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HEWLETT PACKARD

OPERATING AND PROGRAMMING MANUAL

8568B
SPECTRUM ANALYZER
100 Hz – 1.5 GHz

SERIAL NUMBERS

This manual applies directly to Model 8568B RF Sections with serial numbers prefixed 2410A and IF-Display Sections with serial numbers prefixed 2403A.

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

MANUAL PART NO. 08568-90041
Microfiche Part No. 08568-90044

Printed: March 1984

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Manual Operation

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Chapter 7 – SCALE AND REFERENCE LINE
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Chapter 12 – USER DEFINED KEYS
Chapter 13 – PLOTTER OUTPUT

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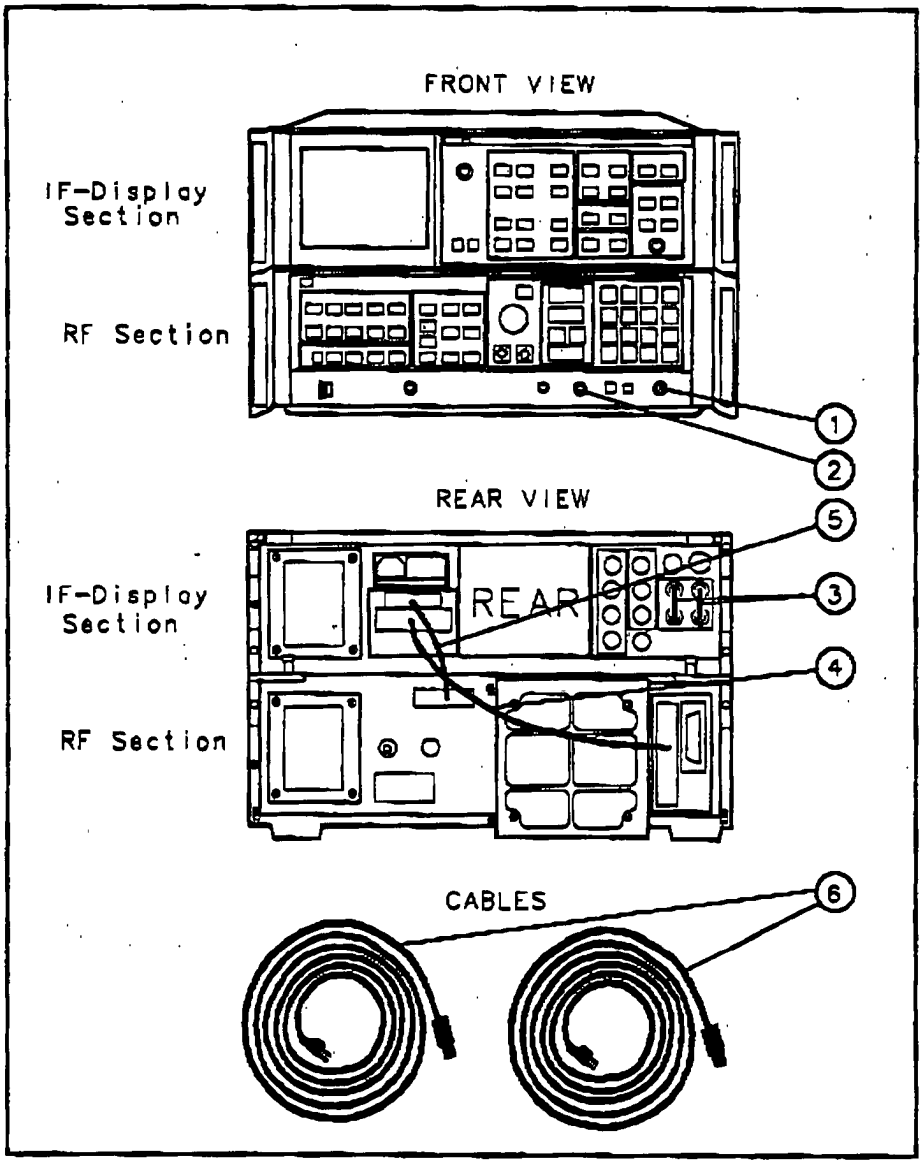


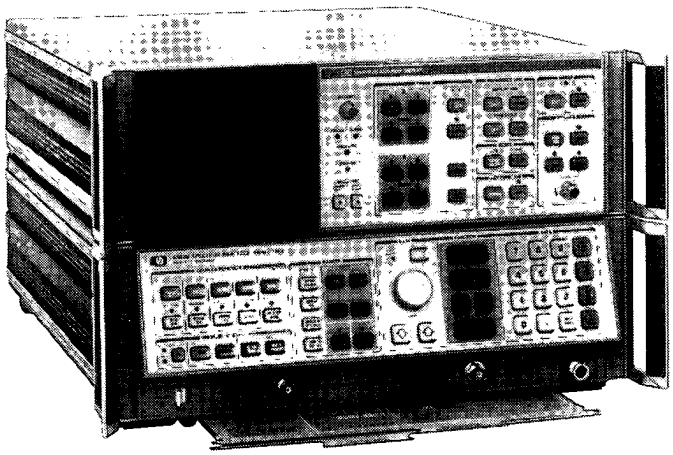
Figure 1-1. HP 8568B with Accessories Supplied

Item	Description	HP Part Number
1	Type N (m) to BNC (f) connector	1250-0780
2	1ST LO OUT BNC termination	HP 11593A
3	BNC jumper cable (quantity: 2)	85660-60117
4	Bus interconnect cable (W31)	85662-60220
5	Coax interconnect cable (W30)	85662-60093
6	Line power cables (2 each)	see Figure 1-2

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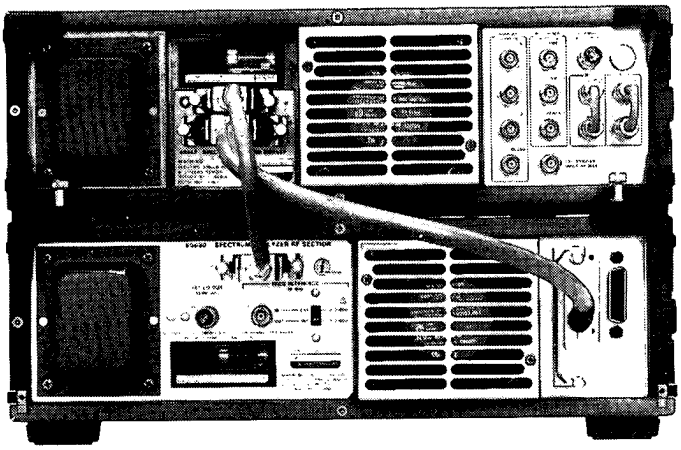
GENERAL INFORMATION

This chapter describes the HP 8568B Spectrum Analyzer's general performance characteristics, hardware, and the initial turn on procedure.



HP 8568B SPECTRUM ANALYZER

Connect interconnection cables as shown:



REAR PANEL CONNECTIONS

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INITIAL POWER ON AND CALIBRATION

CAUTION

Before connecting the line power cords, make sure the appropriate line voltage and line fuse have been selected for both the RF and Display sections of the analyzer. For complete information on line voltage and fuse selection, refer to the HP 8568B Operator's Handbook. For information on line power cords for a specific country, contact the nearest Hewlett-Packard office.

After making the AC power line connections, the STANDBY lights of both the RF and Display section should be on. As long as the instrument is operating (LINE ON) or in STANDBY, the accuracy specifications of the internal frequency standard will be met. After a cold start, such as on-receipt of instrument, the analyzer requires 24 hours to stabilize prior to meeting specified performance.



Upon LINE ON, the instrument will perform an automatic internal instrument check. If one or both of the red instrument check lights (INST CHECK I and II) remain on after this brief check routine, refer to the chart below to localize the problem.

LED On	Problem	Solution
I	Digital Storage failure in 85662A	Check bus interconnect cable (85662-60094)
II	Interface Failure	Check bus interconnect cable (85662-60094) and check if A12 board is connected tightly
I & II	Controller (A15)	Check if A15 is connected tightly in 85660B and that contacts are clean.

Manual Calibrator Signal Adjustment

To meet specified frequency and amplitude accuracy, periodically perform this calibration procedure and the error correction routine below.

1. With LINE power ON, press [INSTR PRESET].
2. Connect CAL OUTPUT to SIGNAL INPUT 2.

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3. Press CENTER FREQUENCY 2 0 MHz -dBm sec
FREQUENCY SPAN 2 MHz -dBm sec
RES BW 1 MHz -dBm sec
REFERENCE LEVEL 7 MHz -dBm sec
LOG ENTER dB/DIV 1 GHz +dBm dB PEAK SEARCH
or press RECALL 8

4. Adjust AMPTD CAL for MKR amplitude of −10.00 dBm.

5. Press FREQUENCY SPAN 0 Hz µV µsec
RES BW 3 0 Hz µV µsec
SWEEP TIME 1 0 MHz -dBm sec
SCALE LOG ENTER dB/DIV 1
or press RECALL 9

6. Maximize response with FREQ ZERO adjustment.

Error Correction Routine

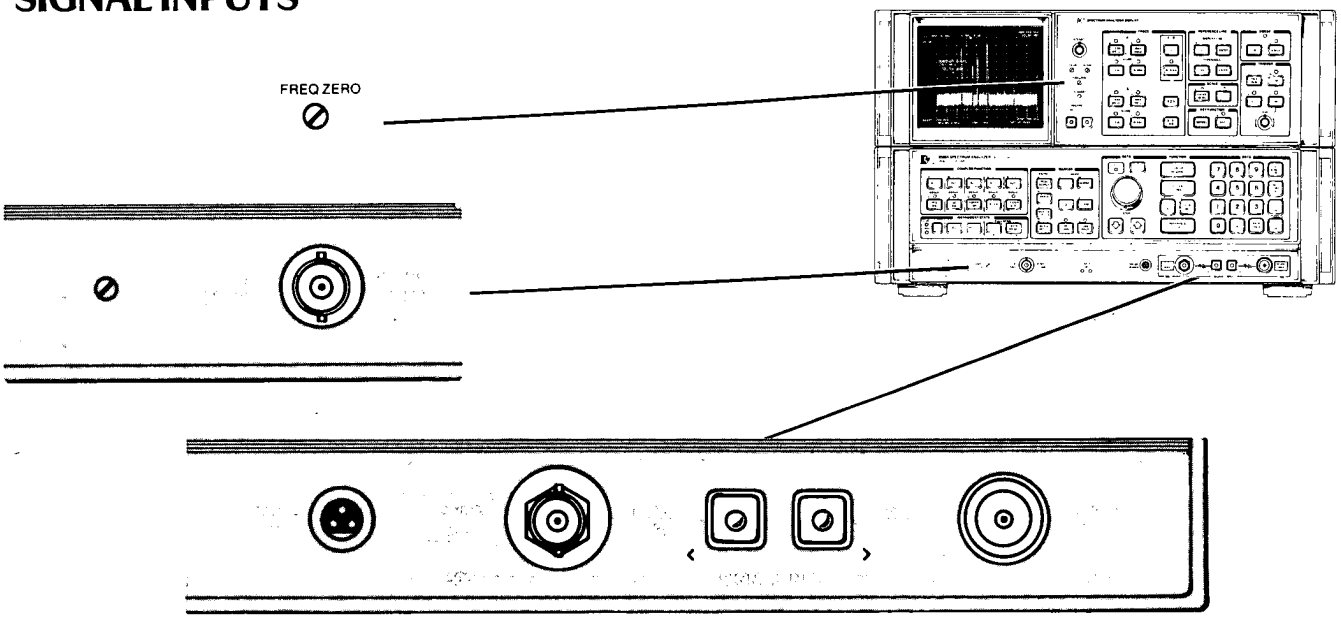
A 1½ minute internal error correction routine minimizes errors caused by changes in IF gain, resolution bandwidth, input attenuator or scale changes. To start the routine press KEY FUNCTION SHIFT FREQUENCY SPAN.

A readout "CORR'D" appears in the CRT display on completion of this routine.

If "Adjust FREQ ZERO and AMPTD CAL" appears in the display, repeat the manual calibration before running the error correction routine again.

Chapter 11, SHIFT KEY FUNCTIONs, discusses the details of this error correction routine.

SIGNAL INPUTS



SIGNAL INPUT AND CALIBRATION CONTROLS

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Either of the RF signal inputs can be selected:
INPUT 1: 100 Hz to 1500 MHz, dc coupled, BNC fused 50Ω.
INPUT 2: 100 kHz to 1500 MHz, ac coupled, Type N 50Ω.
Isolation between inputs is >90 dB.

CAUTION

Excessive signal INPUT power will damage the input RF attenuator and the input mixer. The spectrum analyzer total input power must not exceed the values listed:

INPUT	Maximum dc	Maximum RF
1	±0V	+30 dBm (1 watt)
2	±50V	+30 dBm (1 watt)

Probe Power

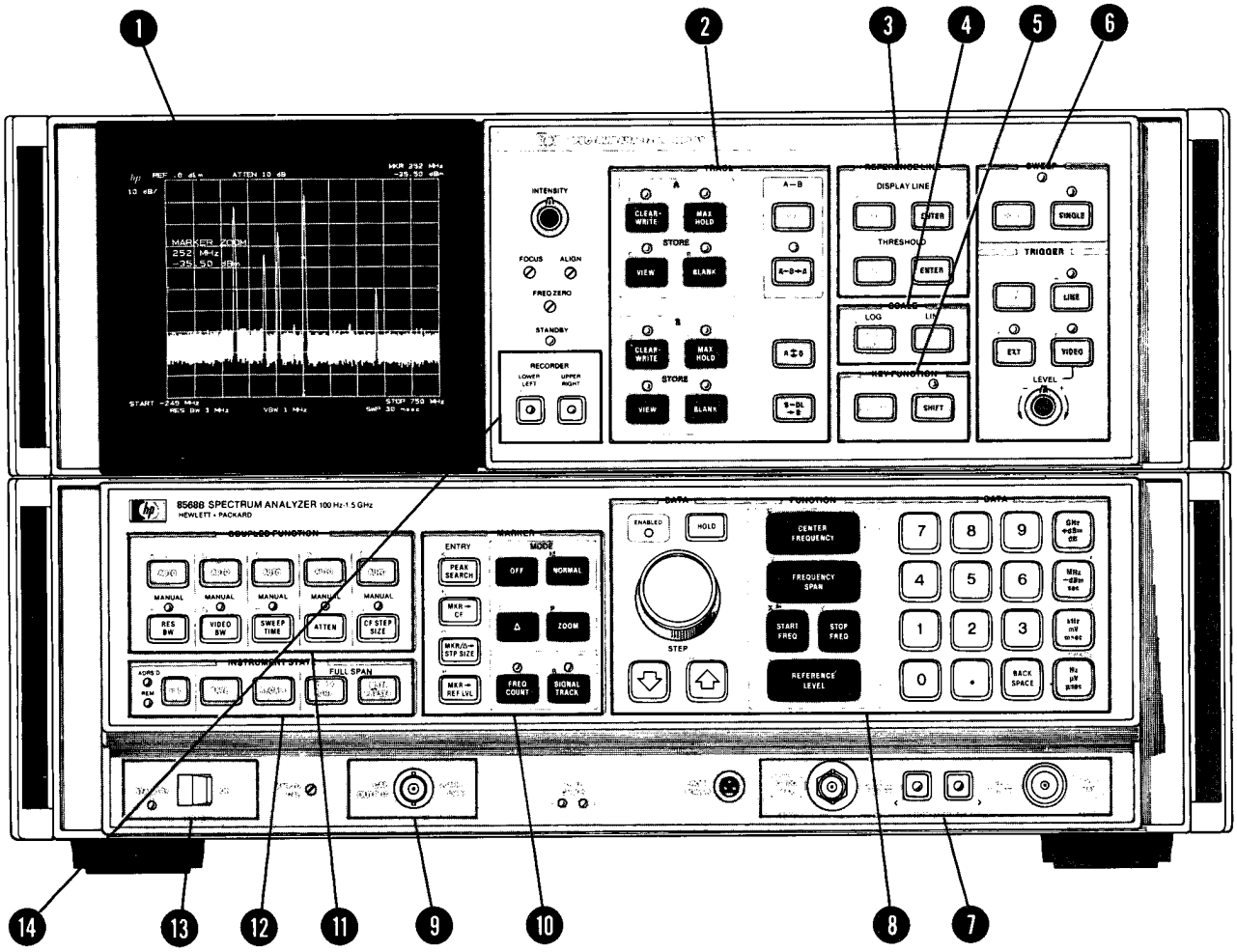
The probe power jack supplies power for high impedance 1:1 active probes, such as the HP 1121A 500 MHz AC Probe, or for 50-ohm preamplifiers, such as the HP 10855A. The voltage outputs are +15V, and −12.6V with a maximum current of 150 mA.

CAUTION

Active probes or amplifiers should not be used on RF Input 1, the dc coupled input, unless their output is specified ac only.

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FRONT PANEL OVERVIEW



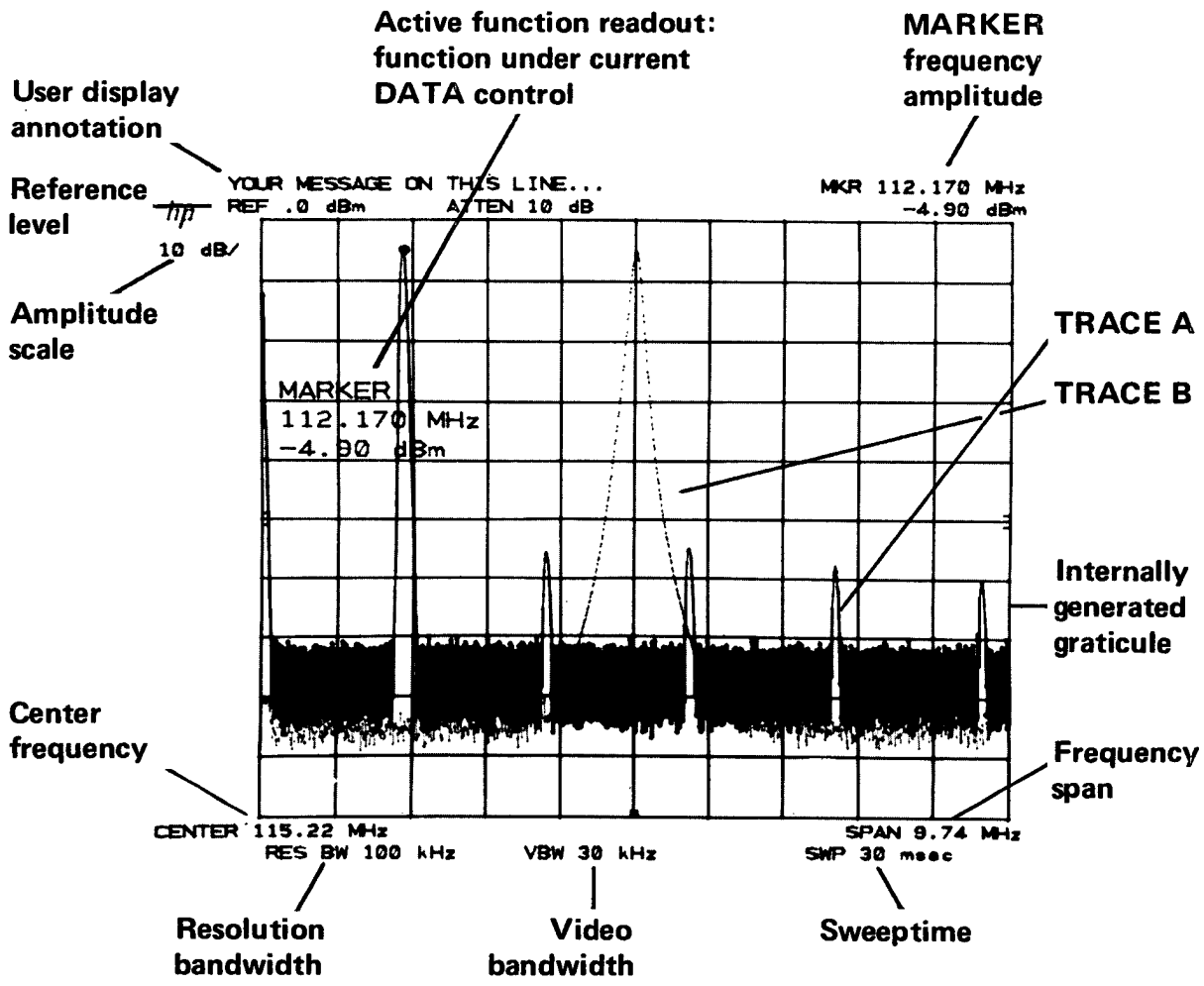
Control Groups

1	**CRT DISPLAY:**	Signal response and analyzer settings
2	**TRACE:**	Control of signal response display
3	**REFERENCE LINE:**	Measurement and display aids
4	**SCALE:**	Selects logarithmic or linear amplitude scale
5	**KEY FUNCTION:**	Access to special functions
6	**SWEEP and TRIGGER:**	Selects trace update trigger
7	**SIGNAL INPUT:**	100 Hz to 1500 MHz
8	**DATA/FUNCTION:**	Fundamental analyzer control
9	**CAL OUTPUT:**	Calibration signal
10	**MARKER:**	Movable bright dot markers for direct frequency and amplitude readout
11	**COUPLED FUNCTION:**	Maintenance of absolute amplitude and frequency calibration by automatically selecting certain analyzer control settings
12	**INSTRUMENT STATE:**	Local, remote and preset control settings. Saving and recalling control settings.
13	**LINE ON/STANDBY:**	Powers instrument and performs instrument check
14	**RECORDER/PLOTTER FUNCTIONS:**	Controls output to recorder or HP-IB controlled plotter

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CRT DISPLAY

The analyzer's CRT display presents the signal response trace and all pertinent measurement data. The active function area names the function under DATA control and shows the function values as they are changed. All the information necessary to scale and reference the graticule is provided.

