HEWLETT PACKARD

OPERATING MANUAL

71100A, 71200A, 71300A
MODULAR SPECTRUM ANALYZERS

LOCAL OSCILLATOR ROM VERSIONS
860203 OR EARLIER

This manual applies directly to the following modules:

HP 70001A	Mainframe
HP 70205A	Graphics Display
HP 70206A	System Graphics Display
HP 70300A	Tracking Generator
HP 70310A	Precision Frequency Reference
HP 70900A	Local Oscillator
HP 70902A	IF Section (RES BW 10 Hz–300 kHz)
HP 70903A	IF Section (RES BW 100 kHz–3 MHz)
HP 70904A	RF Section (100 Hz–2.9 GHz)
HP 70905A	RF Section (50 kHz–22 GHz)
HP 70906A	RF Section (50 kHz–26.5 GHz)
HP 70907A	External Mixer Interface

1212 VALLEY HOUSE DRIVE, ROHNERT PARK, CALIFORNIA, 94928, U.S.A.

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Gain Compression and Maximum Input Levels

The maximum-input softkey specifies a value for the maximum *expected* signal level to the *analyzer* input during a given measurement procedure. The maximum mixer level softkey specifies the maximum signal level at the *mixer* input.

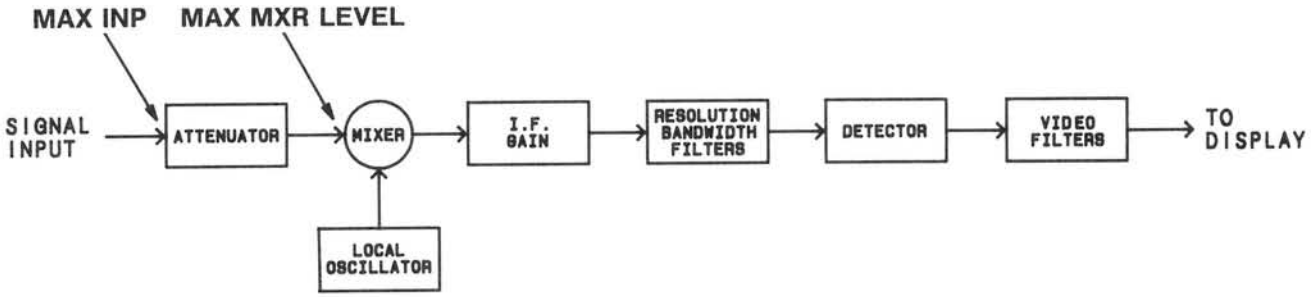


Figure 4-35a.

Together, these softkey settings control the reference level (IF gain) and input attenuation of the analyzer so that any displayed signals whose peaks are below the top graticule line, or a dashed line if it is present, have levels that do not exceed the selected maximum input level and are not affected significantly by gain compression. (Figure 4-35c.)

For example, the figure below shows how the analyzer controls the input attenuator and the IF gain circuitry when the maximum input level is set to -10 dBm and the maximum mixer level is set to -30 dBm.

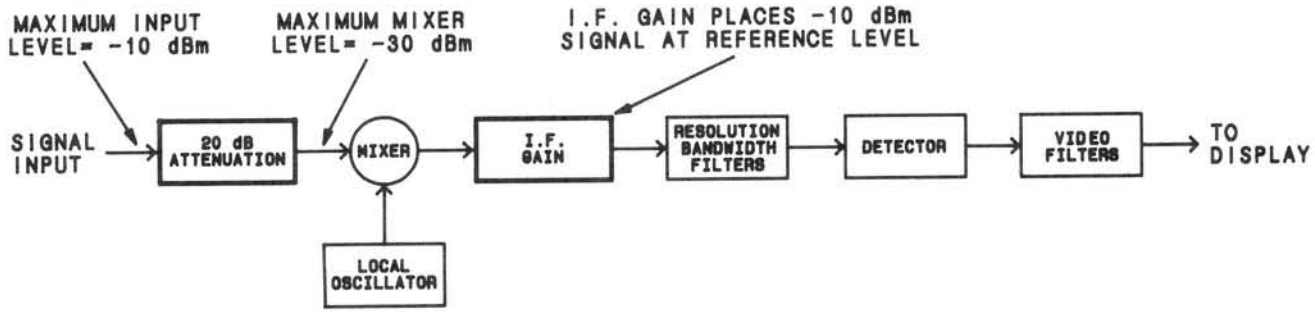


Figure 4-35b

The analyzer first activates 20 dB of input attenuation so that the mixer level never exceeds -30 dBm when the maximum input level (-10 dB) is connected to the analyzer.

input attenuation = maximum input level - maximum mixer level

20 dB = -10 dBm - (-30 dBm)

The analyzer then computes the IF gain necessary to position measurement results as high as possible on the analyzer screen. In most measurement procedures, this is at the top of the graticule when the displayed response equals the maximum input level setting.

maximum input - attenuation - mixer conversion loss + IF gain = maximum detected signal level

To protect the analyzer, the maximum input and maximum mixer level settings cannot effect an input attenuation less than 10 dB. Thus, when maximum input and maximum mixer level settings are both -20 dBm, input attenuation is set automatically to -10 dBm, not zero.

input attenuation = maximum input level - maximum mixer level

10 dB (cannot equal zero) = -20 dBm - (-20 dBm)

(If zero input attenuation is desired, use the ATTEN softkey.)

Use of Maximum Mixer Level Softkey ◀MAX MXR LEVEL▶

Use the maximum-mixer-level softkey to limit signal levels to the mixer in order to meet your measurement needs. Excessive signal levels into the mixer can limit the dynamic measurement range by producing spurious, false responses on the analyzer screen. Likewise, excessive levels can also cause gain compression which limits amplitude accuracy. Gain compression describes the condition where a change in spectrum analyzer response is not proportional to a change in input signal level. For example, the 1 dB gain compression point of the HP 70905A and 70906A RF modules is -7 dBm. This means that the amplitude of a -7 dBm signal at the mixer input in these modules is not reduced by more than 1 dB at the mixer output.

The maximum-mixer-level setting is reset to -7 dBm when the analyzer is turned on or when instrument preset (IP) is pressed. To improve amplitude accuracy or increase dynamic range, decrease the maximum mixer level to any value within 70 dB of the maximum input setting. Optimum dynamic range for most analyzer systems is achieved by setting the maximum mixer level to -30 or -40 dBm. Below, maximum mixer level is set to -40 dBm, which is within 70 dB of the preset value for the maximum input level, 0 dBm.

Press [IP]
[MENU]
◀AMPTD▶
◀MAX MXR LEVEL▶ ◀-40▶ ◀dBm▶

$|0 \text{ dBm} - (-40 \text{ dBm})| < 70 \text{ dB}$

Use of the Maximum Input Level Softkey ◀MAX INP▶

Use the maximum-input-level softkey to simplify the display of normalized measurement results during tracking generator applications. Set the maximum input level to the largest signal level you anticipate measuring at the analyzer input. This ensures that the analyzer attenuation and IF gain are automatically adjusted to display normalized measurement results on the analyzer screen when the screen is calibrated in relative amplitude terms.

When the instrument is turned on, after instrument preset (IP) is pressed, or after MAX INP AUTOMAN is set to AUTO, the maximum input level setting is 0 dBm.

Interpreting Displayed Measurement Results

All displayed signals whose peaks are below the top of the graticule, or dashed line if it is present, have levels that are below the selected maximum input level. In addition, the amplitude accuracy of these responses includes the gain compression error corresponding to the mixer input level setting. Gain compression characteristics are specifed for each RF module, but as a rule, gain compression is about 1 dB for mixer levels of -10 dBm.

Certain combinations of maximum input and maximum mixer level settings may cause the detected signal peak to be clipped on the analyzer screen.

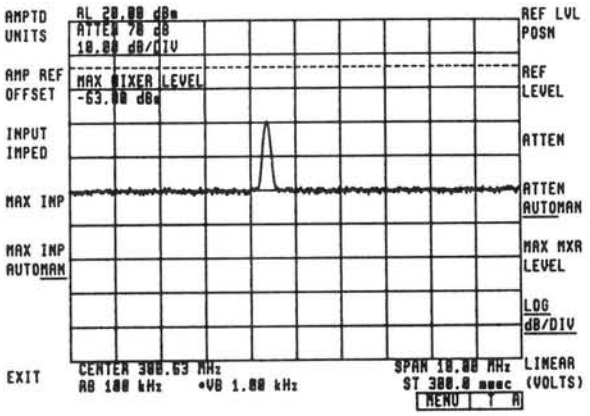


Figure 35c.

Resolution Bandwidth Correction Factors for Frequency and Amplitude

The resolution-bandwidth-frequency and -amplitude softkeys, **RBW FREQ ON OFF** and **RBW AMP ON OFF**, turn off frequency and amplitude corrections of the local oscillator. During normal operation, these corrections improve the amplitude and frequency accuracy of displayed measurement results by compensating for irregularities in the IF resolution bandwidth filters. However, the corrections may be deactivated for special applications. Set **RBW FREQ ON OFF** to **OFF** to eliminate the frequency correction and improve the frequency accuracy of the source output, especially when using resolution bandwidths of 10 KHz or greater.

TRACKING GENERATOR AND SOURCE COMMANDS ROM VERSIONS 851216 OR LATER

MEASURE	Measurement mode: spectrum analysis or stimulus response
MIL	Maximum input level
SRCALC	Source, automatic level control
SRCAM	Source, amplitude modulation
SRCAMF	Source, amplitude modulation frequency
SRCBLANK	Source, retrace blanking
SRCAT	Source, attenuator
SRCMOD	Source, internal or external modulation
SRCOSC	Source, internal or external oscillator
SRCPOFS	Source, power offset
SRCPSTP	Source, power step
SRCPSWP	Source, power sweep
SRCPWR	Source, power level
SRCTK	Source, tracking adjustment
SRCTKPK	Source, automatic peak tracking
STORREF	Store reference (thru, open, or short)

HEWLETT PACKARD

HP 71000 OPERATING MANUAL SUPPLEMENT

HP Part Number 70900-90032

January 1986

This supplement upgrades Modular Spectrum Analyzer Operating Manuals, HP Part Number 5958-4233 (dated January, March, and August, 1985), with operating instructions for features implemented in the local oscillator ROM version 851216 or later.

* **Title Page.** Replace the original title page in your Operating Manual with the new title page. The new title page tells which ROM version(s) the manual reflects.

* **MNU Hardkey Chapter.** Make the following changes at the white MNU HARDKEY tab in Part I, MANUAL OPERATION:

  After page 4-30, insert the pages describing the maximum input and maximum mixer level softkeys, MAX INP and MAX MXR LVL.

  Delete all references to the CAL RES BW softkey in pages 4-89 through 4-93. Add the page describing the resolution-bandwidth-frequency and -amplitude softkeys, RBW FREQ and RBW AMP.

* **Remote Operation, Appendices.** Append the Tracking Generator and Source Command list to the Command Summary.

* **Tracking Generator Operating and Programming.** This chapter introduces users to the manual and remote operation of the HP 70300A Tracking Generator. Place the tab and tracking generator material at the end of your Operating Manual.

HP 70300A TRACKING GENERATOR

OPERATION AND PROGRAMMING

DESCRIPTION: This part of the operating manual introduces users to the manual and remote operation of the HP 70300A Tracking Generator. Tracking generator information is divided into the four sections shown below. The material is intended for both first-time users and for those who have not used softkeys to operate a tracking generator.

HP 70300A: INTRODUCTION

This part of the operating manual discusses the manual and remote operation of the HP 70300A Tracking Generator.

The HP 70300A Tracking Generator is compatible with HP 70900A Local Oscillator ROM versions 851216 (December 16, 1985) and later. Systems with earlier ROM versions must be updated as described in HP 70900A Service Note (No. 70900A-1). To check your ROM version, press [MENU], ◀CONFIG▶, and ◀ROM VERSION▶.

Organization

Introduction

This section briefly describes the front- and back-panel features of the HP 70300A Tracking Generator. An installation checklist is provided to check the configuration of the tracking generator/spectrum analyzer system.

Typical Tracking Generator Measurements

This second section demonstrates three typical tracking generator measurements.

Tracking Generator Softkeys

This section discusses the manual operation of the HP 70300A Tracking Generator by describing each of the softkeys. Tracking generator softkeys are divided by function into six groups. Step-by-step examples demonstrate how the softkeys are used.

Remote Tracking Generator Measurements

The last section discusses the operation of the HP 70300A using a remote controller. The relationship between softkeys and their corresponding remote commands is described. Sample programs are provided to demonstrate tracking generator commands.

Module Description

The HP 70300A Tracking Generator Module generates a signal that precisely tracks (follows) the tuned frequency of the HP 71100A or 71200A Spectrum Analyzer. The signal present at the RF OUTPUT connector on the front panel of the tracking generator is applied to a device under test (DUT) which is connected to the RF INPUT connector on the HP 70904A, 70905A, or 70906A RF module. Thus, the spectrum analyzer/tracking generator system can be used to make stimulus-response measurements (such as transmission and reflection measurements) and the system may be used as a conventional signal source (that is, the output need not be returned to the RF INPUT). And, the system can still be used as a spectrum analyzer (the input need not come from the tracking generator).

Front Panel Features

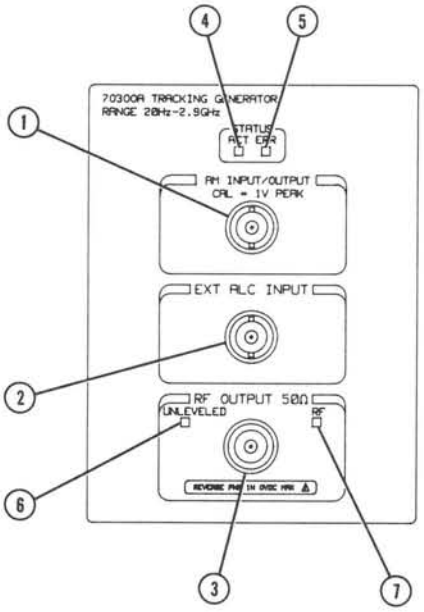


Figure 1-1.

Inputs and Outputs:

1. *AM INPUT/OUTPUT* (type BNC connector) is the input/output for amplitude modulating signals.
2. *EXT ALC INPUT* (type BNC connector) is the input for an external negative diode detector.
3. *RF OUTPUT* (type N connector) is the tracking generator RF output (usually connected through a device under test to the RF INPUT on the HP 70904A or HP 70905A RF modules.)

Indicator Lights:

4. *STATUS ACT* indicates that the HP 70300A Tracking Generator is active.
5. *STATUS ERR* indicates errors. (See System Support Manual "Troubleshooting.")
6. *UNLEVELLED* indicates that the RF OUTPUT power is unlevelled during the time the indicator is lit, possibly during part of a sweep. Unlevelling can occur if the source power (SRC PWR) or power sweep (PWR SWP) are set too high or if the normal ALC detector (ALC NRM) is used at a frequency below the normal detection range.
7. *RF* indicates that the HP 70300A Tracking Generator RF OUTPUT power is turned on. When the ◀SRC PWR ON OFF▶ softkey is on, the indicator is lit.

Back Panel Connectors

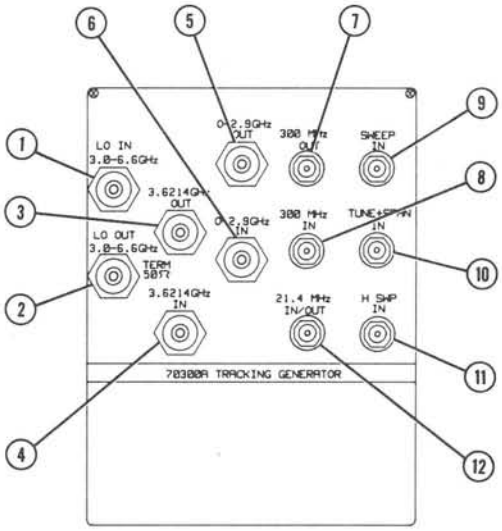


Figure 1-2.

1. *LO IN 3.0-6.6 GHZ* (SMA female connector) normally connected to *1st LO OUT* on the HP 70904A, 70905A, or 70906A RF Module.
2. *LO OUT 3.0-6.6 GHZ* (SMA female connector) normally terminated (50 ohms).
3. *3.6214 GHZ OUT* (SMA female connector) normally connected to *3.6214 GHZ IN*.
4. *3.6214 GHz IN* (SMA female connector) normally connected to *3.6214 GHZ OUT*.
5. *0-2.9 GHz OUT* (SMA female connector) normally connected to *0-2.9 GHZ IN*.
6. *0-2.9 GHz IN* (SMA female connector) normally connected to *0-2.9 GHZ OUT*.
7. *300 MHz OUT* (SMB male connector)
8. *300 MHz IN* (SMB male connector) normally connected to *300 MHZ OUT* on the HP 70900A Local Oscillator module.
9. *SWEEP IN* (SMB male connector) normally connected to *SWP* on the HP 70900A Local Oscillator module.
10. *TUNE + SPAN IN* (SMB male connector) normally connected to *TUNE SPAN* on the HP 70900A Local Oscillator module.
11. *HSWP IN* (SMB male connector) normally connected to *H SWP* on the HP 70900A Local Oscillator module.
12. *21.4 MHz IN/OUT* (SMB male connector)

Note: The System Support Manual is the user's primary reference for system configuration.

Installation Checklist

The following instructions briefly describe how to configure the tracking generator. Use the checklist to ensure that your equipment is properly set up for operation. (Examples in this manual assume that the instrument has been correctly configured.)

For a detailed description of the HP 70300A Tracking Generator's installation, consult the System Support Manual.

1. Connect all back-panel cabling as described in the System Support Manual. If you are programming through a controller and using the HP 70206A System Graphics Display, connect it to the spectrum analyzer with an HP-IB cable.

2. After the HP-IB cable has been installed, reset all instruments connected to the bus by cycling the power. Most plotters and printers can be reset with their front-panel reset keys or by turning their power off and on again.

3. Check the HP-MSIB address by pressing [DSP] and ◀ADDRESS MAP▶. The Hewlett-Packard Modular System Interface Bus (HP-MSIB) has a two-dimensional addressing scheme. Each address consists of a row number and a column number; for example, the local oscillator is typically found at "0,18" (row,column). The local oscillator must be in row 0 for HP-MSIB access. Check this by turning the knob until the local oscillator number appears.

   The HP 70300A Tracking Generator must be addressed above the RF module. Individual modules do not require consecutive row addresses. Not all modules need be in the same column; they need only fall to the right of the local oscillator.

   Note: The System Support Manual is the user's primary reference for addressing modules. Additional information is available in the HP 71000 Operating Manual (see Chapter 2 of Part III, *DSP Hardkey*, under ◀ADDRESS MAP▶).

   HP-MSIB addressing priority for a sample system is shown in Figure 1-3. The sample is a relative address ranking only.

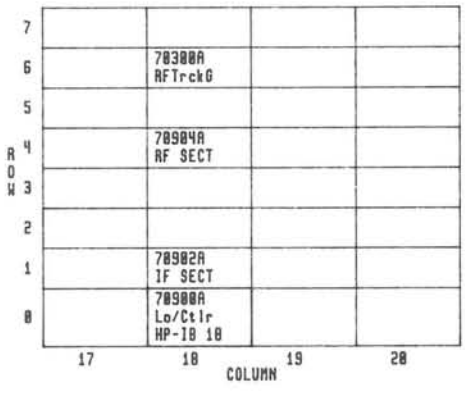


Figure 1-3.

TYPICAL TRACKING GENERATOR MEASUREMENTS

This section introduces you to the HP 70300A Tracking Generator by walking you through typical measurements. Three examples show how common measurements are rapidly and easily made:

1. *Transmission Measurement*: This example tests the transmission characteristics of a bandpass filter. The insertion loss of the filter is examined to determine such factors as the 3 dB bandwidth.

2. *Reflection Measurement*: This example tests the reflection characteristic of a bandpass filter. The return loss of the filter is examined.

3. *Source*: This example uses the spectrum analyzer/tracking generator as a source.

General Guidelines

1. To ensure good repeatability, connectors must be clean, in good condition, and properly tightened. If the test setup is not stable from connection to connection, the frequency response of the test setup will not be removed from the measurement of the device under test (DUT).

2. Make the open/short and thru calibrations using the same adapters and interconnect cables that will be used during measurement of the DUT. If this is impossible, use adapters with similar insertion- and return-loss characteristics.

3. To achieve greatest accuracy, do not change the frequency span or center frequency after the open/short and thru calibrations have been made. If the frequency parameters are changed, the stored reference trace and the current measurement data will pertain to different frequency ranges, and the normalization will no longer be valid. The reference level, reference level position, and vertical log scale (dB/div) can be changed after calibration.

4. If the test setup changes during the normalization process, reconnect the standards or the thru connection, and store a new reference trace.

Transmission Measurement

In this example, the HP 70300A is used to make a normalized transmission measurement. Making normalized transmission measurements involves measuring the difference between the power seen during a "thru calibration" and the power seen when a device under test (DUT) is inserted.

Normalization increases our measurement accuracy. By subtracting the thru calibration, the frequency response variations of the test setup are removed from the measurement.

When the DUT is inserted in the thru path, the transmission measurement appears on the display. By studying the insertion loss or gain of a device such as a bandpass filter, you can find the filter's center frequency, 3 dB bandwidth, average insertion loss, peak-to-peak ripple, and out-of-band attenuation.

In the example below, a normalized transmission measurement is made with a 321.4 MHz center frequency bandpass filter. The softkeys used in the example are described in the following *Softkeys* section.

Setup Procedure

Before we make the transmission measurement, the analyzer must be adjusted for this particular measurement and the device to be tested.

Turn the system on and bring it to an instrument preset state by pressing [I-P].

Connect the device between the RF OUTPUT on the tracking generator and the RF INPUT on the RF module.

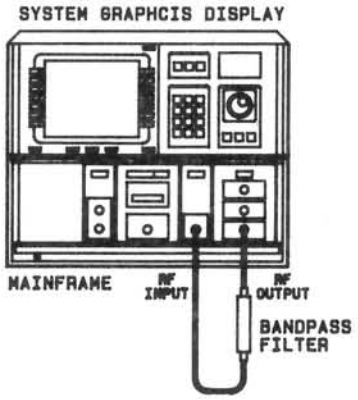


Figure 1-4. Setup Configuration

Press [MENU] and then ◀MEASURE MODE▶. Press ◀STIMULS RESPONS▶ to activate this mode.

Stimulus-response mode optimizes spectrum analyzer/tracking generator operation for transmission and reflection measurements.

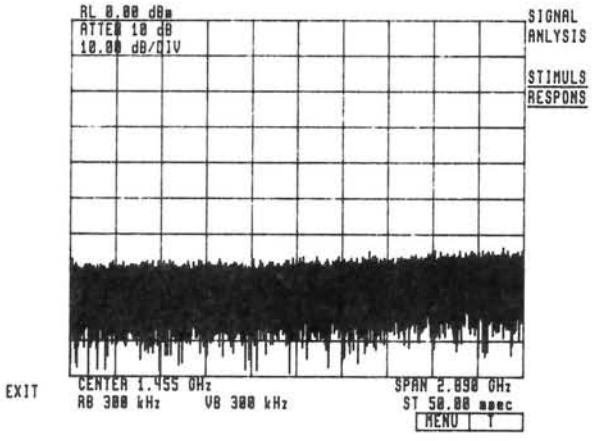


Figure 1-5.

