the marker continuously along the trace at approximately 5 horizontal divisions each full turn. The marker moves in display unit increments.
STEP KEYS 	Moves the marker along the trace one tenth of the total width per step using either step key. Up arrow moves marker to the right.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Places the marker at the frequency entered. An out-of-range entry results in placement of the marker at a graticule edge.

Example:

Reading the frequencies and amplitudes of signals is greatly simplified using ◀MARKER NORMAL▶.

For a given display activate the single marker with ◀MARKER NORMAL▶. Tune the marker with the knob to position it at the signal peak. The frequency and amplitude is read out in two display areas.

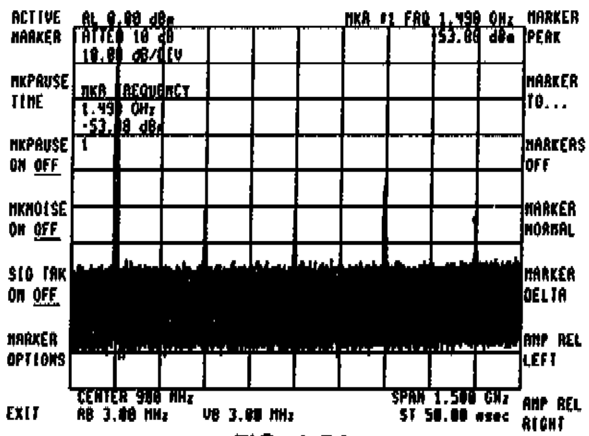


FIG. 4-54

To read the left-hand signal's parameters move the marker to the signal peak with the knob.

The signal's amplitude and frequency is read out directly.

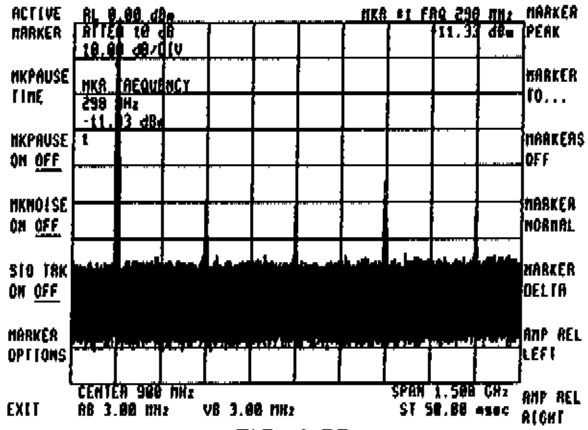


FIG. 4-55

Marker Delta

Selecting ◀MARKER DELTA▶ activates a second marker at the position of a signal marker already on the trace. (If no signal marker has been activated, ◀MARKER DELTA▶ places two markers at the center of the display.) The first marker's position is fixed. The second marker's position is under your control.

The display readout shows the difference in frequency and amplitude.

Example:

Measure the differences between two signals on the same display.

First set the marker on one of the signal peaks with ◀MARKER NORMAL▶ and the tuning knob.

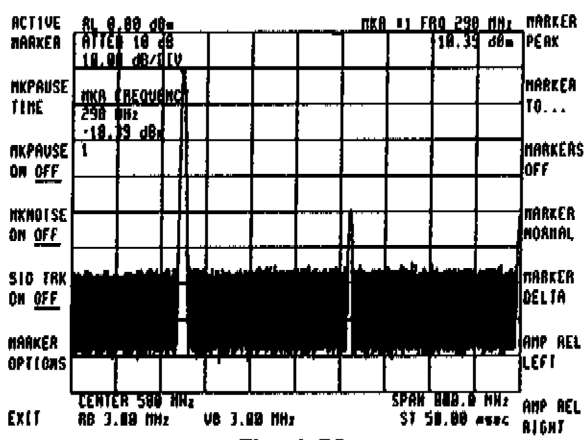


Fig. 4-56

Activate ◀MARKER DELTA▶ and move the second marker to the other signal peak with the knob. The difference between the peaks can be read off the active function area.

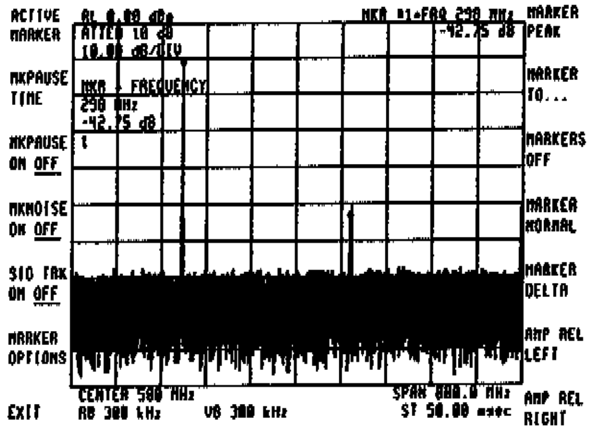


FIG. 4-57

Fractional Differences

When the reference level is calibrated in voltage, ◀MARKER DELTA▶ amplitudes are given as a fraction, the voltage ratio of two levels.

With logarithmic amplitude scale and the reference level in voltage, the fraction is based on the equation

$$\text{fraction} = 10^{-(\text{dB DIFFERENCE}/20)}$$

Since this equation yields the harmonic distortion due to a single harmonic, its distortion contribution can be read directly from the display.

Example:

Set up ◀MARKER DELTA▶ on the peaks of a fundamental (left) and its harmonic (right).

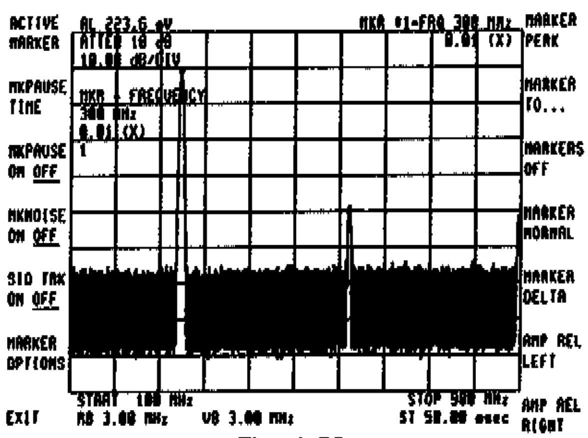


Fig. 4-58

With the display referenced and scaled as shown, the readout ".0100X" designates the fractional harmonic content. Percent is calculated as 100X(.0100)=1.0%.

With a linear amplitude scale and a reference level calibrated in voltage, the fractional amplitude readout is the simple linear ratio of the two markers.

Example:

To measure % AM modulation from a spectrum display, calibrate the display with the reference level in voltage and the amplitude scale in voltage.

Place the single marker on the carrier peak; ◀MARKER NORMAL▶ and the second marker on one of the sideband peaks using ◀MARKER DELTA▶ and the knob. The fractional amplitude readout gives one half the modulation index 0.18. %AM = 100x2x0.18 = 36%

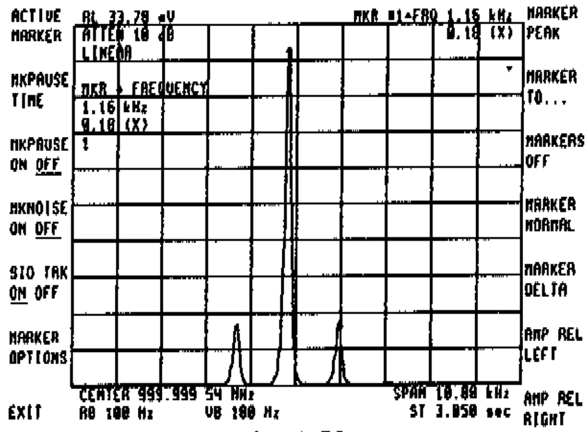


Fig. 4-59

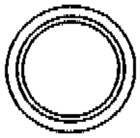
Measurement and Readout Range

The ◀MARKER DELTA▶ function formats the amplitude readout according to the reference level's units and scale.

The frequency readout for all ◀MARKER DELTA▶ conditions has up to 4 significant digits, depending upon the portion of span measured. The amplitude readout in dB has resolution of ±.01 dB for linear scale. The resolution for logarithmic scale depends upon the ◀Log dB/DIV▶.

The minimum incremental change for delta frequency is 0.1% of the frequency span.

The three methods of moving MARKER DELTAS' are shown below:

KNOB 	One full turn moves the active marker approximately one tenth of the horizontal span.
STEP KEYS 	One step moves the marker one tenth of the horizontal span.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Positive entry places marker higher in frequency than the stationary marker, negative entry places marker lower in frequency. If entries are larger than allowable, the marker will be placed on the adjacent graticule border. Negative frequencies can be entered using a minus sign. For example, to set a delta span of 10 MHz with the second marker positioned to the left of the first, press the minus sign and then 1, 0 MHz, -dBm, sec.

Amp Ref Left

Selecting ◀AMP REF MKR▶ results in the following: (1) If ◀MARKER NORMAL▶ is not active, this turns it on and the number 1 marker is placed at the center of the screen; otherwise, the normal marker remains in position (marker 1 is not bright). (2) Marker 2 (the active marker) is moved to a frequency to the left of marker 1 at the requested relative amplitude. This key function is useful for making -3dB and -60dB bandwidth measurements.

Amp Ref Right

Selecting ◀AMP REF RIGHT▶ is the same as ◀AMP REF LEFT▶ except marker 3, rather than marker 2, is the active marker. Also, the active marker is placed to the right, rather than to the left, of marker 1.

Example:

Measure the -60dB bandwidth of the Cal signal.

Connect Cal signal to input. Select ◀CENTER FREQ▶ and set it to 300MHz. Select ◀SPAN▶ and set it to 10KHz.

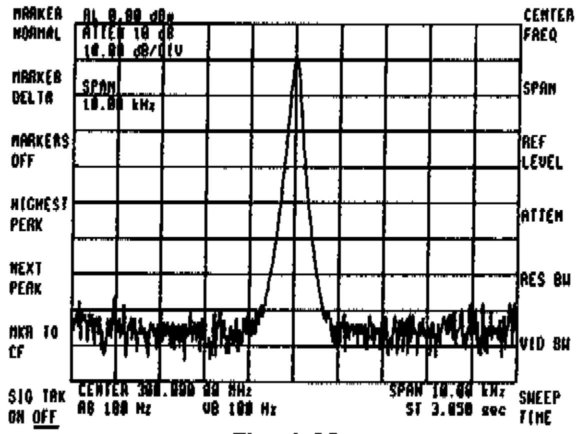


Fig. 4-60

Select [MNU], then select ◀MARKER▶ and ◀MARKER BW▶. Select ◀AMP REF LEFT▶, enter -60dB on the keyboard. Notice that marker 1 is at the center and marker 2 is at -60dB point and intensified.

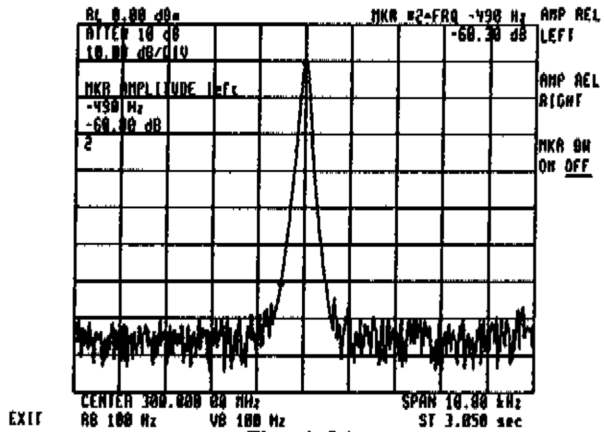


Fig. 4-61

Select ◀AMP REL RIGHT▶, enter -60dB. Notice that marker 3 is at the -60dB point and intensified.

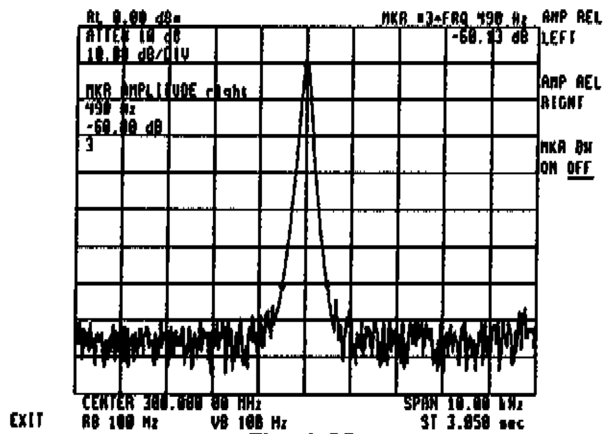


Fig. 4-62

Select ◀MKR BW ON OFF▶ and read the -60dB bandwidth from the CRT display.

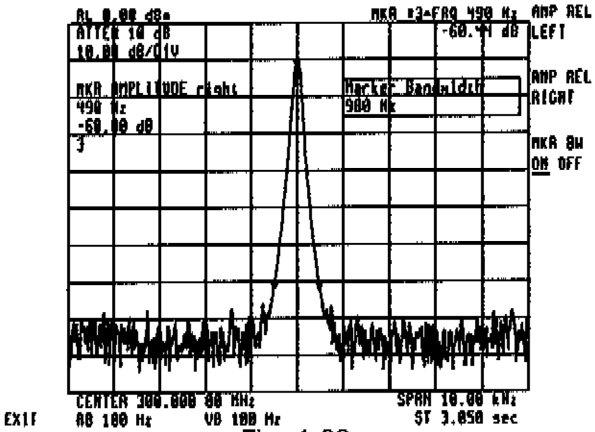


Fig. 4-63

Active Marker

Pressing ◀ACTIVE MARKER▶ activates the marker function and permits selection of one of five markers. To select a marker, use the step keys, knob, or keyboard. The marker number will appear in the upper right hand corner and also in the active function section of the display. Three things happen when you select this softkey: (1) The marker number supplied by the command becomes the active marker. (2) If the marker number was not previously set, the marker is activated using preset type (position), readout (frequency or sweep time if zero span), and trace (by default algorithm), and is placed at the center frequency. 3) The active marker is highlighted on the screen for identification.

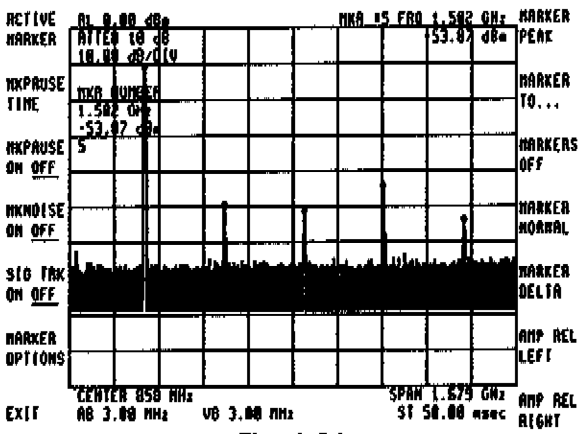


Fig. 4-64

Marker Pause Time

Selecting ◀MKPAUSE▶ causes the analyzers' sweep to stop and pause at the marker for a specified length of time. This command applies to the current active marker. A pause value of zero or turning the marker off, will terminate the pause function. The marker's preset condition is 0. The range is from 0 to 1000 seconds.

The three methods of setting MARKER PAUSE are shown below:

KNOB	One full turn moves the active marker approximately one tenth of the horizontal span.
STEP KEYS	One step moves the marker one tenth of the horizontal span.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Positive entries place the marker higher in frequency than the stationary marker, negative entries place the marker lower in frequency. Entries that are larger than allowable will place the marker on the adjacent graticule border. Negative frequencies can be entered using a minus sign. For example, to set a delta span of 10 MHz with the second marker positioned to the left of the first, press the minus sign then 1, 0 MHz, -dBm, sec.

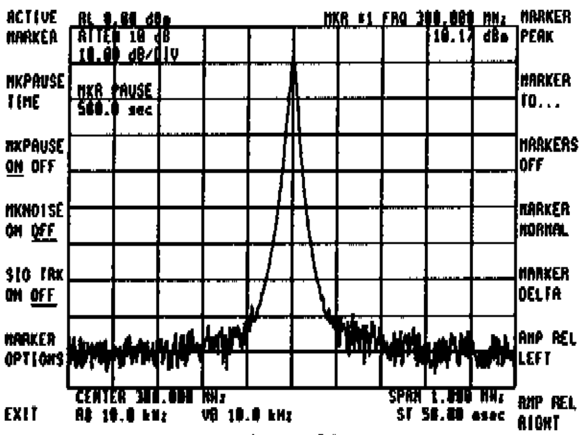


Fig. 4-65

Marker Pause On Off

Selecting ◀MKPAUSE ON OFF▶ allows you to enter a value into the analyzer to stop and pause the sweep. The function is described above in MARKER PAUSE TIME. Notice that the underline toggles back and forth when the softkey is pressed. Also, when ◀MKPAUSE TIME▶ is selected and a value entered, the function goes to the ON position.

The amount of pause time can be entered from the keyboard or with the step key (the 1, 3, 10 sequence will be in effect) or by turning the display knob to the desired value. The range is 0 to 1000 seconds.

Mkr Noise On Off

Selecting ◀MKR NOISE ON OFF▶ causes the analyzer to read out the RMS noise level of the active markers. The readout is normalized to a 1 Hz bandwidth. The noise bandwidth of the IF filters and the logging error (if log in signal path) is taken into account.

The preset condition is "off".

Sig Trk On Off

Selecting ◀SIG TRK ON OFF▶ causes the signal at the marker location to become fixed at the center of the screen. Signal tracking mode is automatically turned off for all other markers when it is turned on for the active marker. Once the signal track function is turned on, the active marker can be changed without affecting the marker that is signal tracked.

The response to a signal track query is the current status of signal track independent of which marker is the current active marker.

When signal tracking is on and span is changed, an automatic zoom is performed. The span will be reduced in steps so that the signal remains at center screen. If the instrument is in zero span then executing signal tracking has no effect.

The preset condition is off.

Marker Options

Selecting ◀MARKER OPTIONS▶ allows you access to the following functions:

1. ◀MARKER TRACE A▶
2. ◀MARKER TRACE B▶
3. ◀MARKER TRACE C▶
4. ◀SIG TRK LIMIT▶
5. ◀PEAK EXCURSN▶
6. ◀MK READ AUTO▶
7. ◀MK READ FREQ▶
8. ◀MK READ PEAK▶
9. ◀MK READ SWP TIM▶
10. ◀MK READ 1/T▶

A detailed description of each function follows:

Selecting ◀MARKER TRACE A▶ causes the analyzer to place the active marker on the A TRACE. If a marker function has not been activated, selecting ◀MARKER TRACE A▶ will have no effect. Having the markers go onto TRACE A is the preset condition.

Selecting ◀MARKER TRACE B▶ operates the same way as TRACE A except that TRACE B must be activated before the marker will appear on the screen. Notice that the underline will also appear under TRACE B when the function is activated.

Selecting ◀MARKER TRACE C▶ operates the same way as TRACE A except that TRACE C must be activated before the marker will appear on the screen. Notice that the underline will also appear under TRACE C when the function is activated.

Selecting ◀SIG TRK LIMIT▶ allows you to set the amplitude limit used by the marker track function when determining the proper signal to track. When choosing between two closely spaced signals, the signal within the amplitude limit of the previous tracked signal amplitude will be tracked. The limit is allowed plus or minus from the previous signal amplitude. The preset state is 5 dB. The minimum is 0dB and the maximum is 300dB.

Selecting ◀PEAK EXCURSN▶ allows you to select the the value of peak excursion. The value is selected in dBs, and can be entered by the standard three methods of entry (keyboard, knob, or step key). If a value of 10dB is entered, then the marker will only go to peaks which rise and fall 10 dB. (With "Normal" Detector, the noise can be peaks, if the excursion isn't set to exclude them.)

Marker Readout

The marker readout function determines the method by which the frequency or time data of the active marker will be read out. There are two basic readout types: frequency related and sweep time related. The following table describes each of the readout types.

When transitioning between different readout types, the position of the marker remains the same and the new readout type is assumed. The full range of readout possibilities is available in either zero or non-zero spans. The meaning of each readout type is explained below.

Selecting ◀MARKER READ AUTO▶ causes the analyzer to read out automatically depending on whether or not you are in zero span. In zero span the marker readout is sweep time; otherwise it reads out frequency.

Selecting ◀MK READ FREQ▶ causes the frequency value of the marker to be the center frequency of the analyzer when in zero span. If not in zero span, the frequency value of the marker is associated with its position on the frequency scale.

Selecting ◀MK READ PERIOD▶ causes the period value of the marker to be determined by 1/analyzer center frequency for the zero span. For a non-zero span condition the period value is determined by the inverse of the marker's frequency value.

Selecting ◀MK READ SWP TIM▶ causes the time value to be determined by the time point on the horizontal scale determined by sweep time.

Selecting ◀MK READ 1/T▶ causes the inverse sweep time to be determined by 1/(the TIM value).

Marker Zoom

The analyzer can automatically zoom in on a signal specified by a marker. The desired frequency span is input from the data number/units keyboard.

To activate the automatic zoom function use ◀MARKER NORMAL▶ knob to identify a specific signal. Press ◀SIG TRK ON OFF▶ and then [USR]. Press ◀SPAN▶, then the desired span with the data number and units keyboard.

When the units key is pressed, the zooming process will begin. Turn signal tracking off when auto zoom is completed.

Example:

A single carrier needs to be examined in a 200kHz span to see the sidebands. Because the SIGNAL TRACK function automatically maintains the signal on the center of the CRT, you can zoom automatically from a wide span to a narrow span for a close look at it.

Place a marker on the carrier with ◀MARKER NORMAL▶, and the knob.

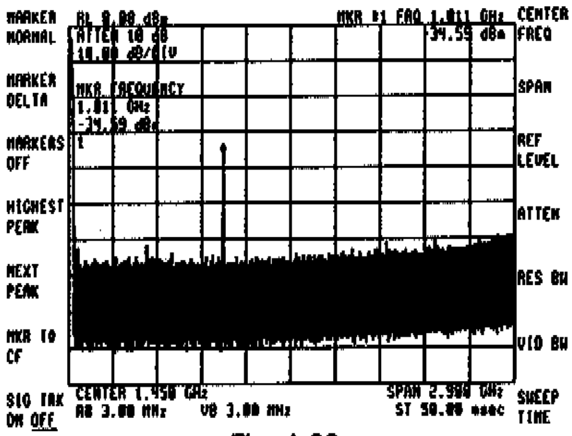


Fig. 4-66

Press ◀SIG TRK ON OFF▶, then the ◀SPAN▶. Enter the span; press [2], [0], ◀kHz▶. Auto zoom will be completed. (Turn off Signal Tracking).

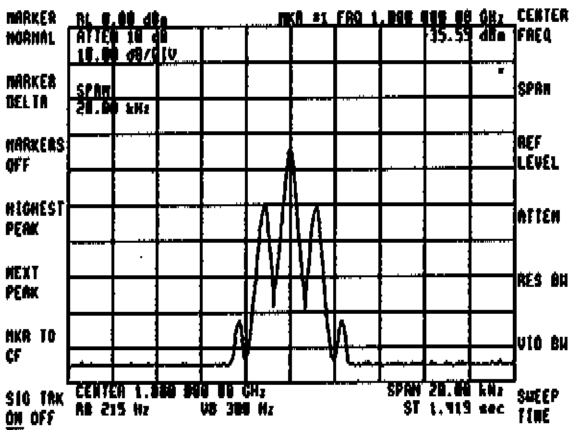


Fig. 4-67

Bandwidth

This section describes softkeys which change resolution bandwidth settings or video bandwidth settings.

Figure 4-68 shows the softkeys which appear when ◀BANDWIDTH▶ is pressed.

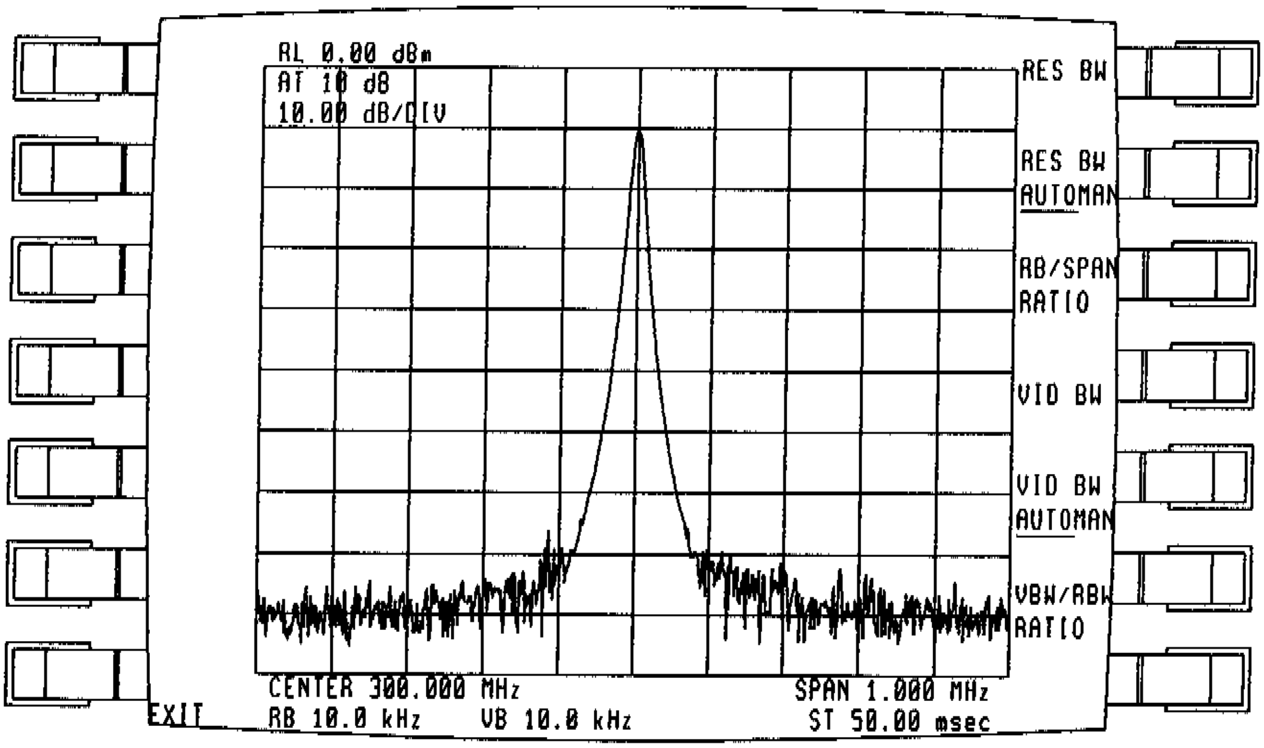


Fig.4-68. Top level menu for ◀BANDWIDTH▶

Resolution Bandwidth

Pressing ◀RES BW▶ sets the resolution bandwidth to the manual position and changes the analyzer's IF bandwidth only when a value is actually entered. It also causes the underline in the ◀RES BW AUTOMAN▶ to change from the auto to manual position. The bandwidths that can be selected are 10Hz, 30Hz, 100Hz, 300Hz, 1kHz, 3kHz, 10kHz, 30kHz, 100kHz, 300kHz. With a 70903A IF module installed, additional 1MHz and 3MHz bandwidths are available. Bandwidths in 10% increments between the steps are available except between the 3KHz-10KHz step.

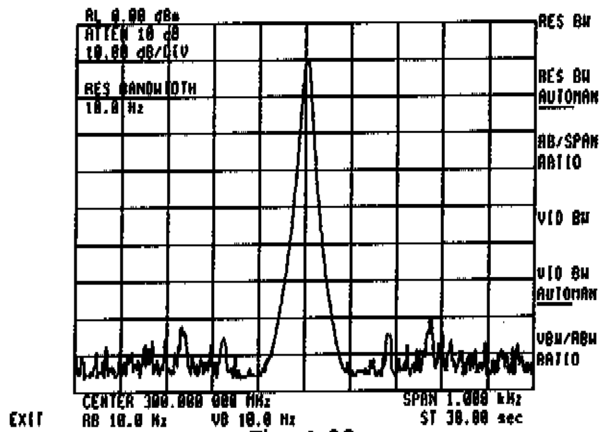


Fig. 4-69

Three methods of setting the RESOLUTION BANDWIDTH are shown below:

KNOB	Changes the RESOLUTION BANDWIDTH continuously.
STEP KEYS	Changes the RESOLUTION BANDWIDTH to the next value in a 1, 3, 10 sequence.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Enters an exact bandwidth value. The allowable bandwidths are dependent on the IF section. The bandwidths allowable are in increments of 10% of the 1, 3, 10 sequence of RES BW. If the entered value differs from the allowable value, the next higher value is chosen.

Example:

A measurement requiring manual resolution bandwidth selection is the zero span (time domain) observation of modulation waveforms. An example can be found in the section under SPAN.

Manual resolution bandwidth can also be used for better sensitivity over a given frequency span.

The low level intermodulation products of a signal need to be measured. With the resolution bandwidth in auto position the analyzer noise may mask the distortion products.

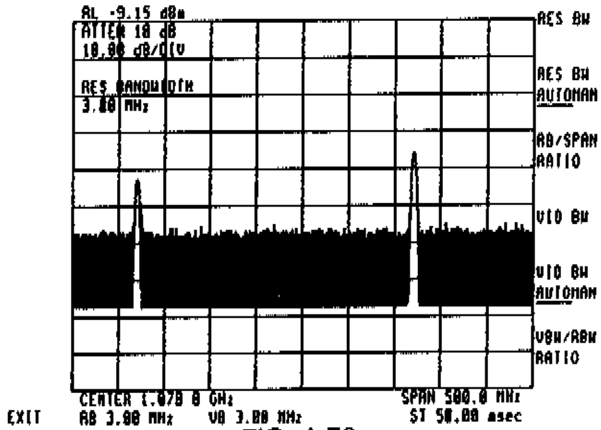


FIG. 4-70

Reduction of the noise level by 10 dB (increased sensitivity) is achieved by decreasing the bandwidth by a factor of 10. Press ◀RES BW▶ and the down step key twice. (◀THRESHOLD▶ has been activated to clarify the display).

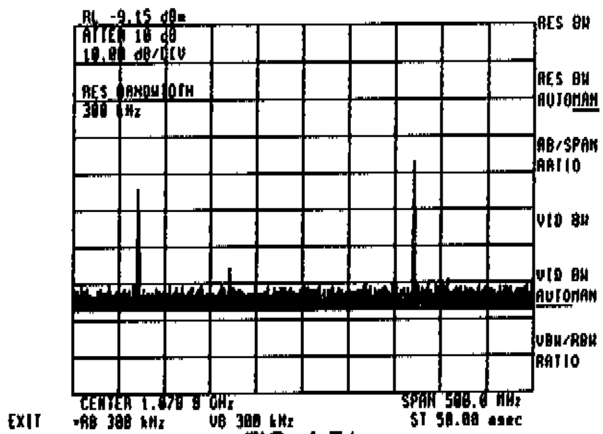


FIG. 4-71

Note: The sweep time automatically slows to maintain absolute amplitude calibration if sweep time is in the Auto position.

Resolution Bandwidth Automan

Another way of setting different resolution bandwidths is to press ◀RES BW AUTOMAN▶. The underline changes to the manual position and the function is as described in the RESOLUTION BANDWIDTH section. To go back to the auto position press ◀RES BW AUTOMAN▶ again and the analyzer will return to Auto position. (The underline toggles back to auto.)

Resolution Bandwidth Ratio

The resolution bandwidth ratio is a function of span. The preset condition of the ratio of resolution bandwidth to span is chosen to provide an aesthetically pleasing display. The ratio can be changed by pressing ◀RES BW RATIO▶ and entering a value.

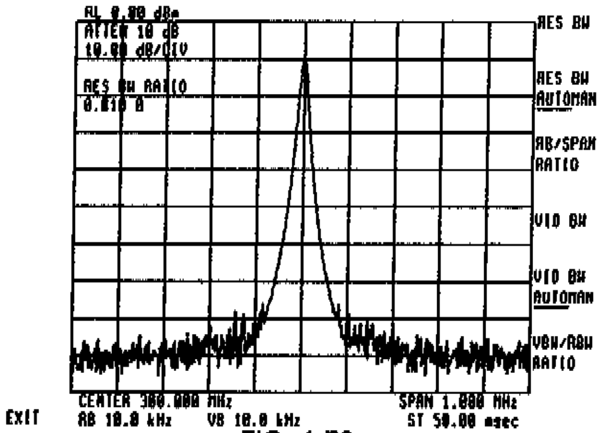
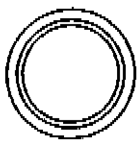


FIG. 4-72

Three methods of setting the RESOLUTION BANDWIDTH RATIO are shown below:

KNOB 	Changes the RESOLUTION BANDWIDTH RATIO continuously.
STEP KEYS ⇧ ⇩	Changes the RESOLUTION BANDWIDTH RATIO to the next value in a 1, 3, 10 sequence.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Enters an exact value which is allowable (any value between 10^{-100} to 10^{+100}). The instrument will only display three significant digits. The preset value is 0.010.

Video Bandwidth

Selecting ◀VIDEO BANDWIDTH▶ allows you to set the analyzer's post-detection filter bandwidth. Video bandwidth can be automatically coupled to the resolution bandwidth. The coupling is set to manual only when a numeric value is input; or an up or down step is received.

When the video bandwidth is coupled, it follows the equation below:

VIDEO BW = RESOLUTION BW * VIDEO BW RATIO

(to the nearest value permitted by hardware)

The preset condition is auto coupled. The range of video bandwidth is ±1000 GHz or the hardware determined limit.

Three methods of setting the VIDEO BANDWIDTH are shown below:

KNOB	Changes the VIDEO BANDWIDTH continuously.
STEP KEYS	Changes the VIDEO BANDWIDTH to the next value in a 1, 3, 10 sequence.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Enters an exact value which is allowable (any value between ±1000 GHz in 1, 3, 10 sequence). If a value is not allowable, it will select the next larger value.

Video Bandwidth Automan

Another way of setting different video bandwidths is to press ◄VID BW AUTOMAN►. The underline changes to the manual position and the function is as described in the VIDEO BANDWIDTH section. To go back to the Auto position press ◄VID BW AUTOMAN►. (The underline toggles back to auto.)

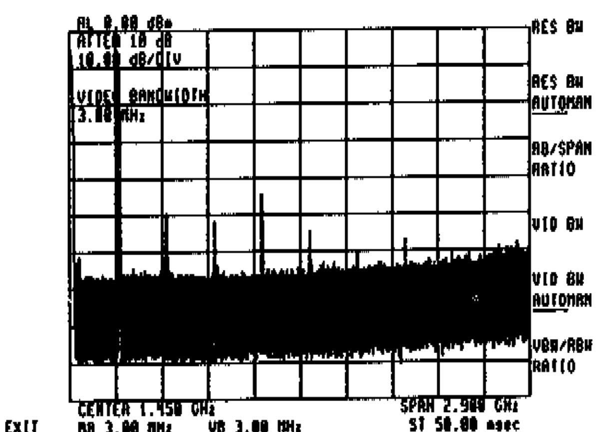


Fig. 4-73

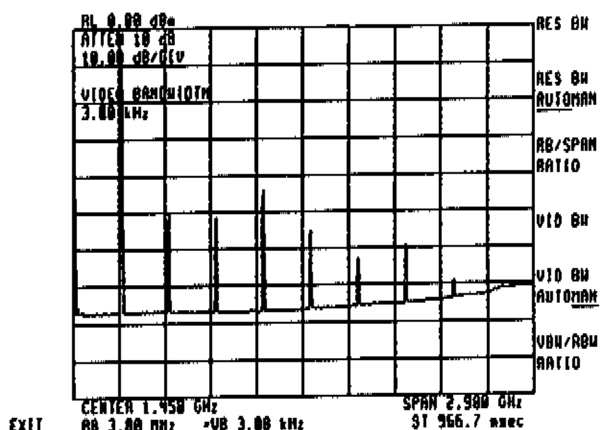


Fig. 4-74

Video Bandwidth Ratio

The video bandwidth ratio is multiplied by the resolution bandwidth to determine the automatic setting of video bandwidth. To set the value press ◀VID BW RATIO▶ and enter a value. Again, there is no manual/auto mode. The user simply changes the ratio.

Three methods of setting the VIDEO BANDWIDTH RATIO are shown below:

KNOB	Changes the ratio in allowable increments continuously.
STEP KEYS	Changes the ratio to the next value in a 1, 3, 10 sequence.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Enters an exact value which is allowable (any value between 10^{-100} to 10^{+100}). The instrument will display only three significant digits. The preset value is 1.

The preset state has a ratio equal to 1.0.

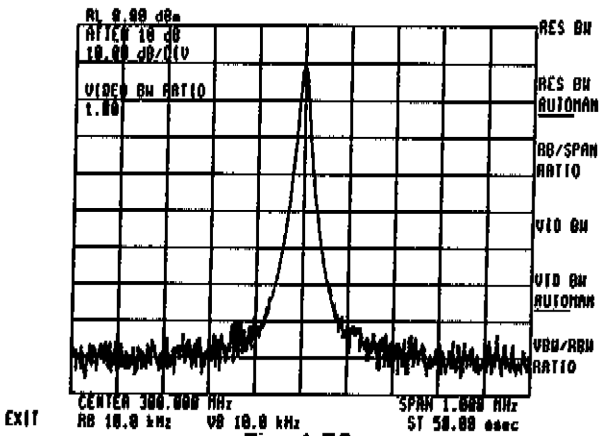


Fig. 4-75

Example:

Signal responses near the noise level of the analyzer will be visually masked by the noise. The video filter can be narrowed to smooth this noise.

A low level signal at this center frequency can just be discerned from the noise.

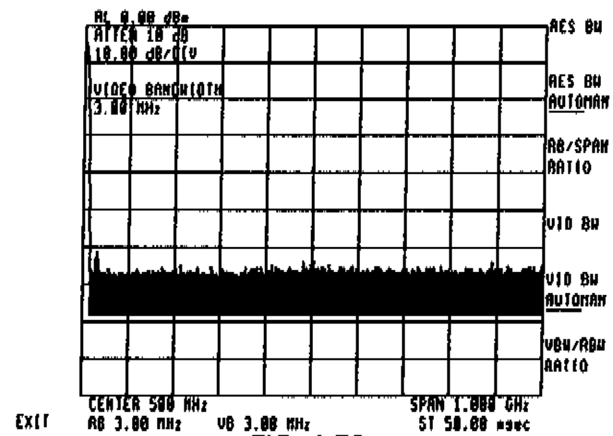


FIG. 4-76

Narrowing the video bandwidth clarifies the signal and allows for its amplitude measurement. Press ◀VID BW▶ and the step key until 3kHz is reached.

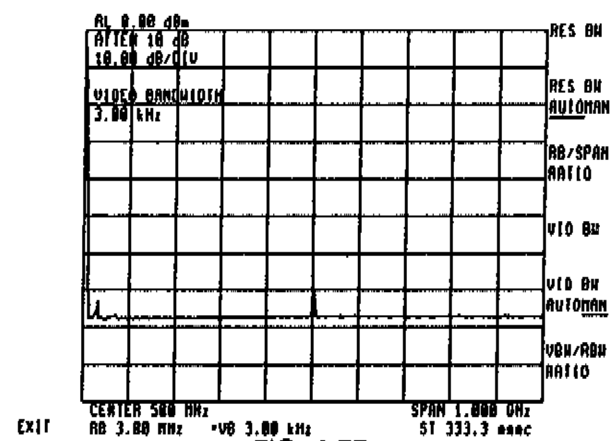


FIG. 4-77

The sweep time will increase to maintain amplitude calibration.

Note

The video bandwidth must be set wider than or equal to the resolution bandwidth when measuring pulsed RF or impulse noise levels.

Trace

This section describes softkeys which use the TRACE functions for writing, storing, and manipulating trace data. It also describes which softkeys are used to select the detector functions.

Figure 4-78 shows the softkeys which appear when ◂TRACE▸ is pressed.

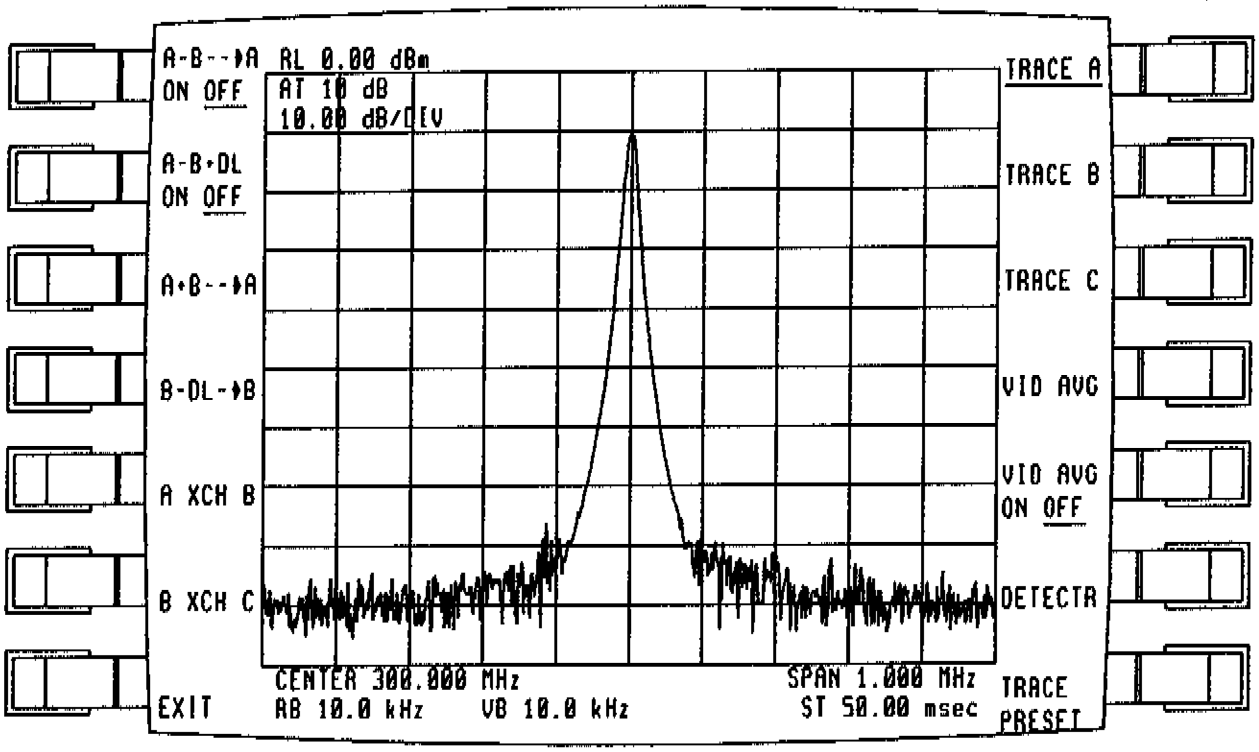


Fig.4-78. Top level menu for ◂TRACE▸

Trace Overview

To access the trace functions, select [MNU] and ◂TRACE▸. This menu displays the different spectrum analyzer trace functions. To select one, press the appropriate softkey. The instrument preset shows trace A being displayed. (Notice ◂<u>TRACE A</u>▸ is underlined.) The three traces A, B, and C can be displayed simultaneously.

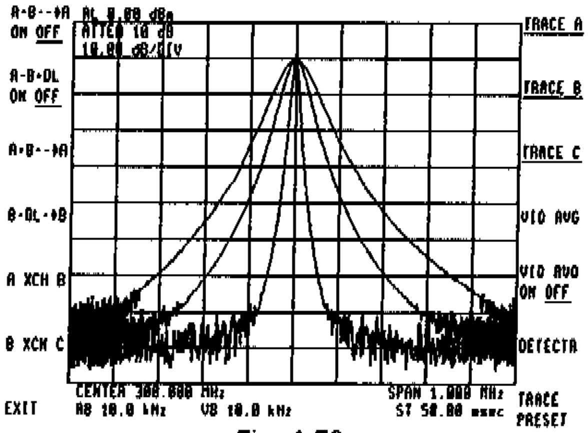


Fig. 4-79

Five mutually exclusive functions for trace A and trace B and trace C determine the manner in which the traces are displayed #6 and #7 aer independently set.

Trace functions:

1. **CLEAR WRITE** - Displays the input signal response in the trace selected.

2. **MAXIMUM HOLD** - Displays and holds the maximum response of the input signal in trace selected.

3. **MINIMUM HOLD** - Displays and holds the minimum response of the input signal in trace selected.

4. **VIEW** - Stores the current trace and displays it on the CRT display.

5. **BLANK** - Stores the current trace and blanks it from the CRT display.

6. **TRACE DISPLAY <u>ON</u> OFF** - Displays or turns off the trace register.

7. **LENGTH OF TRACE** - Defines the number of points in a user defined or predefined trace.

<u>Trace A</u>

Pressing ◀<u>TRACE A</u>▶ allows access to all the functions for trace A display. The softkey is underlined indicating that it is active. The following describes each of the functions in detail:

CLR WRT TRACE A

The clear write function initiates a sequence of events. First, each element in the indicated trace register(A) is set to the bottom of the screen value. Then, new data from the detector is put in the trace register with each sweep. Trace display is activated for the specified trace register (A). Also, the underline will appear below this softkey.

MAX HLD TRACE A

The input data and the specified trace (A) data are examined and the maximum of the two is selected and given to the trace register specified. Display of trace (A) register is activated. The "Det" detector is set to positive peak. Also, the underline appears below this softkey.

MIN HLD TRACE A

The input data and the specified trace (A) data are examined and the smaller of the two is selected and given to the trace register specified. Display of that trace register is activated. The "Det" detector is set to negative peak. The underline appears below this softkey.

VIEW TRACE A

The indicated trace register (A) is disconnected from the input data source and is displayed. The underline appears below this softkey.

BLANK TRACE A

The Blank command disconnects the trace from the input data source. Display of trace (A) is also prevented. The underline will appear below this softkey.

TRDSPL ON OFF

The trace register indicated (A) may be displayed or turned off with this command. When the trace displays are turned off, the total sweep time can be decreased. There is no other effect on the operation of the trace or of its data. Also, the underline will toggle between the ON and OFF position.

LENGTH TRACE A

This command establishes number of points in a user-defined trace or predefined trace. The default length for predefined traces is 800 points. Any number of points may be used for a trace length. By changing the length of the predefined traces, the number of data points acquired can be changed. Since traces of varying length can be created, the following rules are used to manipulate traces of different lengths.

If two traces have different lengths, the smaller length is used for the specified span. The longer trace will acquire data only until the shorter trace is filled up. When a trace of greater length is operated on and stored in a trace of shorter length, the trace is truncated to fit. When a trace of a shorter length is operated on and stored in a trace of longer length, the last trace element is extended for operations with the longer length. For example, a single element trace would act like a display line in trace operations.

Trace B

The operations and functions are the same as those described in TRACE A.

Trace C

The operations and functions are the same as those described in TRACE A. The default trace length is 3, to save user memory.

Vid Avg

Pressing ◀VID AVG▶ sets the average counter to 100, its default value. The count is displayed on the middle left part of the screen. The counting sequence starts with the press of ◀VID AVG ON OFF▶. Pressing the ◀VID AVG▶ allows you to change the number of averages. The numeric keyboard is the only way of entering the new value. If the averaging process is working, any key that affects the data on the display (Span, Center Freq, BW, etc.) restarts the count.

Video Average on-off

Pressing ◀VID AVG ON OFF▶ causes the video average function to begin. The count sequence is displayed on the screen. Notice the underline toggles between the ON and OFF position. While the average function is working, the analyzer's function can be changed; however, the video averaging process will start over if this change alters the source data.

When video average is turned on, the detector is set to sample. If the detector is SAMPLE when video average is turned off, the detector will be set to NORMAL.

Detector

Pressing ◀DETECTR▶ allows the selection of five different modes.

*NORMAL DETECTION

*SAMPLE DETECTION

*POSITIVE PEAK DETECTION

*NEGATIVE PEAK DETECTION

*GROUND DETECTION

The detection mode specifies the input detector used to acquire measurement data. The instrument preset [I/P] is normal detection. The softkey of the activated detection mode is underlined. The following describes each of the detection modes:

◀NORMAL DETECTR▶

The normal detection algorithm selectively chooses between the positive and negative peak values to be displayed. Normal mode is selected on instrument preset.

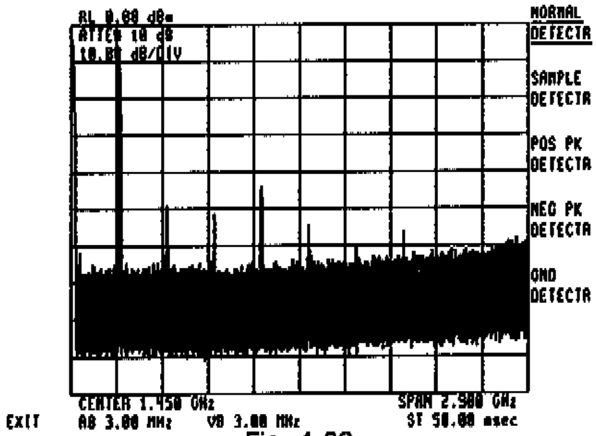


Fig. 4-80

In normal mode a detection algorithm selectively chooses between the positive and negative peak values to be displayed. The choice made depends upon the type of video signal present.

Data from the positive peak detector (signal maximums) will always be displayed in the odd addressed trace memories. If, within the time period following the storage of a value in an odd address memory, there is no change in video signal level, the positive peak detector value will be stored in the even address. In other words, the even addressed memory will also contain positive peak detection data if the signal during that time period is monotonic. Negative peak detector data (video signal minimum) will be stored in the even addressed trace memory if the signal has a point of inflection during the time period.

◀SAMPLE DETECTR▶

The instantaneous signal value of the video a/d conversion is placed in memory. Sample mode is selected automatically when video averaging from the input occurs and when a noise level marker is activated.

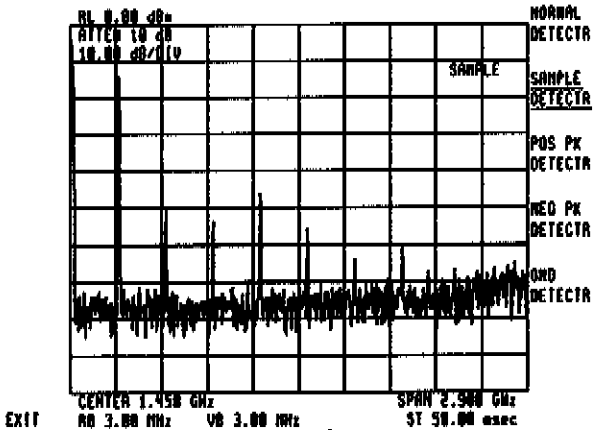


Fig. 4-81

◀POS PK DETECTR▶

The maximum signal value over the conversion period is acquired.

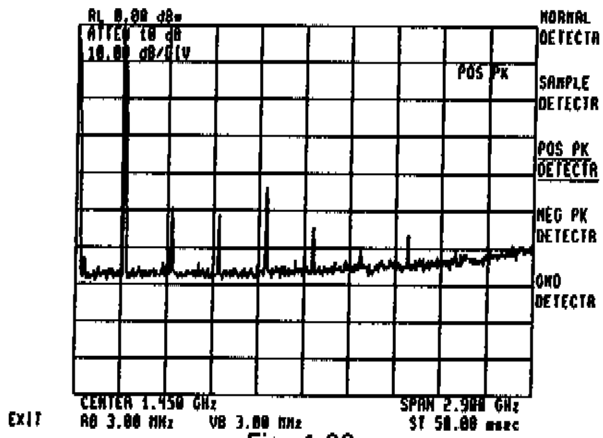


Fig. 4-82

◀NEG PK DECTECTR▶

The minimum signal value over the conversion period is acquired.

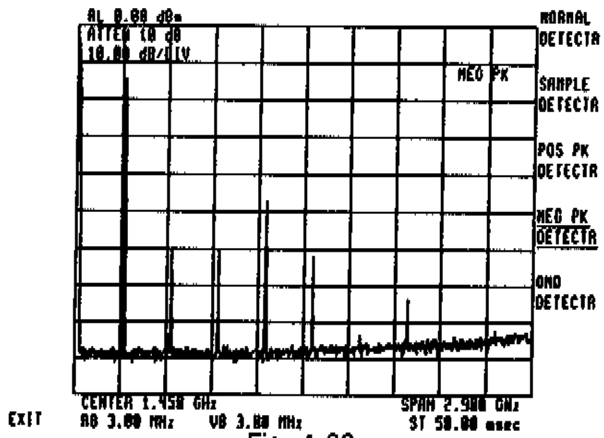


Fig. 4-83

◀GND DETECTR▶

The input signal is connected to ground. This is primarily used for diagnostics.

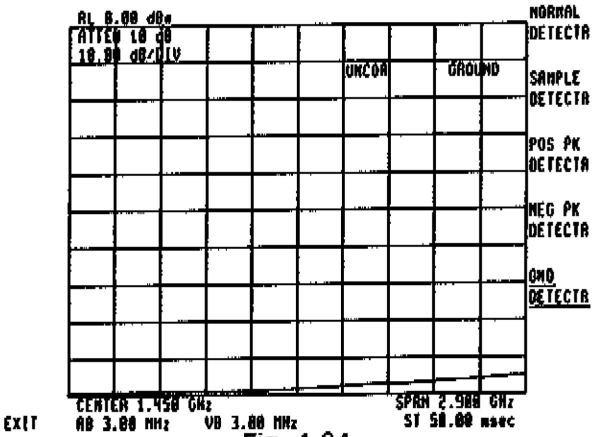


Fig. 4-84

Trace Present

With this command, the trace function can be independently preset. All trace functions are set to their preset values as follows:

1. Input to trace A.
2. Display trace A activated.
3. Zero value entered into trace A.
4. All other math and control functions off.
5. Display line off.
6. Normal detector.

A - B-->A ON OFF

Trace B is subtracted from Trace A and the result is stored in Trace A. Trace B is frozen, no longer affected by input data (writing status off). As new data is measured, the subtraction is performed as each data point is measured. The preset condition is off.

A - B + DL ON OFF

Trace B is subtracted from Trace A, the display line is added, and the result is stored in Trace A. Trace B is frozen, no longer affected by input data (writing status off). As new data is measured, the subtraction and addition is performed point by point. The preset condition is off.

A + B-->A

Trace B is added to Trace A and the result is stored in Trace A. This is done immediately and not on a repetitive basis.

B - DL-->B

The display line is subtracted from Trace B and the result is stored in Trace B. The display of Trace B is activated. Trace B is frozen, no longer being affected by the input data.

A XCH B

Trace B and Trace A are exchanged. Both Trace A and Trace B are frozen, no longer affected by the input data.

B XCH C

The Trace B is exchanged with Trace C. Both Trace B and Trace C are frozen, no longer affected by the input data.

Instrument Display

This section describes softkeys which change instrument display settings or annotation settings.

Figure 4-85 shows the softkeys which appear when ◄INST DSPLY► is pressed.

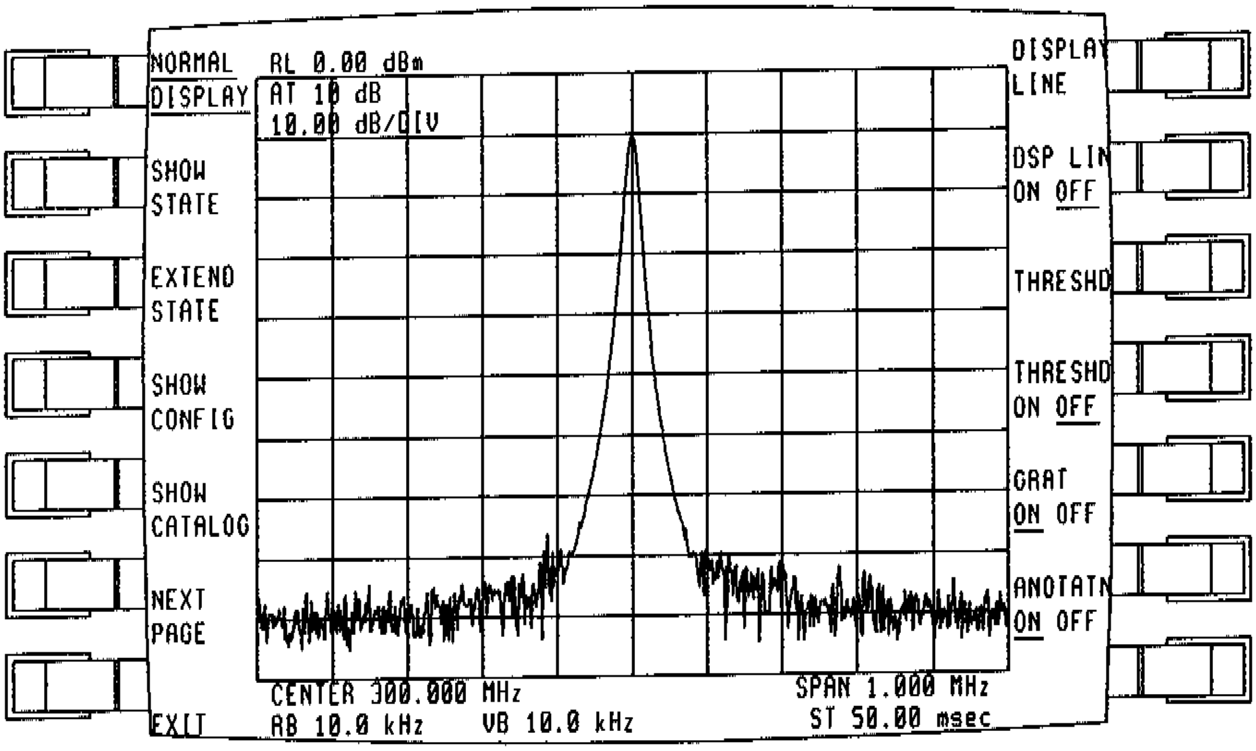


Fig.4-85. Top level menu for ◄INST DSPLY►

Reference Line

The reference line functions, ◄DISPLAY LINE► and ◄THRESHD►, place horizontal reference lines on the display. Their levels are displayed in absolute amplitude units.

DISPLAY LINE is used to:

* measure signal levels with direct readout.

* establish a standard for go/no go test comparisons.

* eliminate or reduce amplitude errors due to system frequency response uncertainty.

THRESHOLD provides:

* a base line clipper whose level is read out.

* a minimum threshold level that can be set.

Display Line

The display line function provides a reference line in units corresponding to the vertical scale for visual and computational purposes. It may be turned on and off and can be assigned a display line level.

The display line is activated when a numeric data field is input, an up or down is entered, or an enable parameter entry is terminated. The preset condition is off.

Pressing ◀DISPLAY LINE▶ places a horizontal reference line at any level on the graticule. The line's amplitude , in reference level units, is read out on the left-hand side of the CRT display.

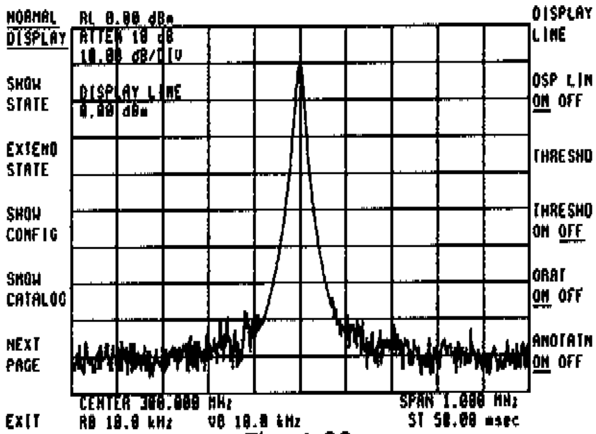


Fig. 4-86

The display line can be positioned anywhere within the graticule. When line power is activated or [I/P] is pressed the display line is placed at the reference level.

Dsp Lin ON <u>OFF</u>

If ◀DSP LIN ON <u>OFF</u>▶ is pressed, a horizontal reference line is placed on the graticule. The line can be placed at any level on the graticule. The line's amplitude, in reference level units, is read out on the left-hand side of the CRT display. The underline toggles to the ON position: this takes place when ◀DISPLAY LINE▶ is pressed.

When the OFF position is selected, the line and readout are erased from the CRT display. This does not reset the last position. If the display line is activated again before Line power ON or [I/P], it will return to its last position.

The display line position is always accessible for HP-IB and ◀B-DL->B▶, even if it has not been activated.

The display line readout has the same number of significant digits as reference level.

Three methods of setting DISPLAY LINE are shown below:

KNOB	Moves the line approximately one division for each full turn. The line moves in display unit increments.
STEP KEYS	Moves the line one tenth of the total amplitude scale per step.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Positions the line to the exact entry level. Entry may be in mV, µV, ±dBm, ±dBmV, or ±dBµV, depending upon which units are selected.

Example: When the amplitude of a number of signals in the same span require a quick readout, the DISPLAY LINE can be used.

Press ◀DISPLAY LINE▶, then with the knob place the line through the peak of a signal and read out its absolute amplitude level.

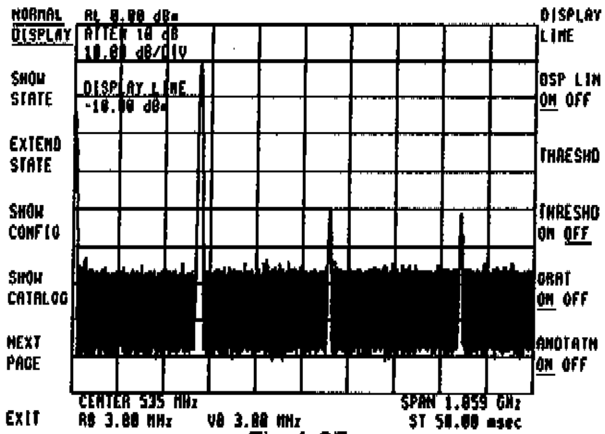


Fig.4-87

The amplitude of each signal can be read by moving the display forward to each signal.

Threshd ON OFF

The softkey ◀THRESHD ON OFF▶ moves a lower boundary to the trace. The lower boundary is similar to a base line clipper on direct writing CRT spectrum analyzers. The boundary's absolute amplitude level, in reference level units, is read out on the middle left-hand side of the CRT display.

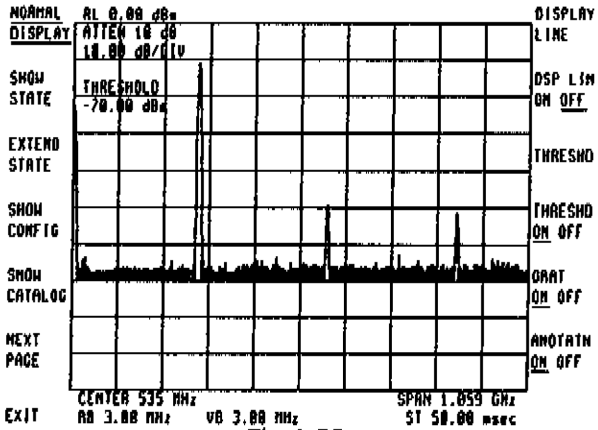


Fig.4-88

The threshold can be positioned anywhere within the graticule. It operates on Trace Clear Write, Maximum Hold, or View for Traces A, B and C simultaneously. When activated by LINE power ON or [I/P], the threshold is placed one division from the bottom graticule.

The threshold level does not influence the trace memory; that is, the threshold level is not a lower boundary for trace information stored and outputted from the trace memories through HP-IB.

Toggling the ◀THRESHD ON OFF▶ changes the underline position and turns the function on and off. Selecting the off position causes the analyzer to remove the threshold boundary and readout from the CRT display but does not reset the position. If threshold is activated again before LINE power ON or [I/P] it will resume operation at its last level.

The threshold readout has the same number of significant digits as reference level. Threshold is also used as a bottom limit for marker peak functions even if it is off.

Three methods of setting THRESHOLD are shown below:

KNOB	Moves the THRESHOLD approximately one division per rotation. The line moves in display unit increments.
STEP KEYS	Moves the THRESHOLD one tenth of the total amplitude scale per step.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Positions the THRESHOLD to the exact entry level. Entry may be in mV, µV, ±dBm, ±dBmV, ±dBµV depending upon units selected.

Example:

The THRESHOLD can be used as a go/no go test limit.

A series of signals can be tested for a specific THRESHOLD level by placing the THRESHOLD at the test level.

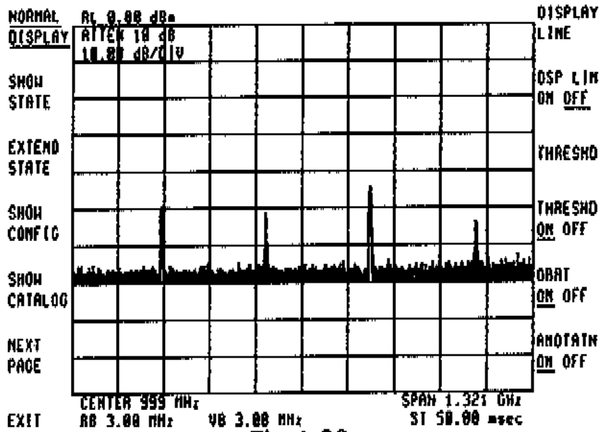


Fig.4-89

Press ◀THRESHD ON OFF▶, then [-], [5], [0], [.], [2], ◀dBm▶. Only those signals > -55.2 dBm will be displayed.

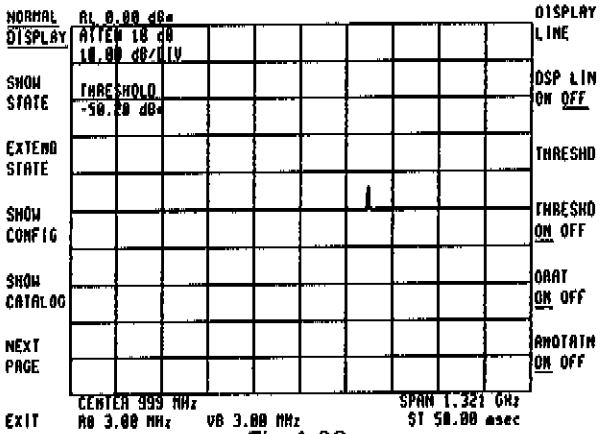


Fig.4-90

Grat ON OFF

Pressing ◀GRAT ON OFF▶ will toggle the underline and activate the function. The preset condition is with the graticule on. Pressing the softkey ◀GRAT ON OFF▶ will turn the graticule off. The graticule will disappear.

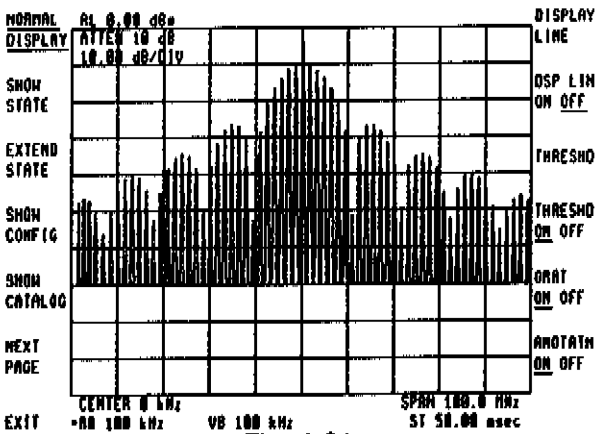


Fig. 4-91

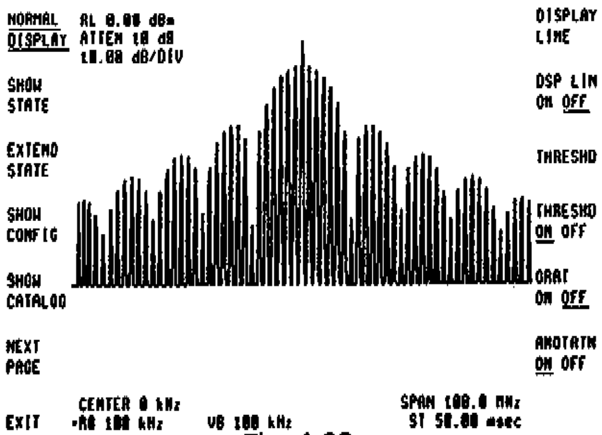


Fig. 4-92

Anotatn ON OFF

Pressing ◀ANOTATN ON OFF▶ will toggle the underline and activate the function. The preset condition is with the annotation on. Pressing the softkey ◀ANOTATN ON OFF▶ will turn the annotation off.

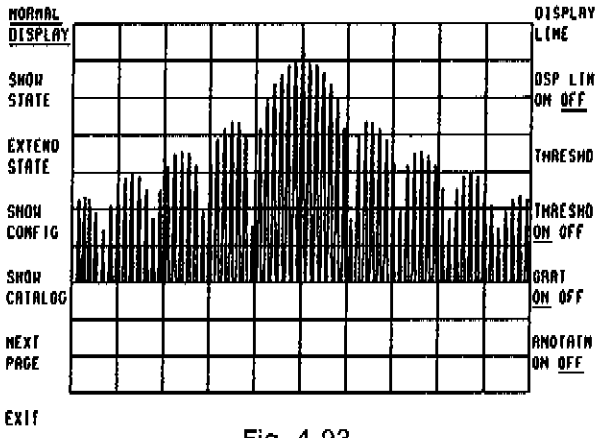


Fig. 4-93

Normal Display

Pressing ◀NORMAL DISPLAY▶ causes the measured trace data and the primary measurement parameters to be displayed. This is the preset display mode.