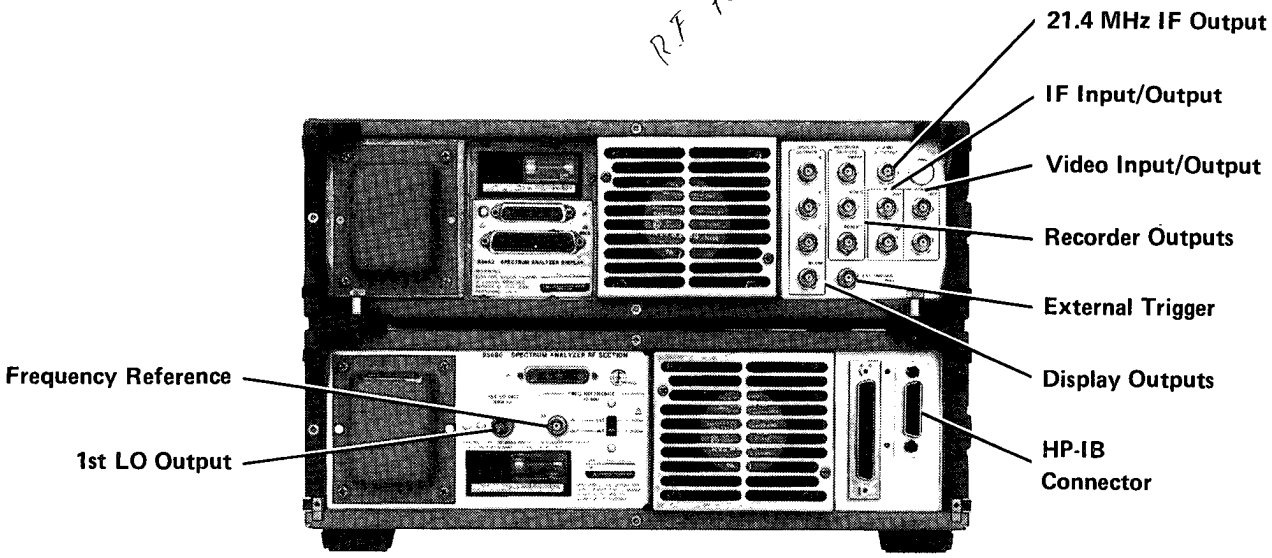


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PLOTTER OUTPUT

The trace data, graticule, and annotation on the analyzer screen can be sent directly via HP-IB to a Hewlett-Packard plotter (such as the HP 7245A/B, 7240A, 7470A, or 9872C) by pressing the LOWER LEFT key on the analyzer front panel.

REAR PANEL OUTPUTS



Display Outputs

Display outputs allow all the CRT information to be displayed on an auxiliary CRT display such as the HP 1310A Large Screen Display.

Display Outputs	Output
X, Y	<75 nsec rise times. 1V full deflection.
Z	<30 nsec rise time. Intensity: −1V blank, 0 to 1V intensity modulation.
BLANK	TTL level >2.4V for blanking. Compatible with most oscilloscopes.

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Recorder Outputs

The recorder outputs allow the x-y plot of trace data with x-y plotters using positive penlift coils or TTL penlift input. The front panel keys enable outputs for the calibration of x-y plotter reference points:

Recorder Outputs	RECORDER LOWER LEFT / UPPER RIGHT 	RECORDER Outputs when keys or HP-IB commands are enabled	
		Lower Left	Upper Right
SWEEP	A voltage proportional to the horizontal sweep of the CRT trace that ranges from 0V for the left edge and to +10V for the right edge.	0V left	10V right
VIDEO	Detected video output (before A-D conversion) proportional to vertical deflection of the CRT trace. Output increases 100 mV/div from 0 to 1V.	0V lower	+1V upper
PENLIFT	A blanking output, 15V, occurs during CRT retrace; otherwise output is low at 0V (pen down).	+15V	+15V

1st LO Output

The 1st LO output allows the use of external mixers to expand the frequency range of the analyzer.

1st LO Output	Output
1ST LO OUT	2–3.7 GHz, >+4 dBm; 50Ω output impedance.

21.4 MHz IF Output

21.4 MHz IF Output	
21.4 MHz IF OUTPUT	A 50Ω, 21.4 MHz IF output related to the RF input to the analyzer. In log scales, the IF output is logarithmically related to the RF input signal; in linear, the output is linearly related. The output is nominally −20 dBm for a signal at the reference level. The analyzer's resolution bandwidth setting controls the bandwidth. The input attenuator and IF step gain positions control the amplitude.

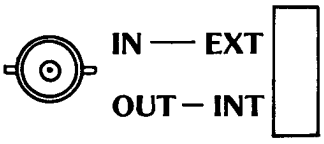
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HP-IB Input Output Connector

The Hewlett Packard Interface Bus allows remote operation of the analyzer as well as input and output of measurement data. See Section II of this manual.

Frequency Reference Input/Output

To lock the spectrum analyzer to an external frequency reference, set the FREQ REFERENCE 10 MHz switch to EXT. Analyzer phase noise performance may be degraded when an external frequency reference is used. To lock another spectrum analyzer to the spectrum analyzer internal frequency reference, set the FREQ REFERENCE 10 MHz switch to INT.

Frequency Reference Input/Output	Input/Output
	External Frequency Reference Requirements: Frequency: 10 MHz ± 50 MHz Power: 0 to 10 dBm Input Impedance: 50Ω Internal Frequency Reference Characteristics: Frequency: 10.000 MHz Power: 0 dBm nominal Output Impedance: 50Ω

IF and Video Connectors

The IF and Video connectors allow the 85650A Quasi-Peak Adapter to be used with the analyzer for EMI measurements.

NOTE

When the Quasi-Peak Adapter is disconnected from the analyzer, make sure the IF INP connector connects to the IF OUT connector with one short BNC cable, and VIDEO INP connector connects to the VIDEO OUT connector with the other short BNC cable. Failure to connect the BNC cables will result in a loss of signal.

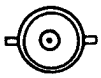
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IF and Video Connectors	Input
 **IF INP**	21.4 MHz input. Input is nominally −11 dBm (with spectrum analyzer input attenuator set to 10 dB). 50Ω input impedance.
 **VIDEO INP**	0 – 2V. 139Ω input impedance.

IF and Video Connectors	Output
 **IF OUT**	21.4 MHz output. Output is nominally −11 dBm (with spectrum analyzer input attenuator set to 10 dB). 50Ω output impedance.
 **VIDEO OUT**	0 – 2V. Output impedance <10 kΩ.

External Sweep Trigger Input

The External Sweep Trigger input allows the analyzer's internal sweep source to be triggered by an external voltage.

External Sweep Trigger Input	Input
 **EXT TRIGGER**	Must be >2.4V (10V max). 1 kΩ nominal input impedance.

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Chapter 1
GETTING STARTED

GENERAL DESCRIPTION

This chapter provides an overview of the use and capability of the Hewlett Packard 8568B Spectrum Analyzer. Chapters 2 through 12 provide details on each aspect of operation.

FRONT PANEL CONCEPT

The front panel keys control functions such as center frequency, frequency span, reference level, resolution bandwidth, and sweep time. Any function can be selected by pressing its key, and can then be changed by using the DATA control knob, step keys, or number/units keyboard. For example, to specify center frequency press [CENTER FREQUENCY], then change the value, as read out on the CRT, with *any* or *all* of the DATA controls:

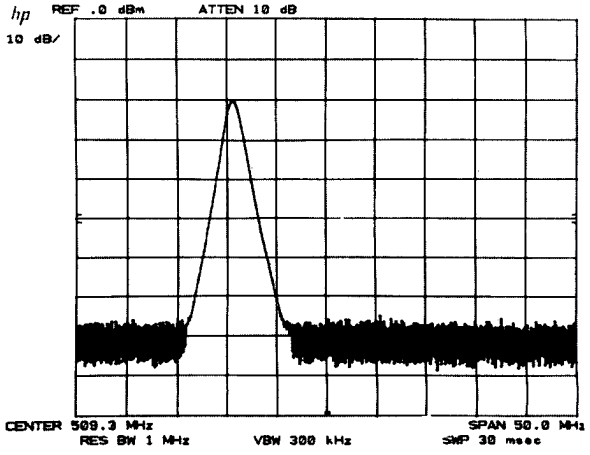
- Continuous coarse and fine tune
- Change in steps
- Set the value exactly

The analyzer's CRT display presents the signal response trace and all pertinent measurement data.

FUNCTION/DATA CONTROLS

The front panel controls are grouped by function. Most measurements can be made from the FUNCTION/DATA control group. The other groups add to the measurement efficiency, convenience, and capability.

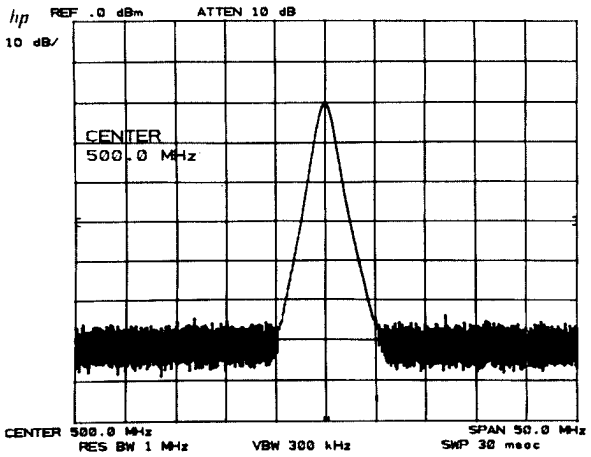
The FUNCTION and DATA controls can be used to measure the frequency and amplitude of a signal such as the one shown.



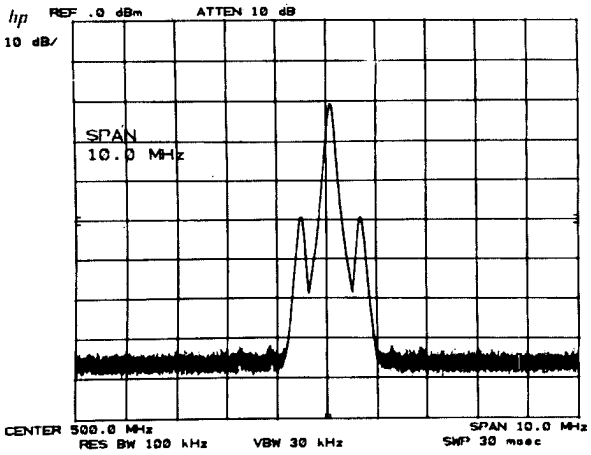
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First, move the signal to the center of the display with CENTER FREQUENCY .

The readout gives the signal frequency. (The DATA step keys or number/units keys could also have been used.)

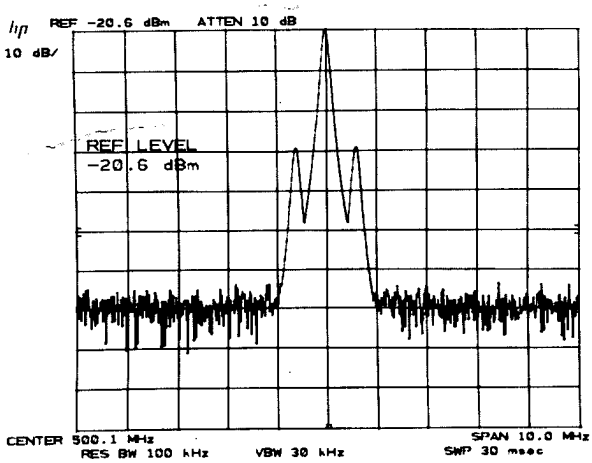


For better frequency resolution, narrow the frequency span with FREQUENCY SPAN .



Now bring the signal peak to the reference level with REFERENCE LEVEL and .

The reference level readout is the signal's power level.



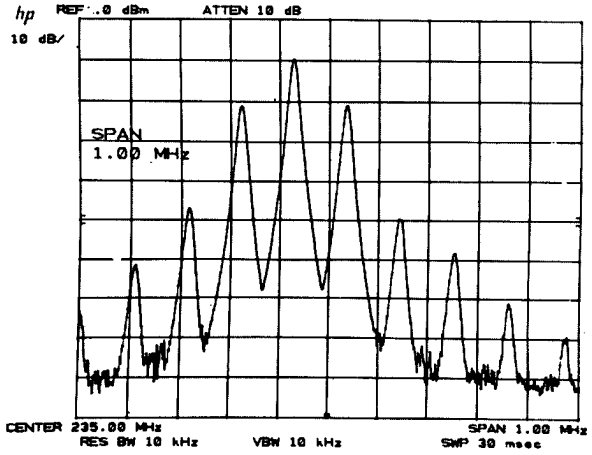
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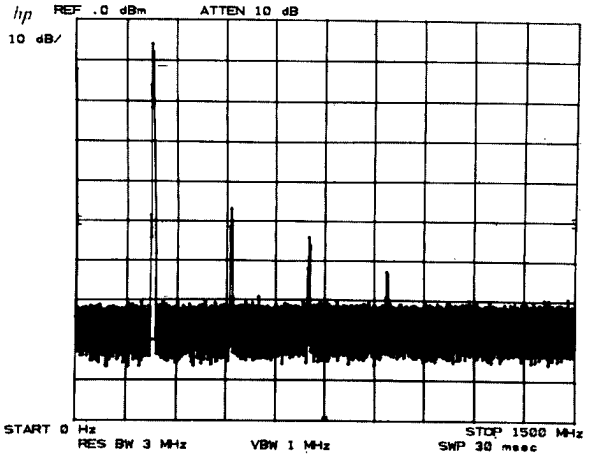
STARTING FROM FULL SPAN

A convenient place to start a new measurement is with a full 1500 MHz frequency span. A single key, INSTR PRESET, presets all the analyzer functions to give you a 0 Hz to 1500 MHz display with a 0 dBm reference level.

For example, after measurements in a narrow frequency span...



INSTR PRESET allows you to view the entire 1500 MHz span for selection of the next signal to investigate.

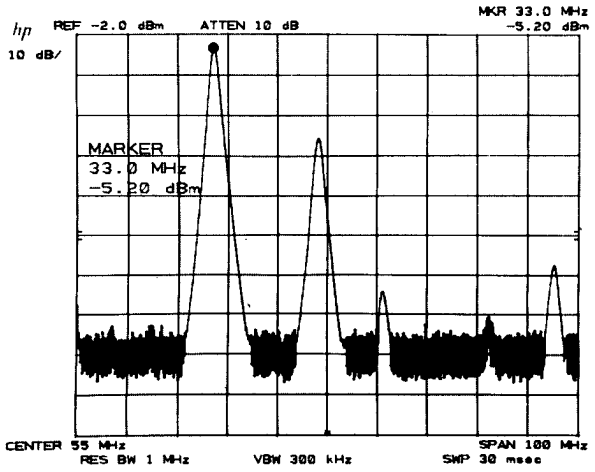


DIRECT SIGNAL FREQUENCY AND AMPLITUDE READOUT

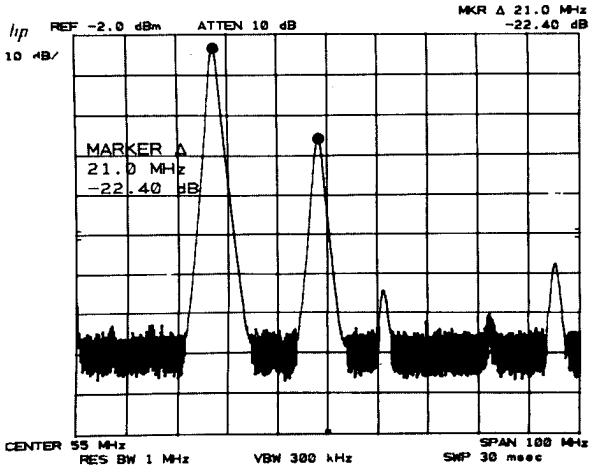
Signal frequencies and amplitudes, as well as differences, can be read out directly with the MARKER and DATA controls, without changing center frequency or reference level.

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Activate the marker with MARKER [NORMAL] . Use the DATA knob ◎ to position the marker. The amplitude and frequency are read out continuously.



To measure the differences between this signal and any other on the display, press [Δ] and use ◎ to move the second marker. The amplitude and frequency differences are read out continuously.



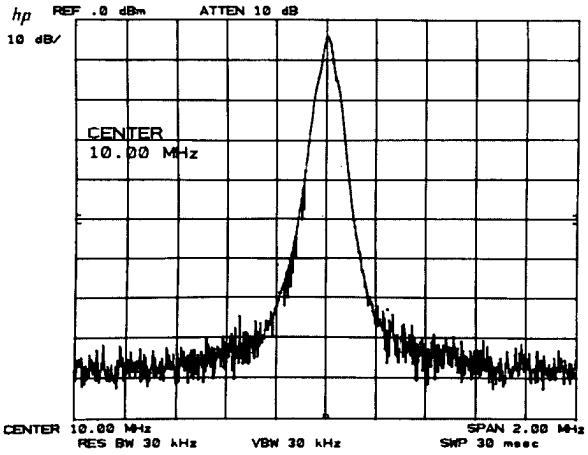
AUTOMATIC DISPLAY CALIBRATION

Unless you specifically override the analyzer's COUPLED FUNCTION state, the analyzer maintains absolute amplitude and frequency calibration during your measurements. Changes of frequency span automatically call for resolution bandwidths, video bandwidths, and sweep times that keep the amplitude calibrated while maximizing the trace sweep rate. You can take manual control over any of these functions with the COUPLED FUNCTION and DATA controls.