Turn on the tracking generator by pressing ◀EXIT▶, ◀SOURCE▶ and then ◀SRC PWR ON OFF▶. The underline will move to the on position.

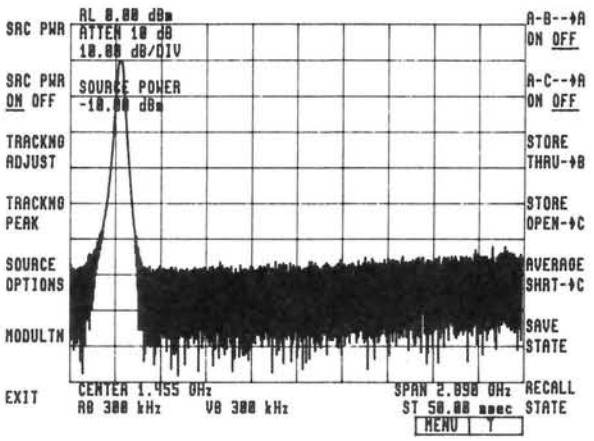


Figure 1-6.

Press [USER] and set the center frequency to 321.4 MHz: ◀CENTER FREQ▶, 3, 2, 1, ., 4, ◀MHZ▶.

Next set the frequency span to 500 MHz: ◀SPAN▶, 5, 0, 0, ◀MHZ▶.

Change the resolution bandwidth to 1 kHz: ◀RES BW▶, 1, ◀KHZ▶. (A resolution bandwidth is selected to optimize the dynamic range of the displayed response, yet maintain a fast sweep time.)

Note: Different DUTs will require different analyzer settings.

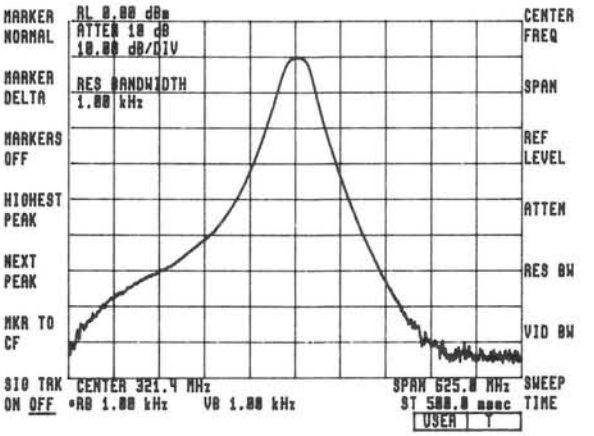


Figure 1-7.

Press the backspace (backarrow) key to return to the SOURCE menu. You can easily move between signal analysis and stimulus-response menus with the [USER] and backspace key.

At this point it is recommended you save the analyzer settings by pressing ◀SAVE STATE▶ and entering a register number.

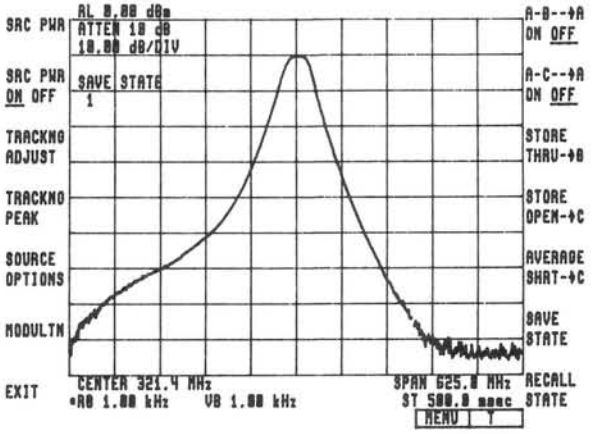


Figure 1-8.

If the resolution bandwidth is less than 2 kHz, the automatic tracking function can be used to optimize measurements.

Disconnect the DUT and connect the RF OUTPUT of the tracking generator directly to the RF INPUT of the RF module.

Press ◀TRACKNG PEAK▶. Wait until "Automatic Tracking Complete" appears.

If the resolution bandwidth is greater than 2 kHz, ◀TRACKNG PEAK▶ is not needed.

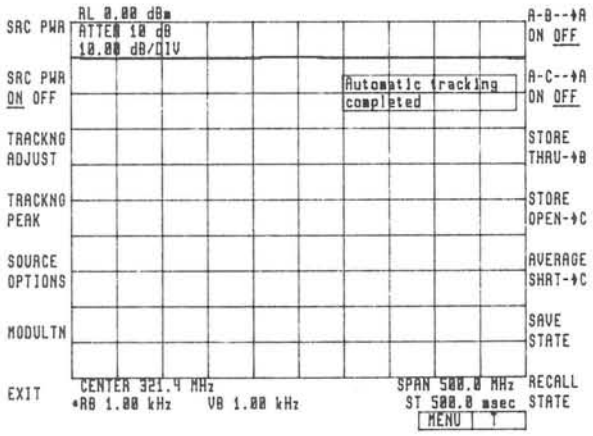


Figure 1-9.

Calibration/Normalization Procedure

Before we can measure transmission loss or gain, we must establish a thru reference.

In the last section we connected the RF OUTPUT of the tracking generator to the RF INPUT of the RF module.

This configuration is called a "thru connection" of our test setup. A thru connection is the calibration standard for 0 dB insertion loss.

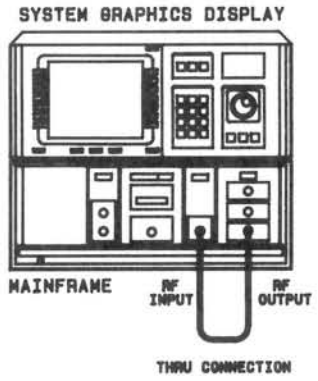


Figure 1-10. Calibration Configuration

The softkeys you will use to store the measurement standards and then to "normalize" are located along the right side of the SOURCE menu.

Wait for the trace to be completely updated.

Press ◀STORE THRU->B▶ to store your thru measurement in trace B. "Function executed" will appear on the display.

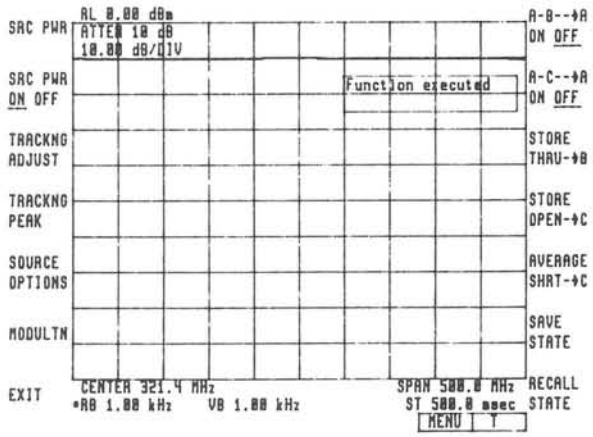


Figure 1-11.

Turn on ◀A - B -> A ON OFF▶ to subtract the thru calibration data from the measurement data and view the normalized transmission measurement. (Before the device is inserted, the 0 dB reference line will appear at the top of the display.)

Re-insert the device in the measurement path. (For this example, we test a 321.4 MHz bandpass filter.)

In stimulus-response mode, when a normalization softkey is on (A - B or A - C is on), scale units change from dBm to dB. The measurement is relative to the thru calibration.

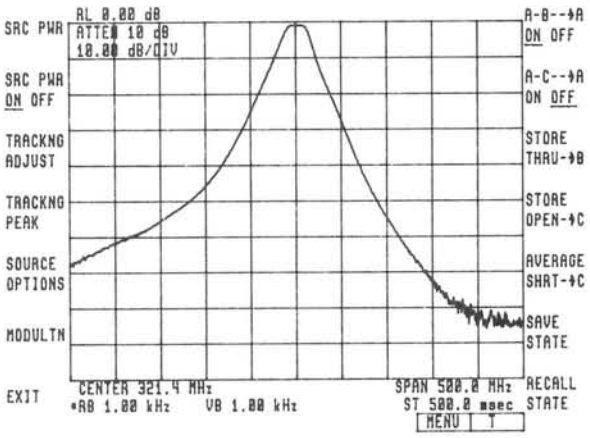


Figure 1-12.

Measurement Procedure:

3 dB Bandwidth:

One convenient method for testing the 3 dB bandwidth is shown below.

First, press [MENU], ◀MARKER▶, and ◀MARKER BW▶.

Select ◀AMP REF LEFT▶ and enter -3 dB. Then select ◀AMP REF RIGHT▶ and enter -3 dB. Turn on ◀MKR BW ON OFF▶ and read the -3 dB bandwidth from the CRT display.

If this measurement is made often, the bandwidth softkeys can be placed on the USER menu. (See the user-defined-key function.)

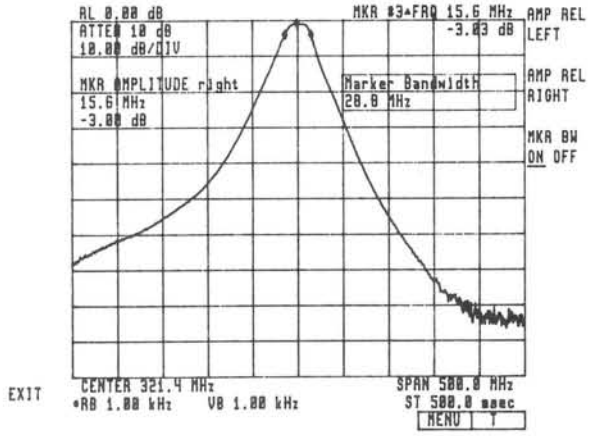


Figure 1-13.

Stop Band Attenuation:

The stop band attenuation can be measured using the marker functions.

Press the backspace key and ◀MARKER NORMAL▶. A marker will appear on the trace and its frequency will be displayed on the screen. The marker can be moved with the knob, step keys, or keypad if desired.

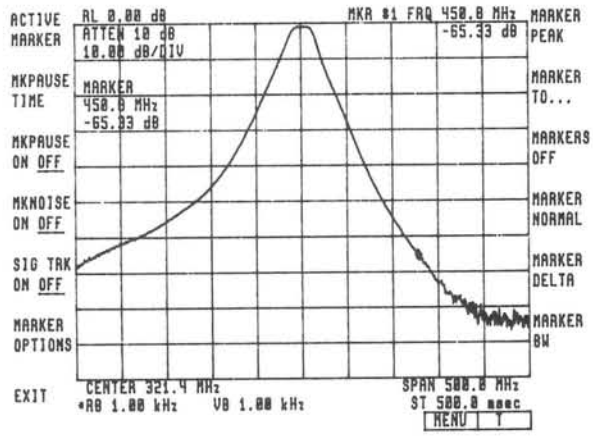


Figure 1-14.

Reflection Measurement

This example uses the HP 70300A to make a normalized scalar reflection measurement. In a typical reflection measurement sequence, a standard (such as an open or short circuit) is connected to a directional bridge or coupler and its trace is stored. Then the test device is connected in place of the standard, and the spectrum analyzer/tracking generator displays the magnitude difference between the response of the standard and the response of the test device.

A short circuit is the usual standard for reflection measurements. The short circuit reflects all incident power so that a convenient 0 dB reference line is obtained. An open circuit can also be used as the standard. But, better accuracy can be obtained by using the open/short average. First, an open circuit is connected to the test port and its frequency response is stored. Then a short is connected, and its frequency response is averaged with the response of the open. Later, the device is connected and the open/short average is subtracted from the measurement. With the open/short average, mismatch and directivity effects are reduced, producing a more accurate frequency-response reference trace than does either standard alone.

In the following example, a normalized reflection measurement is made on a 321.4 MHz bandpass filter. The tracking generator softkeys used in this example are described in the following *Softkeys* section.

Setup Procedure

Before we make the reflection measurement, the analyzer must be adjusted for this particular measurement and the device to be tested. If you have just finished the transmission measurement, skip to the TRACKING PEAK discussion (immediately prior to the calibration procedure).

Turn the system on and bring it to an instrument preset state by pressing [I-P].

Connect a directional bridge or coupler to the RF OUTPUT on the tracking generator and the RF INPUT on the RF module. Connect the device to the bridge or coupler. (Some devices will require a termination.)

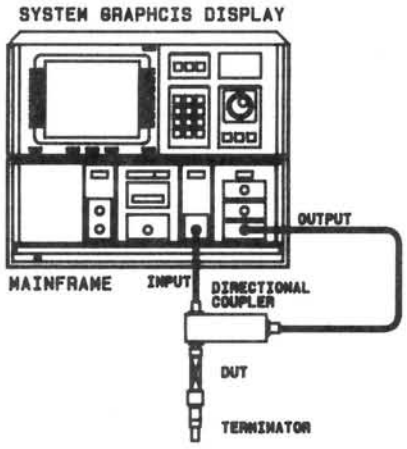


Figure 1-15. Setup Configuration

Press [MENU] and then ◀MEASURE MODE▶. Press ◀STIMULS RESPONS▶ to activate this mode.

Stimulus-response mode optimizes spectrum analyzer/tracking generator operation for transmission and reflection measurements.

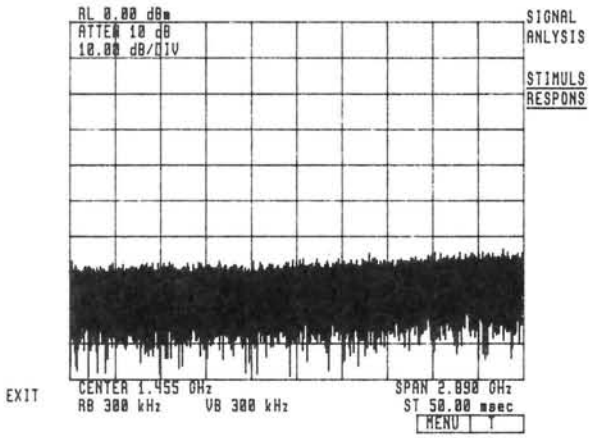


Figure 1-16.

Turn on the tracking generator by pressing ◀EXIT▶, ◀SOURCE▶ and then ◀SRC PWR ON OFF▶. The underline will move to the on position.

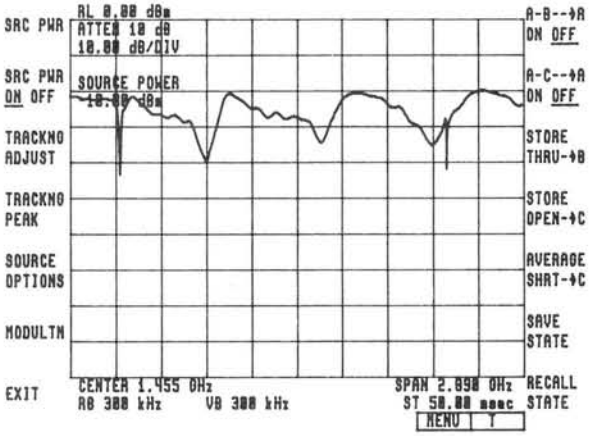


Figure 1-17.

Press [USER], and set the center frequency to 321.4 MHz: ◀CENTER FREQ▶, 3, 2, 1, ., 4, ◀MHZ▶.

Next set the frequency span to 500 MHz: ◀SPAN▶, 5, 0, 0, ◀MHZ▶.

Change the resolution bandwidth to 1 kHz: ◀RES BW▶, 1, ◀KHZ▶. (A resolution bandwidth is selected to optimize the dynamic range of the displayed response, yet maintain a fast sweeptime.)

Note: Different DUTs will require different analyzer settings.

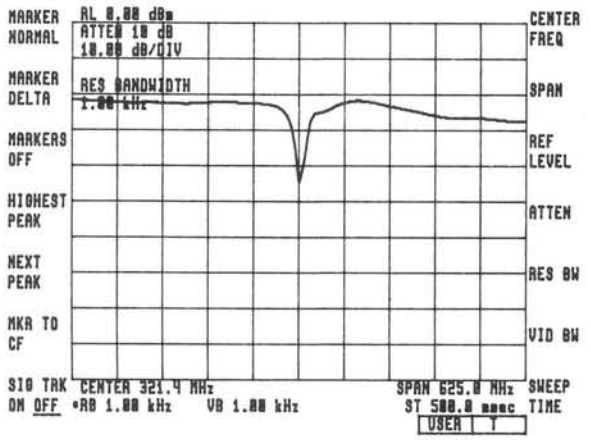


Figure 1-18.

Press the backspace (backarrow) key to return to the SOURCE menu.

At this point it is recommended you save the analyzer settings by pressing ◀SAVE STATE▶ and entering a register number.

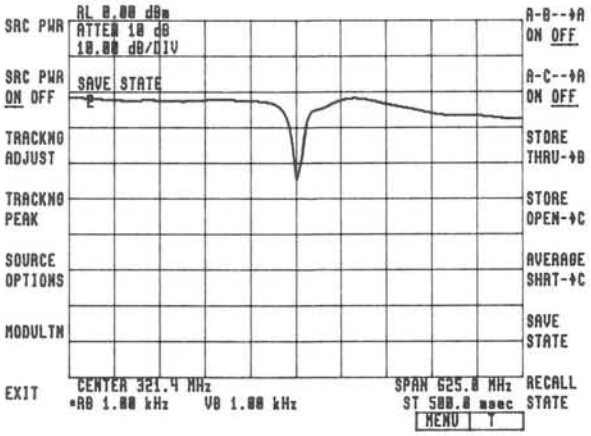


Figure 1-19.

When the resolution bandwidth is less than 2 kHz, the automatic tracking function should be used to optimize the measurement.

Disconnect the DUT from the bridge or coupler.

With the bridge or coupler connected, press ◀TRACKNG PEAK▶. Wait until "Automatic Tracking Completed" appears.

If the resolution bandwidth is greater than 2 kHz, ◀TRACKNG PEAK▶ is not needed.

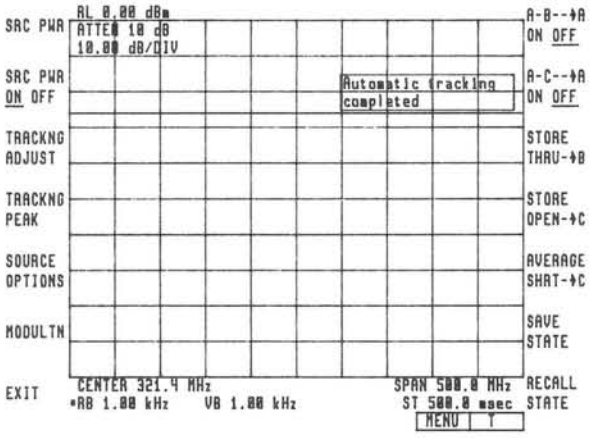


Figure 1-20.

Calibration/Normalization Procedure

Before we make our reflection measurement, we will establish an open/short reference.

In the last step we disconnected the DUT, leaving the test port on the coupler open. Now, connect an open circuit to the port.

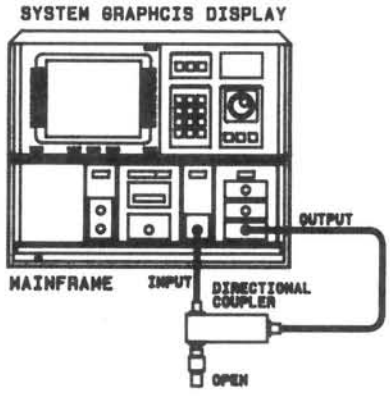


Figure 1-21. "Store open" Configuration

The softkeys used to store the open, average the short, and view the normalized trace are located along the right side of the SOURCE menu.

Connect the open circuit to the bridge or coupler (the point at which the DUT will be connected).

Wait for the trace to be completely updated.

Press ◀STORE OPEN -> C▶. "Function executed" appears.

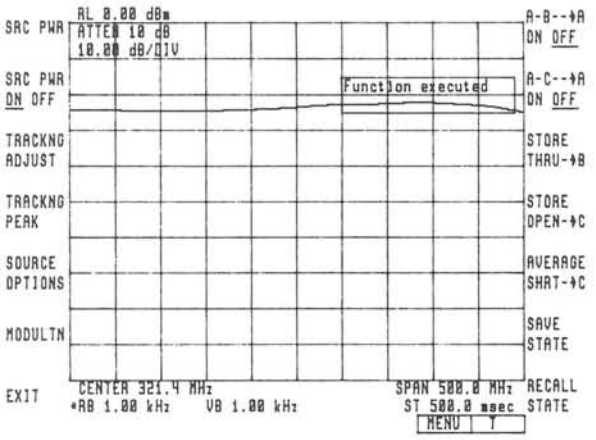


Figure 1-22.

Remove the open circuit and connect the short circuit to the bridge or coupler.

Wait for trace to be completely updated.

Press ◀AVERAGE SHRT -> C▶. The data from trace A (the open measurement) will be averaged with trace C (the short measurement), and the result will be stored in trace C.

"Function executed" appears on the display.

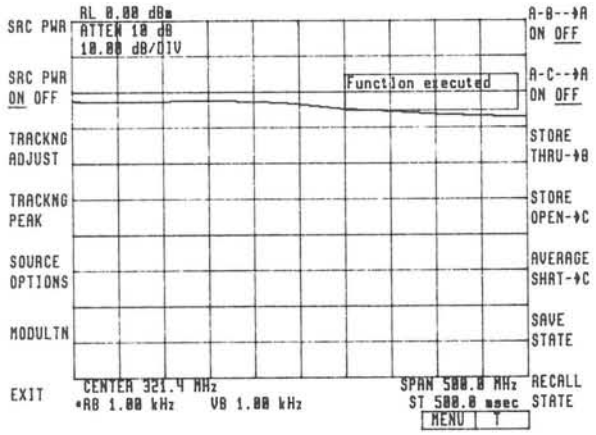


Figure 1-23.

Turn on ◀A - C --> A▶ to later subtract the open/short average from the test measurement. (Before the device is connected, a 0 dB reference line will appear at the top of the display.)

Remove the short circuit and connect the DUT to the test port. (This is the normalized reflection measurement.)

In stimulus-response mode, when a normalization softkey is on (A - B or A - C are on), scale units change from dBm to dB. The measurement is relative to the open/short average. Thus, return loss in dB is displayed.

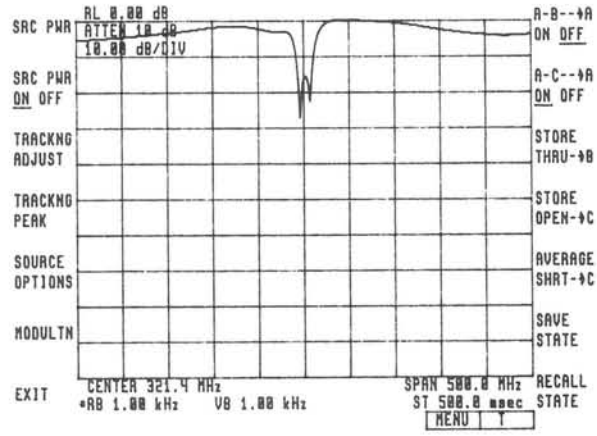


Figure 1-24.