Show State

Pressing ◀SHOW STATE▶ causes all user- setable variables to be displayed in alphanumeric format. If more than one page of information is available, the display annotation indicates this by displaying "(more)" on the bottom of the display. The way to access this additional information is to press ◀NEXT PAGE▶. When the last page is reached, the annotation on the display reads "end of State".

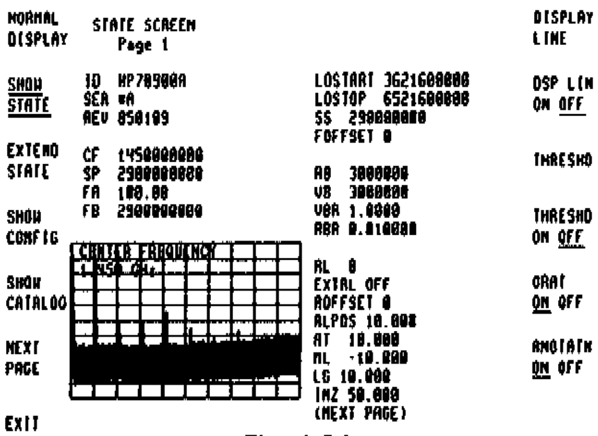


Fig. 4-94

Extend State

Pressing ◀EXTEND STATE▶ causes the analyzer to display additional state information about specific modules. If more than one page of information is available, the display annotation indicates this by displaying "(more)" on the bottom of the display. Select ◀NEXT PAGE▶ for additional information.

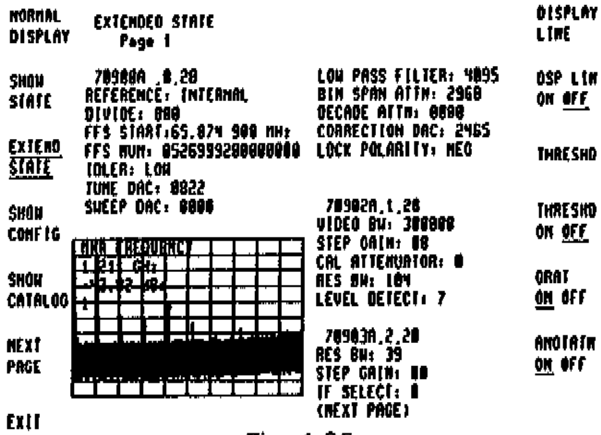


Fig. 4-95

Show Config

Pressing ◀SHOW CONFIG▶ causes the analyzer to display the instrument configuration in alphanumeric format. If more than one page of information is available, the display annotation indicates this by displaying "(more)" on the bottom of the display.

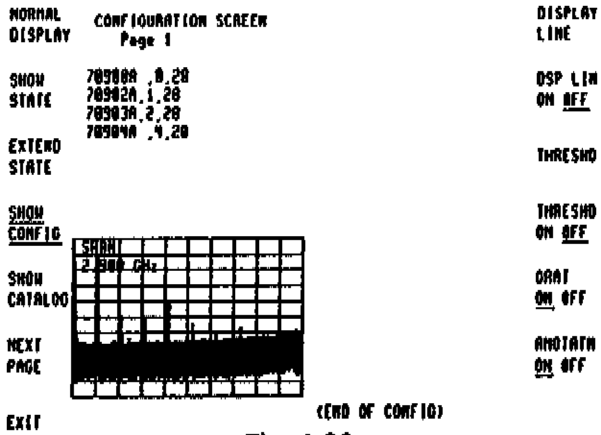


Fig. 4-96

Show Catalog

Pressing ◀SHOW CATALOG▶ brings up a catalog of all user functions, trace, and variable definitions. If more than one page of information is available, the display annotation indicates this by displaying "(more)" on the bottom of the display.

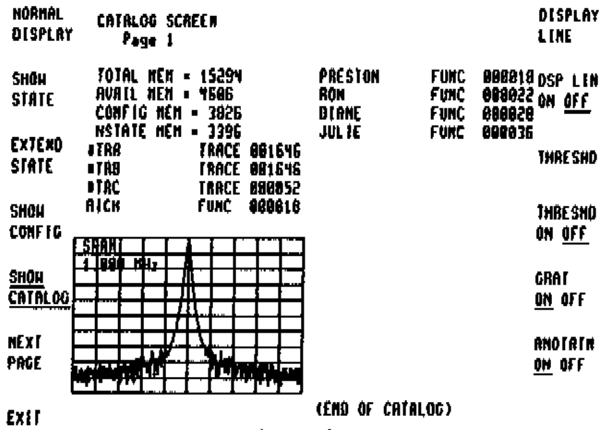


Fig. 4-97

Next Page

Pressing ◀NEXT PAGE▶ causes the analyzer to display any additional information that may not have fit on one screen. There is an annotation at the bottom of the screen just right of center, that indicates whether there is more than one page of data and also which page you are presently on.

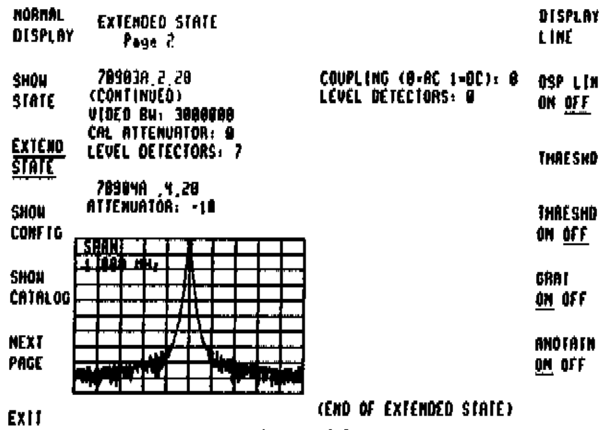


Fig. 4-98

State

This section describes softkeys for saving or recalling trace displays. It also describes how to set up the Spectrum Analyzer's power-up state.

Figure 4-99 shows the softkeys that appear when ◀STATE▶ is pressed.

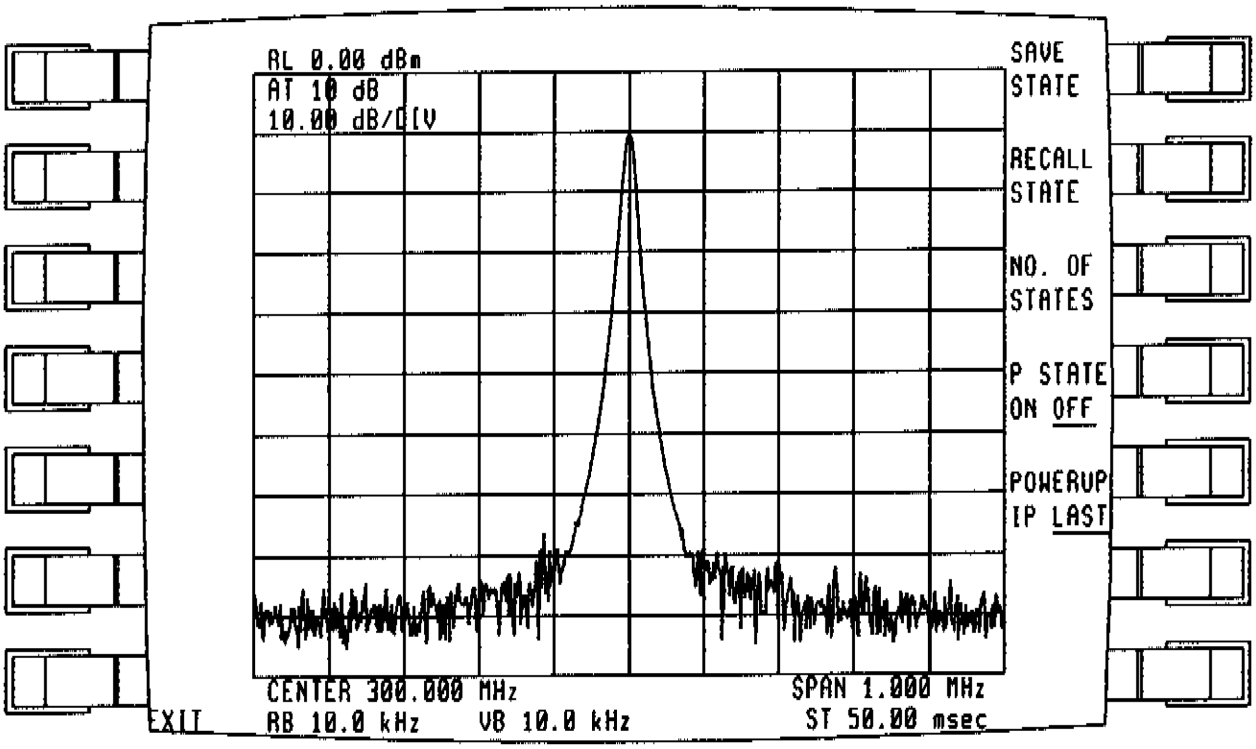


Fig.4-99. Top level menu for ◀STATE▶

Save State

The preset state of the analyzer can be saved in one of several registers referenced by numeric values. The number of state registers is set by the [number of] STATE Registers (◀NSTATE▶) softkey.

To save a state, press ◀STATE▶ and enter a number from the keyboard. The preset number of registers is 2.

Recall State

A previously saved state may be recalled using this function. The instrument state will not be affected if a recall number is selected and that number has not been previously saved.

To recall a saved state press ◀RECALL STATE▶, then enter the number to be recalled using the numeric keypad.

No. of States

This command sets the number of state registers. Since state registers consume large amounts of user memory, this allows the user to trade off the amount of memory used versus the number of state registers needed. When a smaller number of state registers is specified, the memory for the previously used registers is reclaimed and the information stored in them is lost.

State registers are allocated starting with Number 1.

This function is not affected by instrument preset. The preset value is 2. To use this function, press ◀NO. OF STATES▶, and then enter the number.

P State on-off

This command allows the user to protect the state registers so that they will not be accidentally changed. The state registers cannot be changed if ◀P STATE ON OFF▶ is selected. The instrument preset does not change the ◀P STATE ON OFF▶ condition. The factory setting is off.

Power Up IP-Last

This command sets the instrument state when power is applied. If IP is selected, the instrument will default to the instrument preset state. If LAST is selected, the instrument will be set to the state it was in when the power was turned off.

To use the command, press ◀POWERUP IP LAST▶ and select the function wanted. By pressing ◀POWERUP IP LAST▶ the underline will toggle correspondingly to the desired function.

Special Function

This section describes softkeys you will use to select the memory display function and to relabel your own softkeys. It also describes how to write, execute, and debug your own programs from the front panel. Finally, it describes the softkey you will use to perform an analyzer self test.

Figure 4-100 shows the softkeys which appear when ◀SPECIAL FUNCTNS▶ is pressed.

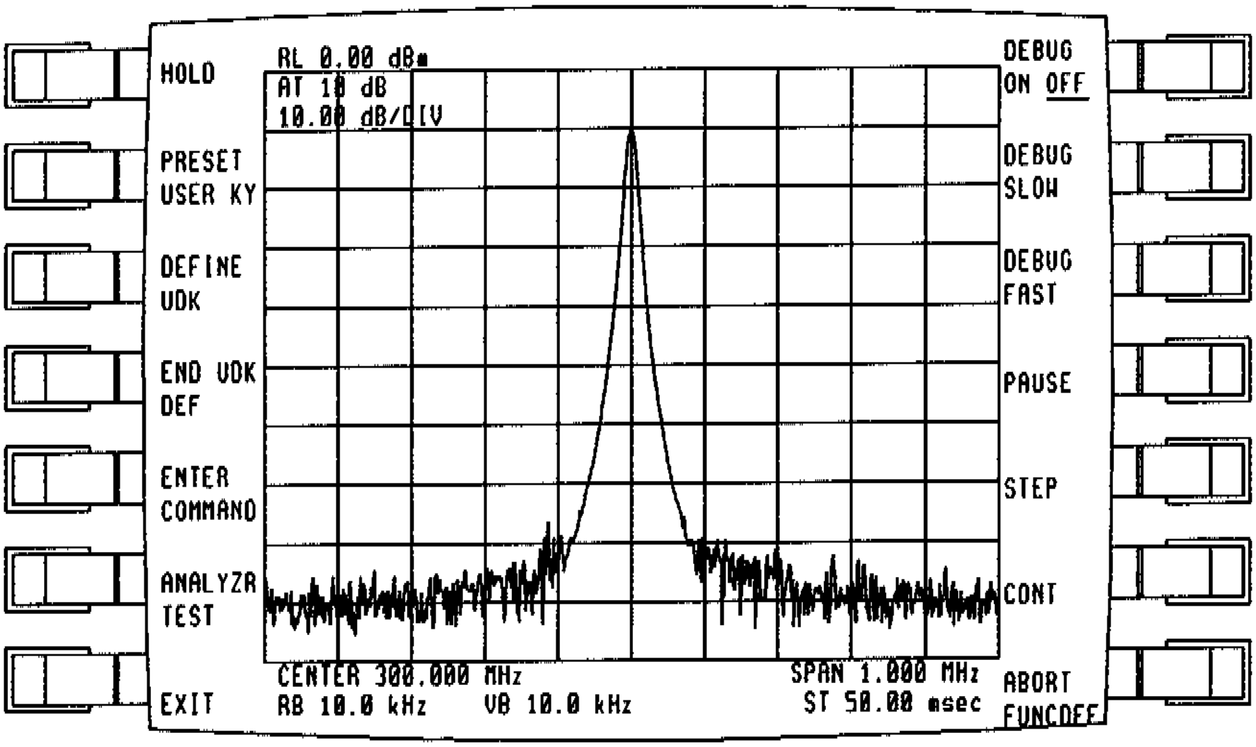


Fig.4-100. Top level menu for ◀SPECIAL FUNCTNS▶

Define UDK

Pressing ◀DEFINE UDK▶ (User Defined Key) allows you to define a softkey function. This softkey will appear when the instrument first powers up, when [I/P] is selected, or when [USR] is selected. The softkey function can become any of those functions which are located under the [MNU] hardkey.

Example:

Select Start Frequency as one of the user define softkeys.

Select [MNU] and then ◀SPECIAL FUNCTNS▶.

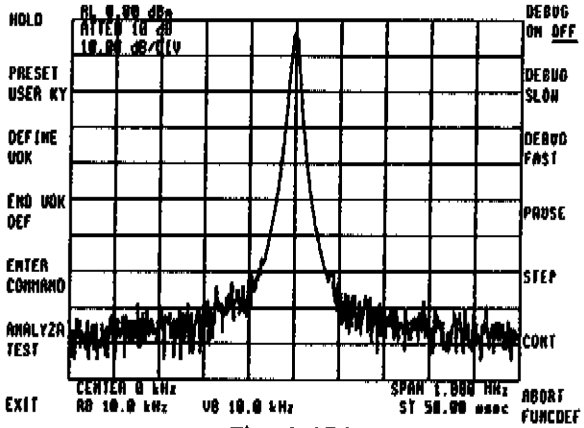


Fig. 4-101

Select ◀DEFINE UDK▶. Notice the softkeys change back to the MENU set and the annotation asks you to select the function.

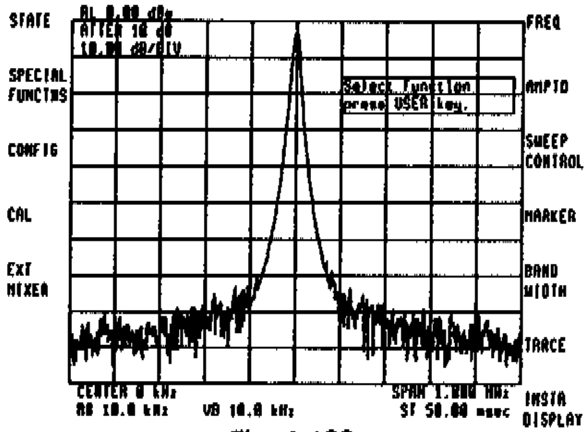


Fig. 4-102

Select ◀FREQ▶, then select ◀START FREQ▶. The annotation asks you to select [USR] then the softkey that you want to redefine.

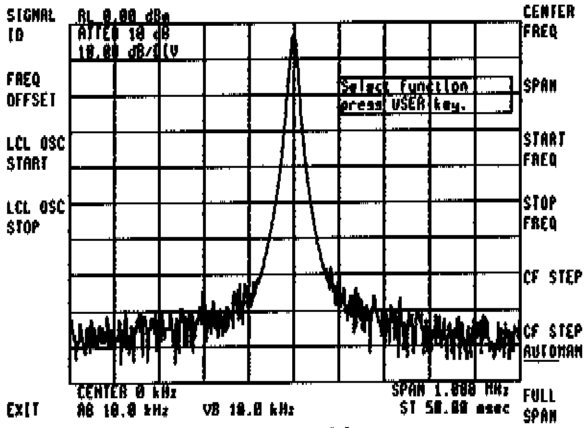


Fig. 4-103

Select ◀CENTER FREQ▶. Notice the softkey now changes to ◀START FREQ▶ instead of ◀CENTER FREQ▶.

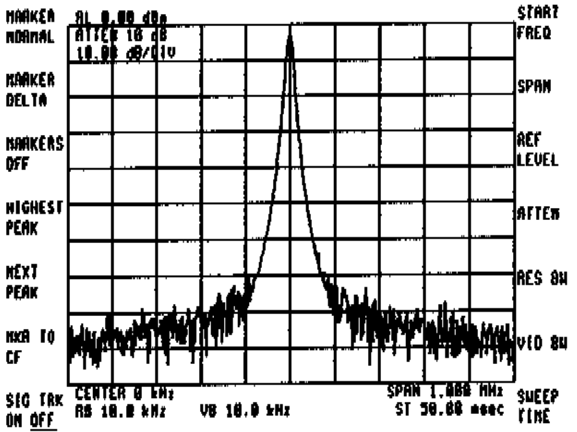


Fig. 4-104

End UDK Def

Pressing ◀END UDK DEF▶ will cause the function that defines UDK (user defined key) to end. The analyzer will go back to the SPECIAL FUNCTION menu.

Debug on-off

Selecting ◀DEBUG ON OFF▶provides a function to aide in debugging your remote programs. When the function is ON (◀DEBUG ON OFF▶), the title line shows the data that is currently being processed by the instrument. In this mode, any detected error will create a pause in the program to be executed. Also, a menu is provided to single step, halt, or continue the processing of remote input. When the function is off (◀DEBUG ON OFF▶), the menus are blanked if the instrument goes into the remote HP-IB state. The off mode is the preset condition.

Debug Slow

Selecting ◀DEBUG SLOW▶ activates the program to process the input slowly so it can be viewed.

Debug Fast

Selecting ◀DEBUG FAST▶ activates the program to process the input at full speed.

Debug Pause

Selecting ◀DEBUG PAUSE▶ halts the processing of the remote commands.

Debug Cont

Selecting ◀DEBUG CONT▶ returns the processing of the remote commands to either fast or slow speed depending on the last setting.

Debug Step

Selecting ◀DEBUG STEP▶ causes the processing of the remote commands to accept one more character of input.

Enter Command

Selecting ◀ENTER COMMAND▶ allows you access to the functions necessary to program the analyzer from the front panel. Below you will find a list of those functions, details of what the functions are, and directions for using them.

;	Execute Line
_	Edit Funcdef
,	Clear To End
"	Insert/Replace
E	Delete Char
SPACE	Enter Anychar
EXIT	Enter Alpha

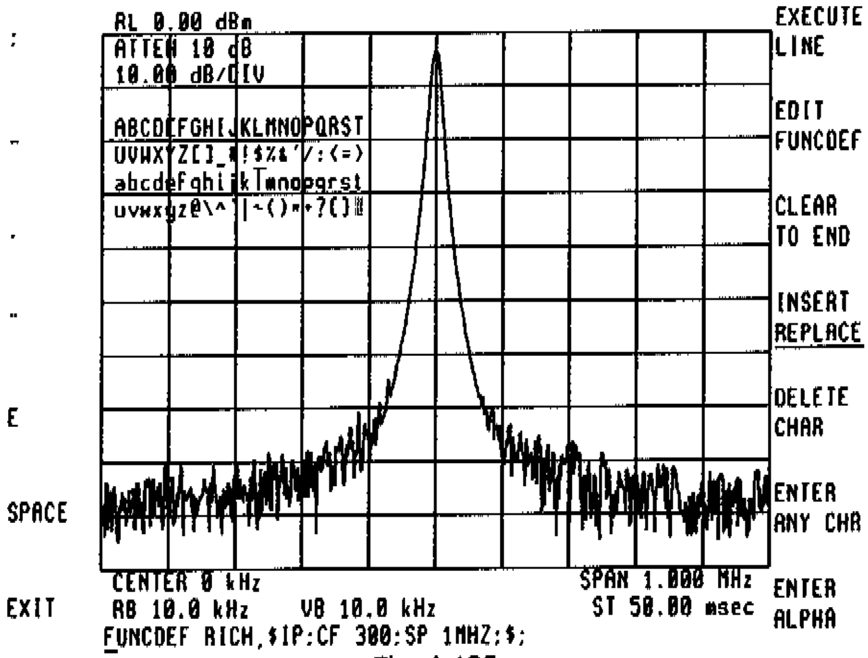


Fig. 4-105

EXECUTE LINE

Selecting ◀EXECUTE LINE▶ tells the analyzer to accept the command that is typed in on the first line. If this is I/P, for instance, the function will be executed. A maximum of 254 characters is accepted for any sequence of characters entered. For the FUNCDEF a maximum of 239 characters can be entered.

EDIT FUNCDEF

Selecting ◀EDIT FUNCDEF▶ allows you the ability to edit the function definition (downloadable program). To edit a particular FUNCDEF, where there are multiple FUNCDEF's, enter the name of the FUNCDEF and press ◀EDIT FUNCDEF▶.

CAUTION

Downloadables which come from an external CPU with more than 239 characters could be destroyed if they are edited with the ◀EDIT FUNCDEF▶ and then ◀EXECUTE LINE▶ is pressed.

CLEAR TO END

Selecting ◀CLEAR TO END▶ tells the analyzer to clear the last line entered from program memory.

INSERT/REPLACE

Selecting ◀INSERT REPLACE▶ allows you to insert or replace a character in the program line.

DELETE CHAR

Selecting ◀DELETE CHAR▶ tells the analyzer to erase the character that is under the cursor from the program memory.

ENTER ANYCHAR

Selecting ◀ENTER ANYCHR▶ allows entry of any character by entering it's ASCII value in decimal.

ENTER ALPHA

Selecting ◀ENTER ALPHA▶ allows you to put any character (a - z) into the program. The display knob gives you access to the different characters. Turning the knob displays the different characters on the screen.

PROGRAMMING AIDES

Selecting ◀;▶ gives you the capability to use this delimiter in your program. This delimiter is used for terminating commands.

Example: FUNCDEF RICH, %IP;CF300;SP1MHZ;%;

Selecting ◀_▶ gives you the capability to use this underscore character in your program. This underscore is used to differentiate function names and variable names from the analyzer command set.

Example: CF_Commands --This causes the program to assign the name CF_Command and not change the center frequency of the analyzer.

Selecting ◀,▶ gives you the capability to use this delimiter in your program. This delimiter is used for separating arguments of functions.

Example: ADD VAL 1, VAL 2, VAL 3 or MOV CF,MKF

Selecting ◀"▶ gives you the capability to use this delimiter in your program. This delimiter is used for delimiting strings (text in quotes).

Example: Title "SPECTRUM ANALYZER DISPLAY"

Selecting ◀E▶ gives you the capability to use this exponent character in your program. This character is used for raising numbers to an exponential power as in "CF1E6".

Hold

Pressing ◀HOLD▶ deactivates the function displayed in the active function area; the readout is blanked from the screen. Pressing a function such as ◀CENTER FREQ▶ will reactivate the function. The function will reappear in the active function area of the screen.

Preset User Key

Selecting ◀PRESET USER KEY▶ returns the [USER] softkeys to the default softkeys (set at the factory).

Analyzer Test

Selecting ◀ANALYZER TEST▶ sends the analyzer into a self-test routine. One of the tests is to light all the indicators in the modules. Any errors are reported with the status byte. Errors can be interrogated with the error query command. On completion of analyzer test, the instrument returns to its power on state. A instrument preset may be used to stop an analyzer test.

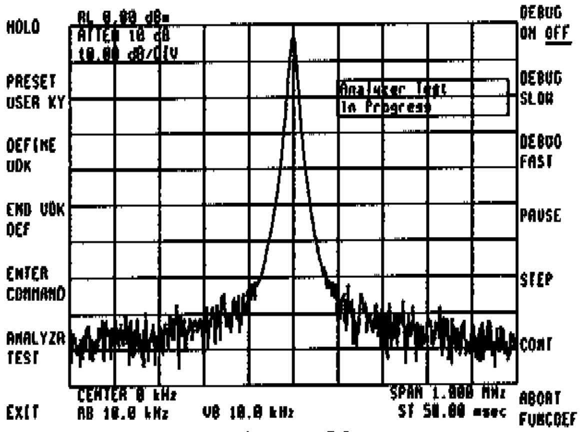


Fig. 4-106

Configuration

This section describes softkeys used to select the input source or the coupling mode. It also describes how to find the version of firmware that is in the instrument and how to lock the path of measurement into the instrument.

Figure 4-107 shows the softkeys that appear when ◀CONFIG▶ is pressed.

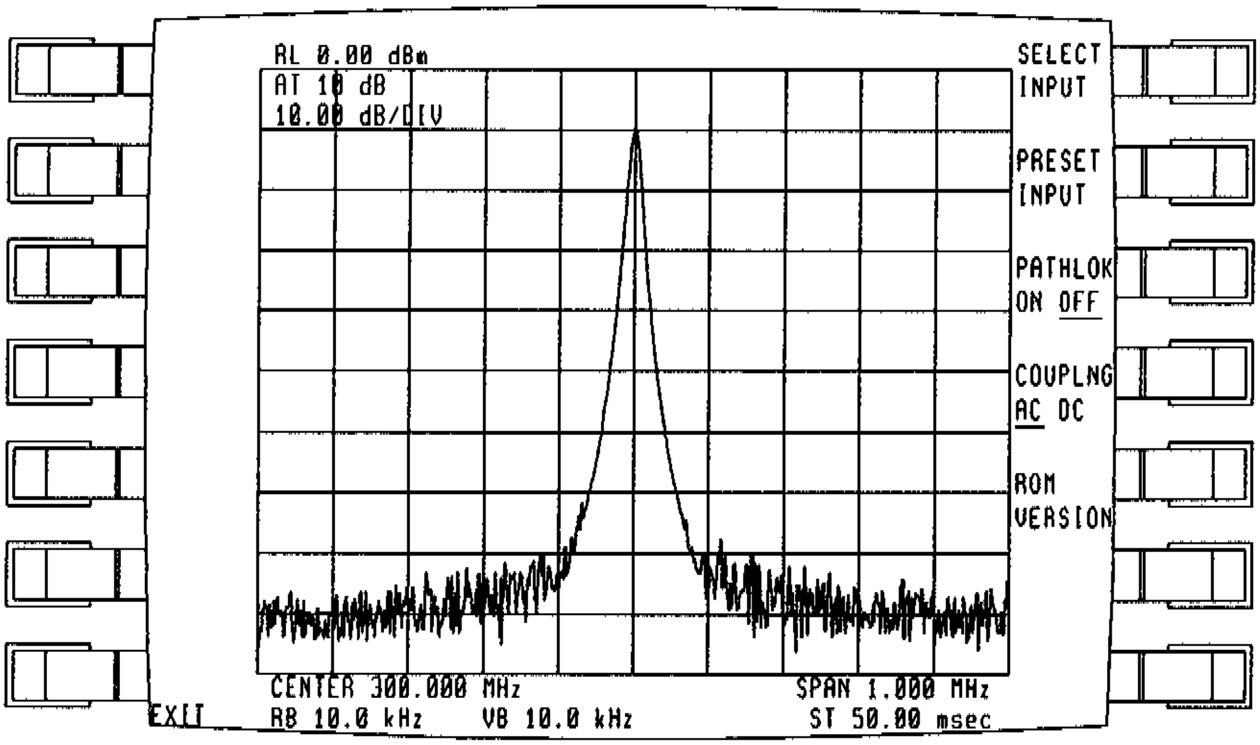


Fig.4-107. Top level menu for ◀CONFIG▶

Select Input

Selecting ◀SELECT INPUT▶ causes the local oscillator to automatically assign input numbers. It assigns numbers according to the input modules if finds on the address map. (See address map discussion in the Display chapter.) It assigns this numbers during the power up sequence.

With this softkey, the input associated with the number is connected to the measurement system. The preset condition is 1.

Preset Input

Selecting ◀PRESET INPUT▶ allows the selection of which input will be selected upon instrument preset.

For example, if input 2 is wanted when I/P is selected pressing the following keys will cause this function to take place.

1. ◀PRESET INPUT▶

2. ◀2▶

3. ◀ENTER▶

Pathlock On Off

Selecting ◀PATHLOK ON OFF▶ activates this function . Since this instrument is modular, there may be more than one path through which the signal can be routed during measurement. Based on your input, the instrument automatically chooses the best path. Under certain measurement conditions, the measurement may require a specific path that is not normally available with automatic path selection. The path lock softkey locks the analyzer in the current measurement path. When path lock is on, the range of inputs is limited to those available on that path.

Coupling AC-DC

Selecting ◀COUPLING AC DC▶ sets the input coupling to AC or DC, depending on your choice. The preset condition is AC coupled if the RF section is 70904A (100Hz-2.9GHz). If DC coupling is wanted, then press ◀COUPLING AC DC▶ and notice the underline's change to DC (◀COUPLING AC DC▶). The indicator light on the RF section (70904A -100Hz to 2.9GHz section) lights up. If the RF section is 70905A or 70906A, the analyzer will not allow an AC coupled mode.

Rom Version

Selecting ◀ROM VERSION▶ will output the revision of the instrument firmware. The indication on the screen will be YEAR-MONTH -DAY.

Example: 841028

Calibration

This section describes softkeys used to calibrate the amplitude, the resolution, the bandwidth, the frequency, and the log amplifier. It also describes the setting of correction features.

Figure 4-108 shows the softkeys that appear when ◀CALIBRT▶ is pressed.

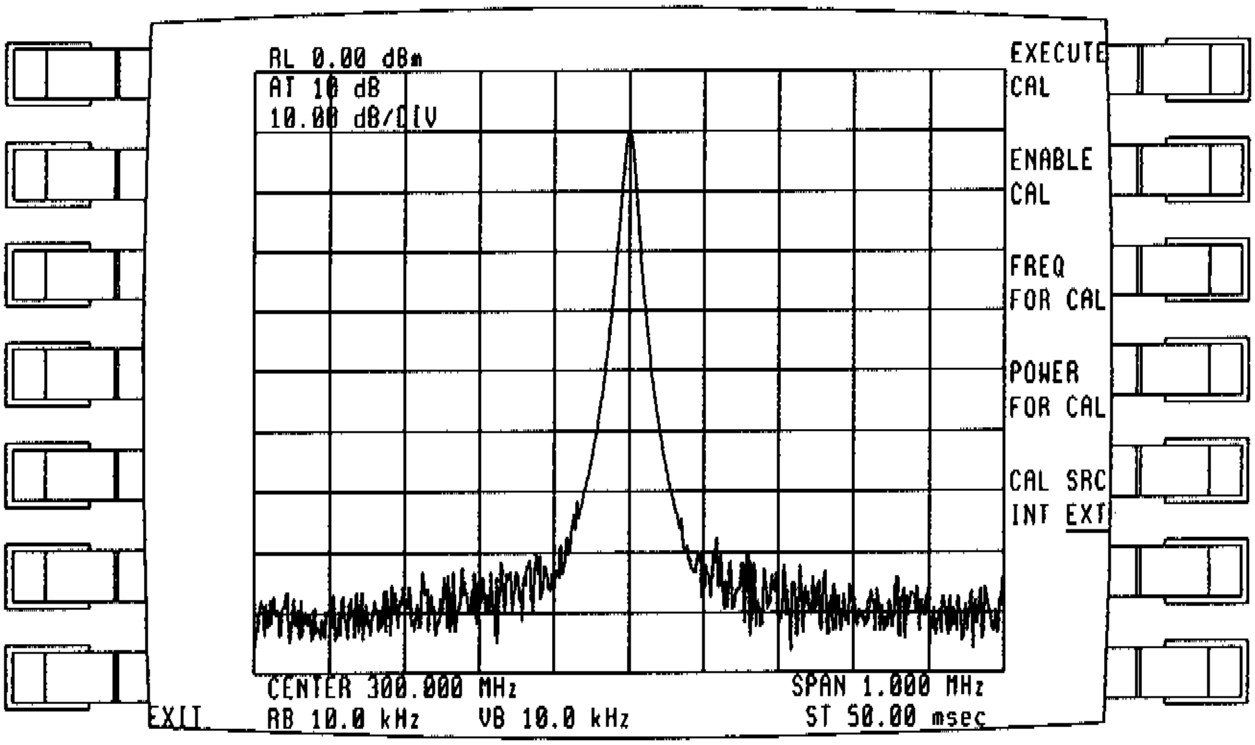


Fig.4-108. Top level menu for ◀CALIBRT▶

OVERVIEW

There are several calibration functions which can be performed by the instrument. The calibration commands found below can be accessed by selecting the particular softkey associated with the calibration function. The calibration source, calibration frequency, and calibration power can be entered with the following softkeys commands:

1. ◀CAL SRC <u>INT</u> EXT▶

2. ◀FREQ FOR CAL▶

3. ◀POWER FOR CAL▶

The following describes in detail what each function calibrates.

Execute Cal

To access each of the calibration functions, press ◀EXECUTE CAL▶, and the following four functions become available:

1. ◀CAL ALL▶

2. ◀CAL LOGAMP▶

3. ◀CAL GAIN▶

4. ◀CAL RES BW▶

CAL ALL

Selecting ◀CAL ALL▶ causes the analyzer to do a complete system calibration. This means the analyzer goes through all the calibration steps for cal LogAmp, Cal Gain, and Cal Res BW. The details are given below.

CAL LOGAMP

Selecting ◀CAL LOGAMP▶ causes the analyzer to intiate a calibration on the LOG AMPLIFIER fidelity. The analyzer uses the Freq For Cal set by the factory (300 MHz) or the one you have selected. The analyzer's resolution bandwidth is set depending on the IF BW, video bandwidth is set to 300 Hz, and the instrument's span is set to zero.

If the Cal signal is not connected, an error condition is indicated (illegal Cal signal). Once the calibration has started, the annotation on the screen indicates the progress of the function. Also, the calibration of each logamp if more than 1 IF is present is stepped through, and this is visible on the screen. Finally, when the calibration is completed, an indication is given on the screen and the instrument is returned to its previous state (before calibration). (If there was enough ram space to save it when cal is begun).

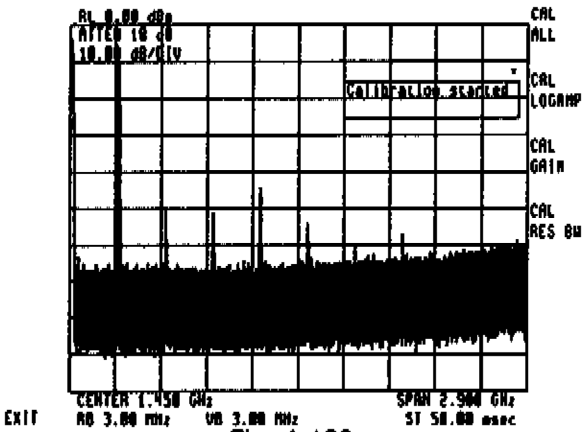


Fig. 4-109

CAL GAIN

Selecting ◀CAL GAIN▶ causes the analyzer to initiate a calibration procedure on the Attentuation and Amplification gain sections. The analyzer uses the Freq For Cal set by the factory

(300 MHz) or the one you have selected. The analyzer's resolution bandwidth is set depending on the IF bandwidth, video bandwidth is set to 300 Hz, and the instrument's span is set to zero.

If the Cal signal is not connected, an error condition is indicated (illegal Cal signal). Once the calibration has started, notice the annotation on the screen indicates the progress of the function. Also, the calibration of each step attenuator is stepped through and this is visible on the screen. Finally, when the calibration is completed, an indication is given on the screen and the instrument is returned to its previous state (before calibration). (If there was enough ram space to save it when cal is begun).

********** **NOTE** **********

For accurate results, the log fidelity calibration must be done first.

CAL RES BW

Selecting ◀CAL RES BW▶ causes the analyzer to initiate a calibration using resolution bandwidth filter amplitude and frequency corrections.

The analyzer uses the Freq For Cal set by the factory (300 MHz) or the one you have selected. The analyzer's resolution bandwidth is set depending on the IF bandwidth , video bandwidth is set to 300Hz, and the instrument's span is set to zero.

If the Cal signal is not connected, an error condition is indicated (illegal Cal signal). Once the calibration has started, notice the annotation on the screen indicates the progress of the function. Also, the calibration of each resolution bandwidth is stepped through and this is visible on the screen. The number of filters is dependent on the IF sections in the system. (70902A, 70903A) Finally, when the calibration is completed, an indication is given on the screen and the instrument is returned to its previous state (before calibration). (If there was enough ram space to save it when cal is begun).

********** **NOTE** **********

For accurate results, the log fidelity calibration must be done first.

Enable Cal

OVERVIEW

There are several calibration functions performed by the instrument. These can be turned on selectively. The correction values may also be turned on or off selectively. It is expected that you will provide your own calibration procedures when the internal calibration functions are turned off. The following describes those functions.

1. FLAT CAL ON OFF
2. LOG CAL ON OFF
3. GAIN CAL ON OFF
4. RB CAL ON OFF

3. GAIN CAL ON OFF

4. RB CAL ON OFF

FLAT CAL ON-OFF

Selecting ◀FLAT CAL ON OFF▶ directs the analyzer to either include this frequencey dependent gain correction function in the overall calibration or not (depending on whether it is on or off).

LOG CAL ON-OFF

Selecting ◀LOG CAL ON OFF▶ directs the analyzer to either include this log amplifier fidelity correction function in the overall calibration or not (depending on whether it is on or off).

GAIN CAL ON-OFF

Selecting ◀GAIN CAL ON OFF▶ directs the analyzer to either include this attenuation and amplification gain correction function in the overall calibration or not (depending on whether it is on or off).

RB CAL ON-OFF

Selecting ◀RB CAL ON OFF▶ directs the analyzer to either include this resolution bandwidth filter amplitude and frequency corrections function in the overall calibration or not (depending on whether it is on or off).

Freq For Cal

Used for factory calibration. Not currently customer supported.

Power For Cal

Used for factory calibration. Not currently customer supported.

Cal SRC Int Ext

Selecting ◀CAL SRC INT EXT▶ allows you to choose whether an internal or external calibration source will be used. An internal source is a source in the current input path that can be switched in without cables. A built-in source from another module is considered an external source.

The preset value is determined by the default input selector (Input 1).

External Mixer

This section explains how to use softkeys to setup an external mixer. It describes the setup of the Bias circuitry.

Figure 4-111 shows the softkeys that appear when ◀EXT MIXER▶ is pressed.

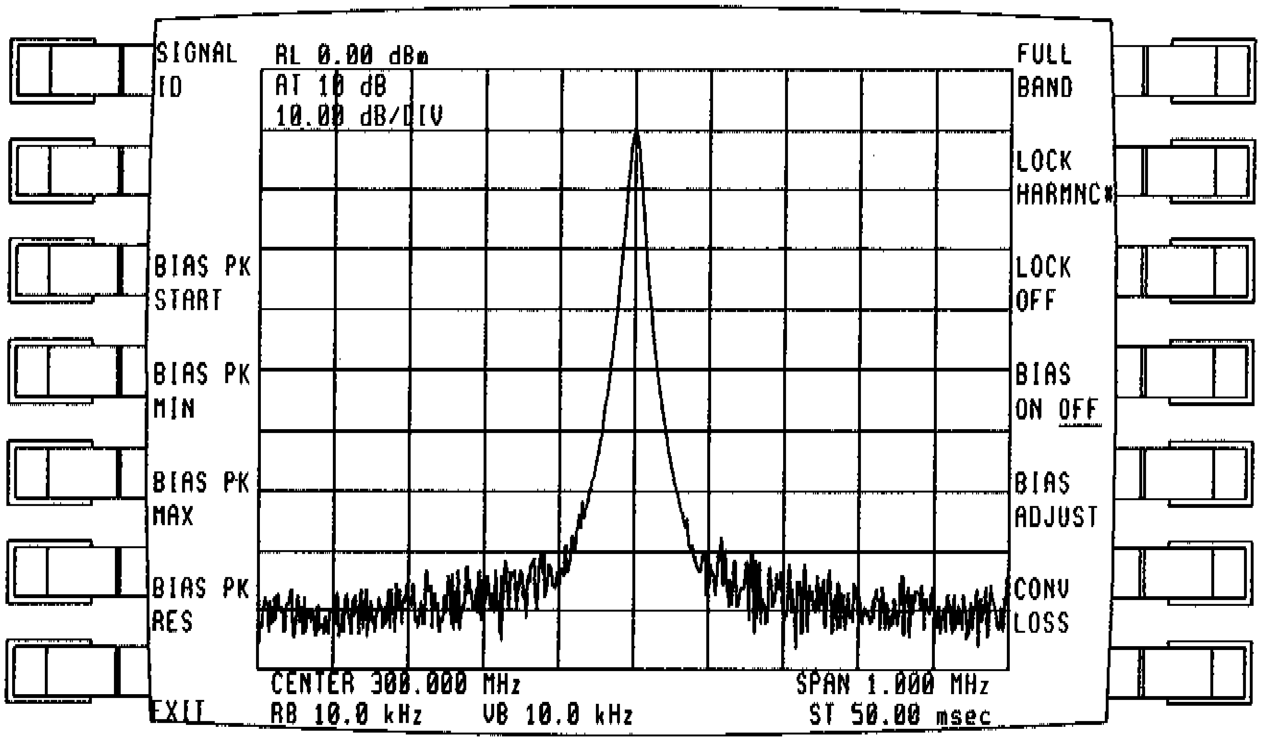


Fig.4-111. Top level menu for ◀EXT MIXER▶

Full Band

Pressing this softkey allows access to the bands K, A, Q, U, V, E, W, F, D, G, Y, and J.

Lock Harmnc #

Pressing this softkey allows the selection of the harmonic number. The number is entered on the keypad.

Bias On Off

Pressing this softkey toggles the bias control on or off. The underline indicates the last state of the control. The preset condition is off.

Bias Adjust

Pressing this softkey allows the setting of the bias current. The value can be entered by the numeric keypad.

Conv Loss

This softkey ◀CONV LOSS▶ can be used to compensate for losses that are not within the instrument system. The conversion loss command can be used to calibrate the input of an external mixer to the measurement results.

The range of values is ± 100 dBm. The preset value is 0.

Signal Id

See frequency section for details.

Bias Peak Start

Pressing this softkey peaks the mixer bias for the current input. The minimum and maximum bias and the resolution of the values to be tried are specified by the ◀BIAS PK MAX▶, ◀BIAS PK MIN▶, and ◀BIAS PK RES▶ commands.

The bias is peaked for the signal at the active marker. If there is no active marker then marker 1 is activated and placed at the highest signal on screen.

A localized peak function will try to maintain the same signal point if there is some instability from sweep to sweep. It is expected that the span is narrow enough and the signal is stable enough to make the adjustment.

This softkey is only applicable when the selected input is an external mixer.

Bias Pk Min

The minimum value of mixer bias current to be used with the Mixer Bias command is set with this softkey ◀BIAS PK MIN▶.

Bias Pk Max

The maximum value of mixer bias current to be used with the Mixer Bias Peak command is set with this softkey ◀BIAS PK MAX ▶ command

Bias Pk Res

This softkey ◀BIAS PK RES▶ sets the number of points of resolution for the Mixer Bias Peak command. The value can be entered by the keypad.

Measurement Mode

The ◀MEASURE MODE▶ softkey accesses softkeys that tell the system the type of measurement to be made (for example, ◀SIGNAL ANLYSIS▶ or ◀STIMULS RESPONS▶).

◀ SIGNAL ANLYSIS ▶ is the preset mode and is used for measurements of absolute amplitude over frequency. (Modes are active when underlined.)

Descriptions for the MEASUREMENT MODE softkeys are found in the manuals for the modules they control. For example, the ◀STIMULS RESPONS▶ softkey is described in the *HP 70300A Tracking Generator Operating Manual.*

Source

The ◀SOURCE▶ softkey accesses the functions of the HP 70300A Tracking Generator. The SOURCE softkeys are described in detail in the *HP 70300A Tracking Generator Operating Manual.*

Note: If a tracking generator in not in the system, a "Hardware not present" error message will appear when many of the softkeys under ◀SOURCE▶ are pressed. Although the majority of softkeys cannot be used when the tracking generator is not in the system, some softkeys, such as ◀A - B --> A▶ and ◀A - C --> A▶, can be used. See the *HP 70300A Tracking Generator Manual* for more information.

INDEX

INDEX

INDEX

This part of the Operating Manual tells how to operate the HP 71000 Modular Spectrum Analyzer by remote, computer control.

Unlike the HP 71000 Language Reference manual that describes the spectrum analyzer commands in alphabetical order, the text here is organized by programming concepts in increasing levels of complexity. If you wish to duplicate manual operation of the analyzer, Chapter 2, *Programming Fundamentals*, should answer most of your programming questions. Chapter 3, *Advanced Programming*, describes techniques for computations, measurements, and graphics. Chapter 1 describes installation procedures for remote operation.

CHAPTER 1

GETTING STARTED

Installation for Remote Operation

The following instructions tell how to set your equipment for remote operation and apply to standard systems and their options: HP models 71100A, 71200A, and 71300A. Examples shown only apply to units with a coaxial RF input.

Setup Procedure

Follow these steps to set up for remote control:

1. Connect computer, spectrum analyzer, and other peripherals with HP-IB cables. The HP-IB connector is located at the back of the mainframe.

2. After the HP-IB cable is installed, reset all instruments connected to the bus. Reset the spectrum analyzer by cycling power. As for resetting peripherals like plotters or printers, most of them are reset by pressing a front panel reset key. However, if you are not sure how to reset a device, switch its line power off, then on, to reset it.

3. Check HP-IB address of the local oscillator module on the address map. To view the map, press [DSP], then press ◀ADDRESS MAP▶. Turn the front panel knob until the local oscillator module appears in the address map.

The HP-IB address is indicated next to the local oscillator module number. The local oscillator must be in row 0 for HP-IB access. (See Figure 1-1.)

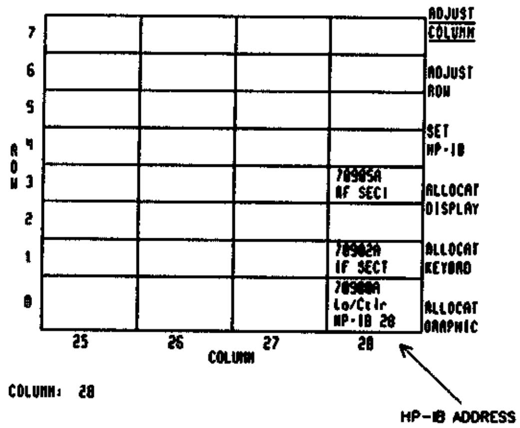


Fig. 1-1.

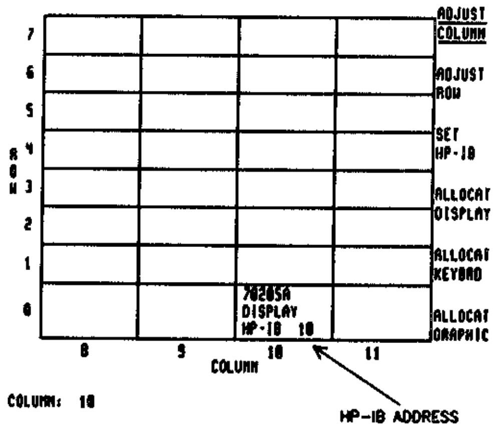


Fig. 1-2.

4. Check system configuration on the address map. For normal spectrum analyzer operation, the local oscillator and display modules are positioned in the bottom row, row 0, of the address map with the other modules stacked in a column above the local oscillator module. (See Figures 1-1 and 1-2.) The column may contain empty spaces between modules. The modules are positioned in this way at the factory. If this is not the case, see Part 1 for configuring instructions, or refer to **ADDRESS SWITCHES** in the following text.

Address Switches

HP-IB addresses may be set manually with address switches or may be set at the front panel.

The switches are located on the side, top cover, or rear panel of the module. Figure 1-3 shows the address switches of the different modules. The "column" switches select the HP-IB address and correspond to the column numbers on the address map.

The "row" switches of the HP70900A Local Oscillator module must be set to 0 for spectrum analyzer HP-IB control. They correspond to the row numbers on the address map. The display module does not have row switches. (Its row address is permanently set to 0.)

Note: HP-IB address 31 is illegal and should not be used.

Figure 1-3 shows how to set the address switches. The numbers in parenthesis indicate the binary value of the individual switches. The column or row address is the sum of the values in the parentheses beside each switch that is set to **1**. For example, a column address of 18 is selected by setting column switches 2 and 5 to **1**, and column switches 1, 3, and 4 to **0**. (18 = 0 + 2 + 0 + 0 + 16.)

All of the modules have address switches. The other switches peculiar to the local oscillator module and the graphics display are described below.

HP 70900A Local Oscillator Module Switches

The **HP-IB** switch breaks or reconnects the module to the HP-IB bus. It must be switched on for HP-IB control.

The **SWI/MEM** (switch/memory) switch specifies how the HP-IB address is set. When set to **SWI**, the address can be changed with the address switch only. When set to **MEM**, the address can be selected with either the switch or the front panel softkeys. The **MEM** position is suggested.

The **MAS/SLA** (master/slave) switch is set to **MAS** during normal spectrum analyzer operation. The switch is set to **SLA** for some special applications that require system reconfiguration.

The **NRML/TEST** (normal/test) switch is set to **NRML**. The **TEST** setting is for diagnostic purposes.

HP 70205A and 70206A Graphics Display Switches

The **HP-IB** switch breaks or reconnects the display to the HP-IB bus. It must be on for HP-IB control.

The **TALK ONLY** switch is set to **0** (off) for normal operation. When set to **1** (on), the display can talk to the HP-IB and not require a reply.

The **SYSTEM CONTROLLER** switch is set to **0** (off) during normal operation. When set to **1** (on), the display may function as a controller on HP-IB.

The **TEST MODE** switch is set to **0** (off) during normal operation, and is for diagnostic purposes.

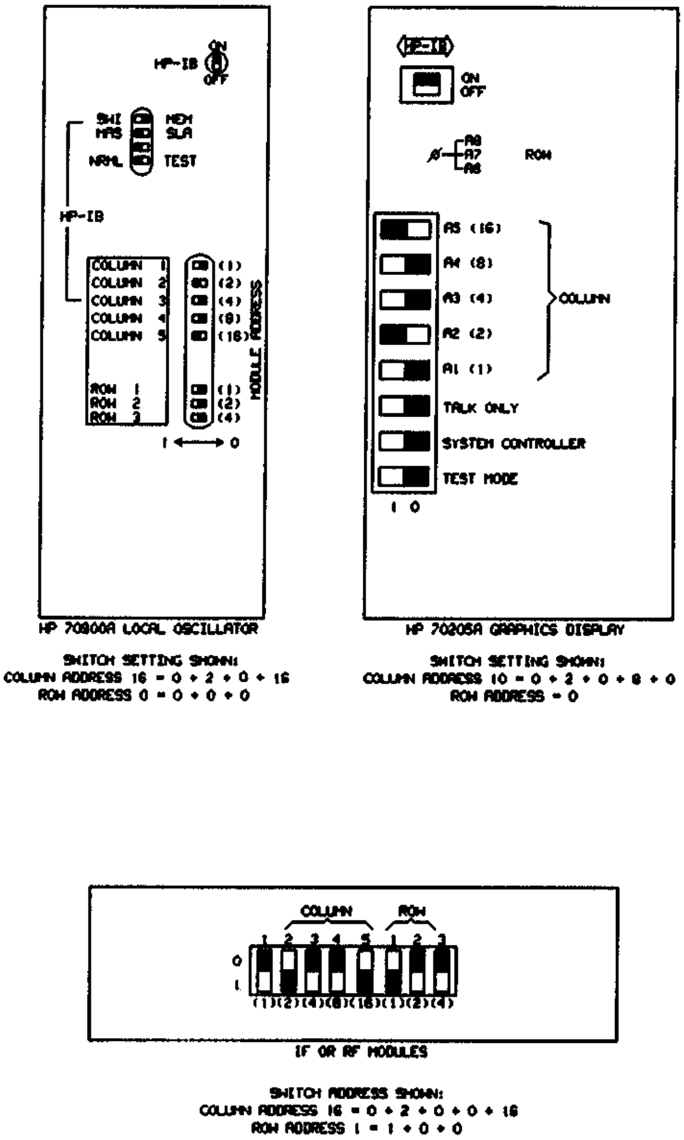


Fig. 1-3.

Changing HP-IB Address at Front Panel

The HP-IB address of the spectrum analyzer may be changed at the front panel when the local oscillator module switch is set to **MEM**. Use this procedure:

Press [DSP].
Press ◂ADDRESS MAP▸.

With the front panel knob, position the box around the local oscillator module.
Press ◂SET HP-IB▸.

Enter the HP-IB address on the front panel numeric keyboard.
Press ◂ENTER▸.

The HP-IB address is indicated inside the local oscillator module box on the address map. Changing the HP-IB address with the front panel keys does not affect the position of the modules on the map.

CHAPTER 2

Programming Fundamentals

FIG. 2-1, Sht 1 of 5

- **FREQ**
  - CENTER FREQ — CF
  - SPAN — SP
  - START FREQ — FA
  - STOP FREQ — FB
  - CF STEP — SS
  - CF STEP AUTOMAN — SS AUTO / SS MAN
  - FULL SPAN — FS
  - SIGNAL ID
    - SIGNAL IDENT — SIGID AUTO
    - SIG ID TO CF — IDCF
    - SIG ID OPTIONS
      - SIG ID MAN OFF — SIGID MAN / SIGID OFF
      - IMAGE SHIFT — SIGID IMAGE / SIGID SHIFT
      - SIG ID AMPTD Δ — SIGDEL
      - IMAGE N START — NSTART
      - IMAGE N STOP — NSTOP
      - EXIT
    - SAVE STATE — SAVES
    - RECALL STATE — RCLS
    - MARKER NORMAL — MKN
    - MARKER DELTA — MKD
    - HIGHEST PEAK — MKPK HI
    - NEXT PEAK — MKPK NP
    - RIGHT PEAK — MKPK NR
    - LEFT PEAK — MKPK NL
    - CLOSEST PEAK — MKPK CP
    - EXIT
  - FREQ OFFSET — FOFFSET
  - LCL OSC START — LOSTART
  - LCL OSC STOP — LOSTOP
  - EXIT

- **AMPTD**
  - REF LVL POSN — RLPOS
  - REF LEVEL — RL
  - EXTD RL ON OFF — EXTRL ON / EXTRL OFF
  - ATTEN — AT
  - ATTEN AUTOMAN — AT AUTO / AT MAN
  - LOG dB/DIV — LG
  - LINEAR (VOLTS) — LN
  - AMPTD UNITS
    - A UNITS AUTOMAN — AUNITS AUTO / AUNITS MAN
    - dBmv UNITS — AUNITS DBMV
    - dBuv UNITS — AUNITS DBUV
    - VOLT UNITS — AUNITS V
    - WATT UNITS — AUNITS W
    - dBm UNITS — AUNITS DBM
    - EXIT
  - AMP REF OFFSET — ROFFSET
  - INPUT IMPED — INZ
  - MAX MXR LEVEL — ML
  - EXIT

- **SWEEP CONTROL**
  - CONT SWEEP — CONTS
  - SINGLE SWEEP — SNGLS
  - SWEEP TIME — ST
  - SWPTIME AUTOMAN — ST AUTO / ST MAN
  - TRIGGER FREE — TM FREE
  - TRIGGER VIDEO — TM VID
  - TRIGGER LINE — TM LINE
  - TRIGGER EXT — TM EXT
  - VID TRG LEVEL — VTL
  - VID HYS LEVEL — VTH
  - EXIT

- **MARKER**
  - MARKER PEAK
    - HIGHEST PEAK — MKPK HI
    - NEXT PEAK — MKPK NH
    - RIGHT PEAK — MKPK NR
    - LEFT PEAK — MKPK NL
    - CLOSEST PEAK — MKPK CP
    - MINIMUM POINT — MKPK MIN
    - EXIT
  - MARKERS OFF — MKOFF
  - MARKER NORMAL — MKN
  - MARKER DELTA — MKD
  - MARKER BW — MKBW ON / MKBW OFF
    - AMP REL LEFT — MKAL
    - AMP REL RIGHT — MKAR
    - MKR BW ON OFF
    - EXIT
  - MARKER TO ...
    - MKR T CF
    - MKR T REF L
    - MKR Δ SPAN
    - MKR T CF ST
    - EXIT
  - ACTIVE MARKER
  - MKPAUS TIME
  - MKPAUS ON OFF
  - MKNOIS ON OFF
  - SIG TR ON OFF
  - MARKER OPTION
    - MARKER TRACE
    - MARKER TRACE
    - MARKER TRACE
    - SIG T LIMIT
    - PEAK EXCURS
    - MK REF AUTOMA
    - MK REF FREQ
    - MK REF PERIOD
    - MK REF SWP TI
    - MK REF 1/T
    - EXIT

FIG. 2-1, Sht 2 of 5

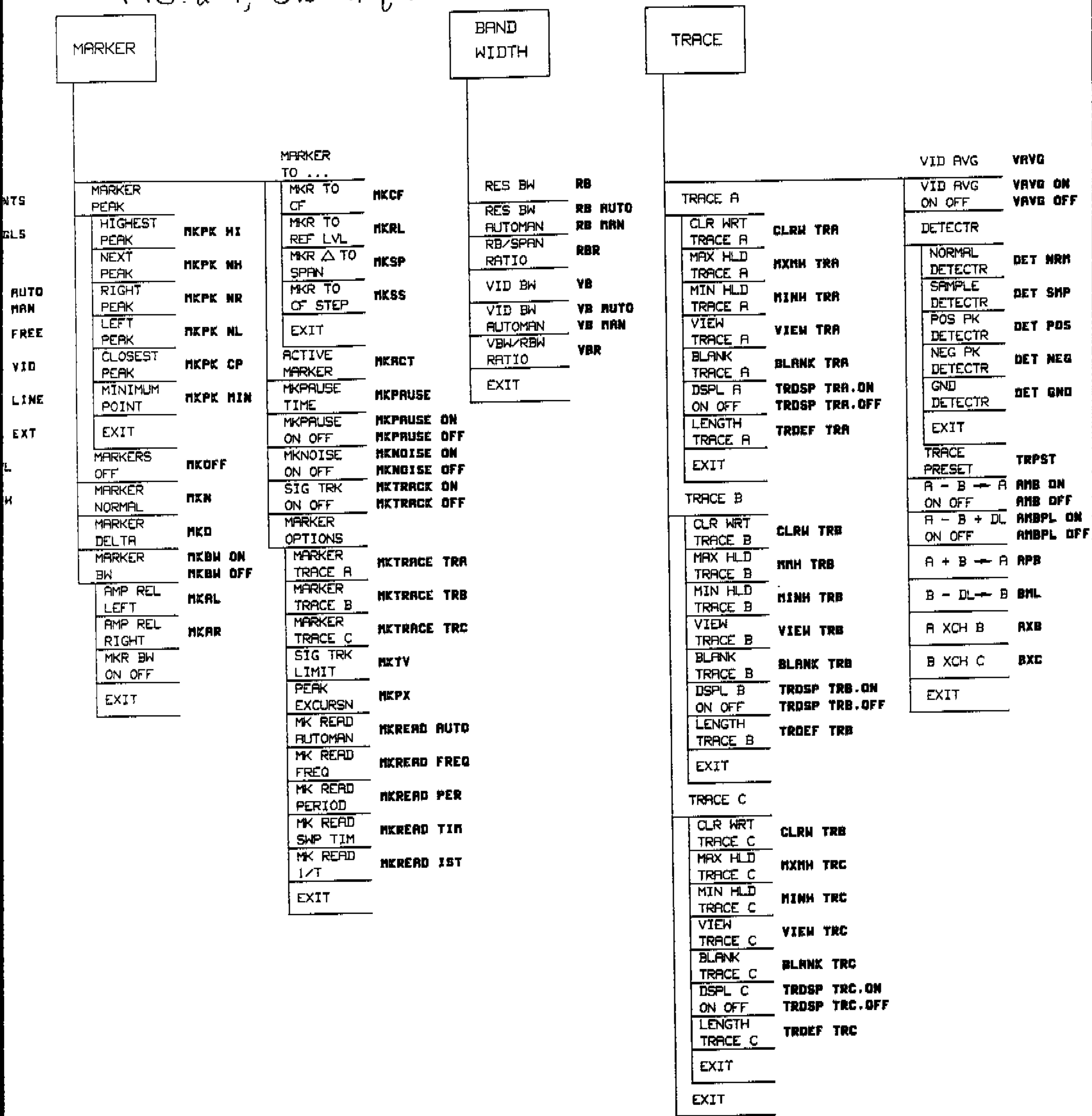


FIG. 2-1, Sht 3 of 5

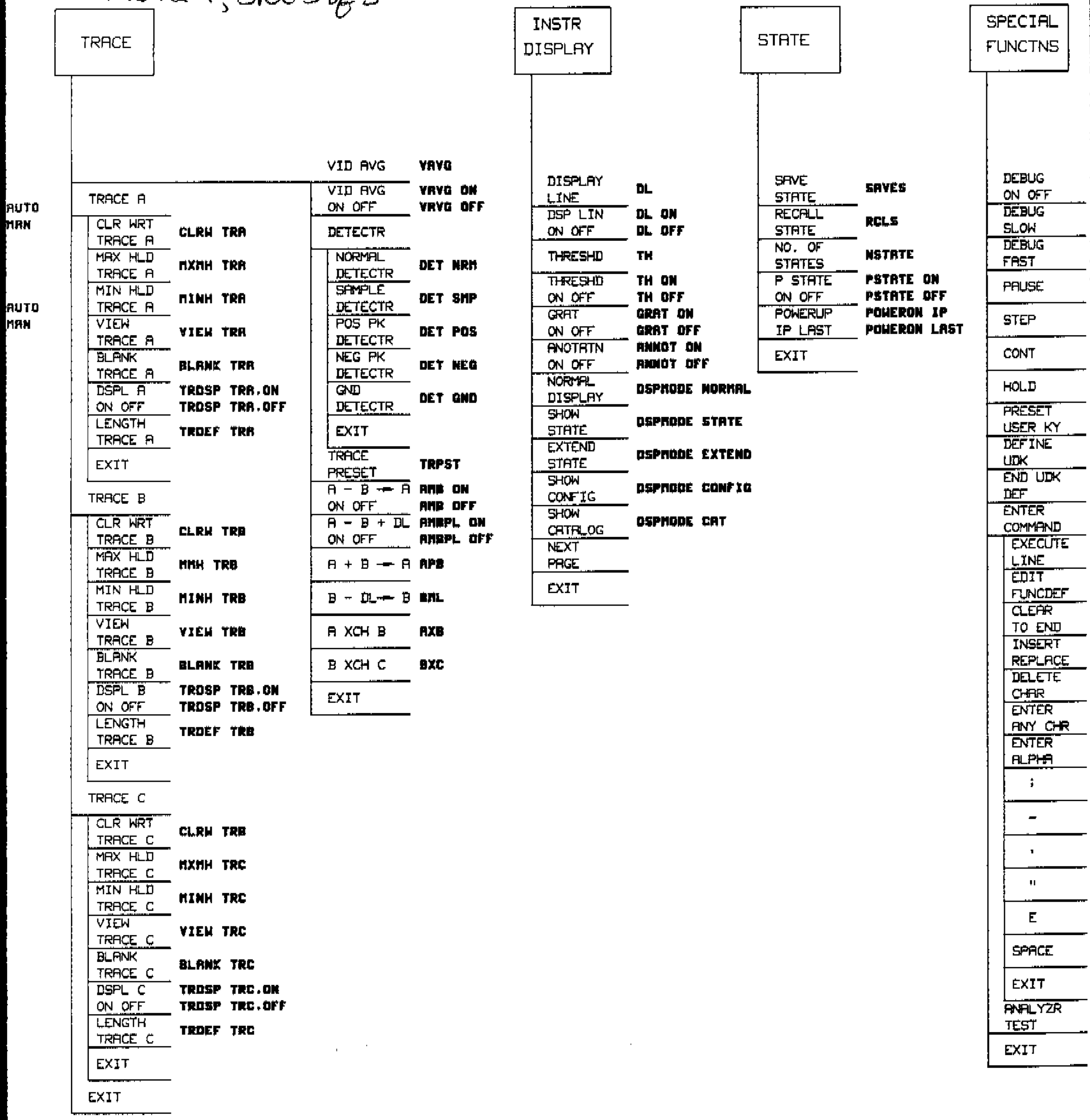


FIG. 2-1, Sht 4 of 5

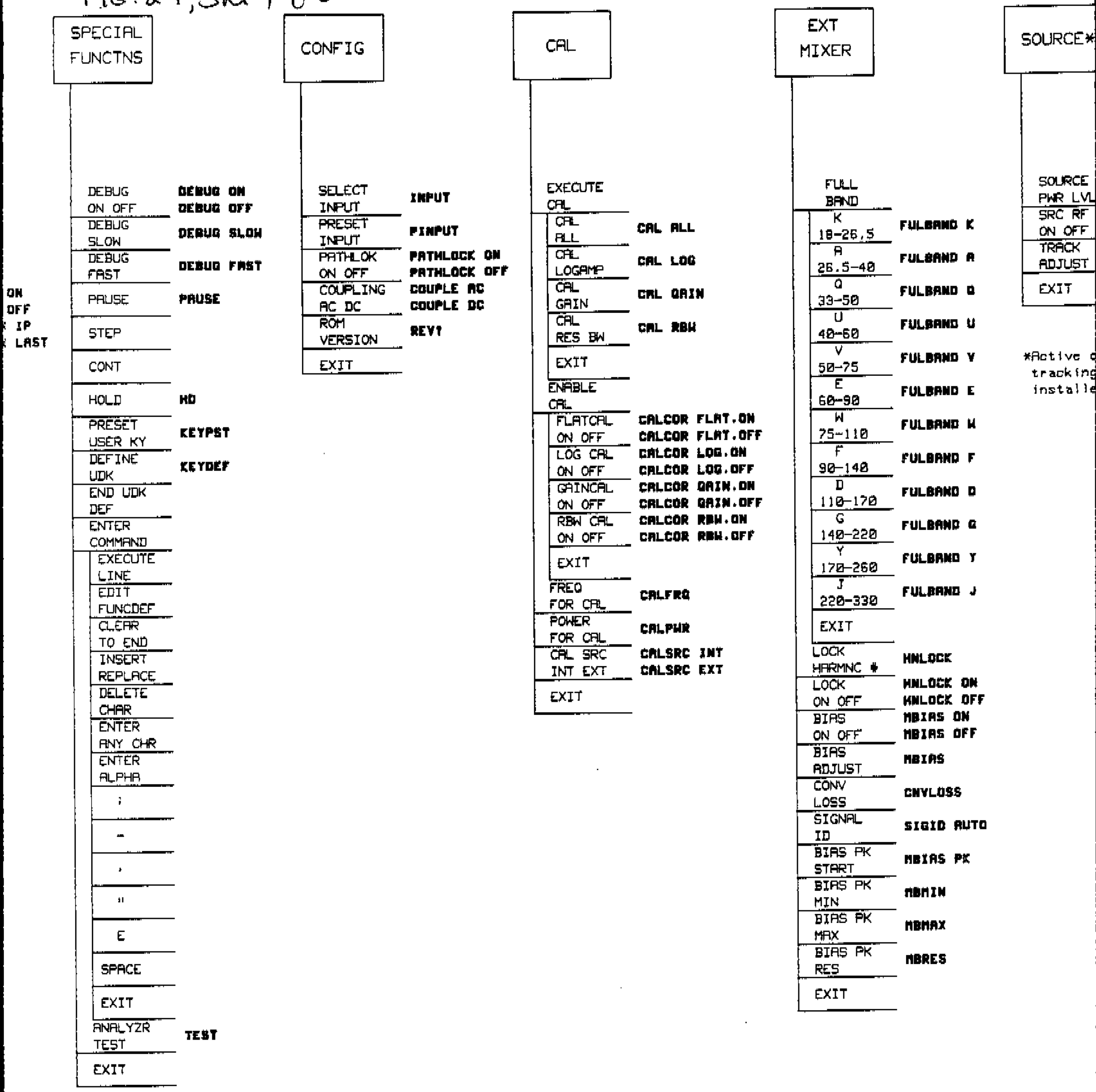


Figure 2-1. MENU Softkeys and Corresponding Remo

FIG. 2-1, Sht 5 of 5

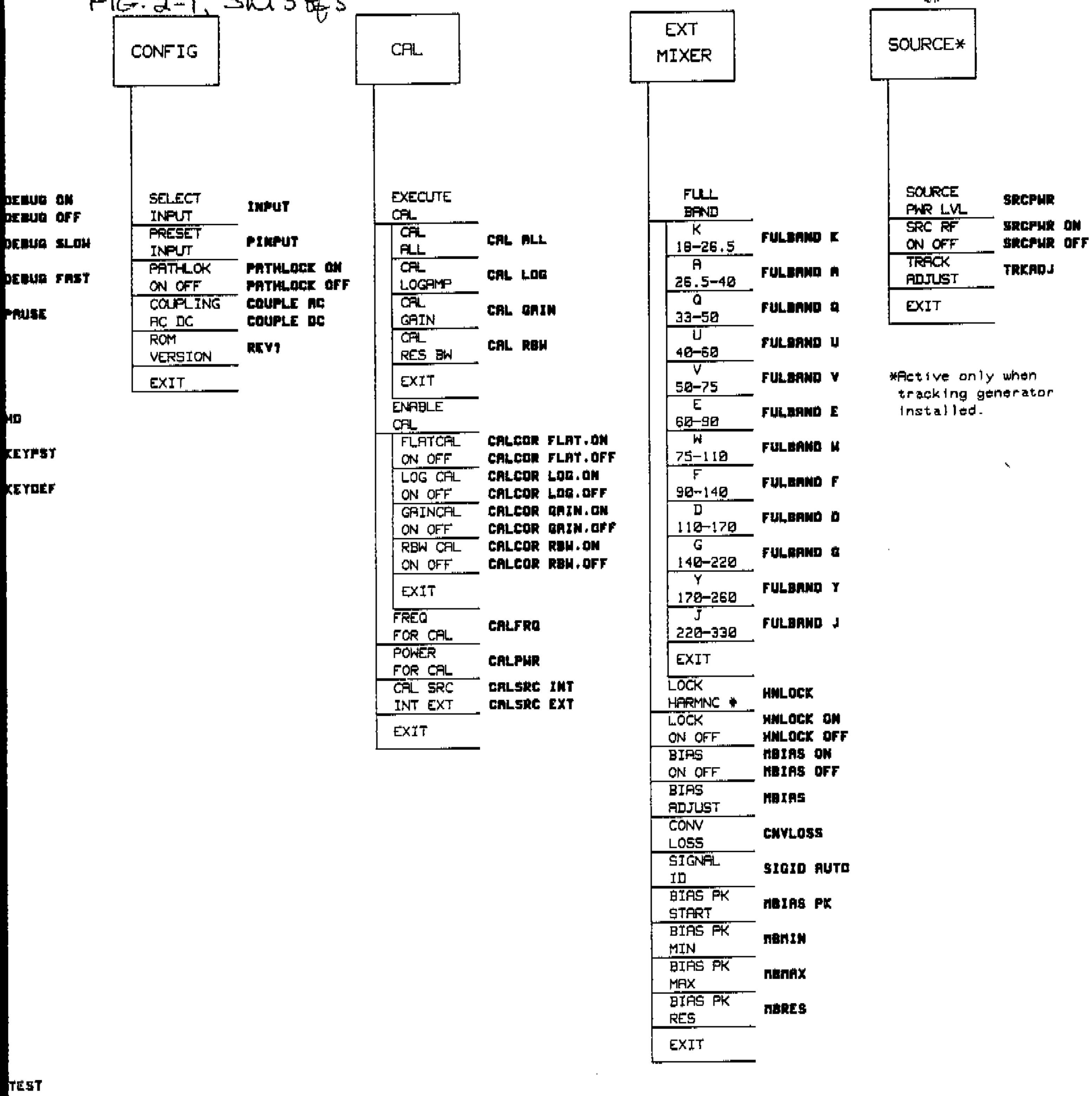


Figure 2-1. MENU Softkeys and Corresponding Remote Commands

Introduction

This section develops some fundamental techniques for controlling the spectrum analyzer and obtaining sound measurement results. Remote operation of the spectrum analyzer is controlled with commands that largely correspond to front panel key functions. These commands are summarized in Figure 2-1. See the Appendices for a complete listing of spectrum analyzer commands, also called keywords.