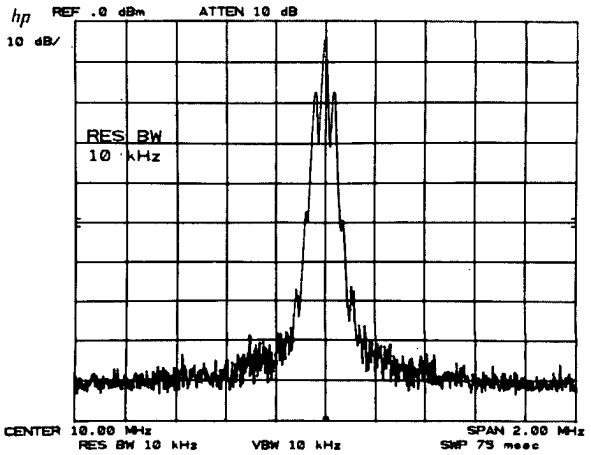
For example, for higher signal resolving capability, the analyzer's resolution bandwidth can be narrowed using the COUPLED FUNCTION [RES BW] .

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A signal with 40 kHz sidebands is viewed in a 2 MHz span. The sidebands are not visible, because of the 30 kHz resolution bandwidth.



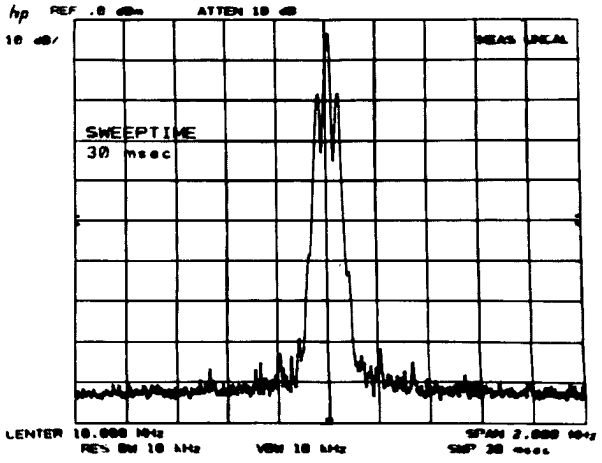
Reduce the resolution bandwidth without changing the span with RES BW ⇩ . (The DATA knob or number/units keyboard could also have been used.)



The sweep time is increased automatically to compensate for the narrower resolution bandwidth. If the sweeptime were in the manual mode, the display could become uncalibrated.

Press SWEEP TIME ⇩ .

The display uncalibrated message appears in the display.



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AUTOMATIC MEASUREMENTS

Just as the front panel keys call functions and change their values, simple programming codes from a computing controller can control the spectrum analyzer for automatic measurement through the Hewlett Packard Interface Bus (HP-IB). HP's implementation of IEEE Standard 488 and identical ANSI Standard MC1.1 "Digital interface for programmable instrumentation."

Detailed information on remote operation is the subject of Section II of this manual.

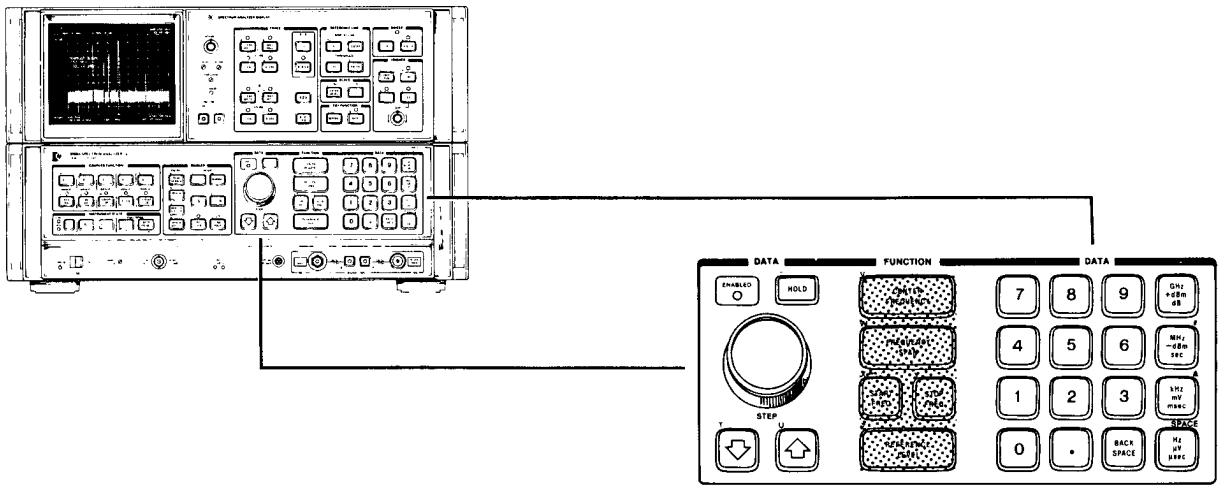
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Chapter 2
DATA

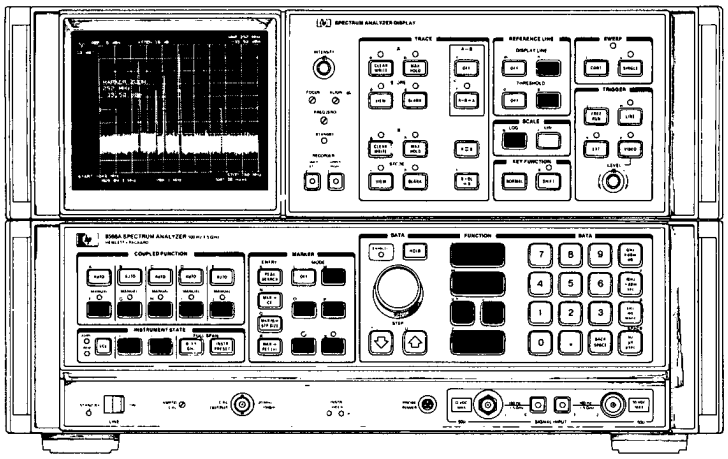
GENERAL DESCRIPTION

DATA controls are used to change function values for functions such as center frequency, start frequency, resolution bandwidth,or marker position.



DATA CONTROLS

The DATA controls are clustered about the FUNCTION keys that "call up" or activate the most frequently used spectrum analyzer control functions: center frequency, frequency span (or start/stop frequency), and reference level. The other functions that accept DATA control are shown below:



FRONT PANEL FUNCTIONS USING DATA CONTROLS

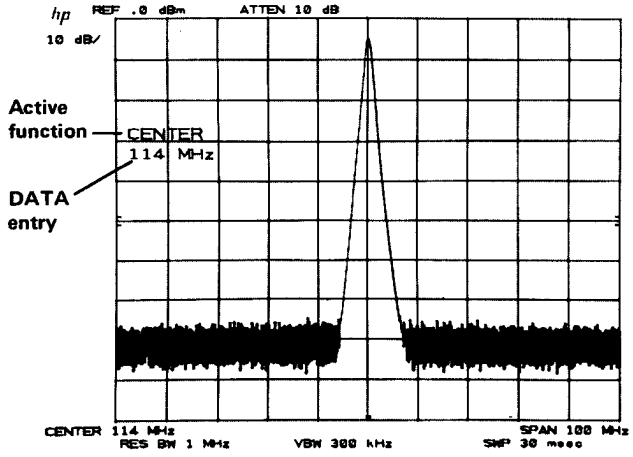
To the left of the FUNCTION keys are the DATA knob and the DATA STEP keys , which are used to make incremental changes to the activated function. To the right of the FUNCTION keys is the DATA number/units keyboard which allows changes to an exact value.

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The DATA controls change the activated function in a manner prescribed by that function. For example, center frequency can be changed continuously with the DATA knob , or in steps proportional to the frequency span with the DATA STEP keys , or set exactly with the DATA number/units keyboard. Resolution bandwidth, which can be set only to discrete values, can still be changed with any of the DATA controls. The DATA knob and DATA STEP keys advance the setting from one bandwidth to the next. A number/units keyboard entry that does not coincide with an allowable bandwidth selects the nearest bandwidth.

DATA ENTRY READOUT

DATA entries are read from the CRT display as they are changed.



PREVENTING DATA ENTRY

A function can be deactivated by pressing [HOLD]. The active function readout is blanked and the ENABLED light goes out, indicating that no DATA entry can be made. Pressing a function key re-enables the DATA controls.

DATA KNOB

The DATA knob allows the continuous change of center frequency, frequency span (or start/stop frequencies), reference level, and the positions of the marker, display line, and threshold. It can also change function values that are stepped in predefined increments.

Clockwise rotation of the DATA knob increases the function value. For continuous changes, the knob's sensitivity is determined by the measurement range and the speed at which the knob is turned. For example, when the center frequency is activated, rotating the DATA knob increases the value of the center frequency by one horizontal division of span per one quarter turn.

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DATA STEP KEYS

The DATA STEP keys allow rapid increase [⇧] or decrease [⇩] of the active function value. The step size is dependent either upon the analyzer's measurements range, on a preset amount, or, for those parameters with fixed values, the next value in a sequence. Examples: Activate center frequency and [⇧] increase the center frequency value by an amount equal to one division of the frequency span (one tenth of the frequency span). If the center frequency step size [CF STEP SIZE] has been preset, [⇧] increases the center frequency by that preset amount. If frequency span were activated, [⇩] would change the span to the next lower value in predetermined sequence. Activate resolution bandwidth and [⇧] selects the next widest bandwidth.

Each press results in a single step.

DATA NUMBER/UNITS KEYBOARD

The DATA number/units keyboard (or DATA keyboard) allows exact value entries to center frequency, frequency span (or start/stop frequency), reference level, log scale, marker positions, display line, threshold, and the COUPLED FUNCTIONS.

An activated parameter is changed by entering the number (with the CRT display providing a readout), then selecting the appropriate units key. The value is not changed (entered) until the units key is pressed.

The number portion of the entry may include a decimal, [•]. If it does not, the decimal is understood at the end of the number. Corrections to number entries are made with [BACK SPACE], which erases the last digit for each press.

Example: With center frequency activated, [1] [•] [2] [6] [5] [BACK SPACE] [BACK SPACE] [5] [GHz +dBm dB]

sets the center frequency to 1.250 GHz.

If the units key is pressed without a number entry, 1 is entered (except in zero frequency span).

Negative DATA Entry

Negative entries from the number units keyboard can be made for power and frequency, but not time and voltage.

Negative power entries can be made using [MHz -dBm sec]. The "−dBm" key can enter −dBm, −dBmV, or −dBμV. For example, in reference level, with the dBmV units, an entry of [5] [0] [MHz -dBm sec] enters −50 dBmV.

Negative frequency entries can be made using [SHIFT] [HOLD]

as a prefix to the frequency entry. For example, to enter a negative start frequency, press [START FREQ] [SHIFT] [HOLD] [1] [0] [0] [MHz -dBm sec]. This enters the frequency value as −100 MHz.

Not all functions accept negative entries (the sign is ignored).

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MULTIPLE DATA CHANGES

A function, once activated, may be changed as often as necessary (see Chapter 3, FUNCTION).

Functions are not always activated to change their value. Sometimes they are activated just to read out an existing value. For example, start and stop frequency may be activated simply to allow the left and right display reference frequencies to be read out as start/stop frequencies.

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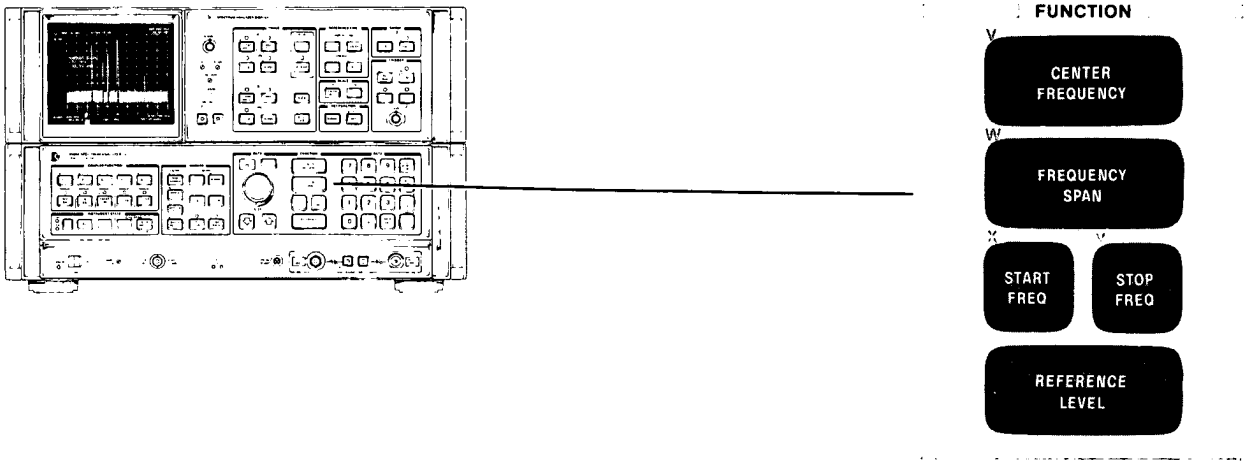
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Chapter 3
FUNCTION

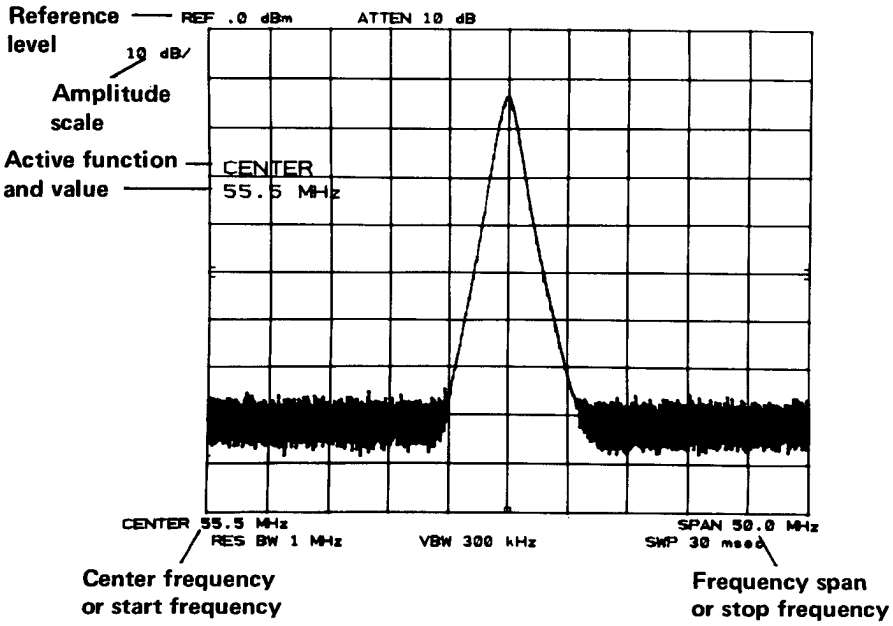
GENERAL DESCRIPTION

This chapter describes the use of FUNCTION and DATA controls for establishing the desired amplitude and frequency display.

The FUNCTION group allows changes to the most used spectrum analyzer functions: center frequency, frequency span, and reference level. An alternate method of setting the frequency scale is provided with the start and stop frequency functions.

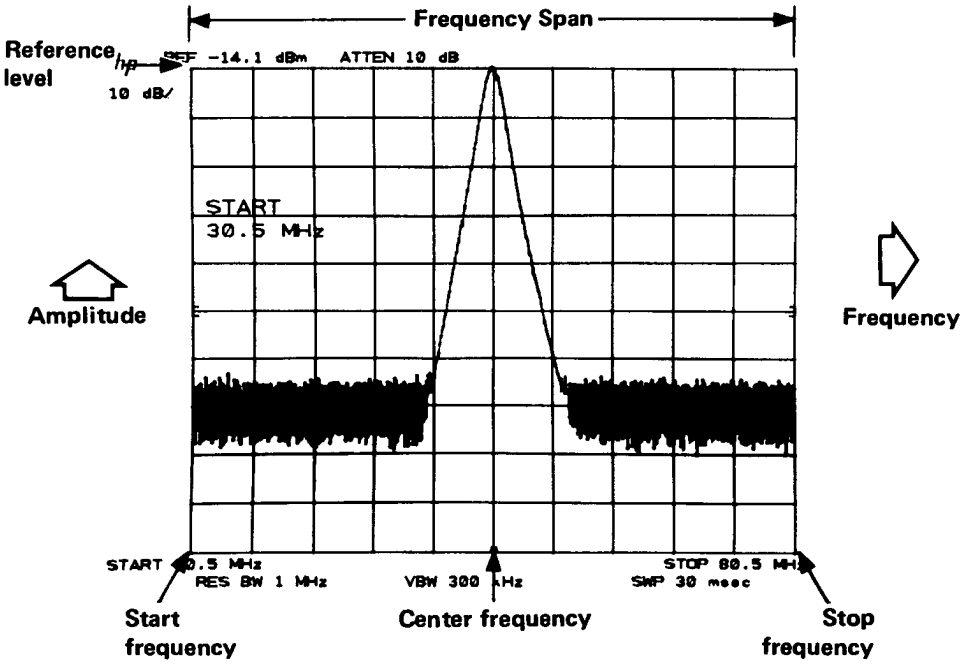


The changing value is read out from the display at the active function area and at the display position dedicated to that FUNCTION.



FUNCTION VALUE READOUTS

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CRT GRATICULE SCALING WITH FUNCTION READOUTS

DISPLAY CALIBRATION

With changes to the displayed frequency range, the spectrum analyzer changes resolution bandwidth, video bandwidth, and sweep time to maintain absolute amplitude and frequency calibration if the COUPLED FUNCTIONs are set to automatic. The examples in this chapter assume this condition. See Chapter 8, COUPLED FUNCTION for additional information on amplitude and frequency calibration.

FREQUENCY DISPLAY RANGE

The frequency range of the horizontal axis can be entered using either of two FUNCTION modes:

CENTER FREQUENCY and FREQUENCY SPAN

or

START FREQ and STOP FREQ

When a function from either mode is activated, only the function values of that mode will be displayed. Switching from one mode to the other with no DATA entry makes no change to the displayed frequency spectrum.

CENTER FREQUENCY

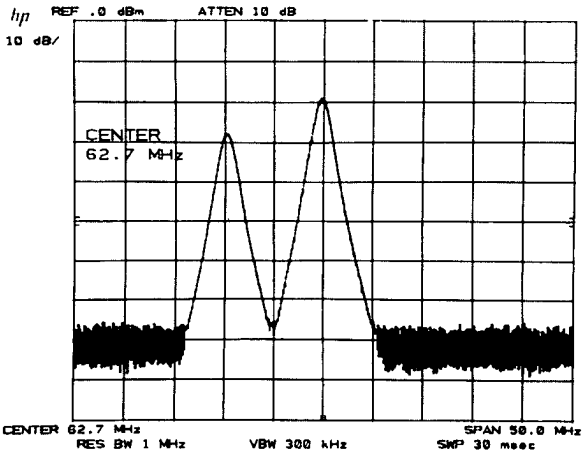
CENTER FREQUENCY (DATA entry) changes the center frequency. Center frequency will remain activated (i.e., capable of being changed) until HOLD, INSTR PRESET or another function requiring DATA entry is activated.

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Measurement and Readout Range

Center frequencies from 0 Hz to 1500 MHz can be entered.

62.7 MHz is the frequency at the center of the display graticule.



The number of significant digits in the readout depends on the frequency span selected. The narrower the span, the more significant digits.