Using the HP 70300A as a Source

In addition to bringing transmission and reflection measurement capability to your HP 70000 System, the HP 70300A can be used as a synthesized signal source.

With the HP 70900A Local Oscillator and the HP 70300A Tracking Generator, you can produce continuous wave (CW) signals, swept signals, or amplitude modulated CW and swept signals.

In the example below, the HP 70300A is used as a source. The softkeys used in the example are described in detail in the following *Softkeys* section. (Note: Tracking Adjustments are not required when the system is used as a source.)

To use the HP 70300A Tracking Generator as a synthesized sweeper, connect the RF OUTPUT of the HP 70300A to the input of a receiver (or another instrument such as a spectrum analyzer).

Turn on the power of both systems, press [MENU], ◀SOURCE▶, and turn on ◀SRC PWR ON OFF▶.

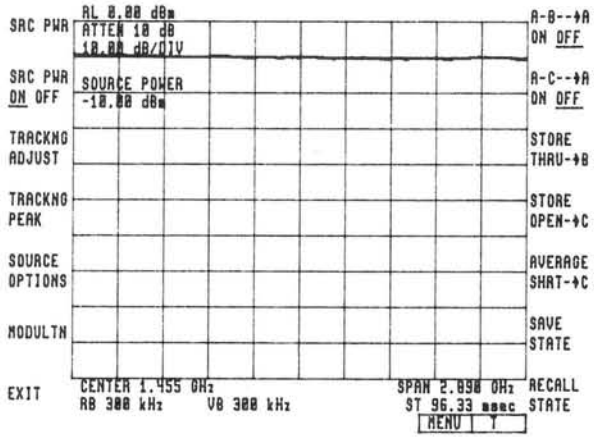


Figure 1-25.

Press [MENU], ◀FREQ▶, ◀CENTER FREQ▶, and enter 1, ◀GHz▶ or some other frequency.

For a swept signal, use the ◀START FREQ▶ and ◀STOP FREQ▶ softkeys. (Or use ◀CENTER FREQ▶ and ◀SPAN▶.)

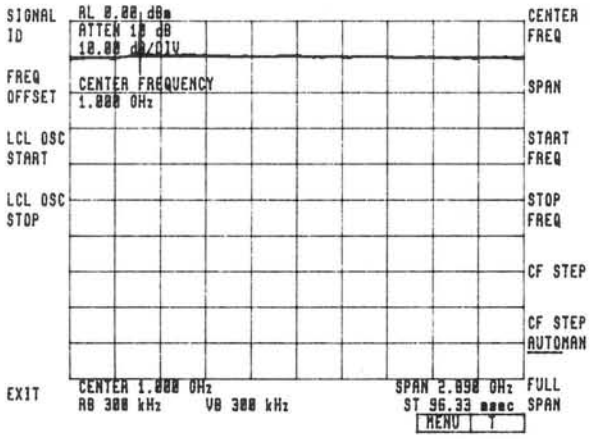


Figure 1-26.

To obtain a single CW signal, press ◀SPAN▶ and enter 0, ◀Hz▶.

(When in zero span, use single sweep mode.)

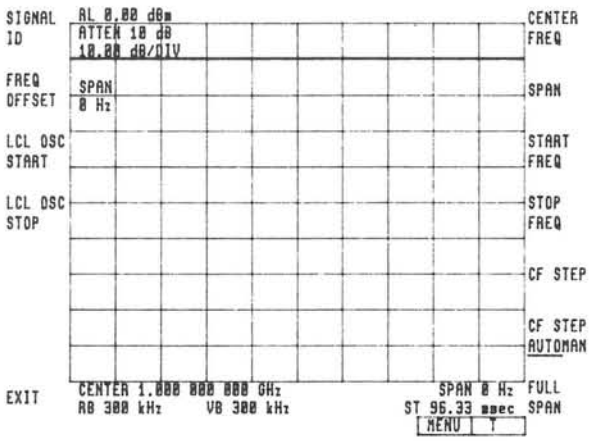


Figure 1-27.

To modulate the signal amplitude, press [MENU], ◀SOURCE▶, and ◀MODULTN▶.

Then press ◀AM %▶ and enter the desired modulation percentage (depth).

Within the MODULATION softkey menu, internal and external modulation can be selected and an amplitude modulation frequency can be specified. These functions are described in the "Modulation" subsection of *Softkeys*.

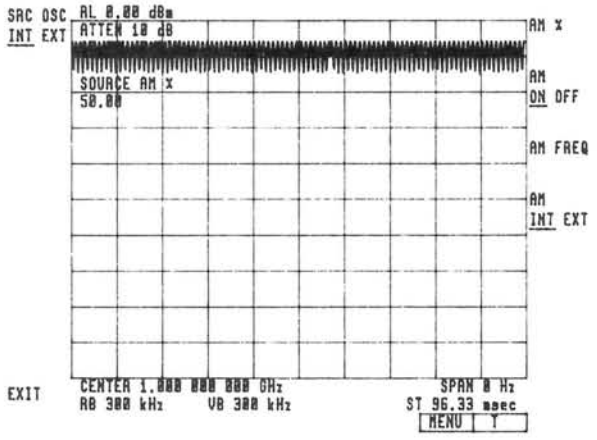


Figure 1-28.

The power of the HP 70300A can be controlled with softkeys under ◀SOURCE▶ and ◀SOURCE OPTIONS▶. (To reach these keys from the MODULATION softkey menu, press the backspace key.)

To change the power level, press the backspace key, ◀SRC PWR▶ and then enter a value. The instrument preset power level is -10 dBm.

The control of power is discused in the "Source: Power Control" subsection of *Softkeys*.

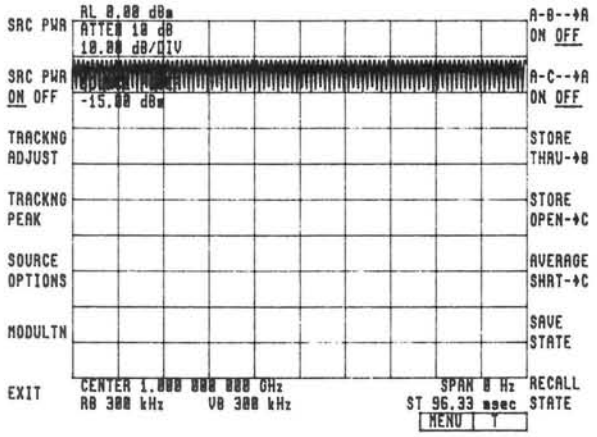


Figure 1-29.

TRACKING GENERATOR SOFTKEYS

Introduction

This section describes the functions of the HP 70300A Tracking Generator softkeys. Step-by-step examples demonstrate how some of these softkeys are used.

Organization of this Section

The tracking generator softkeys are divided by function into six groups. Each group is described in a subsection of *Tracking Generator Softkeys*:

Measurement Mode: Signal Analysis or Stimulus Response presents softkeys that allow you to choose the mode of instrument operation. Differences between the internal analyzer functions of the two modes are described.

Source: Calibration and Normalization describes softkeys that allow you to store calibration traces (such as open/short and thru calibrations) and softkeys that perform math functions for normalized measurements.

Source: Power Control discusses the softkeys that control the power of the HP 70300A Tracking Generator.

Source: Tracking Adjustments describes softkeys that manually or automatically adjust the output frequency of the tracking generator to maximize the amplitude of the active trace.

Source Options describes several specialized softkeys on the SOURCE OPTIONS menu. Among these keys are ◀ALC NRM▶ and ◀BLANKNG ON OFF▶.

Modulation discusses the four softkeys that control the amplitude modulation of the HP 70300A Tracking Generator.

Note: A "Hardware not present" error message will appear if tracking generator softkeys are pressed when the HP 70300A Tracking Generator is *not* in the system. (The error message will also appear, for example, if the AM frequency is changed when external modulation is used.)

Softkey Overview

All HP 70300A functions can be accessed through softkey menus. The four HP 70300A softkey menus are shown below.

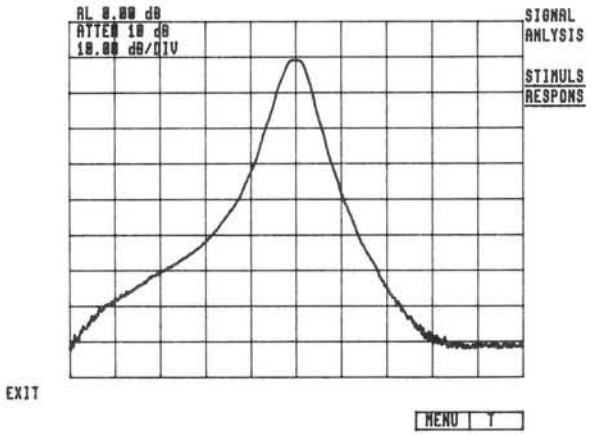


Figure 1-30. MEASURE MODE Softkey Menu

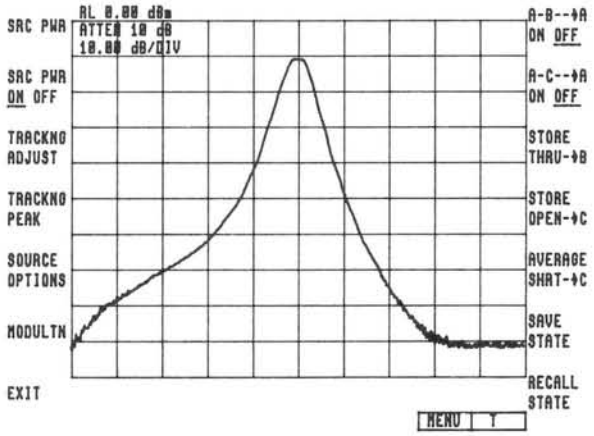


Figure 1-31. SOURCE Softkey Menu

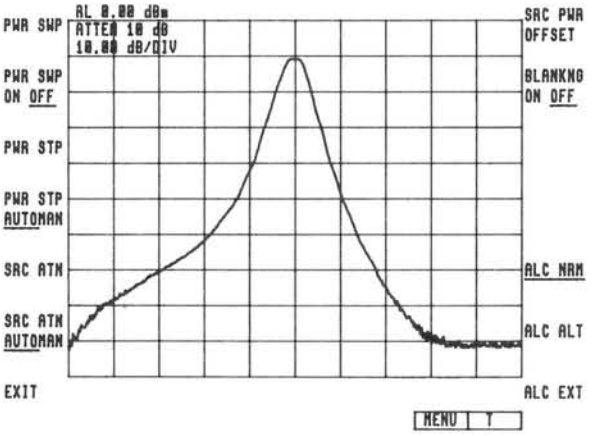


Figure 1-32. SOURCE OPTIONS Softkey Menu

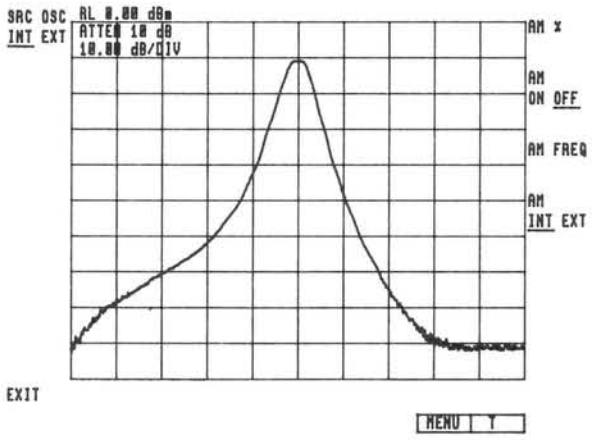


Figure 1-33. MODULATION Softkey Menu

The softkeys shown above are presented graphically in Figure 1-34. Softkeys and their corresponding remote commands are described in the *Remote Operation* section.

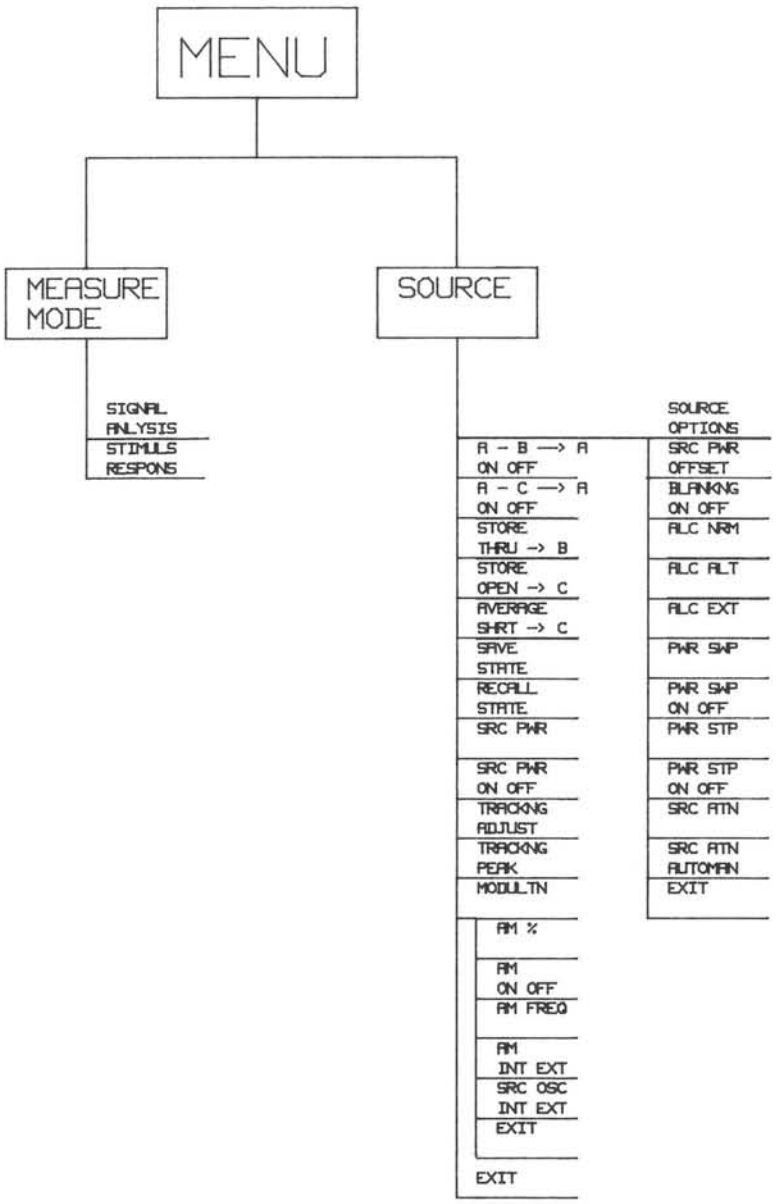


Figure 1-34. HP 70300A Tracking Generator Softkeys

Accessing the Tracking Generator Softkeys

All HP 70300A Tracking Generator functions are accessed through two keys under the [MENU] hardkey: ◀MEASURE MODE▶ and ◀SOURCE▶. These softkeys appear at the lower left side of the [MENU] screen (as shown below).

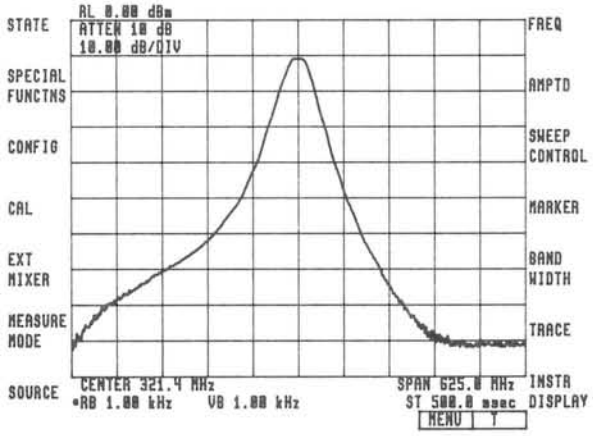


Figure 1-35. The MENU Softkeys

When ◀MEASURE MODE▶ and ◀SOURCE▶ are pressed, the softkeys shown in the previous two pages appear.

Measure Mode: With the HP 70300A Tracking Generator in your system, the system can make both signal analysis measurements and stimulus-response measurements. Press the [MENU] hardkey to access the ◀MEASURE MODE▶ softkey. The ◀MEASURE MODE▶ softkey accesses other softkeys that tell the system which measurement type will be made. These softkeys are described in the following pages.

Source: The HP 70300A Tracking Generator generates a signal that precisely tracks (follows) the tuned frequency of the spectrum analyzer. Because it produces a signal, the tracking generator is a "source." Press the [MENU] hardkey to access the ◀SOURCE▶ softkey. Almost all tracking generator functions are accessed through the ◀SOURCE▶ softkey. These softkeys will be described later in this chapter.

Moving Between Spectrum Analyzer and Tracking Generator Menus

For your convenience, the backspace and USER keys move you between spectrum analyzer and tracking generator menus. When in the tracking generator menus (accessed by the ◀SOURCE▶ softkey), you can press the [USER] key to call up the 14 most frequently used spectrum-analyzer softkeys. Use the following procedure, for example, to quickly activate a marker when using the ◀SOURCE▶ softkeys.

Press [MENU], ◀SOURCE▶, and ◀SOURCE OPTIONS▶ to access the SOURCE OPTIONS menu.

Now press [USER] to access the USER softkeys.

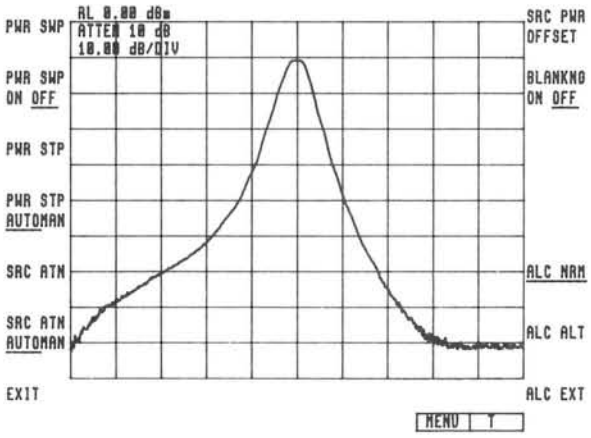


Figure 1-36.

The USER softkeys appear on the display.

Press a softkey on the USER menu, such as ◀HIGHEST PEAK▶.

Next, press the backspace key and the ◀SOURCE OPTIONS▶ menu reappears.

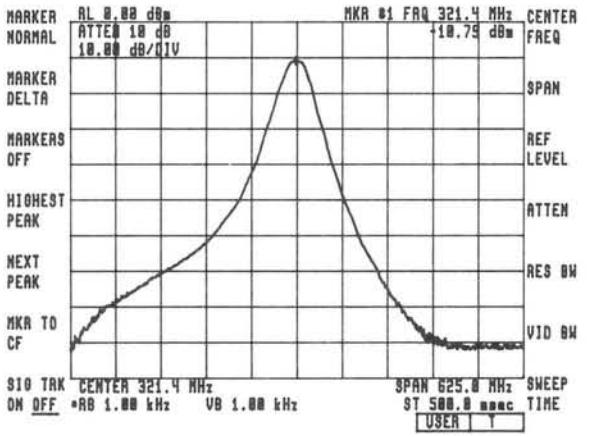


Figure 1-37.

Other functions on the USER menu, such as ◀RES BW▶ and ◀SWEEP TIME▶, can be changed.

You can replace the softkeys found under the [USER] hardkey with softkeys of your own choosing to create a customized softkey menu. For instance, you can place the ◀MARKER BW ON OFF▶ softkey on the USER menu for making 3 dB bandwidth measurements.

The ◀DEFINE UDK▶ softkey defines softkeys. Press [MENU] and ◀SPECIAL FUNCTIONS▶ to access ◀DEFINE UDK▶. Also see the description under ◀SPECIAL FUNCTIONS▶.

Measure Mode

The MEASURE MODE softkeys tell the instrument whether to make signal analysis or stimulus-response measurements. Instrument settings are optimized for each particular measurement type.

When ◀MEASURE MODE▶ is pressed, ◀SIGNAL ANLYSIS▶ and ◀STIMULS RESPONS▶ appear. ◀MEASURE MODE▶ appears at the lower left side of the [MENU] screen as in Figure 1-38.

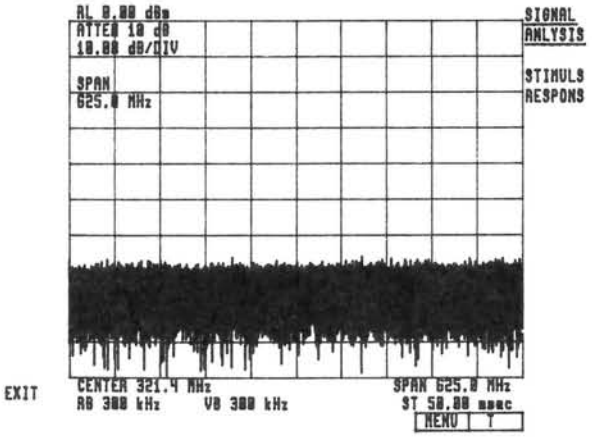


Figure 1-38. The MEASURE MODE Softkeys

Overview

There are two MEASURE MODE softkeys. (See the following pages for detailed descriptions.)

SIGNAL ANALYSIS optimizes system operation for signal analysis measurements--measurements of absolute amplitude versus frequency, where signals from external sources are examined.

STIMULUS RESPONSE optimizes system operation for stimulus-response measurements--transmission and reflection measurements, which use the HP 70300A Tracking Generator as the source.

Signal Analysis Mode

Signal analysis, the basic measurement provided by the HP spectrum analyzer system, measures absolute amplitude relative to frequency. Use signal analysis mode, for example, to survey a wide frequency span or to monitor a frequency band.

The system is instrument preset to signal analysis mode. The mode is active when ◀ SIGNAL ANLYSIS ▶ is underlined.

When ◀ SIGNAL ANLYSIS ▶ is enabled, the displayed units are dBm. (Power level in decibels is referenced to a power of one milliwatt.) This is referred to as *absolute amplitude mode*. For example, the reference level in Figure 1-39 is "RL 0.00 **dBm**."

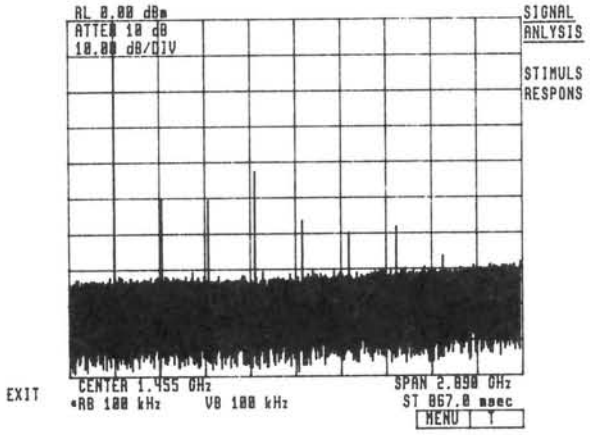


Figure 1-39.