At the outset of our discussion, it is important to understand how messages are communicated to the spectrum analyzer. We will discuss enter and output statements and command syntax, and inspect sample programs written in the HP BASIC language for HP series 200 computers. Topics discussed are initializing the analyzer, controlling analyzer functions, data entry, analyzer timing, data transfer to and from the computer (I/O), program debugging, and graphics.

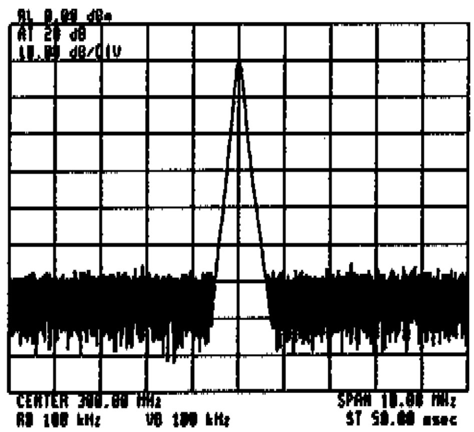
Communicating with the Analyzer

Spectrum analyzer programs control the passage of spectrum analyzer commands and data between the analyzer and the computer on the Hewlett-Packard Interface Bus (HP-IB) using the computer *output* and *enter* statements.

An *output* statement tells the computer to send a message to the spectrum analyzer. For example, executing this output statement sets the center frequency to 300 MHz:

```
OUTPUT 718;"CF 300MHZ;"
```

```
computer send message
HP-IB select code
analyzer address
activate center frequency
set center frequency value
command terminator
```



Set center frequency to 300MHz.

An *enter* statement used in conjunction with an analyzer *query* returns information to the computer. To return the center frequency value to the computer, first form a query by adding a question mark (?) to the command:

```
OUTPUT 718;"CF?;"

center frequency
activate query
command terminator
```

Next, use the enter statement to assign the returned value to a variable in the computer:

```
ENTER 718;Freq

computer receive message
HP-IB select code
analyzer address
computer variable
```

The value of the center frequency above is equated to the computer variable, Freq. The variable may be printed, stored, or used for any other computer function.

Syntax Requirements

All of the program examples in this manual show the recommended command syntax. All spectrum analyzer commands must be constructed according to specific syntactical rules which are outlined in this manual's counterpart: the HP 70900A Language Reference manual. The Language Reference lists all of the remote spectrum analyzer commands in alphabetical order and has a syntax diagram for each command.

Local and Remote Control

Whenever the analyzer is addressed, its front panel softkeys are disabled. Similarly, whenever the graphics display is addressed, its softkeys are disabled. Pressing the ◀LOCAL▶ key or executing the HP BASIC command, LOCAL, reenables the keys.

Initial Program Considerations

Programs should begin with a series of HP BASIC and spectrum analyzer commands that form a good starting point for spectrum analyzer measurements. The following example shows how to initialize the analyzer to form a good starting point.

Example: Initialize analyzer.

```
10 ASSIGN @Sa TO 718
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
```

The ASSIGN command is an HP BASIC command that creates an I/O path name and assigns that name to an I/O resource. In the example above, the I/O path name is "@Sa" and is assigned to the device at HP-IB address 718. (All program examples in this manual assume that a spectrum analyzer is at HP-IB address 718.)

The ASSIGN command offers several advantages when included in a spectrum analyzer program. For example, the spectrum analyzer address is easily changed in the computer program and the program can transfer data to a mass storage unit.

The CLEAR command is an HP BASIC command that resets a device on HP-IB to a known state unique to each instrument. CLEAR can reset devices on the bus singly or in unison. It is often desirable to reset only one instrument so that other instruments on the bus are not affected.

Example: Clear devices individually.

```
30 CLEAR @Sa            !Clear spectrum analyzer
40 CLEAR @Sg            !Clear signal generator
```

Example: Clear all devices at select code 7.

```
30 CLEAR 7              !Clear all devices on HP-IB at select code 7.
```

The instrument preset command, IP, sets all of the analog parameters of the spectrum analyzer and provides a good starting point for all measurement processes. Executing IP actually is the same as executing a number of spectrum analyzer commands that set the analyzer to a known state.

The single sweep and take sweep commands, SNGLS and TS, control the sweep and are discussed in Analyzer Timing.

Another useful command is CAL ALL, which calibrates the spectrum analyzer system. Below, CAL ALL calibrates with the 300 MHz calibration signal.

Example: Analyzer calibration.

(Connect calibration signal to analyzer input.)

```
10 ASSIGN @Sa TO 718              !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 OUTPUT @Sa;"CAL ALL;"          !Calibrate all correction factors.
```

Since CAL ALL takes up to 3 minutes depending on configuration, it is generally not performed except when the system requires calibration, such as at beginning of the day after the instrument has warmed-up.

All of the initializing commands discussed above work together to place the spectrum analyzer in a known state. Incorporate them at the beginning of spectrum analyzer programs so that repeatable measurement results are obtained. It is a good practice to also include other program information, such as program title, author, date, and revision numbers.

Executing Remote Spectrum Analyzer Commands

Remote operation is very similar to manual operation. In fact, the two measurement procedures are identical except for timing considerations which become important during remote operation. Remote measurements are executed with commands that correspond to the front panel keys. Programs for remote operation are composed as follows:

1. Measure, then list the order of keystrokes used.
2. Using Figure 2-1, find commands that correspond to keystrokes.
3. Incorporate commands into output statements.

ACTIVATING ANALYZER COMMANDS

Most spectrum analyzer commands first activate a function, then enter a number followed by a units code and a command terminator:

```
OUTPUT @Sa;"CF 300MHZ;"
```

Activate center frequency
Space required by syntax
Number (data entry)
Units code
Command terminator

The number within the quote field must be a string of (ASCII) decimal numbers plus an optional decimal point and may be preceded by a minus or plus sign. Either fixed or floating point notation may be used. For example, "12.3E3", "12.3e3", and "12300" each enter the same number.

The number of significant digits the analyzer accepts depends upon which function is active. For example, an 11 digit entry for center frequency can be stored in the analyzer center frequency storage register. (The analyzer does not display all of the significant digits stored.)

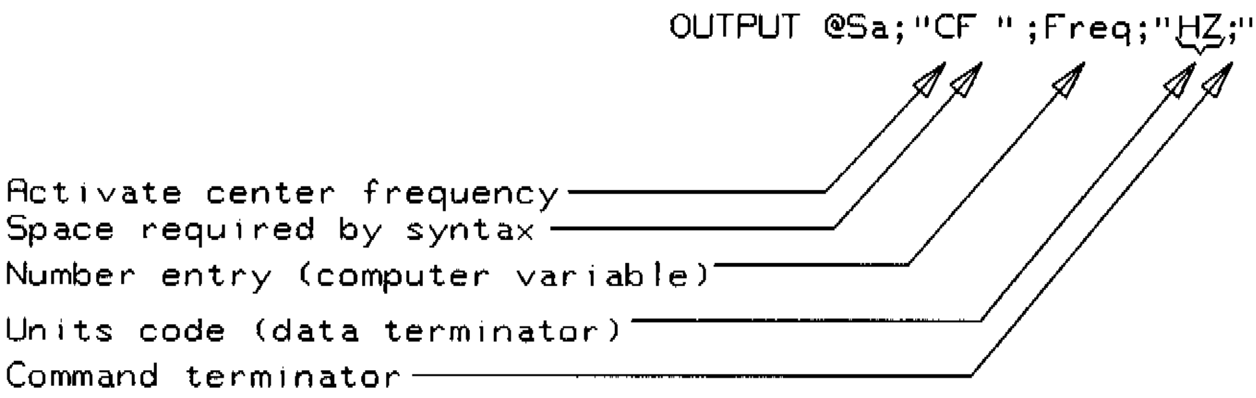
A units code (Figure 2-2) follows a data entry. For compatibility with HP 8568 and 8566 Spectrum Analyzers, optional units codes listed in the HP 70900A Language Reference are also allowed. The preferred codes in Figure 2-2 should be used whenever possible.

UNITS	CODE	UNITS	CODE
Frequency:		Ratio Measurement:	
Hertz	HZ	Decibel	DB
KiloHertz	KHZ		
MegaHertz	MHZ		
GigaHertz	GHZ	Power:	
		Watt	W
Time:		Milliwatt	MW
		Microwatt	UW
Second	S		
Millisecond	MS		
Microsecond	US	Decibels Relative To:	
		1 Milliwatt (dBm)	DBM
Current:		1 Millivolt (dBmV)	DBMV
Amp	A	1 Microvolt (dBuV)	DBUV
Milliamp	MA		
Microamp	UA	Voltage:	
		Volt	V
Impedance:		Millivolt	MV
Ohm	OHM	Microvolt	UV

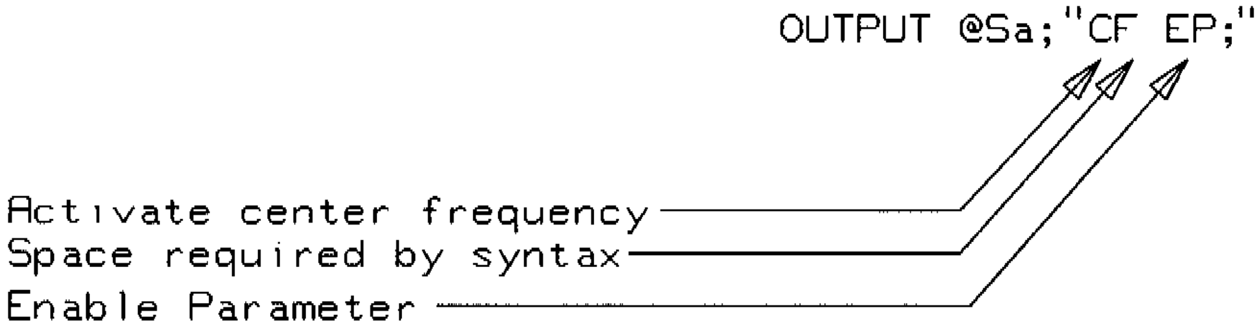
Fig. 2-2. Units codes.

The semicolon is the preferred command terminator. While most functions allow other command terminators, such as carriage-return, line-feed, space, or comma, use the semicolon whenever possible.

Spectrum analyzer commands may be used in conjunction with computer variables. The following program line sets the analyzer center frequency to the value of a computer variable, Freq.



Data may also be entered from the front panel when the analyzer is in remote control. This is done by following the analyzer command with EP (enable parameter).



EP halts execution of analyzer commands so that values may be entered with the front panel numeric keypad, step keys, knob, or units code keys. Data may be entered from the front panel until the ◀ACCEPT VALUE▶ keys is pressed. The syntax diagrams in the Language Reference show which commands can be followed by EP.

Analyzer Timing

Most remotely controlled measurements require control of the sweep. The TS (take sweep) command initiates a sweep when the trigger conditions are met. The TM (trigger mode) command controls trigger conditions and usually is set to the free run mode (TM FREE) so that trigger conditions are always satisfied.

When TS is executed as part of a command sequence, the analyzer starts and completes one full sweep before the next analyzer command is executed. The SNGLS (single sweep) command is also used during remote control to maintain absolute control over the sweep and reduce execution time. Once SNGLS activates the single sweep mode, TS may be used to initiate a sweep only when necessary.

The TS command updates trace information. Since many remote commands process trace information, it is important to update trace information whenever the input signal or analyzer settings change. Thus, use TS to update the trace *after* the analyzer settings or input signals change, but *before* the trace information is returned to the computer or processed by other commands, like trace math or marker commands.

When developing measurement algorithms from the front panel keys, use the ◀SINGLE SWEEP▶ key to simulate the effect of the TS command updating the trace. When the single sweep mode is active, pressing ◀SINGLE SWEEP▶ is the same as executing TS via remote control.

The following examples demonstrate the significance of updating trace information with the TS command.

Example: Change analyzer settings.

(Connect caibration signal input.)

```
10 ASSIGN @Sa TO 718                     !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;"
40 OUTPUT @Sa;"SNGLS;TS;"
50 OUTPUT @Sa;"CF 300MHZ;SP 1MHZ;"       !Change analyzer settings.
60 END
```

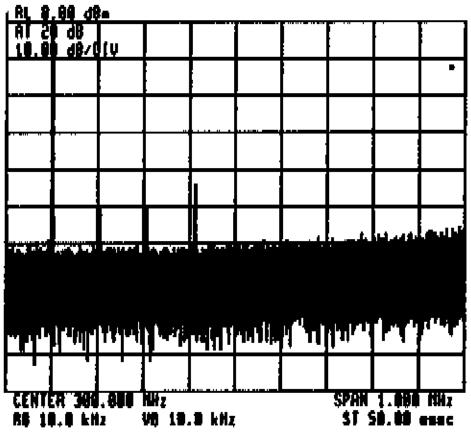


Fig. 2-3. Invalid trace information.

In the previous example, trace information does not reflect the new center frequency and spanwidth settings. To obtain valid trace information, the trace must be updated with the TS command. Here is the program again:

Example: Change analyzer settings *and* update trace.

(Connect calibration to analyzer input.)

```
10 ASSIGN @Sa TO 718                  !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;"
40 OUTPUT @Sa;"SNGLS;TS;"
50 OUTPUT @Sa;"CF 300MHZ;SP 1MHZ;"    !Change analyzer settings.
60 OUTPUT @Sa;"TS;"                   !Take a sweep to update trace.
70 END
```

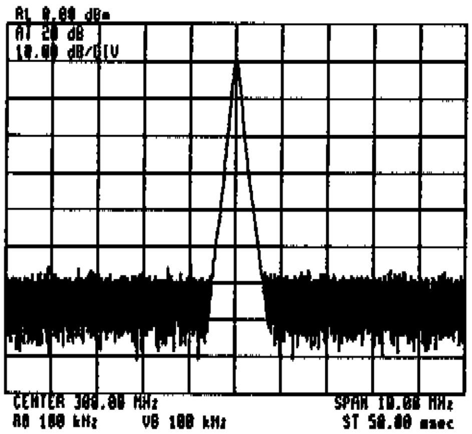


Fig. 2-4. Updated trace information.

The TS command is important in the following example that processes trace information. In the program, marker command MKPK HI examines trace information and positions a marker on the trace element with the highest amplitude level. Since the program changes the analyzer settings, the trace information must be updated with TS before MKPK HI is executed.

Example: Update trace information with TS command before executing marker commands.

(Connect calibration sigal to analyzer input.)

```
10 ASSIGN @Sa TO 718                            !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 OUTPUT @Sa;"CF 300.5MHZ;SP 10MHZ;RL -5DBM;"  !Change analyzer settings.
50 OUTPUT @Sa;"TS;"                             !Take a sweep to update trace.
60 OUTPUT @Sa;"MKPK HI;"                        !Move marker to highest peak.
70 END
```

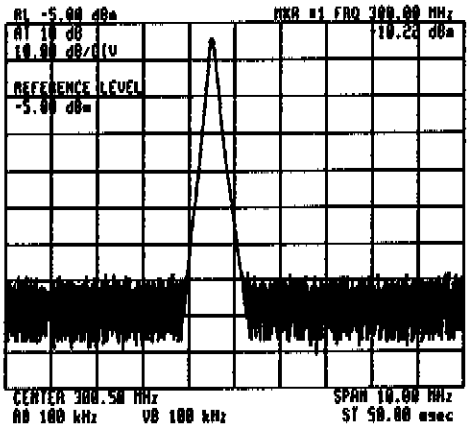


Fig. 2-5.

As the example shows, TS is executed *after* analyzer settings are changed, but *before* trace information is processed. Note that SNGLS cannot be substituted successfully for TS in the program. If this were the case, SNGLS would initiate a sweep, but MKPK HI would be executed before the completion of the sweep.

There are two commands that change the analyzer settings indirectly: MKCF and MKRL. They change the analyzer settings when moving a marker to the center frequency or reference level. If valid trace information is needed, a TS command should be executed after these commands.

In all cases, executing TS invokes at least one entire sweep. However, TS invokes more than one sweep when certain commands are active, such as video averaging (VAVG) or marker tracking (MKTRACK).

Data Transfer from Spectrum Analyzer to Computer

Data transfer varies in simplicity, but in all cases it is initiated with an analyzer *query*. When a programming command is appended with a question mark (?), it becomes a query which tells the spectrum analyzer to send data to the HP-IB bus. An enter statement follows the query to assign the value to a computer variable.

The following example shows how the value of an analyzer setting is transferred to the computer.

Example: Return analyzer center frequency to computer.

```
10  ASSIGN @Sa to 718            !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  OUTPUT @Sa;"CF?;"            !Return center frequency value to computer.
50  ENTER @Sa; Freq              !Assign center frequency to computer variable, Freq.
60!
70!
80!
90!
100 END
```

Values of other analyzer settings, such as span, attenuation, and resolution bandwidth are transferred similarly to the computer. The Language Reference syntax charts show which commands can be queries.

After instrument preset or power-up, the analyzer returns information as decimal values in fundamental units listed in Figure 2-6. However, trace information that has been manipulated with math commands or the MOV command may be returned in other units. (See Internal Processing in Chapter 3.)

MEASUREMENT TYPE	FUNDAMENTAL UNIT
Frequency	Hertz
Power	dBm, dBmV, dBuV, or watt
Ratio	dB
Voltage	Volt
Time	Second
Current	Amp
Impedance	Ohm

Fig. 2-6. Fundamental units.

Measurement data trace information is returned two different ways, either directly as trace information, or indirectly with the use of markers. The next example marks trace A with a marker and returns the frequency and amplitude values at the marker.

Example: Return marker frequency and amplitude to computer.

(Connect calibration signal to analyzer input.)

```
10  ASSIGN @Sa TO 718
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  OUTPUT @Sa;"CF 300MHZ;SP 100MHZ;"   !Tune to signal.
50  OUTPUT @Sa;"RL -5DBM;"              !Set amplitude range.
60  OUTPUT @Sa;"TS;"                    !Take a sweep to update trace.
70  OUTPUT @Sa;"MKPK HI;"               !Move marker to highest displayed peak.
80  OUTPUT @Sa;"MKF?;"                  !Return marker frequency in Hz to computer.
90 ENTER @Sa;Freq                       !Assign frequency to computer variable, Freq.
100 OUTPUT @Sa;"MKA?;"                  !Return marker amplitude to computer.
110 ENTER @Sa;Ampl                      !Assign amplitude to computer variable, Ampl.
120 Freq=Freq/1.E+6                     Convert frequency from Hz to MHz.
130 PRINT Freq,Ampl
140  END
```

Printed result: 300 -10

Note that each query is followed by a single enter statement. Also note the importance of placing the marker on the appropriate signal peak before querying marker information.

Queries do not decouple analyzer functions that are automatically coupled, such as resolution bandwidth, video bandwidth, and sweeptime.

Use the TRA command to return the amplitude value of an entire trace or individual points on the trace. The following examples return the amplitude of the 400th element and all elements in trace A.

Example: Return amplitude of 400th element in trace A.

(Connect calibration signal to analyzer.)

```
10  ASSIGN @Sa TO 718
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;"SNGLS;TS;"
40  OUTPUT @Sa;"CF 305MHZ;SP 100MHZ;"
50  OUTPUT @Sa;"RL -5DBM;"
60  OUTPUT @Sa;"TS;"
70  OUTPUT @Sa;"TRA[400]?;"             !Return amplitude of 400th element in trace A.
80  ENTER @Sa;Ampl                      !Assign amplitude to controller variable, Ampl.
70  PRINT Ampl                          !Print value of Ampl on designated printer.
80  END
```

Example: Return amplitude values of all elements in trace A to computer.

(Connect calibration signal to analyzér input.)

```
10  DIM Array (1:800)                      !Declare array of 800 elements, called Array.
20  ASSIGN @Sa TO 718
30  CLEAR @Sa
40  OUTPUT @Sa;"IP;SNGLS:TS:'
50  OUTPUT @Sa;"CF 305MHz;SP 100MHZ;"
60  OUTPUT @Sa;"RL -5DBM;"
70  OUTPUT @Sa;"TS;"
80  OUTPUT @Sa;"TRA?;"                     !Return amplitude of all points in trace A.
90  ENTER @Sa;Array (*)                    !Assign trace amplitude values to array.
100!
120!
130!
140 END
```

Formats are available that return data in units other than the fundamental units, such as binary. These formats are activated with the MDS (measurement data size) and TDF (trace data format) commands, and are explained in Chapter 3.

Debugging Programs

The debug mode simplifies analysis of faulty programs. When the mode is on, spectrum analyzer commands are displayed on the data line at the bottom of the CRT as they are executed. When a faulty spectrum analyzer command is encountered, subsequent analyzer commands are not executed. The faulty command is the last command shown at the right end of the data line.

The debug mode has a fast and slow setting. Fast debugging executes the program quickly and is useful for trapping errors. Slow debugging executes the program slowly so that you can monitor the execution of each command, much like stepping through a program on a computer.

The debug mode slows execution of analyzer commands and should be turned off when not needed.

The debug mode may be turned on at the front panel or remotely via HP-IB. The DEBUG ON and DEBUG FAST commands select fast debugging. The DEBUG SLOW command selects slow debugging. The DEBUG OFF command turns off the debug mode. Enter a debug command at the beginning of the program section for analysis.

Example: Debugging spectrum analyzer programs.

(Connect calibration signal to input.)

```
10 ASSIGN @Sa TO 718                     !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 OUTPUT @Sa;"DEBUG SLOW;"              !Activate slow debug mode.
50 OUTPUT @Sa;"CF 300MHZ;SN 100MHZ;"     !Analyzer stops at illegal command.
60 OUTPUT @Sa;"TS;"
70 OUTPUT @Sa;"MKPK HI;"
80 END
```

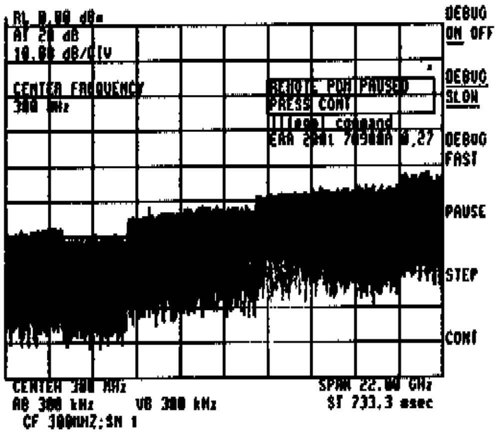


Fig. 2-7. Debug mode trapping a syntax error.

The PAUSE command is another debugging function. When executed, it suspends program operation and activates the debugging softkeys at the front panel. This way, front panel step and continue keys, ◀STEP▶ and ◀CONT▶, may be used to step through the analyzer program or resume program operation. Once program execution is halted either by command or by error during debug mode, no further remote input is possible until ◀CONT▶ or ◀DEBUG OFF▶ is pressed or a device clear is sent.

Creating Graphics

Creating custom graphics allows measurement results to be displayed the way you want. The graphics capabilities discussed in this section illustrate how to use spectrum analyzer commands to draw objects and print text anywhere on the display. Also see Chapter 3 in Part III, Display Operation.

Clearing the Display

The spectrum analyzer graphics are usually blanked before drawing graphics. Use the command sequence shown in the following example to clear the display before drawing new graphics.

Example: Clear the display.

```
70  OUTPUT @Sa;"ANNOT OFF;GRAT OFF;"
80  OUTPUT @Sa;"DL OFF;TRDSP TRA OFF;"
90  OUTPUT @Sa;"TRDSP TRB OFF;"
100 OUTPUT @Sa;"TRDSP TRC OFF;"
110 OUTPUT @Sa;"CLRDSP;"
```

The ANNOT OFF (annotation off) command turns off all of the analyzer annotation except for the display status box and the data line (used in debug mode) on the bottom of the display. Although the graticule is generally turned off, it may be left on as part of the final graphics or you may create your own graticule with the GRID command covered later in this section.

The DL OFF command blanks the display line. The CLRDSP (clear display) command deletes user-created graphics.

The TRDSPLY OFF (trace display off) command blanks traces A, B, or C. TRDSP also blanks the markers. Blanked traces may still be updated with a new sweep (TS), processed in math operations, or used with the markers just as though the traces were displayed. When developing measurement programs, monitor program operation with the traces displayed before using the TRDSP command.

Some of the commands in the clearing sequence (previous program example) are automatically executed with instrument preset. However, the sequence ensures that all of the graphics on the display are cleared. Thus, execute the sequence after program lines that measure or generate other graphics so that new graphics may be generated properly:

Example: Display-clearing sequence as part of a program.

```
10  ASSIGN @Sa to 718                    !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP,SNGLS;TS;"
40  !
50  !                                    !Do measurement here.
60  !
70  OUTPUT @Sa;"ANNOT OFF;GRAT OFF;"     !Clear the display.
80  OUTPUT @Sa;"DL OFF;TRDSP TRA OFF;"
90  OUTPUT @Sa;"TRDSP TRB OFF;"
100 OUTPUT @Sa;"TRDSP TRC OFF;"
110 OUTPUT @Sa;"CLRDSP;"
120 !                                    !Do graphics here.
130 !
140 !
150 END
```

The remaining program examples in this chapter assume that the analyzer has been initialized and its display has been cleared with the commands shown in the above example. Thus, subsequent program examples begin with line 120.

Graphics Origin and Scale

Graphics are drawn on a display 1024 dots wide by 384 dots high. Most graphics are drawn between the lower left position, P1, and the upper right position, P2, when the analyzer has been assigned the full screen as shown in Figure 2-8. P1 and P2 are fixed, non-movable reference points for scaling the display size. In Figure 2-8, P1 is located at the edge of the graticule, just above the data line. P2 is located at the right edge of the graticule at the top of the display. For smaller windows, P1 and P2 are changed.

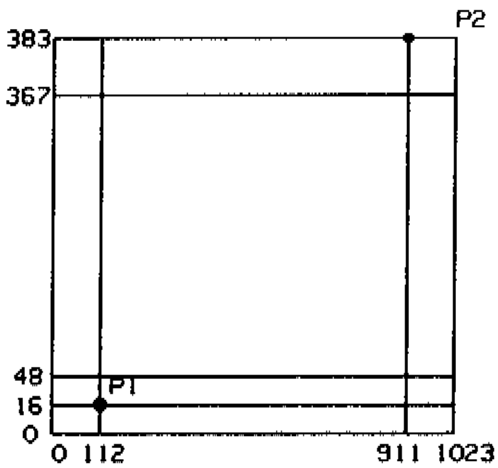


Fig. 2-8. Display Reference Positions.

P1 and P2 have preset values of 0,0 and 1000,1000. This preset coordinate system is shown in Figure 2-9.

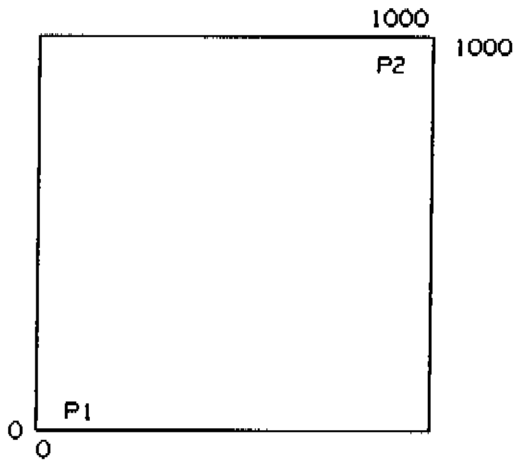


Fig. 2-9. Default display coordinates.

Pen and Plot Commands

Creating graphics is just like using a pen and paper. Graphics are drawn on the display using an imaginary pen on an electronic tablet. The PD (pen down) command allows graphics to be drawn as the pen is moved. The PU (pen up) command allows the pen to be positioned on the display without drawing unwanted lines. When the pen is up, previously drawn graphics are not erased from the display (just as with a pen and paper).

The pen is positioned on the display using plot commands and x-y coordinates. There are two ways to position the pen. The PA (plot absolute) command moves the pen to an absolute position on the display, referenced to P1 and P2. The PR (plot relative) command moves the pen to a position on the display relative to the current pen position.

Coordinates specified with the PA command move the pen to an absolute position on the display. Once PA is executed, a series of x-y coordinate pairs is specified. If several program lines are used to specify coordinate pairs, either the carriage return and line feed must be suppressed at the end of the program line or each new line must begin with a PA command since the carriage return or line feed will terminate the PA command. The following example positions the pen and then draws a rectangle using absolute coordinates.

Example:

```
(Initialize analyzer and clear the display.)
120 OUTPUT @Sa;"PU;PA 0,0;PD;"                    !Position pen.
130 OUTPUT @Sa;"PA 300,0,300,200,0,200,0,0;"      !Draw rectangle.
140 !
150 END
```

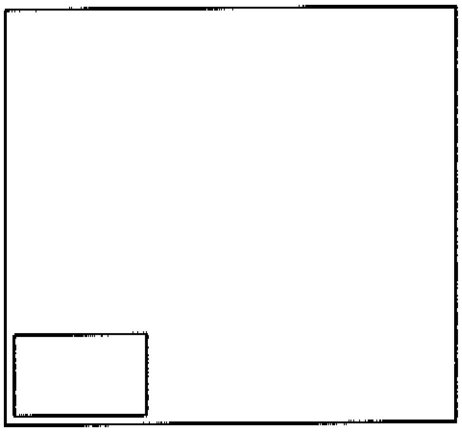


Fig. 2-10. Rectangle drawn with absolute coordinates.

Some graphics solutions are more effectively done using the PR (plot relative) command, which specifies pen movement relative to the current pen position. PR is useful when the same object appears in more than one position on the display. The PA command positions the object on the display, then PR draws the object using relative coordinates. The following example draws the same rectangle as before, this time using PR.

Example:

```
(Initialize analyzer and clear the display.)
120 OUTPUT @Sa;"PU;PA 0,0;PD;"                      !Position pen.
130 OUTPUT @Sa;"PR 300,0,0,200,-300,0,0,-200;"      !Draw rectangle.
140 !
150 END
```

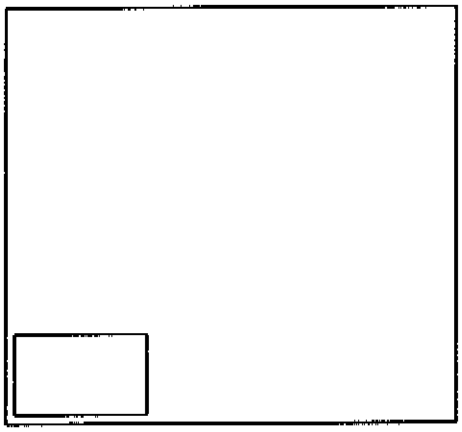


Fig. 2-11. Rectangle drawn with relative coordinates.

The next example shows how easy it is to move the rectangle to different positions on the display.

Example:

```
(Initialize analyzer and clear the display.)
120 FOR N=0 TO 600 STEP 300
130  OUTPUT @Sa;"PU;PA ";N,N;";PD;"                  !Position pen.
140  OUTPUT @Sa;"PR 300,0,0,200,-300,0,0,-200;"      !Draw rectangle.
150 NEXT N
160 END
```

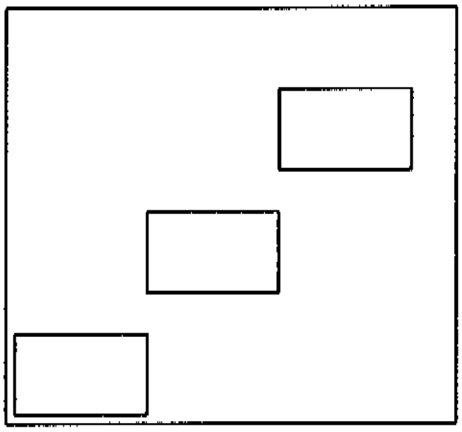


Fig. 2-12. Rectangle repositioned with absolute coordinates.

Line Type and Pen Color

The analyzer draws several different types of lines using the LINET (line type) command. Once the line type is specified, all subsequent lines are drawn with that new type. The next example shows how the line type is used to differentiate the different boxes drawn.

Example:

```
(Initialize analyzer and clear the display.)
120 FOR N=0 TO 750 STEP 150
130   L=L+1
140   OUTPUT @Sa;"LINET ";L;";"                      !Change line type.
150   OUTPUT @Sa;"PU;PA ";N,N;";PD;"                 !Position pen.
160   OUTPUT @Sa;"PR 300,0,0,200,-300,0,0,-200;"     !Draw rectangle.
170 NEXT N
180 END
```

The analyzer also selects plotter pens with the PEN command. Once the pen is selected, all subsequent lines are drawn with that pen. The pen may be used in conjunction with the different line types.

Incorporate PEN commands into your graphics when plotted copies of the display are anticipated. For example, the following program line may be inserted into the previous program example to plot each rectangle in a different color:

```
135 OUTPUT @Sa;"PEN ";L;";"     !Change pen color.
```

Drawing Grids

The GRID command draws a variable size grid anywhere on the display. The size of each division and the number of divisions are specified with the GRID command. Use the PA command to position the lower left corner of the grid. LINET (line type) and PEN commands may be used to modify the grid. The following example places a 5 division by 4 division grid in the upper right quadrant of the display. (GRID does not work when DWINDOW ON is active.)

Example:

(Initialize analyzer and clear the display.)

```
120 OUTPUT @Sa;"PU;PA 500,500;PD;"       !Position pen to center of display.
130 OUTPUT @Sa;"GRID 100,125,5,4;"       !Draw 5x4 division grid.
140 !
150 END
```

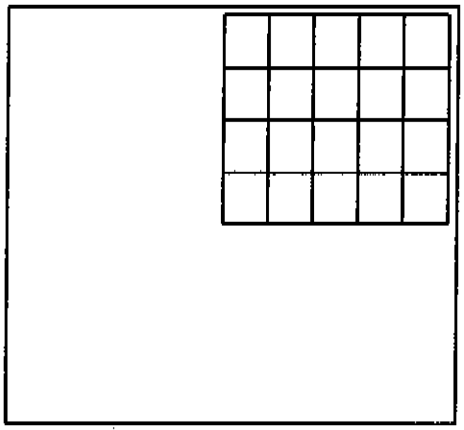


Fig. 2-13.

Writing Text

Writing messages on the display can be done whether or not the spectrum analyzer graphics have been cleared. Messages may be written using either of two commands: TITLE or TEXT.

The TITLE command is the easiest way to label spectrum analyzer displays. Use TITLE to place messages on the title line at the top of the display.

The following example shows how to form a message with the TITLE command and delimiters listed in the HP70900A Language Reference manual, such as $, %, or @. Note that the message characters must be different than the delimiter chosen.

Example:

```
10  ASSIGN @Sa TO 718                          !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  OUTPUT @Sa;"TITLE$YOUR MESSAGE HERE$;"     !Display title.
50  END
```

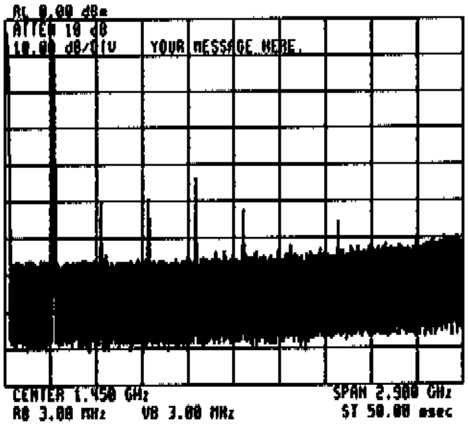


Fig. 2-14. Analyzer Title Line.

The TEXT command places messages anywhere on the display. The next example shows how TEXT is used. The PA command positions the pen, then TEXT prints a message on the display. (TEXT does not work when DWINDOW ON is active.)

Example:

```
10  ASSIGN @Sa TO 718                        !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  !
50  OUTPUT @Sa;"PU;PA 400,700;PD;"           !Position pen.
60  OUTPUT @Sa;"TEXT$YOUR MESSAGE HERE.$"    !Print text.
70  !
80  END
```

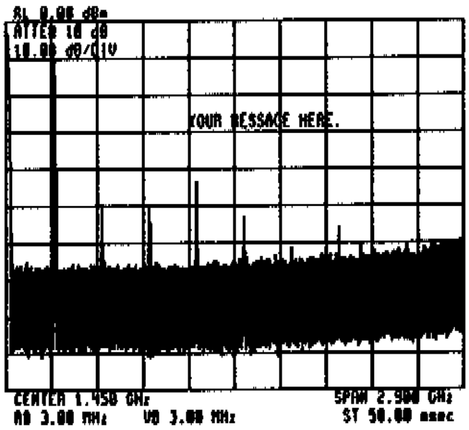


Fig. 2-15. Printing text.

Measurement data (variables) is displayed by using the DSPLY (display variable) command. DSPLY formats the data, specifying the field width and decimal places in the variable. When specifying the field width, be sure to account for the greatest number of characters that will be printed including the sign and decimal point.

The data (a variable) is positioned with the PA (plot absolute) command or it can simply follow a TEXT message. This next example uses the DSPLY and TEXT commands to display the value of the computer variable, Freq.

Example:

(Connect calibration orignal to analyzer)

```
10  ASSIGN @Sa TO 718                           !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  !
50  Freq=123                                    !Assign value to Freq.
60  OUTPUT @Sa;"PU;PA 400,700;PD;"              !Position pen.
70  OUTPUT @Sa;"TEXT$The frequency is:$;"       !Print a message.
80  OUTPUT @Sa;"DSPLY ";Freq;",7,1;"            !Print the value.
90  OUTPUT @Sa;"TEXT$ MHz$;"                    !Print a label.
100 !
110 END
```

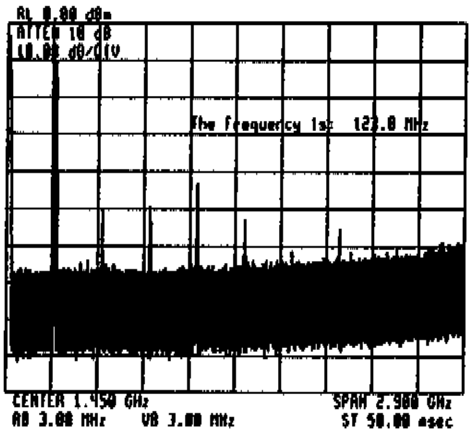


Fig. 2-16.

Use CLRDSP (clear display) to erase any user-created text from the display. ANNOT OFF does not blank text created by the TEXT command.

Creating a Graphics Workspace

A dedicated workspace for displaying messages and measurement data is easily created using the IWINDOW (instrument window) command. This command changes the size of the "window" used by the spectrum analyzer, leaving space for displaying other graphics (lines or text).

The following program uses the IWINDOW command to create a workspace at the top of the display. The program then measures the calibrator signal and two harmonics and displays the amplitudes at the top of the display. Also note how the marker amplitude (MKA) is displayed directly with the DSPLY command.

Example:

(Connect calibration signal to analyzer.)

```
10  ASSIGN @Sa TO 718                          !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"                  !IP clears display.
40  OUTPUT @Sa;"SP 1MHZ;"
50  !
60  OUTPUT @Sa;"IWINDOW 1000,800;"            !Create workspace.
70  OUTPUT @Sa;"PU;PA 0,955;PD;"
80  OUTPUT @Sa;"TEXT$SIGNALS FOUND:$;"         !Print heading.
90  !
100 FOR N=1 TO 3
110  OUTPUT @Sa;"CF ";(N*300);"MHZ;TS;"        !Measure three signals.
120  OUTPUT @Sa;"MKPK HI;"                     !Tune & measure signal.
130  OUTPUT @Sa;"PU;PA 20,";(955-N*45);";PD;"  !Position pen.
140  OUTPUT @Sa;"DSPLY ";N;",3,0;"             !Label signal.
150  OUTPUT @Sa;"TEXT$AMPLITUDE = $;"
160  OUTPUT @Sa;"DSPLY MKA,6,1;"               !Print amplitude.
170  OUTPUT @Sa;"TEXT$ dBm$;"
180 NEXT N
190 !
200 LOCAL @Sa
210 END
```

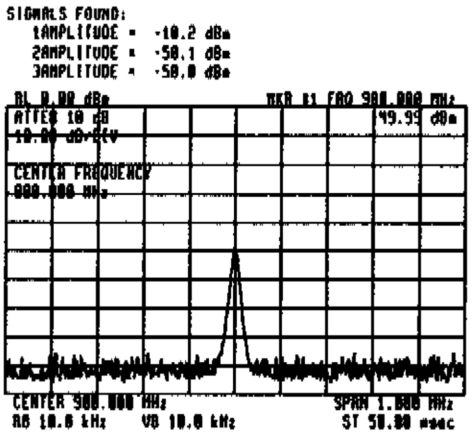


Fig. 2-17. Use IWINDOW to display measurement results.

Printing and Plotting the Display

The PLOT command reproduces the display on a plotter or printer. The softkey labels are also reproduced depending on the setting of the ◂KEYCOPY ON/OFF▸ softkey. See the Hardcopy Output section in Chapter 3, Part III.

CHAPTER 3

ADVANCED PROGRAMMING

INTRODUCTION

This chapter describes advanced programming techniques. Section I, *Trace Processing, Variables, and Math Functions*, is prerequisite material for the rest of the chapter.

Section I describes the kinds of units that define measurement results. It also describes how to manipulate measurement results and store them as variables and trace arrays in the spectrum analyzer memory.

Section II describes input/output techniques and optional data formats.

Section III tells how to create user-defined functions and softkey menus.

Section IV describes advanced graphics techniques.

Section V describes how to use service requests to interrupt computer operation.

Section VI tells how to use the analyzer as a system controller.

SECTION I. MATH FUNCTIONS, VARIABLES, AND TRACE ARRAYS

The spectrum analyzer processes and stores measurement results that can be displayed on the CRT or manipulated arithmetically. The analyzer contains memory (RAM) where user-defined traces and variables may be stored for future calculation or display on the CRT.

This section describes the internal processing of traces and variables and tells how to manipulate data correctly with the math commands.

UNITS

Measurement results are referenced on the display graticule according to frequency, time, and amplitude. The terms that describe measurement results are *parameter units* and *measurement units*.

Parameter Units

A *parameter unit* is a standard scientific unit. In its preset state, the analyzer returns all measurement results in parameter units. Parameter units for amplitude are as follows:

DECIBELS	WATTS	VOLTS
dB	W	V
dBm	mW	mV
dBmV	uW	uV
dBuV		

Use the AUNITS command to change the active amplitude units. Other parameter units are seconds, hertz, amperes, and ohms.

Measurement Units

All trace information is stored internally in *measurement units*. For logrithmic trace information, a measurement unit is one hundredth of a dBm:

[value in dBm] X 100 = measurement units

Thus, a -10 dBm value is equal to -1000 measurement units:

-10 dBm X 100 = -1000 measurement units

Measurement units apply only to entire traces and trace elements. For linear trace information, *measurement units* are defined as 0 (zero) for the bottom of the display, and 10,000 for the top of the screen (reference level).

The measurement-unit range is restricted to integers between +32,767 and -32,768. Since measurement units are restricted to integers, -10.115 dBm equals -1012 measurement units, *not -1011.5* measurement units because decimal values are rounded to the nearest integer.

-10.115 dBm X 100 = -1012 measurement units (rounded to nearest integer)

The AMPU command converts measurement-unit values to parameter unit values. The MEASU command converts parameter-unit values to measurement-unit values. These commands are discussed later in this section.

Position Units and Trace Elements

The terms that describe trace composition are defined as follows:

Point. A *point*, also called *data point* or *element*, is a fixed location on the horizontal axis of a trace. Each point contains amplitude information. The TRDEF command specifies how many data points a trace contains. However, after initiating instrument preset (IP) or trace preset (TRPST) traces A and B each contain 800 points and trace C contains 3 points.

Position Units. Position units describe the position of a point along the horizontal axis of a trace. The point at the left end of the trace has a position unit value of *1*. The point at the right end of an 800-point trace has a position-unit value of *800*.

The POSU command converts the frequency of a point on a trace to position units. The FREQU command converts a point on a trace indicated in position units to hertz, or in zero span mode, to units of time.

VARIABLES AND TRACES

The spectrum analyzer processes all information as variables and trace arrays. For example, the spectrum analyzer reserves an area in its memory called an array for trace A information. Whenever trace A is swept, the analyzer updates the array with new data. The analyzer also has space in its memory for variables. Whenever a marker is placed on a trace, the analyzer assigns the amplitude value to the variable, MKA.

The spectrum analyzer processes two kinds of variables and traces, *pre-defined* and *user-defined*. Pre-defined variables and traces, like trace A and MKA, exist permanently in the analyzer memory and their preset values are invoked after instrument preset (IP) or power-up. User-defined variables and trace arrays are created by the user, are given preset values, and remain permanently in the analyzer memory, even when power is turned off, unless they are removed with the DISPOSE command.

Variables and traces are discussed individually below.

Variables

Pre-defined variables exist permanently in the analyzer memory. The VARDEF command creates user-defined variables which can be erased from analyzer memory with the DISPOSE command. User-defined variables are from 1 to 14 characters long and are assigned values immediately after VARDEF is executed.

The programs below define a spectrum analyzer variable called FREQUENCY.

Example: Create a user-defined variable.

```
10 ASSIGN @Sa TO 718                   !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 OUTPUT @Sa;"VARDEF FREQUENCY,0;"    !Declare user-defined variable.
50 END
```

Example: Erase user-defined variable.

```
10 OUTPUT @Sa;"DISPOSE FREQUENCY;"      Erase variable from analyzer memory.
20 END
```

Do not use pre-defined variable or function names for user-defined variable names. This interrupts the defining process and executes the invoked function instead. For example, removing "ENCY" from "FREQUENCY" above invokes the FREQU function.

Traces

Trace arrays comprise a series of data points that contain amplitude information. Three separate traces may be swept: trace A, B, or C. These are the pre-defined traces that exist permanently in the analyzer memory. Traces A and B have preset lengths of 800 data points and trace C has a preset length of 3. Use the TRDEF command to change the length of any trace from 3 to a maximum of 1024 data points. Use the IP or TRPST (trace preset) command to reset the lengths to their preset values.

The following example defines the length of trace C as 1000 data points.

Example: Change trace length.

```
OUTPUT @Sa;"TRDEF TRC,1000;"            !Change trace length to 1000 data points.
```

The TRDEF command also allocates space in memory for user-defined traces. Like traces A, B, and C, user-defined traces can be 3 to 1024 data points. Unlike traces A, B, and C, they cannot be swept. In the example below, measurement results are transferred to a user-defined trace array.

Example: Store trace A in a user-defined trace.

```
10 ASSIGN @Sa TO 718                    !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;"
40 OUTPUT @Sa;"SNGLS;TS;"
50 OUTPUT @Sa;"TRDEF TRACE_Z, 800;"     !Create user-defined trace array.
60 OUTPUT @Sa;"MOV TRACE_Z,TRA;"        !Copy trace A into TRACE_Z.
70 END
```

Use DISPOSE to erase a trace from analyzer memory.

Example: Erase trace.

```
10 OUTPUT @Sa;"DISPOSE TRACE_Z;"
20 END
```

Do not use pre-defined variable or function names as trace labels. This interrupts the trace-defining process and executes the invoked function instead. For example, substituting the label TEST for TRACE_Z in the previous example invokes the test function.

MATH AND MOVE COMMANDS

Math and move commands are data-manipulating functions that modify data and store results in the analyzer memory.

Each of these functions modify a value, called the *operand*. The results of the modification are stored in an area of the analyzer memory, called the *destination*. Variables, traces, real numbers, or commands listed in Table 3-2 form the operand(s) of these commands. Only variables or traces can form the destination.

```
              FUNCTION   DESTINATION   OPERAND   OPERAND
                 |            |            |         |
OUTPUT @Sa;    "SUB          TRB,         TRA,      TRC;"
```

The math and move commands comprise the user-operator, trace-math, and trace commands listed in the Language Reference. All the commands operate on an operand on a point-by-point basis.

Below, the MOV command transfers a value from the operand to the destination.

Example: Store center frequency in a user-defined variable.

```
10 ASSIGN @Sa TO 718                     !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
50 OUTPUT @Sa;"VARDEF FREQUENCY,0;"      !Declare user-defined variable.
60 OUTPUT @Sa;"CF 300 MHZ;"              !Set center frequency value.
70 OUTPUT @Sa;"MOV FREQUENCY, CF;"       !Copy value in FREQUENCY.
80 END
```

The next example demonstrates a math command, MPY (multiply). In this example, one of the operands and the destination are formed by the pre-defined variable for center frequency, CF. The other operand is a real number (1.1).

Example: Use the multiply command to increase the center frequency by 10 percent.

```
(Connect calibration signal.)
10 ASSIGN @Sa TO 718                     !Initialize analyzer
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS"
50 OUTPUT @Sa;"CF 300MHZ;SP 1MHZ;"       !Change analyzer settings.
60 OUTPUT @Sa;"TS;"                      !Take a sweep to update trace.
70 OUTPUT @Sa;"MPY CF,CF,1.1;"           !Increase center frequency by 10%.
80 OUTPUT @Sa;"WAIT 5;"                  !Program pauses for 5 seconds.
90 OUTPUT @Sa;"TS;"                      !Take a sweep with new center frequency.
100 END
```

Many math applications require the creation of user-defined variables and traces, which are often used for temporary storage of intermediate results. This leaves the pre-defined variables and traces available for active measurement results. For example, in the previous example, math results are stored in CF. However, since CF always contains the center frequency value, it is updated whenever the center frequency changes. Thus, the math results from the previous example could be lost. The example below avoids this problem by storing results in a user-defined variable.

Example: Store math results in a user-defined variable.

```
10 OUTPUT @Sa;"VARDEF VAR,0;"          !Declare user-defined variable called VAR.
20 OUTPUT @Sa;"MPY VAR,CF,1.1;"        !Multiply 1.1 and CF; send result to VAR.
40 OUTPUT Sa;"VAR?;"
50 ENTER @Sa;Value                     !Assigns value of CF to computer variable.
60 END
```

Four Rules for Trace Math

Special consideration must be exercised when using the math and move commands with trace arrays and elements. Otherwise, these data-manipulating commands may yield inaccurate results. Follow these four rules to obtain accurate results:

1. **To avoid truncation of data, be sure the destination length is equal to or greater than the operand length.**

2. **Remember that the analyzer truncates numbers greater than +32,767 and less than -32,768 when operating with trace elements.**

3. **Use the MEASU command to preserve decimal values and yield parameter units.**

4. **To achieve the best accuracy, use a single point for the destination, such as a trace element or variable.**

Let us consider the rules one at a time.

1. To avoid truncation of data, be sure the destination length is equal to or greater than the operand length. The first rule tells us some care must be taken to avoid inadvertent shortening of trace arrays. For example, when an active trace is operated on and stored in a trace of lesser length (that is, of fewer data points), or in a variable, the portion of the trace not stored is lost when it is updated with new sweep information. The example below shows how trace information may be lost when moving a trace array into a shorter trace array. Since the user-defined trace array, TRACE, is shorter than trace A, amplitude information contained in the last 400 data points is lost when trace A is updated.

Example: Move an active trace into a smaller trace array.

(Connect calibration signal to analyzer input.)

```
10 ASSIGN @Sa TO 718                   !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
50 OUTPUT @Sa;"TRDEF TRACE,400;"       !Define user-defined trace with 400 elements.
60 OUTPUT @Sa;"MOV TRACE,TRA;"         !Duplicate amplitude information of
                                        trace A in TRACE.
70 OUTPUT @Sa;"TS;"                    !Update trace A with new sweep information.
80 END
```

When a short trace or variable is operated on and stored in a trace of longer length, the last trace element is extended for operations with the longer length.

2. Remember that the analyzer truncates numbers greater than +32,767 and less than -32,768 when operating with trace elements. Math operations are restricted to the legal range of measurement units when trace arrays or elements form the destination or operand. The two following examples truncate numbers exceeding the legal range. They move the number 32,767 - *not 100,000* - into the one hundredth element of trace A.

Example: Truncation and the Move command.

```
10  OUTPUT @Sa;"MOV TRA[100],100000;"      !Moves 32,767 into trace element.
```

Example: Truncation of multiplication results.

```
10  OUTPUT @Sa;"MPY TRA[100],1000,1000;"   !Multiplies 1000 times 1000.
                                            Sends 32,767 to trace element.
```

3. Use the MEASU command to preserve decimal values and yield parameter units. All trace amplitude information is internally stored and manipulated in measurement units. (See UNITS in previous text.) This means a -10 dBm reference-level value is internally converted to -1000 measurement units before it is transferred to a trace element. (Recall that a measurement unit is one hundredth of a decibel.) This process is invisible to the user except in math and move functions where the operand is formed by a variable or real number, and the destination is formed by a trace array or element. In these cases, the operand and destination express numbers in different units, making a conversion necessary. Otherwise, returned data will be inaccurate by a factor of 100 and significant digits may be lost.

The examples below demonstrate how misleading results are obtained if the conversion is neglected. They emphasize that the analyzer will only transfer integer values to a trace element. Subsequent examples show how to transfer correct values.

Example: Rounding of decimal values to integers.

```
10  OUTPUT @Sa: MOV TRA[100],-10.33;"      !Moves -10, not -10.33, to trace element.
```

Example: Rounding of decimal values to integers.

```
10 OUTPUT @Sa;"MOV TRA[100],MKA;"          !Moves -10 into trace element because MKA
                                            (marker amplitude) equals -10.33.
```

The next example shows how erroneous results are returned to the analyzer if the MEASU conversion is neglected. The example places a marker at the calibration signal peak, which is assumed to be -10 dBm. However, this -10 dBm value becomes -10 measurement units when it is transferred to a trace element with the MOV command. If the amplitude of the element were queried, its level would be -0.1 dB, instead of the correct value, -10 dB.

Example: Return of false trace amplitude level because conversion is omitted.

```
(Connect calibration signal to analyzer input.)
10  ASSIGN @Sa TO 718                     !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
50  OUTPUT @Sa;"FA 50MHZ;FB 1050MHZ;"     !Change analyzer setttings.
60  OUTPUT @Sa;"TS;"                      !Take a sweep to update trace.
70  OUTPUT @Sa;"MKPK HI;"                 !Move marker to highest signal peak.
80  OUTPUT @Sa;"MOV TRB[100],MKA;"        !Copy integer value of marker
                                            (-10) into trace B element.
                                            TRB[100] now contains -10
                                            measurement units.
90  OUTPUT @Sa;"TRB[100]?;"               !Returns -0.1 dB. (false value).
100 END
```

Below, the MEASU command preserves decimal values and returns trace amplitude values in parameter units. Note that the conversion in line 80 preserves the decimal values of the marker amplitude.

Example: Return of correct trace amplitude data using the MEASU command.

```
(Connect calibration signal to analyzer input.)
10  ASSIGN @Sa TO 718                          !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
50  OUTPUT @Sa;"FA 50MHZ;FB 1050MHZ;"          !Change analyzer settings.
60  OUTPUT @Sa;"TS;"                           !Take a sweep with new analyzer settings.
70  OUTPUT @Sa;"MKPK HI;"                      !Move marker to highest signal peak.
80  OUTPUT @Sa;"MOV TRB[100],MEASU MKA;"       !Convert marker amplitude (-10.33) to
                                                 measurement units, then move value
                                                 (-1033) into trace element. TRB[100]
                                                 now contains -1033 measurement units.
90  OUTPUT @Sa;"TRB[100]?;"                    !Returns -10.33.
100 END
```

Here is another example showing how the MEASU command is used to return correct math results. In line 90 below, MEASU converts 10 dB to 1000 measurement units. The program raises the level of trace A by 10 dB.

Example: Add 10 dB to trace A.

```
10  ASSIGN @Sa TO 718                      !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
50  OUTPUT @Sa;"FA 50MHZ;FB 1050MHZ;"      !Change analyzer settings.
60  OUTPUT @Sa;"TS;"                       !Take a sweep to update trace.
70  OUTPUT @Sa;"WAIT 5;"                   !Program pauses for 5 seconds.
90  OUTPUT @Sa;"ADD TRA,TRA,MEASU 10;"     !Add 10 dB to trace A.
100 OUTPUT @Sa;"VIEW TRA;"                 !View trace A.
110 END
```

Table 3-1 is a list of the math and move commands that may require the use of the MEASU command.

Table 3-1. Math and Move Commands

ABS	Absolute.
ADD	Add operands, point by point.
AVG	Average.
CONCAT	Concatenate trace.
DIV	Divide operands, point by point, discard remainder.
EXP	Divide operand by scaling factor and raise to power of 10.
INT	Compute integer value.
LOG	Compute logarithm.
MEAN	Compute mean value of data points.
MIN	Retain minimum value.
MOD	Divide operands, point by point, retain remainder.
MOV	Duplicate value(s) contained in operand in destination.
MPY	Multiply operands, point by point.
MXM	Retain maximum value.
RMS	Compute root mean square of operand, point by point.
SQR	Compute square root of operand, point by point.
STDEV	Compute standard deviation.
SUB	Subtract operands, point by point.
SUM	Add operands, point by point.
SUMSQR	Add square of operands, point by point.
VARIANCE	Compute variance.
XCH	Exchange operands, point by point.

4. To achieve the best accuracy, use a single point for the destination, such as a trace element or a variable. If the destination consists of multiple points, the math functions round the operands first, then perform the requested operation. If the destination is a single point, the math functions compute the results in floating point, and then round the results if necessary. The example below shows how the product of 2.45 and 3.45 is 6 or 8 depending on the character of the destination.

Example: Compute product using single and multiple points as destination.

```
10  ASSIGN @Sa TO 718                    !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  OUTPUT @Sa;"TDF M;"                  !Return data in measurement units to computer.
50  !                                     (Data formats described in Section II.)
60  OUTPUT @Sa;"MPY TRC,2.45,3.45;"      !Fills trace C array with 2 X 3, or 6.
70  OUTPUT @Sa;"TRC[1]?;"                !Returns 6 to computer.
80  OUTPUT @Sa;"MPY TRC[1],2.45,3.45;"   !Loads trace element with integer value
                                          of 2.45 X 3.45, or 8.
90  OUTPUT @Sa;"TRC[1]?;"                !Returns 8 to computer.
100 END
```

USING PRE-DEFINED FUNCTIONS AS OPERANDS

The commands listed in table 3-2 form a unique set of commands that must be used in one of two ways, as queries or as operands of other analyzer commands.

Table 3-2. Commands Restricted to Operands and Queries

AMPU	Amplitude unit conversion
FREQU	Frequency unit conversion
MEAN	Mean value of data points
MEASU	Measurement unit conversion
MEM	Available memory query
PEAKS	Trace peaks
POSU	Position unit conversion
PWRBW	Power bandwidth
REV	Revision number
RMS	Root mean square
STB	Status byte query
STDEV	Standard deviation of trace amplitudes
SUM	Sum
SUMSQR	Sum of squared values
VARIANCE	Variance of data points

Below, the POSU command is used as a query.

Example: Find marker position in position units.

(Connect calibration signal to analyzer input.)

```
10 ASSIGN @Sa TO 718                 !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 OUTPUT @Sa;"CF 300MHZ;SP 1MHZ;"   !Set analyzer settings.
50 OUTPUT @Sa;"MKPK HI;"             !Set marker at signal peak
                                       (center screen).
60 OUTPUT @Sa;"POSU MKF,?;"          !Convert marker frequency to
                                       position units.
70 ENTER @Sa;N                       !Return position unit value (400).
80 END
```

The commands in Table 3-2 may be used to form the operands of the commands listed in Table 3-1 only. In the next example, POSU forms the operand of the MOV command.

Example: Forming operands with other analyzer commands.

(Connect calibration signal to analyzer input.)

```
10 ASSIGN @Sa TO 718                     !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 OUTPUT @Sa;"CF 300MHZ;SP 1MHZ;"       !Set analyzer range.
50 OUTPUT @Sa;"MKPK HI;"                 !Set marker at signal peak
                                           (center screen).
60 OUTPUT @Sa;"VARDEF VAR,0;"            !Declare analyzer variable called VAR.
70 OUTPUT @Sa;"MOV VAR,POSU MKF;"        !Convert marker frequency to position
                                           units. Transfer value to VAR.
80 OUTPUT @Sa;"VAR?;"                    !Return value, 400, to computer.
90 ENTER @Sa;N
100 END
```

SECTION II. TRACE DATA FORMAT

The spectrum analyzer returns all output data, except trace information as decimal values. The TDF (trace data format) command formats trace amplitude information in five different ways. The output formats are summarized in Table 3-3. (Parenthetical numbers in the table are decimal values representing binary, 8-bit numbers.)

Table 3-3. Trace Data Output Formats for Amplitude Information

Spectrum Analyzer Output	Command	Trace Element Output: Amplitude of +10 dBm
Returns ASCII decimal value. Values are in parameter units. Data output is followed by line-feed (ASCII code 10) and end-or-identify (EOI).	TDF P	+10.00
Returns ASCII integer value. Values are in measurement units. Line feed (ASCII code 10) and EOI follow data output.	TDF M	+1000
Returns binary value as two 8-bit bytes, the most significant byte first. Values are in measurement units. Asserts EOI with last byte.	TDF B	(3) (232)
Sends series of 8-bit bytes (A-block data field). Data preceded by "#" and "A" and length of data field. Data followed by line feed (ASCII code 10) and EOI. Values are in measurement units.	TDF A	(#)(A) (0) (2) (3)(232) (number of data bytes)
Sends a series of 8-bit bytes (I-block data field). Data is preceded by "#" and "I." Values are in measurement units. Asserts EOI with last byte.	TDF I	(#) (I) (3) (232)

FORMAT MODES

The trace data format (TDF) command controls the format of trace amplitude data at the analyzer HP-IB output. All the format modes return amplitude information in *measurement units* except for one, TDF P, which returns *parameter units*. (See *UNITS* in section I of this chapter.)

TDF P: Return Decimal Numbers in Parameter Units

The TDF P command transmits data as ASCII decimal values in parameter units. Instrument preset (IP) automatically activates the mode, and the AUNITS (amplitude units) command specifies the kind of parameter units. The default units are volts for linear trace information and dBm for logarithmic trace information.

A line feed (ASCII code 10) follows data output. The end-or-identify state (EOI) is asserted with line feed.

The TDF P mode is convenient because it returns parameter-unit values, but it is the slowest of the data-format modes.

TDF M: Return Decimal Numbers in Measurement Units

The TDF M command transmits data as ASCII integer values in measurement units. A line feed (ASCII code 10) follows data output. The end-or-identify state (EOI) is asserted with line feed.

The measurement-unit mode is faster than the parameter-unit mode (TDF P), but requires conversion to parameter units.

TDF B: Return Binary Numbers in Measurement Units

The TDF B command transmits data in measurement units as binary numbers. Numbers are usually transmitted as words (two 8-bit bytes). The most significant byte is sent first, followed by the least significant byte. EOI is asserted with the last byte.

Most Significant Byte	Least Significant Byte
XXXXXXXX	XXXXXXXX

The measurement data size command (MDS) may be used to consolidate the information contained in two-byte words into one byte (MDS B). However, since trace math operations often produce numbers too large to be contained in one byte, the use of bytes instead of words as the data size is not recommended, especially during trace math operations. Instrument preset (IP) selects words as the default data size.

TDF A and TDF I: Return Block-Data Fields in Measurement Units

The TDF A and TDF I commands activate the absolute and indefinite block-data format modes. Both modes return the same kind of data, binary words (MDS W) or bytes (MDS B) in block form. However, the TDF A mode precedes the data block with "# A" and a value that specifies the number of bytes in the block. TDF I precedes the data block with "# I" and asserts EOI with the last byte of data in the block. Instrument preset (IP) selects words as the default data size.

The block-data format modes are available for compliance with IEEE standards. These modes have the same limitations as the binary format mode when bytes are chosen as the measurement data size.

TRANSMISSION SEQUENCE OF DATA ON THE HP-IB BUS

Table 3-4 shows an HP-IB transmission sequence for each format mode. Each mode transmits the +10 dBm amplitude level of a trace element. Remember that even though the analyzer transmits binary or ASCII information on HP-IB, a decimal number is always returned to the Hewlett-Packard series 200 controller display. The parenthetical numbers in the table are decimal values representing binary, 8-bit numbers.

Table 3-4. HP-IB Transmission Sequence

Format	TDF P	TDF M	TDF B	TDF A	TDF I
Byte 1	1	1	(3)	#	#
Byte 2	0	0	(232-EOI)	(A)	(I)
Byte 3	.	0		(0)	(3)
Byte 4	0	0		(2)	(232-EOI)
Byte 5	0	10 (EOI)		(3)	
Byte 6	10 (EOI)			(232)	
				(10-EOI)	

CONTROLLER FORMATS

The format of the controller must be compatible with the output format of the analyzer. The following table and programming examples illustrate this concept.