The number of center frequency readout *digits to the right of the decimal* are as follows:

	Frequency Span						
Center Frequency	100 Hz to 999 Hz	1.00 kHz to 9.99 kHz	10.0 kHz to 99.9 kHz	100 kHz to 999 kHz	1.00 MHz to 9.99 MHz	10.0 MHz to 99.9 MHz	100 MHz to 1500 MHz
0 Hz to 999 Hz	0	0	0	0	0	0	0
1.000 kHz to 999.999 kHz	3	2	1	0	0	0	0
or 1.000000 MHz to 1499.999999 MHz	6	5	4	3	2	1	0

DATA Entry

CENTER FREQUENCY ◎	Changes the center frequency by about one-half the total frequency span each full turn.
CENTER FREQUENCY ⇩ ⇧	Changes the center frequency by one-tenth of the frequency span, i.e., by one division. COUPLED FUNCTION (CF STEP SIZE) can be used to change this step size.
CENTER FREQUENCY ▦	Allows direct center frequency entry. The analyzer accepts a center frequency entry of up to 9 digits for frequencies less than 1000 MHz and 10 digits for frequencies of 1000 MHz to 1500 MHz. Even though the readout may show a fewer number of digits (due to wide frequency span), as the span is narrowed, the full entry will be read out. Abbreviated readouts are not rounded.

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Only after a center frequency entry has been made will points along the trace reflect the spectrum change. For example, if the center frequency is changed when a slow sweep is in the middle of the graticule, signal responses on the left-hand side bear no relation to the new center frequency until the sweep passes through them.

SIGNAL TRACK– AUTOMATIC FREQUENCY CONTROL

The center frequency can be locked to a specific signal using the MARKER function [SIGNAL TRACK]. Chapter 6 discusses the procedure and examples.

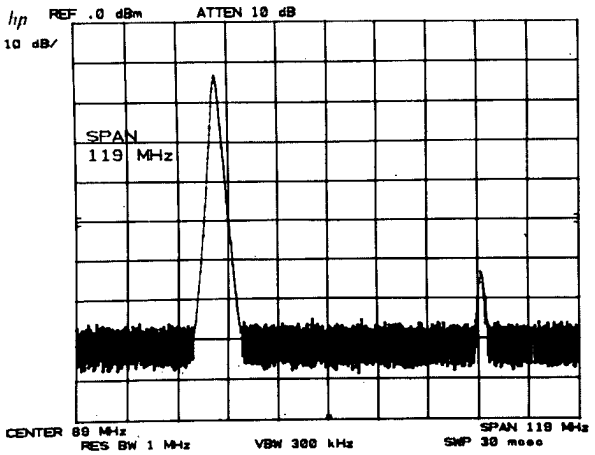
FREQUENCY SPAN

[FREQUENCY SPAN] (DATA entry) changes the total display frequency range symmetrically about the center frequency. Frequency span is read from the display.

> **NOTE**
>
> Frequency span readout refers to the total display frequency range. Divide by 10 to determine frequency span per division.

Measurement and Readout Range

Frequency span can be varied from 100 Hz to 1500 MHz. Three significant digits are displayed for frequency spans up to 1000 MHz and four digits for spans of 1000 MHz to 1500 MHz.



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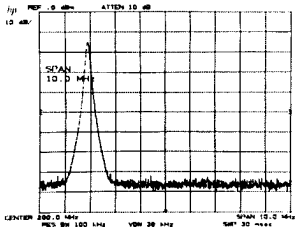
DATA Entry

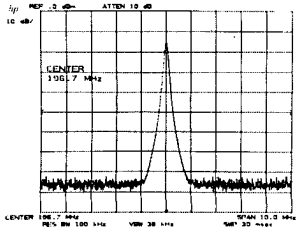
FREQUENCY SPAN + knob	Changes the frequency span by about a factor of 2 for each half turn.
FREQUENCY SPAN + ⇩ ⇧	Changes the frequency span to the next value in a 1, 2, 5, 10 sequence.
FREQUENCY SPAN + keypad	Enters an exact value up to three or four digits, depending on span. Additional digits will be deleted without rounding.

Example of CENTER FREQUENCY FREQUENCY SPAN

Once a signal response is placed at the center of the display frequency range, the signal's frequency can be read from center frequency. Reduction of the frequency span will increase the frequency readout resolution.

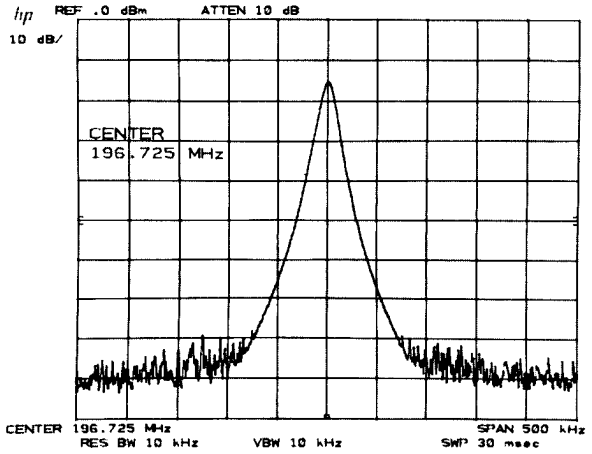
A signal lower than the center frequency can be brought to the center with CENTER FREQUENCY ⇩ ⇩ ⇩, using ⇩ as a coarse tune, then fine tuning with knob.





Narrowing the frequency span increases the center frequency resolution.

FREQUENCY SPAN ⇩ ⇩ ⇩ ⇩



ZERO FREQUENCY SPAN – FIXED TUNED RECEIVER OPERATION

The spectrum analyzer can operate as a receiver fixed tuned to the center frequency. Modulation waveforms can be displayed in the time domain with calibrated sweep time.

To fix tune the spectrum analyzer press FREQUENCY SPAN 0 MHz –dBm sec and tune to the desired frequency with CENTER FREQUENCY (DATA entry).

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The horizontal display axis becomes calibrated in time. The following functions establish a clear display of the video waveform:

TRIGGER/LEVEL [VIDEO] (knob)	Stabilizes the waveform trace on the display by triggering on the modulation envelope.
SCALE [ ] LIN	Voltage amplitude calibration.

COUPLED FUNCTIONS [SWEEP TIME]	Adjusts the full sweep time. Sweep times down to 1 μsec full scale are available in zero span. Signal responses for sweep times <20 msec are not digitally stored.
[RES BW] and [VIDEO BW]	Select according to signal bandwidth.

Each of the COUPLED FUNCTION values remain at their current values when zero span is activated.

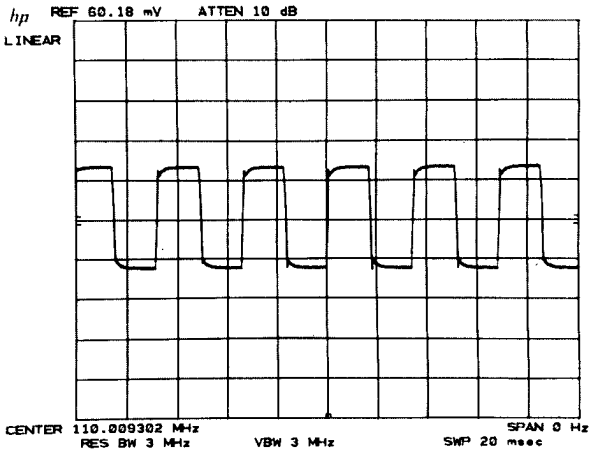
Measurement and Readout Range

An example shows the readout:

Press [FREQUENCY SPAN] [0] [Hz μV μsec] to activate zero span.

Press [CENTER FREQUENCY] [1] [1] [0] [MHz -dBm sec], then fine tune with (knob) for optimum trace.

The analyzer is fixed tuned to 110 MHz. The time domain display shows a modulation waveform at 2 msec/division.



NOTE

The sweep time readout refers to the full 10 division display sweep time. Divide by 10 to determine sweep time per division.

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In the time domain, sweep time range is 1 μsec to 10 msec in a 1, 2, 5, 10 sequence, and 20 msec to 1500 sec in a 1, 1.5, 2, 3, 5, 7.5, 10 sequence.

The sensitivity of center frequency to the DATA ◎ and ⇩ ⇧ is dependent upon resolution bandwidth:

DATA ENTRY	CENTER FREQUENCY CHANGE
one revolution ◎	6 x (resolution bandwidth)
⇩ or ⇧	1 x (resolution bandwidth)

START AND STOP FREQUENCY

A specified frequency range can be displayed by using

START FREQ (DATA entry) to set left graticule frequency.

STOP FREQ (DATA entry) to set right graticule frequency.

Start and stop are mutually exclusive with the center frequency and frequency span active functions. Activating either start or stop causes both to read out in place of center frequency and frequency span.

Measurement and Readout Range

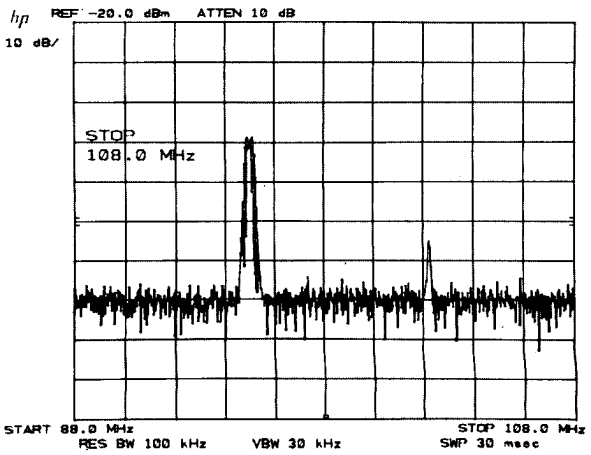
START FREQ can be varied from −850 MHz to 1500 MHz, although entries less than 1700 MHz below stop frequency will effect the STOP FREQ readout.

STOP FREQ can be varied from 000 to 2500 MHz, although entries 1700 MHz above the start frequency will effect the START FREQ readout.

The number of readout digits depends upon the frequency span. Narrower frequency ranges add digits to the readout.

The key sequence START FREQ 8 8 MHz -dBm sec STOP FREQ 1 0 8 MHz -dBm sec

gives this readout.



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The rules governing the number of significant readout digits are the same as for [CENTER FREQUENCY]

DATA Entry

Both start and stop frequencies can be entered from any of the DATA controls.

[START FREQ] or [STOP FREQ] 	Changes the start or stop frequency. The amount of change per turn is a constant percentage of the frequency span.
[START FREQ] or [STOP FREQ] 	Changes the frequency by one tenth of the total frequency span.
[START FREQ] or [STOP FREQ] 	Exact start or stop frequencies can be entered. The number of digits read out depends upon the frequency span.

REFERENCE LEVEL

[REFERENCE LEVEL] (DATA entry) changes the absolute amplitude level of the top graticule line. The amplitude scale – that is, the number of amplitude units per division – is entered from the SCALE control group or [INSTR PRESET].

Signal responses below the top graticule are measured by bringing the response to the reference level with [REFERENCE LEVEL] (DATA entry).

NOTE

In logarithmic 10 dB per division scaling, the top 9 divisions are calibrated.

The maximum reference level value is dependent on the input attenuator setting. Levels to the input mixer that could cause gain compression are displayed off the top of the reference level graticule. The maximum reference level limit can be extended with KEY FUNCTION [SHIFT] [ATTEN], allowing a maximum reference level of +60.0 dBm. See Chapter 11 for details concerning reference level ranges.

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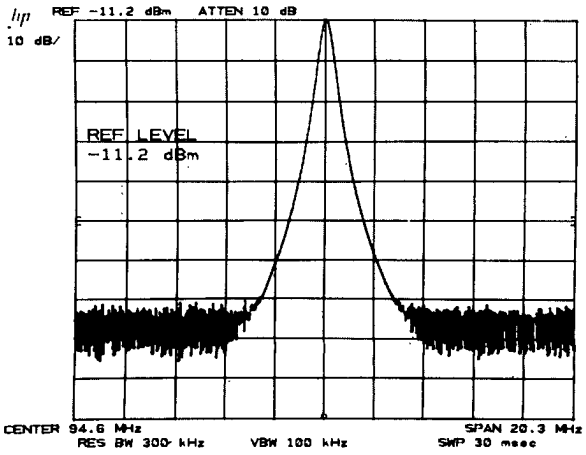
CAUTION

Even with the reference level set to +60 dBm, the total input power should not exceed +30 dBm.

Measurement and Readout Range

The reference level can be changed from +30 dBm to −89.9 dBm in 0.1 dB steps. The readout shows one significant digit to the right of the decimal.

RF attenuator: 10 dB
Reference level: −11.2 dBm



Reference level dBm units are selected with [INSTR PRESET] : dBmV, dBμV, and volts referred to the analyzer's input impedance can be selected with KEY [SHIFT] FUNCTIONS. The absolute power of the reference level remains constant when units are changed.

Full amplitude readout units information can be found in Chapter 11, [SHIFT] KEY FUNCTIONS, under AMPLITUDE UNITS SELECTION.

DATA Entry

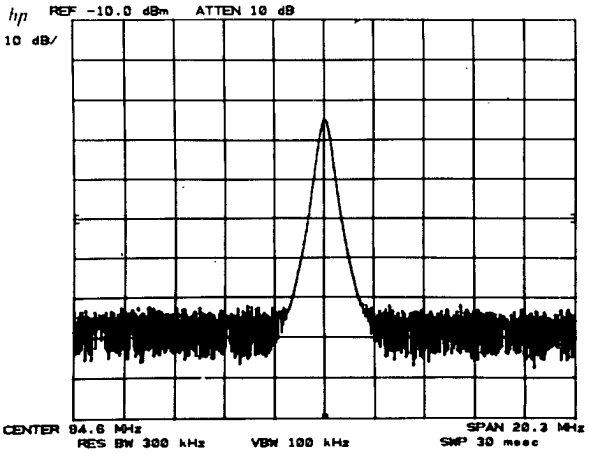
[REFERENCE LEVEL] ◎	In logarithmic scale, the changes are in 0.1 dB steps: in linear scale, the changes are made to the least significant digit.
[REFERENCE LEVEL] ▽ △	In logarithmic scale, changes the reference level in steps according to dB/division scale. In linear scale, changes the reference level in 1 dB steps.
[REFERENCE LEVEL] ▦	Allows entry of exact reference levels. Digits entered beyond the displayed number of digits are deleted.

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Example

A signal's power level is measured by setting the reference level equal to the signal level.

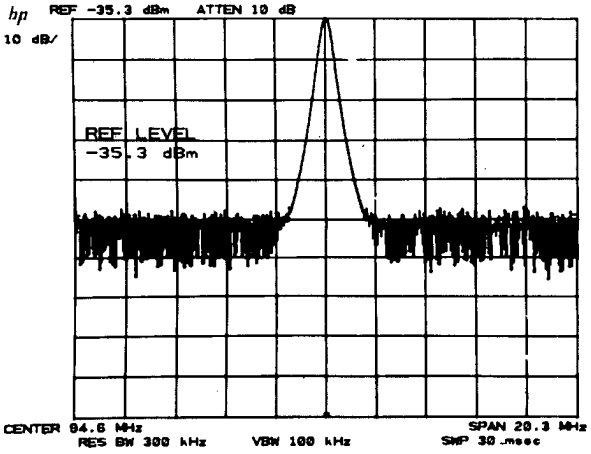
The signal level is roughly −35 dBm.



Change the reference level to the signal with

REFERENCE LEVEL ⇩ ⇩ ◯ .

The signal level measured is −35.3 dBm.

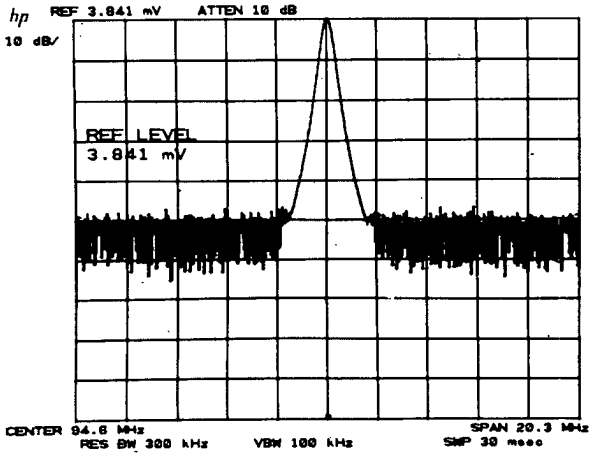


For voltage amplitude units, press

D

SHIFT AUTO

The corresponding level is 3.841 mV.



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FREQUENCY AND AMPLITUDE OFFSETS

The display readout (HP-IB readout) of frequency and amplitude can be offset by values entered through [SHIFT] KEY FUNCTIONS. The offset values are read out on the display. Frequency offset is entered with

[SHIFT] [CENTER FREQUENCY] V (DATA entry).

Frequency offset may be used, for example, to provide a baseband frequency display scale for a signal that has been converted up or down.

Amplitude offset is entered with

[SHIFT] [REFERENCE LEVEL] Z (DATA entry).

External attenuation or gain in series with the analyzer RF input can be compensated for by offsetting the analyzer reference level. This calibrates the analyzer reference level readings to the input of the external attenuator or amplifier.

More details and examples are in Chapter 11, [SHIFT] KEY FUNCTIONS, under FREQUENCY AND AMPLITUDE OFFSET.

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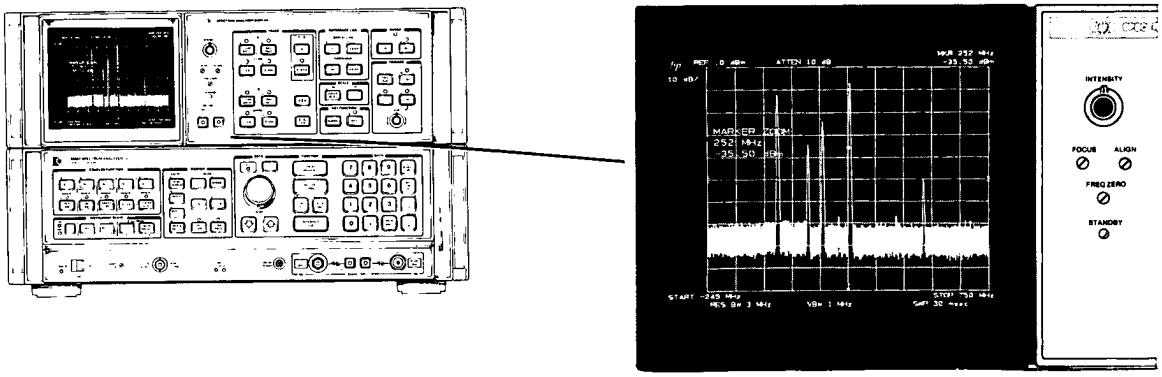
Chapter 4
CRT DISPLAY

GENERAL DESCRIPTION

This chapter describes the CRT display adjustments, readouts, and graphics.

ADJUSTMENT OF THE DISPLAY

Adjustments for intensity, focus, and alignment affect all the lines and characters on the display simultaneously.



CRT Display and Adjustments

INTENSITY



Controls intensity for all the CRT writing

FOCUS



A screwdriver adjustment for focusing all the CRT writing. Focusing any one element on the CRT focuses all the writing.

ALIGN



A screwdriver adjustment for tilting all the displayed CRT information.

DISPLAY SECTION LINE POWER

STANDBY



A lamp that indicates the power condition of the Spectrum Analyzer Display section as dictated by the setting of the LINE power switch on the HP 85680B RF section.