Stimulus-Response Mode

Stimulus-response mode optimizes spectrum analyzer/tracking generator operation for stimulus-response measurements. Use stimulus-response mode to make transmission or reflection measurements on devices such as filters and amplifiers.

◀STIMULS RESPONS▶ is active when underlined as in Figure 1-40. When active, ◀STIMULUS RESPONS ▶ activates the stimulus-response auto sweep time (which is typically valid for devices when the system's span is less than 20 times the bandwidth of the device).

Activating ◀ STIMULS RESPONS ▶ and either of the math function softkeys (◀A - B --> A▶ or ◀A - C --> A▶), activates *relative amplitude mode*. When the system enters relative amplitude mode, the reference level is set to 0 dB and the following functions are displayed in dB units: amplitude unit coversion (AMPU), display line (DL), measurement unit coversion (MEASU), marker amplitude (MK), reference level (RL), threshold (TH), and trace data input/output (TRA/TRB/TRC). For example, the reference level in Figure 1-40 is set to "RL 0.0 **dB**." (For more information, see "MEASURE" in the HP 71000 Language Reference.)

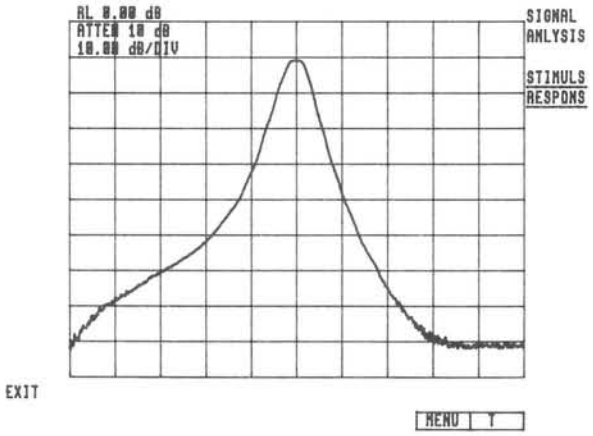


Figure 1-40.

Hints:

1. The stimulus-response AUTO sweep time differs from the signal analysis AUTO sweep time. In stimulus-response mode, AUTO sweep times are usually much faster for swept-response measurements than spectrum analyzer AUTO sweep times.

   Sweep times adjust automatically when the resolution bandwidth (RES BW) or video bandwidth (VID BW) change. In the AUTO (coupled) sweep time state, the UNCAL (uncalibrated) indication will not be displayed, since the AUTO mode choses valid sweep times.

   If necessary, the sweep time can be manually increased or decreased with the ◀SWEEP TIME▶ softkey. In the MANUAL (uncoupled) state, if you change the resolution bandwidth, video bandwidth, or sweep time, the UNCAL indication may appear.

2. Linear mode is not allowed in stimulus-response mode. The analyzer automatically changes to LOG in stimulus-response mode. If told to change to linear, the analyzer returns the error message: "Linear not allowed."

3. For greater frequency accuracy when using resolution bandwidths greater than 10 kHz, turn off the resolution bandwidth frequency corrections with the ◀RBW FRQ ON OFF▶ softkey (located under ◀CAL▶ and ◀ENABLE CAL▶).

Source: Calibration and Normalization

Softkeys on the right side of the SOURCE menu allow you to make calibrated and normalized measurements and to store and retrieve instrument states. Press [MENU] and then ◀SOURCE▶ to access these softkeys.

The softkeys that appear when ◀SOURCE▶ is pressed are shown in Figure 1-41 below. Except for the ◀SAVE STATE▶ and ◀RECALL STATE▶ softkeys, the softkeys on the right side are used to increase measurement accuracy.

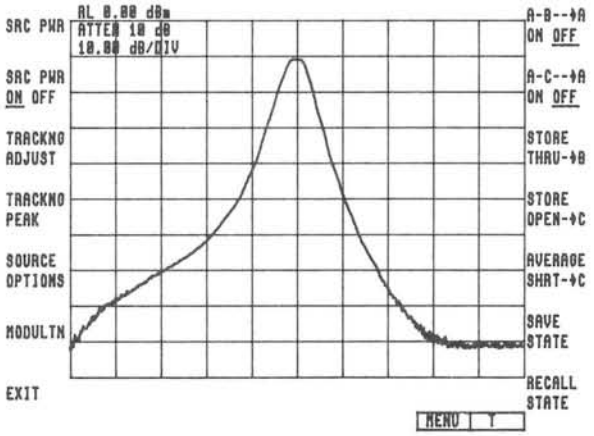


Figure 1-41. SOURCE Softkeys

Overview

The calibration and normalization softkeys are briefly described below. The function of each softkey is described in greater detail on the following pages. Examples of softkey usage are also given.

A - B --> A is used in normalization measurements to subtract trace B amplitude (the thru calibration data) from the measured data. The normalized data is displayed in trace A.

A - C --> A is used in normalization measurements to subtract trace C amplitude (the open/short calibration data) from the measured data. The normalized data is displayed in trace A.

STORE THRU -> B stores a thru measurement (thru reference) in trace B.

STORE OPEN -> C stores an open measurement (open reference) in trace C. (A short circuit response could be stored.)

AVERAGE SHRT -> C averages the short measurement with an open (previously stored in trace C) and then stores the open/short average in trace C.

SAVE STATE places analyzer settings into storage registers.

RECALL STATE retrieves previously stored analyzer settings.

Hint: The examples in *Typical Measurements* use the normalization and calibration softkeys.

A - B --> A

When ◀A - B --> A▶ is turned on, the data in trace B is subtracted from the measured data, and the resulting trace (trace A) is displayed. (That is, input minus calibration is displayed.) The ◀A - B --> A▶ math function, used in the normalization process, improves your measurements by allowing you to subtract out system errors that existed before your device was connected.

◀A - B --> A▶ is used with ◀STORE THRU -> B▶. Activate ◀A - B --> A ON OFF▶ to subtract the thru calibration data (trace B) from trace A. Removing the thru data from trace A sets trace A to a reference level of 0 dB. (Only one math function can be ON at one time.)

If the tracking generator is in stimulus-response mode when ◀A - B --> A▶ is turned on, relative amplitude mode is activated. In this mode, certain functions will have dB units. The active trace is relative to the thru calibration measurement; and 0 dB is established as the transmission loss of the thru. (See "Stimulus-Response Mode" for more information.)

A measurement using ◀A - B --> A▶ is shown in the ◀STORE THRU -> B▶ example later in this subsection. (Also see the Transmission Measurement example in *Typical Measurements*.)

A - C --> A

When ◀A - C --> A▶ is turned on, the data in trace C is subtracted from trace A. The resulting trace is displayed in trace A. The ◀A - C --> A▶ math function, used in the normalization process, improves your measurements by allowing you to subtract out errors that existed before your device was connected.

◀A - C --> A▶ is used with ◀STORE OPEN -> C▶ and ◀AVERAGE SHRT -> C▶. Activate ◀A - C --> A ON OFF▶ to subtract the average of the open and short (trace C) from trace A. Removing the open/short calibration data from trace A sets trace A to a reference level of 0 dB. (Only one math function can be ON at one time.)

If the instrument is in stimulus-response mode when ◀A - C --> A▶ is pressed, relative amplitude mode is activated. In this mode, certain functions have dB units. The active trace is relative to the open/short calibration data; and 0 dB is established as the return loss of the open/short average.

A measurement using ◀A - C --> A▶ is shown in the ◀AVERAGE SHRT -> C▶ example later in this chapter. (Also see the Reflection Measurement example in *Typical Measurements*.)

Hints:

1. Both ◀A - B --> A▶ and ◀A - C --> A▶ must be turned off to store open/short and thru calibration traces.

2. The ◀A - B --> A▶, ◀A - C --> A▶, ◀STORE THRU -> B▶, ◀STORE OPEN -> C▶, and ◀AVERAGE SHRT -> C▶ softkeys can be used for spectrum analysis measurements even if there is no tracking generator in the system.

3. One of the math functions and stimulus-response measurement mode must be active for the system to use relative amplitude mode.

Store Thru -> B

The ◀STORE THRU -> B▶ softkey is used in the normalization process for transmission measurements. Normalization improves your measurements by allowing you to subtract out system errors such as frequency response and cable losses.

Press ◀STORE THRU -> B▶ to place the data from trace A (presumably a thru trace) in trace B. "Function executed" appears on the display. If the span or the start and stop frequencies are changed after the thru has been stored, the calibration trace will no longer be valid. A new thru calibration trace must be stored. (The reference level, reference position, and vertical log scale can be changed and the trace will remain valid.)

Storing the thru connection saves correction factors that can later be subtracted out. This is sometimes referred to as "calibrating" the instrument setup.

The following example demonstrates a normalized transmission measurement. (Also see the Transmission Measurement example in *Typical Measurements*.)

Hints:

1. Pressing ◀STORE THRU -> B▶ removes any data previously stored in trace B.

2. If ◀STORE THRU -> B▶ is pressed when ◀A - B --> A▶ is on, the "Not stored; A-x ->A on" error message appears. The thru calibration trace *is not stored*. ◀A - B --> A▶ must be turned off.

Example: Measure the insertion loss or gain of a filter.

Turn on the spectrum analyzer; press [MENU] and ◀MEASURE MODE▶.

Press ◀STIMULS RESPONS▶ to activate stimulus-response mode.

Stimulus-response mode optimizes spectrum analyzer/tracking generator operation for transmission and reflection measurements.

Select the center frequency, span, and other analyzer settings for your particular device under test (DUT). During setup, place the DUT between the RF OUTPUT on the tracking generator and the RF INPUT on the RF module.

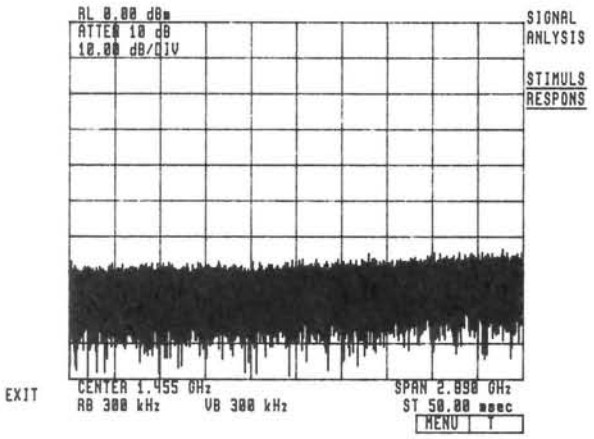


Figure 1-42.

Press [MENU], ◀SOURCE▶, and turn on ◀SRC PWR ON OFF▶. The RF light on the tracking generator turns on.

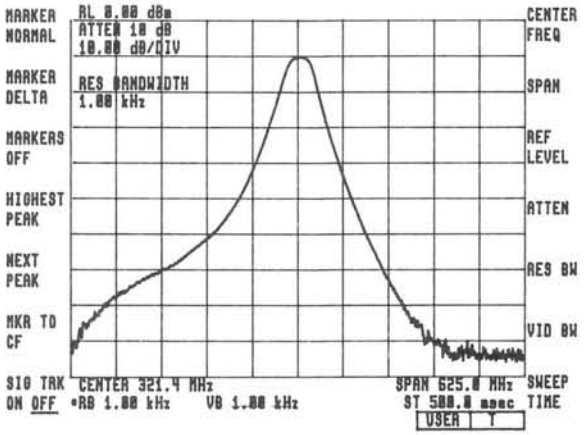


Figure 1-43.

The softkeys required for instrument calibration and normalization are located along the right side of the SOURCE menu.

Connect the RF OUTPUT on the tracking generator to the RF INPUT on the RF section.

Wait for the trace to be completely updated. (Do not store data if the "invalid" asterisk appears in the upper right corner of the display.)

Press ◀STORE THRU -> B▶. Trace A is stored in trace B and all data previously stored in trace B is written over.

"Function executed" appears on the display.

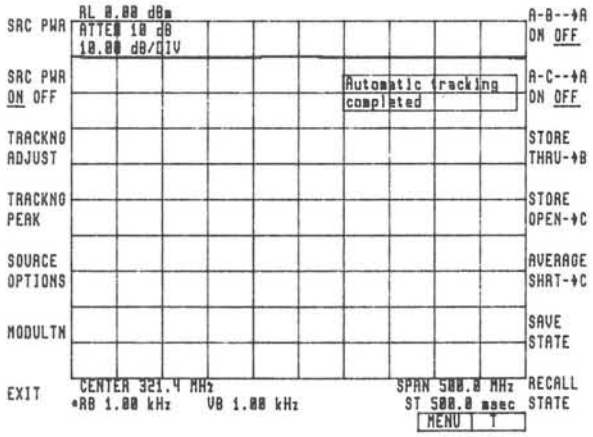


Figure 1-44.

Turn on ◀A - B --> A▶. (The 0 dB reference will appear at the top of the display.)

Insert the DUT in the through path. Trace B is subtracted from the measured data and the normalized transmission measurement appears on the display.

To view both trace B (the calibration) and trace A (the normalized measurement) at one time, use the ◀VIEW TRACE B▶ softkey. (Press [MENU], ◀TRACE▶, and ◀TRACE B▶.)

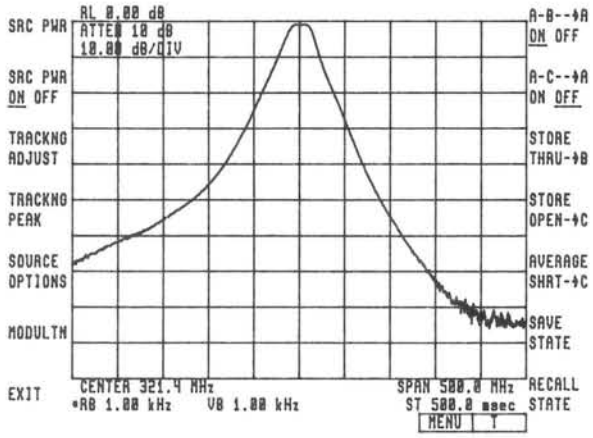


Figure 1-45.

Store Open -> C

A short circuit is the usual standard for reflection measurements. The short circuit reflects all incident power so that a convenient 0 dB reference line is obtained.

The ◀STORE OPEN -> C▶ softkey is used with the ◀AVERAGE SHRT -> C▶ and ◀A - C --> A▶ softkeys in the normalization process. The ◀STORE OPEN -> C▶ softkey stores an open calibration in trace C. Then, ◀AVERAGE SHRT ->C▶ averages a short-circuit data with the open-circuit data. Finally, device under test is inserted and ◀A - C --> A▶ is activated to subtract trace C and view the normalized trace. Normalization improves your measurements by allowing you to subtract out errors that existed before your device was connected.

Once the open is stored in trace C, "Function executed" appears on the display. If the span or the start and stop frequencies are changed after the open has been stored, the calibration trace will no longer be valid. A new open-calibration trace must be stored. (The reference level, reference level position, and vertical log scale can be changed and the trace will remain valid.)

The example under ◀AVERAGE SHRT -> C▶ demonstrates the usage of ◀STORE OPEN -> C▶. (Also see the Reflection Measurement example in *Typical Measurements*.)

Hints:

1. Press ◀STORE OPEN -> C▶ to place the data from trace A (presumably the open calibration data) in trace C. This removes any data that was previously stored in trace C.

2. If ◀AVERAGE SHRT -> C▶ is pressed before ◀STORE OPEN -> C▶, a "Not stored, open 1st" error message appears reminding you to store the open first.

3. If ◀STORE OPEN -> C▶ is pressed when ◀A - C --> A▶ is on, the "Not stored; A-x->A on" error message appears. The open calibration *is not stored*. ◀A - C --> A▶ must be in the off position.

4. Use the ◀STORE OPEN -> C▶ softkey to store a short when an open/short average is not required. In this case, connect the short and press ◀STORE OPEN -> C▶. Then connect the DUT and press ◀A - C --> A▶.

Average Short -> C

Although a short circuit is the usual standard for reflection measurements, better accuracy can be obtained with an open/short average. The open/short average reduces mismatch and directivity effects, and this produces a more accurate frequency-response reference trace.

Use the ◀AVERAGE SHRT -> C▶ softkey with the ◀STORE OPEN -> C▶ softkey to store correction information for normalized measurements. First, connect the open circuit and press ◀STORE OPEN -> C▶. Then, connect the short circuit and press ◀AVERAGE SHRT -> C▶ to average the data from trace A (the short calibration data) with trace C (the previously-stored open calibration). Once this open/short average is stored in trace C, "Function executed" appears on the display. Finally, connect the DUT and press ◀A - C --> A▶ to subtract out trace C, and view the normalized trace. (See the following example for more details.)

If the span or the start and stop frequencies are changed after the open/short average has been stored, the calibration trace will no longer be valid. A new open/short average trace must be stored.

Hints:

1. Pressing ◀AVERAGE SHRT -> C▶ removes any data that was previously stored in trace C.

2. If ◀AVERAGE SHRT -> C▶ is pressed before ◀STORE OPEN -> C▶, a "Not stored, open 1st" error message appears, reminding you to store the open first.

3. If ◀AVERAGE SHRT -> C▶ is pressed when ◀A - C --> A▶ is on, the "Not stored; A-x->A on" error message appears. The short *is not averaged*. ◀A - C --> A▶ must be turned off.

Example: Measure the return loss of a filter.

Turn on the spectrum analyzer, press [MENU], and then press ◀MEASURE MODE▶.

Next, press ◀STIMULS RESPONS▶ to activate stimulus-response mode.

Stimulus-response mode optimizes spectrum analyzer/tracking generator operation for transmission and reflection measurements.

Select the center frequency, span, and other analyzer settings for your particular DUT. The device can be connected to a directional bridge or coupler during the setup procedure.

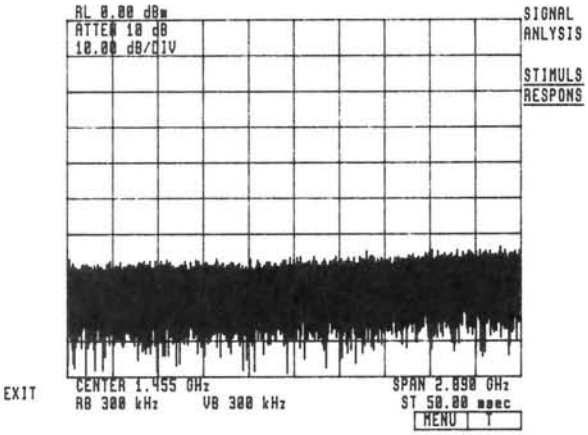


Figure 1-46.

Press ◀EXIT▶, ◀SOURCE▶, and then turn on ◀SRC PWR ON OFF ▶.

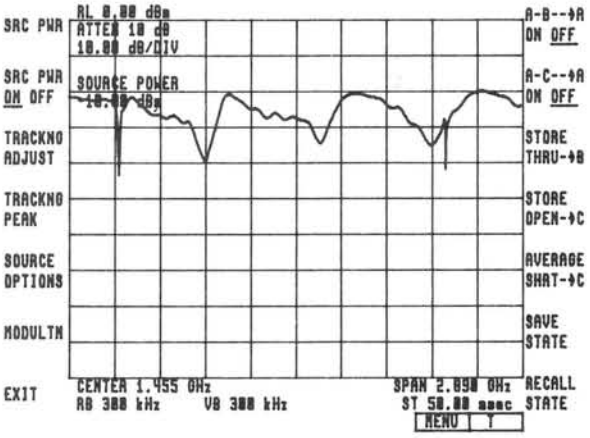


Figure 1-47.

When using bandwidths less than 2 kHz, connect your bridge or coupler from the RF OUTPUT on the tracking generator to the RF INPUT on the RF section. Press ◀TRACKNG PEAK▶ and wait until "Automatic Tracking Completed" appears. (The ◀TRACKNG PEAK▶ softkey is described later in this subsection.)

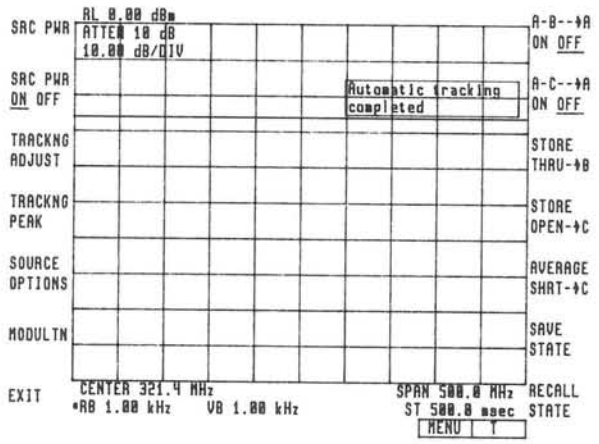


Figure 1-48.

The softkeys required for instrument calibration are located along the right side of the SOURCE MENU.

Connect an open circuit to your test coupler or bridge. (This is also shown in the Reflection Measurement example in *Typical Measurements*.)

Wait for the trace to be completely updated. (Do not store data if the "invalid" asterisk appears in the upper right corner of the diplay.)

Press ◀STORE OPEN -> C▶. The trace on the display is stored in trace C. Any data previously stored in trace C is removed, and "Function executed" appears on the display.

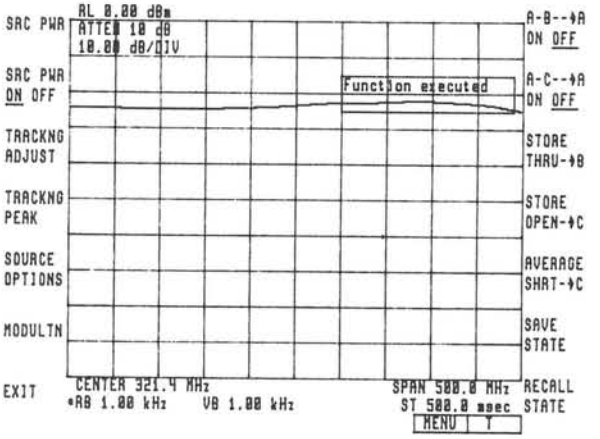


Figure 1-49.

Remove the open circuit and connect the short circuit to the test setup.

Again, wait for the trace to be completely updated.

Press ◀AVERAGE SHORT -> C▶ to average the data from trace A (the open calibration data) with trace C (the short calibration data). This open/short average is stored in trace C, and "Function executed" appears on the display.

If the span or start/stop frequencies are changed after the calibration is made, the calibration is no longer valid. A new open/short average must be made.

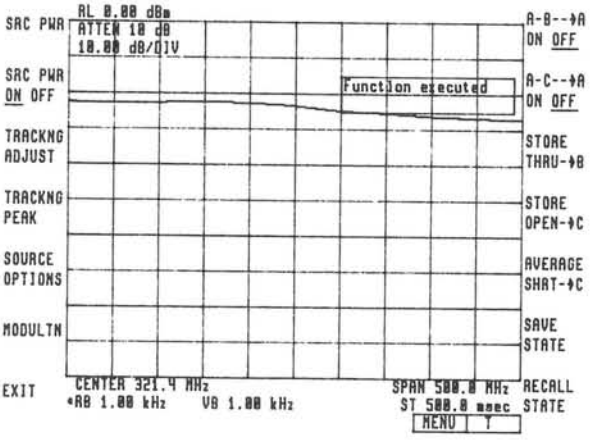


Figure 1-50.