Table 3-5. Controller Formats

Analyzer Format	Controller Format Requirements	Example Statement
TDF M	Free field	ENTER 718;Amplitude
TDF P	Free field	ENTER 718;Amplitude
TDF B	Binary. Read twice for each value.	ASSIGN @Sa TO 718;FORMAT OFF ENTER @Sa USING "#,W";Z(*)
TDF A		ASSIGN @Sa TO 718;FORMAT OFF ENTER @Sa;Poundi,Num_bytes ALLOCATE INTEGER Z(1:Num_bytes/2) ENTER @Sa;Z(*)
TDF I		ASSIGN @Sa TO 718;FORMAT OFF ENTER @Sa;Poundi ENTER @Sa USING "#,W";Z(*)

TRACE DATA FORMAT EXAMPLES

Example: Parameter-unit format with decimal values (TDF P).

```
10 ASSIGN @Sa TO 718
20 OUTPUT @Sa;"TDF P;"
30 OUTPUT @Sa;"TRA[10]?;"                !Return amplitude of trace element
                                          in parameter units.
40 ENTER @Sa;N                           !Assign value (-10.33) to N.
50 END
```

Example: Measurement-unit format with integer values (TDF M).

```
10 ASSIGN @Sa TO 718
20 OUTPUT @Sa;"TDF M;"                   !Activate measurement-unit format.
30 OUTPUT @Sa;"TRA[10]?;"                !Return amplitude of trace element
                                          in measurement units.
40 ENTER @Sa;N                           !Assign value (-1033) to N.
50 END
```

Example: Binary format with data size of one word (TDF B).

```
10 INTEGER Z(1:800)                      !Declare integer array.
20 ASSIGN @Sa TO 718
30 ASSIGN @Sa_fast TO 718;FORMAT OFF     !Assign (fast) I/O path to 718.
40 OUTPUT @Sa;"MDS W;"                   !Define word as data size.
50 OUTPUT @Sa;"TDF B;"                   !Activate binary data format.
60 OUTPUT @Sa;"TRA?;"                    !Return amplitude of all trace
                                          elements in measurement units.
70 ENTER @Sa_fast USING "#,W";Z(*)       !Load binary values into array Z. "#" specifies
                                          that line execution is terminated when last
                                          ENTER item is terminated. "W" specifies that
                                          items loaded are words (two bytes).
80 END
```

Example: Block data format with data size of one word (TDF A).

```
10 INTEGER Pounda,Num_bytes              !Declare integer array.
20 ASSIGN @Sa TO 718
30 ASSIGN @Sa_fast TO 718;FORMAT OFF     !Assign (fast) I/O path to 718.
40 OUTPUT @Sa;"MDS W;                    !Declare word as data size.
50 OUTPUT @Sa;"TDF A;"                   !Activate absolute block-data format
60 OUTPUT @Sa;"TRA?;"                    !Return amplitude of all trace elements.
70 ENTER  @Sa_fast;Pounda,Num_bytes      !Assign #A to Pounda. Assign length,
                                          i.e, number of bytes in block, to
                                          Num_bytes. (Temporary variables.)
80 ALLOCATE INTEGER A(1:Num_bytes/2)     !Declare array with length of Num_bytes/2.
90 ENTER Sa_fast A(*)                    !Load block data into array A.
100 END
```

SECTION III. STORING NEW FUNCTIONS IN THE SPECTRUM ANALYZER

This section tells how to store series of commands in the spectrum analyzer to form new, custom-made functions called user-defined functions.

User-defined functions have many applications. They are ideal for repetitive measurements and make it possible to conduct complicated measurements with the press of a single front panel key.

When a user-defined function operates, it does not suspend HP-IB activity. Thus, the computer is free to control other devices on the bus while the analyzer measures, processes, and stores data. When the analyzer is part of a large scale measurement system, this makes more computer processing time available.

In addition, the operation of user-defined functions does not require a computer; the functions may instead be activated with the analyzer keys. This is useful in small-scale test systems, where custom soft-key menus help create a friendly user interface to simplify test procedures.

This section tells how to create user-defined functions with the define-functions command (FUNCDEF) and assign soft keys to user-defined functions. It describes how to enhance functions with the looping and conditional constructs REPEAT/UNTIL and IF/THEN/ELSE.

CREATING USER-DEFINED FUNCTIONS WITH THE FUNCDEF COMMAND

The FUNCDEF (define function) command consolidates a series of analyzer commands into one function and gives it a name. Executing the function name is the same as executing the series of commands contained in the function.

Before a function can be executed, it must be stored in the analyzer. The example below stores a user-defined function called HIGH_PEAK in the analyzer.

Example: Store function in analyzer.

(Connect calibration signal to analyzer.)

```
10  ASSIGN @Sa TO 718
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  OUTPUT @Sa;"FUNCDEF HIGH_PEAK,@"     !Delimiter marks beginning of command list
                                          assigned to HIGH_PEAK.
50  OUTPUT @Sa;"FA 50 MHZ;FB 1GHZ;"
60  OUTPUT @Sa;"TS;MKPK HI;"
70  OUTPUT @Sa;"@;"                      !Matching delimiter marks end of command list.
80  END
```

Once HIGH_PEAK is *stored* in the analyzer, it can be *executed* in several ways. To execute HIGH_PEAK via remote control, incorporate it into an output statement as you would any spectrum analyzer command. Like other spectrum analyzer commands, user-defined functions require a terminating semicolon:

```
10  OUTPUT @Sa;"IP;HIGH_PEAK;"
```

User-defined functions may also be executed with the front panel keys. See *Executing User-Defined Functions with Soft Keys* at the end of this section.

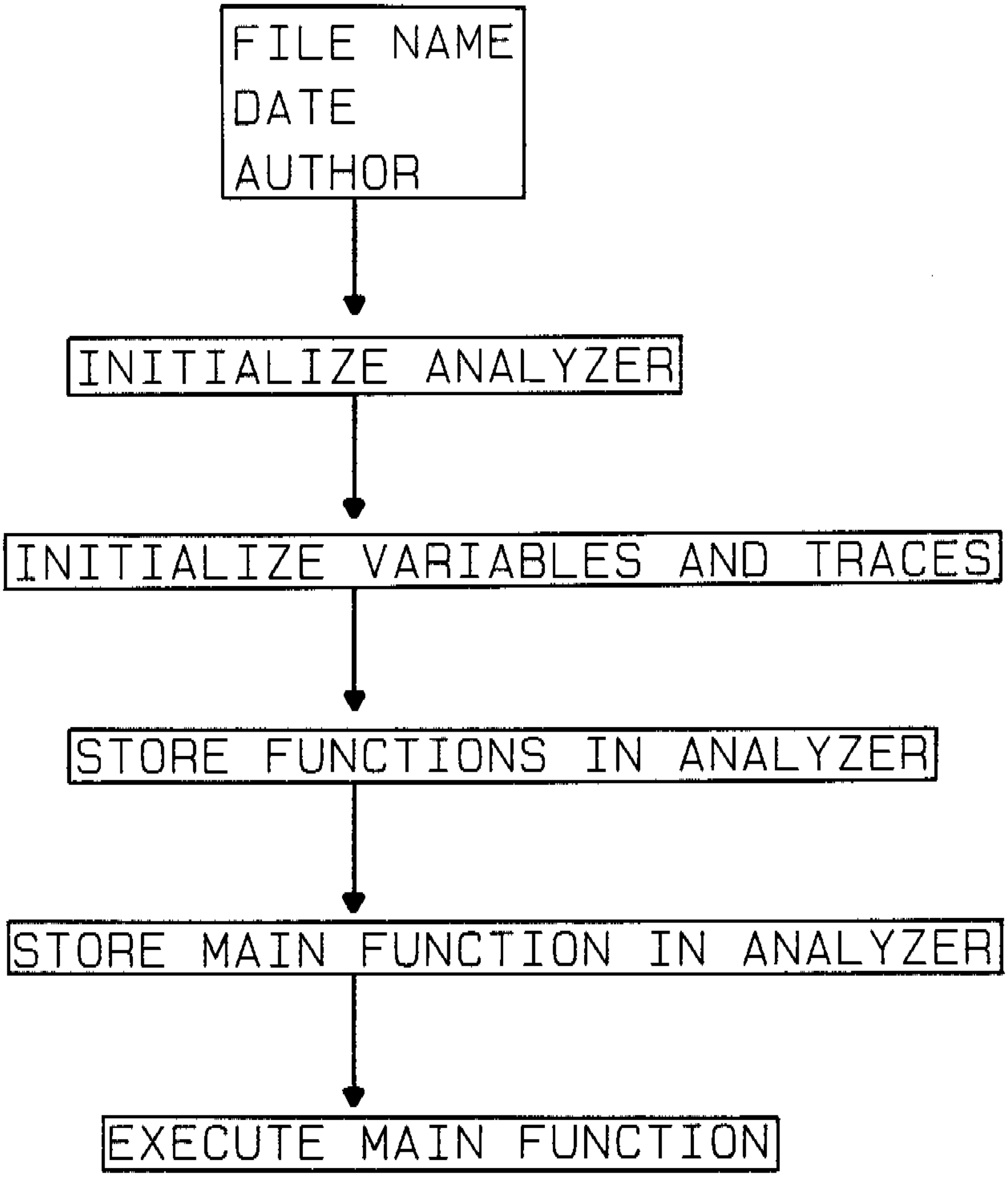


FIGURE 3-1. PROGRAM STRUCTURE

Illegal Operations

Executing a user-defined function within the FUNCDEF statement that defines it is an illegal recursion that must be avoided:

```
10 OUTPUT @Sa;"FUNCDEF SELECT_SPAN,@"
20   OUTPUT @Sa;"FA 500MHZ;FB 1GHZ;"
30   OUTPUT @Sa;"SELECT_SPAN;"                    Illegal recursion
40 OUTPUT @Sa;"@;"
50 END
```

It is also illegal to nest FUNCDEF commands:

```
10 OUTPUT @Sa;"FUNCDEF ONE,@"
20 OUTPUT @Sa;"FA 10MHZ;FB 10GHZ;"
30    OUTPUT @Sa;"FUNCDEF TWO,@FA 20MHZ;FB 20GHZ;@;"
40 OUTPUT @Sa;"@;"
```

Do not use existing function names or secondary key words as user-defined functions. This interrupts the defining process and executes the invoked function instead. For example, if the user-defined function in the previous example was called "SS" instead of "SELECT_SPAN," the analyzer step size function would be activated. Likewise, if the function was called "ALL," it would disrupt the operation of any function modified by ALL, such as DISPOSE ALL.

STORING FUNCTIONS IN THE ANALYZER

The easiest way to store new functions in the analyzer is with a computer program. Figure 3-1 illustrates an efficient program structure that simplifies the process. The model simplifies debugging and documentation and conserves analyzer memory.

In the model, the first part tells what the program does and gives other appropriate information such as the author's name, the date, and a file name if the program is stored on a disc.

The second part initializes the analyzer in order to form a good starting point for measurements. CLEAR @Sa and IP set the analyzer to a known state. DISPOSE ALL clears user-memory to maximize storage space for functions, variables, and traces.

The third part defines all user-defined variables and traces that are utilized by any of the user-defined functions. It specifies a size for each trace and a value for each variable. Always define variables and traces apart from any user-defined functions. This avoids memory overflow problems. For instance, if the initialization of several traces is made part of a function definition, analyzer memory is not allocated to the traces until the function has been executed. Thus, if available memory is checked (with the MEM? command or the ◀SHOW CATALOG▶ key) before the function has been run, the value returned accounts only for the space occupied by the function, not for the space occupied by the function *plus* the traces.

The fourth part is reserved for user-defined functions that are incorporated into and executed by a main user-defined function, which is the last part of the program. When a series of commands are consolidated in a function, they can be executed many times, even though they are stored in the analyzer only once. This conserves analyzer memory and simplifies programming.

The following example illustrates this program structure. Note that the sub-function called VIEW_SIGNAL is executed twice in the main function, SCAN.

```
10  FILE NAME: Peaks   DATE: 4/1/85      AUTHOR: Name
20 !
30 !PROGRAM DESCRIPTION:
40 !View the largest signal in two frequency ranges using a narrow
50 !spanwidth. Store the amplitude level of the largest signal of
60 !each range.
70 !
80 !Program begins here. . .
90 !
100 !INITIALIZE ANALYZER
105 !
110  ASSIGN @Sa TO 718
120  CLEAR @Sa
130  OUTPUT @Sa;"IP;SNGLS;TS;"
135  OUTPUT @Sa;"DISPOSE ALL;"
140  !
150  !INITIALIZE VARIABLES AND TRACES
160  !
170  OUTPUT @Sa;"VARDEF AMP_A,0;"
180  OUTPUT @Sa;"VARDEF AMP_B,0;"
190  !
200 !STORE SUB-FUNCTIONS IN ANALYZER
210 !
220 !Place marker on largest signal and view it with narrow spanwidth:
230    OUTPUT @Sa;"FUNCDEF VIEW_SIGNAL,@"
240         OUTPUT @Sa;"TS;MKPK HI;"
250         OUTPUT @Sa;"MKTRACK ON;TS;"
260         OUTPUT @Sa;"SP 100KHZ;"
270    OUTPUT @Sa;"@;"
280 !
290 !STORE MAIN FUNCTION IN ANALYZER
292 !
295 ! Select two frequency ranges, execute VIEW_SIGNAL function and
297 ! store amplitude data in analyzer:
298    OUTPUT @Sa;"FUNCDEF SCAN,@"
300         OUTPUT @Sa;"IP;"
310         OUTPUT @Sa;"FA 50MHZ;FB 400MHZ;"
320         OUTPUT @Sa;"VIEW_SIGNAL;"
330         OUTPUT @Sa;"MOV AMP_A,MKA;"
340         !
350         OUTPUT @Sa;"WAIT 2;"
360         !
370         OUTPUT @Sa;"FA 500MHZ;FB 1 GHZ;"
380         OUTPUT @Sa;"VIEW_SIGNAL;"
390         OUTPUT @Sa;"MOV AMP_B,MKA;"
400    OUTPUT @Sa;"@;"
410    !
420 !EXECUTE MAIN FUNCTION
422 !
425    OUTPUT @Sa;"SCAN;"
430    END
```

Here are some additional guidelines for writing user-defined functions:

1. Write short program lines, and document them when necessary.
2. Indent program lines to mark sub-functions and points of looping and branching.
3. Use descriptive labels for variables, functions, and traces.
4. Define all variables and traces at the beginning of the program, not within a FUNCDEF definition.
5. Use recommended syntax shown in Language Reference.

BRANCHING AND LOOPING

Use the IF/THEN/ELSE and REPEAT/UNTIL commands to add decision-making and looping capability to user-defined functions.

The example below tests the marker amplitude, MKA. If MKA is greater than -10 dBm, the amplitude is displayed.

Example: Conditional branching.

```
60  OUTPUT @Sa;"IF MKA,GT,-10DBM;THEN DSPLY MKA;"
70  OUTPUT @Sa;"ENDIF;"
```

The example below illustrates multiple conditional branching. If MKA is greater than -10 dBm or less than -30 dbm, its value is displayed. Otherwise, the message "SIGNAL WITHIN TOLERANCE" is displayed.

Example: Multiple conditional branching.

```
60  OUTPUT @Sa;"IF MKA,GT,-10DBM;THEN;DSPLY MKA;"
70  OUTPUT @Sa;"ELSIF MKA,LT,-30DBM;THEN;DSPLY MKA;"
80  OUTPUT @Sa;"ELSE TEXT $SIGNAL WITHIN TOLERANCE$;"
90  OUTPUT @Sa;"ENDIF;"
```

The next example illustrates a repeat/until loop. Repetition is controlled with a user-defined variable, N, which incrementally increases each time the loop is repeated. The example stores the amplitudes of the three largest signals in the first three elements of a trace array. In addition, N doubles as a pointer that specifies where data is stored in the trace array.

Example: Repeat/Until looping construct.

```
(Connect calibration signal to analyzer.)
10  ASSIGN @Sa TO 718                        !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  OUTPUT @Sa;"DISPOSE ALL;"
50  !
60  OUTPUT @Sa;"TRDEF TR_AMP,10;"            !Define 10 element trace, TR_AMP.
70  OUTPUT @Sa;"VARDEF N,0;"                 !Define variable, N, as equal to 0.
80  !
```

```
90 OUTPUT @Sa"MKPK HI;"                         !Place marker on highest peak.
100 OUTPUT @Sa;"REPEAT;"                        !Begin repeat loop.
110 OUTPUT @Sa;"ADD N,N,1;"                     !Add 1 to N.
120 OUTPUT @Sa;"MKPK NH;"                       !Move marker to next highest peak.
130 OUTPUT @Sa;"MOV PEAK[N],MEASU MKA;"         !Store amplitude in nth element of trace.
140 OUTPUT @Sa;"UNTIL N,EQ,3;"                  !Define end of repeat loop. Looping
150 END                                           ends when N equals 3.
```

MEMORY

All user-defined functions, variables, traces, and registers occupy memory in the analyzer. Items may be stored in the memory until it is full, in which case a memory-overflow message appears on the screen. A complete listing of all stored items is displayed on the analyzer screen when the following front panel keys are pressed:

[MENU]
◀INSTR DISPLAY▶
◀SHOW CATALOG▶

Variables, traces, and functions are listed by name on the screen. The number of bytes that each item occupies appears at its right. The amount of unused memory is also listed and may be queried with the MEM? command.

Items are erased from memory singly or in mass with the DISPOSE command:

Example: Erasing memory

```
10 OUTPUT @Sa;"DISPOSE HIGH_PEAK;"  !Dispose of single user-defined function.

10  OUTPUT @Sa;"DISPOSE ALL;" !Dispose of all user-defined functions, variables, and traces.
```

DISPOSE erases user-defined traces, variables, functions, and soft keys, and any command lists defined with the ONEOS command. Items not erased are the contents of the state registers or traces A, B, and C.

Available analyzer memory is increased by erasing all user-defined traces, variables, functions, *and* trace registers, as follows:

```
10  OUTPUT @Sa;"DISPOSE ALL;"             !Disposes all user-defined variables,
                                            traces, functions, and associated soft keys.
20  OUTPUT @Sa;"PSTATE OFF;NSTATE 0;"     !Disables trace-register protect
                                            mode, then clears registers.
```

The amount of available memory varies with the system configuration. If memory space is critical, it may be conserved in several ways. First, erase unneeded traces, variables, and functions using DISPOSE, or reduce trace size using TRDEF. An 800 element trace occupies 1646 bytes of memory, that is, 2 bytes for each element and 46 bytes for trace overhead. Use the NSTATE command to eliminate unneeded state registers.

User-defined functions may be streamlined to conserve analyzer memory. The space they occupy is reduced by inhibiting the carriage-return/line-feed (CR/LF) generated by the computer at the end of each program line. The HIGH_PEAK function is shown below with carriage-return/line-feed suppressed. Using this configuration, PEAK occupies 14% less memory space, or 30 bytes instead of 36.

Example: Suppressed carriage-return/line-feed.

```
(Connect calibration signal to analyzer.)
10 ASSIGN @Sa TO 718
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;DISPOSE ALL;"
40 OUTPUT @Sa;"FUNCDEF HIGH_PEAK,@";        !Semicolon added to suppress CR/LF.
50 OUTPUT @Sa;"FA 50 MHZ;FB 1GHZ;";         !Semicolon added to suppress CR/LF.
60 OUTPUT @Sa;"TS;MKPK HI;";                !Semicolon added to suppress CR/LF.
70 OUTPUT @Sa;"@;"
80 END
```

EXECUTING USER-DEFINED FUNCTIONS WITH SOFT KEYS

User-defined functions are activated with the analyzer front panel keys in several ways. One way is with the analyzer ◀ENTER▶ key:

Press [USR]
Press ◀Special Functions▶

Press ◀ENTER COMMAND▶, then spell out the command name. For example, the HIGH_PEAK function is executed by sequentially positioning the cursor underneath the characters H-I-G-H-_-P-E-A-K contained in the alphabet shown on the analyzer screen. Press ◀ENTER ALPHA▶ for each new cursor position. As each letter is entered, it appears in the *data line* at the bottom of the analyzer screen.

After HIGH_PEAK is entered into the command line, press ◀EXECUTE LINE▶.

The KEYDEF command simplifies front panel execution of user-defined functions by assigning a function to an analyzer soft key. Up to 14 soft keys can be displayed on the analyzer screen at one time. The keys are numbered 1 through 14, keys 1 and 8 occupying the upper right and left corners respectively. Below, the PEAK function is assigned to a new key, called "FIND PEAK."

Example: Assign function to softkey.

```
10 OUTPUT @Sa;"KEYDEF 7,HIGH_PEAK,$FIND PEAK$;"  !Specify key number, function,
                                                  and label.
```

The READMENU command facilitates the creation of soft key menus. In the next example, READMENU works with the IF/THEN/ELSE commands to build a soft key menu that activates three different frequency ranges, called bands A, B, and C. Whenever a key is pressed, the READMENU command transfers the key number to a user-defined variable. The IF/THEN/ELSE commands then test the key number and activate the associated function. The REPEAT/UNTIL commands repeat the key testing process until the exit key is pressed.

Example: Use READMENU command to build soft key menus.

```
10  ASSIGN @Sa TO 718                                        !Initialize analyzer.
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;DISPOSE ALL;"
32  !
35  !
40  !
50  OUTPUT @Sa;"FUNCDEF BANDA,@FA 10MHZ;FB 500MHZ;@;"     !Declare key functions.
60  OUTPUT @Sa;"FUNCDEF BANDB,@FA 500MHZ;FB 1GHZ;@;"
70  OUTPUT @Sa;"FUNCDEF BANDC,@FA 1GHZ;FB 1.5GHZ;@;"

80  !
82  !
85  !
90   OUTPUT @Sa;"VARDEF KEY,0;"          !Declare variable for storing key number.
100 OUTPUT @Sa;"VARDEF END_LOOP,0;"      !Declare variable for monitoring REPEAT loop.
110 !
115 !
117 !
120 OUTPUT @Sa;"REPEAT;"                 !Begin REPEAT loop.

125 !   Assign labels to soft keys 1, 2, 3, and 14. Store pressed-key number in variable, KEY:
127 !
130     OUTPUT @Sa;"READMENU KEY,1,$BAND A$,2,$BAND B$,3,$BAND C$,14,$EXIT$;"
135 !
140   OUTPUT @Sa;"IF KEY,EQ,1;THEN;BANDA;"        !Evaluate KEY to execute function.
150     OUTPUT @Sa;"ELSIF KEY,EQ,2;THEN;BANDB;"
160     OUTPUT @Sa;"ELSIF KEY,EQ,3;THEN;BANDC;"
170     OUTPUT @Sa;"ELSIF KEY,EQ,14;"             !When key 14 is pressed, END_LOOP
180     OUTPUT @Sa;"THEN MOV END_LOOP,1;"           contains a "1" and ends loop.
190   OUTPUT @Sa;"ENDIF;"
200 OUTPUT @Sa;"UNTIL END_LOOP,EQ,1;"
210 END
```

With further use of the READMENU, KEYDEF, and FUNCDEF commands, you may assign a soft-key menu to a soft key that can be activated by yet another soft key, thus creating multi-level menus. The above example has been altered slightly in the next example to demonstrate one way of assigning a menu to another soft key. The entire program algorithm is incorporated into a user-defined function, which in turn is assigned to a single soft key (SELECT_SPAN).

Example: Use READMENU, KEYDEF, and FUNCDEF to build multi-level menus.

```
10 ASSIGN @Sa TO 718                                          !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;DISPOSE ALL;"
40 !
42 !
45 !
50 OUTPUT @Sa;"FUNCDEF BANDA,@FA 10MHZ;FB 500MHZ;@;"     !Declare key functions.
60 OUTPUT @Sa;"FUNCDEF BANDB,@FA 500MHZ;FB 1GHZ;@;"
70 OUTPUT @Sa;"FUNCDEF BANDC,@FA 1GHZ;FB 1.5GHZ;@;"

80 !
82 !
85 !
90  OUTPUT @Sa;"VARDEF KEY,0;"            !Declare variable for storing key number.
100 OUTPUT @Sa;"VARDEF END_LOOP,0;"       !Declare variable for monitoring REPEAT loop.

110 OUTPUT @Sa;"FUNCDEF SELECT_SPAN,@"
115 !
120     OUTPUT @Sa;"REPEAT;"                              !Begin REPEAT loop.

125 !   Assign labels to soft keys 1, 2, 3, and 14. Store pressed-key number in variable, KEY:
127 !
130    OUTPUT @Sa;"READMENU KEY,1,$BAND A$,2,$BAND B$,3,$BAND C$,14,$EXIT$;"
135 !
140   OUTPUT @Sa;"IF KEY,EQ,1;THEN;BANDA;"          !Evaluate KEY to execute function.
150    OUTPUT @Sa;"ELSIF KEY,EQ,2;THEN;BANDB;"
160    OUTPUT @Sa;"ELSIF KEY,EQ,3;THEN;BANDC;"
170    OUTPUT @Sa;"ELSIF KEY,EQ,14;"                !When key 14 is pressed, END_LOOP
180    OUTPUT @Sa;"THEN MOV END_LOOP,1;"             contains  a "1" and ends loop.
190   OUTPUT @Sa;"ENDIF;"
200 OUTPUT @Sa;"UNTIL END_LOOP,EQ,1;"
210 OUTPUT @Sa;"@;"

200 OUTPUT @Sa;"KEYDEF 8,SELECT_SPAN,$SELECT SPAN$;"
210 END
```

SECTION IV. ADVANCED GRAPHICS

This section describes advanced techniques for displaying measurement results and custom graphics on the CRT.

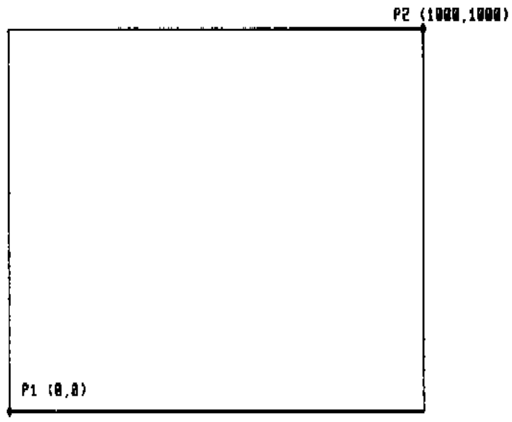
Graphics techniques are demonstrated using program examples. Each example requires that the analyzer be initialized and its CRT cleared of all existing graphics. Program lines 10 through 100 below perform this function. If you wish to run the program examples found in this section, it is only necessary to enter lines 10 through 100 into your computer once. Enter lines after the sequence to exercise the individual examples.

```
10 ASSIGN @Sa TO 718                     !Initialize analyzer.
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 !
50 OUTPUT @Sa;"ANNOT OFF;GRAT OFF;"      !Clear CRT graphics.
60 OUTPUT @Sa;"TRDSP TRA OFF;"
70 OUTPUT @Sa;"TRDSP TRB OFF;"
80 OUTPUT @Sa;"TRDSP TRC OFF;"
90 OUTPUT @Sa;"DL OFF;"
100 OUTPUT @Sa;"CLRDSP;"                 !Select default X-Y coordinates (0,1000,0,1000).
110 !
120 !                                    !Program examples begin here.
```

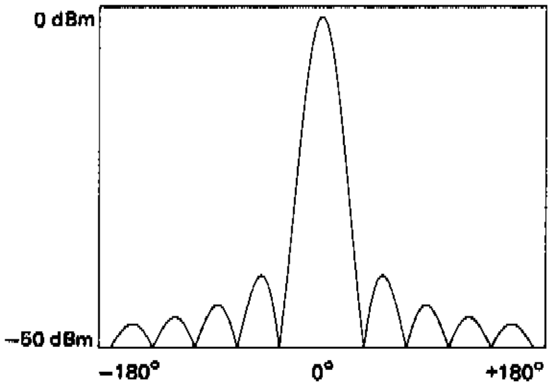
When you begin writing your own graphics programs, you may wish to save lines 10 through 30, and 50 through 100 in the analyzer as user-defined functions, or in your computer as subroutines. This way, they may be easily recalled to initialize the analyzer or to clear CRT graphics.

DEFINING CRT SCALE UNITS

All analyzer graphics are drawn on a coordinate system. For your convenience, a default coordinate system is always active whenever instrument preset (IP) or clear-display (CLRDSP) is executed. These commands set the minimum and maximum values of the X and Y coordinates to 0 and 1000. Thus, the coordinates of the lower left and upper right points, P_1 and P_2, are 0,0 and 1000,1000.



Use the SCALE command to match the scale of the CRT to the scale of the graphics you wish to display. The CRT coordinates, X and Y, may be rescaled to any values between -32,768 and +32,767. Below, SCALE changes the X and Y coordinates to new terms in decibel and degree units to illustrate an antenna pattern adjustment.



OUTPUT @Sa;"SCALE -180,180,-50,0"

X_{min} X_{max} Y_{min} Y_{max}

The SCALE command defines X-Y coordinates in integer values only. When redefining the scale, use numbers large enough to give adequate resolution. Units greater than 50 are suggested.

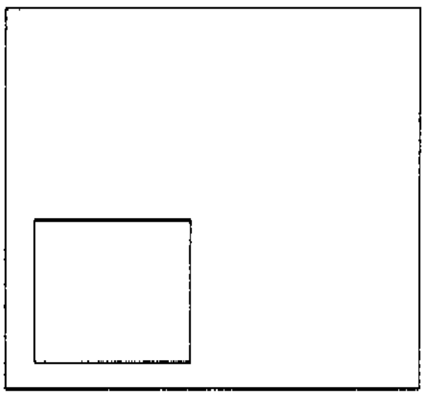
POSITIONING GRAPHICS ON CRT

Once graphics are "drawn," they may be repositioned with the OR (origin) command. This command *offsets* the position of graphics on the CRT relative to P1, in the current CRT scale units.

The programs below draw a box. In the first example, the box is drawn without any offset. In the second, the box is offset 500 units in the X and Y directions.

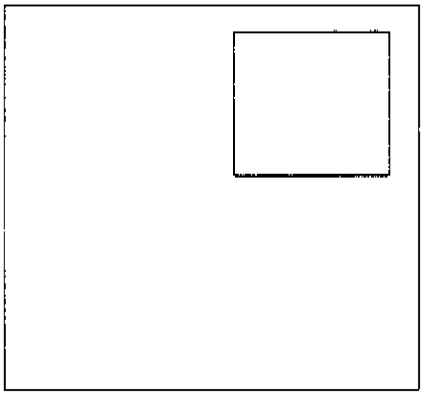
Example: Draw box without offset

```
120 OUTPUT @Sa;"PU;PA 0,0;PD;"                        !Place pen down at 0,0.
130 OUTPUT @Sa;"PA 0,400,400,400,400,0,0,0;"          !Draw to coordinates X1,Y1,X2,Y2,
                                                       X3,Y3,X4,Y4.
```



Example: Draw box with offset

```
120 OUTPUT @Sa;"OR 500,500;"                        !Offset origin.
130 OUTPUT @Sa;"PU;PA 0,0;PD;"                      !Draw box.
140 OUTPUT @Sa;"PA 0,400,400,400,400,0,0,0;"
```



RESIZING COORDINATE SYSTEM

So far, we have examined graphics drawn on one scale that occupies the entire analyzer screen. The DWINDOW command magnifies or reduces a coordinate system. This new coordinate system can be thought of as a window for viewing measurement results or graphics which also lets you resize graphics.

DWINDOW first specifies the physical size of the window in the current scale units. (As before, current scale units are either default values of 0 to 1000 for X and Y coordinates, or are specified by the SCALE command.) DWINDOW then defines a scale for the new coordinate system *within* the window:

OUTPUT @Sa;"DWINDOW Length, Width, Xmin, Xmax, Ymin, Ymax;"

window length

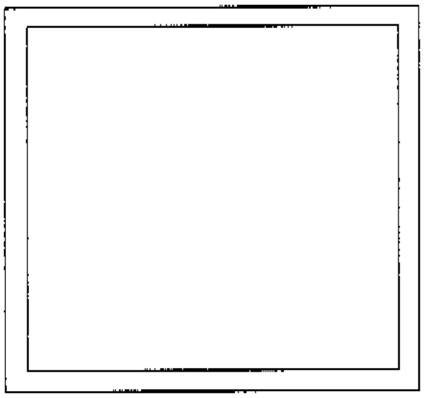
window height

minimum and maximum values
for X and Y coordinates within window

For example, the next program draws a box on the default coordinate system. Each side of the box has a length of 1000, and thus outlines the limits of the default coordinate system.

Example: Draw box.

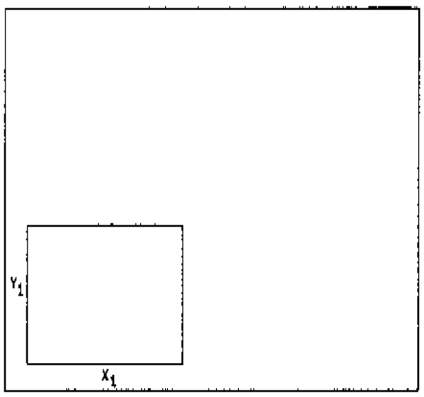
```
120 OUTPUT @Sa;"PU;PA 0,0;PD;"                          !Draw box.
130 OUTPUT @Sa;"PA 0,1000,1000,1000,1000,0,0,0;"
```



In the next program, DWINDOW orients the box in a new coordinate system, or "window." The window dimensions are 400 X 400 (current scale units) and the window X_1-Y_1 coordinates have units from 0 to 1000. Since the sides of the box are still 1000 units long, it outlines the limits of the window.

Example: Draw box within window

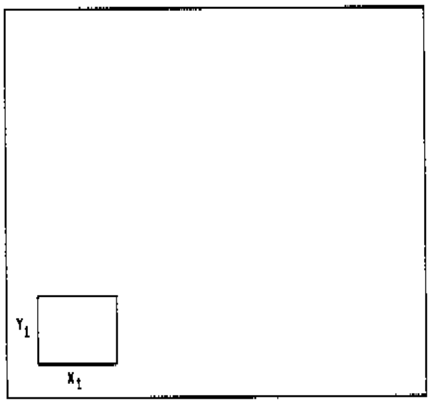
```
120 OUTPUT @Sa;"DWINDOW 400,400,0,1000,0,1000;         !Define window size and scale.
130 OUTPUT @Sa;"PU;PA 0,0;PD;"                          !Draw box.
140 OUTPUT @Sa;"PA 0,1000,1000,1000,1000,0,0,0;"
```



The window scale may be changed to enlarge or reduce graphics within it. Below, the same box is drawn in a window where the X_1- Y_1 coordinates are twice as long as before. Thus, the box is half as large.

Example: Change window scale

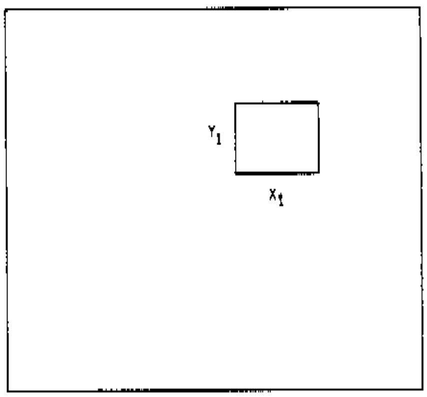
```
120 OUTPUT @Sa;"DWINDOW 400,400,0,2000,0,2000;"    !Change window scale.
130 OUTPUT @Sa;"PU;PA 0,0;PD;"                     !Draw box.
140 OUTPUT @Sa;"PA 0,1000,1000,1000,1000,0,0,0;"
```



Use OR to position the window anywhere on the CRT. The OR command offsets coordinates of the window in the current scale units, as defined by the current scale units.

Example: Offset window position.

```
120 OUTPUT @Sa;"DWINDOW 400,400,0,2000,0,2000;"    !Define window size.
130 OUTPUT @Sa;"OR 500,500;"                       !Offset window position.
140 OUTPUT @Sa;"PU;PA 0,0;PD;"                     !Draw box.
150 OUTPUT @Sa;"PA 0,1000,1000,1000,1000,0,0,0;"
```



DWINDOW is especially useful for displaying traces. When traces are displayed, the window scale is set by the trace conditions:

```
OUTPUT @Sa;"DWINDOW,500,500,TRA;"
```

window length

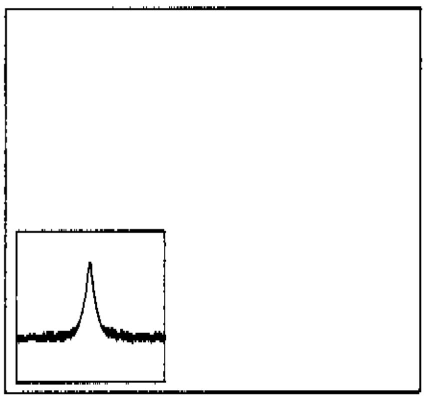
window height

trace

Trace A is reproduced below in a window.

Example: Draw trace within window

```
120 OUTPUT @Sa;"DWINDOW 400,400,TRA;"                 !Define window size and contents.
130 OUTPUT @Sa;"GRAPH TRA;"                           !Display trace A.
140 OUTPUT @Sa;"DWINDOW 400,400,0,1000,0,1000;"       !Draw box to outline trace.
150 OUTPUT @Sa;"PU;PA 0,0;PD;"
160 OUTPUT @Sa;"PA 0,1000,1000,1000,1000,0,0,0;"
```



Execute DWINDOW OFF to turn a window off.

Example: Turn off window.

```
10 OUTPUT @Sa;"DWINDOW OFF;"
```

ITEMS

The item command, IT, assigns an item number from 0 to 255 to a series of graphics commands. When graphics are assigned a non-zero number, the referenced-graphics mode is activated. Executing IT 0, IP, or CLRDSP turns off the referenced-graphics mode.

In the referenced-graphics mode, referenced graphics (called *items*) may be redrawn or modified without re-executing the individual graphics commands. This is useful when a graphics item needs to be blanked and redrawn, reshaped, or repositioned at a later time. Non-referenced graphics may not be redrawn or reshaped at a later time.

All graphics items are created by assigning each one a unique, nonzero number. Once assigned, an item is automatically displayed. An item is modified by first activating it, then modifying it with one of the item-modifying commands. The details of this process are discussed below.

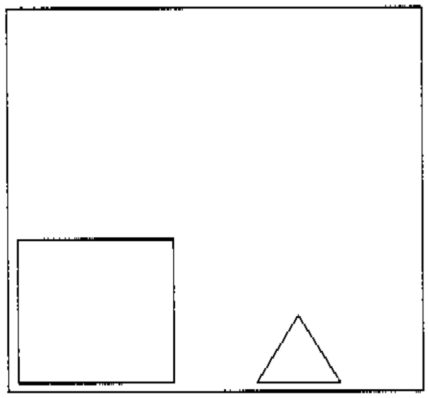
Assigning Item Numbers

Use the IT command to assign item numbers. Below, the points that comprise a box and a triangle are assigned:

Example: Assign triangle and box item numbers.

```
120 OUTPUT @Sa;"IT 1;"                              !Assign box item number 1.
130 OUTPUT @Sa;"PA 0,0,0,400,400,400,400,0,0,0;"    !Draw box.
140 OUTPUT @Sa;"IT 2;"                              !Assign triangle item number 2.
150 OUTPUT @Sa;"PA 600,0;700,200,800,0,600,0;"      !Draw triangle.
```

In the referenced-graphics mode, each item has its own pen, which is automatically in the down position. Thus, a pen-down command (PD) is not required. Items 1 and 2 are shown below.



Activating and Modifying Items

An item can be redrawn or modified whenever it is active. Only one item can be active at a time. The active item is determined by the last executed IT command.

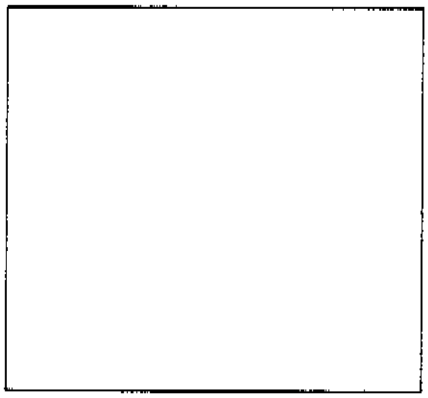
These are the commands that modify items:

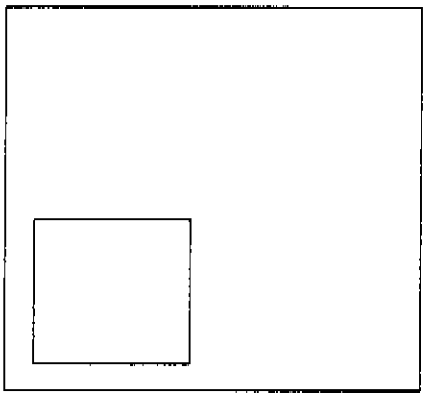
VW OFF (view item off).................Blank item
VW ON (view item on)..................Redraw item
OR (origin)....................................Offset item position
TP (pointer)...................................Change item shape.
DELETE..Delete item

Below, item 1 is activated, blanked, and then redrawn. Notice that it is not necessary to re-execute the individual graphics commands assigned to the item.

Example: Blank and redraw item

```
160  OUTPUT @Sa;"WAIT 5;"
170  OUTPUT @Sa;"IT 1;"                          !Activate item
180  OUTPUT @Sa;"VW OFF;"                        !Blank item
190  OUTPUT @Sa;"WAIT 5;"
200  OUTPUT @Sa;"VW ON;"                         !Redraw item.
```

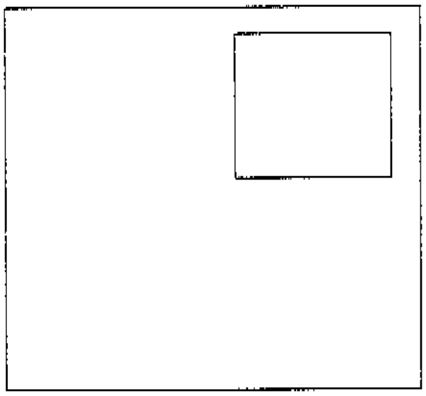




The OR command offsets item positions:

Example: Offset item.

```
160 OUTPUT @Sa;"WAIT 5;"
170 OUTPUT @Sa;"IT 1;"                           !Activate item 1.
180 OUTPUT @Sa;"OR 500,500;"                     !Offset item 1.
```



If OR is not executed with an item, its origin is assumed to be at 0,0 (OR 0,0) and no offset occurs.

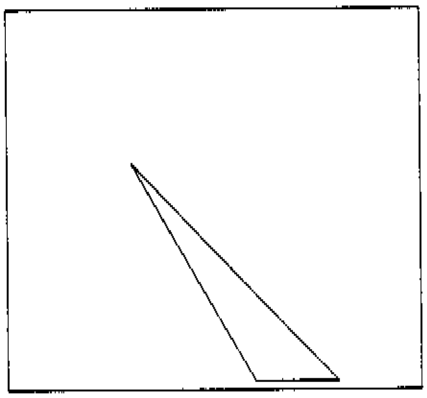
The TP command modifies item shapes. The TP command may be thought of as a tablet pointer that selects a point of graphics for modification. For example, consider item 2, the triangle. It is composed of four points, numbered 0 through 3:

#0	#1	#2	#3
(600,0)	(700,200)	(800,0)	(600,0)

Executing TP 1 selects point (700,200) for modification. (TP begins counting with zero.) The point value is changed with the plot absolute command (PA) that follows the TP command. In the program below, point #1 (700,200) of the triangle is modified.

Example: Modify item shape.

```
160 OUTPUT @Sa;"WAIT 5;"            !Activate item.
170 OUTPUT @Sa;"IT 2;"
180 OUTPUT @Sa;"TP 1;"              !Select point.
190 OUTPUT @Sa;"PA 300,600;"        !Specify new point value.
```



Any modifications made with OR, VW, or TP become permanent characteristics of the item unless the item is remodified or deleted with the DELETE or CLRDSP commands.

Deleting Items

The DELETE command blanks the *active* item and clears it from the analyzer memory. The CLRDSP command blanks and deletes *all* items, regardless of their state. Deleted items cannot be referenced again unless they are reassigned.

Example: Delete item.

```
160 OUTPUT @Sa;"WAIT 5;"
170 OUTPUT @Sa;"IT 1;"                    !Activate item.
180 OUTPUT @Sa;"DELETE;"                  !Delete item.
```

Example: Delete all items.

```
400 OUTPUT @Sa;"CLRDSP;"                  !Delete all items.
```

Item Types

In addition to point-by-point drawing, items can be used to display text, grids, or trace information. The commands associated with these tasks are divided into groups listed below:

TASK	COMMANDS
Plot-absolute, point-by-point drawing	PA,PU,PD
Plot-relative, point-by-point drawing	PR,PU,PD
Display trace data	GRAPH
Draw grid	GRID
Display text	TEXT,DSPLY
Display graphics marker.	MK

A single item can be assigned to do only one task. For example, a single item cannot draw a box and display text. In this case, two items are required: one for the box, another for the text.

SECTION V. CONTROLLING SYSTEM OPERATION WITH SERVICE REQUESTS

The programming techniques discussed so far describe communication between the analyzer and the computer, where the sequence of all data transfer is controlled by a computer program. Service requests let the analyzer temporarily interrupt the normal sequence of program operation.

Service requests have many applications. They facilitate economical use of computer processing time when the analyzer is part of a large scale measurement system. For example, after the computer initiates an analyzer measurement, it can make calculations or control other devices via HP-IB while the analyzer is measuring. When the analyzer is through, it signals the computer with a service request. The service-request subprogram then determines what the computer will do next. Service requests are also used to report analyzer errors and interrupt computer processing.

HP-IB INTERRUPT PROCESS

The interrupt process begins when the analyzer "requests" attention by setting the HP-IB service request (SR) line true. The controller responds by branching to a special subroutine that examines the status of each instrument on HP-IB. Controller operation then branches to another subroutine that is determined by the status of the instrument that requested service (the analyzer in this case). In this way, the computer "services" the analyzer's "request." These steps are summarized below:

1. Computer monitors HP-IB service request (SR) line.
2. Analyzer requests service by setting SR line true.
3. Computer branches to subroutine that examines analyzer state.
4. Computer branches to subroutine determined by analyzer state.

Several system level commands are required to make the computer responsive to service requests. The HP BASIC command, ENABLE INTR (enable interrupt), tells the computer to monitor the service request line. The on-interrupt command, ON INTR, specifies where the computer program will branch when a service request occurs. If more than one service request is possible, the serial-poll command, SPOLL, is needed to examine the nature of the service request. These HP BASIC commands are used with the HP series 200 computers.

ANALYZER STATUS BYTE

The analyzer status is summarized in the 8-bit status byte. Bits 1, 2, 4, and 5 represent particular aspects of analyzer operation, such as end-of-sweep, or error conditions. These are listed in Table 3-7. The state of these bits, set (true) or cleared (false), is determined by the analyzer status.

If the service request mode is not enabled, the bits always reflect the current analyzer state. Since bits 3 and 4 represent transient events, END-OF-SWEEP and COMMAND-COMPLETE, their state is not easily detected.

If the service request mode is enabled, all of the status byte bits reflect the current state of the analyzer until the conditions of a service request are met. In this case, the bit or bits that satisfy the service request condition remain in the true state until the status byte is interrogated by the serial-poll command, SPOLL, or until the CLEAR 718 command is executed. These commands clear the status byte so that all the bits in the byte once again reflect the current status of the analyzer until another service request occurs. In this way, the process begins again.

THE REQUEST-FOR-SERVICE MASK

The service request mode is enabled and controlled by the request-service-condition command, RQS. It defines a mask which has a twofold purpose. It enables the service request mode and specifies which of the status byte bits may generate a service request. For example, to enable the service request mode, a decimal number representing bit 6 is sent by using RQS.

Example: Enable service request mode.

```
OUTPUT 718;"RQS 64;"          !Selects bit 6 (64) to enable the service request mode.
```

The RQS command specifies the analyzer states that produce a service request by selecting their corresponding status bits. Below, RQS specifies the ERROR-PRESENT and COMMAND-COMPLETE states (bits 5 and 4).

Example: Enable service requests for ERROR-PRESENT and COMMAND-COMPLETE conditions.

```
OUTPUT 718;"RQS 112;"         !Selects bits 6, 5, and 4 (64+32+16) to enable service
                              request mode and select service request conditions.
```

Once RQS is executed, a service request is generated whenever any of the selected service request conditions occur.

Table 3-7. Spectrum Analyzer Status Byte

BIT NUMBER	DECIMAL EQUIVALENT	ANALYZER STATE	DESCRIPTION
7	128		Unused
6	64	RQS	Set when any selected service condition is met.
5	32	ERROR-PRESENT	Set when error register contains an error.
4	16	COMMAND-COMPLETE	Set at completion of command execution.
3	8		Unused
2	4	END-OF-SWEEP	Set at completion of sweep.
1	2	MESSAGE	Set when MESSAGE, UNCOR (uncorrected), or UNCAL (uncalibrated) messages appear.
0	1		Unused

SERVICE REQUEST EXAMPLES

The program below uses service requests to monitor measurement errors in the analyzer. If an error occurs, computer operation is interrupted and a description of the error is printed.

Example: Enable ERROR-PRESENT service request.

```
10  ASSIGN @Sa TO 718                       !Initialize analyzer.
15  COM\INSTR\@Sa
20  CLEAR @Sa
30  OUTPUT @Sa;"IP;SNGLS;TS;"
40  ON INTR 7 CALL Error                    !Define computer interrupt branching.
50  ENABLE INTR 7;2                         !Enable computer interrupts.
60  OUTPUT @Sa;"RQS 96;"                    !Enable ERROR-PRESENT service request.
70  !
90     Idle:GOTO Idle                       !Monitor service request line
100 !                                        while measuring. (This is where your
110    END                                  measurement routine would be.)
120 !
130      SUB Error                          !Interrupt-handling subprogram.
140      COM\INST\@Sa
150      DIM Mod_num$[6],Err_text$[30]
160      OUTPUT @Sa;"XERR?;"                !Return error description.

170      ENTER @Sa USING "5(K)";Error_num,Mod_num$,Row_num,Col_num,Err_text$
180      PRINT Error_num;Mod_num$;Row_num;Col_num;Err_text$
190      SUBEND
```

The next program uses service requests to allow the computer to process data or control other instruments while the spectrum analyzer is taking a long sweep. When the sweep is completed, the analyzer generates a service request which interrupts the computer, instructing it to accept the measurement data from the analyzer.

Example: Enable END-OF-SWEEP interrupt.

```
10  OPTION BASE 1                           !Define first element of array as "1."
20  ASSIGN @Sa TO 718                       !Initialize analyzer
30  COM\INSTR\@Sa
40  COM Trace_a(800)
45  CLEAR @Sa
50  OUTPUT @Sa;"IP;SNGLS;TS;"
60  ON INTR 7 CALL Trace_out                !Define computer-interrupt branching.
70  ENABLE INTR 7;2                         !Enable interrupts.
80  OUTPUT @Sa;"RQS 68;"                    !Enable END-OF-SWEEP service request.
90  OUTPUT @Sa;"ST 100SC;"                  !Set sweep time to 100 seconds.
100 OUTPUT @Sa;"TS;"                        !Sweep analyzer.
110 !
130      Idle:  GOTO Idle                   !Monitor service request line while
140 !                                         controlling other devices via HP-IB.
150 END
160 !
170 SUB Trace_out                           !Trace-output subprogram
180 OPTION BASE 1
190 COM\INST\@Sa
```

```
200 COM Trace_a(800)
210 OUTPUT @Sa;"TRA?"                    !Return trace data.
220 ENTER @Sa;Trace_a(*)
230 SUBEND
```

The program below allows for two types of service requests. One of them requests service when the analyzer has completed a sweep. The other requests service when an error occurs in the analyzer. When either request is generated, the computer examines the status byte using the SPOLL command to determine what caused the service request.

Example: Enable multiple service requests. Use SPOLL to examine status byte.

```
10  OPTION BASE 1
20  ASSIGN @Sa TO 718                    !Initialize analyzer.
30  COM\INSTR\@Sa
40  COM Trace_a(800)
40  CLEAR @Sa
50  OUTPUT @Sa;"IP;SNGLS;TS;"
60  ON INTR 7 CALL Interrupt             !Define interrupt branching.
70  ENABLE INTR 7;2                      !Enable interrupts.
80  OUTPUT @Sa;"RQS 100;"                !Enable END-OF-SWEEP and
                                          ERROR-PRESENT service request.
90  OUTPUT @Sa;ST 10SC;"                 !Set sweep time to 10 seconds.
100 OUTPUT @Sa;"TS;"                     !Take sweep.
120 !
130 Idle:  GOTO Idle                     !Monitor service request line while
140 !                                     processing data or controlling other
150 END                                   devices.
160 !
180   SUB Interrupt                      !Interrupt handling subprogram.
190   S=SPOLL(718)                       !Poll the spectrum analyzer status byte.
200   IF S=68 THEN CALL Trace_out        !If END-OF-SWEEP service request has
                                          occurred, return trace data.
210   IF S=96 THEN CALL Error            !If ERROR-PRESENT service request has
                                          occurred, return error description.
220   SUBEND
230 !
240      SUB Trace_out                   !Trace output subprogram.
250      OPTION BASE 1
260      COM\INSTR\@Sa
270      COM Trace_a(800)
280      OUTPUT @Sa;"TRA?;"
290      ENTER @Sa;Trace_a(*)
300      SUBEND
310 !
320         SUB Error                    !Error handling subprogram.
330         DIM Mod_num$[6],Err_text$[30]
340         ASSIGN @Sa TO 718
350         OUTPUT @SA;"XERR?;"

360         ENTER @Sa USING "S(K)";Error_num,Mod_num$,Row_num,Col_num, Err_text$
370         PRINT Error_num;Mod_num$;Row_num;Col_num;Err_text$
380         SUBEND
```

SECTION VI. ANALYZER CONTROL OF HP-IB

This section tells how to use the analyzer as a controller on HP-IB. As a controller, the spectrum analyzer can transfer data to, or accept data from, other HP-IB devices. This capability has many applications. For example, the analyzer can control an HP-IB switch driver in order to select the correct antenna for an EMI measurement, or the analyzer can execute a system calibration routine that controls a power meter and signal source.

OUTPUT AND ENTER COMMANDS

Use the OUTPUT command to send data to an HP-IB device. The HP-IB device is specified by its HP-IB address. Below, the spectrum analyzer sends the message "FA 1 MHZ" to a device at HP-IB address 19 (on interface 7).

Example: Analyzer sends data to HP-IB device.

```
10  OUTPUT @Sa;"OUTPUT 19,KL,$FA 1 MHZ;$;"                !Set start frequency.
```

All data is sent as free-field ASCII numbers in three different output formats, called K, KC, and KL. The K format sends data without a terminator. The KC format terminates the data with a carriage-return and line-feed. The KL format terminates data with a line-feed and END. Use the format that is compatible with the HP-IB device receiving the data.

Use the ENTER command to receive data from an HP-IB device. Below, ENTER receives a value sent by the device at HP-IB address 19 and stores the value in a user-defined variable in the analyzer.

Example: Analyzer requests data from HP-IB device.

```
10  OUTPUT @Sa;"OUTPUT 19,KL,$CF?;$;"      !Request center frequency value.
20  OUTPUT @Sa;"ENTER 19,K,NN;"            !Receive center frequency value.
```

Three input formats for data are available: K for free-field ASCII numbers, B for bytes (8 bits), and W for words (two 8-bit bytes). Be sure to use an input format that is compatible with the output format of the HP-IB device.

In the program below, the spectrum analyzer sets the start frequency of a sweeper equal to the analyzer start frequency. The message must be sent with several output statements, since one part of the message is a string of characters and another part is a spectrum analyzer variable. Notice that a character string must be delimited.

```
10  OUTPUT @Sa;"OUTPUT 19,K,$FA$;"       !Sends letters "FA" to the sweeper.
20  OUTPUT @Sa;"OUTPUT 19,K,FA;"         !Sends current value of analyzer start frequency.
30  OUTPUT @Sa;"OUTPUT 19,KL,$HZ;$;"     !Sends letters "HZ" to the sweeper.
```

COMPUTER CONTROL VERSUS ANALYZER CONTROL OF HP-IB

The analyzer can control HP-IB only if the computer is not in control of the bus. For this reason, ENTER and OUTPUT commands are incorporated into user-defined functions that are executed by the spectrum analyzer with user-defined softkeys. (See FUNCDEF and KEYDEF commands in Section III of this chapter.)

Before the ENTER and OUTPUT functions are executed, the computer must be disconnected from HP-IB. This is accomplished by either physically disconnecting the computer from the bus, or by executing the HP-IB system level commands that release the computer from HP-IB. The HP BASIC command sequence that does this is shown below.

Example: Release computer from HP-IB.

```
10 LOCAL 7
20 ABORT 7
```

The release HP-IB command (RELHPIB) must be included at the end of any user-defined functions containing ENTER or OUTPUT commands. This ensures that the analyzer surrenders control of HP-IB after all ENTER and OUTPUT commands have been executed.

APPENDIX A

COMMAND SUMMARY

AMPLITUDE COMMANDS

AT	Input attenuator
AUNITS	Absolute amplitude Units
INZ	Input impedance
LG	Logarithm scale
LN	Linear scale
ML	Mixer level
RL	Reference level
RLPOS	Reference level position
ROFFSET	Amplitude reference offset

BANDWIDTH COMMANDS

RB	Resolution bandwidth
RBR	Resolution-bandwidth/span ratio
VB	Video bandwidth
VBR	Video bandwidth ratio

CALIBRATION AND DIAGNOSTIC COMMANDS

AMPCOR	Amplitude correction
CAL	Calibrate
CALCOR	Calibration correction
CALFREQ	Calibration frequency
CALPWR	Calibration power
CALSRC	Calibration source
DEBUG	Debug mode
PAUSE	Command execution pause

CONFIGURATION COMMANDS

COUPLE	Input coupling
INPUT	Select input
MODID	Module identification
PATHLOCK	Path lock

DISPLAY COMMANDS

ANNOT	Annotation on/off
CONFIG	Configuration query
DL	Display line
DSPMODE	Display mode
GRAT	Graticule on/off
HD	Hold data entry
IWINDOW	Instrument window
TH	Threshold

EXTERNAL MIXER COMMANDS

CNVLOSS	Conversion loss
FULBAND	Full band
HNLOCK	Harmonic number lock
MBIAS	Mixer bias
MBIASPK	Mixer bias peak
MBMAX	Mixer bias, maximum level
MBMIN	Mixer bias, minimum level
MBRES	Mixer bias resolution

FREQUENCY COMMANDS

CF	
FA	Center frequency
FB	Start frequency
FOFFSET	Stop frequency
FS	Frequency offset
LOSTART	Full span
LOSTOP	Local oscillator start frequency
SP	Local oscillator stop frequency
SS	Frequency span
	Center frequency step size

GRAPHICS COMMANDS

CLRDSP	Clear display
DELETE	Delete item
DSPLY	Display variable
DWINDOW	Dispolay window
GRAPH	Graph trace
GRID	Display grid
IT	Identify item
LINET	Line type
MK	Marker display
OP	Output display parameters
OR	Set origin
PA	Plot to abasolute coordinates
PD	Pen down
PEN	Select pen
PR	Plot to relative coordinates
PU	Pen up
SCALE	Scale graphics
TEXT	Text
TITLE	Title entry
TP	Trace pointer
VW	View item

INFORMATION COMMANDS

ERR	Error
ID	Identification (model number) query
MSG	Message query
REV	Revision number query
SER	Serial number
TEST	Self test
USERERR	User error report
XERR	Extended error query

INPUT/OUTPUT COMMANDS

DONE	Done. Previous commands completed.
ENTER	Enter from HP-IB
MDS	Measurement data size
OUTPUT	Output via HP-IB
RELHPIB	Release HP-IB
RQS	Request service conditions
SRQ	Service request
STB	Status byte query
TDF	Trace data format
TS	Take sweep

INSTRUMENT STATE COMMANDS

ERASE	Erase all memory
IP	Instrument preset
NSTATE	Number of state registers
POWERON	Power on
PSTATE	Protect state
RCLS	Recall state register
SAVES	Save state
STATE	Instrument state

MARKER COMMANDS

MKA	Marker amplitude
MKACT	Active marker
MKAL	Marker amplitude relative left
MKAR	Marker amplitude relative right
MKCF	Marker to center frequency
MKD	Marker delta
MKF	Marker frequency
MKMIN	Marker to minimum level
MKN	Marker normal
MKNOISE	Marker noise level
MKOFF	Marker off
MKP	Marker position
MKPAUSE	Pause at marker
MKPK	Marker peak search
MKPX	Marker peak excursion
MKREAD	Marker readout
MKRL	Marker to reference level
MKSP	Marker delta to span
MKSS	Marker to center frequency step size
MKT	Marker time
MKTRACE	Marker trace
MKTRACK	Marker signal track
MKTV	Marker tracking variance
MKTYPE	Marker type

SIGNAL IDENTIFICATION COMMANDS

IDCF	Signal identified frequency to center frequency
IDFREQ	Signal identified frequency
IDMODE	Signal identification mode
IDSTAT	Signal identification status
NSTART	Start harmonic number
NSTOP	Stop harmonic number
SIGDEL	Signal amplitude delta
SIGID	Signal identify

SWEEP AND TRIGGER COMMANDS

CONTS	Continuous sweep
SNGLS	Single sweep
ST	Sweep time
TM	Trigger mode
VTH	Video trigger hysteresis
VTL	Video trigger level

TRACE COMMANDS

COMPRESS	Compress trace
DET	Detection mode
FFT	Fast fourier transform
FFTKNL	Fast fourier transform kernal
MEAN	Trace mean
PDA	Probability distribution of amplitude
PDF	Probability distribution of frequency
PEAKS	Trace peaks
PWRBW	Trace power bandwidth
RMS	Trace root mean square value
SMOOTH	Smooth trace
STDEV	Standard deviation of trace amplitudes
SUM	Sum of trace amplitudes
SUMSQR	Sum of square of trace amplitudes
TRA/TRB/TRC	Trace data input/output
TRCOND	Trace conditions
TRDEF	Trace definition
TRPST	Trace preset
TRSTAT	Trace status
TWNDOW	Trace window
VARIANCE	Variance of trace amplitudes

TRACE MATH COMMANDS

AMB	Trace A minus trace B
AMBPL	Trace A minus trace B plus display line
APB	Trace A plus trace B
AXB	Trace A exchange trace B
BML	Trace B minus display line
BXC	Trace B exchange trace C
VAVG	Video average

TRACE PROCESSING COMMANDS

BLANK	Blank trace
CLRW	clear write
MINH	Minimum hold
MXMH	Maximum hold
TRDSP	Trace display on/off
VIEW	View trace

UNIT CONVERSION COMMANDS

AMPU	Amplitude unit conversion
FREQU	Frequency unit conversion
MEASU	Measurement unit conversion
POSU	Position unit conversion

USER COMMAND-FLOW COMMANDS

ABORT	Abort user functions
IF/THEN/ELSIF/ELSE/ ENDIF	Conditionals
REPEAT/UNTIL	looping
RETURN	Return from function
WAIT	Wait specified time

USER DEFINITION COMMANDS

CATALOG	Catalog query
DISPOSE	Dispose
FUNCDEF	Function definition
KEYCLR	Clear user-defined keys
KEYDEF	Define user-defined key
KEYPST	Preset user-defined keys
MEM	Available memory query
ONEOS	Execute functions on end of sweep
READMENU	Read menu input
USERKEY	User-defined keys input/output
USTATE	User state input/output
VARDEF	Define variable

USER OPERATOR COMMANDS

ABS	Absolute
ADD	Add
AVG	Average
BIT	Bit test
CONCAT	Concatenate
DIV	Divide
EXP	Exponent
INT	Integer
LOG	Logarithm
MIN	Minimum
MOD	Modulo
MOV	Move
MPY	Multiply
MXM	Maximum
SQR	Square root
SUB	Subtract
XCH	Exchange

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INDEX

PART III

Display Operation

CHAPTER 1

GETTING STARTED

Description: This chapter highlights key features of the HP 70205A Graphics Display and the HP 70206A System Graphics Display and tells the user where to find instructions for such system-level operations as obtaining hardcopy output, configuring the display screen, examining the Hewlett-Packard Modular System Interface Bus (HP-MSIB) and the Hewlett-Packard Interface Bus (HP-IB) addresses, receiving error messages, and more.

CHAPTER 2

DSP HARDKEY (MANUAL DISPLAY OPERATION)

DESCRIPTION: This chapter describes in detail the manual operation of the displays. All manually-available functions are accessed by pressing the [DSP] hardkey ([DISPLAY] hardkey on the HP 70206A). All softkeys are described and examples are included with sample outputs. In addition, a brief discussion is included on the addressing of modules on the Hewlett-Packard Interface Bus (HP-IB) and the Hewlett-Packard Modular System Interface Bus (HP-MSIB).

CHAPTER 3

REMOTE DISPLAY OPERATION

DESCRIPTION: This chapter discusses the remote operation of the HP 70205A Graphics Display and the HP 70206A System Graphics Display by remote control over HP-IB.

DISPLAY COMMAND SUMMARY

INDEX

CHAPTER 1

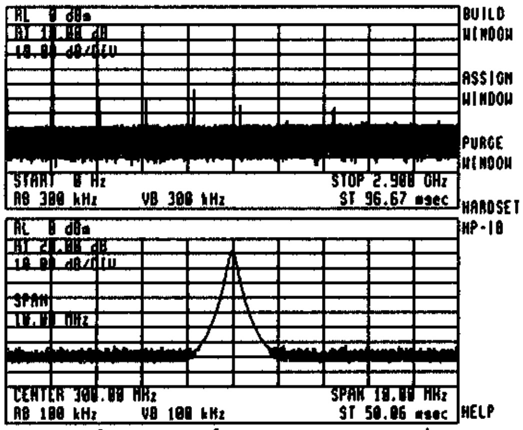
GETTING STARTED

Description: This chapter highlights key features of the HP70205A Graphics Display and the HP70206A System Graphics Display and tells the user where to find instructions for such system-level operations as obtaining hardcopy output, configuring the Display screen, examining HP-MSIB and HP-IB addresses, receiving error messages, and more.

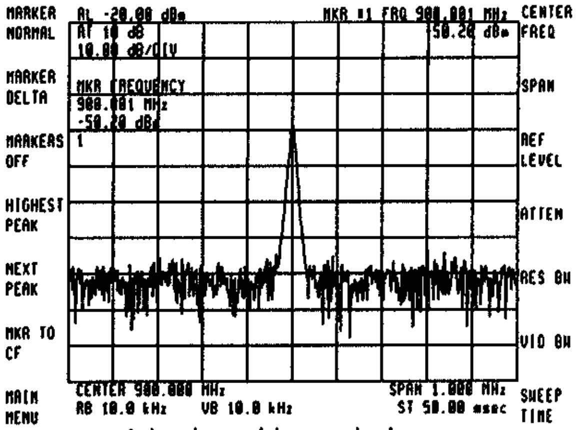
Introduction

This chapter, Getting Started, is the first chapter of Part III, Display Operation, of the Operating Manual for the HP 70000 Modular Measurement System. Part III does not cover the operation of any particular measuring instrument in the HP 70000 System (e.g., a spectrum analyzer): instead, it covers the operation and capabilities of the Display elements--the HP 70205A Graphics Display and the HP 70206A System Graphics Display--which are common components of the HP 70000 Series.

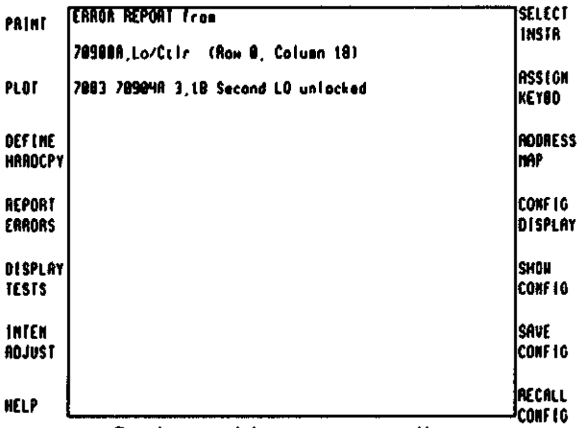
An HP 70000 series measuring instrument consists of a set of modules (for example, a spectrum analyzer composed of a Local Oscillator, an IF Section, and a RF section). However, such an instrument has neither a keyboard nor a screen: the measuring instrument itself is separate from the display. An HP 70000 series Display is an **essential** part of a **manually-operated** system and a powerful addition to a remotely operated system. A Display provides such capabilities as:



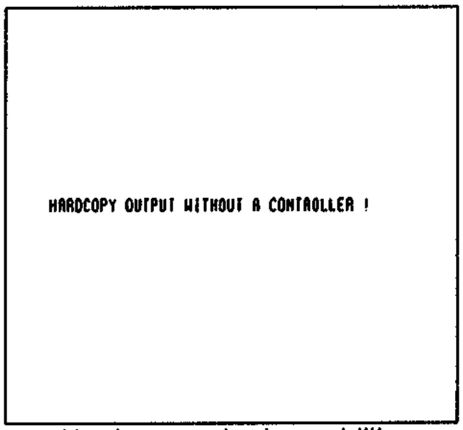
A screen for one or several instruments to write on.