CRT DISPLAY OVERVIEW

The cathode ray tube of the Spectrum Analyzer Display section displays:

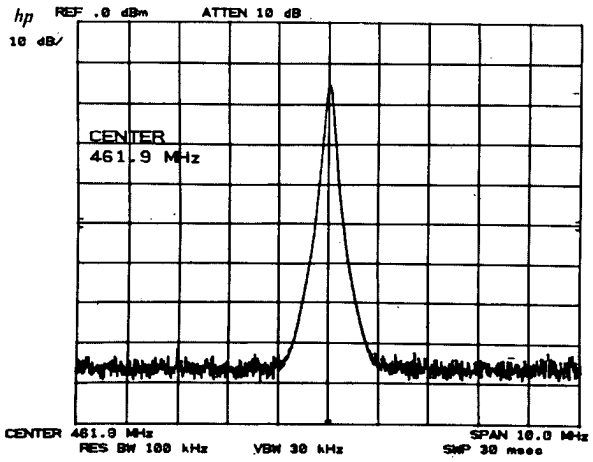
- active function name and value
- graticule
- traces of the signal response
- values that calibrate the frequency, time, and amplitude axes
- values for the spectrum analyzer receiver parameters, that is, COUPLED FUNCTIONS
- operator originated labels and graphics

Active Function

The function that has been activated for DATA entry is read out in the graticule area shown.

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Activating a function immediately writes its name in the active function area along with its present value.



The following summarizes the names and readout formats for front-panel-controlled active functions.

Function	Examples of Active Function Readout
FUNCTION	
CENTER FREQUENCY	CENTER 750 MHz
FREQUENCY SPAN	SPAN 1500 MHz
START FREQ	START 0 Hz
STOP FREQ	STOP 1500 MHz
REFERENCE LEVEL	REF LEVEL .0 dBm
MARKER	
NORMAL	MARKER 550 kHz 19.8 dBm
Δ	MARKER Δ 20.0 MHz −12.4 dB
ZOOM	MARKER ZOOM 20.5 MHz −32.8 dBm
NORMAL, FREQ COUNT	COUNTER 19.998 MHz −12.0 dBm
Δ, FREQ COUNT	COUNTER Δ 20.000 MHz −.2 dB
ZOOM, FREQ COUNT	COUNTER ZOOM 20.000 MHz −.2 dBm
NORMAL, SHIFT M	MARKER 16.3 MHz −140.4 dBm (1 Hz)

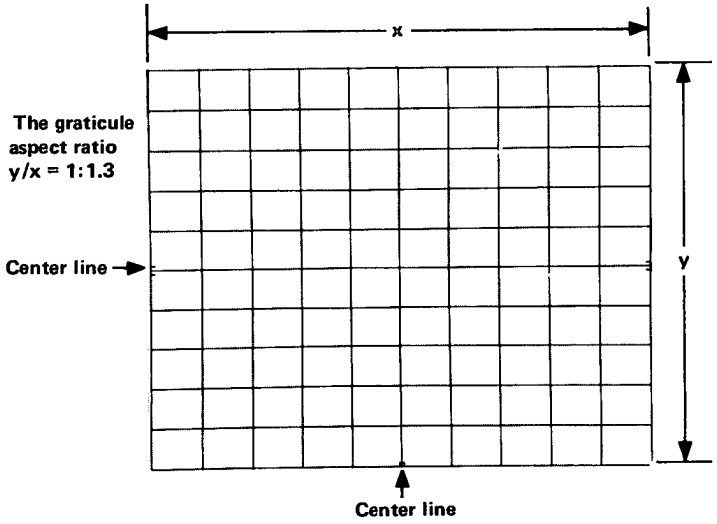
Function	Examples of Active Function Readout
COUPLED FUNCTION	
RES BW	RES BW 3 MHz
VIDEO BW	VIDEO BW 3 MHz
SWEEP TIME	SWEEP TIME 20 msec
ATTEN	RF ATTEN 10 dB
CF STEP SIZE	CF STEP 150 MHz
REFERENCE LINE	
ENTER	DISPLAY LINE −45.0 dBm
ENTER	THRESHOLD −90.0 dBm
SCALE	
ENTER dB/DIV	LOG 10 dB/
KEY FUNCTION	
(See SHIFT KEY FUNCTIONS, Chapter 11.)	

HOLD SHIFT deactivates any active function (except for E), blanking the active parameter readout.

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Graticule

The display graticule is an internally generated 10-division by 10-division rectangle for referencing frequency, time, and amplitude measurements. Double markings at the left, right, and bottom designate the center axes.



The graticule can be blanked from the display with KEY FUNCTION [SHIFT] m and restored with [SHIFT] n.

For CRT photography, the graticule can be intensified independent of the annotation and trace by pressing the following sequence:

[SHIFT] z [2] [1] [5] [6] [Hz μV μsec]
[SHIFT] | [1] [1] [6] [3] [Hz μV μsec]
[2] [1] [1] [5] [Hz μV μsec]

For more intensity, repeat the last two number entries, 1163 Hz and 2115 Hz. [INSTR PRESET] returns the graticule to normal.

Traces

Three separate traces, A, B, and C, can be written onto the display. Each trace consists of 1000 separate straight-line elements drawn between 1001 fixed points across the CRT. X and Y axis coordinates designate the particular points between which the elements are drawn. Terms used to describe trace composition are defined as follows:

Point A "point" in the context of this manual is a fixed location on the CRT display. There are 1,001 points along the X (horizontal) axis of the CRT graticule, numbered from 0 on the far left graticule line to 1000 on the far right graticule line. Similarly, there are 1,001 points along the Y (vertical) axis of the CRT graticule, numbered from 0 on the bottom graticule line to 1000 on the top graticule line. An additional 22 points of overrange available above the top graticule line provide the Y axis with a total of 1,023 points.

Display Unit One display unit is the distance between two points (see above) along an X or Y axis. The distance along the X axis between the far left graticule line and the far right graticule line is

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1000 display units. The Y axis length between the bottom graticule line and the top graticule line is also 1000 display units. Although the Y axis can be extended another 22 display units above the top graticule line, the extended area is not calibrated.

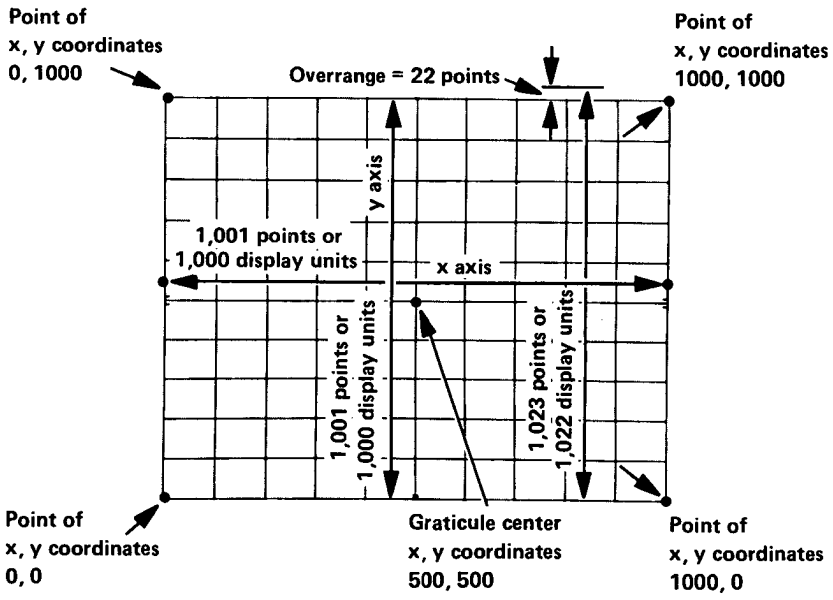
X, Y coordinates to a particular point on the display are given in display units relative to X, Y coordinates 0,0 at the junction of the far left and bottom graticule lines.

Element An element is a distinct portion of the trace drawn on the CRT. It comprises a point and the visible straight line drawn to it from the preceding point. An element drawn parallel with a vertical or horizontal graticule line is one diplay unit long. An element drawn at an angle to the graticule lines is longer, its actual length depending on the angle.

Vector A vector is identical with an **element**, except that it can be either visible or blanked.

NOTE

When the analyzer is operated manually (i.e., with its front-panel controls), the display size remains constant and the above definitions are fully applicable. When it is operated remotely with a controller, however, three additional larger display sizes are available through the display-size programming commands. For these larger-than-normal display sizes, the lower left reference coordinates and the upper right trace limit expand beyond the CRT's outer graticule lines. For further information on remotely-controlled (i.e., programmed) display sizes, refer to commands D1, D2, and D3 under Programming Commands in Section II of this manual.

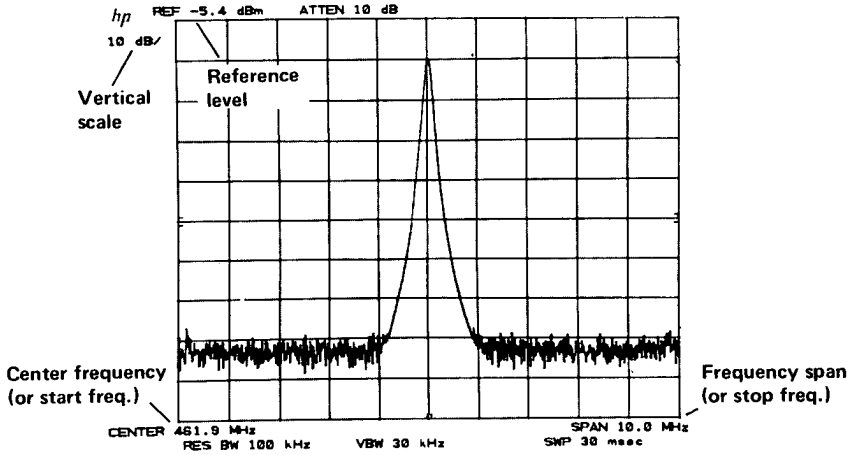


TRACE DISPLAY TERMS

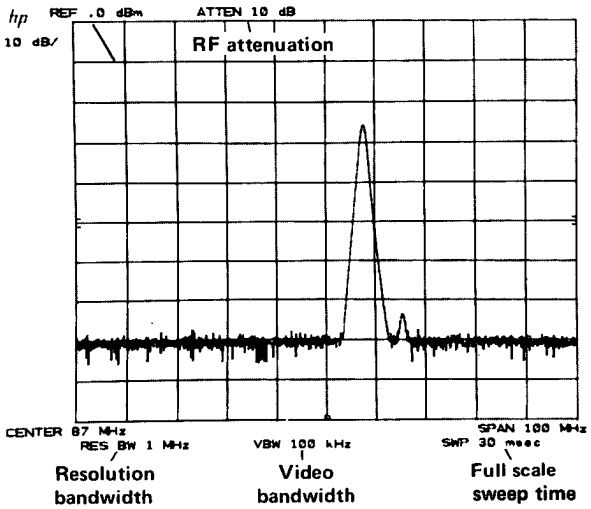
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Locations of Permanent Readouts

The vertical and horizontal graticule axes are scaled by these readouts:



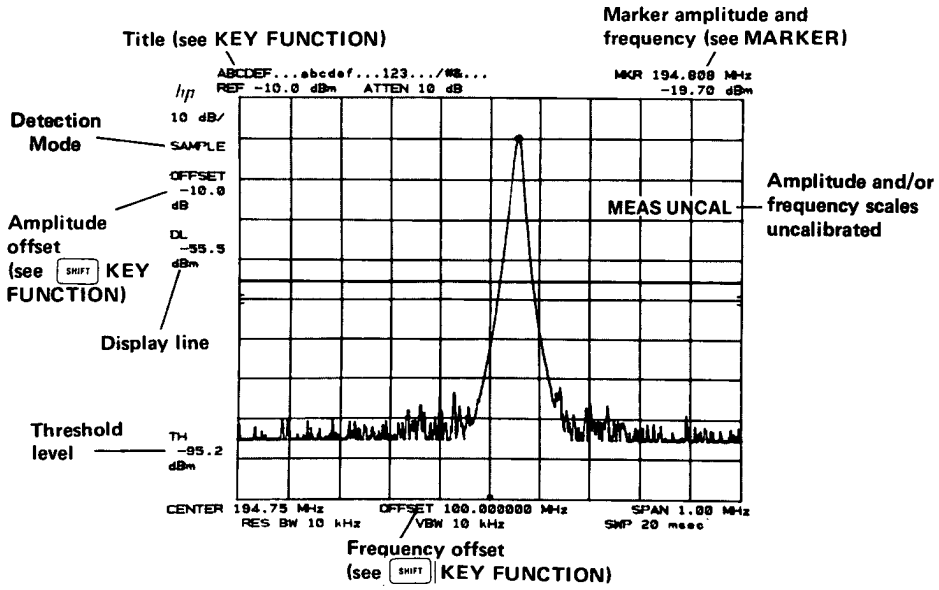
The COUPLED FUNCTIONS that describe the swept receiver characteristics of the spectrum analyzer are:



To blank all the character readouts, press KEY FUNCTION [SHIFT] o. To restore, press [SHIFT] p.

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Other Readouts



A number of other special function readouts can be activated. These are covered in Chapter 11.

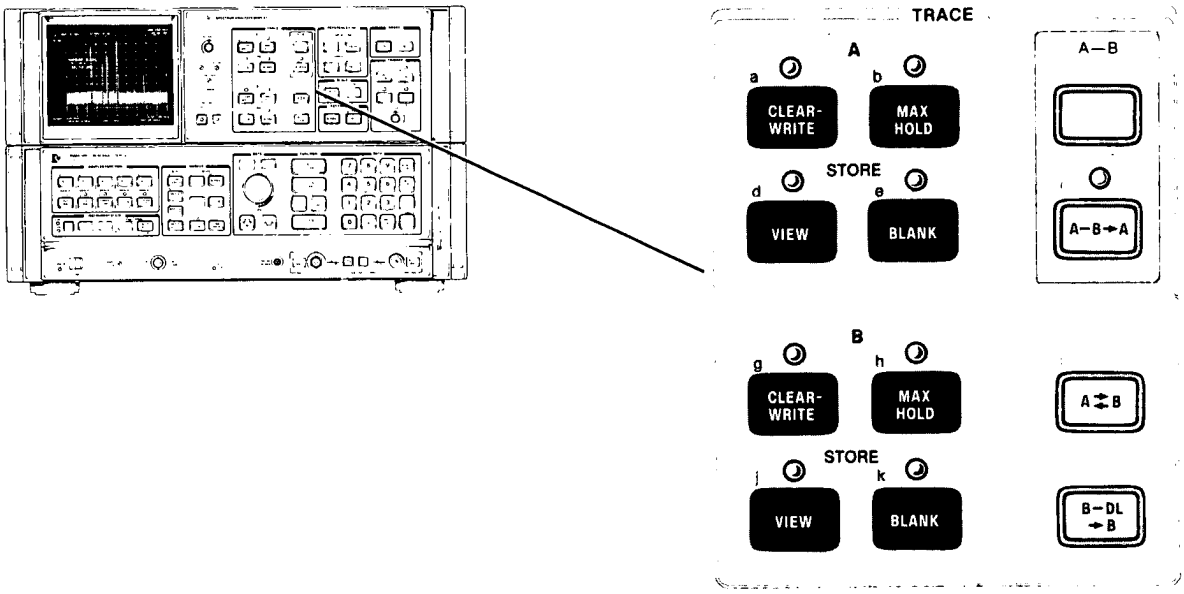
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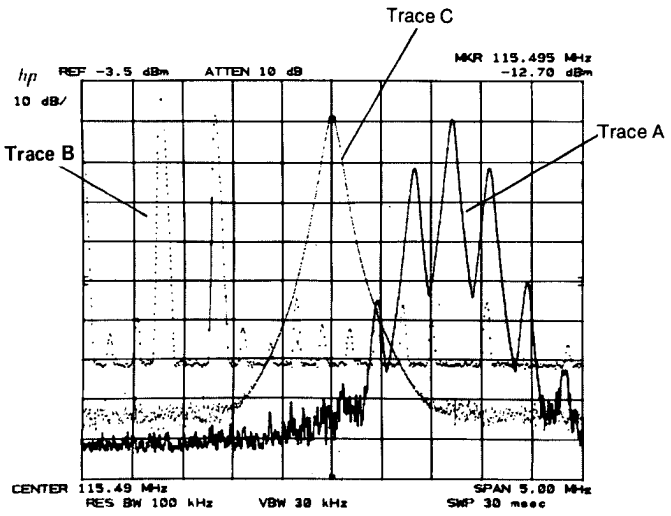
Chapter 5
TRACE

GENERAL DESCRIPTION

This chapter describes the use of the TRACE functions for writing, storing, and manipulating trace data.



TRACE CONTROLS



TRACE IDENTIFICATION

Traces are differentiated by intensity. Trace A is bright, trace B is of medium intensity, and trace C has the least intensity. [VIEW] and [BLANK] allow positive identification.

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TRACE MODES

Four mutually exclusive functions or modes for trace A and trace B determine the manner in which the traces are displayed. Indicator lights by the keys show the current modes.

WRITE MODES (sweeping):

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

MAX HOLD — Displays and holds the maximum responses of the input signal in trace selected.

STORE MODES (not sweeping):

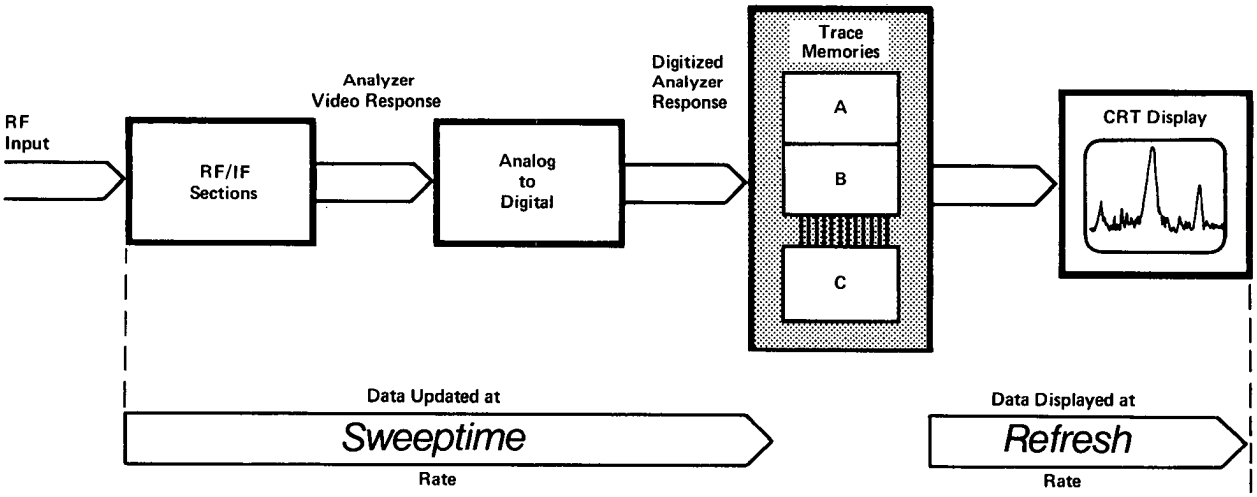
VIEW — Stores the current trace and displays it on the CRT display.

BLANK — Stores the current trace and blanks it from the CRT display.

Trace Memory

An understanding of the TRACE modes requires a familiarity with the analyzer trace memory and trace data transfer functions.

Display traces are not written onto the CRT directly from the spectrum analyzer's IF section. Instead, the analog signal response is converted to digital information and stored in one trace memory. This information can then be transferred to the CRT display. The way in which the information is displayed depends upon the TRACE mode selected.



TRACE MODES DETERMINE HOW DATA IS ENTERED INTO AND DISPLAYED FROM TRACE MEMORIES

The analyzer's response is transferred into the trace memory at the sweep rate of the analyzer (that is, in accordance with the sweep time setting). The trace memory is written onto the CRT display at a refresh rate of about 50 Hz, which is rapid enough to prevent flickering of the trace on the CRT. Trace intensities remain constant as analyzer sweep times are changed.

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NOTE

It is important to understand the difference between sweep and refresh.