Turn on ◀A - C --> A▶ to subtract the open/short average from the measurement data.

Remove the short circuit and connect your DUT to the test setup.

The normalized reflection measurement of the filter appears on the screen as shown in Figure 1-51.

To view both the active trace (trace A) and the stored average (trace C), press [MENU], ◀TRACE▶, ◀TRACE C▶, and ◀VIEW TRACE C▶.

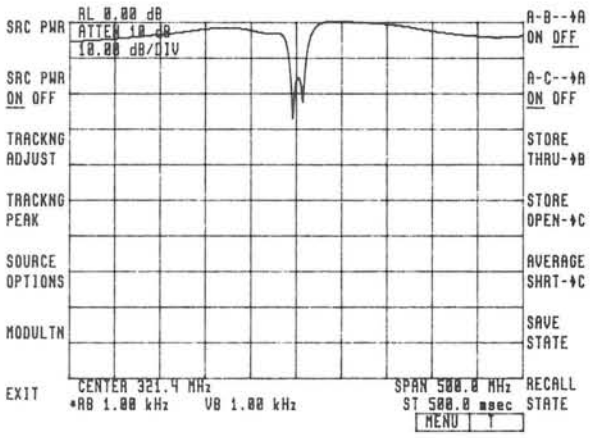


Figure 1-51.

Save/Recall State

The ◀SAVE STATE▶ and ◀RECALL STATE▶ softkeys store and retrieve operator-determined analyzer settings. With ◀SAVE STATE▶, the current state of the analyzer is stored in one of several registers. ◀RECALL STATE▶ brings back a previously stored state. The storage registers are referenced by numeric values.

1. To save a state, press ◀STATE▶ and enter a register number with the keyboard. There are two preset registers. More state registers can be created depending upon the amount of available memory. (Press ◀INST DISPLAY▶, ◀SHOW CONFIG▶, and ◀SHOW CATALOG▶ to check the available memory.)

   Additional registers created using ◀NO. OF STATES▶ should be protected by turning on ◀P STATE ON OFF▶.

2. To recall a saved state, press ◀RECALL STATE▶ and enter the register number.

Additional information can be found under ◀STATE▶ in the HP 71000 Operating Manual.

Hint: For convenience, you can create a save state for stimulus-response measurements. In this saved state, activate ◀ STIMULS RESPONS ▶ mode, turn on ◀SRC PWR ON OFF▶, and select a resolution bandwidth (for example, 1 kHz).

Source: Power Control

Nine softkeys allow you to control the HP 70300A Tracking Generator's power. These keys are located on the upper left side of the display screen on the SOURCE menu and on the SOURCE OPTIONS menu (as shown below).

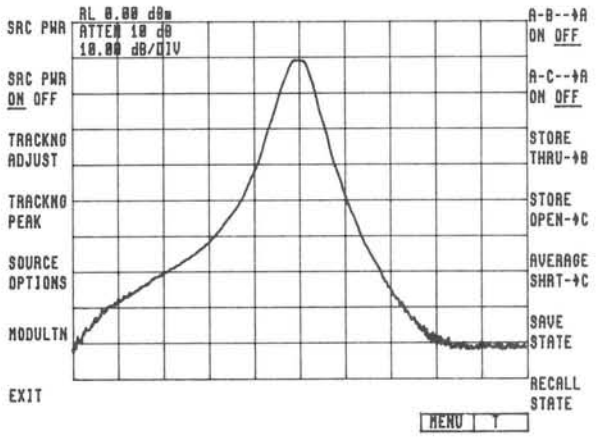


Figure 1-52. SOURCE Softkeys

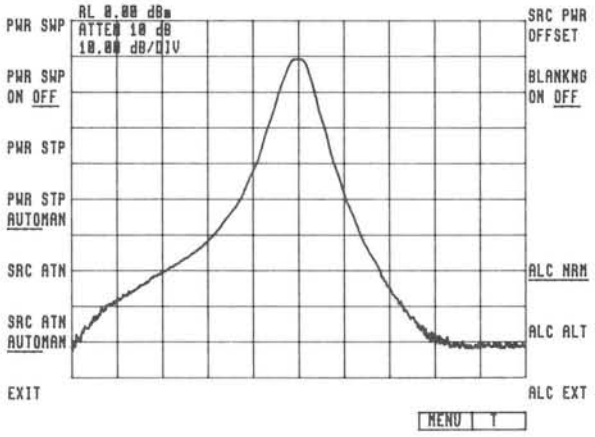


Figure 1-53. SOURCE OPTIONS Softkeys

Overview

The softkeys that control tracking-generator power are briefly described below. See the following pages for detailed descriptions.

SOURCE POWER turns the tracking generator on and changes the source power level.

SOURCE POWER ON OFF turns the source power (tracking generator RF OUTPUT) on and off.

SOURCE OPTIONS accesses the following power controls:

POWER SWEEP sets the power sweep amplitude range.

POWER SWEEP ON OFF turns the power sweep function on and off.

POWER STEP changes the step size for the source power level, power sweep, and source offset functions.

POWER STEP AUTO/MANUAL sets the step size for either automatic or manual control.

SOURCE ATTENUATOR changes source attenuation for the Option 001 HP 70300A Tracking Generator, which has a 70 dB attenuator with 10 dB steps.

SOURCE ATTENUATOR AUTO/MANUAL sets the source attenuator for either automatic or manual control.

SOURCE POWER OFFSET adds a user-determined numeric value to the source power output level readout. Offsets change the tracking generator's displayed output level, but do not change the actual signal level produced.

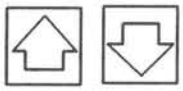
Source Power

The ◀SRC PWR▶ softkey sets the source power level and turns the source power on when a value is entered. The ◀SRC PWR ON OFF ▶ softkey turns the tracking generator on and off.

Press ◀SRC PWR ON OFF ▶ to turn on the RF output power of the tracking generator. The underline moves to the on position and the RF light turns on.

The instrument preset tracking generator power level is -10 dBm. The specified power level range is from -10 to -21 dBm. Entering a power level with the keypad, turns on ◀SRC PWR ON OFF▶. Otherwise, simply turn on ◀SRC PWR ON OFF▶ and the previous source power level will be activated.

The three methods of setting the power level are shown:

KNOB 	The source power level value is changed by knob rotation. The knob rotation speed determines the rate of change.
STEP KEYS 	The step keys change the power level in steps. The step size can be changed with the ◀PWR STP▶ softkey.
KEY PAD 	The keypad directly enters a specific power level. The specificied range for the HP 70300A is from -10 to -21 dBm, but this range is increased with the Option 001 70 dB step attenuator.

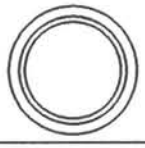
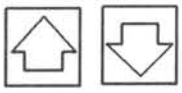
Source Power Step

The ◀PWR STP▶ softkey sets the power step size for the ◀SRC PWR▶ (source power), ◀PWR SWP▶ (power sweep), and ◀SRC PWR OFFSET▶ functions.

When the ◀PWR STP AUTOMAN▶ softkey is in the AUTO position, the step size is automatically set to the value of the LOG dB/DIV. Pressing ◀PWR STP▶ and the step keys changes the step size in a 1, 2, 5, 10 step increment sequence.

The step size can be set to a value between 0 and 300 dB. Entering a step size moves ◀PWR STP AUTOMAN▶ to the MANUAL position. Pressing ◀PWR STP AUTOMAN ▶, returns the step size to the LOG dB/DIV value.

The three methods of setting the power step size are shown:

KNOB 	The power step size value is changed by knob rotation. The knob rotation speed determines the rate of change.
STEP KEYS 	The step keys change the power step size in a 1, 2, 5, 10 increment sequence.
KEY PAD 0 1 2 3 4 5 6 7 8 9	They keypad directly enters a power step size value between 0 and 300 dB. When values other than those in the range or hardware limit are entered, "Parm out of range" appears and the closest allowed value is used.

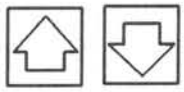
Power Sweep

The amplitude range of the power sweep is set with the ◀PWR SWP▶ softkey. The ◀PWR SWP ON OFF▶ softkey turns this function on and off. (Press ◀SOURCE OPTIONS▶ to access these softkeys.) This function enables the output power to be swept up.

Entering an amplitude range value, moves ◀PWR SWP ON OFF▶ to the on position. The power sweep function may also be turned on to the current amplitude range value or turned off directly.

The sweep amplitude range is instrument preset to 0 dB. The maximum power sweep allowed is limited by the output-power range of the tracking generator (for example, -10 to -21 dBm). Therefore, when sweeping from -10 to -21 dBm, the maximum calibrated sweep range is 11 dB. (First, change the source power level to -21 dBm with ◀SRC PWR▶, then change the power sweep to 11 dB.)

The three methods of setting the power sweep amplitude range are shown:

KNOB 	The knob changes the power sweep amplitude range continuously from 0 to 20 dB.
STEP KEYS 	The step keys change the power sweep size in steps. Change the step size with the ◀PWR STP▶ softkey.
KEY PAD 0 1 2 3 4 5 6 7 8 9	The keypad directly enters a power sweep amplitude range between 0 and 20 dB with resolution to 0.1 dB. When an unacceptable value is entered, the instrument defaults to the closest allowed value.

Source Power Offset

◀SRC PWR OFFSET▶ adds a user-determined value to the source power output level readout. For example, when compensating for transmission line loss, you can add an offset value to reduce the displayed power level. This does not change the actual signal level produced by the tracking generator nor affect the displayed trace.

Press ◀SOURCE OPTIONS▶ to access ◀SRC PWR OFFSET▶.

The ◀SRC PWR OFFSET▶ is instrument preset to 0 dB. Pressing ◀SRC PWR OFFSET▶ and entering a value activates this function. An offset value remains in affect until turned off. The display screen does **not** indicate whether source power offsets are active.

To elimate an offset, press ◀SRC PWR OFFSET▶ and enter zero. Pressing [I-P] also sets the offset to zero. (Offsets are stored in save states and recalled.)

The three methods of changing the offset are shown:

KNOB 	The source power offset value is changed by knob rotation. The knob rotation speed determines the rate of change.
STEP KEYS 	The step keys change the offset value in steps. Change the step increment with the ◀PWR STP▶ softkey.
KEY PAD [0] [1] [2] [3] [4] [5] [6] [7] [8] [9]	The keypad directly enters a power offset value between ± 300 dB. If an unacceptable value is entered, the instrument defaults to the closest allowed value. Least significant digits are truncated for power offset entries. The resolution is 0.01 dB.

Source Attenuator

The ◀SRC ATN▶ and ◀SRC ATN AUTOMAN▶ softkeys change the attenuation level of the HP 70300A Option 001 70 dB Attenuator. Press ◀SOURCE OPTIONS▶ to access these softkeys.

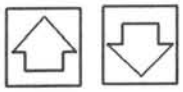
The attenuator increases the power level range from a range of -10 to -21 dBm to a range of -10 to -91 dBm. The example that follows decreases the power level from -10 dBm to -60 dBm.

The instrument is preset with 0 dB attenuation and with AUTO source attenuation. In the AUTO state, the source attenuator is controlled automatically as required to produce the requested source output power. (For tracking generators with the attenuator, press ◀SRC PWR▶, the step keys, and observe how the attenuator changes to produce the requested source output.) For most applications, leave ◀SRC ATN AUTO MAN▶ in the AUTO state.

Under MANUAL control, attenuation in increments of 10 dB is available; however, the source power is limited for any given source attenuator setting. Pressing ◀SRC ATN▶ and entering an attenuator value, changes ◀SRC ATN AUTOMAN▶ to the MANUAL position. If you press these softkeys and the attenuator is not present, the "Hardware not present" error message appears on the screen.

The attenuator is not calibrated during the system CAL routine. Since the attenuator is not calibrated, the ◀SRC PWR OFFSET▶ softkey may be used to add an offset to the displayed power level and bring the displayed power level up to a standard.

The three methods of changing the attenuation value are shown:

KNOB 	The knob changes the attenuation level in 10 dB increments. If the knob is turned counterclockwise when the minimum attenuation value (0 dB) is indicated, a "Param out of range" error appears.
STEP KEYS 	The step keys change the attenuation level in 10 dB increments, from 0 to 70 dB.
KEY PAD 	The keypad directly enters an attenuation level between 0 and 70 dB (in 10 dB increments). When an unacceptable value is entered, the instrument defaults to the closest allowed value. (For example, an entry of 16 dB would be rounded to 20 dB.)

Example: Change the source power level to -50 dBm.

Connect the RF OUTPUT on the tracking generator to the RF INPUT on the RF module.

Press [MENU], ◀MEASURE MODE▶, and ◀STIMULS RESPONS▶.

Press ◀EXIT▶ and ◀SOURCE▶.

Turn on the tracking generator by pressing ◀SRC PWR ON OFF ▶. The power level is preset to -10 dBm.

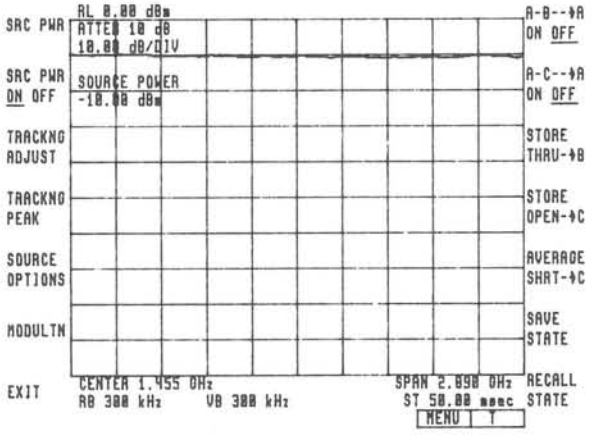


Figure 1-54.

Press ◀SOURCE OPTIONS▶ and ◀SRC ATN▶.

Enter 40 dB.

◀SRC ATN AUTOMAN▶ moves to the manual position.

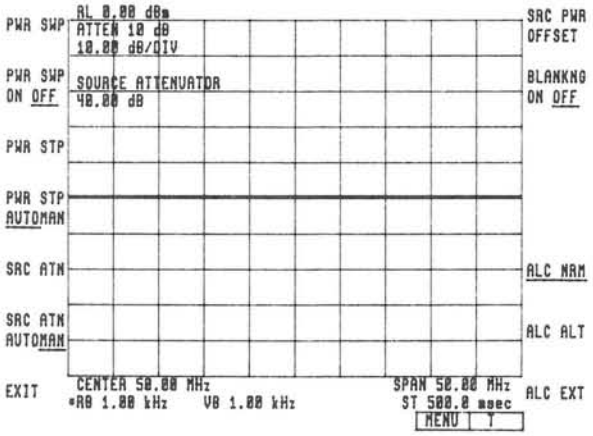


Figure 1-55.

Press ◀EXIT▶ and ◀SRC PWR▶.

Use the step key to decrease the power level to -60 dBm.

Notice that with 40 dB of attenuation, the power can be decreased lower than -60 dBm.

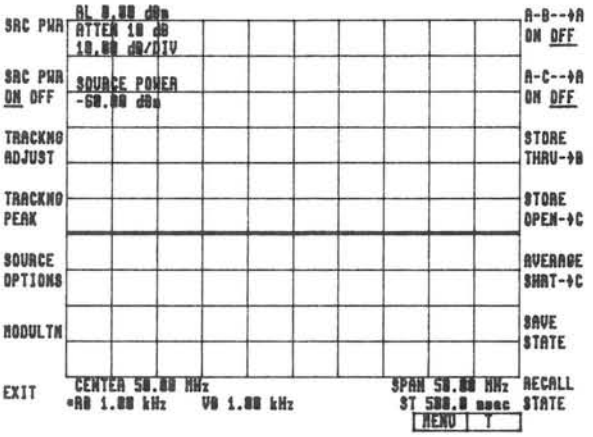


Figure 1-56.

Source: Tracking Adjustments

Two softkeys on the SOURCE softkey menu allow you to adjust the tracking. These softkeys are shown on the left side of Figure 1-57 below.

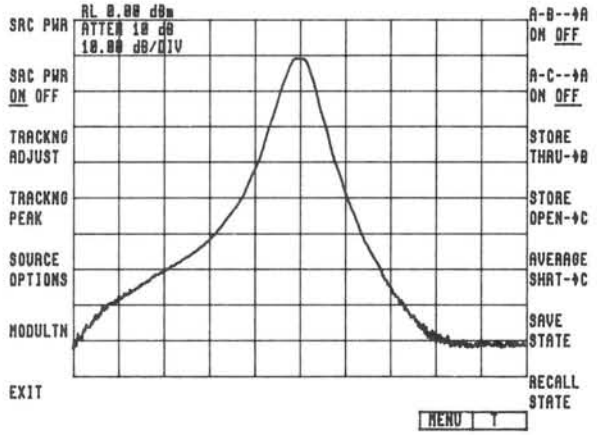


Figure 1-57. The SOURCE Softkeys

Overview

Tracking adjustments are made to maximize the amplitude of the active trace and increase frequency accuracy. During tracking, the frequency of the 21.4 MHz oscillator in the tracking generator is tuned so that the RF OUTPUT frequency precisely tracks the frequency to which the spectrum analyzer is tuned. That is, tracking tunes the 21.4 MHz oscillator of the tracking generator to the precise frequency of the IF bandwidth filter.

Due to the relative flatness of the IF bandwidths, there can be a range of frequencies that yield the same peak amplitude. Thus, each time the tracking is adjusted, the resulting adjustment values may vary.

The tracking adjustment range is $\pm$ 500 Hz. Adjustments are typically made in resolution bandwidths less than 300 Hz. Typically, at resolution bandwidths greater than 300 Hz, tracking is unnecessary. Resolution bandwidths greater than 2 kHz do not require tracking. In fact, if the resolution bandwidth is greater than 2 kHz and automatic tracking is activated, "Tracking not required" appears on the display.

TRACKING ADJUST allows you to manually adjust the output frequency of the tracking generator to maximize the amplitude of the active trace.

TRACKING PEAK automatically adjusts the output frequency of the tracking generator to maximize the amplitude of the active trace.

Tracking Adjust

The ◀TRACKNG ADJUST▶ softkey allows you to manually adjust the output frequency of the 21.4 MHz oscillator in the tracking generator. During tracking, the tracking generator is tuned to maximize the amplitude of the active trace.

The ◀TRACKNG ADJUST▶ is instrument preset to 0 Hz.

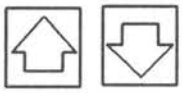
Tracking adjustments are used for resolution bandwidths less than 2 kHz; they are typically necessary for resolution bandwidths less than 300 Hz only. Resolution bandwidths greater than 2 kHz do not require ◀TRACKNG ADJUST▶.

Placing ◀SRC OSC INT EXT▶ in the external mode disables the ◀TRACKNG ADJUST▶ and ◀TRACKNG PEAK▶ softkeys. Pressing either of these tracking adjustment softkeys will produce an error message.

Once the instrument has warmed up and the tracking has been adjusted, the source tracking does not need to be re-adjusted. If the resolution bandwidth is changed, tracking adjustments should be repeated.

Use ◀TRACKNG PEAK▶ instead of ◀TRACKNG ADJUST▶ for most applications.

The three methods of setting the tracking adjust are shown below.

KNOB 	The knob adjusts the tracking continuously between ± 500 Hz with 1 Hz resolution.
STEP KEYS 	The step keys change the tracking in increments of 10 Hz between ± 500 Hz.
KEY PAD [0] [1] [2] [3] [4] [5] [6] [7] [8] [9]	The keypad directly enters tracking adjustment values between ± 500 Hz with 1 Hz resolution.

Example: Adjust tracking to maximize the amplitude of the active trace.

Connect the RF OUTPUT on the tracking generator to the RF INPUT on the front end module. (Include connectors and adapters that will allow the DUT to be inserted easily.)

Press [MENU], ◀MEASURE MODE▶, and then ◀STIMULS RESPONS▶.

Press the backspace key and ◀SOURCE▶, and turn on ◀SRC PWR ON OFF▶.

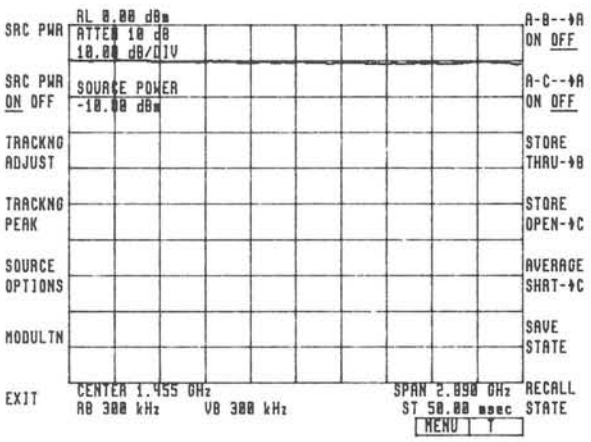


Figure 1-58.

Press [USER] and then ◀RES BW▶.

Select a narrow bandwidth to achieve higher dynamic range. For example, change the resolution bandwidth to 300 Hz. (The video bandwidth changes automatically with the resolution bandwidth.)

◀TRACKNG ADJUST▶ is used for bandwidths less than 2 kHz.

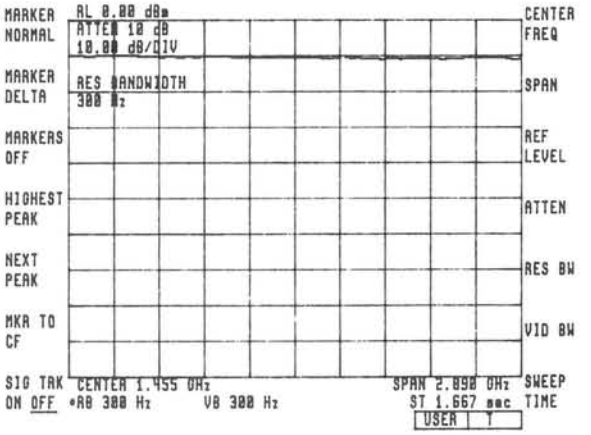


Figure 1-59.

Press the backspace key and then ◀TRACKNG ADJUST▶.

Press the step keys and observe the trace. Determine where the trace peaks, then use the knob to maximize the amplitude of the active trace.

Due to the relative flatness of the IF bandwidths, there can be a range of frequencies that yield the same peak amplitude. Thus, each time tracking is adjusted, the resulting adjustment values may vary.

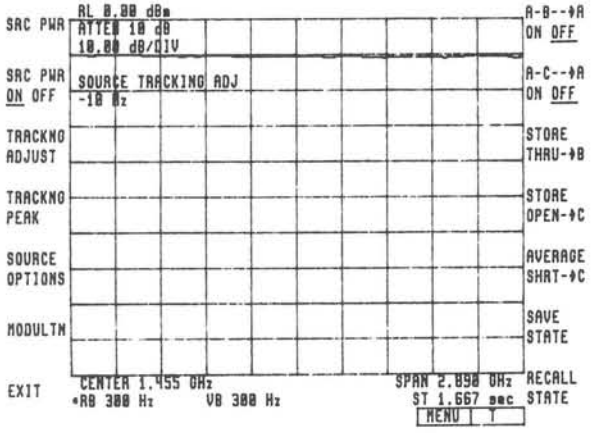


Figure 1-60.