A keyboard to control one instrument at a time.



System-wide error reporting.



Hardcopy output capability without an external controller.

For a more complete description of the Display features, see the Display Capabilities section of this chapter.

The chapters in Part III are organized in the following manner:

Chapter 1: Getting Started

Briefly discusses capabilities and features of the two Display elements.

Chapter 2: DSP Hardkey (Manual Operation)

Discusses the manual operation of the Displays by describing the use of the softkeys under the [DSP] hardkey ([DISPLAY] on the HP 70206A). Includes step-by-step examples and a softkey menu tree diagram, Figure 2-2.

Chapter 3: Remote Display Operation

Discusses the operation of the Display using a remote controller on the Hewlett-Packard Interface Bus (HP-IB). Covers both instrument-related Display operations (windowing, labeling, output, etc.) and use of the HP 70205A and HP 70206A as stand-alone Graphics Displays.

Chapter 4: Appendices

Contains the Display Command Summary

Chapter 5: Index

Tabs:

Part III is marked by a large blue tab labeled "Display Operation." Each chapter is marked by a white tab labeled with the individual chapter title (e.g., Getting Started).

Page Headings:

Each page has a heading that shows the chapter title and the section within the chapter. For example, this page is in the "Introduction" section of the "Getting Started" chapter.

Table of Contents and Index:

The Table of Contents shows all chapter and section titles (from page headings) and also the division of each section into subsections. This Table of Contents appears immediately following the blue Part III "Display Operation" Tab. The index contains entries for all chapter sections and subsection titles, as well as other key words. The index for Part III, Display Operation, appears as Chapter 5.

Front Panel Concept

The Graphics Displays serve as the "Front Panel" for the instruments in the HP 70000 Modular Measurement System. For simplicity of operation (since a single system can include several spectrum analyzers), the user interface for each system is a general-purpose, high-quality, digital display screen and keyboard. If desired, multiple displays may be used in the same system.

The compact HP 70205A Graphics Display and the larger HP 70206A System Graphics Display each have one screen with 14 unlabeled "softkeys" next to it (see Figure 1-3). These keys are labeled on the screen by whichever instrument controls the keyboard. Softkeys are used for all manual instrument control functions.

Notation:
Throughout this operating manual, softkey labels are denoted as ◀XXXX▶. Fixed-label keys are referred to as "hardkeys" and are denoted as [XXXX]. Hardkey labels on the HP 70205A differ slightly from hardkey labels on the larger HP 70206A. For example, on the HP 70206A the Display hardkey is denoted by [DISPLAY] while on the HP 70205A the same hardkey is abbreviated to [DSP]. The key functions are identical, but the abbreviated hardkey labels are used throughout this operating manual.

Hardkeys:
For data entry, each display has a single knob and 15 labeled keys (0 - 9, decimal point, minus sign, back-space, step-up, and step-down). In most cases, data can be entered with either the numeric keypad (0 - 9), the display knob, or the stepkeys.

[I/P] (Instrument Preset)--When an instrument controls the keyboard, pressing [I/P] will cause the spectrum analyzer to preset many of its own operating parameters. This does **not** affect operation of the display.

[USR] (User)--This key brings up from the spectrum analyzer the 14 softkeys most commonly needed by the user for instrument control. These keys are also available under the [MNU] (Menu) hardkey, although more than one keystroke is required to reach them. For more information on the [USR] hardkey, including instructions for modifying the [USR] keys, see the chapter entitled "USR Hardkey" in Part I.

[MNU] (Menu)--This key brings up a more general menu of softkeys for instrument control. This provide access to all softkeys shown on the Spectrum Analyzer Menu Tree Diagram (found in Chapter 4, "MNU Hardkey," in Part I). This key accesses more functions, but is less convenient, than [USR] for most operations. For more information, see Chapter 4 in Part I.

[DSP] (Display)--This key calls up a set of softkeys used to control the operations of the display itself. For a discussion of the functions of the display, see the "Display Capabilities" section later in this chapter. For instructions on using the individual softkeys under [DSP], see Chapter 2, "DSP Hardkey (Manual Operation of the Display)," in this part of the manual (Part III).

A section in this chapter entitled "Softkey Concept" gives some examples of how to use the different softkey levels found under the [DSP] (Display) hardkey.

HP 70205A Graphics Display

The Graphics Display is a 3/8-width module which provides the human interface and manual control capability of the HP 70000 Modular Measurement System. It displays instrument status and measurement output and has graphics, trace, text, and marker capability. Controls include 14 user-definable menu keys (referred to as softkeys in the text), 10 data keys (numbered 0 - 9), 10 control keys (3 of which are referred to as Hardkeys in the text), and an analog control knob. Instrument control is accomplished using softkeys to establish an interactive front panel for an accessed instrument.

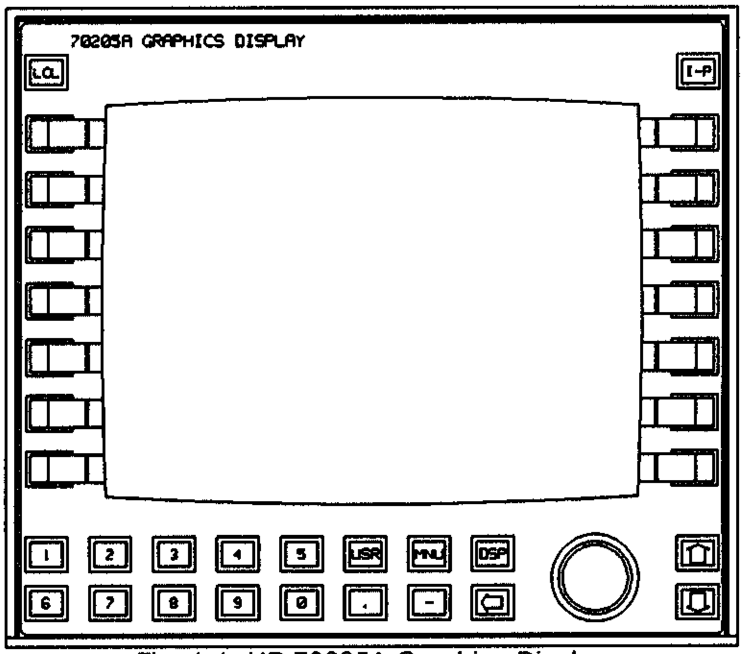


Fig. 1-1. HP 70205A Graphics Display

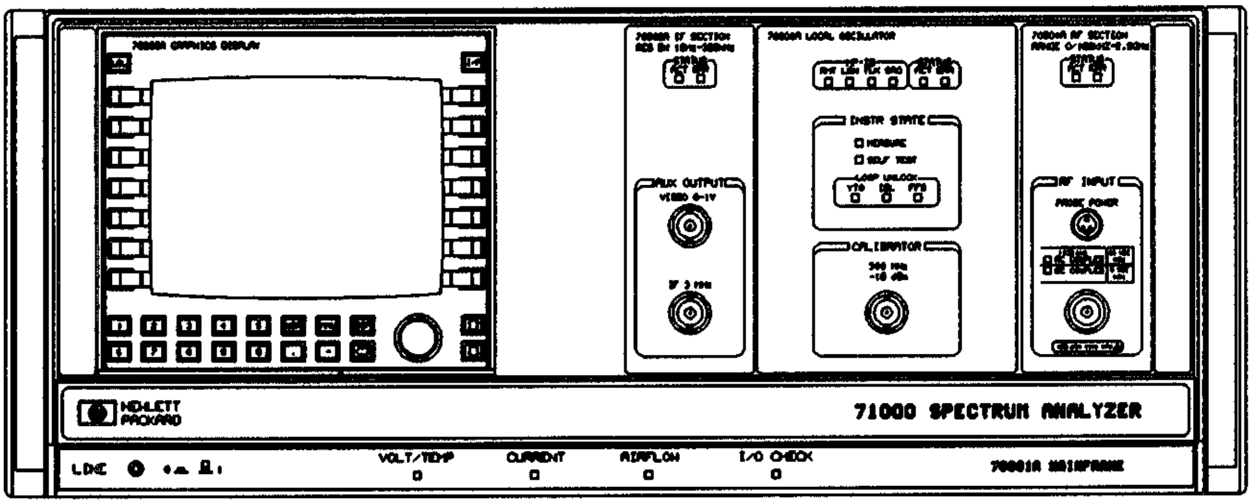


Fig. 1-2. HP71100A Measurement System Including HP70205A Graphics Display

There are 14 softkeys, 7 on each side of the CRT display (HP 70205A). Three hardkeys ([USR], [MNU], and [DSP]), located underneath the CRT, each provide access to a different set of softkeys. Pressing any one of these hardkeys brings up a menu of softkeys on the screen; some of these softkeys provide further access to other menus. (See the Menu Tree Diagrams in Part I, Chapters 3 and 4, and Part III, Chapter 2).

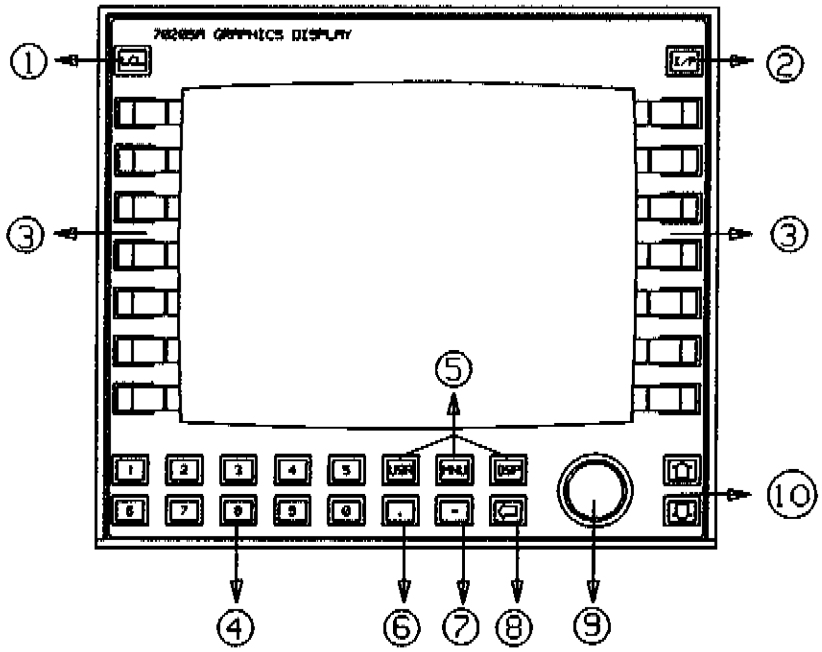


Fig.1-3 HP 70205A GRAPHICS DISPLAY

1. Local Control - This key returns the instrument from remote to local control.
2. Instrument Preset - This key activates all the preset conditions of the instrument presently controlled by the keyboard.
3. Softkeys - These keys are used for most instrument and system control operations (see the "Softkey Concept" section of this Chapter).
4. Numeric Keypad - (0 - 9) This enters numeric values.
5. USR, MNU, DSP Hardkeys - These access three different top-level softkey menus.
6. Decimal Point. - This key enters a decimal point with the keypad.
7. Minus Sign - This key enters negative numbers.
8. Back Space (back arrow) - This key is used to move from a low level of softkeys to a higher level. It also moves the cursor to the beginning of the line.
9. Display Knob - This knob is used to change parameter values and to select alpha characters.
10. Step Keys - These two keys are used to change parameter values up or down.

HP 70206A System Graphics Display

The System Graphics Display is a stand-alone, large-screen display for the HP 70000 Modular Measurement System. It has a 9-inch raster CRT in a 7 inch, full-rack, System II frame and is stack-compatible with the HP 70001A Mainframe and other System II instruments. It supplies the same display and manual control capability as the HP 70205A Graphics Display. The primary advantages of the HP 70206A are its large display size and the fact that when it is used in place of the HP 70205A, 3/8 of the mainframe capacity is released for use by other modules.

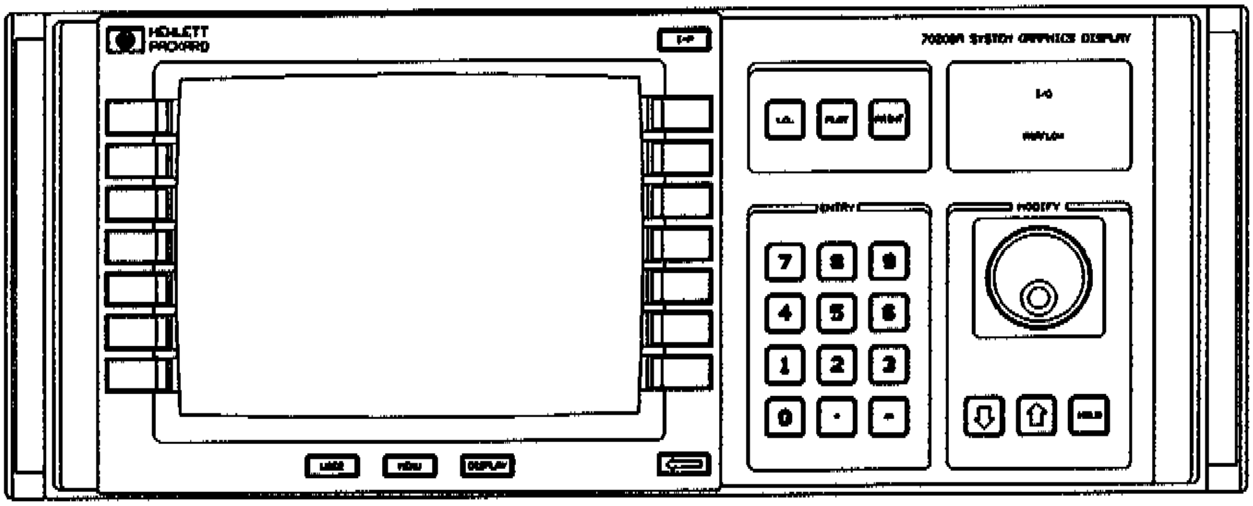


Fig. 1-4 . HP 70206A System Graphics Display

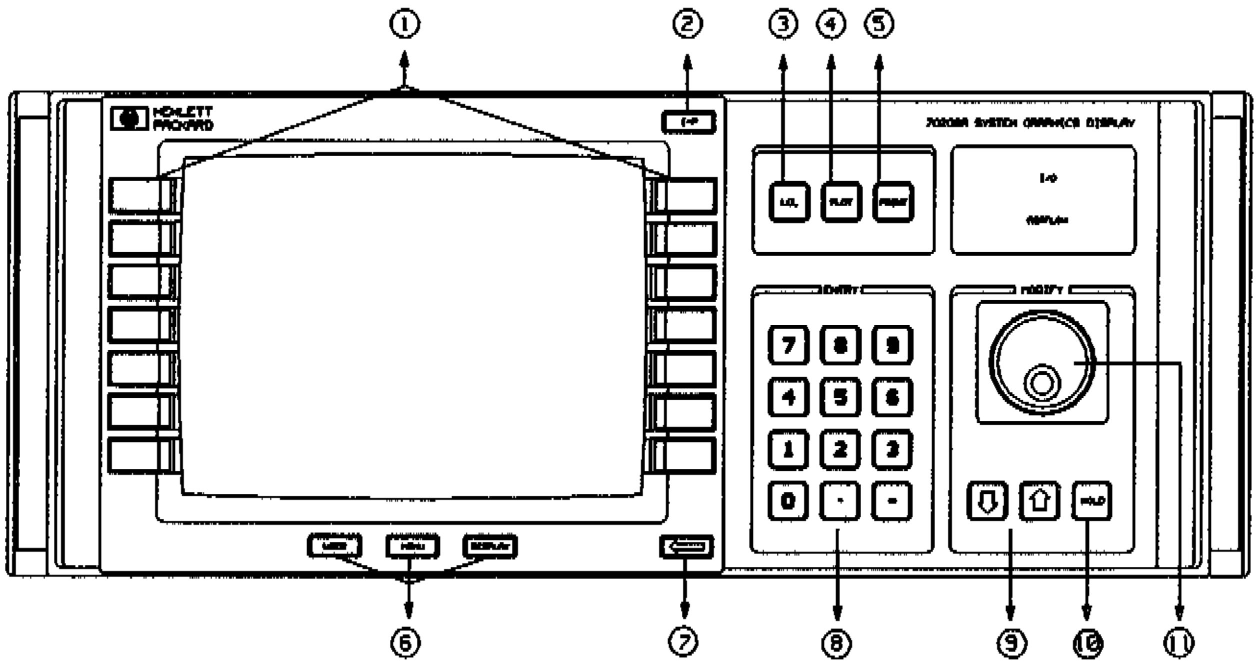


Fig. 1-5 HP70206A SYSTEM GRAPHICS DISPLAY

1. Softkeys - These keys are used for most instrument and system control operations (see the "Softkey Concept" section later in this chapter.)

2. Instrument Preset - This key activates all the preset conditions of the instrument presently controlled by the keyboard.

3. Local Control - This key returns the instrument from remote control to local control.

4. Plot - This key starts a vector plot output of the present display screen over HP-IB.

5. Print - This key starts a raster print output of the present display screen over HP-IB.

6. Hardkeys - These three keys (USER, MENU, DISPLAY) call the top level softkey menus to the screen. Throughout this manual these hardkeys are abbreviated to USR, MNU, and DSP.

7. Back Space (back arrow) - This key is used to move from a low level of softkeys to the next higher level. It is also used in text entry to move the cursor.

8. Numeric Keypad - This keypad enters numeric values.

9. Step Keys - These two keys are used to change parameter values up or down.

10. Hold - This key deactivates the function displayed in the active function area; the readout is blanked from the screen.

11. Display Knob - This knob is used to change parameter values and to select alpha characters.

Softkey Concept

All the major functions of the spectrum analyzer and the display are accessed using softkeys. These softkeys, in turn, are accessed by three hardkeys: [USR], [MNU] and [DSP]. The [USR] and [MNU] hardkeys control functions of individual instruments in the sytem. For instructions on how to use the softkeys under [USR] and [MNU], see the "USR Hardkey" and "MNU Hardkey" chapters in Part I, "Manual Operation." The [DSP] hardkey accesses the display only and is dealt with in this portion of the operating manual, Part III "Display Operation."

The hardkey [DSP] is a top level key that brings up the entire Display Menu. Softkeys in the Display Menu allow the user to:

* Format and obtain hardcopy output.
  ◀PRINT▶
  ◀PLOT▶
  ◀DEFINE HARDCPY▶

* Configure the display screen into individually assignable windows.
  ◀CONFIG DISPLAY▶
  ◀SHOW CONFIG▶
  ◀SAVE CONFIG▶
  ◀RECALL CONFIG▶

* Quickly access any of several instruments in the HP 70000 Measurement System.
  ◀SELECT INSTR▶
  ◀ASSIGN KEYBD▶

* Obtain system-wide error reports.
  ◀REPORT ERRORS▶

* Implement several self-tests that relate specifically to the display.
  ◀DISPLAY TESTS▶

* Examine or modify addresses on the HP-MSIB, the local bus for modular instruments.
  ◀ADDRESS MAP▶

* Alter the brightness of the display screen.
  ◀INTENS ADJUST▶

* Review some brief key descriptions.
  ◀HELP▶

The softkeys listed above are described in detail in Chapter 2, DSP Hardkey (Manual Operation). In addition, Chapter 2 contains practical examples of softkey usage.

Top Level Softkeys

Figure 1-6 shows the softkeys that appear when the [DSP] hardkey is pressed. These are refered to as "Top Level" softkeys. Press the [DSP] hardkey and examine the softkeys.

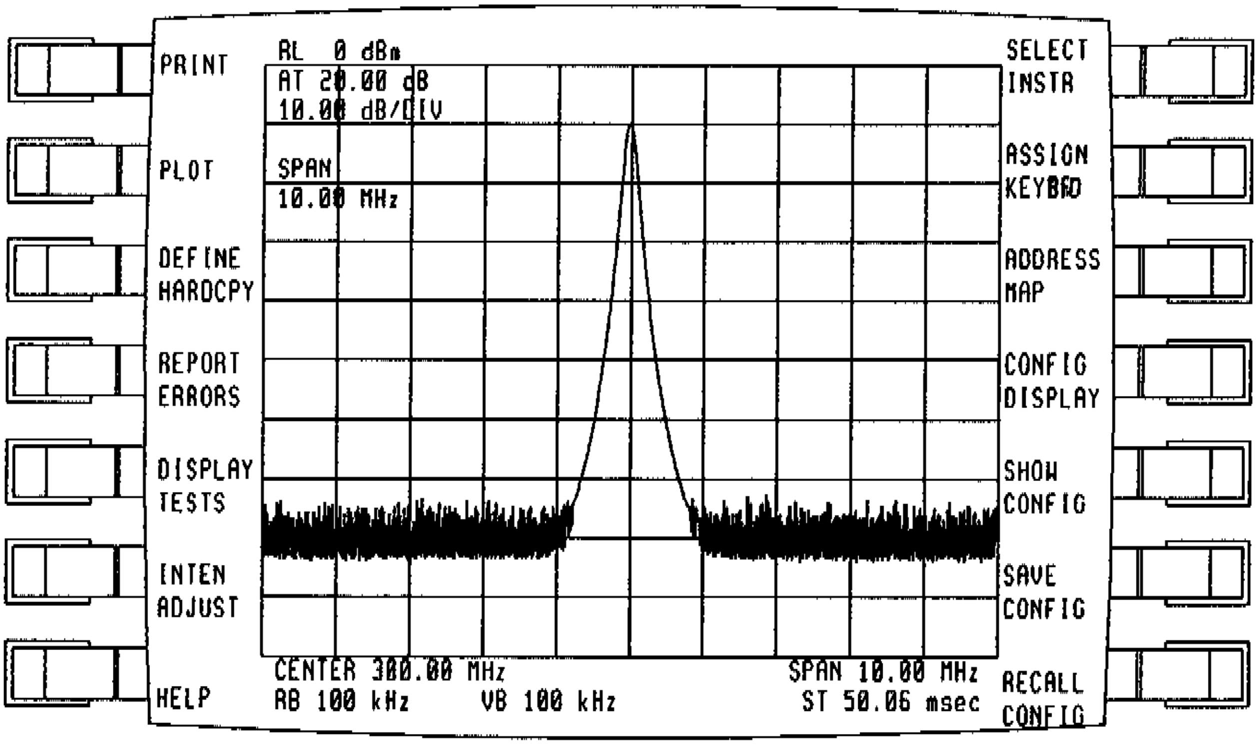


Fig. 1-6.

Figure 2-2 in Chapter 2 is a "Menu Tree Diagram" of the softkeys available under the [DSP] hardkey. This page is designed so that it can be unfolded and viewed when the manual is open to another page. The 14 boxes along the top represent the 14 top level softkeys shown in Figure 1-6.

Some softkeys bring up another set of softkeys. These lower-level keys are represented in the Menu Tree Diagrams by branches below the top level key. From a lower level, you can move "up" one level by pressing the backspace (back arrow) hardkey. The following example shows how to move between levels of softkeys.

Example:

Access the Tumble Figures.

Turn the instrument on. Press [DSP] and then ◀SELECT INSTR▶. Notice the top level softkeys; these are also shown in the foldout Menu Tree Diagram in Chapter 2. In the Menu Tree Diagram, top level softkeys are enclosed in boxes.

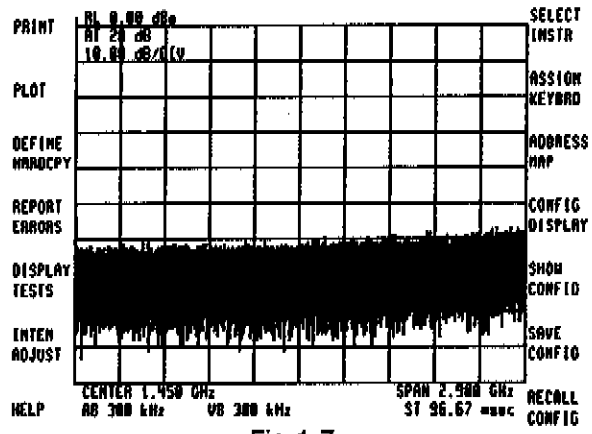


Fig.1-7.

Press ◀DISPLAY TESTS▶. Examine the Display Test Menu. Notice the ◀TUMBLE FIGURES▶ softkey on the screen and its location in the Menu Tree Diagram.

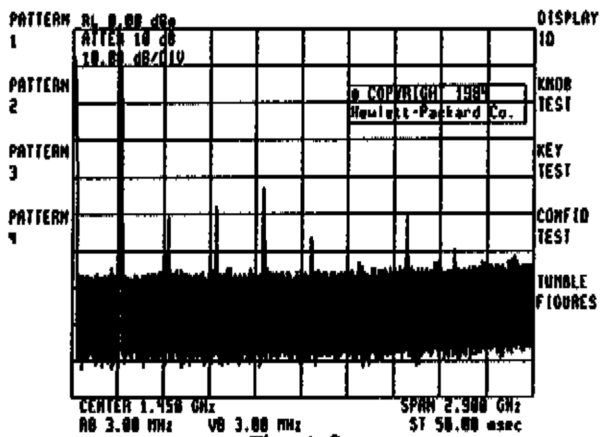


Fig. 1-8.

Press ◀TUMBLE FIGURES▶. Press the softkeys and observe the different figures.

To return to the Display Test Menu, press the backspace (back-arrow) key located to the left of the display knob. Press the backspace again to return to the Display top level menu.

Note: The softkeys used above are described in detail in Chapter 2, DSP Hardkey (Manual Operation of the Display).

Example:

Find the HP-IB (Hewlett-Packard Interface Bus) and HP-MSIB (Hewlett-Packard Modular System Interface Bus) addresses of the Local Oscillator Module.

Press [DSP], then ◀ADDRESS MAP▶. The address Map shown in Figure 1-9 should appear on the screen.

The address map is a real-time graphical representation of the elements on the local instrument bus, HP-MSIB (Hewlett-Packard Modular System Interface Bus). HP-MSIB is distinct from HP-IB (or IEEE-488).

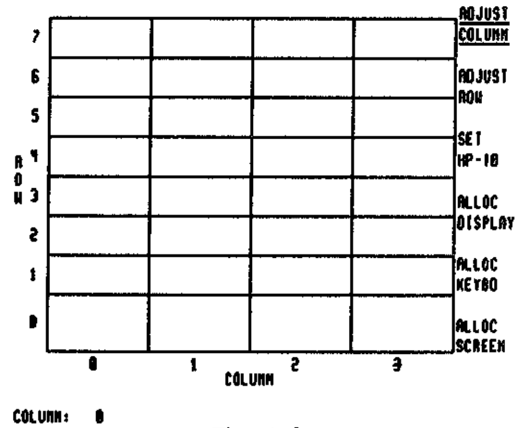


Fig. 1-9.

Turn the display knob clockwise. The column numbers along the bottom of the screen change as the knob is turned. Turn the knob until the display appears. This typically is in row 0, column 4, as in Figure 1-10.

Continue turning the display knob until the highlighted cursor box appears around the HP 70900A Local Oscillator. The local oscillator is usually shipped from the factory with an address of Row 0, Column 18, as in the following figure.

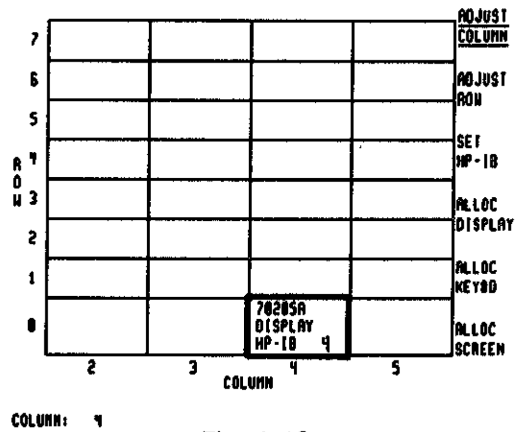


Fig. 1-10.

Note that the HP-MSIB address for each module is indicated by the row and column numbers in the Address Map and that the HP-IB address is shown in the box. (In this case the HP-MSIB address is 0,18 and the HP-IB address is 18.) An HP-IB address is given for master modules only (HP 70900A), but as the other modules are slaves to a master, the whole instrument (spectrum analyzer) may be addressed over HP-IB at the address of the master.

To return to the Display Menu, press the backspace key. To use the keyboard to control a spectrum analyzer, press ◀SELECT INSTR▶ and [USR].

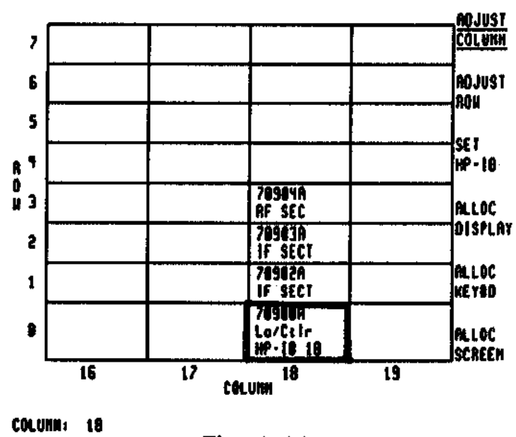


Fig. 1-11.

Display Capabilites

The following section is a brief overview of what the HP 70205A and HP 70206A Graphics Displays can do. The displays' capabilites are discussed in detail in the following chapter, DSP Hardkey (Manual Operation of Display).

The display serves as the central user interface for all instruments on HP-MSIB, the HP 70000 Series interface bus. It provides a screen on which the instruments write information and a keyboard used for manual instrument control.

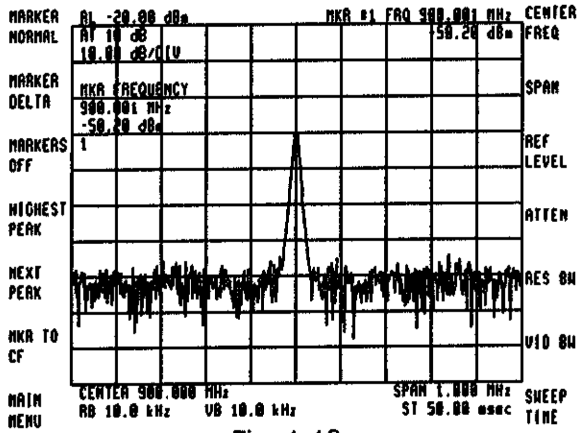


Fig. 1-12.

To manually operate a single analyzer, the display can be used as a conventional keyboard and screen.

To achieve the configuration in Figure 1-13, simply press the [DSP] (DISPLAY) hardkey, press the ◀SELECT INSTR▶ softkey, and then press the [USR] (USER) hardkey. A display similar to the one at right should appear. The softkeys shown can be used to control the instrument settings such as CENTER FREQ and SPAN. See the ◀SELECT INSTR▶ softkey description in Chapter 2 for more information.

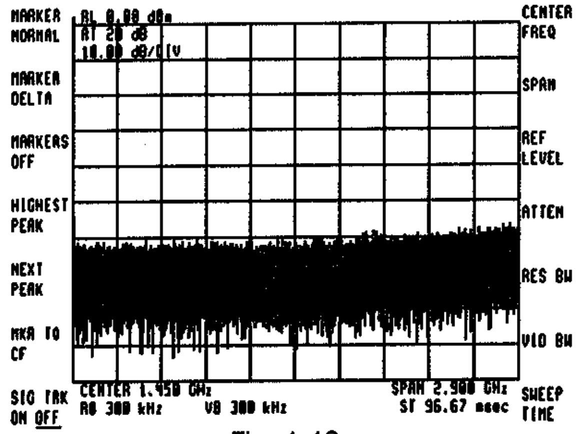


Fig. 1-13.

The display helps the user obtain hardcopy output without the need of an external controller. For more information, see the key descriptions in Chapter 2 for ◀PRINT▶, ◀PLOT▶, and ◀DEFINE HARDCPY▶.

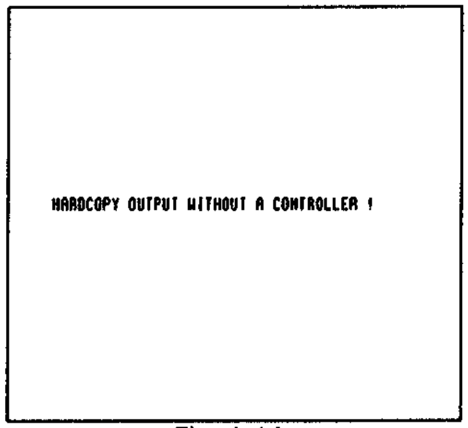


Fig. 1-14.

The display allows users to view output from multiple instruments simultaneously. See the ◀CONFIG DISPLAY▶ softkey description in Chapter 2 for further instructions.

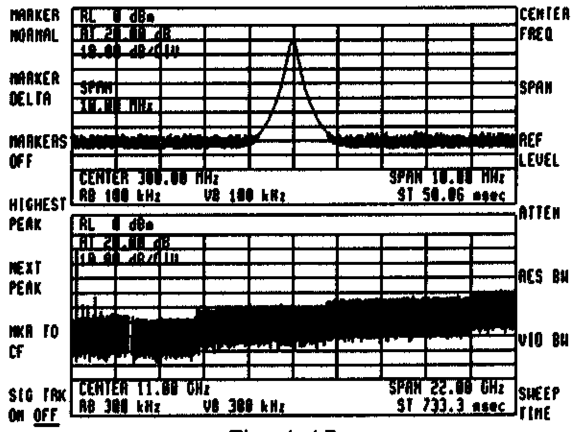


Fig. 1-15.

By means of the display, users can examine the addresses of modules on HP-IB and HP-MSIB (Hewlett-Packard Modular System Interface Bus) and can change the HP-IB addresses of certain modules. See the ◀ADDRESS MAP▶ softkey description in Chapter 2 for instructions and a description of the HP-MSIB addressing scheme.

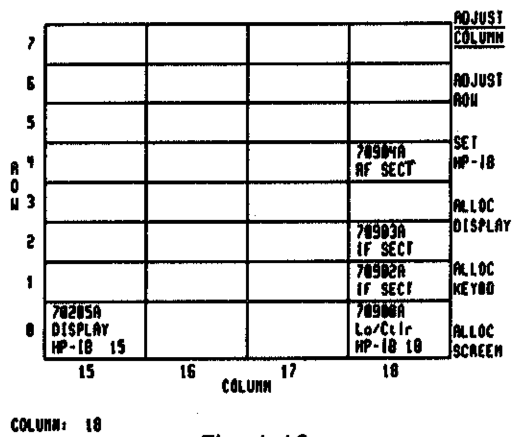


Fig. 1-16.

The display reports any errors detected on HP-MSIB to the user. See the ◀REPORT ERRORS▶ softkey description in Chapter 2 for more information.

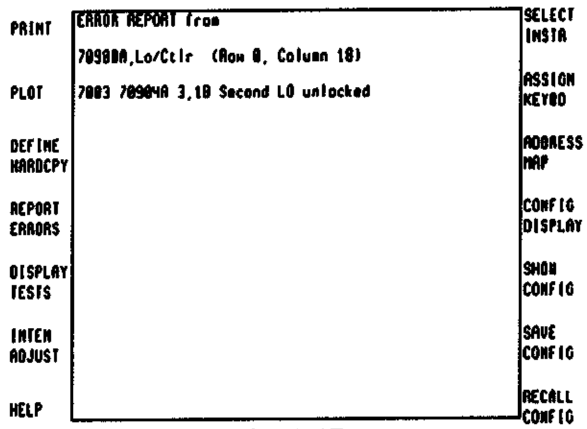


Fig. 1-17.

The display explains its own operation with information available under the various ◀HELP▶ softkeys.

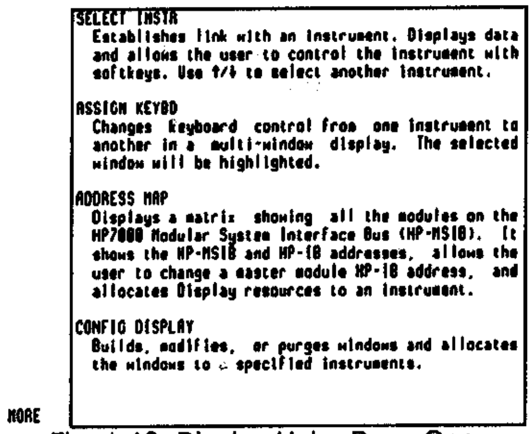


Fig. 1-18. Display Help: Page One.

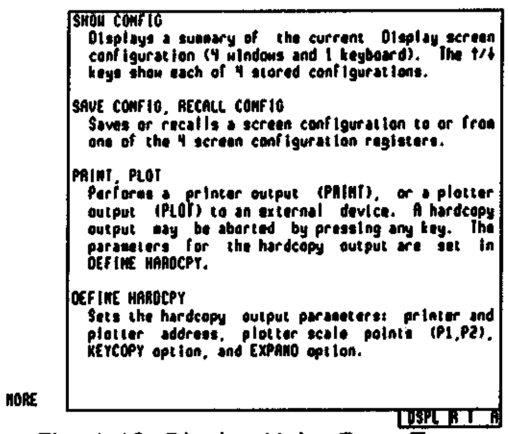


Fig. 1-19. Display Help: Page Two.

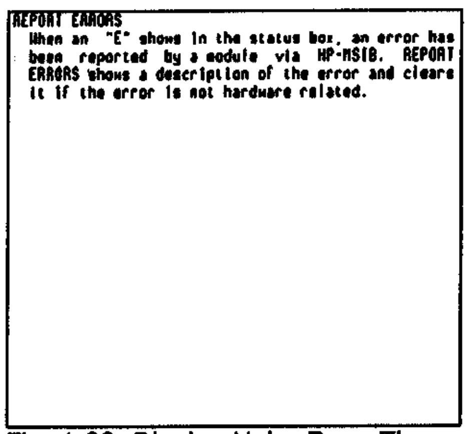


Fig. 1-20. Display Help: Page Three.

CHAPTER 2

DSP HARDKEY

DESCRIPTION: This chapter describes in detail the manual operation of the displays. All manually-available functions are accessed by pressing the [DSP] hardkey ([DISPLAY] on the HP 70206A). All softkeys are described and examples are included with sample outputs. In addition, a brief discussion is included on the addressing of modules on HP-IB and HP-MSIB.

Introduction

This chapter describes in detail the functions accessed by pressing the [DSP] hardkey.

The hardkey [DSP] is a top level key that allows the user access to the entire Display menu. Softkeys in the Display menu enable the user to format and obtain hardcopy output (◀PRINT▶, ◀PLOT▶, and ◀DEFINE HARDCOPY▶), to configure the display screen into individually assignable windows (◀CONFIG DISPLAY▶, ◀SHOW CONFIG▶, ◀SAVE CONFIG▶, and ◀RECALL CONFIG▶), and to quickly access any of several instruments in the HP 70000 Measurement System (via ◀SELECT INSTR▶ and ◀ASSIGN KEYBRD▶). Furthermore, system-wide error reporting is available through the Display (◀REPORT ERRORS▶), as well as several self-test features that are specific to the display (under ◀DISPLAY TESTS▶).

In addition, all addressing on the HP-MSIB (the local bus for modular instruments) can be examined via the ◀ADDRESS MAP▶ softkey. The display screen brightness can be changed (◀INTENS ADJUST▶), and some brief key descriptions are available under ◀HELP▶.

Top Level Softkeys

Figure 2-1 shows the softkeys that appear when [DSP] is pressed.

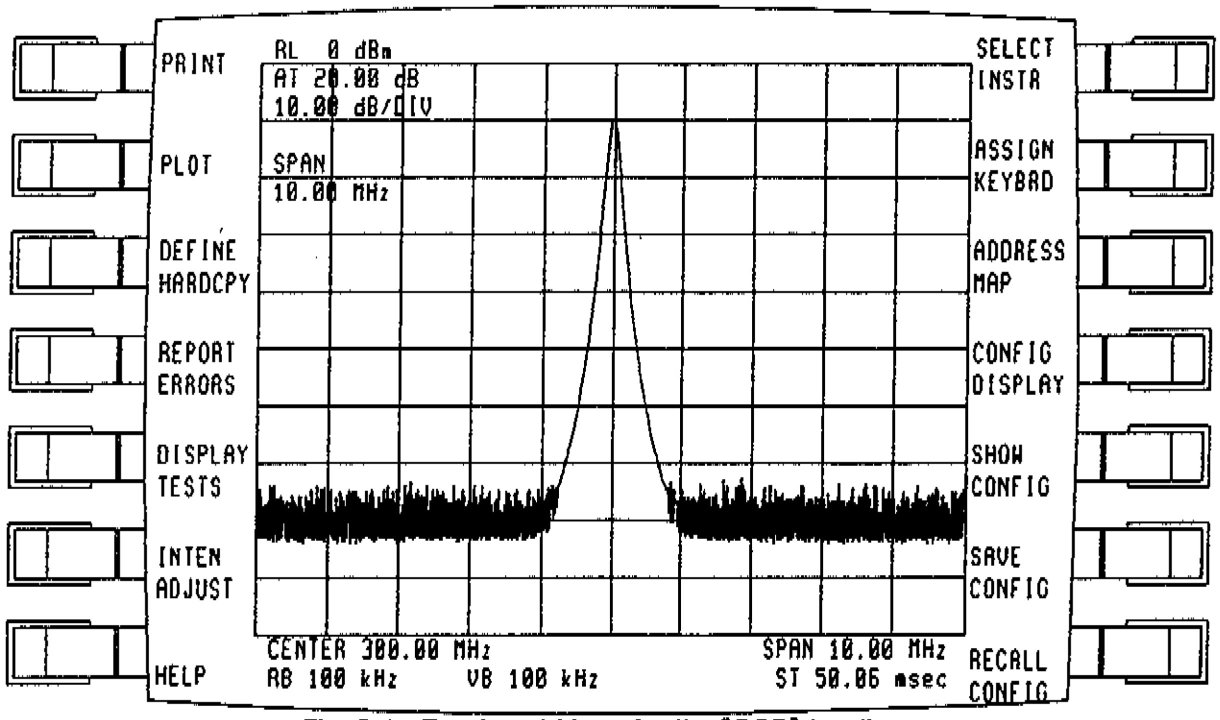


Fig. 2-1. Top Level Menu for the [DSP] hardkey

Figure 2-2 is a graphical representation of the softkeys accessed at various levels under [DSP]. The 14 boxes at the top of Figure 2-2 represent the softkeys shown above in Figure 2-1. This chapter describes the operation of all softkeys shown in the menu tree diagram, Figure 2-2.

FIG. 2-2
Sht 1 of 2

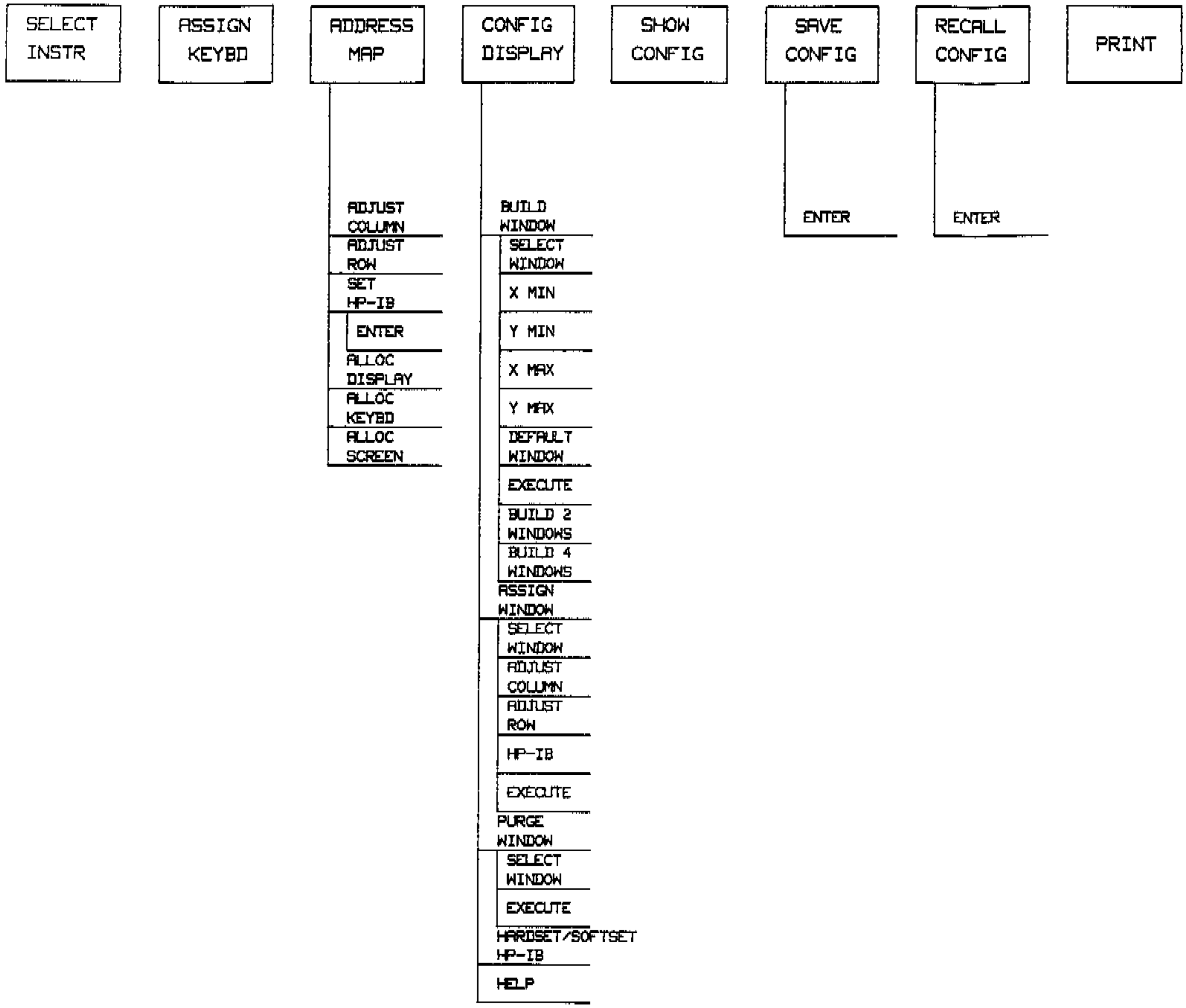


FIG. 2-2, Sht 2 of 2

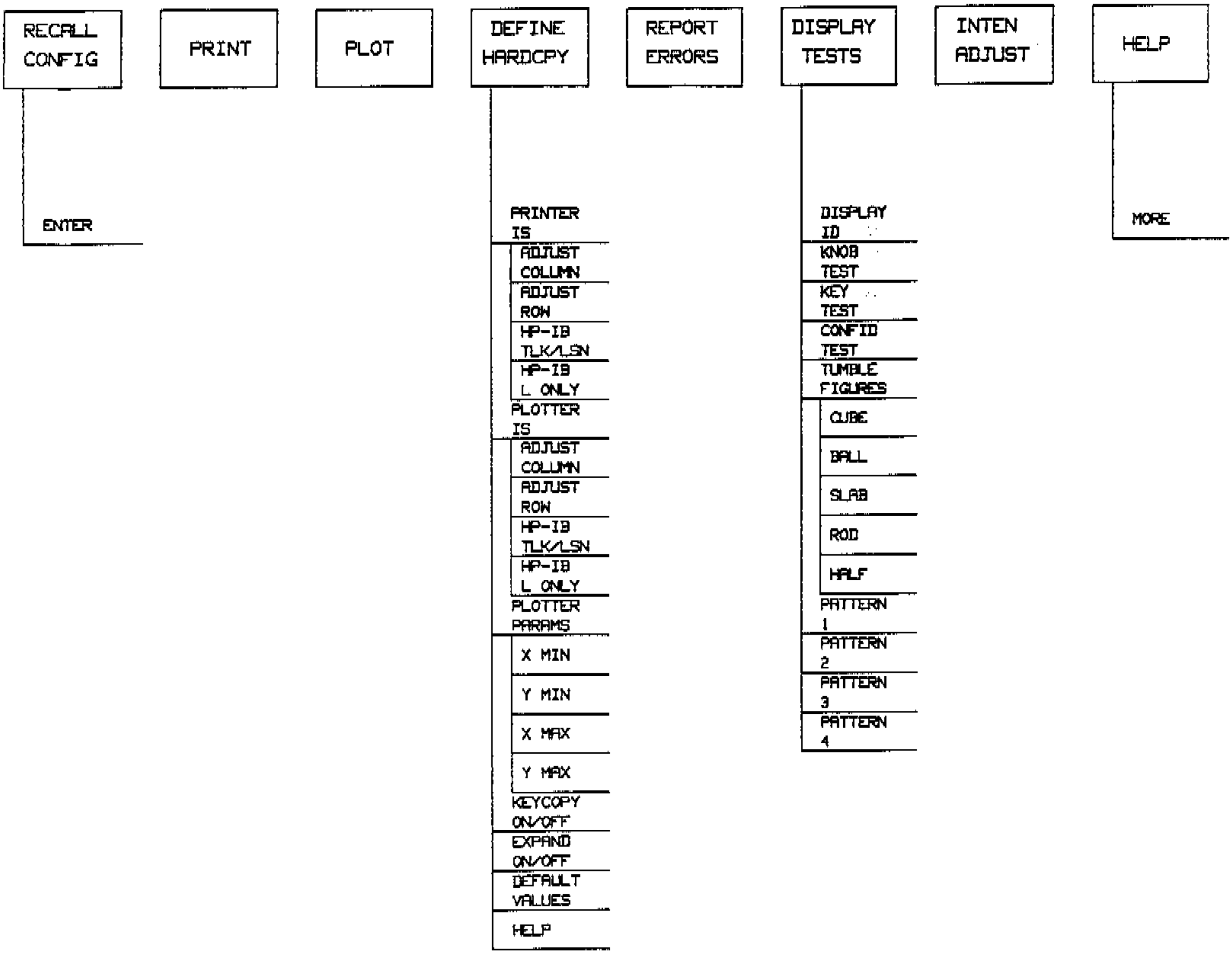


Figure 2-2. The DISPLAY Softkeys

FIG. 2-2A, Sht 1 of 2

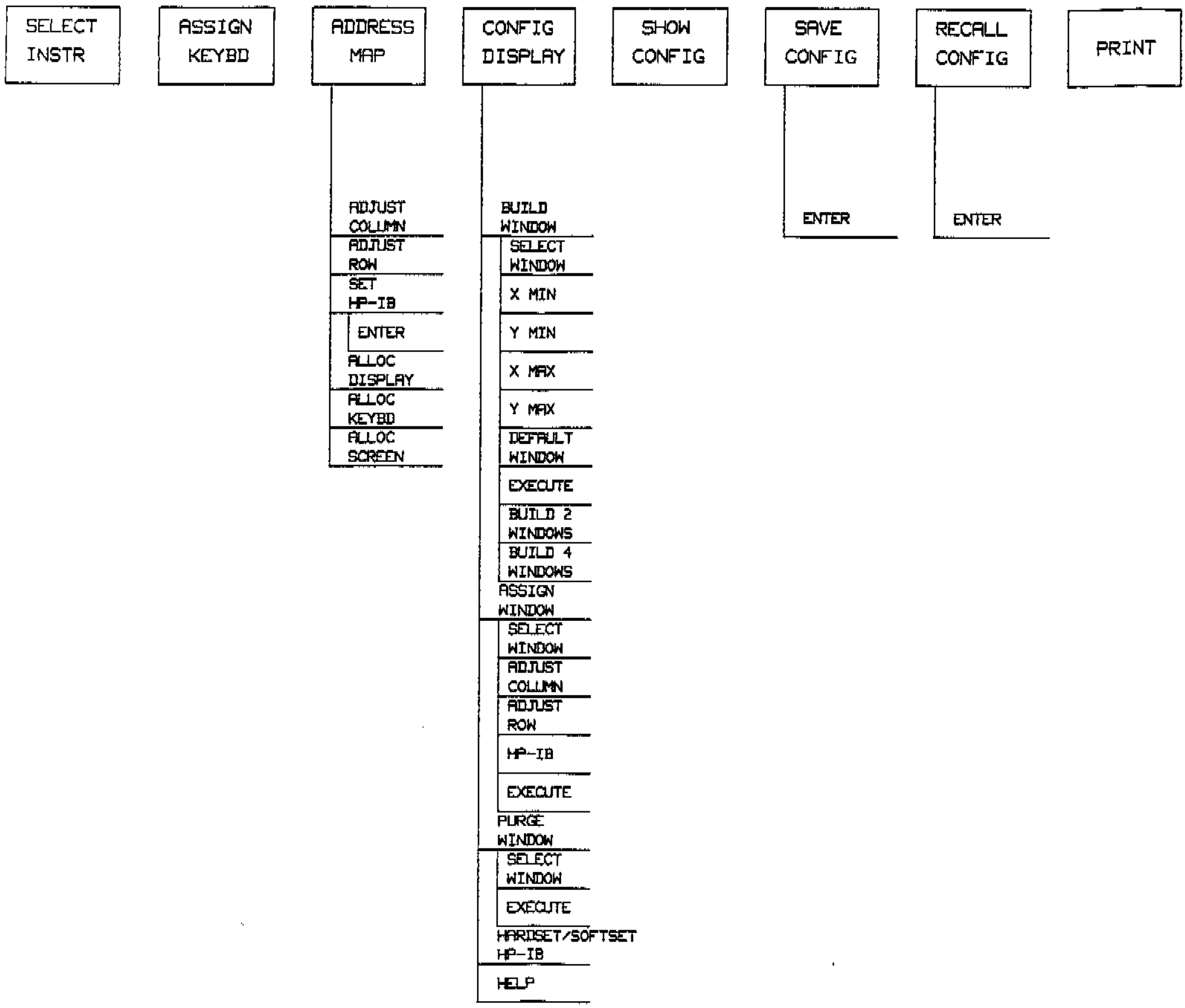
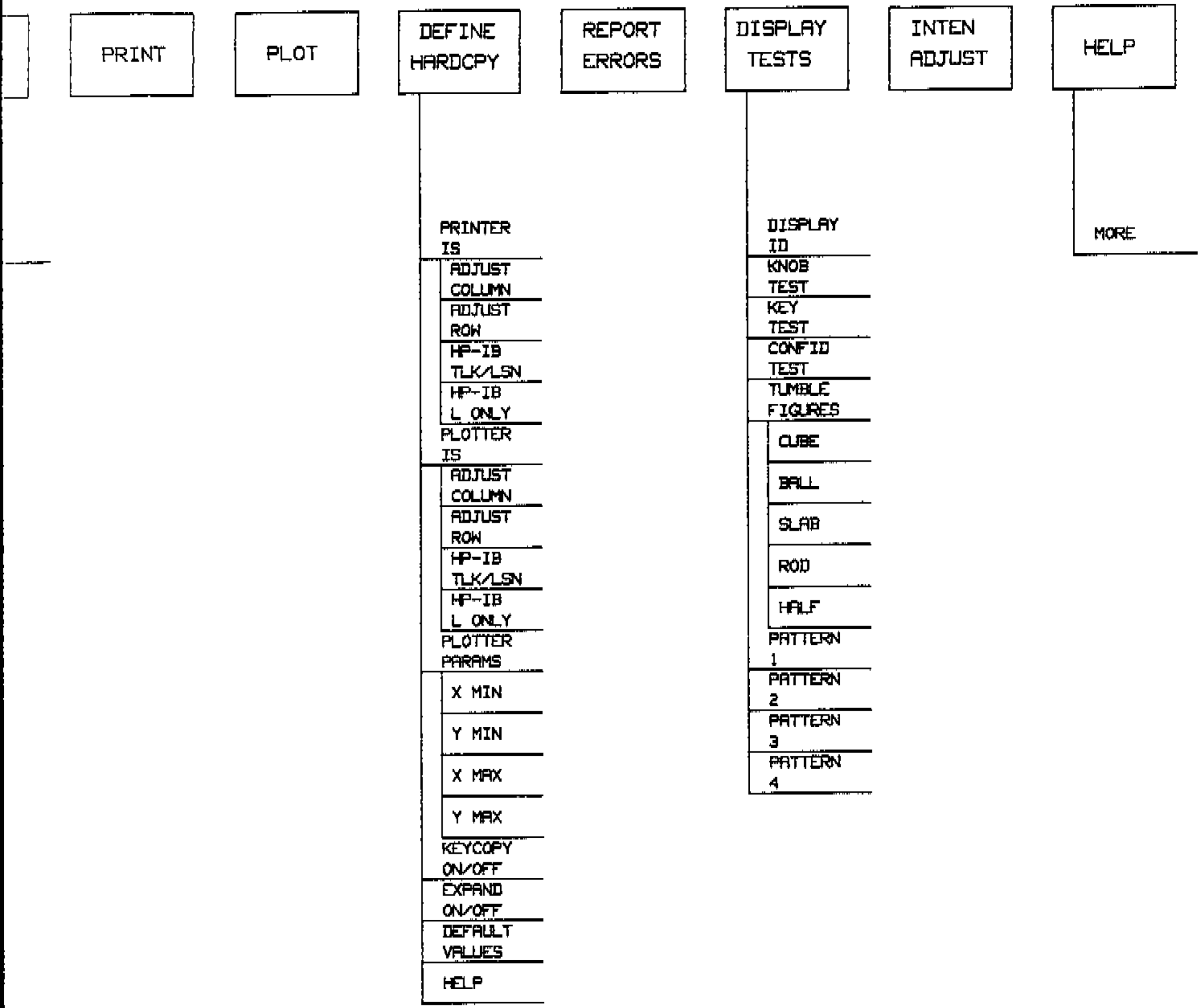


FIG-2-2A, Sht 2 of 2



Select Instrument

The ◀SELECT INSTR▶ softkey establishes basic contact between the display and any instrument in the currently configured HP 70000 System (e.g., any of several spectrum analyzers). This contact is required for manual control of an instrument, since the display serves as the interface between that instrument and the user.

To use this softkey, simply press [DSP], ◀SELECT INSTR▶, and either [USR] or [MNU]. The display will look for the instrument with the lowest column address on the HP-MSIB (the HP 70000's bus) and allocate the entire screen and the 14 softkeys to that instrument. Use the step-up and step-down keys to select the instrument with the next highest or next lowest address.

The information displayed depends on the specific instrument selected. Since this key only establishes communication links between the display and the instument, no instrument settings are changed. However, any previously defined display windows are erased. After using ◀SELECT INST▶, press [USR] or [MNU] to access the spectrum analyzer softkeys.

This key is useful for establishing initial contact with a single instrument. To preserve existing windows, use the ◀ASSIGN WINDOW▶ softkey, available under ◀CONFIG DISPLAY▶. (These softkeys are described in detail in the CONFIG DISPLAY subsection of this chapter.)

Example:

Obtaining spectrum analyzer display and keyboard control.

This example describes how the user can quickly obtain a spectrum analyzer display on the screen regardless of the current screen configuration.

It begins by breaking contact with the instrument, then re-establishes contact using the ◀SELECT INSTR▶ softkeys.

Press ◀ADDRESS MAP▶, ◀ADJUST COLUMN▶, [3], [1], and ◀ENTER▶. This should result in a screen similar to Figure 2-3.

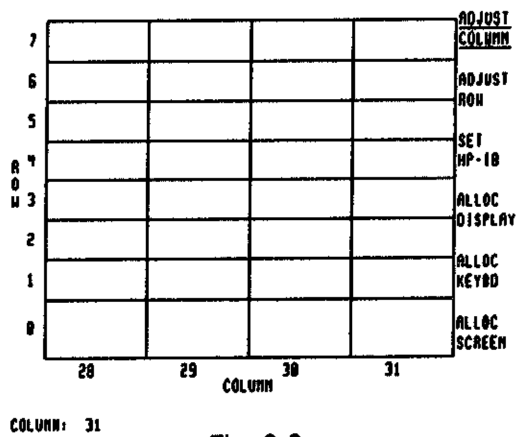


Fig. 2-3.

Press ◀ALLOC DISPLAY▶. This breaks contact between the display and the analyzer by "allocating" the display to a non-existent module. The resulting screen should be blank, as in Figure 2-4.

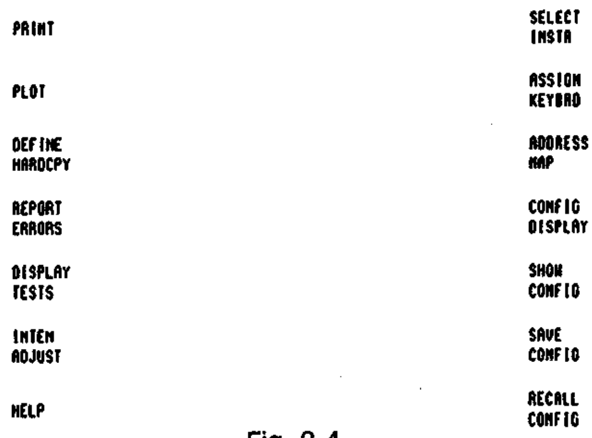


Fig. 2-4.

If you press [USR], even the softkey labels disappear (Figure 2-5). No key other than [DSP] gives a response.

[USR] does not call up any softkeys because no instrument is currently linked to the display. All softkeys under [USR] and [MNU] are created by and responded to by an instrument (the spectrum analyzer), while all softkeys under [DSP] are generated by the display itself.

Fig. 2-5.

To obtain a spectrum analyzer display on the screen, press [DSP], and then ◀SELECT INSTR▶. This should result in a display similar to Figure 2-6. To use the analyzer now, simply press [USR] or [MNU] and use the appropriate softkeys.

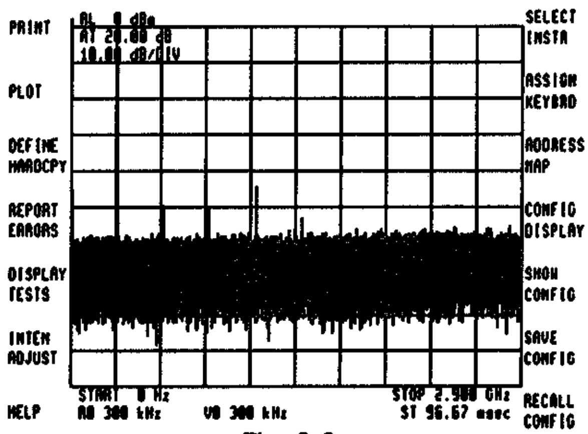


Fig. 2-6.

Assign Keyboard

This softkey gives the user keyboard control over any instrument currently writing information to a window on the screen.

To use this softkey, press [DSP] and ◀ASSIGN KEYBD▶, then use the step keys, the display knob, or the numeric keypad to select the window desired (i.e., the window written to by the instrument you wish to control). If it is defined, the window corresponding to the number chosen (1 through 4) will be highlighted on the screen. Next press [MNU] or [USR], and the specified instrument will respond with the appropriate softkey menu. A communication link between the keyboard and the module is established when the user leaves the ◀ASSIGN KEYBD▶ function (for instance, by pressing [MNU] or [USR]).

Example:

Use ◀ASSIGN KEYBD▶ to control separate spectrum analyzers, both simultaneously writing to the display. (If you have already covered ◀ASSIGN WINDOW▶ and ◀BUILD 2 WINDOWS▶, and if you have two spectrum analyzers in your system, try this example.)

Build two windows, one atop the other. (Use the ◀BUILD 2 WINDOWS▶ softkey if desired.) Assign each to a different instrument in the system, so that the Display screen is similar to Figure 2-7.

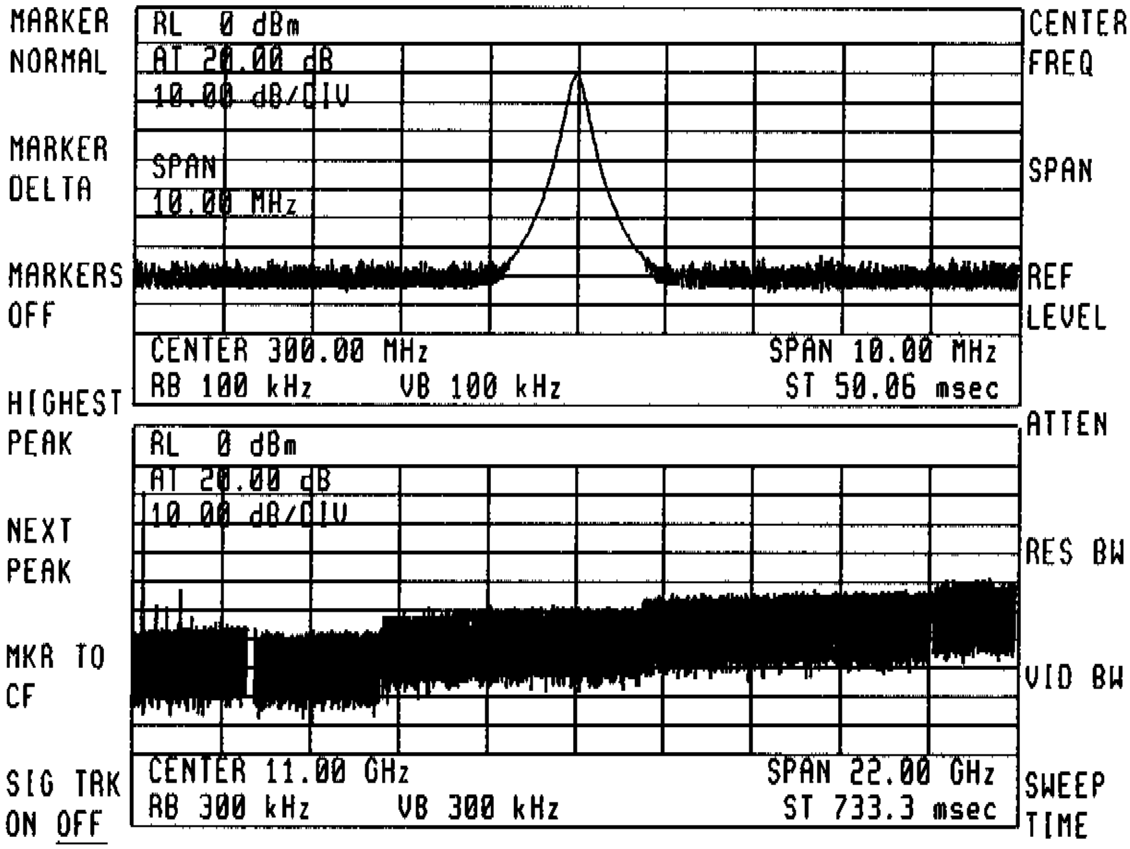


Fig. 2-7.

Press ◀ASSIGN KEYBD▶, then use the step-keys until the upper window is highlighted on the screen. Next, press [USR].

You now have access to the basic instrument control keys of the instrument writing to the top window. In this figure, the user pressed [USR] then ◀SPAN▶. Note that SPAN 10 MHZ is denoted in the upper window as the active function.

◀ASSIGN KEYBD▶ and ◀ALLOC KEYBD▶ (under ◀ADDRESS MAP▶) both link the keyboard with an instrument or module. They differ in the method by which the instrument to be controlled is selected. Both link the keyboard to a module: ◀ASSIGN KEYBD▶ by selection of a window in the display, ◀ALLOC KEYBD▶ by moving the cursor in the address map.

Address Map

The softkey ◀ADDRESS MAP▶ allows you access to the address map. The address map is a real-time graphical representation of the HP 70000 system elements--modules and graphics displays--that are on the Hewlett-Packard Modular System Interface Bus (HP-MSIB). Note: HP-MSIB is distinct from HP-IB or IEEE-488.

Figure 2-8 below shows a typical address-map screen.

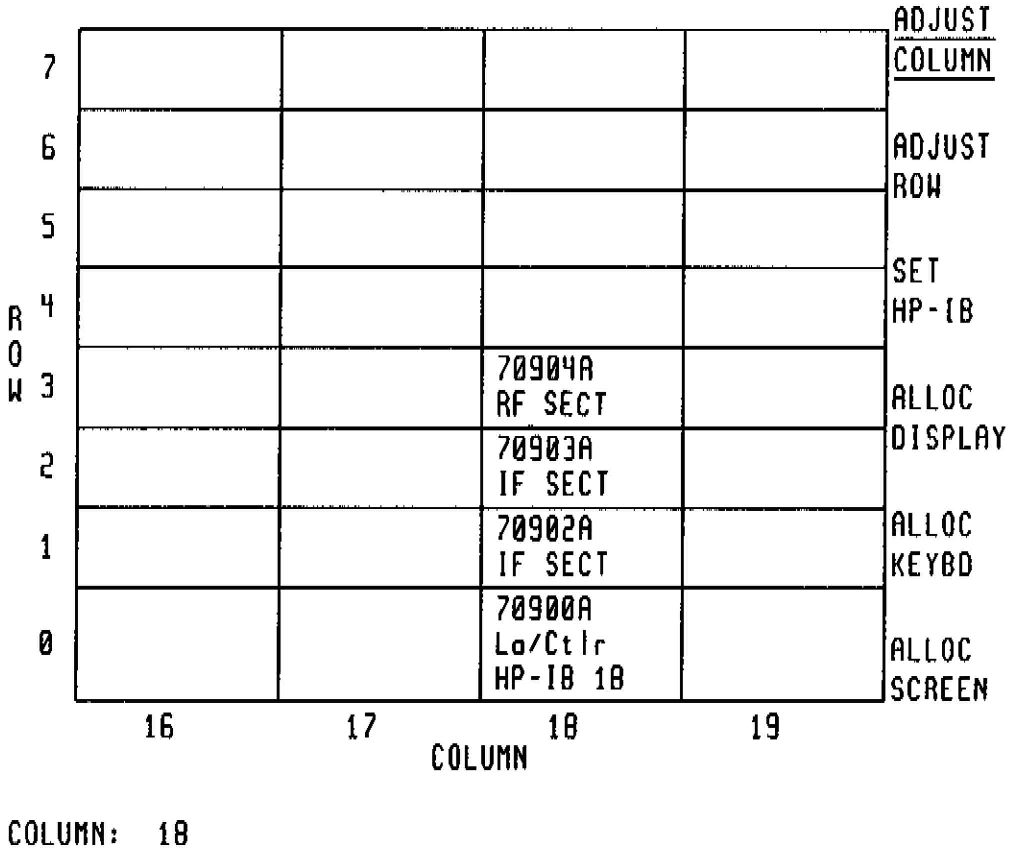


Fig. 2-8. Typical HP 70000 Address Map Detail

The operation of individual softkeys under ◀ADDRESS MAP▶ is described in the following pages. In this subsection we will briefly discuss the concept of the HP 70000 Measurement System address map, HP-MSIB, and the capabilities accessible via the ◀ADDRESS MAP▶ softkey. More information about the HP-MSIB is available in the System Support Manual which is the primary user reference for addressing modules.