Sweep refers to the spectrum analyzer sweeping from a start frequency to a stop frequency and storing measured amplitude data into a trace memory.

Refresh refers to the transfer of display memory data to the CRT display

Write Modes

For the write modes, the analyzer signal response is written into trace memory during the sweep and the memory contents are displayed on the CRT.

[CLEAR-WRITE] A(B) Sets all the values in the trace memory A(B) to zero when first activated (bottom line graticule), then displays the signal response.

[MAX HOLD] A(B) Latest signal response is written into the trace A(B) memory only at the horizontal positions where the response is greater than the stored response.

When both [CLEAR-WRITE] A and [CLEAR-WRITE] B modes are selected, the analyzer writes into (*sweeps*) A and B alternately.

STORE Modes

In the STORE modes, no updating of the trace memory is made. The current memory data is saved.

[VIEW] A(B) The trace A(B) data are displayed on the CRT (refresh is enabled).

[BLANK] A(B) The trace A(B) data are not displayed on the CRT (refresh is disabled).

Example

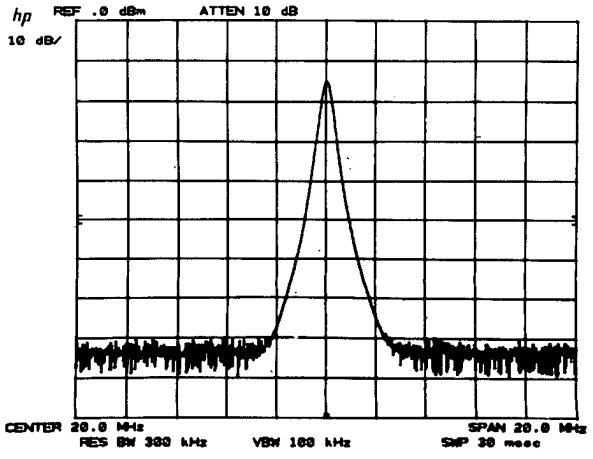
With TRACE modes, signals can be observed as the analyzer sweeps. Signals can also be stored for comparison, erased, or monitored for frequency drift.

Center and zoom in on a 20 MHz signal:

Press [CENTER FREQUENCY] [2] [0] [MHz -dBm sec]

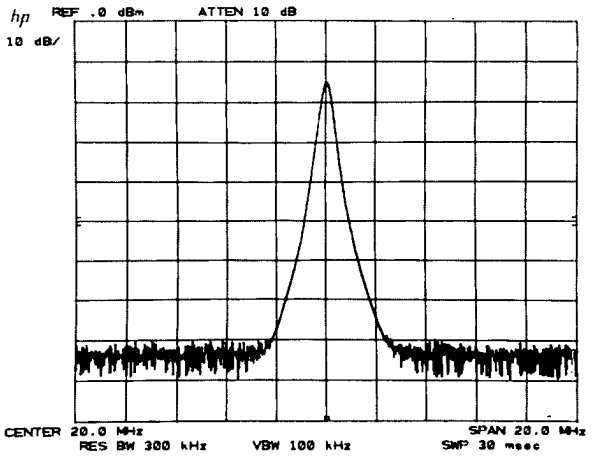
[FREQUENCY SPAN] [2] [0] [MHz -dBm sec]

Since [INSTR PRESET] has set [CLEAR-WRITE] A and [BLANK] B, only A is displayed.

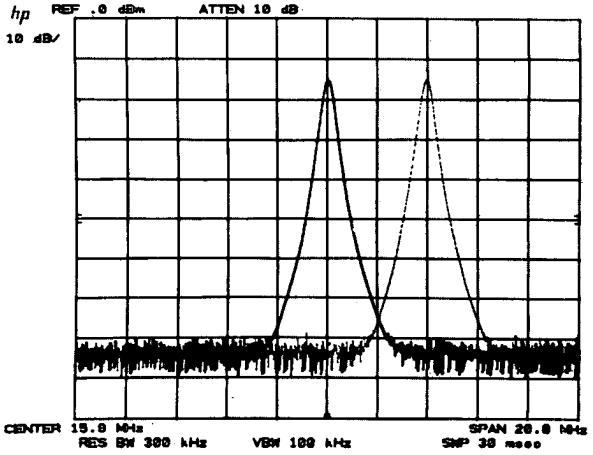


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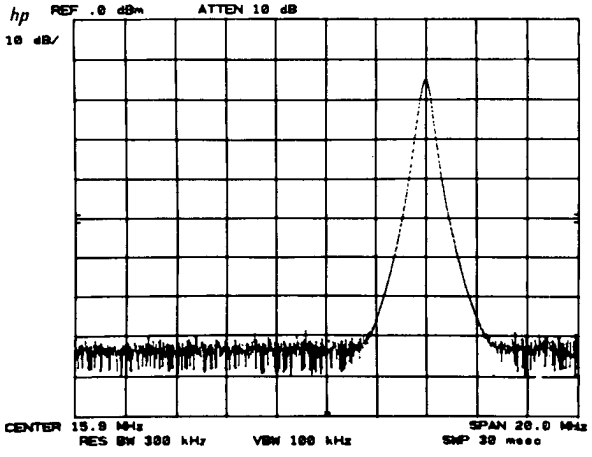
This response can be stored:
Press [VIEW] A.



Write the same signal with B and change its position relative to trace A:
Press [CLEAR-WRITE] B.
[CENTER FREQUENCY] ◎

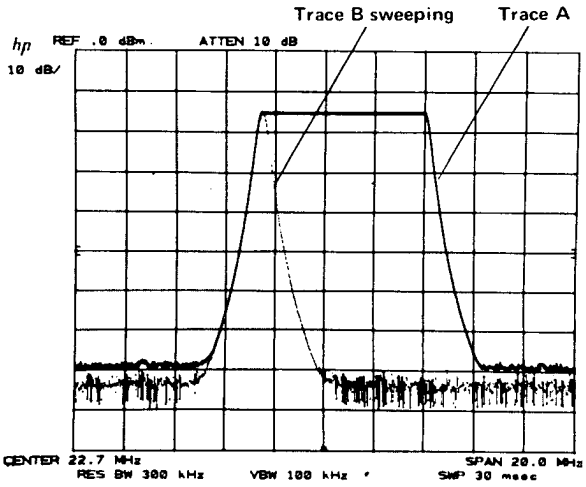


Blank trace A;
Press [BLANK] A.
This trace can be recalled with [VIEW] A as long as [CLEAR-WRITE] A or [MAX HOLD] A is not used first.



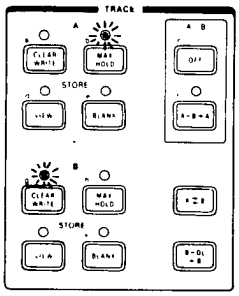
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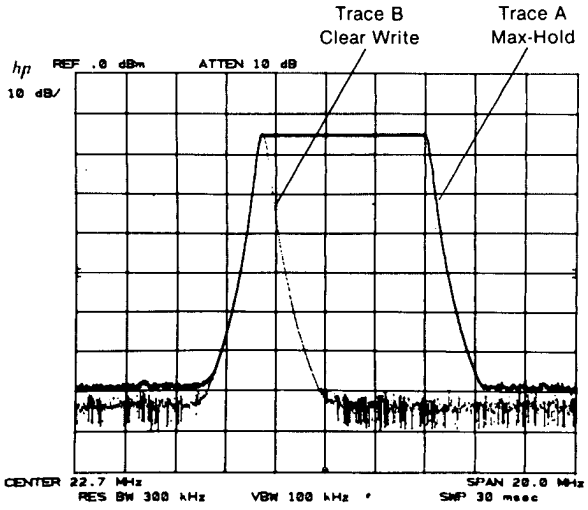
To display the drift of a signal, press [MAX HOLD] A. (Simulate frequency drift with [CENTER FREQUENCY] .)



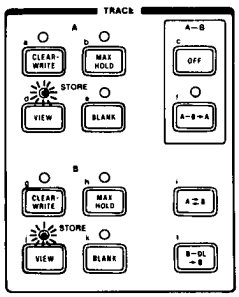
TRACE EXCHANGE

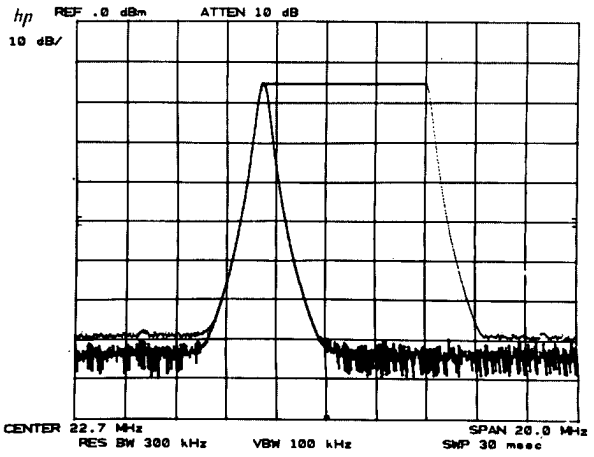
[A⇄B] exchanges traces A and B, changing their relative intensities and storage memory locations, and enables A and B [VIEW] . For example, in the trace display above, the modes and display appear.





Press [A⇄B]





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TRACE C MODES

A third trace, C, can be used to store a signal response. Trace C is not swept from the analyzer IF section as are traces A and B, but is input using a trace B into C function (B → C) or a B and C exchange function (B ⇄ C).

Access to the trace C modes is through KEY FUNCTION [SHIFT] . The modes are:

View C: [SHIFT] j Displays trace C.

Blank C: [SHIFT] k Blanks trace C from CRT display.

B → C: [SHIFT] l Writes trace B into trace C. Trace A and B modes are not changed. If trace C is not displayed, it remains undisplayed.

B ⇄ C: [SHIFT] i Exchanges traces B and C. If trace B is displayed before the exchange, trace C is now displayed. If trace B is not displayed before the exchange, trace C is not displayed.

TRACE ARITHMETIC

TRACE arithmetic allows one trace to be modified by another trace or a display line position.

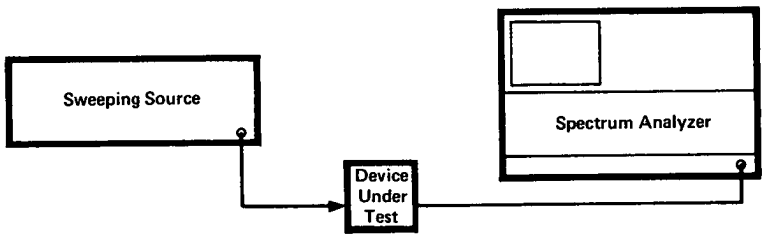
A – B [A–B→A] Trace B amplitude (measured in divisions from the bottom graticule) is subtracted from trace A and the result written into trace A from sweep to sweep. Trace B is placed or kept in a STORE mode.

A – B [OFF] Turns [A–B→A] off.

[B–DL →B] Subtracts the amplitude of the display line from trace B and writes the result into trace B. Trace B is placed or kept in [VIEW] . Details on display line are in Chapter 7, REFERENCE LINE.

Example

Trace arithmetic with the display line can be used to correct for the frequency response characteristics (flatness) of a swept measurement system typified by this setup:

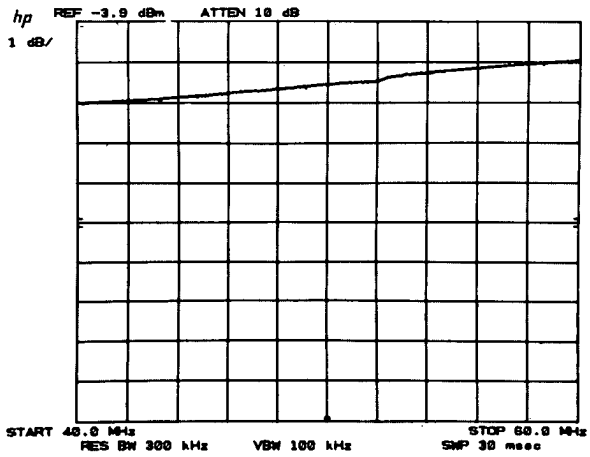


where the device under test is to be characterized for insertion loss over a specific frequency range.

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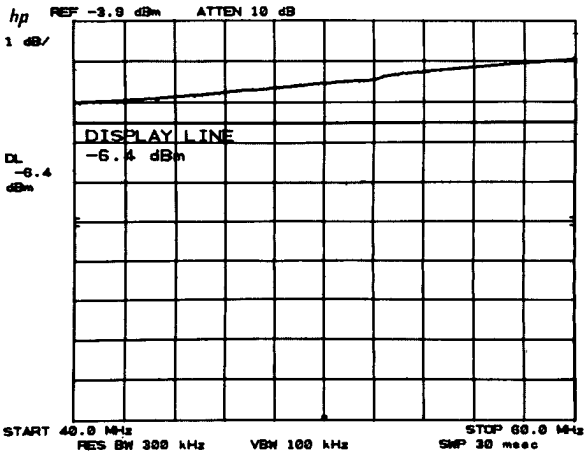
The analyzer and source are set to the proper amplitude level and frequency span with the source output connected directly to the analyzer input.

[MAX HOLD] B, sweep source, then [VIEW] B.



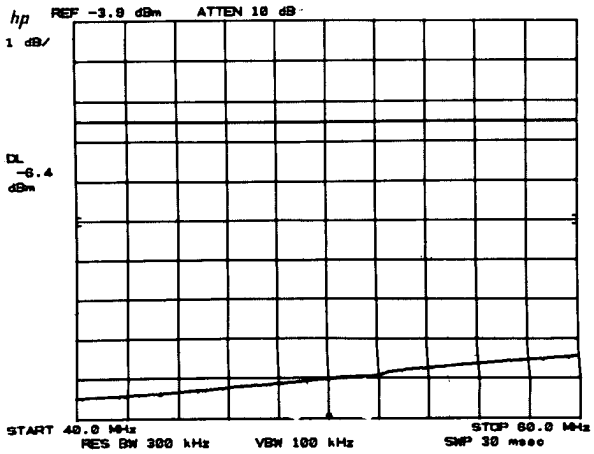
The display line is activated and set below the source/analyzer response.

DL [ENTER]  .



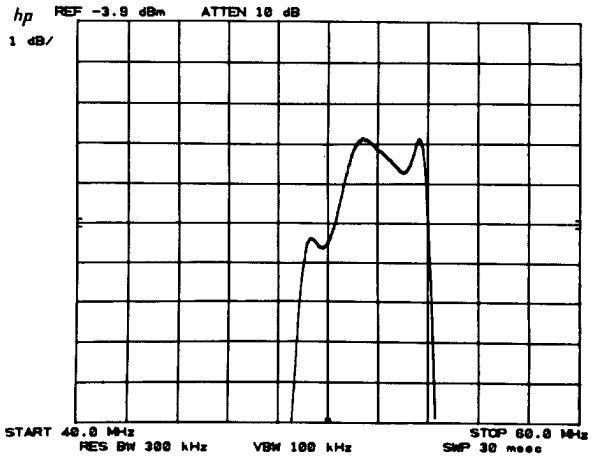
The difference between the display line (in display units) and the source/analyzer response is stored in trace B with [B-DL → B] .

Negative values of the [B-DL → B] line would be stored even though not displayed.



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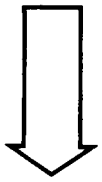
Now the device under test is connected between source and analyzer, and its response is corrected for source flatness uncertainty by using [MAX HOLD] A [A→A].



TRACE PRIORITY

Functions that act upon a trace always act upon the highest priority trace. Priority is defined by the trace modes as follows:

Highest priority



Lowest priority

[CLEAR-WRITE] A or [MAX HOLD] A
[CLEAR-WRITE] B or [MAX HOLD] B
[VIEW] A
[VIEW] B

view C

[BLANK] A
[BLANK] B

blank C

Marker functions, for example, use trace priority to decide which trace to mark. See Chapter 6.

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Chapter 6
MARKER

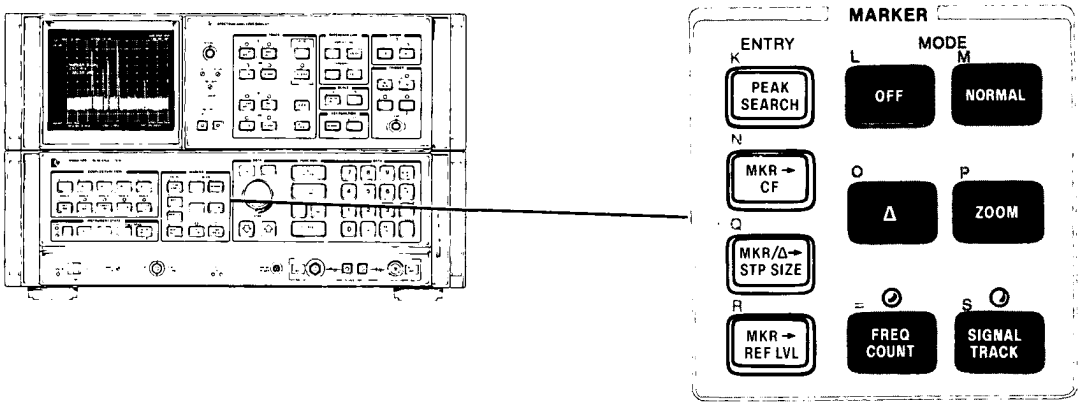
GENERAL DESCRIPTION

This chapter describes the use of the MARKER and DATA controls for faster and more accurate measurements. Markers can be displayed only on TRACE A and TRACE B.

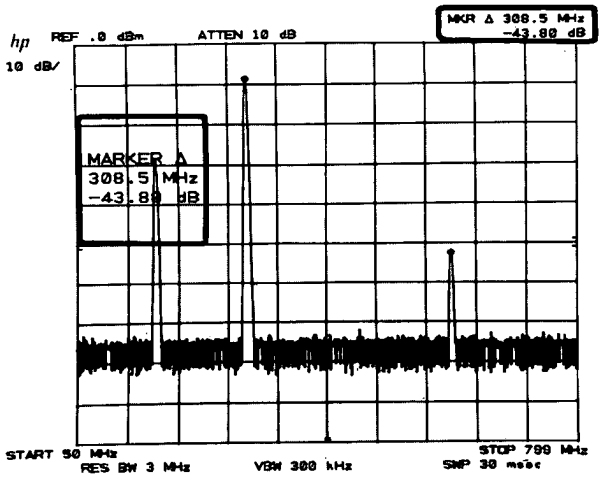
Two types of functions make up the MARKER group: MARKER MODEs, which enable or disable markers and their related functions; and MARKER ENTRY functions which allow the scaling of the display frequency and amplitude using marker information.

Markers are bright spots which lie directly on the display trace. The horizontal position of an activated marker is controlled by the DATA controls. The marker can be positioned at a specific frequency with the DATA number/ units keyboard.

Readout of marker amplitude and frequency appears in the upper right of the display outside the graticule. When a MARKER MODE is active, its amplitude and frequency readout also appears in the active function area of the graticule.



MARKER CONTROLS



MARKER READOUT LOCATIONS

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MARKER OVERVIEW

FUNCTION:

- Direct readout of the amplitude and frequency of a point along the trace. — NORMAL
- Direct readout of amplitude and frequency differences between points on the trace. — Δ
- Expansion of the span about a specific frequency. — ZOOM
- Placing a single marker at the highest response. — PEAK SEARCH
- Counter accuracy frequency measurements. — FREQ COUNT
- Direct noise level readout. — SHIFT M
- Analysis of stored traces. — MARKER with VIEW
- Amplitude and frequency display scaling. — ENTRY MKR→CF, MKR/Δ→STP SIZE, MKR→REF LVL

MARKER ON BUT NOT ACTIVE

An activated marker mode can be deactivated by activating another function, such as display line, or by DATA HOLD. This does not erase the marker itself nor the upper right display readout. If the marker mode is reactivated, DATA control and active function readout will continue from its last position.