Tracking Peak (Automatic Tracking)

The automatic tracking function, tracking peak, maximizes the amplitude of the active trace. During tracking, the frequency of the 21.4 MHz oscillator in the tracking generator is tuned so that the RF OUTPUT precisely tracks the spectrum analyzer. Automatic tracking changes analyzer settings (described below), but these settings are restored at completion.

Press ◀TRACKNG PEAK▶ and "Automatic tracking" appears on the screen. Then, the system searches for a marker. If no marker is present, automatic tracking places a marker at the center frequency. This marker is used by ◀TRACKING PEAK▶ to find the highest amplitude. The marker can be placed at another point on your trace (rather than at center frequency) by using ◀MARKER NORMAL▶. For example, the marker could be placed at a peak on the active trace and automatic tracking will move the marker to the center frequency.

Once a marker has been positioned, the system changes to zero span and reads the current resolution bandwidth value. As with ◀TRACKNG ADJUST▶, if the resolution bandwidth is greater than 2 kHz, tracking adjustments are not required and "Tracking not required" appears. (At wider bandwidths, since the adjustment range is small in comparison, tracking is not required.)

If the resolution bandwidth is less than 2 kHz, the sweep time and trace length are altered automatically to maximize the tracking adjustment speed. When the system has found the highest amplitude, "Automatic Tracking Completed" appears. At this time, your original trace length, sweep time, and span values are recalled. All markers are turned off at the completion of automatic tracking.

Hints:

1. If the RF OUTPUT is not connected to the RF INPUT, "no peak found" appears after approximately one minute. If you press [I-P] during automatic tracking, the current instrument settings will be lost unless they have been saved in a state register.

   "Tracking not required" will appear if the tracking generator is turned off. Press ◀SRC PWR ON OFF▶ to turn on the tracking generator. (The underline moves to the on position.)

2. Do not press any softkeys until "Automatic Tracking Completed" appears. This message appears in approximately five seconds to one minute. If you press a softkey during tracking, that function will be executed immediately upon completion of automatic tracking.

3. Although ◀TRACKING PEAK▶ is normally used with a thru connection, you can insert a DUT in the signal path.

4. Measuring high insertion-loss devices may require adjusting the reference level prior to tracking.

Example: Use ◀TRACKING PEAK▶ to maximize the amplitude of the active trace.

Connect the RF OUTPUT on the tracking generator to the RF INPUT on the RF module.

Press [MENU], ◀MEASURE MODE▶, and then ◀STIMULS RESPONS▶.

Set the resolution bandwidth by pressing [USER] and ◀RES BW▶; then enter 300 Hz.

Press [MENU] and ◀SOURCE▶, and turn on the tracking generator by pressing ◀SRC PWR ON OFF ▶. The underline toggles to the on positon.

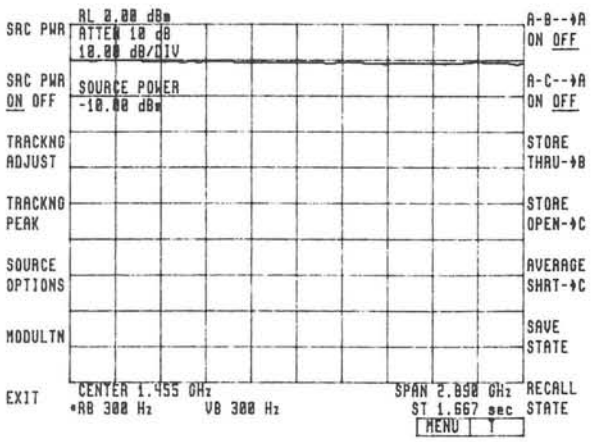


Figure 1-61.

Press ◀TRACKNG PEAK▶.

Wait until "Automatic Tracking Completed" appears. (Automatic tracking usually takes five seconds to one minute, depending on the bandwidth and the amount the system is mistracked.) If you press a softkey during peaking, that function will be executed immediately upon completion of automatic tracking.

Due to the relative flatness of the IF bandwidths, there can be more than one frequency at which the amplitude peaks. Thus, each time automatic tracking is used, the resulting adjustment values may vary.

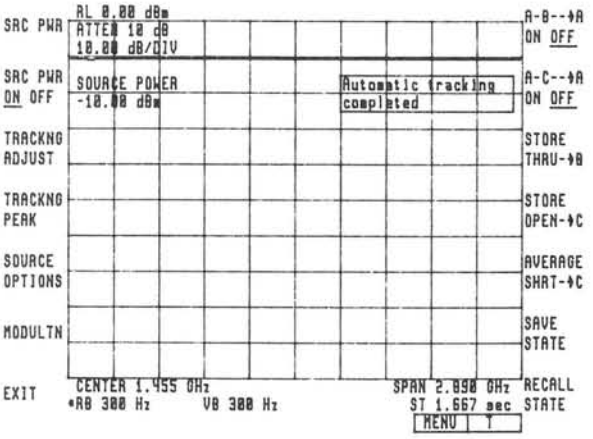


Figure 1-62.

Source Options

The ◀SOURCE OPTIONS▶ softkey calls up a variety of source softkeys as shown in Figure 1-63 below.

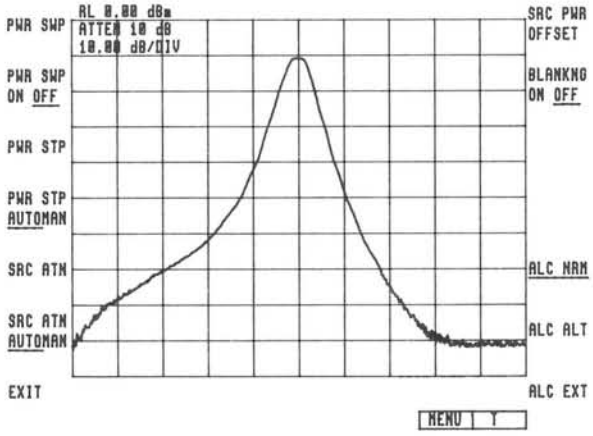


Figure 1-63. SOURCE OPTIONS Softkeys

Overview

Many of the softkeys on the SOURCE OPTIONS screen (◀PWR SWP▶, ◀PWR SWP AUTOMAN▶, ◀SRC ATN▶, ◀SRC ATN AUTOMAN▶, and ◀SRC PWR OFFSET▶) control the power of the tracking generator. These softkeys are described in the *Source: Power Control* section.

The remaining SOURCE OPTIONS softkeys are discussed in this section. Each of these keys is briefly described below.

BLANKING ON OFF (when on) reduces the output power of the source to a low level during retrace. *When measuring power sensitive devices, turn this function ON.*

ALC NORMAL connects the automatic level control to the normal internal detector. The normal detector is active in the instrument preset state.

ALC ALTERNATE connects the automatic level control to an alternate internal detector.

ALC EXTERNAL connects the automatic level control of the source to an external detector.

Blanking

The ◀BLANKNG ON OFF▶ softkey (when on) reduces the output power of the tracking generator. Otherwise, in certain span and center frequency combinations, a power spike of + 5 dBm can occur.

> **CAUTION!**
>
> When you measure devices sensitive to a power of + 5dBm, TURN BLANKING ON!

Blanking is turned OFF (◀BLANKNG ON OFF ▶) in the instrument preset state.

Automatic Level Control

The automatic level control of the source is set with three softkeys: ◀ALC NRM▶, ◀ALC ALT▶, and ◀ALC EXT▶. These softkeys are described below.

◀ALC NRM▶ connects the automatic level control to the normal internal detector. The normal detector is active in the instrument preset state. The normal internal detector at the tracking generator RF OUTPUT is normally used for measurements between 10 MHz and 2.9 GHz.

◀ALC ALT▶ connects the automatic level control to an alternate internal detector. The alternate detector at the internal 3.6 GHz amplifier is typically used for measurements between 20 Hz and 10 MHz. The alternate detector can be used above 10 MHz, but the output flatness is better with normal detection. Accurate measurements can be made with the alternate detector by normalizing. Choose the alternate detector for wideband applications (for example, 1 kHz to 100 MHz).

◀ALC EXT▶ connects the automatic level control to an external negative detector (0 to 100 millivolts). An external detector can be used, for example, to level at the output of an amplifier or splitter. With external detectors, use the "ALC EXT INPUT" connector on the front panel of the tracking generator.

Activate an ALC mode by pressing the desired softkey. The active mode is underlined. (See the following example.)

Example: Using the alternate detector.

In this example, the start frequency is set to 100 kHz and the stop frequency to 100 MHz.

If the start frequency is less than 10 MHz in normal detection mode, an "Output unleveled" error may appear on the display, as in Figure 1-64.

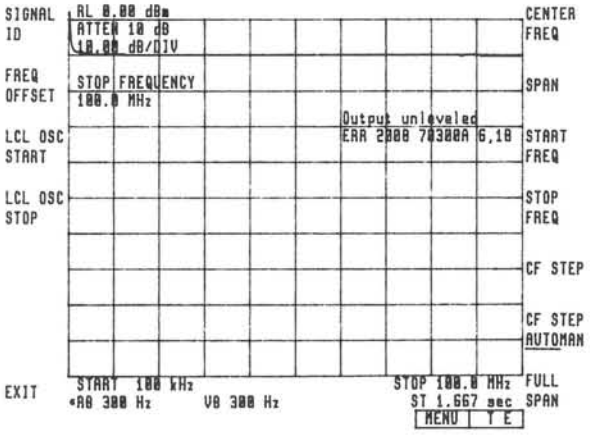


Figure 1-64.

The alternate detector can be used.

To activate this detector, press ◀SOURCE▶, ◀SOURCE OPTIONS▶, and ◀ALC ALT▶.

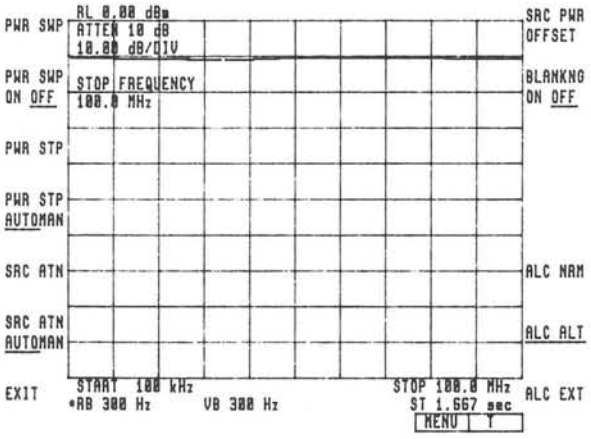


Figure 1-65.

Modulation

The MODULATION softkeys control the modulation of the tracking generator's output and select the tracking generator oscillator.

Press ◀MODULTN▶ and the MODULATION softkeys appear as shown in Figure 1-66 below.

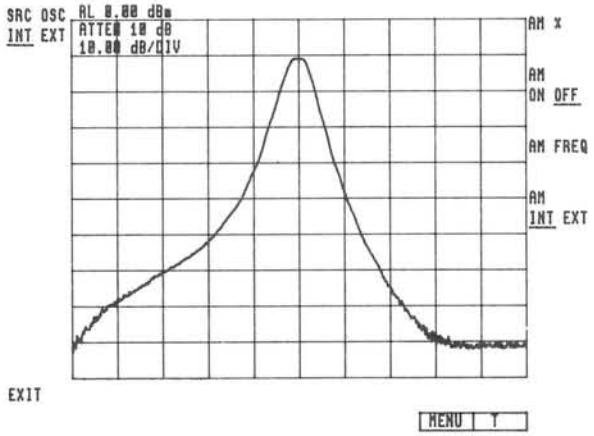


Figure 1-66. The MODULATION Softkeys

Overview

The MODULATION softkeys are briefly described below. See the following pages for detailed descriptions.

AM PERCENT sets the amplitude modulation percentage (depth).

AM ON OFF turns the amplitude modulation on and off.

AM FREQUENCY selects the internal amplitude modulation frequency: 1 kHz or 400 Hz.

AM INTERNAL/EXTERNAL selects the amplitude modulation input. External modulation and internal continuous-wave modulation are available.

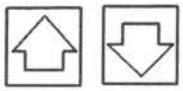
SOURCE OSCILLATOR INTERNAL/EXTERNAL selects the 21.4 MHz source oscillator, either internal or external.

AM Percentage

The amplitude modulation percentage (depth) of the source is set and controlled with the ◀AM %▶ and ◀AM ON OFF▶ softkeys.

To enter a percent value, press ◀AM %▶ and use the keypad. ◀AM ON OFF▶ automatically moves to the ON position. If turned on with ◀AM ON OFF▶, the amplitude modulation is set to the current amplitude modulation depth.

The three methods of setting the amplitude percentage (depth) are shown:

KNOB 	The knob adjusts the amplitude modulation percentages continuously between 0 and 100%.
STEP KEYS 	The step keys change the amplitude modulation percentage in increments of 10 %.
KEY PAD 0 1 2 3 4 5 6 7 8 9	The keypad directly enters percent values between 0 and 100%. Entering any non-zero value turns amplitude modulation on.

AM Frequency

Select the internal amplitude modulation frequency with the ◀AM FREQ▶ softkey. Selections are limited to 1 kHz and 400 Hz. The instrument preset amplitude modulation frequency is 1 kHz. If you enter a frequency other than 1 kHz or 400 Hz, the instrument defaults to the nearest value.

AM Internal/External

Select the amplitude modulation input with the ◀AM INT EXT▶ softkey. The INTERNAL continuous wave modulation input is the instrument preset condition.

If frequencies other than 1 kHz or 400 Hz are needed, an EXTERNAL oscillator can be used. For example, in an AM receiver application requiring 10 kHz modulation, a function generator can be used.

Source Oscillator Internal/External

Select the 21.4 MHz source oscillator for the tracking generator with the ◀SRC OSC INT EXT▶ softkey. The INTERNAL source oscillator is active in the instrument preset state. With external source oscillation, the tracking generator output may be offset up to ± 10 MHz. A modulated external 21.4 MHz source will put modulation on the RF OUTPUT of the tracking generator. (With external oscillators, tracking adjustments are not functional.)

TRACKING GENERATOR REMOTE OPERATION

Introduction

This section, *Remote Operation*, categorizes tracking generator commands and provides some examples of their usage. (Individual tracking generator commands are described in detail in the HP 71000 Language Reference.)

Organization of This Section

Set-up for Remote Operation lists the suggested equipment for remote operation and describes the HP-IB and HP-MSIB addressing scheme. A short procedure that demonstrates communication between the analyzer and computer is provided.

Tracking Generator Remote Commands shows the relationship between the HP 70300A softkeys and their corresponding remote commands. In addition, commands are summarized by function.

Tracking Generator Program Examples describes several tracking generator programs in order of increasing complexity. Refer to *Remote Operation* in the HP 71000 Operating Manual for an introduction to spectrum analyzer programming.

HP 71000 Documentation

Other HP 71000 documentation covers remote operation:

The HP 71000 Language Reference lists the HP 71000 Modular Spectrum Analyzer remote commands. Commands appear in alphabetical order, each with a description that contains a syntax flow chart and a definition of command parameters.

The HP 71000 Operating Manual Part II: Remote Operation introduces HP 71000 Spectrum Analyzer programming. Programming concepts are discussed in levels of increasing complexity in "Programming Fundamentals" and "Advanced Programming." Refer to *Remote Operation* for an introduction to spectrum analyzer programming.

The HP 71000 Operating Manual Part III: Display Operation describes remote operation of the HP 70205A and 70206A Displays. (See "Remote Display Operation.")

Setup for Remote Operation

Suggested Equipment

The following equipment was used to run the programs in this chapter:

HP 71100A or HP 71200A with the HP 70206A Graphics Display
HP 70300A
HP 9836, 9826, 9817, 9816 Computer, or equivalent
Cables
Connectors
Device for Testing (A filter is used in this chapter.)

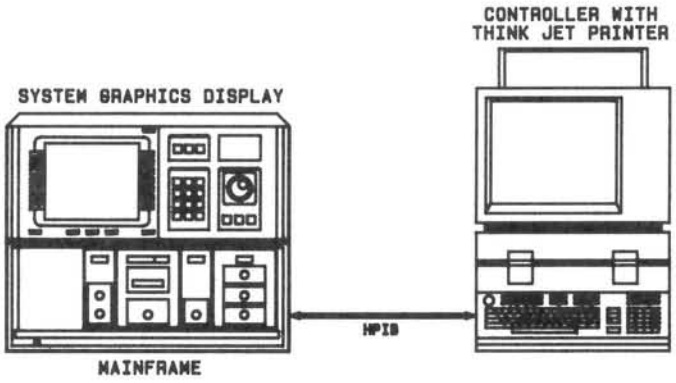


Figure 1-67. Typical Equipment Configuration for Remote Operation

HP-IB Address

For remote operation, the Hewlett-Packard Interface Bus (HP-IB) address must be set properly. Check the HP-IB address by pressing [DSP], ◀ADDRESS MAP▶, and then rotating the knob until the HP 70900A Local Oscillator (or controller) appears. The HP-IB instrument address will appear in the cursor box with the LO. (See Figure 1-68.)

The HP-IB address is formed by combining the interface select code (7) with the instrument address (18 in this case). The HP-IB address in this example, 718, will be used throughout this chapter. If the HP-IB address of your instrument is different, substitute the appropriate value in all examples.

Note: The System Support Manual is the primary user reference for addressing modules.

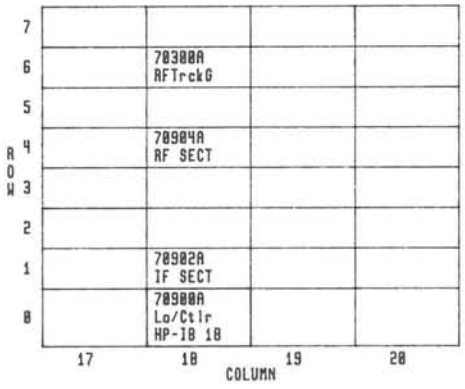


Figure 1-68.

Check-Out Procedure

To verify that the HP-IB connections and interface are functional, perform the following procedure:

1. Press [RESET] on the computer.
2. Type "OUTPUT 718"
3. Press [EXECUTE].

If the system is functional, the RMT (remote) indicator on the local oscillator will turn on. If the light does not turn on, check the power cables and HP-IB cables.

Tracking Generator Remote Commands

Remote operation of the tracking generator is similar to manual operation. Remote measurements are executed with commands that correspond to the front panel softkeys.

The relationship between tracking generator softkeys and remote commands is shown in Figure 1-69. Since this figure contains all of the manual and remote commands, it is a helpful reference.

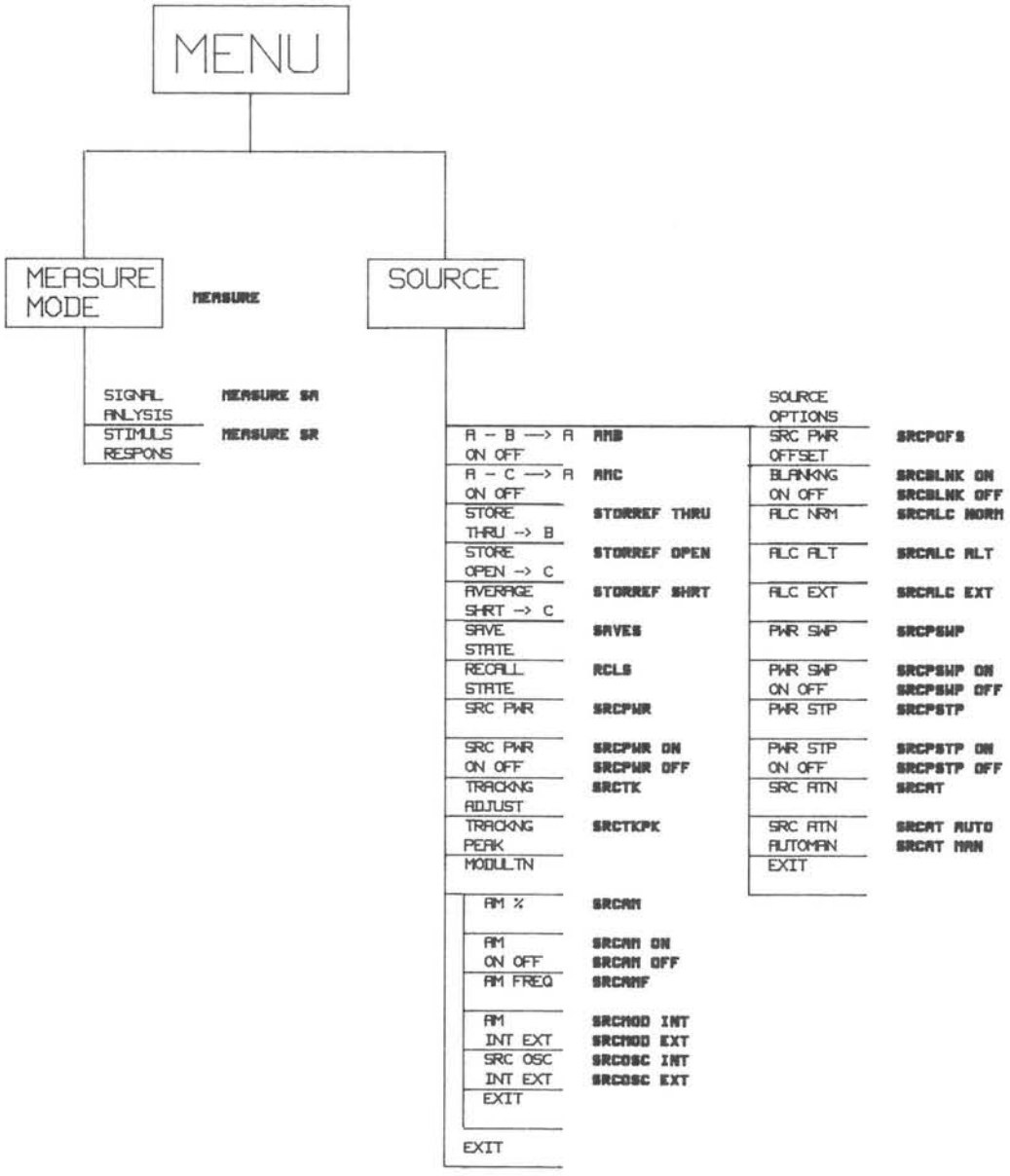


Figure 1-69. HP 70300A Softkeys and Corresponding Remote Commands

Command Summary

The command summary below categorizes the HP 70300A commands by type of function. These commands are also listed in the index. As a mnemonic aid, the majority of tracking generator commands begins with the prefix SRC (SOURCE). (A detailed description of each command is provided in the HP 71000 Language Reference which lists commands alphabetically.)