The HP-MSIB (Hewlett-Packard Modular System Interface Bus) has a two-dimensional addressing scheme. Each system element such as the HP 70900A Local Oscillator module or the HP 70206A System Graphics Display has a two-part bus address. The address consists of a row number and a column number; for example, "0,18" (row,column). This unique address serves as an identifier so that any element can talk with any other element on HP-MSIB, regardless of physical proximity or other bus traffic.

The address map is designed so that each element can be located by its unique address. The row address (first number) specifies the horizontal row of the grid where the element is located, and the column address specifies the vertical column. Rows have numbers 0 through 7 ("0" is at the bottom of the screen) and columns are numbered 0 through 31 ("0" at the left edge of the map). The address "0,31" is not available for use; hence, there are 255 available addresses.

Each modular measuring instrument (composed of several modules) will typically occupy all or part of a single column. (The exception to this is multi-column instruments. See the System Support Manual.) Note that the display elements (the HP 70205A and the larger HP 70206A) are **not** part of any measuring instrument. Each display serves as a general-purpose man-machine interface, providing a screen for the instruments and keys that enables the user to control the system. Since the displays are not part of any particular instrument, each will occupy its own column in the address map. See the figures below.

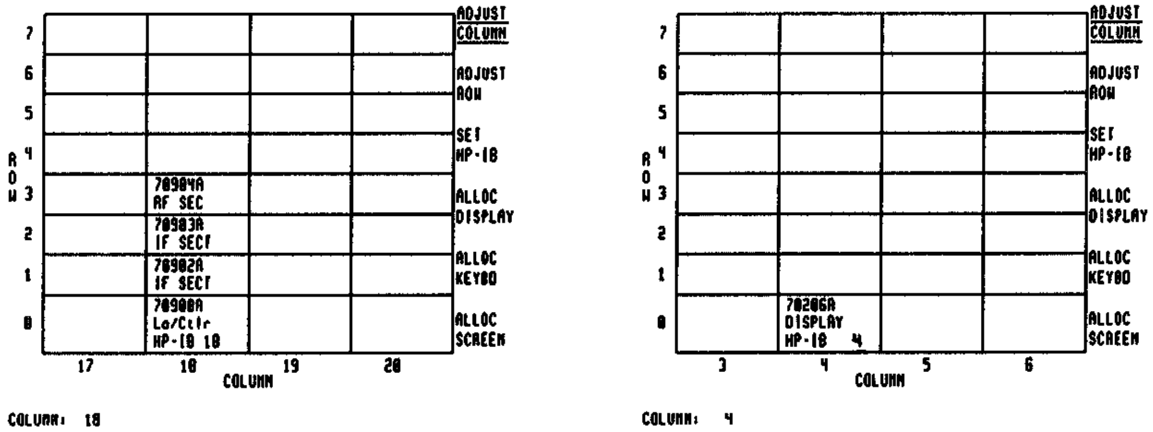


Fig. 2-9.

Addressing Conventions for Individual Elements (Modules)

Note: A more detailed description of HP-MSIB addressing conventions is given in the System Support Manual. The System Support Manual is the primary user reference for addressing modules.

MSIB addresses are set only by switches located on each module or display. All elements (modules and HP 70206A displays) have adjustable column addresses. All elements except the displays have adjustable row addresses. (The displays are confined to row 0.) An appropriate element, when located in row 0, acts as a "master" to all modules above and to the right of it; this master has control as far as the column of the next master, which supersedes the first. The master module is able to control another module by ordering it to perform tasks and controlling the flow of information to and from that module. For example, an error detected in an IF section will be reported to the master module, which will in turn report it to the user via the display. Currently, the only module capable of being a master is the HP 70900A Local Oscillator.

The modules controlled by a master are referred to as slaves. Slave modules are addressed "above" the master; that is, slaves have higher row addresses than their master. A measuring instrument such as a spectrum analyzer will typically consist of one master (local oscillator module) and several slaves (IF sections, RF "Front End" sections, tracking generators, etc.). While a master module must be located in row 0, slave modules can be addressed in any of several rows, according to these rules:

* Only one RF section (HP 70904A, HP 70905A, or HP 70906A) may be used with a single local oscillator module.

* The tracking generator (HP 70300A), if present, must have the highest row address of that column.

* If no tracking generator is present, the RF section should occupy the highest row address of that column. If a tracking generator is present, the RF section is addressed immediately below it (in the column).

* External mixer interface modules are to be addressed immediately below the RF section and/or tracking generator (in the column). Multiple external mixer interface modules should have consecutive row addresses. If neither tracking generator nor RF section is present, an external mixer interface module will have the highest row address of that column.

* The HP 70902A IF section, if present, must be closest to the local oscillator. (That is, the HP 70902A should be immediately above the HP 70900A in the address map.)

* The HP 70903A IF section, if present, should be immediately above the HP 70902A (in that column). If the HP 70902A is not present, the HP 70903A should be directly above the local oscillator.

* A single master may control only a certain number of slave modules. At present, the number is seven. For example, a modular spectrum analyzer (with a single local oscillator) could consist of that one local oscillator with two IF sections, one RF section, and four separate external mixer interface modules (each covering a separate frequency band).

The row-addressing priority for a sample system is shown below. (Note: the sample is a **relative** row-address ranking only.) The individual modules do not require consecutive row addresses (i.e., there can be empty rows between modules). Also, note that all modules need not be in the same column: they need only fall in the "slave area" of the master module (above and to the right) as described in the System Support Manual.

Highest row:
HP 70300A Tracking Generator
HP 70904/5/6A RF Section (one only)
HP 70907A External Mixer Interface modules (several allowed)
HP 70903A IF Section
HP 70902A IF Section

Lowest row (row 0):
HP 70900A Local Oscillator

Note: HP-MSIB addresses must be unique. Setting two HP 70000 elements to the same address will create an error and make the system bus (HP-MSIB) inoperative. If the cursor cannot be moved about within the address map after a module has been re-addressed, check to see if two modules have the same row and column address. If the Address Map function is inoperative, removal of the modules is required. See the System Support Manual for instructions.

HP-IB, HP-MSIB, and the Address Map

Although HP-IB and HP-MSIB are different buses, some elements on HP-MSIB are accessible via HP-IB. Specifically, certain elements that have an HP-MSIB row address of 0 may be addressed over HP-IB with the proper configuration. A brief discussion of HP-IB usage with HP 70000 systems will be presented here, but a more detailed coverage is given in the System Support Manual.

Between mainframes (HP 70001A), HP-IB and HP-MSIB are completely separate and are carried on separate cables. HP-IB is a parallel-connected single cable bus; HP-MSIB is a series-connected dual-cable bus. Two HP 70000 System Mainframes are connected to the same HP-IB network only if each is connected to it individually, or if there is an HP-IB cable linking the two.

Within a single mainframe, however, HP-IB and HP-MSIB connections are carried along the backplane bus and are provided at the back of each 1/8-width module slot. A mainframe has exactly one HP-IB port (one connector) and one HP-MSIB port (two connectors: one "in" and one "out"). Hence, all modules in a particular mainframe have access to both the HP-IB lines and the HP-MSIB lines.

All modules can communicate over HP-MSIB, but, as previously mentioned, only certain modules or elements can talk over HP-IB. Therefore, while every HP 70000 Series element takes up an HP-MSIB address, only the row 0 modules can occupy HP-IB addresses. At present, the only HP 70000 series elements that can use HP-IB are the HP 70900A Local Oscillator and the HP 70205A/ 70206A Graphics Displays. No other modules affect HP-IB in any way.

Each system element that can talk over HP-IB can also be removed from HP-IB by positioning the "HP-IB ON/OFF" switch in the "OFF" position. On the HP 70205A and HP 70206A Displays, this switch is readily accessible from the back panel. On the HP 70900A Local Oscillator, the switch is located on the top of the module, along with the other HP-IB and HP-MSIB switches. Changing any of these switches on the Local Oscillator requires removal of the module from the mainframe (see the System Support Manual for more information).

The HP-IB address and the HP-MSIB address of a system element are not necessarily related. The HP-MSIB address is determined solely by the setting of the address switches on the module (see the System Support Manual).

When applicable, the HP-IB address of each module defaults to the HP-MSIB column address. For example, the HP-MSIB address 0,18 has a default HP-IB address of 18. Note, however, that the HP-IB address of the local oscillator and of both displays may be set to any valid address using the ◀SET HP-IB▶ softkey, which is available through ◀ADDRESS MAP▶. See the ◀SET HP-IB▶ softkey description in this chapter for instructions.

Adjust Column/Adjust Row

The ◀ADJUST COLUMN▶ and ◀ADJUST ROW▶ softkeys, available directly under ◀ADDRESS MAP▶, allow you to move the cursor (the highlighted box) within the address map.

Example:

Adjusting the column and row.

Press [DSP], ◀ADDRESS MAP▶, ◀ADJUST COLUMN▶, then turn the display knob until the cursor rests on the Local Oscillator module.

Next press ◀ADJUST ROW▶ and use the step-up key to place the cursor on the RF Section as in Figure 2-10.

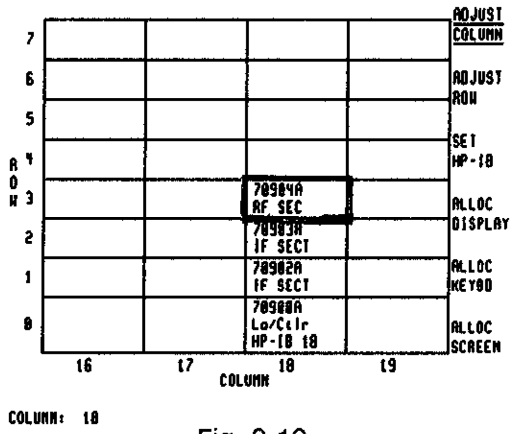


Fig. 2-10.

The ◀ADJUST COLUMN▶ and ◀ADJUST ROW▶ softkeys accept data entry from the display knob, from the step-up and step-down keys, and from the numeric key pad.

The three methods of adjusting the Address Cursor are shown below.

KNOB	Moves the cursor box digitally from one column or row to the next.
STEP KEYS	Moves the cursor box digitally from one column or row to the next in steps.
KEY PAD 0 1 2 3 4 5 6 7 8 9	Allows entry of exact row or column number.

Note: The module currently highlighted in the address map will have a green "ACT" light on its front panel. (The displays show an "A" in the lower right-hand status box on the screen.) This light enables you to correlate the specific physical HP 70000 System elements to their locations in the address map. Default addresses of some modules shipped from the factory are:

HP 70900A 0,18
HP 70205A 0,4
HP 70206A 0,4

Set HP-IB

The ◀SET HP-IB▶ softkey allows you to change the HP-IB address of any element currently on HP-IB if that element (a local oscillator or display) will permit it. The specific conditions are discussed earlier in this section.

Example:

Change the HP-IB address of the display.

Press [DSP], ◀ADDRESS MAP▶, ◀ADJUST COLUMN▶; then turn the display knob so that the cursor box stops on the display.

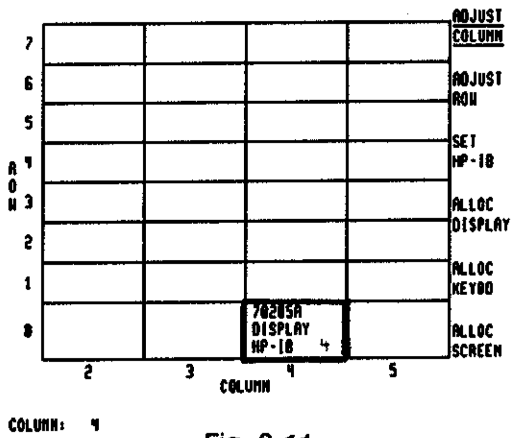


Fig. 2-11.

Press ◀SET HP-IB▶, [2], [0], and ◀ENTER▶. The HP-IB address of the display should immediately change to 20 as in Figure 2-12.

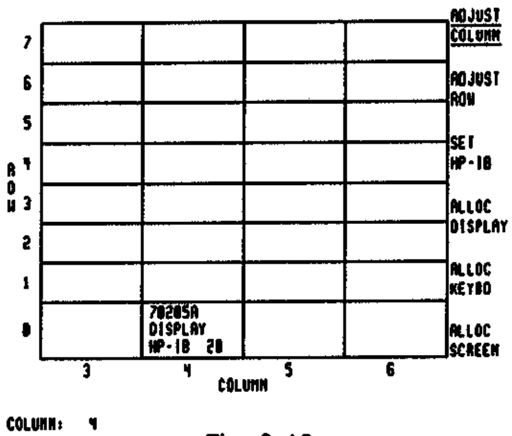


Fig. 2-12.

Notes:

1. An HP 70000 System element can show an HP-IB address on the Address Map even though the element is disabled and cannot communicate on HP-IB. This is accomplished with the "HP-IB ON/OFF" hardswitch. (See HP-MSIB description following the Address Map section in this manual, or see the System Support Manual.)

2. The HP70900A Local Oscillator module has the ability to lock its HP-IB address so that it cannot be changed from the front panel. To do this, set the "SW1/MEM" hardswitch on the Local Oscillator to the "SW1" position. With this switch set to "SW1," the module will not respond to the ◀SET HP-IB▶ softkey. The module's HP-IB address will remain identical to the HP-MSIB column address.

3. Upon power-up, the HP-IB addressing is handled differently by different elements. Displays can be configured to have a power-up HP-IB address of either the HP-MSIB column address or the most recent HP-IB address given to the display with the ◀SET HP-IB▶ softkey. This option (for displays only) is discussed in the ◀HARDSET/SOFTSET HP-IB▶ section of this chapter. The local oscillator module, however, always has a power-up HP-IB address identical to its HP-MSIB column address.

Allocate Display

The softkey ◀ALLOC DISPLAY▶ is used to establish contact between the display and a specific module. It allocates the screen and softkeys to the module currently highlighted by the cursor in the address map.

Example:

Allocate the display to a particular instrument. Begin by breaking contact with the instrument; then re-establish contact.

To begin, break contact with the spectrum analyzer. Press [DSP], ◀ADDRESS MAP▶, ◀ADJUST COLUMN▶, and use the display knob to place the cursor on an empty address, as in Figure 2-6. On the display screen the cursor is the highlighted box.

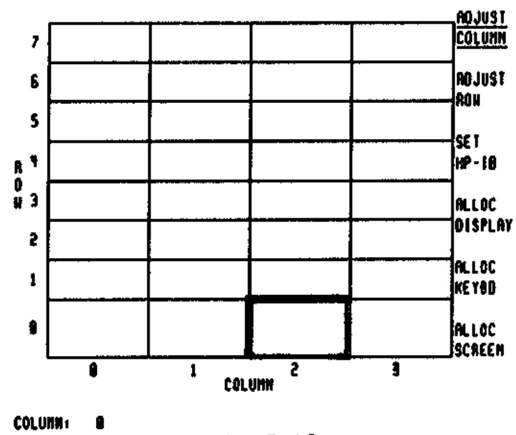


Fig. 2-13.

Press ◀ALLOC DISPLAY▶. This breaks all links with the existing instrument and attempts to establish a link between the display and a nonexistent instrument. This results in a blank screen, as in Figure 2-14.

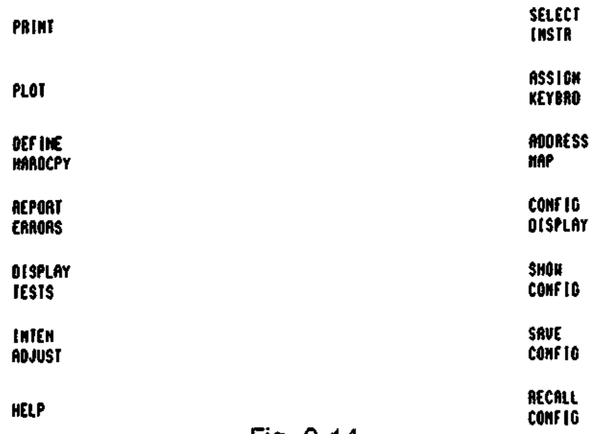


Fig. 2-14.

Re-establish contact with the spectrum analyzer by pressing ◀ADDRESS MAP▶, ◀ADJUST COLUMN▶, and then turning the knob to position the cursor on the local oscillator module.

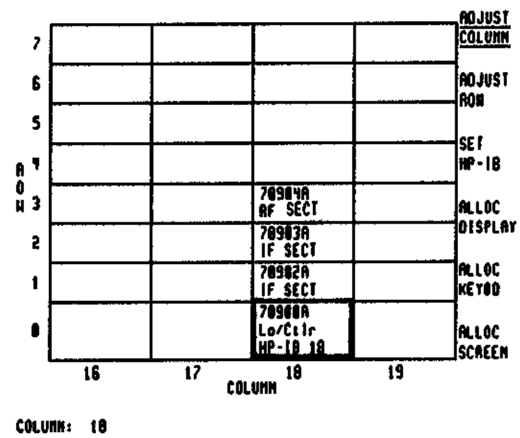


Fig. 2-15

Press ◀ ALLOC DISPLAY▶. This should result in a screen similar to that shown in Figure 2-16, depending on the previous settings of the spectrum analyzer being used.

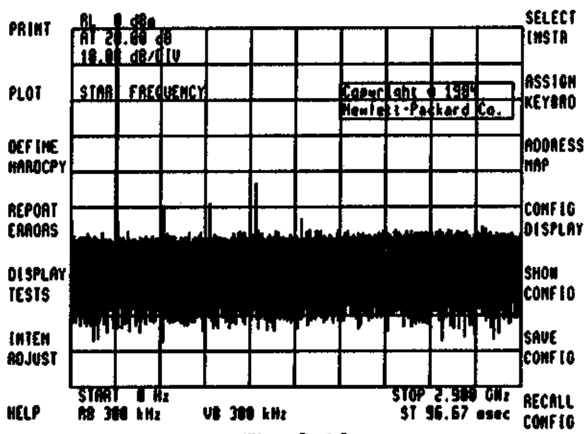


Fig. 2-16.

In summary, ◀ALLOC DISPLAY▶ establishes contact between the display (the user interface) and an HP 70000 module, but differs from ◀SELECT INSTR▶. ◀ALLOC DISPLAY▶, used in the Address Map, requires that a particular module (element) be specified. ◀SELECT INSTR▶ selects an instrument on its own. Both, however, destroy any links between the display and any other instruments. Both destroy any existing windows in the display. At present, the only HP-MSIB module that can establish a link with the display is the HP 70900A Local Oscillator.

Allocate Keyboard

The ◀ALLOC KEYBD▶ softkey is used to allocate the keyboard to a specific module. The keyboard can then be used to control the instrument settings of a spectrum analyzer, such as Center Frequency and Span.

Press [DSP], ◀ADDRESS MAP▶, and move the cursor to the module desired. Then press ◀ALLOC KEYBD▶ and the keyboard will be linked to that module.

Notes:

1. The keyboard and the screen can be allocated separately. ◀ALLOC KEYBD▶ links the keyboard with an instrument, but does not necessarily display any trace data from that instrument. Hence, the softkeys may not correspond to the instrument display shown.

2. At present, only a master module such as the HP 70900A can receive the keyboard. Attempts to allocate the keyboard to slave modules will result in an error.

3. ◀ALLOC KEYBD▶ lets the user link the keyboard with any **master module** by way of the address map. Another softkey, ◀ASSIGN KEYBOARD▶, which is available directly under [DSP], is generally quicker and easier to use.

Allocate Screen

The two resources of the display, the keyboard and the screen, can be allocated separately. ◀ALLOC SCREEN▶ assigns the whole screen to a particular module, even though the keyboard may be assigned elsewhere. This allows the user to view the trace output from one instrument (on the screen) while controlling a different instrument (with the keyboard).

To use the ◀ALLOC SCREEN▶ key, press ◀ADDRESS MAP▶, and move the cursor box to the module or instrument desired. Press ◀ALLOC SCREEN▶ and the screen will be immediately allocated to that module. If the module is ready to put out trace information, the information will be immediately displayed.

Note: Only master modules can be linked to the display. Therefore, use ◀ALLOC SCREEN▶ only for HP 70900A Local Oscillator modules. Attempting to allocate the screen to a slave module will result in an error.

Configure Display

◀CONFIG DISPLAY▶ gives the user access to a submenu of softkeys that configure the various features of the display. (See Figure 2-17.) These features and capabilities consist of building windows on the screen and selecting the instruments that may write to those windows.

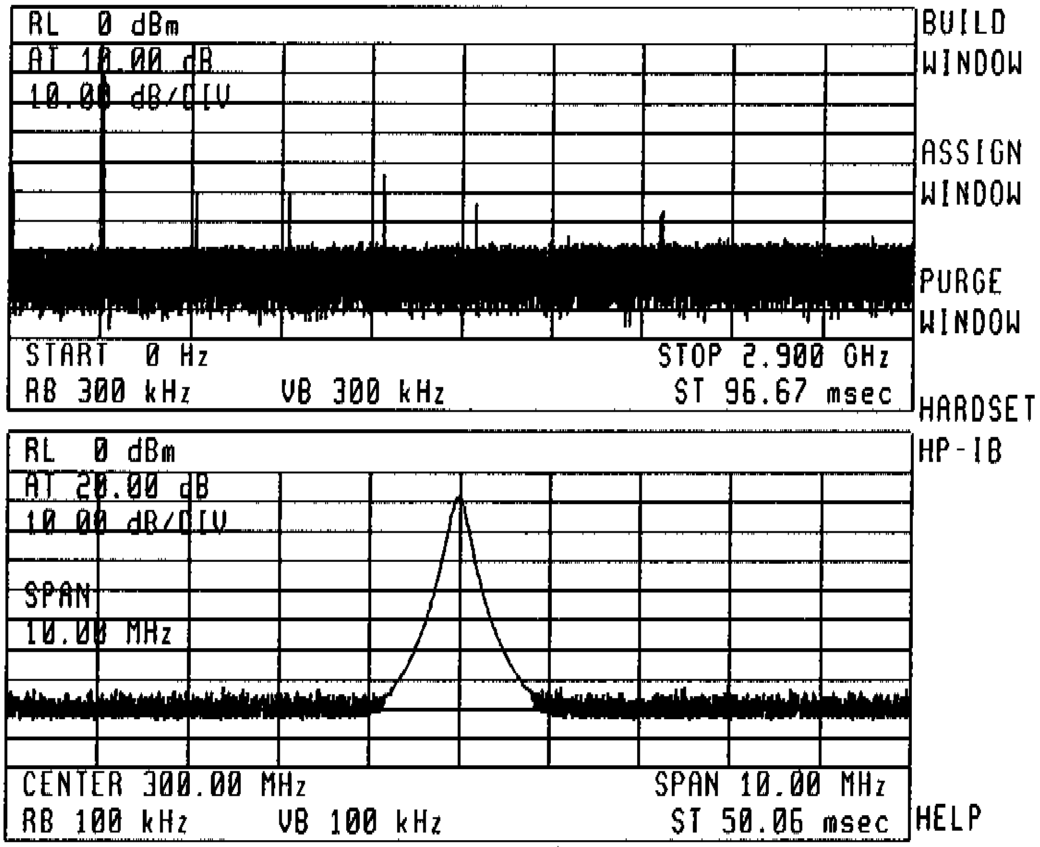


Fig. 2-17.

The softkeys accessed by pressing ◀CONFIG DISPLAY▶ include ◀BUILD WINDOW▶, ◀ASSIGN WINDOW▶, ◀HARDSET/SOFTSET HP-IB▶, and ◀HELP▶. The following pages contain descriptions and examples of these softkeys. Below is a listing and a brief description of each:

◀BUILD WINDOW▶ allows the user to construct up to four separate windows on the screen.

◀ASSIGN WINDOW▶ links windows with modules so that trace information can be displayed.

◀PURGE WINDOW▶ removes a previously-built window.

◀HARDSET/SOFTSET HP-IB▶ allows the user to determine the power-up HP-IB address of the Display.

◀HELP▶ calls up some brief descriptions of the keys available under ◀CONFIG DISPLAY▶.

Build Window

The ◀BUILD WINDOW▶ softkey allows the user to construct up to four separate "windows" on the screen. A window is a user-defined portion of the screen that is set aside for a single instrument to display information.

Example:

Building two windows.

Note: The ◀BUILD TWO WINDOWS▶ softkey performs a similar function.

Press [DSP], ◀CONFIG DISPLAY▶, and then ◀BUILD WINDOW▶.

The ◀BUILD WINDOW▶ submenu appears with ◀SELECT WINDOW▶ automatically underlined. The underline indicates that this function is active. Select a window, numbered 1 through 4, by using any data entry method (step-keys, display knob, or numeric key pad). If the key pad is used to enter the window number, the user must press ◀ENTER▶. In this example, build window #1.

Note: The window selected, if currently defined, is highlighted.

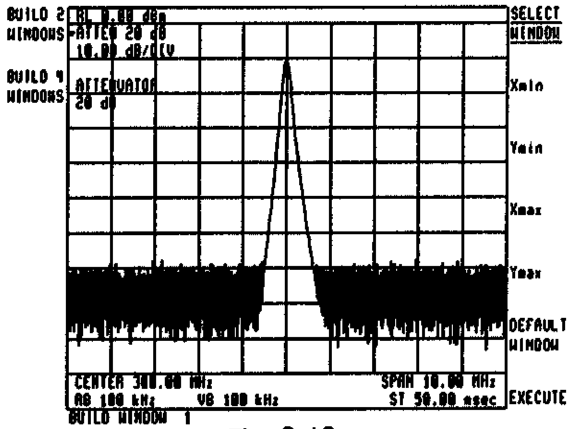


Fig. 2-18.
Softkeys Available Under ◀BUILD WINDOW▶

Press ◀Ymax▶, then turn the knob counterclockwise to bring the top line to a point just below the middle of the screen. At the bottom of the screen a Ymax value will be displayed and will change as the display knob is turned. Set Ymax at approximately 195. Press ◀EXECUTE▶. Window #1 has now been redefined as in Figure 2-19.

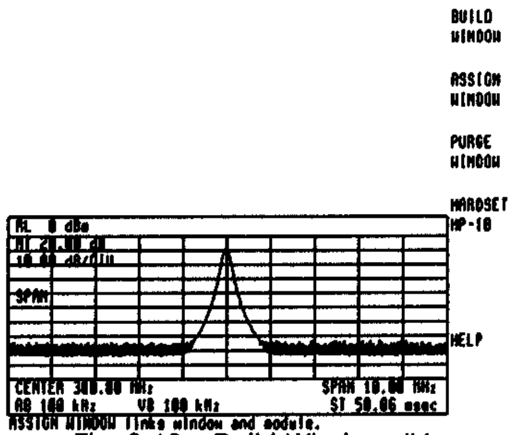


Fig. 2-19.. Build Window #1

Press ◀BUILD WINDOW▶, ◀SELECT WINDOW▶, [2], and ◀ENTER▶.

Select ◀Ymin▶ and, with the display knob, move the bottom line to a position just above the other window (Ymin=205). Press ◀EXECUTE▶. Two windows are now defined as in Figure 2-20. Each window could be assigned to different instruments if desired. (See ◀ASSIGN WINDOW▶ description.) See the ◀PURGE WINDOW▶ description to remove the windows.

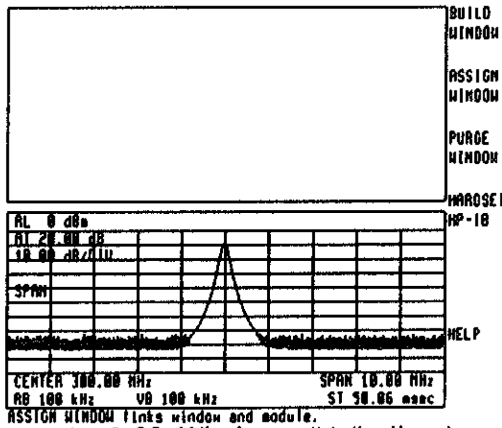


Fig. 2-20. Windows #1 (bottom) and #2 (top)

The values of Xmin, Ymin, Xmax, Ymax represent the distances of the lines from the origin. The origin (X = 0, Y = 0) is located at the lower-left corner of the screen. The top right corner of the screen is X = 1023, Y = 383. These dimensions are in units of pixels (dots on the screen).

The standard sized window, available via ◀DEFAULT WINDOW▶, has the following dimensions:

Xmin = 112
Ymin = 16
Xmax = 911
Ymax = 383

The default window is the window which is created by ◀SELECT INSTR▶, ◀ALLOC DISPLAY▶, and ◀ALLOC SCREEN▶.

Note:

1. Any window can be changed in size or shape by re-building. Up to four windows may be defined and written to simultaneously by different instruments; thus, four different instruments can "talk" to the display simultaneously. The screen annotation usually present with one or two large windows may not appear on smaller windows.

2. The softkeys ◀BUILD 2 WINDOWS▶ and ◀BUILD 4 WINDOWS▶ can be used to construct multiple windows with a single keystroke.

Assign Window

A window on the screen can be written to by any HP-MSIB master module (HP 70900A) or by an HP-IB controller. ◀ASSIGN WINDOW▶ lets the user select the instrument that will write to a chosen window. The user can select a module on HP-MSIB by using ◀ADJUST COLUMN▶, ◀ADJUST ROW▶, and ◀EXECUTE▶ (see following example).

Alternatively, a window may be accessed over HP-IB. To do this, press ◀ASSIGN WINDOW▶, select the window, then press ◀HP-IB▶ and ◀EXECUTE▶. The window will then have the HP-IB address of the display. (See ◀ADDRESS MAP▶ to determine the HP-IB address of the display.) Only one display window at a time can be assigned to HP-IB.

Example:

Building two windows and assigning one to an analyzer.

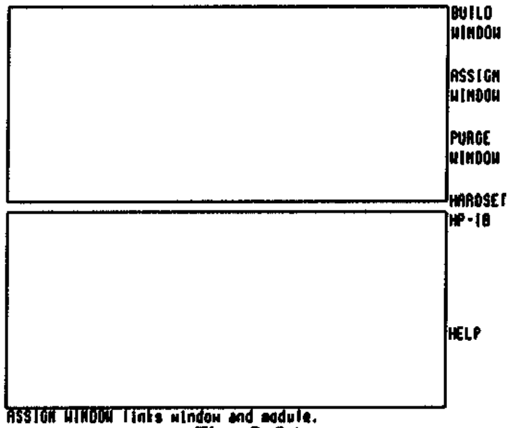


Fig. 2-21.

Clear the screen of all windows (see ◀PURGE WINDOW▶). Next, build two windows as in the ◀BUILD WINDOW▶ example, leaving the screen with two blank, unassigned windows as in Figure 2-21. The lower window should be #1 and the upper window should be #2.

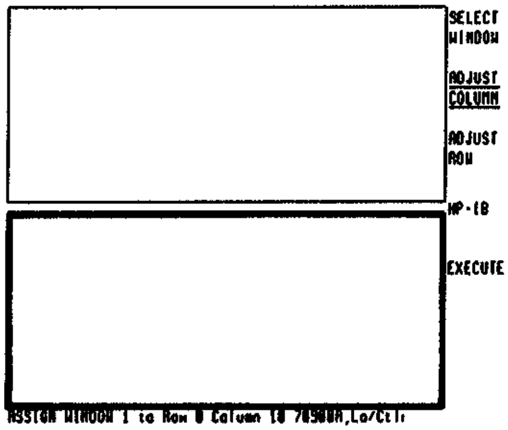


Fig. 2-22.

Press ◀ASSIGN WINDOW▶, ◀SELECT WINDOW▶, [1], and ◀ENTER▶. The lower window should be highlighted.

Press ◀ADJUST COLUMN▶ and turn the knob until the bottom line on the screen shows that an HP 70900A module has been found (the factory default address is 0,18).

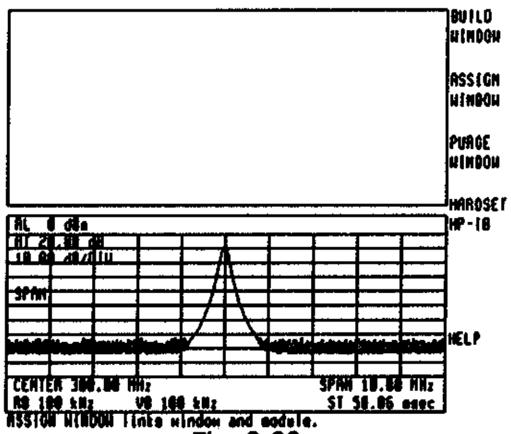


Fig. 2-23.

Press ◀EXECUTE▶, and the trace output from that spectrum analyzer should appear in the window as in Figure 2-23.

The softkeys displayed now are those of the display. To access the softkey menu to control the spectrum analyzer, press [USR] or [MNU]. To control a different instrument, use ◀ASSIGN KEYBD▶ to link the softkeys with a master module that has a window. ◀ASSIGN KEYBD▶ is available directly under the [DSP] hardkey.

If your system contains only one spectrum analyzer, then the second window can be assigned to it. This will result in the analyzer's trace information shifting to the second window, which demonstrates the flexibility of the windowing capabilities. This also demonstrates that an instrument can be re-assigned to another window from the front panel without changing any analyzer settings or interrupting the sweep sequence. Note that the analyzer only writes to one window at a time.

Example:

Assigning the other window to the spectrum analyzer.

Press ◀SELECT WINDOW▶ and use the step keys to select the other window (the window that is presently blank).

Press ◀ADJUST COLUMN▶ and turn the knob until the 70900A LO/Controller module is indicated at the bottom of the screen.

Press ◀EXECUTE▶, and the display should shift to the other window as in Figure 2-24.

With only one instrument writing to the display, the analyzer softkeys will be immediately available by pressing [USR] or [MNU]

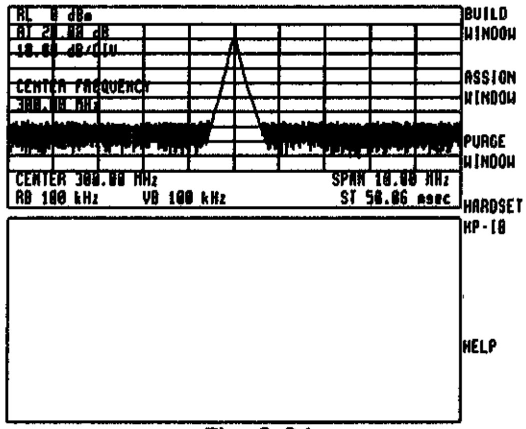


Fig. 2-24.

If your system contains more than one spectrum analyzer, assign the second window to the second instrument. This will result in each analyzer writing to a separate window. The two separate traces need not be restricted to sequential updating, as with a single-analyzer display. The traces are both being taken in real time by separate instruments. Only the display element is common.

Example:

Assigning two windows to different spectrum analyzers.

Start with a two-window, one-analyzer display similar to Figure :2-25. (See the first example in this section.)

Press ◀ASSIGN WINDOW▶ and ◀SELECT WINDOW▶. Use the step keys to select the window that is defined but not written to.

Press ◀ADJUST COLUMN▶ and turn the knob until the other HP 70900A LO/Controller module is indicated at the bottom of the screen.

On the front panel of each local oscillator is an "ACT" or "ACTive" light. The two local oscillators can be distinguished by the "ACT" light; the module indicated by the bottom line on the display screen will show "ACT" lit.

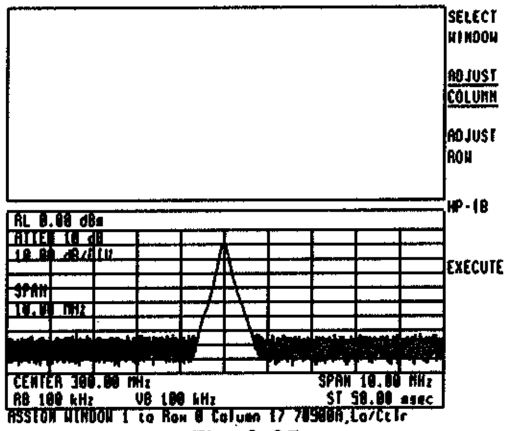


Fig. 2-25.

Once the other HP 70900A has been indicated, press ◀EXECUTE▶ and the second analyzer's trace information should appear in the other window as in Figure 2-26.

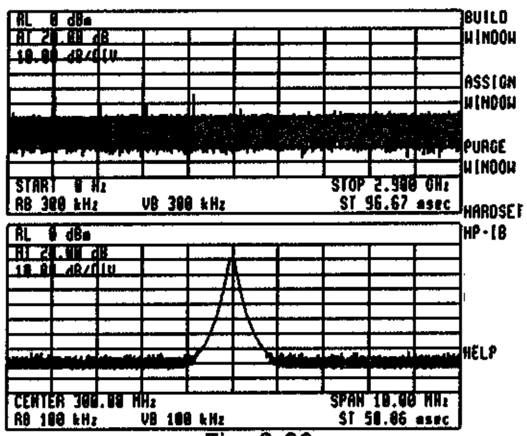


Fig. 2-26.

Note: The softkeys now displayed are those of the display. By pressing [USR] or [MNU], softkeys for one of the instruments will be obtained.

To control the other analyzer, press ◀ASSIGN KEYBD▶, use step keys to select a window, and press [USR] or [MNU]. (See the ◀ASSIGN KEYBD▶ description in this chapter.)

Note: ◀ASSIGN WINDOW▶ shifts the analyzer's output back and forth between windows. ◀ASSIGN WINDOW▶, however, does not disturb the link between the keyboard and an instrument. Whichever instrument has the keyboard before ◀ASSIGN WINDOW▶ is used will have it after.

Purge Window

◀PURGE WINDOW▶ removes a previously defined window from the screen. Upon pressing ◀EXECUTE▶, the window is destroyed, and any link with an instrument or module is broken. Trace information displayed in the window disappears from the screen, but is **not** destroyed: it resides in the spectrum analyzer and may be accessed again by assigning a different window to the analyzer (see ◀BUILD WINDOW▶ and ◀ASSIGN WINDOW▶).

Example:

Purge two windows.

Start by building two windows, as in the ◀BUILD WINDOW▶ example (#1 on the bottom, #2 on the top). Assign window #1 to a spectrum analyzer. The resulting screen should be similar to Figure 2-27.

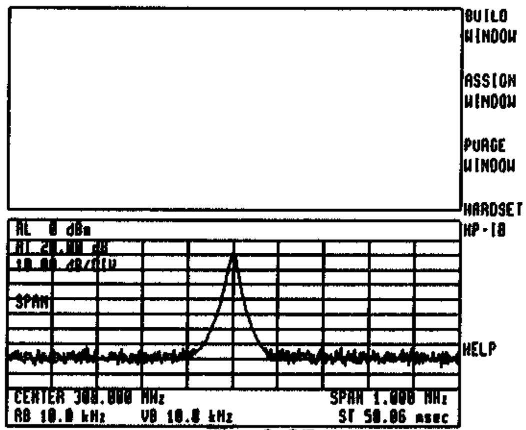


Fig. 2-27.

Press ◀PURGE WINDOW▶, ◀SELECT WINDOW▶, and use the step-keys, knob, or keypad (plus ◀ENTER▶) to select window #1 (the window with the trace displayed).

Press ◀EXECUTE▶. The entire window should disappear as in Figure 2-28.

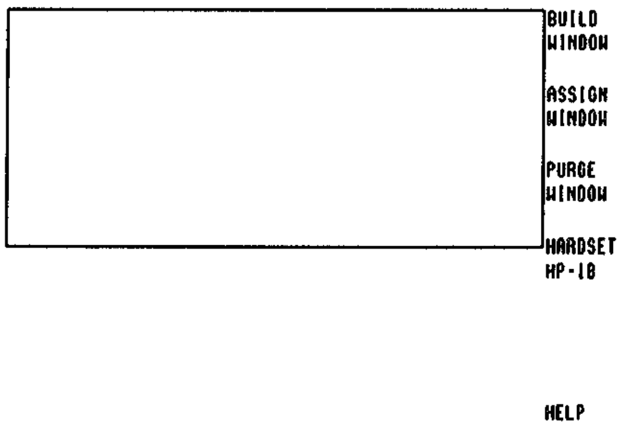


Fig. 2-28.

To remove the second window, press ◂PURGE WINDOW▸, ◂SELECT WINDOW▸ and use the step-keys to select window #2. Press ◂EXECUTE▸ and the remaining window should disappear (see Figure 2-29).

BUILD
WINDOW

ASSIGN
WINDOW

PURGE
WINDOW

HARDSET
HP-IB

HELP

Fig. 2-29.

Note: Windows need not be purged and rebuilt in order to change size. An existing window can be modified simply by using ◂BUILD WINDOW▸.

Hardset/Softset HP-IB

◂HARDSET/SOFTSET HP-IB▸ helps select the HP-IB address that the display will have when the HP 70000 System is next turned "on." Switch the modes back and forth between HARDSET and SOFTSET by pressing the ◂HARDSET/SOFTSET HP-IB▸ softkey.

Note: In the HARDSET mode, the display will power-up with an HP-IB address identical to the HP-MSIB column address (see ◂ADDRESS MAP▸ description).

In the SOFTSET HP-IB mode, the HP-IB address of the display, upon power-up, will be the same as it was before the power was turned off. In fact, that address will be retained even if the instrument is disconnected from the power source and transported.
Example:

Demonstration of HARDSET HP-IB action.

Change the HP-IB address of the display by using ◂SET HP-IB▸. ◂SET HP-IB▸ is available via the keystroke sequence [DSP] and ◂ADDRESS MAP▸. (See the Address Map section within this chapter.) Make sure that the HP-IB address does not match the HP-MSIB column address. (See Figure 2-30.)

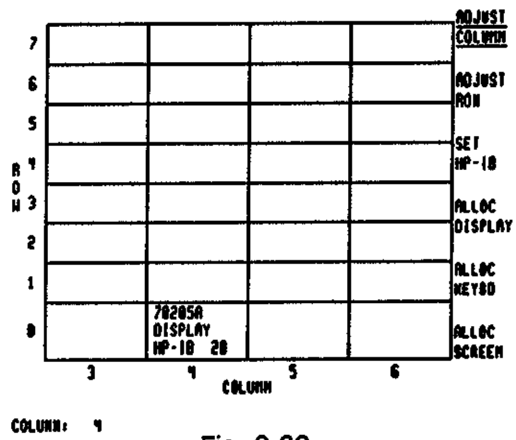


Fig. 2-30.

Press [DSP], ◀CONFIG DISPLAY▶, and ◀HARDSET/SOFTSET HP-IB▶ so that the display is left in the HARDSET mode as in Figure 2-31.

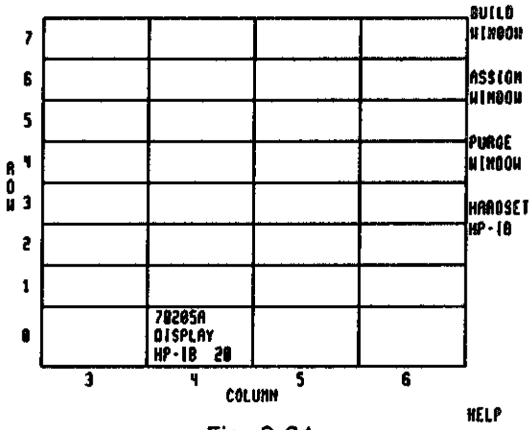


Fig. 2-31.

Turn the system off and then on. Look at the display in the address map by pressing [DSP], ◀ADDRESS MAP▶, and using the knob to move the cursor to the display.

Note that the HP-IB address is now the same as the HP-MSIB column address, as in Figure 2-32.

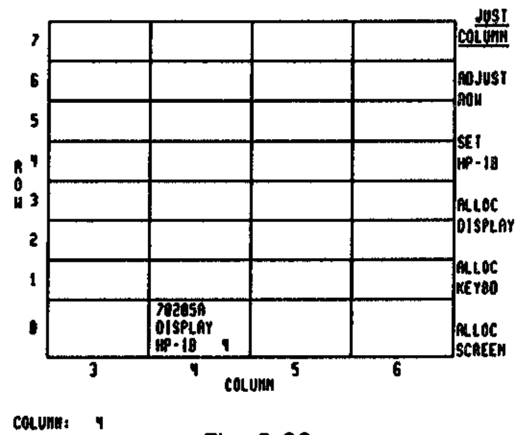


Fig. 2-32.

In the SOFTSET HP-IB mode, the HP-IB address of the display, upon power-up, will be the same as it was before the power was turned off. In fact, that address will be retained even if the instrument is disconnected from the power source and transported.

Example:

Demonstration of SOFTSET HP-IB action.

As in the last example, set the HP-IB address of the display to something other than its HP-MSIB row address.

Select SOFTSET mode by pressing [DSP], ◀CONFIG DISPLAY▶, and ◀HARDSET HP-IB▶. This will toggle the options back and forth between HARDSET and SOFTSET. Leave the display in the SOFTSET mode.

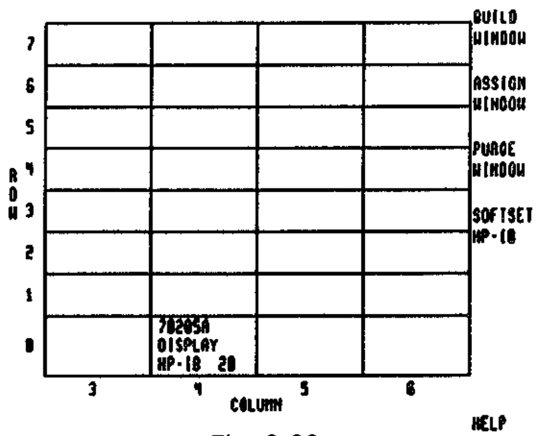


Fig. 2-33.

Turn the instrument off and then on.

Look at the display in the address map by pressing [DSP], ◀ADDRESS MAP▶, and turning the knob to place the cursor on the display.

Note that the HP-IB address is the same as it was before the power was turned off.

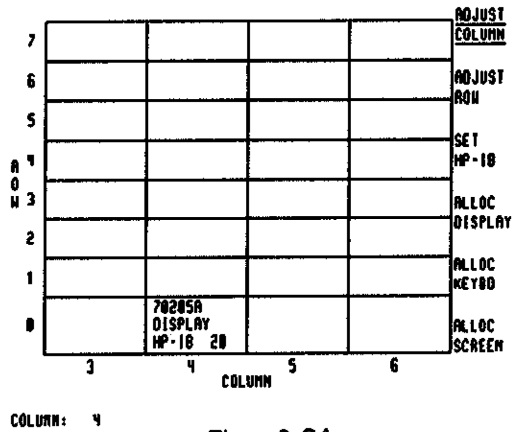
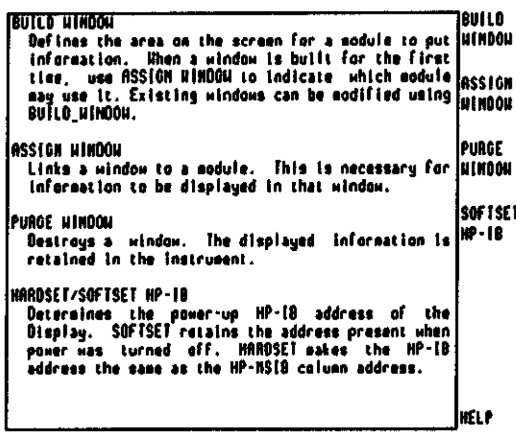


Fig. 2-34.

Note: ◀HARDSET/SOFTSET HP-IB▶ **affects the HP-IB address of the display ONLY, not the spectrum analyzer master module (HP 70900A).** Also, this key affects the address only after the instrument has been shut off and then turned on again, and does not keep the user from changing the HP-IB address of the display or the local oscillator (by means of the ◀SET HP-IB▶ softkey).

Help

This softkey brings up a screen that contains brief descriptions of several ◀CONFIG DISPLAY▶ subkeys.



Show Configuration

The display has five resources that it can "allocate" or "assign" to any of several HP 70000 System elements: these resources consist of a screen composed of up to four windows and one keyboard. The ◀SHOW CONFIG▶ softkey shows the user, at a glance, the following:

* which windows are defined (1 through 4)

* what the dimensions of each window are

* the instrument or module each window is allocated to (i.e., which module can write to a given window)

* which module the keyboard is assigned to

◀SHOW CONFIG▶ not only brings up the current configuration of the display but also shows four other complete display configurations. These configurations reside in continuous-memory registers, so they will be recalled even if the power had been turned off. (See the sections in this chapter on ◀SAVE CONFIG▶ and ◀RECALL CONFIG▶ for more information.)

Example:

Viewing the Current Configuration.

Press [DSP] and then ◀SHOW CONFIG▶. This should result in a screen similar to the one on the right, depending on the windows that have been defined.

In the figure shown, only one window is defined, and it is assigned to an HP 70900A Local Oscillator/Controller module at HP-MSIB address "0,18." The keyboard is also assigned to that module. This is the standard configuration obtained by pressing ◀SELECT INSTR▶.

The window is of standard size; namely, it is 800 pixels wide (911-112 +1) and 368 pixels high (383-16 +1), which leaves room for softkeys. Windows 2, 3, and 4 are undefined.

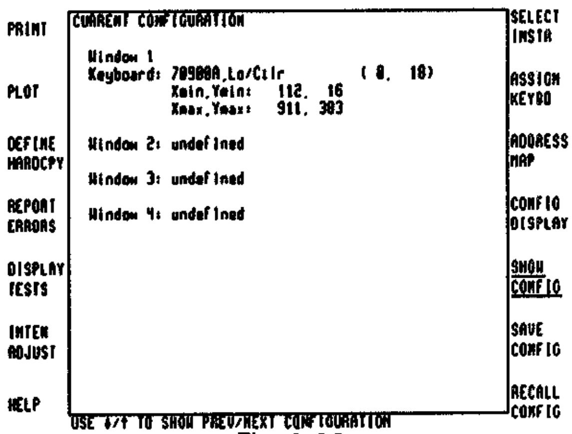


Fig. 2-35.

Example:

Viewing Configuration Registers 1 through 4.

As mentioned earlier, there are four continuous-memory registers that store display configurations. To view these, press [DSP] and ◀SHOW CONFIG▶ (which will display the current configuration).

Press the step-up key. CONFIGURATION REGISTER 1 should appear as in Figure 2-36. Press the step-up key three more times to view CONFIGURATION REGISTERS 2, 3, and 4.

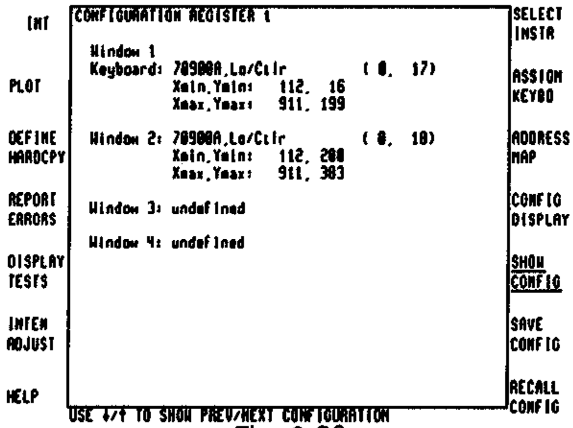


Fig. 2-36.

Note: If the Current Configuration or any of the registers contain only undefined (and unassigned) windows, try using ◀BUILD WINDOW▶ and ◀ASSIGN WINDOW▶ to reconfigure the Display. Then use ◀SAVE CONFIG▶ to store the new configuration. Observe how the changes are shown on the CURRENT CONFIGURATION and CONFIGURATION REGISTER screens by using the ◀SHOW CONFIG▶ softkey. If multiple instruments are available on HP-MSIB, try using ◀ASSIGN KEYBOARD▶.

For example, CONFIGURATION REGISTER 1 shown in the above figure describes the layout of the screen shown in Figure2-37below. The softkeys shown (below) are for the analyzer writing to the bottom window (window #1). This can be inferred from "Keyboard" appearing below "Window 1" in the above figure. Users can determine that window #1 is the bottom window by comparing the Ymin and Y max values for the two windows (see ◀BUILD WINDOW▶).

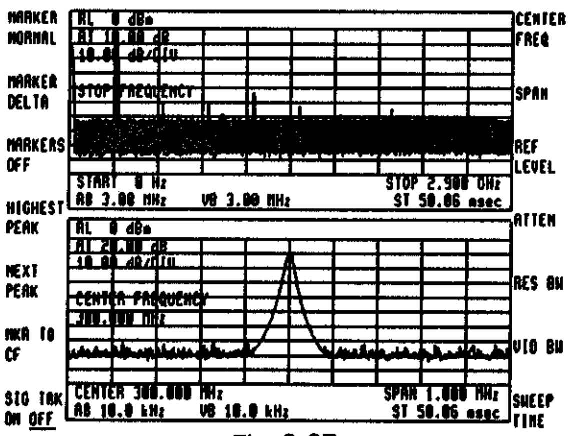


Fig. 2-37.

Save Config/Recall Config

◀SAVE CONFIG▶ stores the complete configuration of the screen windows in a continuous-memory register. Four (4) registers are available, 1 through 4. (See ◀SHOW CONFIG▶.)

Note: The Current Configuration will be retained if the power is turned off, but will be lost if a different configuration is recalled from one of the four registers.

◀RECALL CONFIG▶ lets the user reconfigure the screen to a pre-saved state with only a few keystrokes.

Example:

Saving a screen configuration and recalling it.

Configure a screen with multiple windows, as in Figure 2-38. (See the ◀BUILD WINDOW▶ example.)

Assign an instrument (eg., a spectrum analyzer) to one window. (See the ◀ASSIGN WINDOW▶ section of this chapter.)

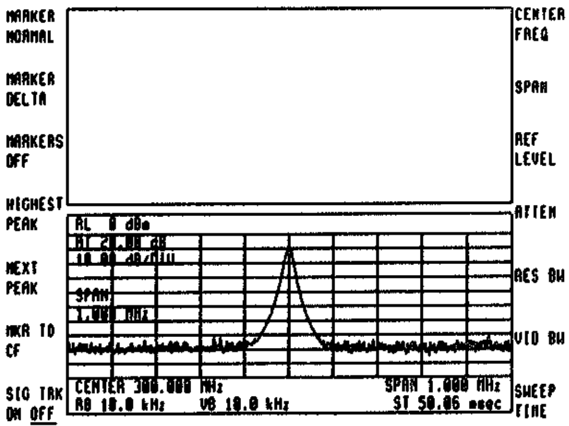


Fig. 2-38.

Save the configuration by pressing [DSP] ◀SAVE CONFIG▶, [1], and then ◀ENTER▶.

Change the current configuration by purging the lower window. Press ◀CONFIG DISPLAY▶, ◀PURGE WINDOW▶, [1], ◀ENTER▶, and ◀EXECUTE▶. The screen should resemble Figure 2-39.

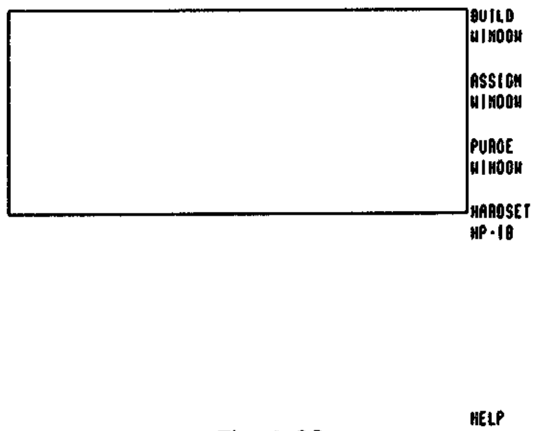


Fig. 2-39.

Recover the original screen by pressing [DSP], ◀RECALL CONFIG▶, [1], and ◀ENTER▶. The recovered configuration should look the same as the configuration that was saved.

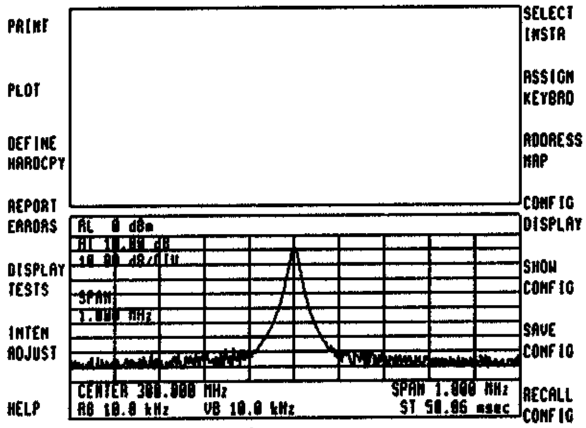


Fig. 2-40.

Print

The ◀PRINT▶ softkey (or [PRINT] hardkey on the HP 70206A System Graphics Display) initiates a raster print dump of the screen (and of the instrument's softkeys if configured to do so).

Example:

Print a copy of the spectrum analyzer display.

Note: To follow this example, you may need to enter the address of you printer into the HP 70000 System and specify whether the softkeys are to be printed. (See ◀PRINTER IS▶ and ◀KEYCOPY ON/OFF▶ under ◀DEFINE HARDCPY▶.)

Enter the address of your HP-IB printer via the ◀PRINTER IS▶ key, available under ◀DEFINE HARDCPY▶. Select ◀KEYCOPY ON/ OFF▶ if desired.

Obtain the spectrum analyzer display you want to print by using the softkeys in the [USR] menu.

Press [DSP] and ◀PRINT▶. The printing process will begin immediately. It can be halted by pressing any front-panel key on the display during the print sequence.

The screen will be frozen (no further sweeps taken) until the data transfer to the printer is complete.

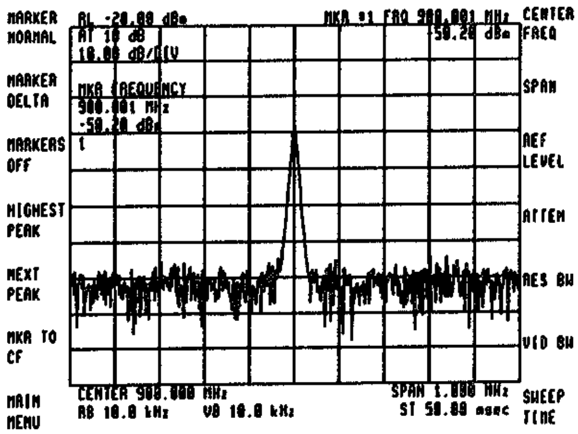


Fig. 2-41 Typical Spectrum Analyzer Hard Copy Output

Notes:

1. When ◀PRINT▶ is pressed, the screen displayed will be printed.
2. The softkeys printed if ◀KEYCOPY ON/ OFF▶ is selected are the last ones displayed that were associated with the **spectrum analyzer**, not the display element. Softkeys available under [DSP] are referred to as "display utility keys" and are not normally shown on hardcopy output.
3. Compatibility: the raster print dump process works with HP raster-format printers (dot-matrix) that can accept printer dumps of at least 384 lines by 512 points; for example, the HP2673A printer and the HP 2225A Thinkjet Printer. (Expand function, in ◀DEFINE HARDCPY▶, requires capability of 384 lines by 1024 points.) Most of the printers that work with the HP200 series computers will work with the HP 70000 System.
4. Direct hardcopy output from the HP 70000 System without a controller requires a display element, either the HP 70205A or HP 70206A.

Plot

Pressing ◀PLOT▶ initiates a vector plot dump over HP-IB to the plotter specified under ◀DEFINE HARDCPY▶. The operation of this key is almost identical to the operation of ◀PRINT▶, but the HP-IB output address of the plotter is set using ◀PLOTTER IS▶ rather than ◀PRINTER IS▶.

Notes:

1. (RE: compatibility) The HP 70205A and HP 70206A Displays require that the plotter implement HP-GL, Hewlett-Packard's Graphics Language. These displays work with potters such as the HP 7470A, HP 7475A, and HP 7090A.

2. Printing is usually faster than plotting; but plotting provides higher quality output.

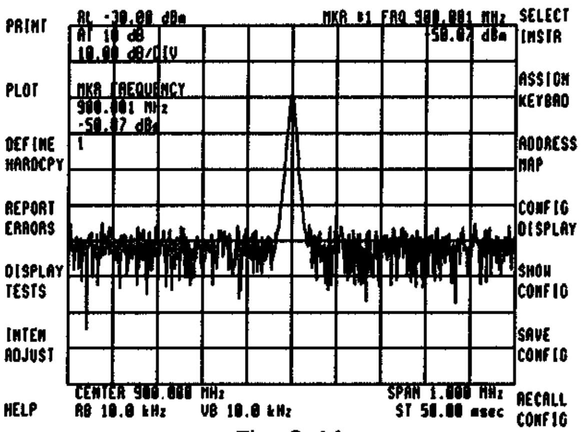


Fig. 2-44

See the ◀PLOTTER IS▶ softkey description to set the plotter parameters, including HP-IB address.

Define Hardcopy

The ◀DEFINE HARDCOPY▶ key allows the user access to several subkeys are used to define parameters for hardcopy output. (See figure 2-43 below.) These parameters include:

* Output Device Address (◀PRINTER IS▶ and ◀PLOTTER IS▶)
* Plotter Working Surface Size (◀PLOTTER PARAMS▶)
  This can be used to change the physical size of plots.
* Formatting Functions (◀KEYCOPY▶ and ◀EXPAND▶)

See subsequent key descriptions for further instructions.

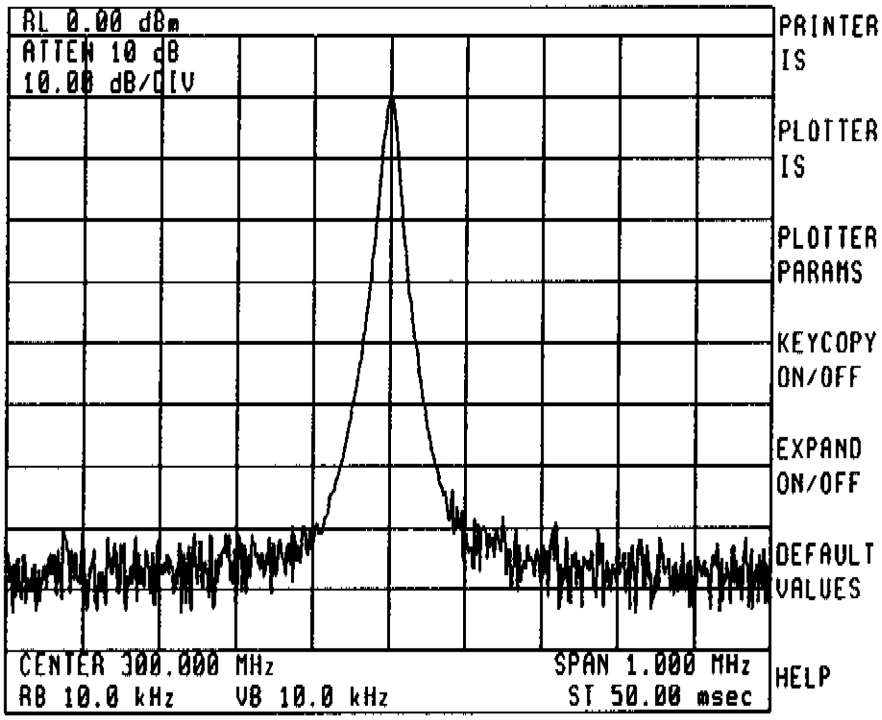


Fig. 2-43. Define Hardcopy Menu

Printer Is

◀PRINTER IS▶ defines the HP-IB address and status of the output printer. The printer's address can be entered as:

* TLK/LSN or "Talk/Listen." (For example, "TLK/LSN 1" means that the display expects the printer to be in Talk/Listen Status at HP-IB address 1.)
* L ONLY or "Listen Only." In this mode the printer is expected to be set to Listen Only on HP-IB. (For instructions, consult the operating documentation for the specific printer to be used.)

Example:

Setting the expected printer address to HP-IB Talk/Listen 01.

Press [DSP], ◀DEFINE HARDCPY▶, and ◀PRINTER IS▶.

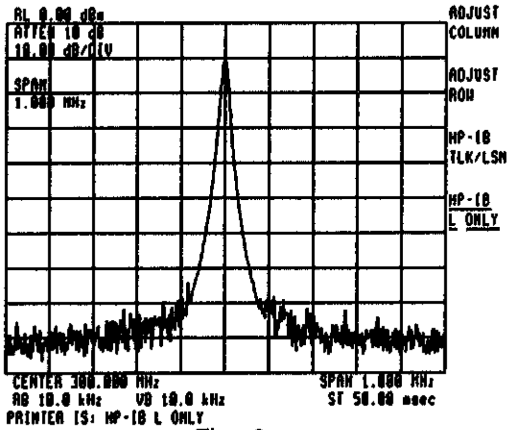


Fig. 2-44.

Select ◀HP-IB TLK/LSN▶ and enter the address 1 (printers are typically addressed at "01").

Next press ◀ENTER▶. The address should change immediately, as in the lower left corner of Figure 2-45.

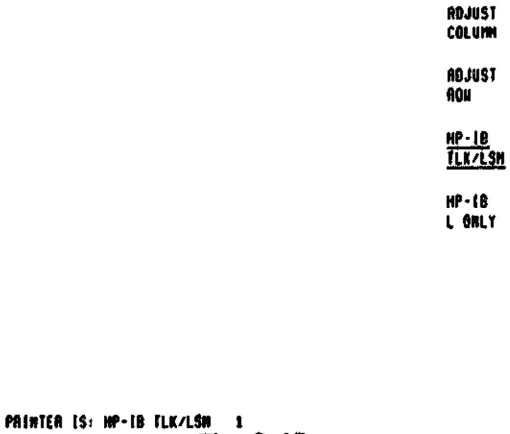


Fig. 2-45.

Notes:

1. To select Listen Only press the softkey so that ◀HP-IB L ONLY▶ is underlined and "PRINTER IS HP-IB L ONLY" is shown in the lower left corner as in Figure 2-46.

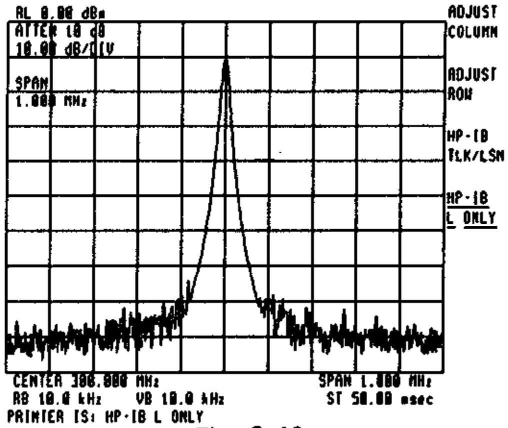


Fig. 2-46.

2. Switching from ◀HP-IB L ONLY▶ back to ◀HP-IB TLK/LSN▶ can change the HP-IB TLK/LSN address to 30. Check the address before you leave the ◀PRINTER IS▶ submenu.

3. ◀ADJUST COLUMN▶ and ◀ADJUST ROW▶ are not used at present. They will be used with future HP-MSIB output devices.

4. For a discussion of printer compatibility, see the ◀PRINT▶ key description.

Plotter Is

◀PLOTTER IS▶ is used to specify the HP-IB address of the hardcopy output plotter. The operation of ◀PLOTTER IS▶ is similar to that of ◀PRINTER IS▶. (Plotters, however, usually have an HP-IB address of 5.)