If a marker mode is deactivated by a function (other than MARKER ENTRY) where a value change of the new function results in a rescaling of the amplitude or frequency axes, the marker will not stay on the trace. Reactivating the marker will start it at the display center.

MARKER OFF

OFF disables any marker mode, including FREQ COUNT and SIGNAL TRACK, and blanks the marker readout from the CRT display. DATA controls are disabled if the marker was active.

MARKER IN VIEW

MARKER NORMAL and Δ may be used on traces A or B in the view mode. This allows detailed analysis of responses that are nonperiodic or unstable.

The markers are placed on a viewed trace according to the priority defined in Chapter 5, TRACE PRIORITY.

SINGLE MARKER – NORMAL

NORMAL activates a single marker at the center of the display on the trace of highest priority. Trace priority is defined in Chapter 5. The marker does not activate on the TRACE modes BLANK A, BLANK B, view C, or blank C.

Measurement and Readout Range

The number of significant digits to the right of the decimal in the marker frequency readout is the same as for center frequency readout.

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DATA Entry

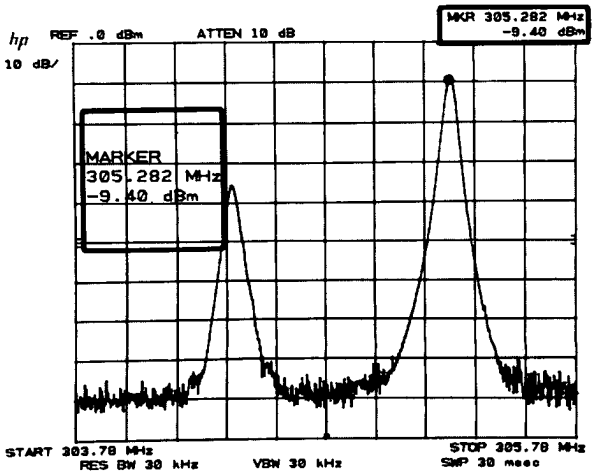
NORMAL ◎	Moves the marker continuously along the trace at about 5 horizontal divisions each full turn. The marker moves in display unit increments.
NORMAL ⇧ ⇩	Moves the marker along the trace one tenth of the total width per step. ⇧ moves marker to the right.
NORMAL ⠿	Places the marker at the frequency entered. An out-of-range entry results in placement of the marker at a graticule edge.

Example

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

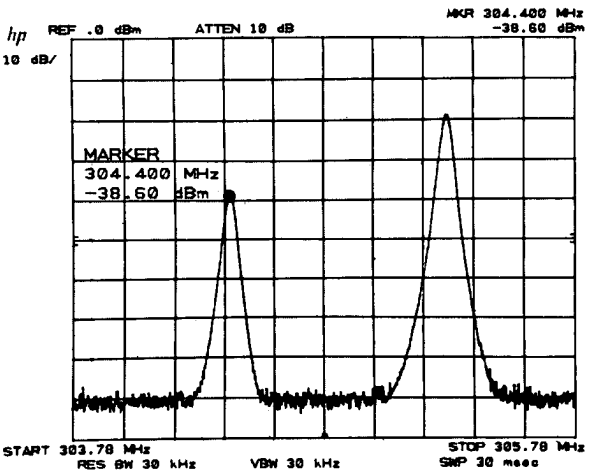
For a given display, activate the single marker with NORMAL, then tune the marker with ◎ to position it at the signal peak.

The frequency and amplitude is read out in two display areas.



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

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



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DIFFERENTIAL MARKERS – Δ

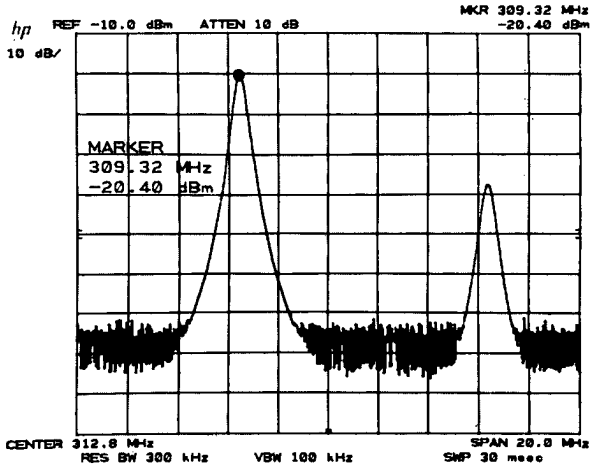
[Δ] activates a second marker at the position of a single marker already on the trace. (If no single marker has been activated, [Δ] places two markers at the center of the display.) The first marker's position is fixed. The second marker's position is under DATA control.

The display readout shows the difference in frequency and amplitude.

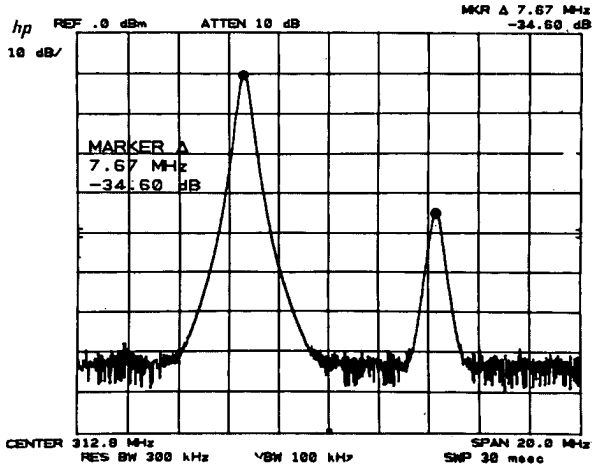
Example

Measuring the differences between two signals on the same display.

First set the marker on one of the signal peaks with [NORMAL] ◎.



Activate [Δ] and move the second marker to the other signal peak with ◎ and read their differences directly.



Fractional Differences

When the reference level is calibrated in voltage, marker [Δ] amplitudes are given as a fraction, the voltage ratio of two levels.

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

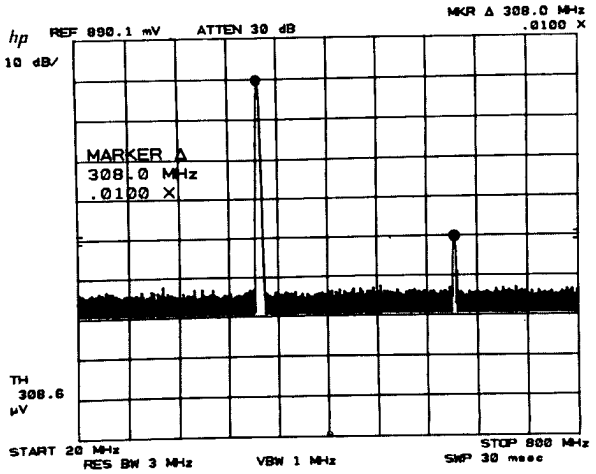
$$\text{fraction} = 10^{-\left(\frac{\text{dB difference}}{20}\right)}$$

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

Example

Set up [Δ] on the peaks of a fundamental (left) and its harmonic (right).



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

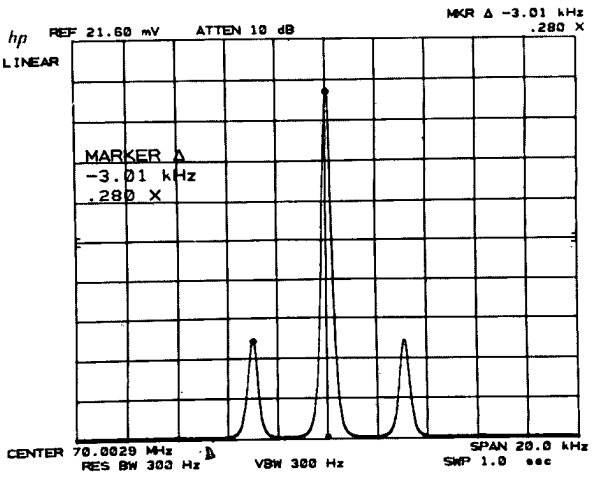
With a *linear* amplitude scale and a reference level calibrated in voltage, the fractional amplitude readout is the simple linear ratio of the two markers.

Example

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

Place the single marker on the carrier peak, [NORMAL] ◎ , and the second marker on one of the sideband peaks, [Δ] ◎ . The fractional amplitude readout gives one-half the modulation index .283.

% AM = 100 x 2 x .28 = 56%



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Measurement and Readout Range

The [Δ] function formats the amplitude readout according to reference level units and scale.

Reference Level Units	SCALE Logarithmic	SCALE Linear
dBm dBmV dBμV	Amplitude in dB	Amplitude in dB
Voltage	Amplitude ratio $10^{-\left(\frac{\text{dB difference}}{20}\right)}$	Ratio of marker amplitudes

AMPLITUDE READOUT FORMAT FOR MARKER [Δ]

The frequency readout for all MARKER [Δ] conditions has up to 4 significant digits, depending on the portion of span measured.

The amplitude readout in dB has a resolution of ±.01 dB for linear scale. The resolution for logarithmic scale depends on the LOG [ENTER dB/DIV] value:

LOG SCALE dB PER DIV	RESOLUTION
10	±0.1 dB
5	±0.05 dB
2	±0.02 dB
1	±0.01 dB

DATA Entry

The minimum incremental change for [Δ] frequency is 0.1% of the frequency span.

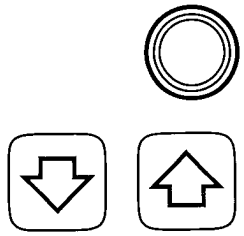
[Δ] ◎	One full turn moves the active marker about one tenth of the horizontal span.
[Δ] [⇧] [⇩]	One step moves the marker one tenth of the horizontal span.
[Δ] ▦	Positive entry places marker higher in frequency than the stationary marker, negative entry places marker lower in frequency. Larger entries than allowable place the marker on the adjacent graticule border. Negative frequencies can be entered using a [SHIFT] [HOLD] prefix as the minus sign. For example, to set a [Δ] span of 10 MHz with the second marker positioned to the left of the first, press [Δ] [SHIFT] [HOLD] [1] [0] [MHz -dBm sec]

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MARKER ZOOM

[ZOOM] activates a single marker on the trace of highest priority (see TRACE PRIORITY, Chapter 5).

In [ZOOM], the DATA knob and STEP keys change the values of *different functions*.

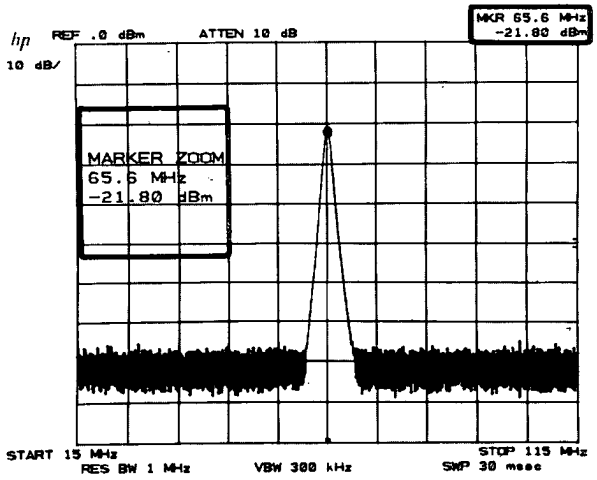


Positions Marker

Changes FREQUENCY SPAN and sets CENTER FREQUENCY equal to MARKER frequency

DATA Control Use for [ZOOM]

The marker can be moved along the trace with the DATA knob , and the frequency span can be changed about the marker with DATA step [⇩] and [⇧]. Each step also sets center frequency equal to the marker frequency.



Measurement and Readout Range

The measurement and readout range for marker zoom is the same as marker [NORMAL].

Better frequency count resolution and automatic recentering of a *signal* are additional zoom features when [FREQ COUNT] is activated.

DATA Entry

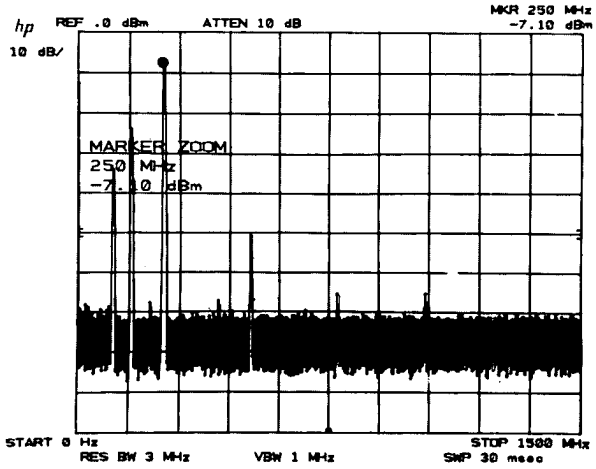
[ZOOM]	Moves the marker continuously along the trace. Rate is dependent on speed of rotation. The marker moves in display unit increments.
[ZOOM] [⇧] [⇩]	Changes the frequency span to the next value in the sequence and sets the center frequency equal to the marker frequency.
[ZOOM]	Places the marker at the frequency entered. An out-of-range entry places the marker at a graticule border.

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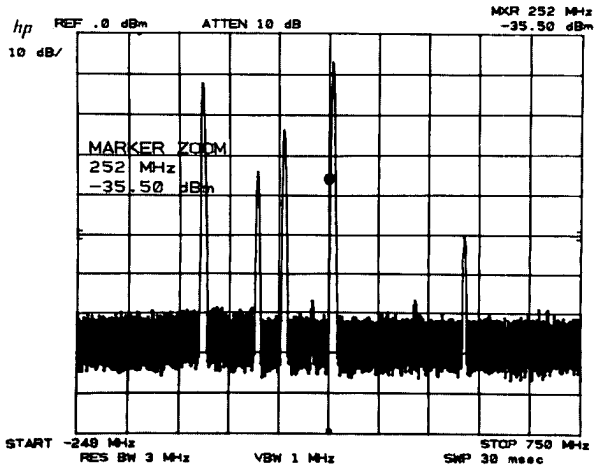
Example

In wide frequency spans, it is often necessary to expand a portion of the frequency span about a specific signal in order to resolve modulation sidebands or track frequency drift.

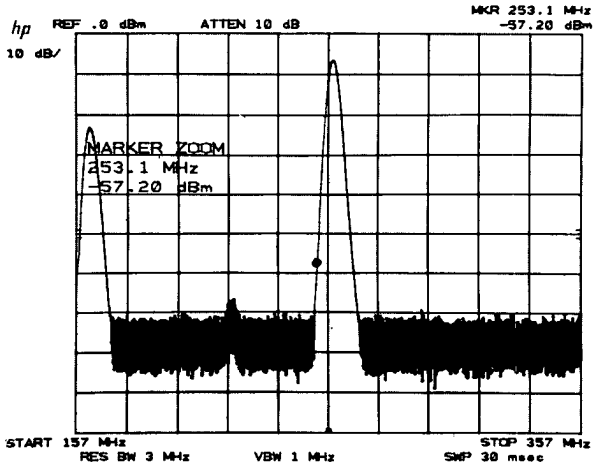
From an [INSTR PRESET] full span, select a signal using the marker with [ZOOM] ◎ .



To center the marker and signal *and* expand the frequency span in one step, press [⇩] .

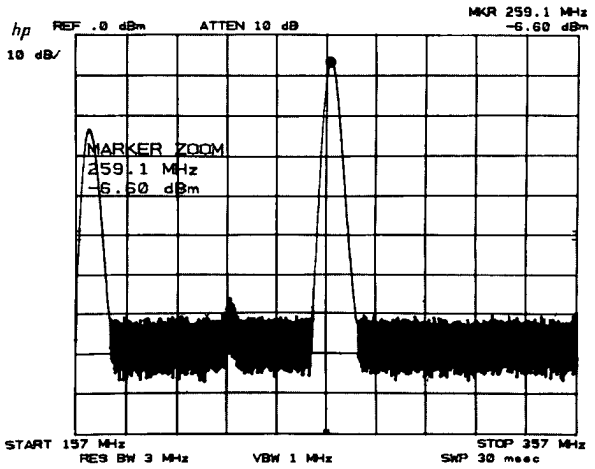


Expanding twice more with [⇩] [⇩] shows that the marker requires recentering on the signal.

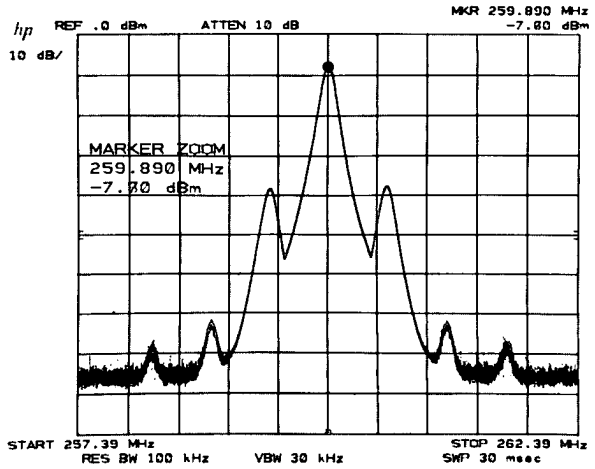


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Recenter with ◎ .



Continue using ▽ (and recentering the marker on the signal when necessary) until the desired resolution is achieved.



AUTOMATIC ZOOM

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

To use the automatic zoom function:

Use [NORMAL] ◎ to identify the signal to be zoomed in on.
Press [SIGNAL TRACK] [FREQUENCY SPAN] and enter the desired span with the DATA number/units keyboard.

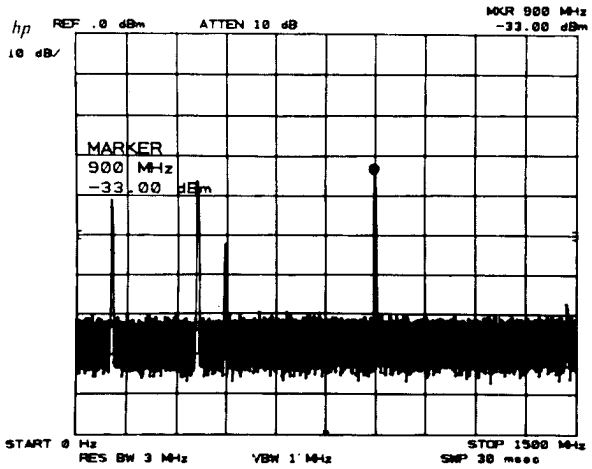
When the units key is pressed, the zooming process begins.

Example

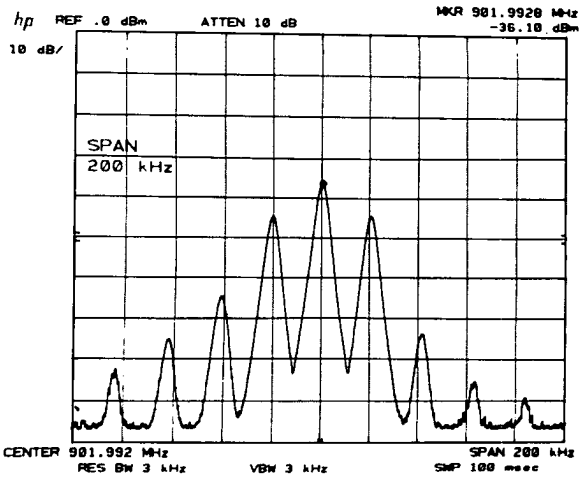
A single carrier needs to be examined in a 200 kHz span to see the sidebands.

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Place a marker on the carrier with [NORMAL] ◎.
Press [SIGNAL TRACK] [FREQUENCY SPAN].