Power Level Controls

MIL	Maximum input level
SRCPWR	Source power level
SRCPOFS	Source power offset
SRCPSWP	Source power sweep
SRCPSTP	Source power step
SRCALC	Source automatic level control (normal, alternate, or external)

Frequency Controls

SRCTK	Source tracking adjustment
SRCTKPK	Source automatic tracking peak
SRCOSC	Source oscillator (internal or external)

Modulation Controls

SRCAM	Source amplitude modulation
SRCAMF	Source amplitude modulation frequency
SRCMOD	Source modulation (internal or external)

Other controls

MEASURE	Measurement mode: spectrum analysis or stimulus response
STORREF	Store reference (thru, open, or short)
SRCBLANK	Source RF blanking
SRCAT	Source attenuator

Tracking Generator Programs

This section introduces you to the commands and programming capabilities of the HP 70300A by walking you through several remote programs.

1. *Transmission Measurement* makes a normalized transmission measurement.

2. *Reflection Measurement* makes a normalized reflection measurement.

3. *3 dB Bandwidth* measures the 3 dB bandwidth of a bandpass filter.

4. *3 dB Bandwidth Softkey: Downloadable Program* discusses downloadable programs written for the 3 dB bandwidth program.

5. *Full Dynamic Range* displays 150 dB of dynamic range on the display at one time.

Programming Guidelines

1. Since remote operation imitates manual operation, review the examples in the previous *Softkeys* section.

2. Before trying the programs in this section, refer to the HP 71000 Operating Manual *Remote Operation* section.

3. Follow the suggestions provided in the previous section, "Setup for Remote Operation."

Tracking Generator Programming Basics

Most HP 70300A Tracking Generator programs contain several common statements. These statements address the spectrum analyzer, preset the analyzer, turn on the tracking generator, and prepare the system to make stimulus-response measurements. We can, for example, write a short program that executes only these "basic" statements.

The first line of our basic tracking generator program assigns an I/O path called @Sa to our spectrum analyzer at address 718. The HP BASIC "CLEAR" command in the second line resets the analyzer on HP-IB. The third line sets the instrument preset state. The IP command corresponds to the [I-P] key on the front of the display. Then, SNGLS activates single sweep mode to control the sweep, and a sweep is taken. (To reduce program-execution time and to ensure complete calibration-trace storage, TS is used to initiate a sweep only when a sweep is necessary. For example, TS is used before a thru trace is stored.)

Next, the tracking generator power is turned on with the SRCPWR command. (The SRCPWR command corresponds to the ◀SRC PWR ON OFF▶ softkey.) Using the MEASURE SR command, the fifth line activates stimulus-response measurement mode. (The MEASURE command corresponds to the ◀MEASURE MODE▶ softkey, and SR corresponds to ◀STIMULS RESPONS▶.) Last, we return the instrument to local control and end the program.

```
10 ASSIGN @Sa TO 718
20 CLEAR @Sa
30 OUTPUT @Sa;"IP;SNGLS;TS;"
40 OUTPUT @Sa;"SRCPWR ON;"
50 OUTPUT @Sa;"MEASURE SR;"
60 OUTPUT @Sa;"TS;"
70 LOCAL 7
80 END
```

As you try the programs in the remainder of this section, you will recognize these basic statements. The statements are rearranged and other statements are added as the programs become more sophisticated.

Program 1: Transmission Measurement

Introduction

This program guides an operator through one method of storing thru calibration data, which is then used to make a normalized transmission measurement. The program imitates manual operation of the "Transmission Measurement" example in the *Typical Measurements* section.

Program Explanation

The first segment of the program initializes the analyzer. Line 30 addresses the spectrum analyzer at address 718. (Your instrument address may differ.) The CLEAR command on line 40 resets the analyzer on HP-IB. Then, line 50 sets the instrument preset conditions, activates single sweep mode to control the sweep, and takes a sweep. (To reduce program-execution time and ensure complete data storage, TS is used to initiate a sweep only before a trace is stored.) The DISPOSE ALL command in line 60 clears spectrum analyzer memory and CLRDSP in line 70 removes all previous user graphics from the display. (If you do not want your analyzer's memory cleared, omit the DISPOSE ALL command.)

In the second segment of the program, the VARDEF commands define KEYA and KEYB variables, which are used later (in lines 240 and 340) to create ◀CONT▶ (continue) softkeys.

The third program segment sets analyzer parameters for a stimulus-response measurement by setting the measurement mode to stimulus-response and turning on the tracking generator.

The fourth segment sets the analyzer parameters. Lines 150 and 160 set center frequency for the device under test (DUT) and narrow the span. Line 170 selects a resolution bandwidth to optimize the dynamic range of the displayed response while maintaining a fast sweep time. (Select a wider resolution bandwidth if you are using the HP 70203A IF module.) This example looks at the transmission characteristics of a 321.4 MHz bandpass filter. Different DUTs will require different analyzer settings.

The fifth program segment stores the thru calibration data. Lines 210 through 240 instruct the operator to make the thru connection. (The RF OUTPUT on the tracking generator is connected to the RF INPUT on the RF module.) Once the thru connection has been made, the operator presses ◀CONT▶ to resume program operation. Line 250 removes instructions from the display. Line 260 takes a sweep to ensure that the trace data to be stored is complete. Then, line 270 uses the STORREF (store reference) command to store the THRU calibration in trace B. Line 280 then activates the AMB (trace A minus trace B) command which later subtracts the thru calibration data from the measurement data.

The last program segment completes the transmission measurement. Lines 310 through 340 instruct the operator to insert the device into the thru path and press ◀CONT▶ to resume program operation. Then, lines 350 and 360 erase instructions from the display and take a sweep. Once the last sweep has been made, the normalized transmission measurement appears in trace A (see Figure 1-70). "Measurement complete" is written on the display and LOCAL 7 returns the instrument to local control.

Running the Program:

1. Clear the computer's memory. (In many computers, the "SCRATCH" command is used.)

2. Type in the program as shown. Modify the analyzer parameters for the DUT to be tested.

3. Press [RUN] on the computer. Follow instructions as they appear on the instrument display.

4. The normalized transmission measurement appears on the display screen.

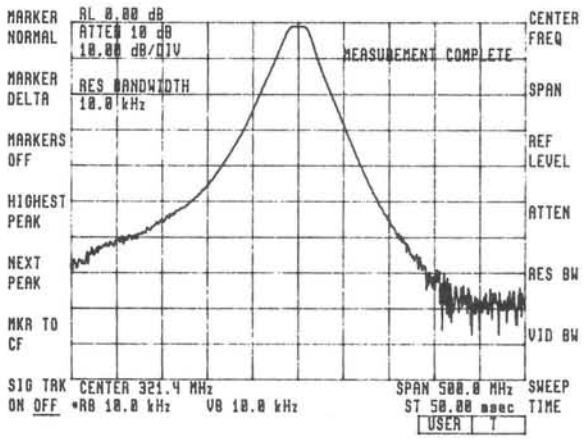


Figure 1-70. Normalized Transmission Measurement.

```
10    !TRANSMISSION MEASUREMENT              FILE:  TRANS
20       !THE FOLLOWING FIVE LINES INITIALIZE THE ANALYZER.
30    ASSIGN @Sa TO 718
40    CLEAR @Sa
50    OUTPUT @Sa;"IP;SNGLS;TS;"
60    OUTPUT @Sa;"DISPOSE ALL;"
70    OUTPUT @Sa;"CLRDSP;"
80       !DEFINE VARIABLE SOFTKEYS USED LATER IN THE PROGRAM.
90    OUTPUT @Sa;"VARDEF KEYA,0;"
100   OUTPUT @Sa;"VARDEF KEYB,0;"
110      !PREPARE THE INSTRUMENT FOR STIMULUS-RESPONSE MEASUREMENTS.
120   OUTPUT @Sa;"MEASURE SR;"               !select stimulus-response mode
130   OUTPUT @Sa;"SRCPWR ON;"                !turn on the tracking generator
140      !SET ANALYZER PARAMETERS TO MEASURE A 321.4MHZ BANDPASS FILTER.
150   OUTPUT @Sa;"CF 321.4MHZ;"
160   OUTPUT @Sa;"SP 500MHZ;"
170   OUTPUT @Sa;"RB 10KHZ;"
180      !INSTRUCT OPERATOR TO MAKE A THROUGH CONNECTION, THEN PRESS CONT.
190      !THE THROUGH IS STORED IN TRACE B WITH THE STORREF COMMAND AND THE
200      !AMB (TRACE A MINUS TRACE B) COMMAND IS ACTIVATED.
210   OUTPUT @Sa;"IT 0;OR 280,955;"
220   OUTPUT @Sa;"TEXT %CONNECT RF OUT TO RF IN, THEN"
230   OUTPUT @Sa;"PRESS CONT (NO DEVICE IN PATH)%;"
240   OUTPUT @Sa;"READMENU KEYA,1,%CONT%;"
250   OUTPUT @Sa;"CLRDSP;"
260   OUTPUT @Sa;"TS;"                       !update trace before storing data
270   OUTPUT @Sa;"STORREF THRU;"             !store the thru calibration data
280   OUTPUT @Sa;"AMB ON;"                   !subtract thru trace from active
290      !INSTRUCT THE OPERATOR TO INSERT THE DEVICE, THEN PRESS CONT.
300      !THE NORMALIZED TRANSMISSION MEASUREMENT WILL APPEAR.
310   OUTPUT @Sa;"IT 0;OR 280,900;"
320   OUTPUT @Sa;"TEXT%FOR TRANSMISSION MEASUREMENT"
330   OUTPUT @Sa;"INSERT DEVICE, PRESS CONT%;"
340   OUTPUT @Sa;"READMENU KEYB,1,%CONT%;"
350   OUTPUT @Sa;"CLRDSP;"
360   OUTPUT @Sa;"TS;"                       !update trace to show device
370   OUTPUT @Sa;"IT 0;OR 600,860;"
380   OUTPUT @Sa;"TEXT%MEASUREMENT COMPLETE%;WAIT 1S;CLRDSP;"
390   LOCAL 7
400   END
```

Program 2: Reflection Measurement

Introduction

This program guides an operator through one method of storing reflection calibration data (an open/short average), which is then used to make a normalized, scalar-reflection measurement. The program imitates the manual operation of the ◀AVERAGE SHRT -> C▶ example in *Softkeys*.

Program Explanation

The first segment of the program initializes the analyzer. Line 30 addresses the spectrum analyzer at address 718. (Your instrument address may differ.) The CLEAR command on line 40 resets the analyzer on HP-IB. Then, line 50 sets the intrument preset conditions, activates single sweep mode to control the sweep, and takes a sweep. (To reduce program-execution time and ensure complete data storage, TS initiates a sweep only before a trace is stored.) The DISPOSE ALL command in line 60 clears spectrum analyzer memory and the CLRDSP in line 70 removes all previous user graphics from the display. (If you do not want your analyzer's memory cleared, omit the DISPOSE ALL command.)

In the second segment of the program, the VARDEF command defines KEYA, KEYB, and KEYC variables, which are used later (in lines 230, 320, and 410) to create ◀CONT▶ (continue) softkeys.

The third program segment sets analyzer parameters for a stimulus-response measurement by selecting stimulus-response measurement mode and turning on the tracking generator.

In the fourth segment, line 160 sets the center frequency for the DUT and line 170 narrows the span. A resolution bandwidth is selected in line 180 to optimize dynamic range of the displayed response, while maintaining a fast sweep time. This example tests a 321.4 MHz bandpass filter. Different DUTs will require different analyzer settings.

The fifth program segment stores the open-circuit trace data. Lines 200 through 230 instruct the operator to connect a directional bridge or coupler. Connect the bridge or coupler to the RF OUTPUT on the tracking generator and to the RF INPUT on the RF module. Then connect the open-circuit to the bridge and press ◀CONT▶ to resume program operation. Line 240 removes instructions from the display and line 250 takes a sweep to ensure that the trace data to be stored is complete. Line 260 then uses the STORREF (store reference) command to store the open-circuit trace data in trace C.

The next segment averages the short-circuit trace data with the open-circuit trace data. Lines 290 through 320 instruct the operator to connect the short-circuit to the bridge or coupler and press ◀CONT▶ to resume program operation. In lines 330 and 340, instructions are removed from the display and a sweep is taken to update the trace. Line 350 uses the STORREF command to average the open data (trace C) with the short data (trace A) and store the resulting open/short average in trace C. Then, line 360 turns on the AMC (trace A minus trace C) command, which later subtracts the OPEN/SHORT average calibration data (trace C) from measurement data (trace A) and displays the normalized measurement on trace A.

The last segment completes the reflection measurement. Lines 380 through 410 instruct the operator to connect the device to the bridge or coupler and press ◀CONT▶ to resume program operation. Again, instructions are removed from the screen and the trace is updated. On line 430 the last sweep is taken and the normalized reflection measurement appears on the display (see Figure 1-71). "Measurement complete" is written on the display and LOCAL 7 returns the instrument to local control.

Running the Program:

1. Clear the computer's memory. (In many computers, the "SCRATCH" command is used.)
2. Type in the program as shown. Modify the analyzer parameters for your device.
3. Press [RUN] on the computer. Follow instructions as they appear on the instrument display.
4. The normalized reflection measurement appears on the display screen.

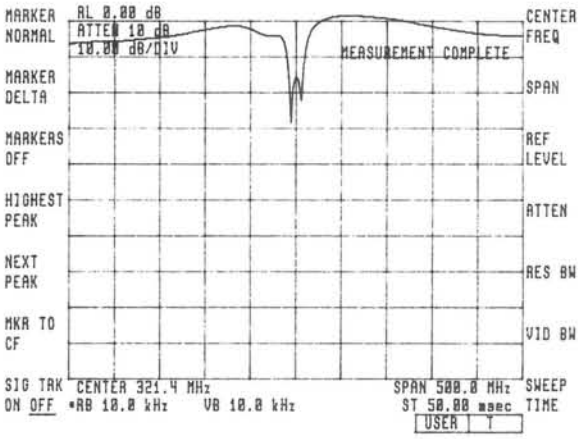


Figure 1-71.

```
10    !REFLECTION MEASUREMENT     FILE:  REFL
20       !THE FOLLOWING FIVE LINES INITIALIZE THE ANALYZER.
30    ASSIGN @Sa TO 718
40    CLEAR @Sa
50    OUTPUT @Sa;"IP;SNGLS;TS;"
60    OUTPUT @Sa;"DISPOSE ALL;"
70    OUTPUT @Sa;"CLRDSP;"
80       !DEFINE VARIABLE SOFTKEYS THAT WILL BE USED IN THE PROGRAM.
90    OUTPUT @Sa;"VARDEF KEYA,0;"
100   OUTPUT @Sa;"VARDEF KEYB,0;"
110   OUTPUT @Sa;"VARDEF KEYC,0;"
120      !PREPARE THE INSTRUMENT FOR STIMULUS-RESPONSE MEASUREMENTS.
130   OUTPUT @Sa;"MEASURE SR;"              !select stimulus-response mode
140   OUTPUT @Sa;"SRCPWR ON;"               !turn on the tracking generator
150      !SET ANALYZER PARAMETERS TO MEASURE A 321.4MHZ BANDPASS FILTER.
160   OUTPUT @Sa;"CF 321.4MHZ;"
170   OUTPUT @Sa;"SP 500MHZ;"
180   OUTPUT @Sa;"RB 10KHZ;"
190      !INSTRUCT OPERATOR TO MAKE OPEN CONNECTION, CONT RESUMES OPERATION.
200   OUTPUT @Sa;"IT 0;OR 280,955;"
210   OUTPUT @Sa;"TEXT %CONNECT BRIDGE TO RF IN AND TO RF OUT"
220   OUTPUT @Sa;"CONNECT OPEN TO BRIDGE,THEN PRESS CONT%;"
230   OUTPUT @Sa;"READMENU KEYA,1,%CONT%;"
240   OUTPUT @Sa;"CLRDSP;"
250   OUTPUT @Sa;"TS;"                      !update trace before storing data
260   OUTPUT @Sa;"STORREF OPEN;"            !store the open in trace C
270      !INSTRUCT OPERATOR TO MAKE SHORT CONNECTION, CONT RESUMES OPERATION.
280      !THE AMC COMMAND (TRACE A MINUS TRACE C) IS ACTIVATED.
290   OUTPUT @Sa;"IT 0;OR 280,955;"
300   OUTPUT @Sa;"TEXT %DISCONNECT OPEN, CONNECT SHORT"
310   OUTPUT @Sa;"TO BRIDGE, PRESS CONT%;"
320   OUTPUT @Sa;"READMENU KEYB,1,%CONT%;"
330   OUTPUT @Sa;"CLRDSP;"
340   OUTPUT @Sa;"TS;"                      !update trace before storing data
350   OUTPUT @Sa;"STORREF SHORT;"           !average the short with the open
360   OUTPUT @Sa;"AMC ON;"                  !subtrace trace C from active trace
370      !INSTRUCT OPERATOR TO CONNECT THE DEVICE TO BE TESTED.
380   OUTPUT @Sa;"IT 0;OR 280,900;"
390   OUTPUT @Sa;"TEXT %FOR REFLECTION MEASUREMENT"
400   OUTPUT @Sa;"CONNECT DEVICE, PRESS CONT%;"
410   OUTPUT @Sa;"READMENU KEYC,1,%CONT%;"
420   OUTPUT @Sa;"CLRDSP;"
430   OUTPUT @Sa;"TS;"                      !update trace to show device
440   OUTPUT @Sa;"IT 0;OR 600,860;"
450   OUTPUT @Sa;"TEXT%MEASUREMENT COMPLETE%;WAIT 1S;CLRDSP;"
460   LOCAL 7
470   END
```

Program 3: 3 dB Bandwidth

Introduction

The following program demonstrates one technique for finding the 3 dB bandwidth of a bandpass filter. This example modifies the transmission measurement program and adds several lines to make 3 dB bandwidth measurements.

Program Explanation

Lines 10 through 380 are copied from the transmission program and then modified as follows. First, on line 160, the span is narrowed to 50 MHz so that only the top portion of the filter is viewed. An optional sweep is taken on line 180 to update the trace. Then, on line 280, the automatic tracking peak function is added to maximize the displayed amplitude. (Automatic tracking is used for resolution bandwidths less than 2 kHz. Since we are viewing only the top of the filter and only minimal dynamic range is required, we could select a wider resolution bandwidth and omit automatic tracking.) Finally, a sweep is taken on line 280 to ensure that the trace data to be stored is complete.

The sixth segment of the program completes the transmission measurement. In lines 330 through 360 the program instructs the operator to insert the device. Once ◀CONT▶ has been pressed, line 370 erases text from the display and line 380 takes a sweep to update trace data.

The last segment makes the 3 dB bandwidth measurement. Line 400 removes all previously-set markers from the display. Then, lines 410 and 420 place markers at the right and left -3 dB points using the MKAR (marker amplitude relative right) and MKAL (marker amlitude relative left) commands. The MKBW (marker bandwidth) function is turned on in line 430. Using the amplitude markers, the bandwidth function finds the 3 dB bandwidth and presents the bandwidth value on the display. LOCAL 7 returns the instrument to local control.

Running the Program:

1. Clear the computer's memory. (In many computers, the "SCRATCH" command is used.)

2. Type in the program as shown.

3. Press [RUN] on the computer and follow instructions as they appear on the display screen.

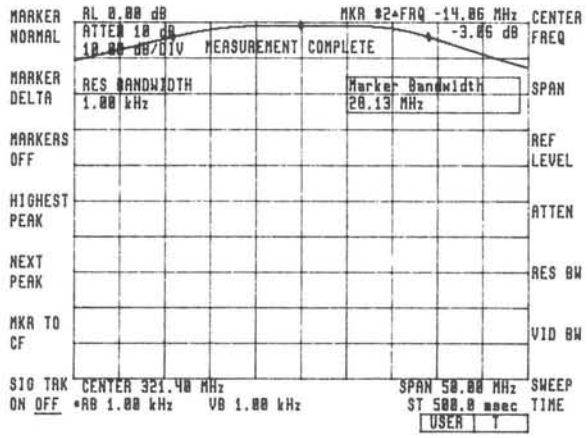


Figure 1-72.

```
10    !3 DB BANDWIDTH MEASUREMENT              FILE:  BWMEAS
20       !THE FOLLOWING FIVE LINES INITIALIZE THE ANALYZER.
30    ASSIGN @Sa TO 718
40    CLEAR @Sa
50    OUTPUT @Sa;"IP;SNGLS;TS;"
60    OUTPUT @Sa;"DISPOSE ALL;"
70    OUTPUT @Sa;"CLRDSP;"
80       !DEFINE VARIABLE SOFTKEYS USED LATER IN THE PROGRAM.
90    OUTPUT @Sa;"VARDEF KEYA,0;"
100   OUTPUT @Sa;"VARDEF KEYB,0;"
110      !PREPARE THE INSTRUMENT FOR STIMULUS-RESPONSE MEASUREMENTS.
120   OUTPUT @Sa;"MEASURE SR;"              !select stimulus-response mode
130   OUTPUT @Sa;"SRCPWR ON;"               !turn on the tracking generator
140      !SET ANALYZER PARAMETERS TO MEASURE A 321.4MHZ BANDPASS FILTER.
150   OUTPUT @Sa;"CF 321.4MHZ;"
160   OUTPUT @Sa;"SP 50MHZ;"
170   OUTPUT @Sa;"RB 1KHZ;"
180   OUTPUT @Sa;"TS;"
190      !INSTRUCT OPERATOR TO MAKE A THROUGH CONNECTION, THEN PRESS CONT.
200      !THE THROUGH IS STORED IN TRACE B WITH THE STORREF COMMAND AND THE
210      !AMB (TRACE A MINUS TRACE B) COMMAND IS ACTIVATED.
220   OUTPUT @Sa;"IT 0;OR 280,955;"
230   OUTPUT @Sa;"TEXT %CONNECT RF OUT TO RF IN, THEN"
240   OUTPUT @Sa;"PRESS CONT (NO DEVICE IN PATH)%;"
250   OUTPUT @Sa;"READMENU KEYA,1,%CONT%;"
260   OUTPUT @Sa;"CLRDSP;"
270   OUTPUT @Sa;"SRCTKPK;"                 !max amplitude w/auto tracking
280   OUTPUT @Sa;"TS;"                      !update trace before storing data
290   OUTPUT @Sa;"STORREF THRU;"            !store the thru calibration data
300   OUTPUT @Sa;"AMB ON;"                  !subtract thru trace from active
310      !INSTRUCT THE OPERATOR TO INSERT THE DEVICE, THEN PRESS CONT.
320      !THE NORMALIZED TRANSMISSION MEASUREMENT WILL APPEAR.
330   OUTPUT @Sa;"IT 0;OR 280,900;"
340   OUTPUT @Sa;"TEXT%FOR TRANSMISSION MEASUREMENT"
350   OUTPUT @Sa;"INSERT DEVICE, PRESS CONT%;"
360   OUTPUT @Sa;"READMENU KEYB,1,%CONT%;"
370   OUTPUT @Sa;"CLRDSP;"
380   OUTPUT @Sa;"TS;"                      !update trace to show device
390      !THE FOLLOWING SIX LINES MEASURE THE -3 DB BANDWIDTH.
400   OUTPUT @Sa;"MKOFF;"
410   OUTPUT @Sa;"MKAR -3DB;"               !set the right -3 dB point
420   OUTPUT @Sa;"MKAL -3DB;"               !set the left -3 dB point
430   OUTPUT @Sa;"MKBW ON;"                 !determine the -3 dB bandwidth
440   OUTPUT @Sa;"IT 0;OR 290,875;"
450   OUTPUT @Sa;"TEXT%MEASUREMENT COMPLETE%;WAIT 1S;CLRDSP;"
460   LOCAL 7
470   END
```

Program 4: 3 dB Bandwidth Softkey

Introduction

HP 71000 spectrum analyzers give you the built-in capability to store and run programs and to control other instruments over the Hewlett-Packard Interface Bus (HP-IB). Programs written on a computer are loaded into the analyzer, which stores them in its battery-backed, continuous memory. The computer can then be disconnected, freeing it for other uses, because the spectrum analyzer alone executes the downloaded programs.