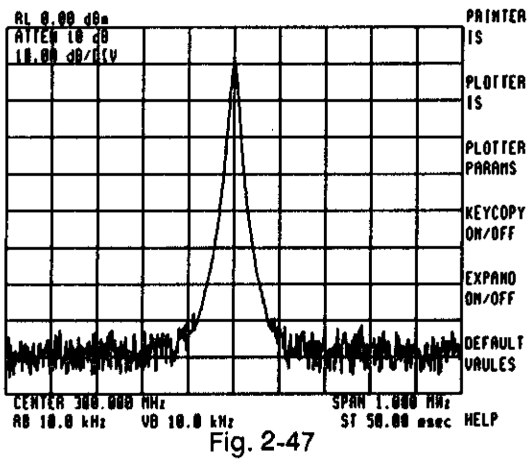


Fig. 2-47

Note: For a discussion on plotter compatibility see the ◀PLOT▶ softkey description.

Plotter Parameters

◀PLOTTER PARAMS▶ is a softkey that allows the user to alter the physical size of hardcopy output plots to Listen Only plotters (or to TLK/LSN plotters if the output is initiated by remote control using the command "CY 1").

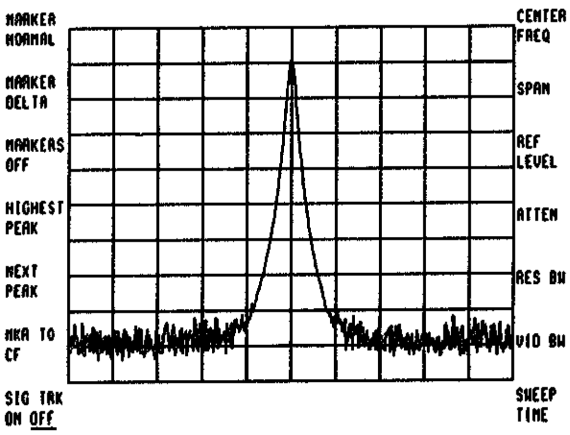


Fig. 2-48. Standard Plot

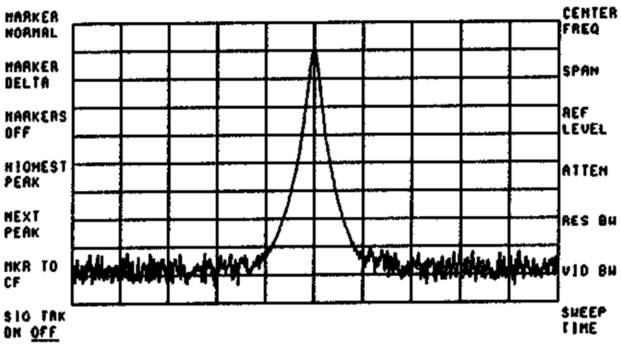


Fig. 2-49. Wider Plot

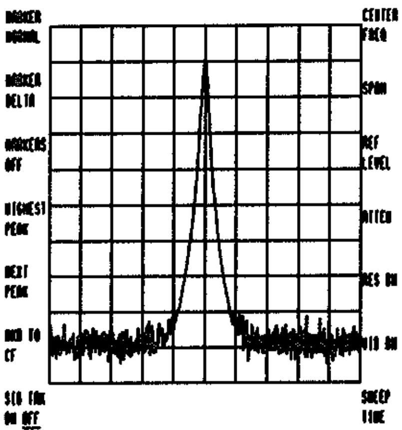


Fig. 2-50. Plot Increased in Height

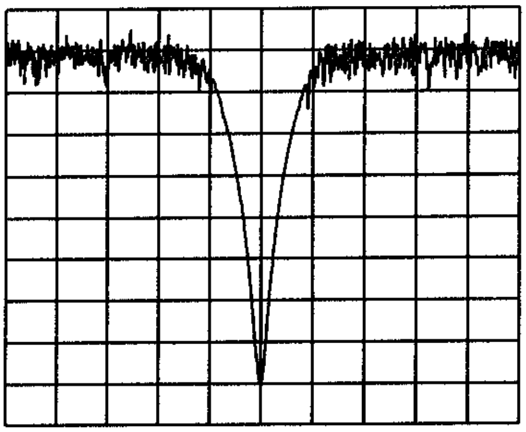


Fig. 2-51. Inverted Plot

On HP Plotters, the physical size and shape of output plots are determined by the locations of the **Scaling Points, P1** and **P2**. These locations are given in Cartesian coordinates; for example, **P1** = 100, 100 and **P2** = 10100, 7600. The actual size of these units depends on the specific plotter used. Typical unit size is 0.025mm, or about 0.001 inch. The units are referenced from the lower left corner of the available plotting surface.

In figure 2-52 the default plotting area for the HP 7475A 6-Pen Graphics Plotter is outlined. **P1** is the lower left corner, **P2** is the upper right corner.

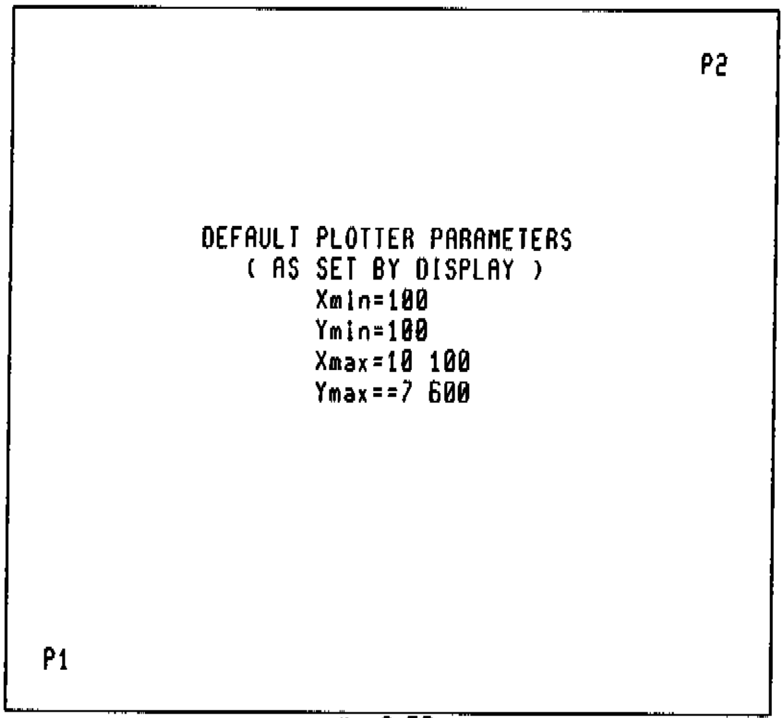


Fig. 2-52.
Plotter Parameters
as Set by HP 70205A and HP 70206A Displays

Notes:

1. To set plotter parameters to their standard default values, press [DSP], ◂DEFINE HARDCOPY▸, and ◂DEFAULT VALUES▸ (see ◂DEFAULT VALUES▸ description in this chapter). Xmin, Xmax, Ymin, and Ymax will be set to the values shown in the figure above (Figure 2-52). These values will allow 0.5 inch margins on 8.5 by 11 inch paper.

2. The plotter parameters are stored in a continuous-memory register; they will be retained even after the power has been turned off. Turning the system off and then on will not set the plotter parameters to their default values. The default values can only be reset by using the sequence in 1 above.

3. Instrument Preset [I/P] does not affect the plotter parameters or any other display features. Plotter parameters are stored in the display, while [I/P] affects only the spectrum analyzer.

4. Plotters may operate differently as a listener (i.e., L ONLY) than as a Talker/Listener (TLK/LSN). Consult the operating instructions for your particular plotter.

Keycopy ON/OFF

◀KEYCOPY ON/OFF▶ enables the spectrum analyzer's softkey labels, status box, and data line to be copied as part of the hardcopy output (to either a printer or plotter).

Example:

Delete softkeys from an analyzer plot.

With ◀KEYCOPY OFF▶ and a plotter connected to the Display via HP-IB, arrange an analyzer screen to be plotted.

Press [DSP] and ◀PLOT▶ on the HP 70205A Display (or the [PLOT] hardkey on the HP 70206A Display). An output plot should appear as in Figure 2-53.

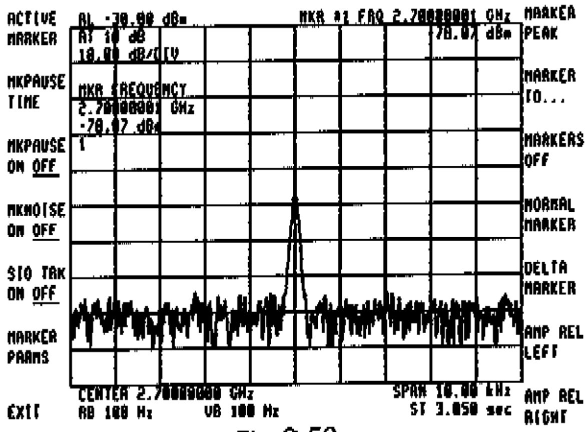


Fig. 2-53.

To delete the keys from the hardcopy output, press [DSP], ◀DEFINE HARDCOPY▶, and ◀KEYCOPY ON/ OFF▶. This should result in ◀KEYCOPY ON/ OFF▶, indicating that key labels will not be plotted. (See Figure 2-54 at right.)

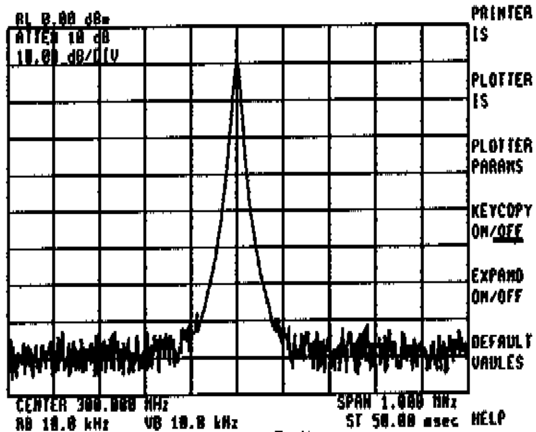


Fig. 2-54.

Now press [USR] or ◀SELECT INSTR▶ and arrange a spectrum analyzer display for the plot.

Press [DSP] and ◀PLOT▶ (or the [PLOT] hardkey on the HP 70206A). The resulting plotter output, as in Figure 2-55, should contain no softkey labels.

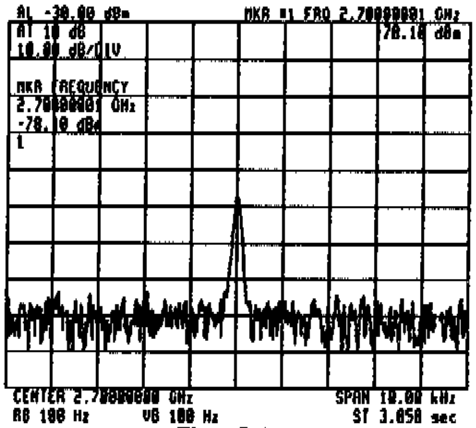


Fig. 2-55.

Notes:

1. ◀KEYCOPY▶ affects key labels only on hardcopy output. It does not remove key labels from the screen.
2. Softkey labels accessible under [DSP] are normally not available for hardcopy output. The key labels that are printed or plotted are the most recent ones displayed by the spectrum analyzer.
3. Annotation other than softkeys can be deleted also, but this is done by the spectrum analyzer, not the display. See the sections on the [MNU] hardkey description and the ◀INST DISPLAY▶ and ◀ANNOT ON/OFF▶ softkey descriptions.

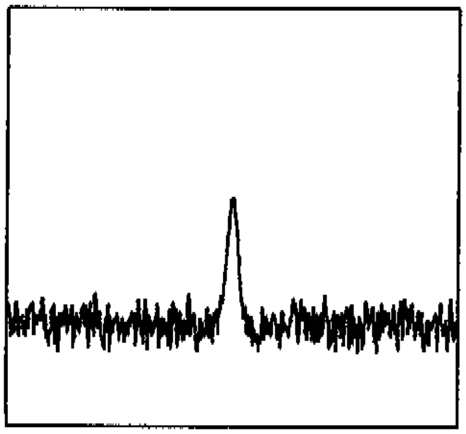


Fig. 2-56 Spectrum Analyzer Output with ◀ANNOT ON/ OFF▶ and ◀KEYCOPY ON/ OFF▶ and ◀GRAT ON/ OFF▶

Expand ON/OFF

The ◀EXPAND▶ option allows the user to obtain higher resolution printouts on certain printers.

To use the ◀EXPAND▶ option, press ◀EXPAND ON/ OFF▶ so that the key appears as ◀EXPAND ON/ OFF▶, then execute a print operation. (See ◀PRINT▶ softkey description.)

Using the EXPAND option in a raster print dump, the HP 70205A and the HP 70206A Displays will put out 384 lines with 1024 points per line.

When the EXPAND option is **not** being used, the displays will put out 384 lines of 512 points per line.

Notes:

1. The higher resolution obtainable with EXPAND is available only on raster PRINT operations. EXPAND does not affect PLOT operations.

2. Not all raster printers can accommodate 384 lines of 1024 points per line. At present, the only Hewlett-Packard printer with a large enough input buffer is the HP Thinkjet Printer.

   When making high-resolution prints with the Thinkjet, the printing operation will be slower than usual. This is due to the process the printer uses to generate the high-resolution output.

Default Values

◀DEFAULT VALUES▶ automatically sets the value of several user-definable parameters for hardcopy output. These parameters and their default values are:

PRINTER: HP-IB Talk/Listen at address 01

PLOTTER: HP-IB Talk/Listen at address 05
Plot limits of Xmin, Ymin = 100, 100
Plot limits of Xmax, Ymax = 10100, 7600

EXPAND: OFF

KEYCOPY: OFF

Note: The default plotter limits are those of the HP 70470A and the HP 7475A Plotters. These allow 0.5 inch margins on standard "A" size paper (8.5 by 11 inches).

Help

The ◀HELP▶ softkey under ◀DEFINE HARDCPY▶ presents a screen of brief descriptions explaining the functions available with other softkeys in the ◀DEFINE HARDCPY▶ menu (see Figure 2-57).

```
PRINTER IS, PLOTTER IS                                      PRINTER
  Defines the address of the printer or plotter.            IS

PLOTTER PARAMS                                              PLOTTER
  Defines the limits used for listen only plotters.         IS

KEYCOPY ON/OFF
  When ON, printer and plotter outputs will copy the        PLOTTER
  softkey labels,  title line, and status box.  When        PARAMS
  OFF, these items will be blanked.

EXPAND ON/OFF                                               UTILITY
  When ON, the printer output will send 384 lines of        COPY ON
  1024 points per line. When OFF, the printer output
  will send 384 lines of 512 points per line.               EXPAND
                                                            ON/OFF
DEFAULT VALUES
  PRINTER IS:     HP-IB TLK/LSN 1
  PLOTTER IS:     HP-IB TLK/LSN 5                           DEFAULT
  PLOTTER PARAMS: P1 = (100,100)   P2 = (10100,7600)        VALUES
  EXPAND:         OFF
  KEYCOPY:        OFF
                                                            HELP
```

Fig. 2-57.

Report Errors

The ◀REPORT ERRORS▶ softkey gives the user a brief description of any error that has been detected by an element on the HP-MSIB.

Example:

Detecting an Illegal Command sent by HP-IB.

Begin by causing an error. Do this by connecting a computer or controller to the HP 70000 system by HP-IB and sending an illegal command. (Example: OUTPUT 718; "XX")

If the HP 70900A Local Oscillator (the Master module of the spectrum analyzer) has an HP-IB address of 18, it will detect an illegal command. An "E" will appear in the Status Box at the lower right-hand corner of the screen, as in Figure 2-58. Also, an error message may appear, in the upper right-hand portion of the screen.

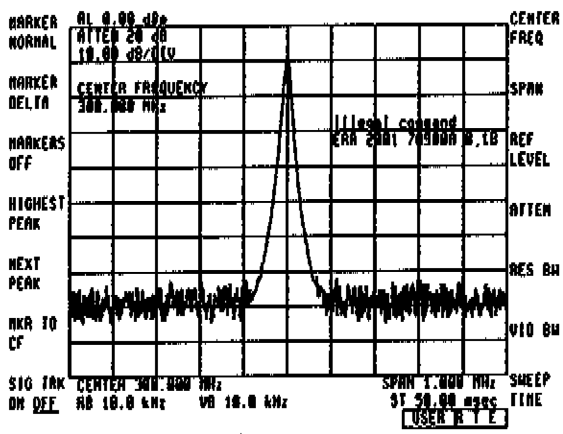


Fig. 2-58

The user can receive the error report by pressing [DSP], then ◀REPORT ERRORS▶. A figure similar to Figure 2-59 appears, and provides the following information:

* which module reported the error (in this case, the HP 70900A LO Module)
* what the HP-MSIB address of that module is (e.g., "0,18")
* an error identification number (e.g., 2001)
* a brief description of the error (e.g., Illegal Command)

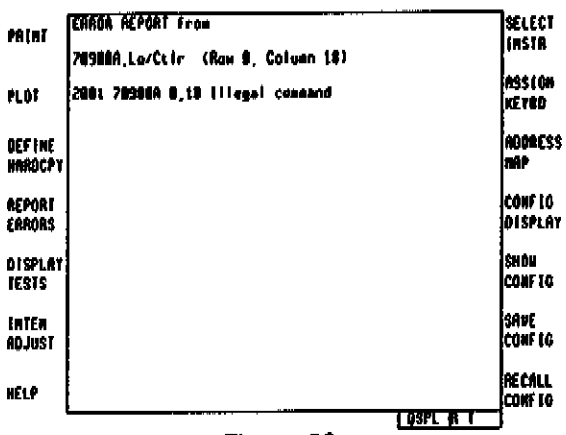


Fig. 2-59.

Most errors reported on the HP-MSIB system are transient errors caused by illegal commands over HP-IB or by violations of the HP-MSIB protocol. These errors, once "reported" via ◀REPORT ERRORS▶, are cleared from memory. Hence they cannot be reported or viewed a second time.

Other errors reported can be "hard" errors. These are caused by hardware problems such as unconnected back panel cables (see the following example) or the failure of an internal component. These problems can affect operation of the instrument, and cannot be cleared from memory until corrected.

Example:

Reporting and correcting a Hardware Error.

If the back panel connection (labeled "300MHz") between the Local Oscillator module (HP 70900A) and the RF section (HP 70904, 5, 6, or 7) is removed, an error is detected by the RF Section and shown on the screen. (See Figure 2-60.)

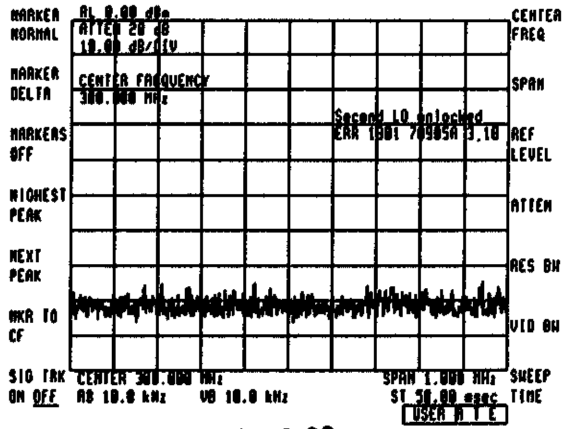


Fig. 2-60.

If [DSP] and ◀REPORT ERRORS▶ are pressed, the error screen is shown, but the error is not cleared from memory as indicated by the presence of the "E" in the Status Box (see Figure 2-61).

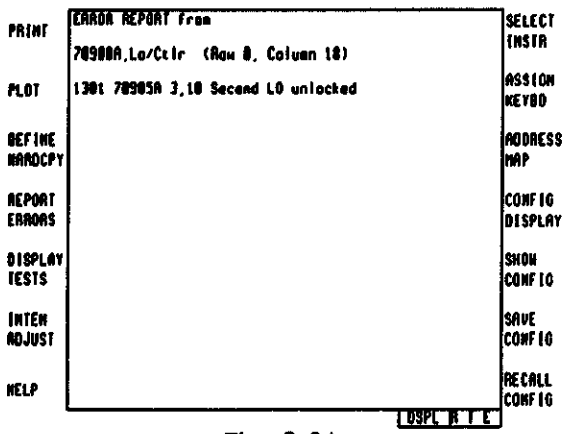


Fig. 2-61.

Note that even if the hardware-related error is corrected at this point, it must be "reported" again to clear the system.

Thus, press ◀REPORT ERRORS▶ to clear the system and remove the "E" from the status box.

Hardware-related errors must be "reported" AFTER they have been corrected in order to clear them from memory. This has been done for the figure at the right.

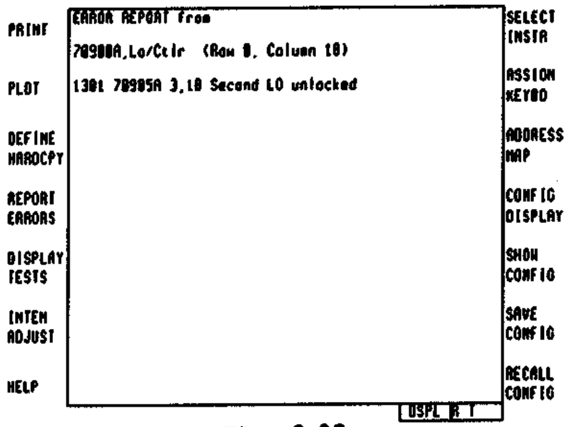


Fig. 2-62.

Example:

Clearing Error Reports from Multiple Instruments.

If a system contains multiple instruments, each instrument will independently report the errors it detects.

For example, send an illegal command via HP-IB to both the the display and the spectrum analyzer.

```
OUTPUT 704; "XX"
OUTPUT 718; "XX"
```

This results in an "E" in the Status Box, just as with a single error.

After pressing [DSP] and ◀REPORT ERRORS▶, the error detected by the module with the lowest column address is reported first (and cleared from memory if it is only a transient error).

Notice that instead of the usual softkey menu under [DSP], ◀MORE ERRORS▶ appears on the screen and the "E" remains in the status box (Figure 2-63). The second error has not been reported yet.

Press ◀MORE ERRORS▶, and the last error is reported (and cleared if it is only a transient error).

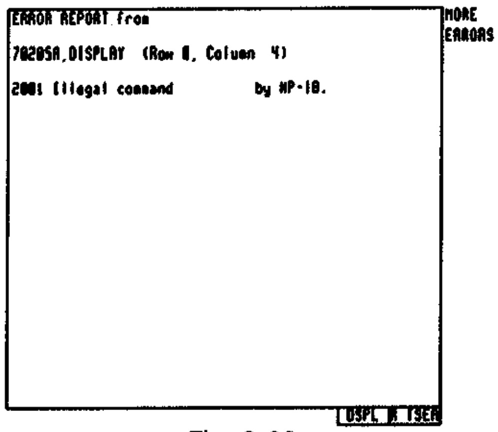


Fig. 2-63.

Note: Some transient errors can be cleared by pressing [USR], [MNU], or by pressing [DSP] and ◀REPORT ERRORS▶.

Display Tests

The ◀DISPLAY TESTS▶ softkey gives the user access to a submenu of keys that provide operational tests of the HP 70205A or HP 70206A Displays themselves, their internal operation, and the keypad and knob.

Figure 2-64 shows the softkey submenu that appears when ◀DISPLAY TESTS▶ is pressed.

See the following pages for a description of each ◀DISPLAY TESTS▶ subkey and its operation.

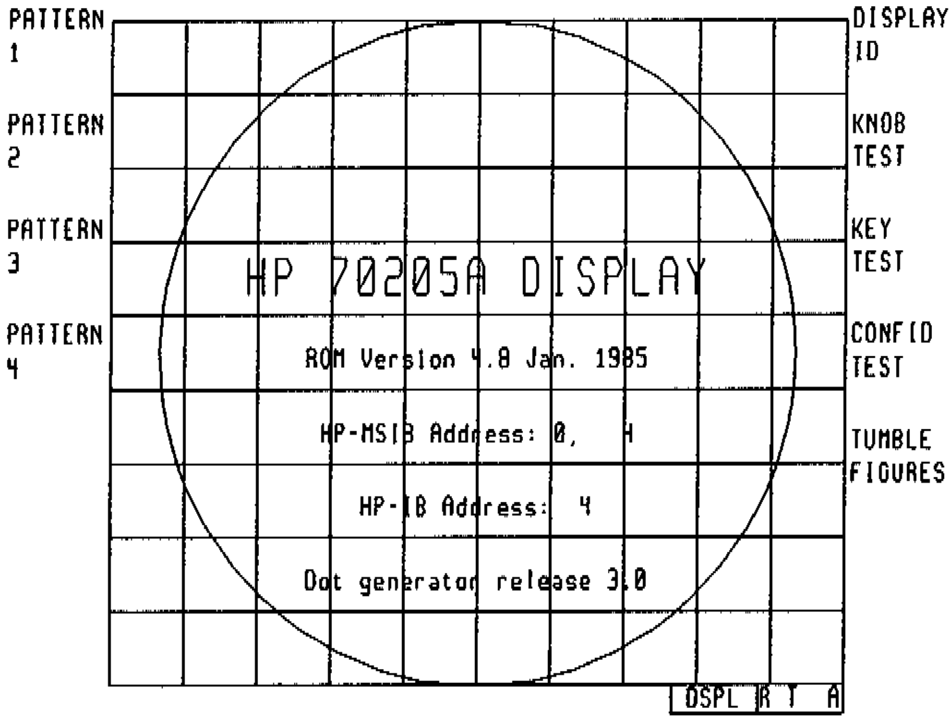


Fig. 2-64. Display Tests Menu

Display Id

The ◀DISPLAY ID▶ softkey brings up an identification screen similar to the figure above. This provides:

1. Basic verification of display operation.

2. Display model number (e.g., HP 70205).

3. ROM firmware version of the display.
   Note: This does **not** provide the ROM version of other modules. For that information, see the appropriate section of the operating instructions for that module. For instance, the local oscillator's ROM version is available by pressing [MNU], ◀CONFIG▶, and ◀ROM VERSION▶.

4. HP-MSIB address (row, column) of the display.

Note: Both displays can only have a row address of zero. The factory-shipped default address is Row 0, Column 4 (0,4).

5. HP-IB address of display.
   Note: This does not necessarily correspond to the HP-MSIB column address. To change the address of any HP-IB enabled module (HP 70900A or displays at present) see the operating instructions in this chapter for the ◀SET HP-IB▶ softkey, which is available under ◀ADDRESS MAP▶.

6. Dot Generator Release code (e.g., 3.0). (This is provided for firmware updating purposes.)

Knob Test

The ◀KNOB TEST▶ softkey brings up a test pattern similar to the one shown in Figure 2-65.

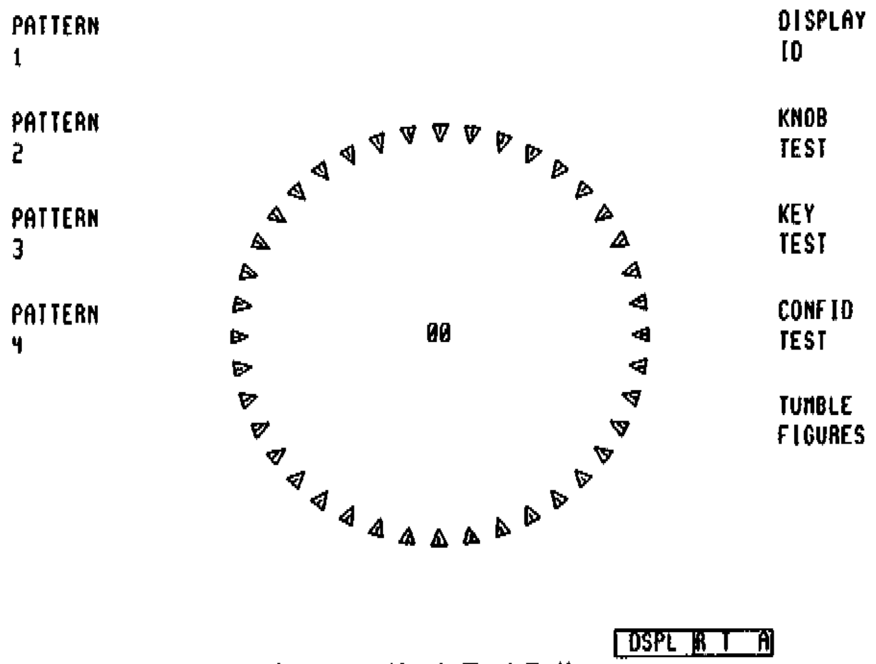


Fig 2-65. Knob Test Pattern

As the knob is turned, the test pattern rotates in a digital fashion. This provides a test of the mechanical and electrical operation of the display knob. Note that the step-keys will rotate the pattern but the numeric entry keypad will not.

Key Test

The ◀KEY TEST▶ softkey allows the user to check the mechanical and electrical operation of every front-panel key on the display.

To use ◀KEY TEST▶:

*Press [DSP], ◀DISPLAY TESTS▶, and ◀KEY TEST▶.

*Press any key on the display's front panel and it will be "echoed" on the screen if it is working properly.

*Exit this function by pressing the back space (back-arrow) hardkey.

```
                    KEYBOARD TEST

To test the keyboard, press each key.  After the key
is pressed the key function/label will be displayed.
Menu key #1 is the upper right menu key, menu key #8
is the upper left menu key. The left arrow key exits
the routine.



          Key pressed: Menu key #  1
```

Fig 2-66.

Confidence Test

The Display Confidence Test, initiated by pressing the ◀CONFID TEST▶ softkey, checks the operation of roughly 90% of the display unit, excluding I/O circuitry. If no fault is found, "CONFIDENCE TEST PASSED" appears in the lower left corner of the screen.

If an error is detected, refer to the System Support Manual.

Tumble Figures

◀TUMBLE FIGURES▶ provides a menu of several keys that show rotating 3-dimensional figures.

* To change the size of the figures, turn the display knob.
* To change the speed of rotation about the three spatial axes, press three consecutive numeric keys; for example, press "999" for rapid rotation and "000" to halt rotation.
* To exit this fuction, press the back space (back-arrow) key.

Patterns 1 - 4

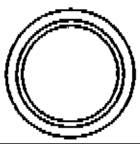
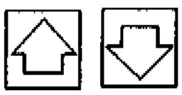
The softkeys ◀PATTERN 1▶ through ◀PATTERN 4▶ produce test patterns used in screen alignment procedures that are described in the System Support Manual.

Intensity Adjust

◀INTEN ADJUST▶ allows the user to change the brightness of the writing on the screen. Brightness is incrementally adjustable from 0 to 19 in steps of 1.

Caution: To extend the life of the display tube, reduce the intensity at high temperatures (55C).

The three methods of adjusting the intensity are shown below:

KNOB		Adjusts the intensity continuously from 0 (dark) to 19 (bright).
STEP KEYS		Increases or decreases the intensity in steps of 1.
KEY PAD	0 1 2 3 4 5 6 7 8 9	Allows entry of exact intensity level. The value must be followed by ◀ENTER▶. The allowable values are from 0 to 19.

Help

The ◀HELP▶ softkey under [DSP] provides three "pages" of information about the operation of the other top-level softkeys directly accessible under [DSP]. (See the figures below.)

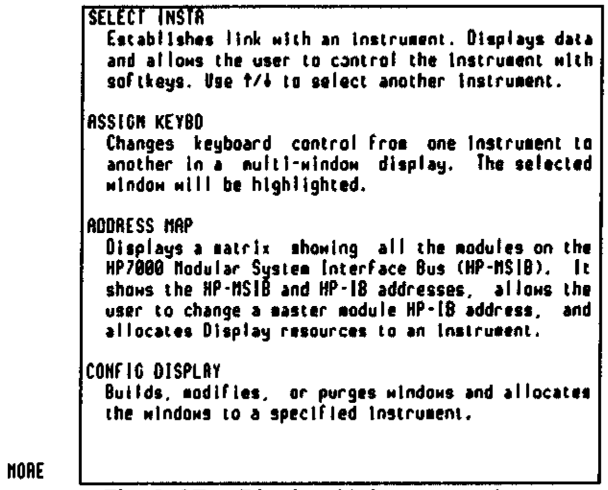


Fig. 2-67. Display Help: page 1

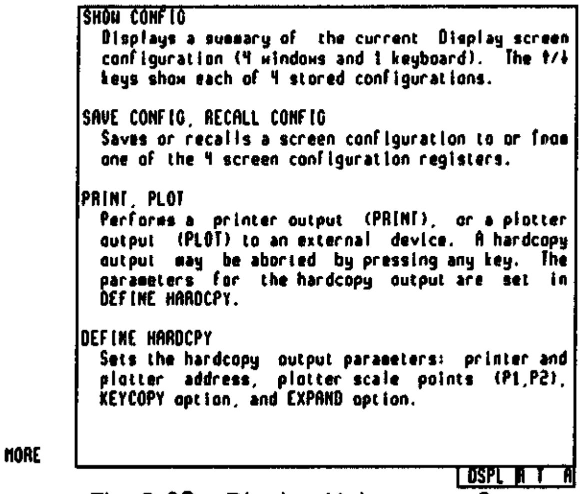


Fig. 2-68. Display Help: page 2

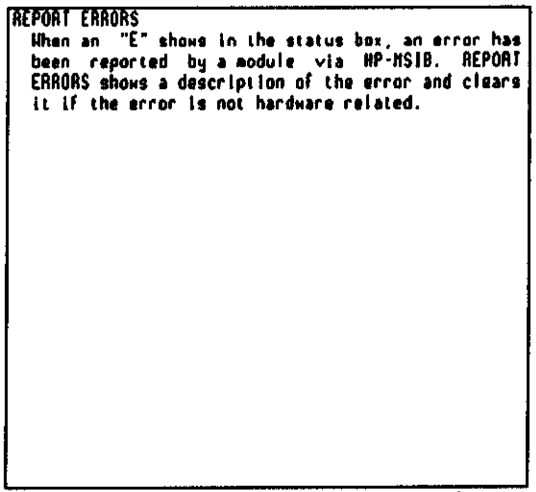


Fig. 2-63. Display Help: page 3

CHAPTER 3

REMOTE DISPLAY OPERATION

DESCRIPTION: This chapter discusses the remote operation of the HP 70205A Graphics Display and the HP 70206A System Graphics Display by remote computer control over HP-IB.

Introduction

Chapter 3 covers remote operation of the HP 70000 series displays. For general information on the two display models, see Chapter 1, Introduction, in this part of the Operating Manual. For instructions on manual operation see Chapter 2, DSP Hardkey (Manual Display Operation). All capabilities and commands covered in this chapter are accessible with a computing controller over HP-IB. From the point of view of remote operation, both displays (HP 70205A and HP 70206A) are essentially identical. Any differences will be described in the text.

This chapter discusses different capabilities of the display accessed through remote operation. Capabilities are accessed by one or more two-letter commands, some of which require alphanumeric parameters: e.g. "PD" (Pen Down), or "RC4" (Recall Screen Configuration from Register #4). The complete set of these commands comprises the HP 70000 Series Graphics Language: which contains (as a subset) HP-GL, the Hewlett-Packard Graphics Language.

Note: Programming techniques for the HP 71000 Series spectrum analyzers are discussed in Part II, Remote Operation. The second chapter of Part II, Programming Fundamentals, contains instructions for imitating manual operation. Chapter 3, Advanced Programming, describes techniques for making computations, measurements, and graphics.

Below is a list of the sections found in this chapter (Chapter 3, of Part III) and a brief description of each:

1. **Display Configuration:** Discusses remote techniques for building and assigning windows on the screen, saving and recalling screen configurations, and interrogating the display about its present configuration. For a more detailed description of the windowing concepts, see Chapters 1 and 2 in this part of the Operating Manual.

2. **Simple Graphics:** Shows how to use the screen of the display like a plotter. Covers pen control, line-type selection, plotting, graphing, scaling of the screen or window, and drawing of axes and graticules.

3. **Labeling the Screen:** Demonstrates the labeling of any type of display and the manipulation of the label, including rotation, relocation, and enlargement.

4. **Hardcopy Output:** Shows how to obtain hardcopy output of the display screen with an external device such as an HP 7470A or 7075A Plotter, or an HP 2673A Printer. Covers the initiation of an output operation, selection of the output device on HP-IB, and the option of including the softkey labels in the output.

5. **Markers:** Demonstrates the selection and placement of a character on the screen as a marker, either for annotation or prompting.

6. **Character Sets:** Covers the use of either the standard character set or a set of the user's creation. This capability can be used to create one or more customized characters such as special markers or logos.

7. **Referenced Graphics:** Discusses the concept and use of a new graphics capability called Referenced Graphics. With this capability, items on the screen such as axes, figures, and labels can be logically grouped together and manipulated as a single entity. The group as a whole can, for example, be moved, turned on or off, deleted, or made to blink. Referenced graphics capability is not included in HP-GL.

8. **Informational Displays:** Discusses some of the informational screens that can be displayed, such as the Address Map, the Screen Configuration, and the Error Screen. See Chapter 2 for a further explanation of these features from the point of view of manual operation.

9. **Error Handling:** Discusses how the display can be used by a controller to report errors over HP-IB or on the screen for direct operator viewing. Modules in the HP 70000 system report all the detected errors to the display.

10. **Utility Commands:** Contains examples, descriptions, and demonstrations of other graphics capabilities of the HP 70000 Series Displays. These include direct and system-wide features such as Page Clearing, Learn Strings, and Beeping.

11. **The Display as a Remotely-Controlled User Interface:** This section shows how softkey labels can be loaded in a computer window, how alphanumeric entries can be received, and how user operation can be simulated, all by remote control.

Note: This document uses brackets ([XXX]) to represent hardkeys and diamonds (◂XXX▸) to represent softkeys. It uses HP 200 Series BASIC Language in all examples.

HP-IB Address

The Display is accessed remotely over HP-IB at its own address, separate from that of any instrument in the HP 70000 system. See the Address Map section in Chapter 2 for more general information on HP-IB and the display.

To find the HP-IB address of the display, press the following keys: [LCL], [DSP], and ◂ADDRESS MAP▸.

Turn the knob until the display element is highlighted. An "A" will appear in the status box in the lower right corner of the screen.

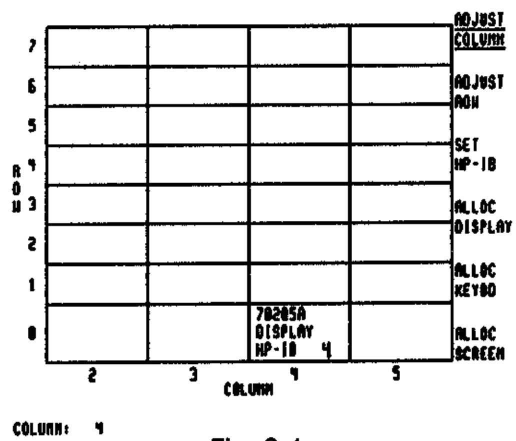


Fig. 3-1.

This display shows an instrument address of 4.

The HP-IB address (also known as the device selector code) is formed by combining the interface select code (7) with the instrument address (4 in this case). The display's factory-shipped HP-IB address in the example, 704, will be used throughout this chapter. If the HP-IB address of your display is different, substitute the appropriate value.

Note: The HP-IB Address can be determined only through manual operation.

Section 1: Display Configuration

The resources of the display can be configured either manually or remotely by the user to meet various testing needs. These resources and capabilities are discussed in general in Chapter 2, DSP Hardkey (Manual Operation of Display), under the ◂CONFIG DISPLAY▸ softkey description. In brief, the resources of the display include one keyboard and up to four separate windows on the screen. Any window can be assigned to any instrument on HP-MSIB or to a controller on HP-IB. The keyboard is typically associated with one window, although it can be independent.

The HP 70000 Series Graphics Language commands that pertain to Display Configuration are listed and described below and demonstrated in the following example. Some command descriptions assume prior definition of other commands or concepts. These other commands are described elsewhere in this chapter (see the Display Command Summary in Chapter 4 for the location) and general concepts of display operation are covered in Chapters 1 and 2.

Assign Keyboard: AK window #

The AK command allows the controller to allocate the keyboard of the display to one of the four existing windows. If an instrument such as a modular spectrum analyzer is writing to that window, the keyboard can be used to control instrument settings such as Center Frequency and Span.

window # = 1 through 4

Build Window: BW Window#,X1,Y1,X2,Y2,Bus,Row,Col,Keyboard Control

BW constructs a window on the screen, assigns the window to an HP-MSIB element or to HP-IB, and determines whether the keyboard is similarly assigned or not.

Window # = 1 through 4

X1,Y1 X2,Y2: coordinates of window vertices

Bus = 0: HP-IB (Window to be used by HP-IB controller)
Bus = 1: HP-MSIB (Window assigned to modular instrument)

Row, Col: HP-MSIB address of controlling module if window is assigned to one. These two parameters are ignored if window is used for HP-IB.

Keyboard Control = 0: Keyboard control unaffected, keyboard not necessarily associated with window.
Keyboard Control = 1: Keyboard linked with window, and can be used to control the modular instrument the window is assigned to.

Delete Entire Screen: DE (no parameters sent)

DE clears the entire screen of all writing, softkeys, windows, and keyboard assignments. All displayed data and current configuration information is lost. DE is useful for clearing the display before building windows.

Default Values: DF (no parameters sent)

DF sets certain display parameters to their default values. These parameters and their values are shown below. Note: If the sender (either an HP 70900A Control Module or an HP-IB controller) does not have a window assigned, only the Input Mask value is reset.

HP-GL Parameters: Line Type--Solid Line; Pen 1; Pen Up; Delta X=1; Standard character size; Standard and alternate character sets both 0; Input Mask (IM)=159,32,0.

Non- HP-GL Parameters: Group 1; Item 0; Blink Off; View On; Display Status Indicator On; Mapping Method (MP) Anisotropic.

Initialize: IN (no parameters sent)

IN sets the Display to an initial power-on state. It clears data from the windows and sets default values as described by the DF command. IN does not alter screen configuration.

Output P1,P2: OP (no parameters required, but response sent by display)

OP interrogates the display for the vertices, in display units, of the window that is currently assigned to HP-IB. The display responds over HP-IB with the values of X1, Y1, X2, and Y2, respectively. See the example in this section and the description of windowing in Chapter 2 under ◀CONFIG DISPLAY▶.

Recall Screen Configuration: RC register #

RC recalls the screen configuration (window sizes and assignment, and keyboard assignment) from the specified register (1 - 4). Operates similarly to the ◀RECALL CONFIG▶ softkey described in Chapter 2.

Show Configuration: SN register #

SN shows a summary of the display screen stored in registers 1 - 4, or in the current configuration (with register number = 0). A value of -1 exits the mode. SN works similarly to the ◀SHOW CONFIG▶ softkey described in Chapter 2.

Note: The configuration summary will remain on the screen until cleared by sending SN without an argument or by sending "SN -1."

Save Configuration: SV register #

SV saves the screen configuration in one of four registers (1 - 4). SV works similarly to the ◀SAVE CONFIG▶ softkey described in Chapter 2.

Example:

Building a Window and Finding P1,P2

Type in and run the following demonstration program on an HP-IB computing controller. Note: This example, like most others in this chapter, uses HP BASIC language and assumes an HP-IB address of 704 for the Display and 718 for an HP 71000 series Modular Spectrum Analyzer (HP-MSIB address 0,18 for the Local Oscillator/Control Module).

```
10  REMOTE 7
20  ASSIGN @Dsp TO 704
                    (DISPLAY'S HP-IB ADDRESS)
30  ASSIGN @Sa TO 718
                    (ANALYZER'S HP-IB ADDRESS)
40  OUTPUT @Dsp;"DE;"
                    (CLEAR THE SCREEN)
50  OUTPUT @Dsp;"BW 1,112,16,911,195,0,0,0,1;"
                    (BUILD WINDOW #1 IN BOTTOM HALF OF SCREEN,
                     ASSIGN TO HP-IB)
60  OUTPUT @Dsp;"OP;"
                    (INTERROGATE FOR X1,Y1,X2,Y2)
70  ENTER @Dsp;X1,Y1,X2,Y2
                    (RECEIVE COORDINATES)
80  DISP X1,Y1,X2,Y2
                    (CONTROLLER SHOWS 112,16,911,195)
90  PAUSE
                    (PRESS "CONTINUE" ON CONTROLLER)
100 OUTPUT @Dsp;"SN0;"
                    (SHOW CURRENT CONFIGURATION ON SCREEN)
110 PAUSE
                    (PRESS "CONTINUE" ON CONTROLLER)
120 OUTPUT @Dsp;"SN;"
                    (CLEAR SCREEN OF CONFIGURATION SUMMARY)
130 OUTPUT @Dsp;"BW2,112,205,911,383,1,0,18,1;"
                    (BUILD WINDOW #2 IN TOP HALF OF SCREEN,
                     ASSIGN TO ANALYZER AT HP-MSIB ADDRESS 0,18
                     WITH KEYBOARD)
140 OUTPUT @Sa;"IP;TS;"
                    (PRESET INSTRUMENT, TAKE SWEEP.
                     TRACE DATA WILL BE DISPLAYED IN WINDOW)
150 PAUSE
                    (PRESS "CONTINUE" ON CONTROLLER)
160 OUTPUT @Dsp;"SN0;"
                    (SHOW NEW SCREEN CONFIGURATION)
170 END
```

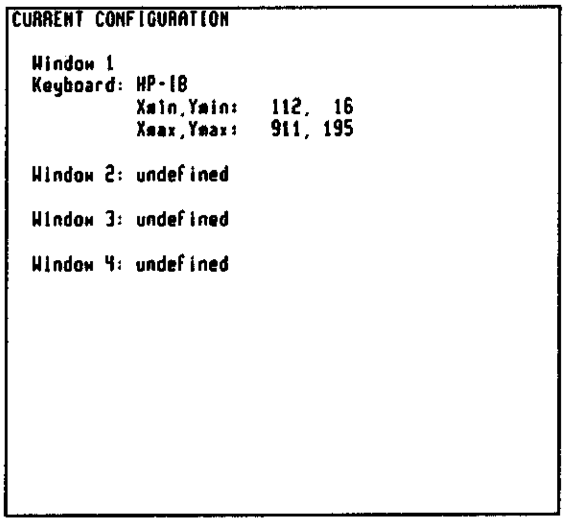


Fig. 3-2. Result of SNO after building one window

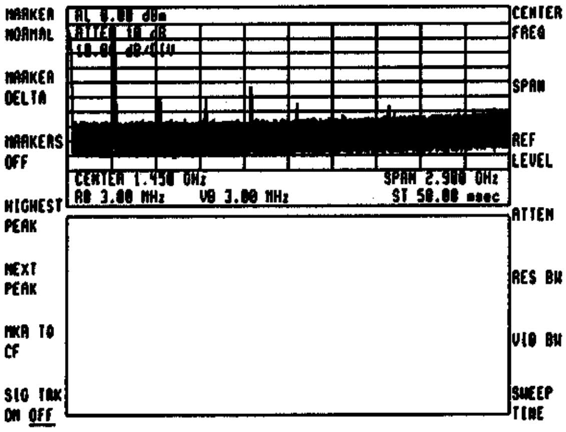


Fig. 3-3. Two-window screen generated in example program.

Section 2: Simple Graphics

The HP 70000 Series Displays can be used like an HP-GL plotter by a remote controller. The user can:

* Draw simple figures on the screen using various line types.
* Plot points by their X,Y coordinates.
* Graph sequential values such as those from an array.
* Change the shape and scale of drawings.
* Draw graticules or axes with a single command.
* Initialize the window to a preset condition.

This section is divided into the following subsections that deal with various simple graphics capabilities:

Pen Control: Covers commands PD (Pen Down), PU (Pen Up), SP (Select Pen), and LT (Line Type).

Plotting: Covers commands PA (Plot Absolute) and PR (Plot Relative).

Graphing: Covers commands GA (Graph Absolute), GR (Graph Relative), and DX (Set Delta - X).

Scaling and Shape: Covers commands SC (Scale to user units) and MP (Mapping Shape).

Axes and Graticules: Covers commands AX (Create Axis) and GT (Create Graticule).

PEN CONTROL

Although the actual lines on the display screen are "drawn" by an electron beam, the term "pen" is used for graphics in two separate contexts. First, terms like "Pen Up" and "Pen Down" mean "turn off the beam" or "turn on the beam." Second, the "Select Pen" command (SP), while not affecting the lines drawn on the screen, indicates which of the plotter's ink pens is to be used for drawing, in anticipation of display-to-plotter output operations.

The pen control commands are described below and shown in the example.

Pen Up: PU (no parameters needed)

Suspends line drawing regardless of pen movement until the PD command is sent or the pen status is otherwise reset.

Pen Down: PD (no parameters needed)

Restarts the line drawing following a PU command.

Select Pen: SP pen #

On a monochromatic display such as the HP 70205A or HP 70206A Graphics Displays, SP affects operation only when the display performs a plotter output operation. The actual pen selected will depend on the plotter used. "Pen #" can range from 0 to 255, with 0 as the default value.

Line Type: LT type, length

LT selects the type of line used for on-screen graphics. The line types are shown below. Note that some plotters may not be support all line types. The line-type default is a solid line.

Type	Line
0	dots only at points plotted
1	. . . .
2	-- -- --
3	--- --- ---
4	--- . --- . ---
5	--- - --- - ---
6	--- - - --- - - ---

The line-type parameter "length" is measured in the currently used scale units (see the SC command).

PLOTTING

Plotting can be thought of as moving a pen from its present position to another specified position. Obviously, pen control is important. If the pen was down before the plot operation, a line will be drawn from the starting point to an endpoint specified in the PA or PR command. If the pen is up, no line will be drawn, but the pen will be located at the new endpoint.

Note: A controller writing on the screen over HP-IB may plot anywhere on the screen, and is not necessarily restricted by window size.

Plot Absolute: PA X1, Y1, ... Xn, Yn

The PA command moves the pen to a specific point on the screen, specified in the current scale units (see SC command description later in this chapter).

The screen is considered to be a grid of points, any of which can be the endpoint of a PA command. Each point has an X and Y value. In the standard display units, the lower left corner of the display screen has coordinates X = 0, Y = 0, and the upper right corner has coordinates X = 1023, Y = 383. With user units, the scaling points of each window can be set separately to any chosen X,Y.

Example:

Using the PA command to draw a box. Execute the following program from an HP-IB controller:

```
10  ASSIGN @Dsp TO 704
                  (DISPLAY'S HP-IB ADDRESS)
20  CLEAR @Dsp
30  OUTPUT @Dsp;"IN;"
40  OUTPUT @Dsp;"DE;"
                  (CLEAR THE SCREEN)
50  OUTPUT @Dsp;"SC;"
                  (SELECT DEFAULT DISPLAY UNITS,i.e.1023x383 UNITS)
60  OUTPUT @Dsp;"PU;PA 100,100;"
                  (MOVE PEN TO LOWER LEFT CORNER)
70  OUTPUT @Dsp;"PD;"
                  (PREPARE TO DRAW A BOX)
80  OUTPUT @Dsp;"PA 900,100,900,300;"
                  (PLOT BOTTOM AND RIGHT SIDES OF BOX)
90  OUTPUT @Dsp;"PA 100,300,100,100;"
                  (PLOT TOP AND LEFT SIDES)
100 OUTPUT @Dsp;"PA 500,200;"
                  (DRAW LINE TO CENTER OF BOX)
110 OUTPUT @Dsp;"PU;PA 700,250;PD;PA 900,300;"
                  (DRAW BROKEN LINE TO TOP RIGHT CORNER OF BOX)
120 END
```

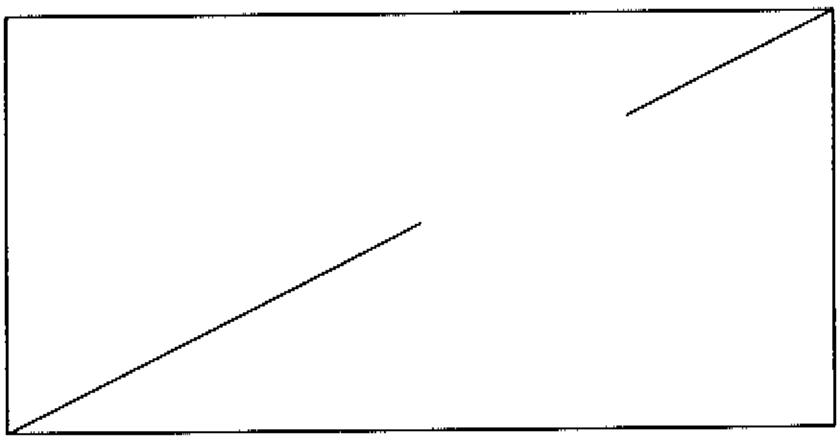


Fig. 3-4. Result of PA example program.

Plot Relative: PR Xincrement1, Yincrement1...Xincrementn,Yincrementn

The Plot Relative command moves the pen Xincrement units to the right and Yincrement units up from its starting position. The currently defined units are used. See the following example for a demonstration.

Example:

Relative Plotting

```
10  ASSIGN @Dsp TO 704
                    (DISPLAY'S HP-IB ADDRESS)
20  CLEAR @Dsp
30  OUTPUT @Dsp;"IN;"
                    (INITIALIZE DISPLAY)
40  OUTPUT @Dsp;"DE;"
                    (CLEAR THE SCREEN)
50  OUTPUT @Dsp;"SC;"
                    (SELECT DEFAULT DISPLAY UNITS,
                     i.e.1023x383 UNITS)
60  OUTPUT @Dsp;"PU;PA 0,0;"
                    (MOVE PEN TO LOWER LEFT CORNER)
70  OUTPUT @Dsp;"PD;"
                    (PREPARE TO DRAW A LINE)
80  OUTPUT @Dsp;"PA 500,200;"
                    (MOVE PEN TO APPROX CENTER OF SCREEN)
90  OUTPUT @Dsp;"PR 100,0;"
                    (PR  DRAWS A LINE 100 UNITS TO THE RIGHT)
100 OUTPUT @Dsp;"PD;PA 100,0;"
                    (NOTE HOW PA COMMAND OPERATES WITH THE SAME
                     COORDINATES AS PR ABOVE)
110 END
```

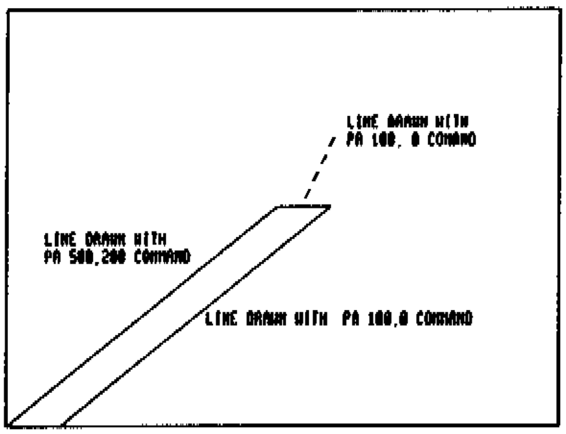


Fig. 3-5.

GRAPHING

Graphing differs from plotting in that only one parameter is specified, namely, the ordinate or y-value, and that graphing is usually faster. The x-value (abscissa) is adjusted automatically by the display according to the DX (Set Delta-X) command.

Graph Absolute: GA Y1, Y2, ...Yn

GA moves the pen to a new point on the screen. The X-coordinate of that point will be the present X-coordinate plus the value set by the DX command. The Y-coordinate of that point will be the Y value. Consecutive Y values can be used with a single GA command.

Set Delta-X: DX Xincrement

The DX command is used for graphing with the GA and GR commands. Each time the GA or GR command is sent, or with each successive Y value, the X-coordinate of the pen is adjusted by Xincrement units. The DX command operates with whatever units (user or display) are presently being used. See the following example.

Example:

Graphing Array Contents

```
10  DIM Array(2000)
20  ASSIGN @Dsp TO 704
                 (DISPLAY'S HP-IB ADDRESS)
30  CLEAR @Dsp
40  OUTPUT @Dsp;"DE;IN;"
                 (CLEAR SCREEN AND INITIALIZE DISPLAY)
50  DEG
60  FOR I=0 TO 1023
70    Array(I)=200+100*SIN(4*I)
                 (FILL ARRAY TO GRAPH LATER)
80  NEXT I
90  OUTPUT @Dsp;"SC;"
                 (SELECT DEFAULT DISPLAY UNITS,i.e.1023x383 UNITS)
100 OUTPUT @Dsp;"PU;PA 0,0;"
                 (MOVE PEN TO LOWER LEFT CORNER)
110 OUTPUT @Dsp;"PD;"
                 (PREPARE TO GRAPH ARRAY CONTENTS)
120 OUTPUT @Dsp;"DX1;"
                 (SET Xincrement TO 1)
130 FOR J=0 TO 511
140   OUTPUT @Dsp;"GA";ARRAY(J);";"
                 (GRAPH ARRAY CONTENTS)
150 NEXT J
160 OUTPUT @Dsp;"DX2;"
                 (EXPAND THE GRAPH HORIZONTALLY)
170 FOR K=512 TO 768
180   OUTPUT @Dsp;"GA";Array(K);";"
                 (PLOT THE EXPANDED PORTION)
190 NEXT K
200 END
```

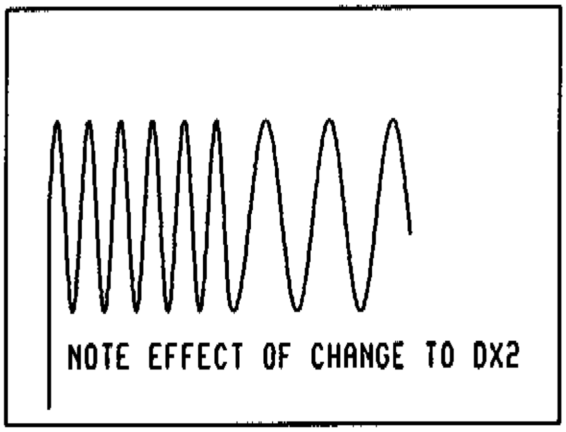


Fig. 3-6.

Graph Relative: GR Yincrement1 ... Yincrementn

GR uses one or several parameters to successively move the pen up or down from its present position. Yincrement is the number of units, positive or negative, that the pen will be moved vertically. The DX command sets the number of units the X coordinate will be incremented.

SCALING

Any individual window on the screen can be given arbitrary dimensions for the convenience of the user. There are two kinds of units (dimensions) used: display units and user units.

Display units are the individual physical locations that can be addressed by the display. The display screen is 1024 units wide (x = 0 to 1023) and 384 units high (Y = 0 to 383), as discussed in the ◀BUILD WINDOW▶ softkey description in Chapter 2. Display units can be specified at any time by sending the SC command with no parameter; e.g., OUTPUT 704;"SC;".

User units are specified by the user with the SC command. These units pertain to the currently active window only, and will not affect graphics operations in other windows, even those on the same screen.

Scale to User Units: SC Xmin, Xmax, Ymin, Ymax

The SC command is used to give the window dimensions that are useful from the user's point of view. Regardless of the physical size of the window, it will subsequently have a "width" in user units of Xmax minus Xmin and a "height" of Ymax minus Ymin. Any parameters can be negative, as long as Xmax is greater than Xmin and Ymax is greater than Ymin. See the following example.

Note: If no window is currently being used, the SC command will apply to the entire screen

Example:

Scaling to User Units (SC command).

```
10  ASSIGN @Dsp TO 704
                  (DISPLAY'S HP-IB ADDRESS)
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
                  (CLEAR THE SCREEN, INITIALIZE WINDOW)
40  OUTPUT @Dsp;"BW 1,112,16,911,383,0,0,0,1;"
                  (BUILD HP-IB WINDOW)
50  OUTPUT @Dsp;"SC;"
                  (USE STANDARD DISPLAY UNITS FIRST)
60  OUTPUT @Dsp;"PU;PA 0,0;PD;PA 1023,0, 1023,383, 0,383, 0,0;"
                  (FRAME THE WHOLE SCREEN IN DISPLAY UNITS)
70  I=0
80  Loop:  I=I+1
90  OUTPUT @Dsp;"PU;PA 112,16;PD;PA 911,16, 911,383, 112,383, 112,16;"
                  (FRAME THE STANDARD WINDOW
                   NOTE SPACE LEFT ON SCREEN FOR SOFTKEYS)
100 OUTPUT @Dsp;"SC 0,1000, 0,1000;"
                  (SCALE THE WINDOW TO 1000 BY 1000)
110 IF I=1 THEN GOTO Loop
                  (GO BACK AND FRAME THE AREA WITH VERTICES P1,P2
                   OF 112,16 AND 911,383 IN THE NEW USER UNITS)
120 END
```

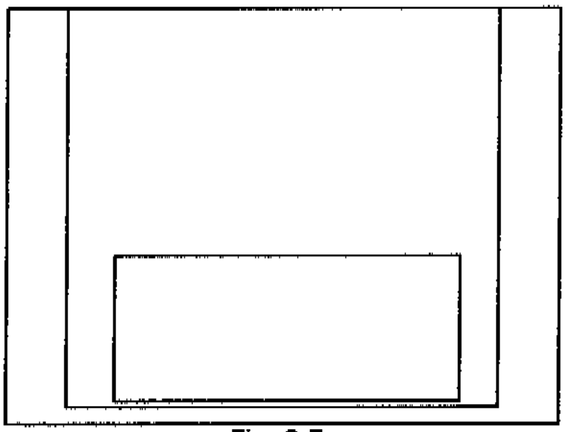


Fig. 3-7.

Mapping Shape: MP shape

The MP command determines whether the shape of the figures drawn in the active window will be square or oblong. The standard aspect ratio (ratio of height to width) is 16/15.

Shape = 0: Standard Oblong Shape
Shape = 1: Square Shape

See the following example.

Example:

Using Mapping Shape (MP command).

```
10  ASSIGN @Dsp TO 704
                  (DISPLAY'S HP-IB ADDRESS)
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
                  (CLEAR THE SCREEN, INITIALIZE)
40  OUTPUT @Dsp;"BW 1,112,16,911,383,0,0,0,1;"
                  (BUILD HP-IB WINDOW)
50  OUTPUT @Dsp;"SC 0,1000, 0,1000;"
                  (SCALE THE WINDOW TO 1000 BY 1000)
60  OUTPUT @Dsp;"PU;PA0,0;PD;PA1000,0, 1000,1000, 0,1000, 0,0;"
                  (FRAME WINDOW)
70  OUTPUT @Dsp;"MP0;"
                  (DEFAULT MAPPING SHAPE, i.e. oblong)
80  OUTPUT @Dsp;"GP1;IT1;OR 0,0;GT 100,100,4,4;"
                  (DRAW OBLONG GRATICULE)
90  OUTPUT @Dsp;"MP1;"
                  (OTHER MAPPING SHAPE, i.e. square)
100 OUTPUT @Dsp;"IT2;OR 0,500;GT 100,100,4,4;"
                  (DRAW SQUARE GRATICULE)
110 END
```

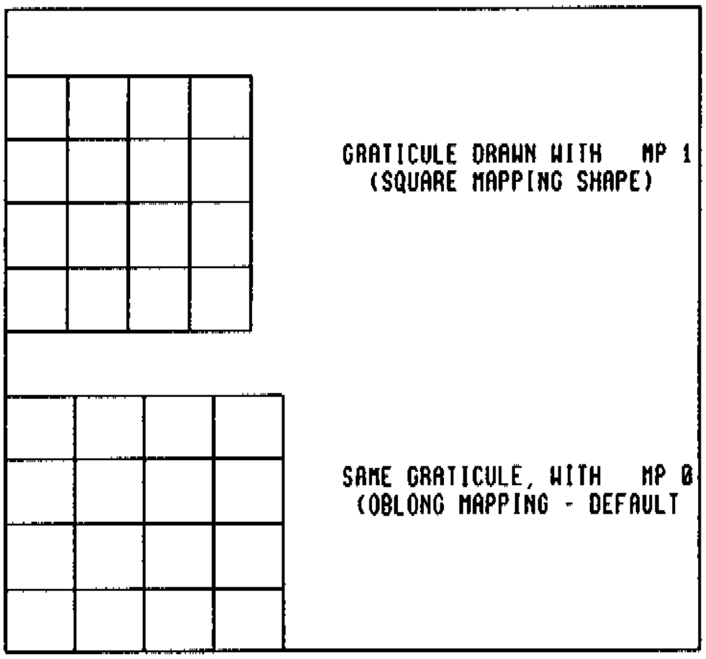


Fig. 3-8.

AXES AND GRATICULES

Axes or graticules can be drawn with a single command. For usage see the example below. For annotation of axes, see the section in this chapter titled "Labeling the Screen."

Axis: AX Xlength, Ylength, Xint, Yint, Xtic, Ytic, Xmaj, Ymaj, Tsize

The Axis command draws a set of axes on the screen. All parameters but Xl and Yl are optional.

Xlength, Ylength: The length of each axis in current units.

Xint, Yint: The point on each axis that is intersected by the other axis (Default is 0,0).

Xtic, Ytic: The distance, in current units, between minor tic marks on each axis. The default condition displays no tic marks.

Xmaj, Ymaj: The number of minor tic spaces between each major tic mark.

Note: When using referenced graphics (see later section), the intersection of the two axes is the point that is "referenced."

Tsize: The length of a minor tic mark (Default 16). Major tic marks are twice as long.

Example:

Drawing a set of axes.

```
10  ASSIGN @Dsp TO 704
                  (DISPLAY'S HP-IB ADDRESS)
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
                  (CLEAR THE SCREEN, INITIALIZE)
40  OUTPUT @Dsp;"BW 1,112,16,911,383,0,0,0,1;"
                  (BUILD A WINDOW FOR HP-IB)
                  (NOTE:  Controller does not require a
                   window to be able to draw on screen)
50  OUTPUT @Dsp;"SC 0,1000,0,1000;"
                  (SCALE TO 1000 USER UNITS IN X AND Y)
60  OUTPUT @Dsp;"PD;"
70  OUTPUT @Dsp;"GP1;IT1;OR200,200;"
                  (REFER TO REFERENCED GRAPHICS SECTION)
80  OUTPUT @Dsp;"AX1000,1000,200,200,10,10,2,2,20;"
                  (DRAW AXIS)
90  END
```

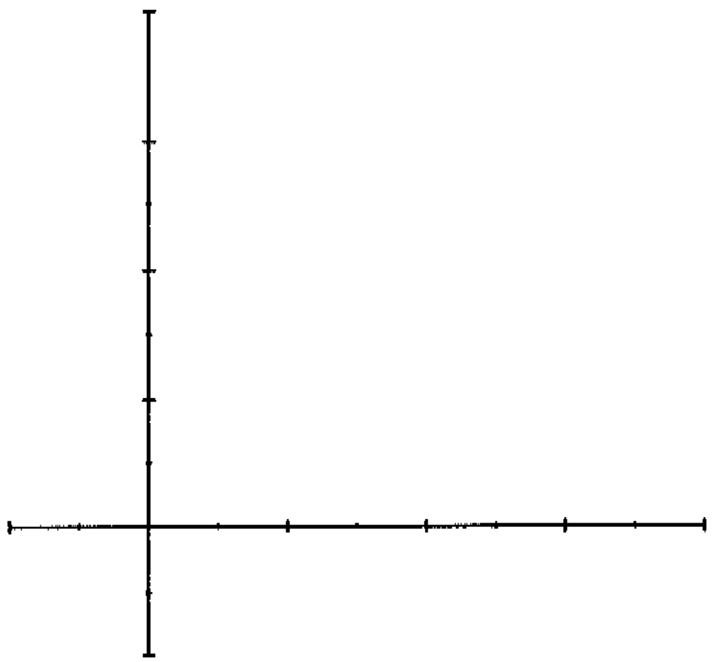


Fig. 3-9.

Graticule: GT Boxwidth, Boxheight, #X boxes, #Y boxes

The GT command draws a graticule on the screen (see the following example). The point on a graticule referenced by the OR command (see Referenced Graphics section) is the lower left-hand corner of the graticule.

Boxwidth, Boxheight: The width and height of each box in current units.

#X boxes, #Y boxes: The number of boxes along each axis.

Example:

Drawing a graticule.

```
10  ASSIGN @Dsp TO 704
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
40  OUTPUT @Dsp;"BW 1,112,16,911,383,0,0,0,1;"
                   (BUILD A WINDOW FOR HP-IB
                    NOTE: Controller does not require a
                    window to be able to draw on screen)
50  OUTPUT @Dsp;"SC 0,1000,0,1000;"
                   (SCALE TO 1000 USER UNITS IN X AND Y)
60  OUTPUT @Dsp;"PD;"
70  OUTPUT @Dsp;"GT100,100,10,10;"
                   (DRAW GRATICULE, 10 BOXES BY 10 BOXES,
                    EACH BOX 100 UNITS SQUARE)
80  END
```

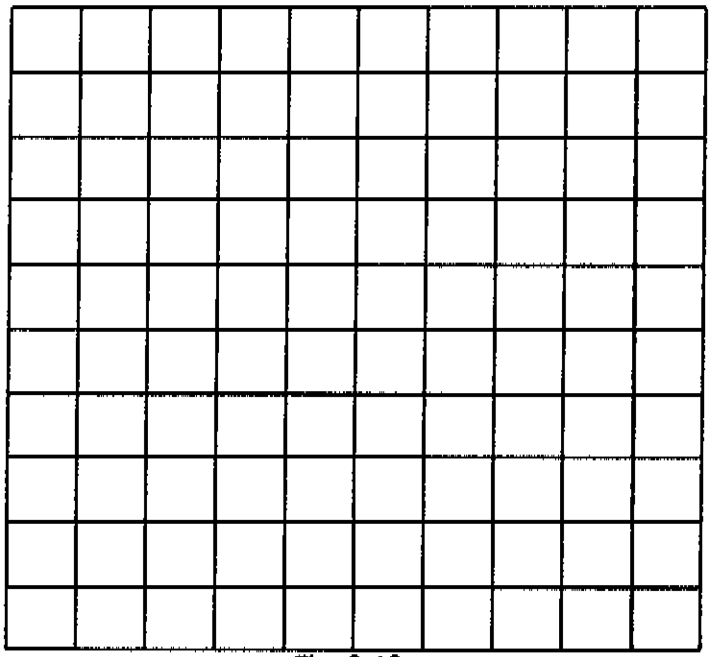


Fig. 3-10.