For user convenience, new softkeys can be created for downloadable programs. These softkeys replace keys on the USER menu and execute downloaded programs. Downloadable programs can be developed and softkeys can be created for the programs in this chapter. As an example, the bandwidth measurement program will be modified.

Program Explanation

The 3dB downloadable-bandwidth program operates the same as the 3dB bandwidth program. In fact, the downloadable-bandwidth program is the same as the 3dB bandwidth program with three exceptions. First, we divide the bandwidth program into a main program and a subprogram. (Breaking a program into subprograms creates smaller subunits that are more easily developed, edited, and combined.) Second, we place the 3dB bandwidth measurement routine in the subprogram and call the routine a "user-defined function." Last, we create a ◀3DB BW MEAS▶ softkey. These alterations are explained below.

The main program is similar to the other programs in this section, with the exception of the CALL command. The CALL command on line 60 transfers program execution to the Bw_meas subprogram (described below). This loads the BW_meas subprogram into the analyzer's memory. As in earlier programs, the DISPOSE ALL command clears all analyzer memory. (If you do not want your analyzer's memory cleared, omit the DISPOSE ALL command.)

The Bw_meas subprogram, beginning on line 100, does two things: it includes the 3dB bandwidth measurement routine as a user-defined function and it creates a ◀3DB BW MEAS▶ softkey.

First, the Bw_meas subprogram uses the FUNCDEF (function definition) command on line 110 to define the bandwidth-measurement routine as a function. Two of the initialization lines from the bandwidth program are included as part of the user-defined function (lines 130 and 140). Lines 150 through 490 are copied directly from the 3 dB bandwidth program. Caret " ^ " delimeters are placed at the beginning and end of the function (lines 110 and 500). To conserve random access memory (RAM) in the analyzer, we add semicolons ";" to the end of our subprogram lines. (Semicolons supress the carriage return/line feed.)

Then, on line 510, the subprogram creates a ◀3DB BW MEAS▶ softkey using the KEYDEF (user-defined softkey) command. The KEYDEF is followed by the number of the softkey to be defined, the user-defined function to be executed, and the softkey label. Percent sign "%" delimeters are placed around the softkey label. (Refer to "Section III: Storing New Functions" in *Advanced Programming* for detailed descriptions of the FUNCDEF and KEYDEF commands.)

Running the Program:

1. Clear the computer's memory. (In many computers, the "SCRATCH" command is used.)

2. Type in the program as shown.

3. Press [RUN] on the computer. Press ◀3 DB MEAS▶ on the analyzer and follow directions as they appear on the display.

4. The value of the 3 dB bandwidth appears on the instrument display.

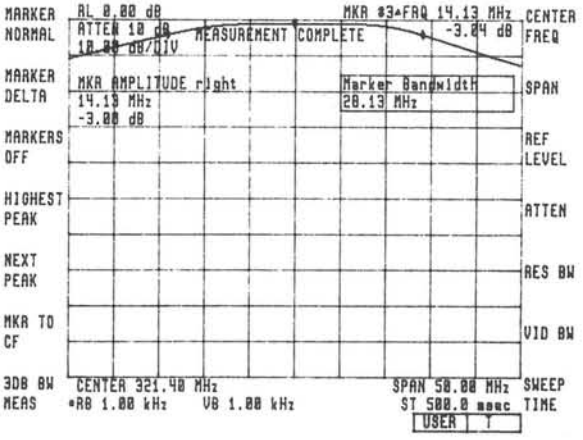


Figure 1-73. 3 dB Bandwidth with ◀3DB BW MEAS▶ Softkey

```
10  !THIS PROGRAM MAKES A -3DB BW MEASUREMENT WITH A "3DB BW MEAS" SOFTKEY
20  !FILE: BWMEAS2
30  ASSIGN @Sa TO 718
40  CLEAR @Sa
50  OUTPUT @Sa;"DISPOSE ALL;";
60  CALL Bw_meas(@Sa)                    !download subprogram into analyzer
70  LOCAL 7
80  END
90  !
100 Bw_meas:SUB Bw_meas(@Sa)              !define the 3 dB bandwidth subprogram
110   OUTPUT @Sa;"FUNCDEF BW_MEAS,^"     !create a user-defined function
120       !THE NEXT TWO LINES PRESET THE ANALYZER.
130     OUTPUT @Sa;"IP;SNGLS;TS;";
140     OUTPUT @Sa;"CLRDSP;";
150       !DEFINE VARIABLES USED LATER IN THE PROGRAM.
160     OUTPUT @Sa;"VARDEF KEYA,0;";
170     OUTPUT @Sa;"VARDEF KEYB,0;";
180       !PREPARE THE ANALYZER FOR A STIMULUS-RESPONSE MEASUREMENT.
190     OUTPUT @Sa;"MEASURE SR;";
200     OUTPUT @Sa;"SRCPWR ON;";
210       !SET ANALYZER PARAMETERS TO MEASURE A 321.4MHZ BANDPASS FILTER.
220     OUTPUT @Sa;"CF 321.4MHZ;";
230     OUTPUT @Sa;"SP 50MHZ;";
240     OUTPUT @Sa;"RB 1KHZ;";
250     OUTPUT @Sa;"TS;";
260       !INSTRUCT OPERATOR TO MAKE THROUGH CONNECTION FOR NORMALIZATION.
270     OUTPUT @Sa;"IT 0;OR 280,955;";
280     OUTPUT @Sa;"TEXT %CONNECT RF OUT TO RF IN, THEN"
290     OUTPUT @Sa;"PRESS CONT (NO DEVICE IN PATH)%;";
300     OUTPUT @Sa;"READMENU KEYA,1,%CONT%;";
310     OUTPUT @Sa;"CLRDSP;";
320     OUTPUT @Sa;"SRCTKPK;";
330     OUTPUT @Sa;"TS;";
340     OUTPUT @Sa;"STORREF  THRU;";
350     OUTPUT @Sa;"AMB ON;";
360       !INSTRUCT OPERATOR TO INSERT DEVICE TO BE TESTED.
370     OUTPUT @Sa;"IT 0;OR 280,955;";
380     OUTPUT @Sa;"TEXT %FOR 3DB BANDWIDTH MEASUREMENT"
390     OUTPUT @Sa;"INSERT DEVICE, THEN PRESS CONT%;";
400     OUTPUT @Sa;"READMENU KEYB,1,%CONT%;";
410     OUTPUT @Sa;"CLRDSP;";
420     OUTPUT @Sa;"TS;";
430       !MEASURE THE -3dB BANDWIDTH.
440     OUTPUT @Sa;"MKOFF;";
450     OUTPUT @Sa;"MKAL -3DB;";
460     OUTPUT @Sa;"MKAR -3DB;";
470     OUTPUT @Sa;"MKBW ON;";
480     OUTPUT @Sa;"IT 0;OR 280,900;";
490     OUTPUT @Sa;"TEXT%MEASUREMENT COMPLETE%;WAIT 1S;CLRDSP;";
500   OUTPUT @Sa;"^;";                          !end function
510   OUTPUT @Sa;"KEYDEF 14,BW_MEAS,%3DB BW MEAS%;";  !create softkey
520 SUBEND
```

Program 5: Dynamic Range

Introduction

The following program displays 150 dB of dynamic range on the display at one time. Under normal conditions, only 90 dB appear on the display, although the instrument is capable of measuring greater dynamic range. The program below increases the displayed dynamic range by manipulating the traces and trace positions. In addition, the program creates a ◀FULL RANGE▶ softkey.

Program Explanation

The following program consists of a main program and a "Full_range" subprogram. The first line of the main program addresses the instrument. The DISPOSE ALL clears analyzer memory, making the total available memory the maximum size. (If you do not want your analyzer memory cleared, omit the DISPOSE ALL command.) The CALL command transfers program execution to the Full_range subprogram (described below). This loads the Full_range subprogram into the analyzer's memory.

The Full_range subprogram, beginning on line 100, does two things: it includes the Full_range measurement routine as a user-defined function and it creates a ◀FULL RANGE▶ softkey. Line 110 uses the FUNCDEF (function definition) command, defining the Full_range-measurement routine as a function. Caret " ^ " delimeters are placed at the beginning and end of the Full_range function (lines 110 and 560).

First, the user-defined function presets the instrument, clears the display, and defines variables. The P_K_AMP, P_OS_L, and P_OS_R variables are used for data storage later in the subprogram.

Lines 200 through 260 set analyzer parameters for stimulus-response measurements and the 321.4 MHz bandpass filter to be tested. The automatic tracking peak function, activated on line 270, maximizes the amplitude of the trace. Then, lines 280 through 300 clear text from the display, remove all previously set markers, and take a sweep to ensure complete data storage.

The next section of the subprogram manipulates trace data to store the top half of the trace. The highest peak on the trace is found with the highest peak marker and is stored in the P_K_AMP (peak amplitude) variable. Next, in lines 340 through 400, amplitude markers are used to identify and store the right and left sections of the trace in the P_OS_R (right position) and P_OS_L (left position) variables. Each stored section is repositioned 75 dB above its previous location. Finally, line 410 turns off all markers.

The next section stores the bottom half of the trace. First, trace A is deactivated (not viewed) and trace B is activated (viewed). Line 450 adjusts the reference level so that the bottom half of the filter's response is displayed. A sweep is then taken to obtain trace B data (that is, the bottom half of trace A's filter response).

At this point the top and bottom halves of the filter's response have been stored. Now, in lines 470 and 480, the reference level is adjusted and trace A data is positioned relative to trace B data. Then, the log scale is adjusted to 15 dB per division, displaying 150 dB of dynamic range. (The dynamic range of the HP 70300A is limited by its specifications.)

Lines 510 through 530 place markers on the trace to find the amplitude difference between the high and low peaks. Lines 540 and 550 write "measurement complete" on the display and line 560

ends the Full_range function. Finally, the KEYDEF command is used to create a ◀FULL RANGE▶ softkey, which executes the Full_range subprogram.

Refer to "Section III: Storing New Functions" in *Advanced Programming* for detailed descriptions of the FUNCDEF and KEYDEF commands. (Also refer to the HP 71000 Language Reference for detailed command information.)

Running the Program:

1. Clear the computer's memory. (In many computers, the "SCRATCH" command is used.)

2. Type in the program as shown.

3. Press [RUN] on the computer. Insert the DUT in the thru path and press the ◀FULL RANGE▶ softkey.

4. The full dynamic range appears on the display screen.

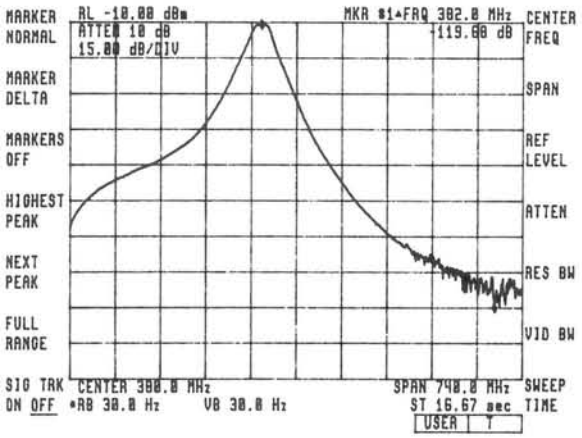


Figure 1-74. Full Dynamic Range of 321.4 MHz Bandpass Filter

```
10  !DISPLAY 150 DB OF DYNAMIC RANGE USING A "FULL RANGE SOFTKEY."
20  !FILE: FULLR
30  ASSIGN @Sa TO 718
40  CLEAR @Sa
50  OUTPUT @Sa;"DISPOSE ALL;"
60  CALL Full_range(@Sa)              !load subprogram into analyzer
70  LOCAL 7
80  END
90  !
100 Full_range:SUB Full_range(@Sa)          !define Full_range subprogram
110   OUTPUT @Sa;"FUNCDEF FULL_RANGE,^";    !create a user-defined function
120       !PRESET ANALYZER.
130     OUTPUT @Sa;"IP;SNGLS;TS;";
140     OUTPUT @Sa;"CLRDSP;";
150       !DEFINE VARIABLES USED LATER IN SUBPROGRAM.
160     OUTPUT @Sa;"VARDEF P_K_AMP,0;";
170     OUTPUT @Sa;"VARDEF P_OS_L,0;";
180     OUTPUT @Sa;"VARDEF P_OS_R,0;";
190       !PREPARE ANALYZER FOR STIMULUS-RESPONSE MEASUREMENT.
200     OUTPUT @Sa;"MEASURE SR;";
210     OUTPUT @Sa;"SRCPWR ON;";
220        !SET ANALYZER PARAMETERS FOR DEVICE TO BE MEASURED.
230     OUTPUT @Sa;"CF 380MHZ;";
240     OUTPUT @Sa;"SP 740MHZ;";
250     OUTPUT @Sa;"RB 30HZ;";
260     OUTPUT @Sa;"TS;";
270     OUTPUT @Sa;"SRCTKPK;";
280     OUTPUT @Sa;"MSG?;";               !clear message from display
290     OUTPUT @Sa;"MKOFF ALL;";
300     OUTPUT @Sa;"TS;";
310         !DIVIDE TOP PORTION OF FILTER'S RESPONSE INTO ITS RIGHT
320         !AND LEFT HALVES AND STORE EACH HALF RELATIVE TO -75DB.
330     OUTPUT @Sa;"MKPK HI;";
340     OUTPUT @Sa;"MOV P_K_AMP,MKA;";
350     OUTPUT @Sa;"MKAL;";
360     OUTPUT @Sa;"SUB MKA,-75,P_K_AMP;";
370     OUTPUT @Sa;"MOV P_OS_L,MKP;";
380     OUTPUT @Sa;"MKAR;";
390     OUTPUT @Sa;"SUB MKA,-75,P_K_AMP;";
400     OUTPUT @Sa;"MOV P_OS_R,MKP;";
410     OUTPUT @Sa;"MKOFF ALL;";
420         !MOVE THE REFERENCE LEVEL TO VIEW THE BOTTOM PORTION OF THE
430         !FILTER'S RESPONSE, THEN ADD IT TO THE TOP HALF.
440     OUTPUT @Sa;"BLANK TRA;CLRW TRB;";
450     OUTPUT @Sa;"RL -75DBM;";
460     OUTPUT @Sa;"TS;";
470     OUTPUT @Sa;"RL -10DBM;";
480     OUTPUT @Sa;"MOV TRB[P_OS_L,P_OS_R],TRA[P_OS_L,P_OS_R];";
490         !SET LOG SCALE TO DISPLAY FULL RANGE AND ACTIVATE MARKERS.
500     OUTPUT @Sa;"LG 15DB;";                !set scale to display full range
510     OUTPUT @Sa;"MKPK HI;";
520     OUTPUT @Sa;"MKD;";
530     OUTPUT @Sa;"MKMIN;";
540     OUTPUT @Sa;"IT 0, OR 600,860;";
550     OUTPUT @Sa;"TEXT%MEASUREMENT COMPLETE%;WAIT 1S;CLRDSP;";
560   OUTPUT @Sa;"^;";                        !end the function
570   OUTPUT @Sa;"KEYDEF 13,FULL_RANGE,%FULL   RANGE%;";   !create softkey
580 SUBEND
```

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SYSTEM DIAGNOSTIC CAUTIONS

Your system may have been shipped with a System Diagnostics program already loaded. System Diagnostics software is a troubleshooting tool which determines if your HP 71000 System is functional.

System Diagnostics occupy user memory. To give you the most flexibility with your system, you can remove the program from user memory. **If you do not have an HP Series 200 computer, make a backup copy of the System Diagnostics BEFORE deleting them. If you do have an HP Series 200 computer, the System Diagnostics discs are your backup.**

To run or remove the diagnostics, refer to the instructions in the System Diagnostics Supplement (HP Part Number 70900-90035) or refer to the System Support Manual.

USER MEMORY GUIDELINES

This analysis of user memory is intended for HP 70900A Local Oscillator ROM Version 860203. Future releases of Local Oscillator ROM versions and other module ROM versions may change the memory requirements of the system.

1 Predefined Usage

Some user memory is used as part of the power-up and Instrument Preset definition.

1.1 Traces

All analyzer traces are stored in user memory. This includes the default traces and all user defined traces. The equation for memory usage due to traces is

$$bytes = 46 + 2(no.\ of\ trace\ points)$$

Using this formula a 3 point trace will occupy 52 bytes of user memory and an 800 point trace will occupy 1646 bytes of user memory.

The predefined traces and their default lengths in a non Tracking-Generator system are defined as: TRA 800 points, TRB 800 points, and TRC 3 points. This is a total of 3,344 bytes.

The predefined traces and their default lengths with a Tracking-Generator module is: TRA 800 points, TRB 800 points, and TRC 800 points. This is a total of 4,938 bytes usage.

All user defined traces use the same memory equation as the analyzers predefined traces.

1.2 Save State Registers

The analyzer's Measurement-Save-State registers take 634 bytes each. At shipment 2 state registers are defined as the default for a total memory usage of 1268 bytes. The number of state registers can be changed by the user with the **NSTATE** command. A user that does not require any state registers can change the number of registers to 0 to restore state memory to the user. Neither **IP** or power-up effects the number of save-state registers. The **ERASE** command will reset the analyzer to the original 2 Save-State condition.

1.3 IP

Instrument Preset will return all predefined traces (TRA, TRB, TRC) to their default lengths. This is regardless of any length the user may have set the traces to. User defined traces are not effected by Instrument Preset.

2 Commands Affecting Usage

Some analyzer commands which are memory intensive compete for memory with the user. The following is a list of those commands and a description of their requirements.

2.1 User Defined

The commands which define user memory for the user are **FUNCDEF** and **VARDEF** . A **VARDEF** command will allocate 8 bytes of memory to store an I.E.E.E format floating point number. A **FUNCDEF** command will allocate 1 byte per character of the defined function then round up to the nearest even number of bytes for alignment purposes. Both variable and function memory can be returned to the user with the **DISPOSE** command.

2.2 ONEOS

The On End Of Sweep command will allocate 1 byte of memory per character of the defined function then round up to the nearest even byte. Memory can be returned to the user via the **DISPOSE** command.

2.3 CAL

The calibration of the analyzer will attempt to allocate enough memory to save the instruments measurement state. If the memory is available it is allocated and after calibration the instrument is returned to the measurement state it was in immediately preceeding calibration. If there is not enough user memory available to save the analyzer's measurement state the calibration will execute and the analyzer will be left in the last measurement state that the calibration process used. At the completion of **CAL** any memory allocated for calibration is released back to the user.

2.4 SIGID

The Signal Identify command will attempt to allocate enough memory to save the instruments measurement state. If the memory is available it is allocated and after **SIGID** the instrument is returned to the measurement state it was in immediately preceeding **SIGID** . If there is not enough user memory available to save the analyzer's measurement state the **SIGID** will execute and the analyzer will be left in the last measurement state that the **SIGID** process used. At the completion of **SIGID** any memory allocated for **SIGID** is released back to the user.

2.5 TRDEF

User defined traces are allocated in User Memory. The memory usage equation is the same as outlined in section 1.1 . User Defined traces are not effected by **IP** .

2.6 FFT

The Fast Fourier Transform command creates a temporary trace in memory whose length is calculated by the equation

$$length = 2 + 1.5 * 2^{\lceil \log_2(\max(DESTlen/2, \min(SRClen, WINDOWlen)) - 1) \rceil}$$

where DESTlen is the destination trace length, SRClen is the source trace length and WINDOWlen is the window length. All lengths are in measurement

points. An example for a 400 point source trace transformed into a 400 point destination with a 400 point window is

$$770 = 2 + 1.5 * 2^{\lceil \log_2(\max(400/2, \min(400, 400)) - 1) \rceil}$$

This length can then be applied to the trace equation in 1.1 to yield total memory usage of 1,586 bytes.

If the necessary memory to perform an **FFT** is not available in User Memory space the analyzer will report an error and abort the function.

The memory used for the temporary trace is returned to User Memory after the function completes execution.

2.7 SMOOTH and PDA

The command for trace SMOOTHing and Probability Distribution of Amplitude both need to create a temporary trace in the User Memory space. These traces are the same length as the source trace argument to the command. The trace equation from 1.1 applies to convert trace length to bytes.

If the memory is not available an error will be reported by the analyzer and the command will be aborted.

The memory used for the temporary trace is returned to User Memory after the function completes execution.

2.8 REPEAT/UNTIL

The REPEAT/UNTIL loop structure needs User Memory to store the repeat loop text for execution. The amount of memory necessary is equal to the length of the loop text including the UNTIL condition text. If the length is odd it is rounded up to the next even byte.

In the event that a repeat loop is executed with insufficient memory the analyzer will report an error and terminate execution of the loop.

2.9 Function Execution

Each user defined function (FUNCDEF) and nested function (FUNCDEF calling another user defined function) requires an environment to operate in. The environment contains pointers to the function and various status flags. The environment occupies 40 bytes in user memory.

If a function attempts to execute and cannot allocate enough memory for it's environment it will report an error and terminate .

3 Module Usage

Each module that is installed in an **MSA** system takes away a piece of User Memory. This memory is acquired by the controller to store information on the capabilities of each module in the system. Each type of module has it's own requirements for memory usage. The more modules a system has installed in it, the more user memory is required to document the systems capabilities. The following table summarizes the user memory requirements for modules.

(The following data may vary slightly depending on module ROM version.)

RAM USAGE

ANALYZER	MODULE	BYTES
Total Available User Mem		15,430
Save States (2)		1,268
Traces (w/o Trk. Gen.)		3,344
Traces (with Trk. Gen.)		4,938
	70900A LO	1,082
	70902A HRIF	1,222
	70903A WBIF	1,218
	70904A RF	682
	70905A microW	1,476
	70907A EMIM	830
	70300A TrkGen	1,138
	70310A PFR	72

4 Summary

User memory available is dependent on: total system memory minus system module requirements, trace defaults, and NSTATES.

IP will reset the predefined traces (TRA, TRB and TRC) to their default length.

Some analyzer commands (FFT, PDA and SMOOTH) are memory intensive and require temporary space in user memory to execute.

All user defined operations (FUNCDEF, VARDEF, REPEAT/UNTIL and ONEOS) are defined in and executed from user memory.