Section 3: Labeling the Screen

The HP 70000 Series Displays have the capability to place text labels anywhere on the screen. Labels can be used by an HP 70000 series modular instrument (e.g., the local oscillator module of a spectrum analyzer) or by an HP-IB controller.

The example below uses Referenced Graphics. Although Referenced Graphics will be covered in a later section of this chapter, notice that labels can be used either in a referenced or non-referenced mode.

The location of a non-referenced label is determined by the location of the pen. To move the pen to a specified location prior to placing the label, use the Plot Absolute (PA) command. Use the Origin (OR) command to shift the location of a referenced label.

MAKING A LABEL

Three commands are required to make a label. Configure Label (CL) defines the shape of the label (number of characters and lines), Define Terminator (DT) allows the user to define the end of a label, and Label (LB) actually places the label on the screen.

Configure Label: CL lines, characters

CL specifies the number of lines in the label ("lines") and the number of characters per line ("characters"). Default condition (when CL is sent with no parameters) is 1 line of 53 characters. No more than 68 characters will fit on any single line of the display.

Note: The CL command affects only those labels used in a referenced mode. Non-referenced labels can be written on multiple lines by sending the text in multiple OUTPUT statements, leaving out the semicolon, as in lines 140 through 160 of the following labeling example.

Define Terminator: DT terminator

The DT command is used to define a character (any ASCII character) that will be used to signal the end of a label.

Note: **The defined terminator character must be sent at the end of each label.** Anything received over HP-IB by the Display between the LB command and the defined terminator will be considered part of the label. See the example below for multi-line labels.

Label: LB text

The LB command causes the display to start placing text on the screen, according to the last CL command, until the terminator character is received. A text string that is longer than the CL command allows will be scrolled off the display (see example).

Example:

Making Labels.

```
10  ASSIGN @Dsp TO 704
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
40  OUTPUT @Dsp;"BW 1,112,16,911,383,0,0,0,1;"
                 (BUILD STANDARD WINDOW #1)
50  OUTPUT @Dsp;"SC 0,1000,0,1000;"
                 (SCALE TO 1000 USER UNITS IN X AND Y)
60  OUTPUT @Dsp;"DT#;"
                 (DEFINE LABEL TERMINATOR TO BE #)
70  OUTPUT @Dsp;"PU;PA700,700;"
                 (MOVE PEN TO TOP RIGHT QUADRANT)
80  OUTPUT @Dsp;"LBUNREFERENCED LABEL#;"
                 (DRAW AN UNREFERENCED LABEL)
90  OUTPUT @Dsp;"GP1;IT1;CL2,10;"
                 (CONFIGURE A REFERENCED LABEL)
100 OUTPUT @Dsp;"OR 100,700;"
                 (SHIFT ORIGIN TO TOP LEFT QUADRANT)
110 OUTPUT @Dsp;"LBREFERENCED LABEL#;"
                 (DRAW THE REFERENCED, CONFIGURED LABEL)
120 OUTPUT @Dsp;"GP1;IT2;CL3,10;"
                 (CONFIGURE LABEL, 3 LINES OF 10 CHARACTERS)
130 OUTPUT @Dsp;"OR 100, 300;"
                 (PLACE LABEL IN LOWER LEFT QUADRANT)
140 OUTPUT @Dsp;"LBLINE 1"
150 OUTPUT @Dsp;"LINE 2"
160 OUTPUT @Dsp;"LINE 3#;"
                 (DRAW A MULTI-LINE LABEL BY SENDING THE
                  LINES SEPARATELY, AND ONLY USING THE TERMINATOR
                  CHARACTER AT THE END)
170 OUTPUT @Dsp;"GP1;IT3;CL2,5;"
                 (CONFIGURE LABEL, 2 LINES OF 5 CHARACTERS)
180 OUTPUT @Dsp;"OR 700,300;"
                 (PLACE LABEL IN LOWER RIGHT QUADRANT)
190 OUTPUT @Dsp;"LBTHIS LABEL IS BY FAR TOO LONG#;"
                 (NOTE HOW LABEL GETS SCROLLED ACCORDING TO CL
                  COMMAND)
200 END
```

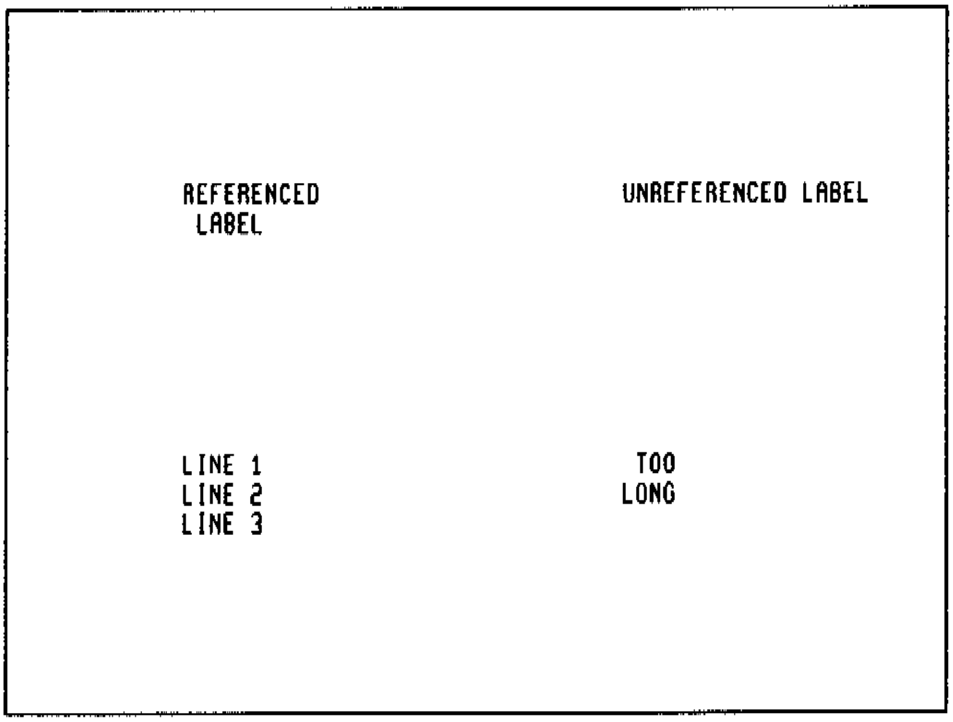

REFERENCED
LABEL
UNREFERENCED LABEL
LINE 1
LINE 2
LINE 3
TOO
LONG

Fig. 3-11.

ENHANCING A LABEL

Labels, uniquely among figures on the display, can be enhanced by changing the size and angle of the characters that comprise them. Three commands are used to do this: DI (Set Character Direction Absolute), SI (Set Character Size Absolute), and SR (Set Character Size Relative).

Set Character Direction Absolute: DI run, rise

The DI command specifies the direction of all text that appears until the direction is changed or reset, or until another referenced group or item is specified.

Set Character Size Absolute: SI width, height

The SI command sets the absolute size of characters used in labels. "Width" and "height" are set in the current units and must be in the ratio 15/16; e.g. 15,16 or 30,32. See the example below for the effect when the command is used with a scale of X = 0 to 1000, Y = 0 to 1000.

Set Character Size Relative: SR percent

The SR command sets the size of the characters as a fixed percentage of the present window width so that character size remains proportional when P1 and P2 are changed.

Note: The HP-GL command SR has another parameter for height, which the HP 70205A and HP 70206A will ignore.

Example:

This example shows how the size and direction of labels can be altered using the DI, SI, and SR commands. The window has been scaled to X = 0 to 1000, Y = 0 to 1000.

Note: Each of these enhancements, when used with referenced graphics, must be specified for each group individually.

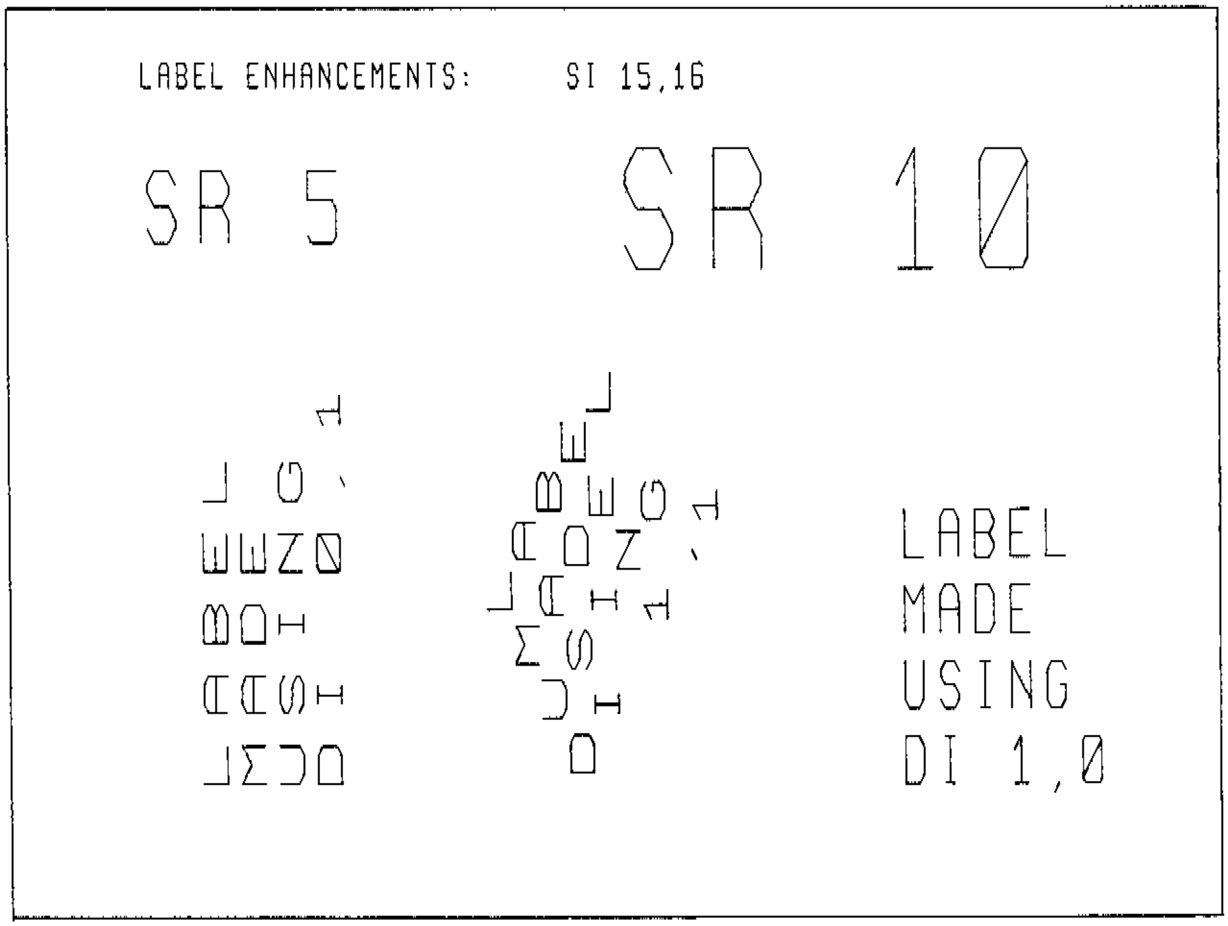


Fig. 3-12.

Section 4: Hardcopy Output

Both of the present HP 70000 Graphics Displays have the ability to provide hardcopy output directly to a printer or plotter over HP-IB without the need for an external controller or computer. Plotter operations are performed using a vector graphics plotter that is HP-GL compatible to yield high-quality output. Printer operations are performed using an HP-IB compatible raster-format graphics printer, and usually take less time than plotter outputs. For more information on output device compatibility and manual operation for obtaining output, see the notes following the ◀PRINT▶ and ◀PLOT▶ softkey descriptions in Chapter 2.

Copy: CY (parameter option)

The CY command initiates a hardcopy output operation over HP-IB to the device specified by the PI (Printer/Plotter Is) command described below. "Parameter option" is used to select the scaling points (P1 and P2) for plotting.

Parameter option = 0: Use P1 and P2 as set by the plotter (for TLK/LSN plotters only). If the plotter is L ONLY, use P1,P2 as set in the display via the PL command or the ◀PLOTTER PARAMS▶ softkey.

Parameter option = 1: Use P1,P2 as set by display.

KeyCopy On/Off: KC option #

The KC command allows the user to select whether or not the softkey labels will be included in the next hardcopy output.

option # = 0: Off -- do not include softkey labels
option # = 1: On -- include softkey labels

Printer/Plotter Is: PI device type, row, col, bus

The PI command is used to specify the HP-IB address of the hardcopy output device. The device can be a printer or a plotter at any address.

device type = 0: Printer (default)
device type = 1: Plotter

row, col: These specify the address of the output device. For HP-IB devices, set row = 0 and col = HP-IB address (e.g., 1 or 5, not 701 or 705). Both parameters are included for use with future HP-MSIB devices.

bus = 0: HP-IB
bus = 1: HP-MSIB

Plotter Parameters: PL X1, Y1, X2, Y2

The PL command sets the parameters (P1 and P2 coordinates) of the output plotter for Listen Only (L ONLY) plotters and for all plotters when the output is initiated with the command "CY1." Physical size of the output is dependent on the output device.

Default values: X1,Y1 = 100,100
Default values: X2,Y2 = 10500,7500

Select Pen: SP pen#

On a monochromatic display such as the HP 70205A or HP 70206A Graphics Displays, SP affects operation only when the display performs a plotter output operation. The actual pen selected will depend on the plotter used. "Pen#" can range from 0 to 255, with 0 as the default value. Use the SP command when creating the figures.

Example: Obtaining Hardcopy Output

Note: The display will not perform an output operation over HP-IB if there is also an active controller on the bus. See the last part of the following example.

```
10  ASSIGN @Dsp TO 704
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
40  OUTPUT @Dsp;"BW 1,112,16,911,383,0,0,0,1;"
                    (BUILD HP-IB WINDOW)
50  OUTPUT @Dsp;"SC 0,1000,0,1000;"
                    (SCALE WINDOW TO 1000 BY 1000 UNITS)
60  OUTPUT @Dsp;"PU;PA0,0;PD;PA1000,0,1000,1000,0,1000,0,0;"
                    (FRAME WINDOW)
70  OUTPUT @Dsp;"OR 100,500;"
                    (SET ORIGIN OF LABEL TO CENTER IT)
80  OUTPUT @Dsp;"DT#;"
                    (DEFINE LABEL TERMINATOR)
90  OUTPUT @Dsp;"LBHARDCOPY OUTPUT WITHOUT A CONTROLLER ! #;"
100 OUTPUT @Dsp;"PI 1,0,5,0;"
                    (SPECIFY OUTPUT DEVICE TO BE PLOTTER AT
                     ADDRESS 5 ON HP-IB)
110 OUTPUT @Dsp USING "#,K";"CY;"
                    (SEND COPY COMMAND,SUPPRESS CR,LF)
120 LOCAL 7
130 SEND 7;UNT UNL DATA
                    (AFTER RECEIVING "CY,"
                     DISPLAY WILL WAIT BRIEFLY BEFORE STARTING
                     PLOT.  WHEN PLOT COMMENCES, CONTROLLER MUST
                     BE OFF HP-IB.  LOCAL 7, UNT, UNL, AND DATA
                     DO THIS)
140 END
```

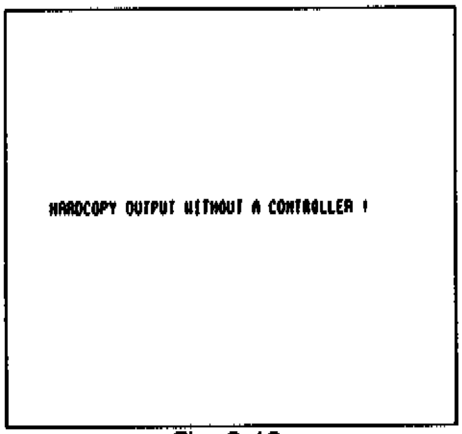


Fig. 3-13.

Section 5: Markers

Multiple single-character fixed-size markers can be placed on the display screen using the commands MA (Marker Attributes) and MK (Place Marker). Markers can be used in either the referenced or non-referenced modes (see "Referenced Graphics" section of this chapter).

Marker Attributes: MA character, position

The MA command is used to specify the character to be used as a marker.

character = any character in the currently active character set (no default value). This character will be used as the marker.

position = (0 - 4). This specifies the position on the character that serves as the reference point for referenced graphics. (See figure below.)

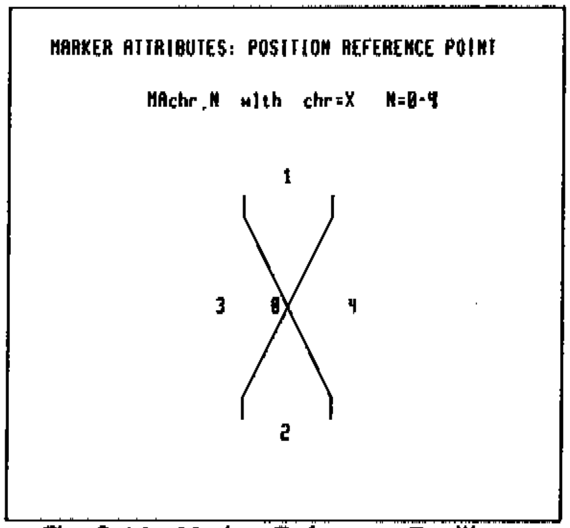


Fig. 3-14. Marker Reference Positions

Place Marker: MK X, Y

The MK command is used to place a marker on the screen. The coordinates X and Y give the distance from the current location (or from the origin) that the marker will be placed.

For NON-REFERENCED graphics, the marker will be placed X units to the right and Y units above the current pen position.

Note: Placing a marker at a point other than the current pen position (neither X nor Y at 0) does NOT affect pen position after marker has been drawn.

For REFERENCED graphics, the marker will be placed X units to the right and Y units above the current item origin. (See section on referenced graphics.)

Section 6: Character Sets

The HP 70205A and HP 70206A Graphics Displays have the capacity to store multiple character sets. At present, two are available:

Character Set 0: US ASCII
Character Set 30: Saved User-Defined Set

The user can create a single new character for special uses (such as a logo or marker), or create a whole new character set in a different font. Once the other character set has been defined, it can be called up at any time by the controller or instrument.

There are six commands which pertain to character sets:

CA - Designate Character Set Alternate
CS - Designate Character Set Standard
SA - Select Alternate Character Set
SS - Select Standard Character Set
SU - Save User-Defined Character
UC - Draw User-Defined Character

Note: The UC command immediately draws a user-defined character (UDC); it does not deal with a stored character set.

Designate Character Set Alternate: CA set#

The CA command specifies which character set will be used for labeling after the SA command has been sent: CA designates the set, and SA calls it into action.

set # = 0: US ASCII (Standard and default)
set # = 30: User-Defined Character Set (see SU command)

Designate Character Set Standard: CS set#

The CS command designates the standard character set. The standard set is used when default conditions exist (power-on, DF, IN) or when the SS (Select Standard Character Set) command is received. Set# designations are the same as for CA.

Select Alternate Character Set: SA (no parameters sent)

The SA command causes the display to begin writing labels and markers using the alternate character set specified by the CA command. It will continue to use this set until the power is turned off, the Default (DF) or Initialize (IN) command is received, or the Select Standard Character Set (SS) command is used. Note that the alternate character set is used only to create labels and markers, and all commands (including the label terminator) must still be sent in the standard US ASCII character set.

Select Standard Character Set: SS (no parameters sent)

The SS command causes the display to activate the standard character set designated by the CS command. The standard character set is also activated upon power-on and by the DF and IN commands.

Save User Defined Character: **SU** char, pen contol, xincrement, yincrement, (pen control), xincrement, yincrement, ...

The SU command is used to define and store a special character in character set 30. "Char" is the ASCII name under which this special character is stored, and the parameters following (pen control, and x and y increments) define its shape.

SU defines the shape of the special character in a cell that is 6 units wide and 16 high, as shown in the figure below.

The SU command does not draw the character on the screen. To do this, create a label using Character Set #30. (See descriptions of the LB, CA, and SA commands for instructions on how to do this.) The physical size of the character is determined by the SI or SR command in effect at the time it is actually drawn on the screen.

Char: The ASCII name that the newly created character is stored under in character set 30.

Pen control: +99 = pen down
-99 = pen up (parameter is optional: pen is initially up)

xincrement, yincrement: the number of units to move the pen in order to create the character. Very much like parameters in the PR command, these must be in successive pairs, all separated by commas and pen control commands.

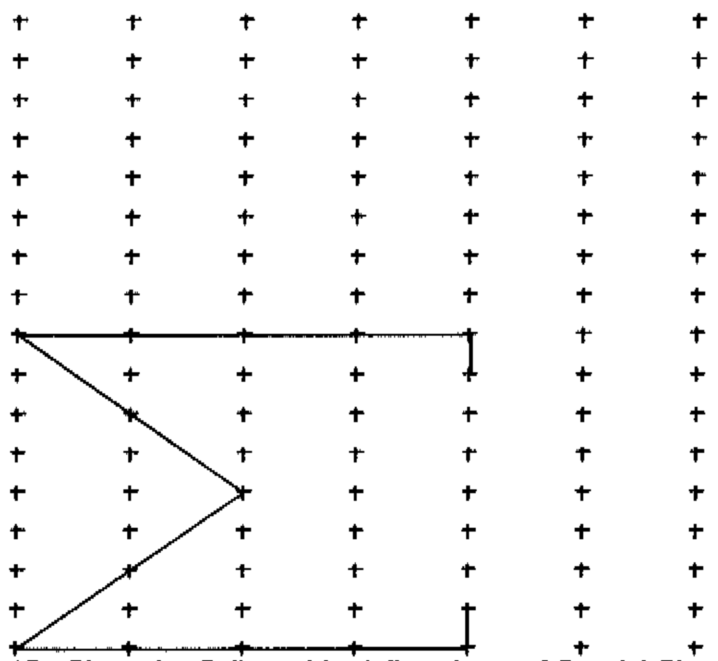


Fig. 3-15. Character Cell used to define shape of Special Character

Draw User-Defined Character: **UC** pen control, xincrement, yincrement, (pen control), xincrement, yincrement, ...

The UC command operates like the SU command, except that the character is drawn immediately and is not saved.

Example:

Character Set Usage

```
10  ASSIGN @Dsp TO 704
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
40  OUTPUT @Dsp;"BW1,112,16,911,383,0,0,0,1;"
                    (BUILD HP-IB WINDOW)
50  OUTPUT @Dsp;"SC0,1000,0,1000;"
60  OUTPUT @Dsp;"PU;PA0,0;PD;PA1000,0,1000,1000,0,1000,0,0;"
70  OUTPUT @Dsp;"CS0;"
                    (DESIGNATE STANDARD CHARACTER SET TO BE 0,
                     i.e., US ASCII -- DEFAULT CONDITION)
80  OUTPUT @Dsp;"CA30;"
                    (DESIGNATE ALTERNATE CHARACTER SET TO BE 30
                     i.e., USER-CREATED SET)
90  OUTPUT @Dsp;"SS;"
                    (SELECT STANDARD CHARACTER SET; START USING IT)
100 OUTPUT @Dsp;"PU;PA400,500;DT#;"
                    (MOVE PEN, DEFINE TERMINATOR)
110 OUTPUT @Dsp;"LBXXXXX#;"
                    (PLACE LABEL OF Xs)
120 OUTPUT @Dsp;"SUX,4,7,+99,0,1,-4,0,2,-4,-2,-4,-2,-4,4,0,0,1;"
                    (SAVE THE USER-DEFINED CHARACTER GREEK SIGMA UNDER
                     THE NAME OF "X" IN SET 30. NOTE: PLACE
                     "char" DIRECTLY AFTER THE SU COMMAND WITHOUT
                     A SPACE, OTHERWISE THE UDC WILL BE STORED UNDER
                     THE NAME"")
130 OUTPUT @Dsp;"SA;"
                    (SELECT--START USING--ALTERNATE CHARACTER SET)
140 OUTPUT @Dsp;"PU;PA400,400;LBXXXXX#;"
                    (PLACE USER-DEFINED CHARACTERS)
150 OUTPUT @Dsp;"PU;PA400,300;SR10;LBXXXXX#;"
                    (PLACE LARGER UDCs)
160 OUTPUT @Dsp;"SR10,UC0,0,-99,6,0,0,16,-6,0,0,-16;"
                    (DRAW A 6X16 BOX USING THE UC COMMAND.  NOTE THAT
                     THE PEN MOVEMENT PARAMETERS ARE INCREMENTAL,
                     IN A 6X16 CELL.  NOTE SIZE OF CELL RELATIVE TO
                     THE UDCs TO THE LEFT, WHICH WERE DRAWN WITH THE
                     SAME SR COMMAND.
170 OUTPUT @Dsp;"SS;"
                    (RE-SELECT THE STANDARD CHARACTER SET )
180 END
```

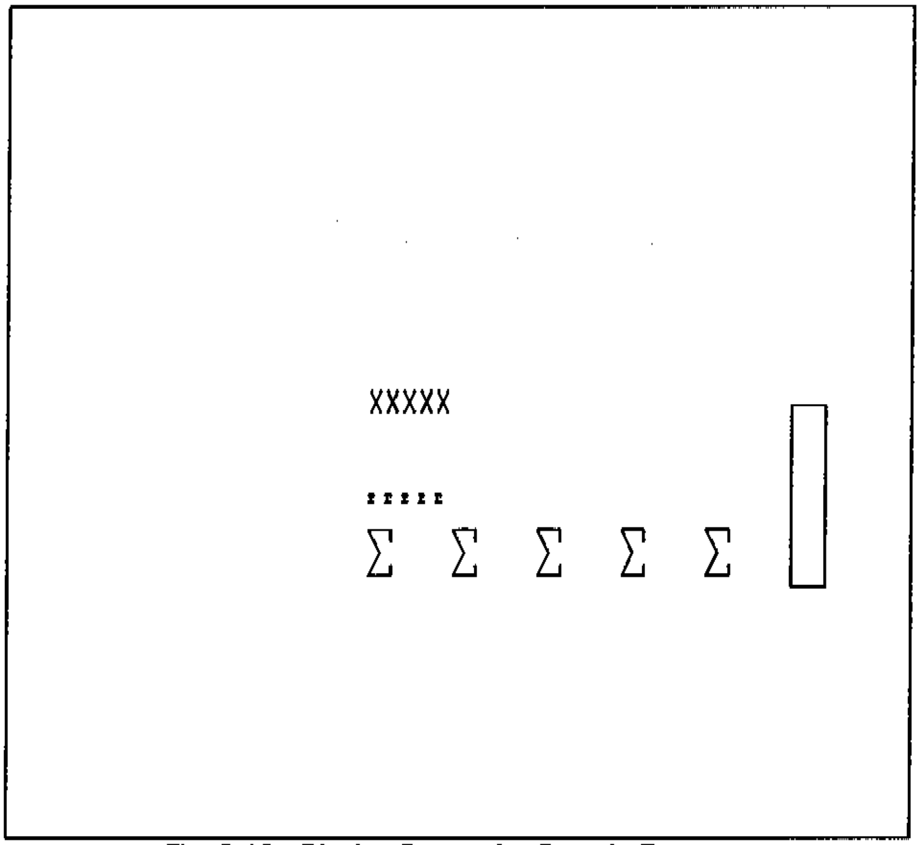


Fig. 3-16. Display Screen for Sample Program

Section 7: Referenced Graphics

Many of the capabilities discussed earlier in this chapter are contained in HP-GL, the Hewlett-Packard Graphics Language. One powerful set of capabilities not included in HP-GL but available with the HP 70205A and HP 70206A Graphics Displays are those of Referenced Graphics. Referenced Graphics allow the user greater flexibility in drawing figures and labeling the screen than would be possible with a regular plotter, printer, or instrument display.

Referenced Graphics allow the user to control and manipulate an item on the screen even after it has been drawn. The object can be moved, enlarged, blanked (turned off), viewed (turned on), deleted entirely, or made to blink. Furthermore, objects can be logically grouped with other objects, and attributes can be applied to each object individually or to the group collectively.

Virtually anything that can be drawn on the screen can be used as a referenced object. All types of objects can be included in the same logical group. Examples include lines, figures, labels, graphs, axes, graticules, and markers. Be aware, however, that referencing capabilities are available only within each window.

Each object drawn on the screen can be used in either a referenced or a non-referenced mode. If created in non-referenced mode, the object cannot be changed after being drawn. If drawn in a referenced mode, the object is known as an "item" and has a specific number associated with it (e.g., Item 3). When multiple items must be referred to at the same time, they may be defined as belonging to a single "group." Each item, however, retains its identity by having a unique reference number (e.g., Group 2, Item 3).

The following attributes can be assigned to **Referenced Items:**

Blinking - See BL command description in this section.
Blanking - See VW command description in this section.
Pen Type - See SP command description in sections 2 and 4.
Origin - See OR command description in this section.
Character size and Direction (labels only) - See the DI, SI and SR command descriptions in section 3.
Marker Character - See section 5.
Line Type (plots and graphs only) - See LT command descriptions in section 2.
Delta-X (graphs only) - See DX command descriptions in section 2.

To determine whether an object will be drawn as referenced or non-referenced, and to refer to a referenced item once it has been drawn, use the commands Identify Item (IT) and Identify Group (GP). If GP or IT commands are not received by the display, all objects drawn will be non-referenced. If the last IT command received was IT0 or the last GP command received was GP0, the next object drawn will be non-referenced. As previously mentioned, objects can be drawn in referenced mode (but without a group designation) simply by not sending any GP commands, causing each item's group number to default to 1. In this case, the whole concept of groups can be ignored for purposes of remote operation. The display will automatically be put in the non-referenced mode upon power-up or upon receipt of either DF or IN command.

Identify Item: IT item#

The most recently received IT command for the current window determines whether the next object to be drawn or modified will be referenced or non-referenced, and, if referenced, what its item number will be.

item# = 0: activates non-referenced mode
item# = 1 - 50: referenced item number 1 - 50.

Identify Group: GP group#

The most recently received GP command determines the group number of all referenced items (item# not 0) drawn or referred to. Attributes that may apply to an entire group include blinking, blanking (view command), and origin.

group# = 0: activates non-referenced mode (can be reversed by subsequent IT or GP commands)
group# = 1 - 16: referenced group number 1 - 16

Set Origin: OR Xposition, Yposition

The OR command specifies the origin of the current entity. Both groups and items have an origin (location on the screen): the origin of a group is relative to the 0,0 point of the window (see SC command) and the origin of an item is relative to the origin of the group that contains the item.

The physical location of a group's reference point on the screen (its origin) is determined by the OR command **according to the units (scale) in effect at the time the group's origin is specified** (that is, when the OR command is received). This means that the scale of the screen can be changed after the group's origin has been specified and the physical location of that origin will not be affected.

The physical location of an item's reference point on the screen (its origin) is determined by the OR command **relative to the group's origin** (which is already established) **according to the units (scale) in effect at the time the item's origin is specified.** (If no group has been specified or if GP0 has been most recently received, the origin of the item will be located with respect to the 0,0 point of the window in current units).

Note: **The OR command requires that parameters be sent.** No default values exist for Xposition and Yposition. The command sequence

```
SC 0,1000,0,1000
GP1;OR 500,500
IT1;OR 0,0
```

would place both the group's origin and the item's origin at the center of the window (not necessarily the center of the screen), while the sequence

```
SC 0,1000,0,1000
GP1;OR 500,500
IT1;OR 500,500
```

would place the group's origin in the center of the window (500,500) but the item's origin at the top right corner of the window (1000,1000).

Note: Once the origin of a group or item has been specified, it can be changed at any time. The effect of changing the origin is to immediately shift the position of the group or item on the screen.

```
GP1;OR 500,500
IT1;OR 500,500
: :
GP1;IT1;OR 0,0     (Resets item's origin)
GP1;OR 0,0         (Resets group's origin)
```

Blink On/Off: BL mode

The BL command causes the currently active entity (group or item) to blink on and off.

mode = 0: off
mode = 1: on

Delete All Ref./Non-Ref. Objects: DA #

The DA command allows the user to delete (not just blank) all referenced or all non-referenced objects.

= 0: Delete all non-referenced objects.
= 1: Delete all referenced items and groups.

Delete Active Item or Group: DL (no parameter)

The DL command deletes (removes entirely) only the active entity (i.e., the last object or group of objects referred to by an IT or GP command).

Note: Be sure that the proper entity is active (e.g., send GP1;IT2;DL).

View On/Off: VW mode

The VW command allows the user to view (turn on) or blank (turn off) the currently active entity (group or item). If no group or item has been specified (i.e., the window is in non-referenced mode), then all non- referenced objects are blanked.

mode = 0: blank active entity
mode = 1: view (unblank) active entity

For example:

GP1; IT1; VW0 blanks Item 1 in Group 1
GP1; VW0; blanks all items in Group 1
GP0, IT0; VW0 blanks all non-referenced objects

Example:

Using Referenced Graphics.

```
10  ASSIGN @Dsp TO 704
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
40  OUTPUT @Dsp;"BW 1,112,16,911,383,0,0,0,1;"
50  OUTPUT @Dsp;"SC0,1000,0,1000;"
60  OUTPUT @Dsp;"GP1;OR0,0;
                (GROUP 1 HAS ORIGIN AT LOWER LEFT CORNER)
70  OUTPUT @Dsp;"IT1;OR250,250;"
                (ITEM 1 IN GROUP 1 HAS ORIGIN 250,250 RELATIVE TO
                 ORIGIN OF GROUP 1. THAT IS, ITEM 1 HAS ORIGIN
                 250,250)
80  OUTPUT @Dsp;"MAX,0;MK0,0;"
                (PLACE A MARKER (X) AT ORIGIN OF ITEM 1, GROUP 1)
90  OUTPUT @Dsp;"GP2;OR500,500;"
                (ORIGIN OF GROUP 2 IS AT MIDDLE OF SCREEN)
100 OUTPUT @Dsp;"IT1;MAX,0;MK0,0;"
                (PLACE A MARKER (X) AT ORIGIN OF GROUP 2)
110 OUTPUT @Dsp;"IT2;OR 250,250;"
                (ITEM 2 IN GROUP 2 HAS ORIGIN 250,250 RELATIVE TO
                 ORIGIN OF GROUP 2, WHICH IS AT 500,500.  HENCE
                 GP2,IT2 HAS ABSOLUTE ORIGIN 750,750 ON SCREEN)
120 OUTPUT @Dsp;"MAX,0;MK0,0;"
                (PLACE MARKER AT ORIGIN OF ITEM 2 IN GROUP 2)
130 OUTPUT @Dsp;"IT3,OR250,250;MAX,0;MK0,100;"
                (ITEM 3 HAS SAME ORIGIN AS ITEM 2, BUT DATA
                 (X=0,Y=100) PLACES IT ABOVE ITS ORIGIN)
140 END
```

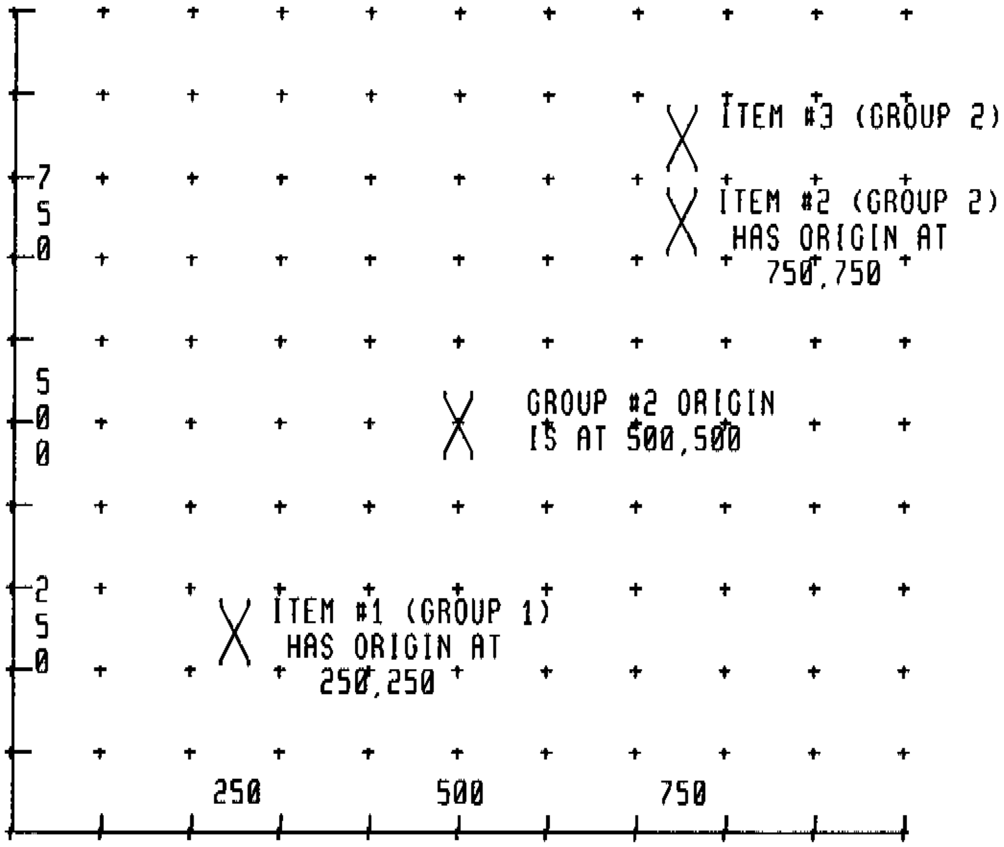


Fig. 3-17. Output From the Referenced Graphics Example.

Section 8: Informational Displays

The HP 70205A and HP 70206A Graphics Displays have the capability to provide various types of system-level information, both on the screen for viewing by the user and over HP-IB for receipt by a controller. The informational screens include the Address Map, the Error Screen, and the Screen Configuration. Each of these is described in detail in Chapter 2 of this part, "DSP Hardkey (Manual Display Operation)," and the remote commands used to access them will be covered here.

Address Map: AM row, col

This command displays the Address Map screen, with the cursor (the highlighted box) resting in the space given by "row, col." The map is removed if either "row" or "col" is -1.

Example:

Checking for Spectrum Analyzer in Address Map: OUTPUT @Dsp;"AM0,18;"

ROW				
7				
6				
5				
4				70904A RF SECT
3				
2				70903A IF SECT
1				70902A IF SECT
0				70900A Lo/Ctlr HP-IB 18
COLUMN	15	16	17	18

Fig. 3-18.

Display Status On/Off: DS statusbox, dataline

The DS command allows the usèr to selectively blank either or both of the two display status items: the status box and the data line.

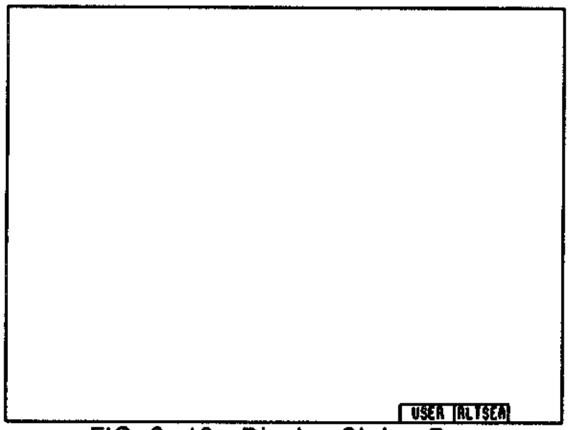


FIG. 3- 19. Display Status Box

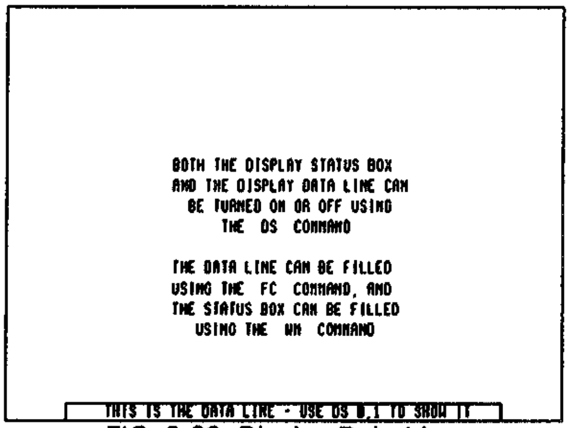


FIG. 3-20. Display Data Line

The display status box, shown in figure 3-20, gives status indications to the user for several aspects of the display's current operating mode. The left half of the box shows one of three indicators:

USER - the softkey labels shown are those sent to the display by the master module of an instrument (e.g. HP 70900A) in response to pressing the [USER] or [USR] hardkey.

MENU - the softkey labels shown are those found in the main menu of the modular instrument that has control of the keyboard. MENU appears in the status box after the [MENU] or [MNU] hardkey is pressed.

DSPL - the softkey labels shown are those of the display itself. DSPL shows in the status box after the [DISPLAY] or [DSP] hardkey has been pressed.

The right half of the display status box gives any of six single-letter indicators:

R - Display is in remote mode on HP-IB. The keyboard is not accessible to the user until the [LOCAL] key on the display is pressed.
L - Display is in listen mode on HP-IB.
T - Display is in talk mode on HP-IB.
S - Display is asserting SRQ (Service Request) on HP-IB.
E - Display has detected an error on HP-MSIB (see REPORT ERRORS softkey description in chapter 2).
A - Display is addressed on HP-MSIB. This means either that its address is being interrogated (e.g., the cursor box in the address map is resting on the display) or that the display itself has control of the softkeys.

statusbox = 0: blank status box
statusbox = 1: show status box

dataline = 0: blank data line
dataline = 1: show data line

Error Screen: ES mode#

The ES command forces the display to show the error screen, which lists any errors currently reported on HP-MSIB. Just like the REPORT ERRORS softkey (described in Chapter 2), the ES command clears non-hardware-related errors from the memory after they have been reported.

The errors are reported from one master module at a time. Hence, if more than one master module has errors to report, multiple ES commands must be sent. Also, only as many errors as can fit on the screen at once may be reported with a single ES command.

mode# = 0: Show error report screen from module with lowest column address that has errors to report. (Mode# may have values greater than 1; however, errors will be reported only from modules with column addresses greater than or equal to mode#.)

mode# = -1: Turn off error reporting mode (default value)

Output Identification: OI (no parameter sent, but response is generated)

The OI command causes the display to output, over HP-IB, an ASCII string that identifies the display as either an HP 70205A or HP 70206A.

Example:

Interrogating Display for Identification.

```
OUTPUT @Dsp; "OI"
ENTER @Dsp;A$
DISP A$
```

The screen of the controller should show either "70205A" or "70206A."

Output Version: OV (no parameters sent, but response is generated)

The OV command causes the display to respond over HP-IB with an ASCII string that gives the firmware version (for the display ROMs only).

Example:

Finding Display Firmware Version

```
10 DIM A$[30]
20 ASSIGN @Dsp TO 704
30 OUTPUT @ Dsp;"OV;"
40 ENTER @Dsp;A$
50 DISP A$
60 END
```

The controller should display something similar to "ROM Version 4.8 Jan. 1985."

Show Configuration: SN register#

The SN command shows a summary of the screen configuration, very much as the ◀SHOW CONFIG▶ softkey does (see Chapter 2). It lists all windows, their sizes and instrument assignments, and the allocation of the keyboard.

register # = 0: show current screen configurations
1 - 4: show configuration from register's 1 through 4
-1: exit the Show Configuration function.

Example:

Show Current Screen Configuration OUTPUT @Dsp;"SN0;"

```
CURRENT CONFIGURATION

  Window 1
  Keyboard: 70900A.Lo/Ctlr         ( 0,  18)
            Xmin,Ymin:   517, 205
            Xmax,Ymax:   911, 383

  Window 2: HP-IB
            Xmin,Ymin:   112, 205
            Xmax,Ymax:   507, 383

  Window 3: unassigned
            Xmin,Ymin:   112,  16
            Xmax,Ymax:   507, 195

  Window 4: unassigned
            Xmin,Ymin:   517,  16
            Xmax,Ymax:   911, 195
```

Fig. 3-21.

Section 9: Error Handling

Both the HP 70205A and the HP 70206A Graphics Displays can detect and report errors that occur on either HP-IB or HP-MSIB. The general procedure for reporting errors is discussed in Chapter 2 under the ◀REPORT ERRORS▶ softkey description.

Output Error String: EG (no parameters sent, but response generated)

The EG command causes the display to output an ASCII string over HP-IB describing any detected error pertains to the currently active window.

Notes:

1. EG responds only to errors detected at the display.

   Errors detected elsewhere but reported to the display by another master module (such as the HP 70900A) will not be indicated by the EG command.

2. EG does not clear any errors from memory.

Example:

Receiving Error Report from Illegal Command

```
10  DIM A$ [30]
20  ASSIGN @Dsp to 704
30  OUTPUT @Dsp;"DE;IN;XX;"
                (SEND ILLEGAL COMMAND "XX" TO THE DISPLAY)
40  OUTPUT @Dsp;"EG;"
                (ASK FOR REPORT)
50  ENTER @Dsp;A$
60  DISP A$
70  END
```

This program should result in the following message on the screen of the controller (see the System Support Manual for error numbers):

2001 Illegal command

Error Screen: ES mode#

See the description in Section 8, Informational Displays.

Note: The ES command clears some errors from memory.

Output Error Number: OE (no parameter sent, but response generated)

The OE command causes the display to send an ASCII number over HP-IB describing the last error detected that pertains to the currently active window. The error numbers sent in response are described in the System Support Manual.

Notes:

1. OE responds only to errors detected at the display. (see EG description above) The errors described by both OE and EG pertain to the currently active window; i.e., the window assigned to the element that sends the OE or EG command.

2. OE clears reported errors from memory.

Example:

Detecting a parameter out of range using OE command.

```
10  ASSIGN @Dsp TO 704
20  OUTPUT @Dsp;"DE;"
30  OUTPUT $Dsp;"KC5:"
40  OUTPUT @Dsp;"OE"
50  ENTER @Dsp;A$
60  DISP A$
70  END
```

This should result in an error number of 2006, which indicates "Parameter Out of Range."

Output Status: OS (no parameter sent, but response generated)

Upon receipt of the OS command, the display makes available over HP-IB a status byte, which is an unsigned ASCII integer, terminated by (CR) and (LF). The status byte provides information about the active window (values 1 and 8), the keyboard (values 2, 4 and 128) and the display as a whole (values 32 and 64).

The display maintains a separate status byte for each window. Hence, if an HP-IB controller sends OS, the status byte pertains to the window assigned to HP-IB; if an HP-MSIB module sends OS, the status byte refers to the window assigned to that module.

The decimal value of the status byte is the sum of eight different quantities:

Quantity	Meaning
1	Pen down
2	I/P key pressed
4	Knob count available
8	Window initialized
16	Ready/Not Busy
32	Error detected by the display (not by another module on HP-MSIB)
64	Service request asserted on HP-IB by the display
128	Keyboard data available

Note: The value 16 (Ready/Not Busy) is provided for consistency with HP-GL (but a Display will never be "Not Busy" while responding to the OS command over HP-IB).

Example:

Receiving Status Byte

```
10  ASSIGN @Dsp TO 704
20  OUTPUT @Dsp;"IN;"
                      (INITIALIZE WINDOW)
30  OUTPUT @Dsp;"OS;"
                      (REQUEST STATUS BYTE)
40  ENTER @Dsp;A$
                      (READ STATUS BYTE - EXPECTED VALUE OF 8)
50  OUTPUT @Dsp;PD;OS;"
                      (PEN DOWN, REQUEST STATUS BYTE)
60  ENTER @Dsp;B$
                      (READ STATUS BYTE - EXPECTED VALUE OF 1)
70  DISP A$,B$
                      (DISPLAY BOTH STATUS BYTES, VALUES 8 AND 1)
80  END
```

Input Mask: IM Emask, Smask, Pmask

The IM command allows the user to specify the conditions under which the display will:

* Set the Error Detected value in the status byte (see the OS command description)
* Assert SRQ (Service Request) on HP-IB

The parameters Emask and Smask, sent along with the IM command, are each 8-bit numbers given in decimal notation: their value will determine under what conditions the above actions are taken. The specific value of either parameter should be the sum the values (given below) corresponding to all conditions the user determines as prerequisite to setting the Error Detected bit in the status byte, or to asserting SRQ. See the OS command description for a discussion of the status byte.

Note: The Pmask parameter is included for consistency with HP-GL, where it is used to determine the response to an HP-IB Parallel Poll. The HP 70205A and HP 70206A Displays, however, do not have Parallel Poll response capability, so the parameter Pmask will be accepted by display, but then ignored.

Emask parameter composition values and meanings:

If the value of Emask contains:	Then the Error Detected bit in the status byte will be set if:
1	Instruction not recognized
2	Wrong number of parameter received
4	Bad parameter received
8	Illegal character received
16	Unknown character set referenced
32	Missing terminator
64	(not used)
128	Self Test failed

For instance, Emask = 159 (128+16+8+4+2+1) sets the error value in the status byte if any error condition other than "Missing Terminator" occurs. This is the default condition.

Smask parameter composition values and meanings:

If the value of Smask contains:	Then the Display will assert SRQ on HP-IB if:
1	Pen down
2	I/P key pressed (cleared upon receipt of KY)
4	Knob count available
8	Window initialized (cleared upon receipt of OS)
16	Ready/Not Busy
32	Error detected at display
64	Require service (for HP-GL compatibility)
128	Keyboard data is available

Notes: See notes below for individual values.

Value

1 --- Refers to current window only

2 --- SRQ will be asserted on HP-IB in response to keyboard action only if:
- Pre-Process mode is on, regardless of where the keyboard is assigned (see PP command description)
  OR
- Pre-Process mode is off, but the keyboard is assigned to HP-IB

4 --- See note for 2

8 --- See note for 1

16 -- Refers to entire display. If the value 16 is included, SRQ will be asserted if:
- a copy operation has been completed (see CY)
- the HF1 command has been received and all data sent to the display before HF1 has been drawn. (Ready for more trace data)

32 -- SRQ will be asserted if an error is detected at the display. This does not pertain to errors reported by the spectrum analyzer (i.e., the HP 70900A Local Oscillator/Control module). The HP 70900A can be instructed to assert SRQ in response to its own errors using the RQS command.

64 -- This value is included for HP-GL compatibility only. Its inclusion in Smask will have no effect.

128 - See note for 2

For instance, sending IM159,32 (Smask = 32) will assert SRQ if an error is detected at the display. This is the default condition.

Section 10: The Display as a Remotely-Controlled User Interface

The HP 70205A and HP 70206A Graphics Displays can be used in a variety of ways as a user interface while being remotely controlled. The displays have the capability to accept alphanumeric entry from the user, to display messages, prompts, and softkeys, and to send all keyboard entries to a controller for processing before being sent to an instrument.

The commands covered in this section are:

AE: Alpha Entry -- Allows the user to directly enter general ASCII text.

FC: Fill Command Window -- Allows controller to display prompts on screen.

KP: Simulate Key Pressed -- Allows controller to simulate any keyboard entry.

KY: Send Keyboard Data -- Allows controller to interrogate display for keyboard entry.

ML: Menu Load -- Allows controller to load softkey labels.

PP: Pre-Process -- Forces the display to send all keyboard entries to the controller for processing.

RG: Simulate Knob Turned -- Allows controller to simulate rotating the knob.

Alpha Entry

When AE is received, the display clears the data line and softkey labels, then shows a portion of the character set on the data line with one character underlined by the cursor. The user may select a character by turning the display knob to position the cursor, then pressing ◀ENTER▶. As the knob is turned further, the remainder of the character set will scroll into the data line.

The data entered with this simulated keyboard is immediately sent to the element controlling the keyboard. To determine which element controls the keyboard, see the ◀SHOW CONFIG▶ softkey and the discussions of the BW (Build Window) and PP(Pre-Process) commands.

mode# = 0: Disable Alpha Entry mode--clear line (default condition).
mode# = 1: Enable Alpha Entry mode.

Fill Command Window: FC text

The FC command allows the user to place a message or prompt on the data line, as shown below.

Note: The "text" message sent must end with the previously defined label terminator (see the DT command description).

Example:

```
OUTPUT @Dsp;"DS0,1;DT#;FCThis Is The Data Line#;"
```

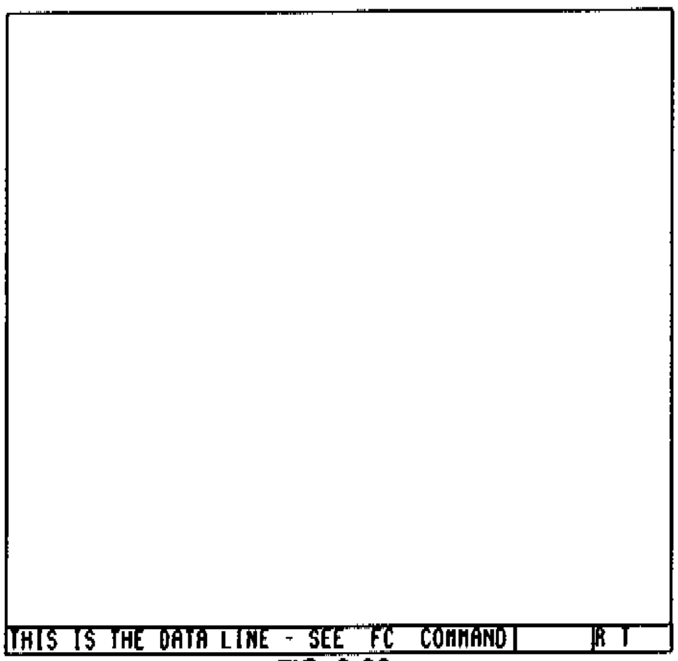


FIG. 3-22.

Simulate Key Pressed: KP keycode

The KP command allows the computing controller to simulate any sequence of key closures exactly as if a user had pressed the keys manually. The phantom key closure will be sent to the element that has keyboard assignment. This capability works in conjunction with the PP, RG, and RP commands for flexibile semi-automatic operation.

The keycodes are given below. The default code is 64, the Null Key (simulates no key closure).

Key Simulated	Keycode
Numeric 0	0
Numeric 1	1
Numeric 2	2
Numeric 3	3
Numeric 4	4
Numeric 5	5
Numeric 6	6
Numeric 7	7
Numeric 8	8
Numeric 9	9
Softkey 1	17
Softkey 2	18
Softkey 3	19
Softkey 4	20
Softkey 5	21
Softkey 6	22
Softkey 7	23
Softkey 8	24
Softkey 9	25
Softkey 10	26
Softkey 11	27
Softkey 12	28
Softkey 13	29
Softkey 14	30
Decimal Point	32
Minus Sign	33
Left Arrow	34
Down Key	35
Up Key	36
Menu [MNU]	37
User [USR]	39
Local	40
Hold	41
Print	42
Display [DSP]	43
Instrument Preset [I/P]	46
Plot	47
Null Key	64

Keycodes for other ASCII characters are 256 + N, where "N" is the character's decimal value in ASCII.

Note: The HP 70000 element receiving the phantom key closures may not be able to process incoming key signals as quickly as a controller can send them. A WAIT statement or equivalent may be used by the controller if necessary.

Send Keyboard Data: KY responsemode

Upon receipt of the KY command, the display will output, over HP-IB, the code of the key that was last pressed. See the KP description for a listing of the keycodes.

responsemode = 0: Send keycode in ASCII (default mode).
responsemode = 1: Send keycode in binary.

Menu Load: ML key#, label, key#, label...

The ML command enables the controller to place softkey labels on the screen. These labels serve as prompts for the user but do not affect the value of the key when it is pressed.

The softkeys are numbered 1 - 14, as shown in the figure below. The "label" can be one or two lines of up to seven characters: the lines are either separated by a line feed or simply scrolled over to fit the window. **Note use of the label terminators.**

Example:

Loading Menu Key Labels.

```
10 ASSIGN @Dsp TO 704
20 OUTPUT @Dsp;"DE;IN;"
30 OUTPUT @Dsp;"DT%;"
                (NOTE THAT LABEL TERMINATOR MUST BE USED!)
40 OUTPUT @Dsp;"ML1,KEY   #1%,7,KEY   #7%;"
                (LOAD KEYS #1 AND 7)
50 OUTPUT @Dsp;"ML8,KEY   #8%,14,KEY   #14%;"
                (LOAD KEYS #8 AND 14)
60 END
```

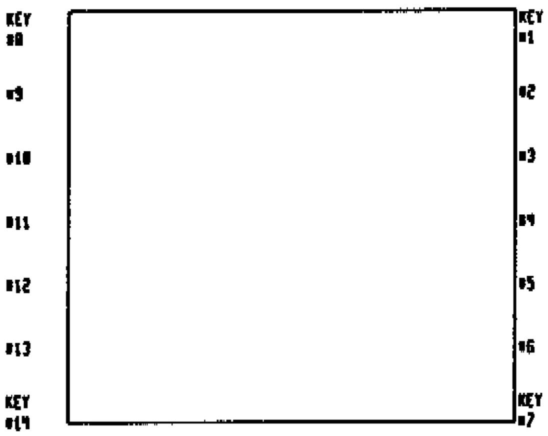


Fig. 3-23. Use of the Menu Load Command (ML)

Pre-Process: PP mode #

The PP command allows the user to direct that all key closures and knob data be reported directly to the controller, not to the active element (the modular instrument to which the keyboard is assigned). This allows the controller to process inputs intended for the instrument, and to send whatever key closure signals it determines are suitable using the commands KP (Simulate Key Pressed) and RG (Simulate Knob Turned).

mode # = 0: Turn off Pre-Process mode (default condition).
mode # = 1: Turn on Pre-Process mode;
report keyboard entry to controller.

Simulate Knob Turned: RG count

The RG command, like the KP command, allows the controller to send phantom keyboard inputs to the instrument that the keyboard is assigned to. By sending either a positive or negative "count," the controller can simulate either a clockwise or counter-clockwise rotation of the knob.

Example:

```
OUTPUT @Dsp;"RG 48;"
```

This simulates the clockwise rotation of the knob one full revolution.

Note: Depending on the element receiving the knob count, the response may not be proportional to the size of the count; e.g., RG10 may result in a larger effect than RG5;RG5.

Send Knob Data: RP responsemode

The RP command causes the display to output, over HP-IB, the count of knob rotations accumulated since the last knob count reading. The response may be sent in either ASCII or binary format.

responsemode = 0: ASCII (default condition)
responsemode = 1: Binary

Example:

```
OUTPUT @Dsp;"RP;"
ENTER @Dsp;Count
```

Section 11: Utility Commands

The HP 70205A and HP 70206A Graphics Displays have several capabilities not mentioned in prior sections that deal with such things as self-testing of the display, automatically reconfiguring the screen, moving traces, and interrogating the display for available memory space. This section covers the following commands.

BP - Output audible "beep" tone
HF - Temporarily hold off on trace drawing
OL - Output learn string for reconfiguration
PG - Clear page (delete contents of only one window)
PN - Pan trace (graph or plot) across screen
RM - Interrogate display for remaining memory space
TE - Initiate self-test of display
TP - Specify trace pointer for graph updating
WM - Load label stating which menu is in use

Beep: BP frequency, duration

The BP command causes the display to put out an audible beep. The frequency and duration are independently adjustable to any of several discrete values, as shown below.

Frequency	Duration
444 (Hz)	8 (mS)
500	15
571	31
666	61
800	123
1000	246
1333	492
2000	983

Hold Off: HF mode#

The HF command lets the user force the display to stop drawing new figures, although more data can still be sent. Once the HF command is received with "mode #" equal to 1, the display will finish drawing all figures in the input buffer, and then stop displaying new data until the "HF0" command is received. This command can be used to present only complete traces on the screen, but will affect speed of drawing, and may affect other windows in a multi-instrument system.

mode# = 1: Stop updating trace data.
mode# = 0: Resume updating trace data.

Output Learn String: OL (no parameters)

The OL command can be used to obtain, over HP-IB, a string of ASCII characters describing the current configuration of the display screen (window definitions and assignments, but not trace data or stored configurations). This string can be stored in a controller or on a disc, and later sent back to the display, causing the display to reconfigure itself as it was prior to receiving the OL command.

Example:

Reconfigure Display to Prior State.

```
10  ASSIGN @Dsp TO 704
20  DIM L$[100]
30  OUTPUT @Dsp;"DE;IN;"
40  OUTPUT @Dsp;"BW1,112,16,911,195,0,0,0,0;"
                (BUILD WINDOW #1, ASSIGN TO HP-IB)
50  OUTPUT @Dsp;"BW2,112,205,911,383,1,0,18,1;"
                (WINDOW #2,ASSIGN TO SPECTRUM ANALYZER AT 0,18)
60  OUTPUT @Dsp;"SNO;"
70  PAUSE
                (VIEW CONFIGURATION - PRESS CONTINUE)
80  OUTPUT @Dsp;"OL;"
                (ASK FOR LEARN STRING ON HP-IB)
90 ENTER @Dsp USING "%,K";L$
                (RECEIVE LEARN STRING)
100 OUTPUT @Dsp;"DE;"
                (DELETE SCREEN)
110 OUTPUT @Dsp;"SNO;"
                (SHOW BLANK CONFIGURATION ON SCREEN)
120 PAUSE
                (VIEW CONFIGURATION - PRESS "CONTINUE")
130 OUTPUT @Dsp USING "#,K";L$
                (SEND LEARN STRING - RECONFIGURE SCREEN)
140 SEND 7;DATA 0 END
150 OUTPUT @Dsp;"SN0;"
                (SHOW "NEW" CONFIGURATION)
160 END
```

Page: PG (no parameters sent, no response generated over HP-IB)

The PG command erases all information displayed in the current window. While this does cause all trace data in that window to be lost, it does not alter the screen configuration as DE (Delete Screen) does, nor does it affect information contained within the other windows.

Pan: PN offset

The PN command is used to move an entire trace (plot or graph) horizontally in the current window. "Offset" gives the number of endpoints to shift the trace to the right (positive offset) or to the left (negative offset). Endpoints are just X-axis points or values on a plot or graph: the physical distance between endpoints depends on the scale being used (SC command) and, in the case of a graph, on the Delta-X value in force (DX command).

Remaining Memory: RM (no parameters sent, but response generated)

The RM command causes the display to output over HP-IB an ASCII string describing the amount of memory remaining for displayed information. The information is in the form: # blocks, block size (words).

Example:

Interrogate Display for Remaining Memory.

```
10 ASSIGN @Dsp TO 704
20 OUTPUT @Dsp;"DE;IN;"
30 OUTPUT @Dsp;"RM;"
40 ENTER @Dsp;L$
50 DISP L$
60 END
```

The controller screen should respond with a number such as "96, 128" (96 blocks remaining, 128 words each).

Self Test: TE (no parameters)

The TE command initiates the self-test routine of the display. This is the same test described under the ◀CONFID TEST▶ softkey discussion in Chapter 2.

If the display fails the self test, that potential error will be handled according to the parameters of the last IM command. In order to determine the nature of the error, execute the OE (Output Error Number) or the EG (Output Error String) command.

Trace Pointer: TP endpoint

The TP command is used to specify the next point on a trace (graph or plot) that is to be referenced. This capability can be used to re-draw only a specific portion of a trace, as shown in the figure below.

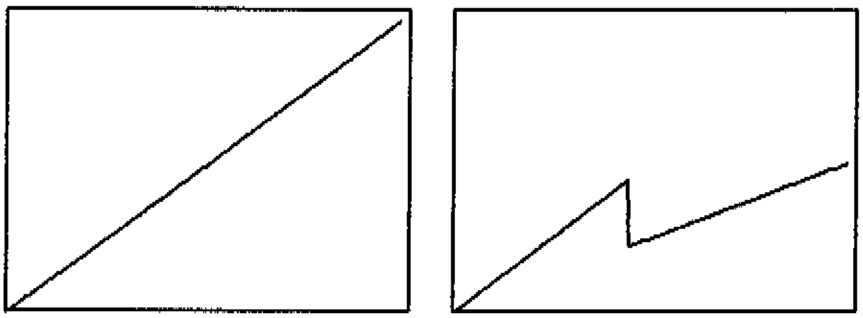
"Endpoint" is the number of x-values from the beginning of a trace that the trace pointer will point to; i.e., the next graph command will begin at that x position.

Note: The TP command can only be used with referenced graphics.

Example:

Re-Drawing a Trace Using Trace Pointer.

```
10  ASSIGN @Dsp TO 704
20  CLEAR @Dsp
30  OUTPUT @Dsp;"DE;IN;"
40  OUTPUT @Dsp;"SC0,1000,0,1000;"
                  (SCALE SCREEN TO 1000X1000)
50  OUTPUT @Dsp;"PU;PA0,0;"
60  OUTPUT @Dsp;"DX1;"
                  (SET Xincrement TO 1)
70  OUTPUT @Dsp;"GP1;IT1;"
                  (TRACE POINTER MAY ONLY BE USED WITH
                   REFERENCED ITEMS)
80  OUTPUT @Dsp;"PD;"
90  FOR J=0 TO 900
100    OUTPUT @Dsp;"GA";J";"
                  (GRAPH DIAGONAL LINE)
110 NEXT J
120 OUTPUT @Dsp;"TP450;"
                  (SET TRACE POINTER TO CENTER OF LINE)
130 FOR K=450 TO 900
140    OUTPUT @Dsp;"GA";K/2;";"
                  (START RE-GRAPHING POINTS WITH NEW VALUES,
                   STARTING WITH THE POINT SPECIFIED BY THE
                   TP COMMAND)
```



INITIAL GRAPH BEFORE TRACE POINTER WAS USED

GRAPH AFTER LAST HALF WAS RE-DRAWN USING TRACE POINTER TO REFERENCE CENTER

FIG. 3-24.

Which Menu: WM menu

The WM command can be used to load a menu name into the left half of the display status box.

Note: The menu name placed on the screen by the WM command does not necessarily relate to the actual softkeys displayed.

menu = 0: Blank the menu status box.
menu = 1: Load menu status box with "MENU."
menu = 2: Load menu status box with "USER."

Display Command Summary

The command summary below is a listing of HP 70205A and HP 70206A Display commands. The categories of commands correspond to the section headings in Chapter 3, Remote Display Operation. Commands are also listed alphabetically in the index.

Section 1: Display Configuration

AK	Assign Keyboard
BW	Build Window
DE	Delete Entire Screen
DF	Default Values
IN	Initialize
OP	Output P1,P2
RC	Recall Screen Configuration
SN	Show Configuration
SV	Save Configuration

Section 2: Simple Graphics

AX	Axis
DX	Set Delta-X
GA	Graph Absolute
GR	Graph Relative
GT	Graticule
LT	Line Type
MP	Mapping Shape
PA	Plot Absolute
PD	Pen Down
PR	Plot Relative
PU	Pen Up
SC	Scale to User Units
SP	Select Pen

Section 3: Labeling the Screen

CL	Configure Label
DI	Set Character Direction Absolute
DT	Define Terminator
LB	Label
SI	Set Character Size Absolute
SR	Set Character Size Relative

Section 4: Hardcopy Output

CY	Copy
KC	Keycopy On/Off
PI	Printer/Plotter Is
PL	Ploter Parameters
SP	Select Pen

Section 5: Markers

MA	Marker Attributes
MK	Place Marker

Section 6: Character Sets

CA	Designate Character Set Alternate
CS	Designate Character Set Standard
SA	Select Alternate Character Set
SS	Select Standard Character Set
SU	Save User-Defined Character
UC	Draw User-Defined Character

Section 7: Referenced Graphics

BL	Blink On/Off
DA	Delete All Referenced/Non Referenced Objects
DL	Delete Active Item or Group
GP	Identify Group
IT	Identify Item
OR	Set Origin
VW	View On/Off

Section 8: Informational Displays

AM	Address Map
DS	Display Status On/Off
ES	Error Screen
OI	Output Identification
OV	Output Version
SN	Show Configuration

Section 9: Error Handling

EG	Output Error String
ES	Error Screen
IM	Input Mask
OE	Output Error Number
OS	Output Status

Section 10: The Display as a Remotely Controlled User Interface

AE	Alpha Entry
FC	Fill Command Window
KP	Simulate Key Pressed
KY	Send Keyboard Data
ML	Menu Load
PP	Pre-Process
RG	Simulate Knob Turned
RP	Send Knob Data

Section 11: Utility Commands

BP	Beep
HF	Hold Off
OL	Output Learn String
PG	Page
PN	Pan
RM	Remaining Memory
TE	Self Test
TP	Trace Pointer
WM	Which Menu

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