Enter the span.
Press [2] [0] [0] [kHz mV msec] and auto zoom will be completed.



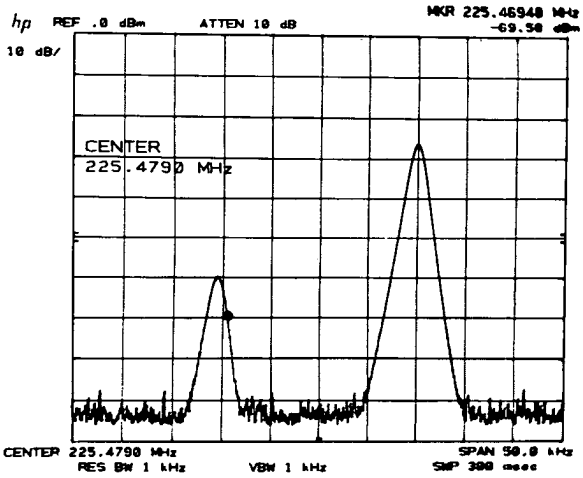
PEAK SEARCH

Peak search places a single marker at the highest trace position of the highest priority trace. The active function is not changed.

Example

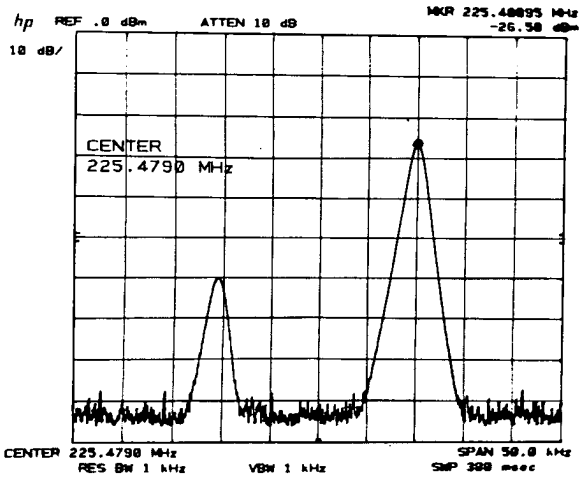
[PEAK SEARCH] positions the marker at the peak of the highest signal response.

In a narrow span, the marker may be placed at the signal peak.



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Press [PEAK SEARCH] .



Note that the marker seeks the maximum trace response, no matter what the cause of the response. A larger signal, or the local oscillator feedthrough, would also have attracted the marker.

MARKER ENTRY

[MKR→ CF] , [MKR→ REF LVL] , and marker [Δ] into span. Immediately set the corresponding FUNCTION value equal to the readout of the active marker or markers:

ENTRY	RESULT
[MKR→ CF]	marker frequency into [CENTER FREQUENCY]
[SHIFT] O [Δ]	marker [Δ] frequency into [FREQUENCY SPAN] or [START FREQ] / [STOP FREQ] ,
[MKR→ REF LVL]	marker amplitude into [REFERENCE LEVEL]

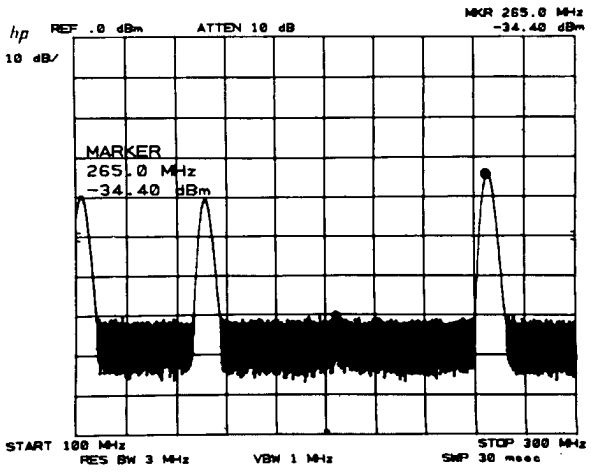
[MKR/Δ→ STP SIZE] immediately records the single or the differential marker frequency in COUPLED FUNCTION [CF STEP SIZE] for use with [CENTER FREQUENCY] DATA [▲] [▼] .

A marker entry can be made any time a marker is on the trace. ([SHIFT] O [Δ] with only one marker displayed takes 0 Hz as the lowest frequency.) The active function is not changed.

Example

One of the fastest, most convenient ways to bring a signal to the center of the display is by using [MKR→ CF] .

Activate a single marker and bring it to the desired signal: [NORMAL] ◎



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SIGNAL TRACK – AUTOMATIC FREQUENCY CONTROL

The analyzer is capable of automatically maintaining a drifting signal at the center of the display. To operate a signal tracking,

Press [NORMAL], and place the marker on the signal to be tracked with ◯.

Press [SIGNAL TRACK] to initiate the tracking. The light above the key indicates tracking. (Press again to turn off.)

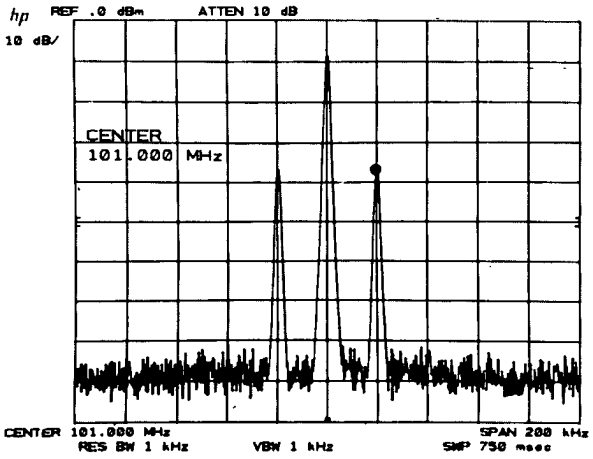
As the signal drifts, the center frequency automatically changes to bring the signal and marker to the center of the display.

MARKER [OFF], any other MARKER mode, or the instrument preset turns the tracking function off.

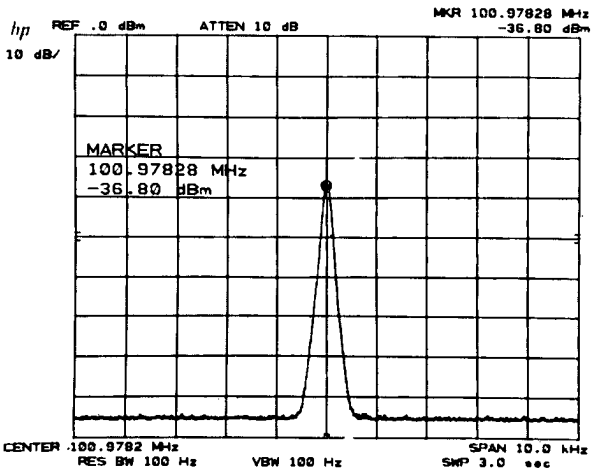
Example

The upper sideband of a transmitter is to be monitored as the carrier frequency is tuned.

Locate the sideband with [NORMAL] ◯.



The upper carrier sideband is tracked with [SIGNAL TRACK], then zoomed in with [FREQUENCY SPAN] [1] [0] [kHz mV msec].



As the carrier frequency is changed, the sideband response will remain in the center of the display. Both the center frequency and marker frequency read out in the sideband's frequency.

A combination of [SIGNAL TRACK] and [Δ] allows the "real time" signal frequency drift to be read on the display.

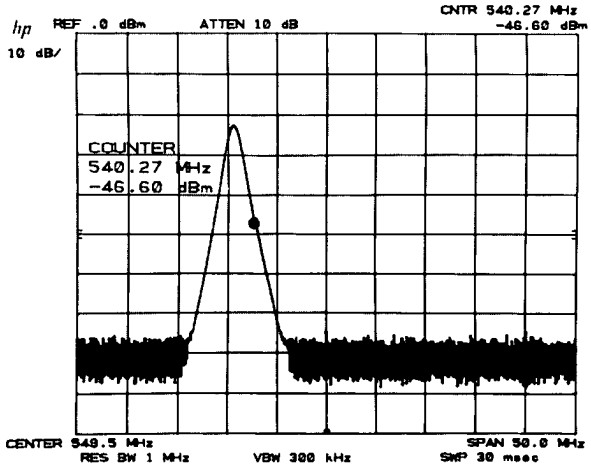
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FREQUENCY COUNT

Frequency count allows a number of measurements beyond the standard capability of the standard marker modes. Each is used with one of the three active marker modes, [NORMAL] , [Δ] , or [ZOOM] and each uses the DATA controls in the same manner.

[FREQ COUNT] counts the frequency of signals with great precision and accuracy, even if the marker is not positioned at the signal peak.

When [FREQ COUNT] is on, and the active marker is placed on a signal response such that the marker is >20 dB out of the noise or the intersections of two signal responses and in the top 6 divisions of the graticule, the signal's frequency is read out directly. [FREQ COUNT] works only for frequency spans of 500 MHz and below.



If the marker is not in the top 6 divisions, the display readout "CNTR" in the top right-hand marker area blinks, indicating the reading may be in error.

NOTE

The amplitude readout is for the absolute marker position and not the signal peak.

The marker mode combinations with [FREQ COUNT] are:

	Readout
[FREQ COUNT] + [NORMAL]	Signal frequency and marker amplitude.
[FREQ COUNT] + [Δ]	Frequency between the signal at the first marker, whose frequency has been *stored*, and the second marker's *counted* signal frequency. Amplitude between marker positions.
[FREQ COUNT] + [ZOOM]	Signal frequency and marker amplitude. Causes automatic recentering to exact signal frequency on each successive reduction of span with [⇩] .

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Measurement and Readout Range

The measurement and readout range for frequency count is the same as the associated marker modes: normal, differential, and zoom. Counter resolution to 1 Hz is available using the KEY FUNCTION [SHIFT] [FREQ COUNT] . See Chapter 11.

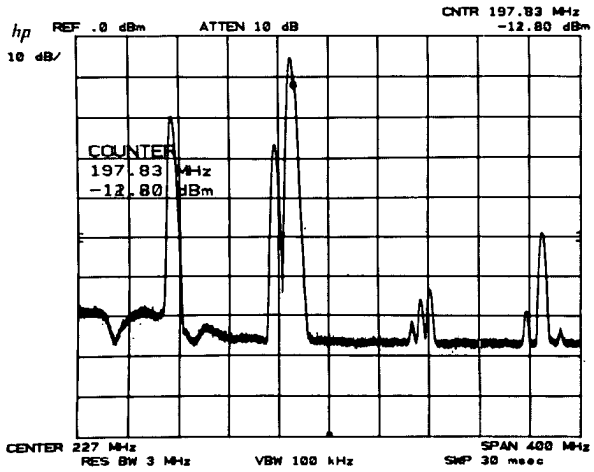
DATA Entry

See MARKER [NORMAL] , [Δ] , and [ZOOM] .

Example

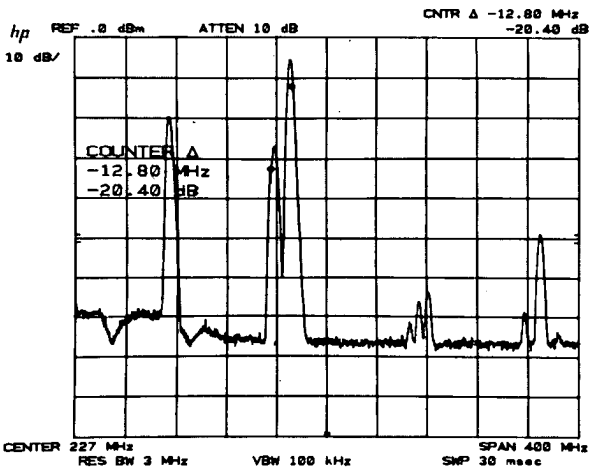
Counted frequency differences between stable signals can be measured.

Activate the frequency counter in a 400 MHz span and position the marker with ✳ [FREQ COUNT] ◯ .



To count the difference between the signal and its neighbor, place the marker on one signal with ◯ ; then activate marker differential and count the next signal.

Press [Δ] ◯ .



Note that the difference is not the difference between two current counter readings, but between one stored counter reading and the current counter reading.

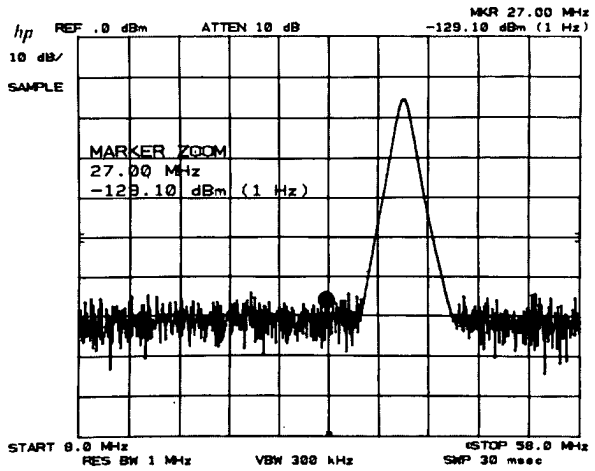
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NOISE LEVEL MEASUREMENT

When noise level is activated and the marker is placed in the noise, the rms noise level is read out normalized to a 1 Hz noise power bandwidth.

Noise level enabled: [SHIFT] [M NORMAL]

Noise level disabled: [SHIFT] [L OFF]



The noise level measurement readout is corrected for the analyzer's log amplifier response and detector response. The value is also normalized to a 1 Hz bandwidth.

Measurement and Readout Range

Noise level measures noise accurately down to 10 dB above the spectrum analyzer's noise level. The readout resolution is in steps of ±0.1 dB.

DATA Entry

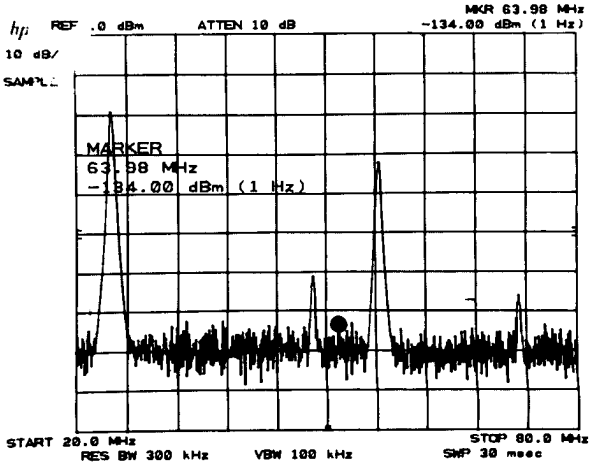
See MARKER [NORMAL], [Δ], and [ZOOM].

Example

In a communication system, the baseband noi[illegible]el as well as signal to noise ratio measurements are required.

Select a frequency in the baseband [illegible]rum clear of signals with a single marker.

Press [NORMAL] ◯.



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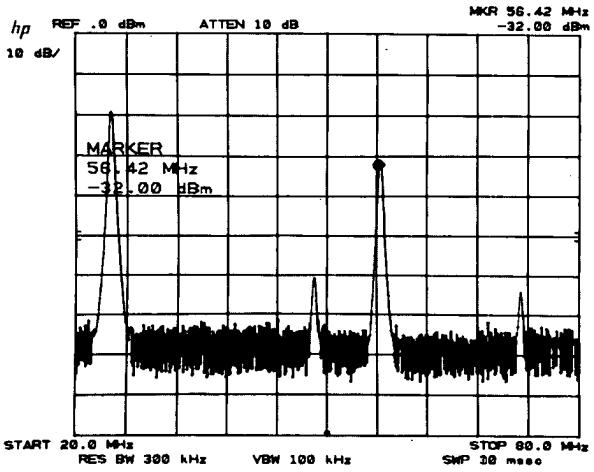
Read the noise at the marker by pressing SHIFT M (NORMAL).

The noise at 64 MHz is −134 dBm in a 1 Hz bandwidth. This corresponds to −134 dBm + 36 dB/4 kHz = −98 dBm in 4 kHz voice channel bandwidth.

Signal to noise measurements require the measurement of the noise level, as in the example above, and the measurement of the absolute signal level.*

Measure the power level of the adjacent signal. To turn the noise level off, press SHIFT L (OFF) and read the power level.

The signal to noise ratio referenced to 4 kHz bandwidth is −32 dBm − (−98 dBm) = 66 dB.



*Normalization to a desired bandwidth uses the equation $10 \log_{10} \left(\frac{\text{desired BW}}{1 \text{ Hz}} \right)$

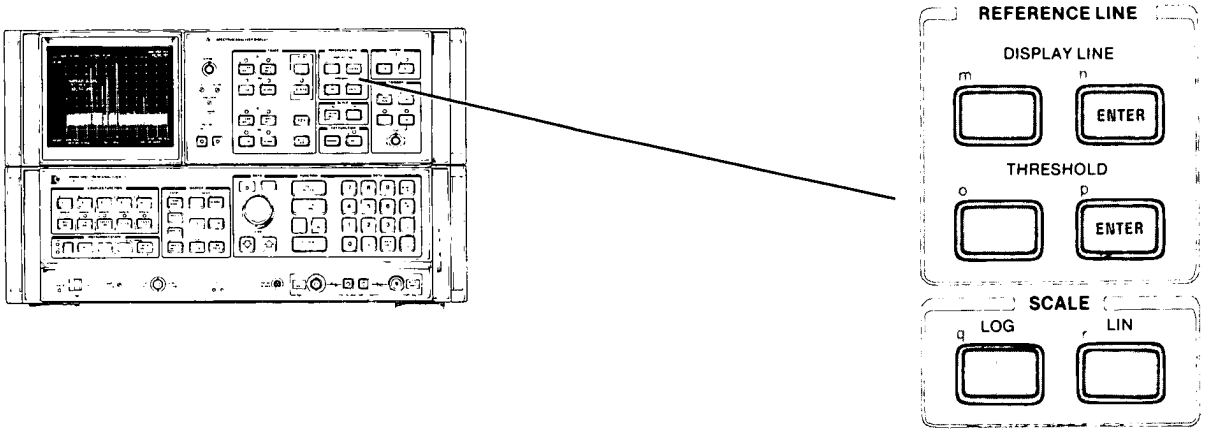
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Chapter 7
SCALE AND REFERENCE LINE

GENERAL DESCRIPTION

This chapter describes the use of SCALE and REFERENCE LINE control groups for setting the amplitude scale, and for making amplitude level measurements more conveniently.



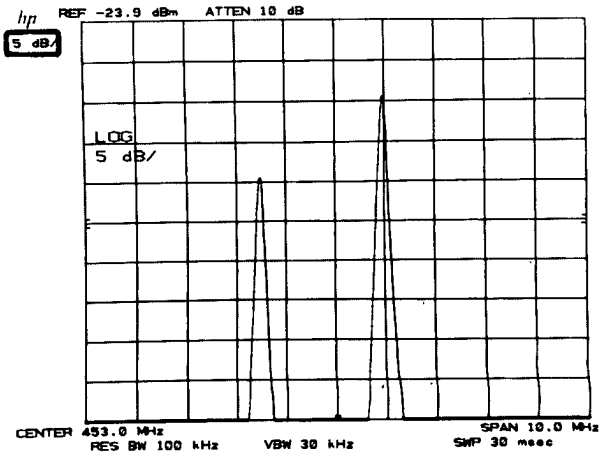
SCALE

SCALE keys allow the scaling of the vertical graticule divisions in logarithmic or linear units without changing the reference level value.

LOG
ENTER dB/DIV (DATA entry) scales the amplitude to 1 dB, 2 dB, 5 dB, or 10 dB per division.

If ENTER dB/DIV is pressed when the scale is linear, 10 dB per division is automatically entered. The subsequent (DATA), if any, then replaces the automatic 10 dB/div.

Press LOG ENTER dB/DIV 5 GHz +dBm dB

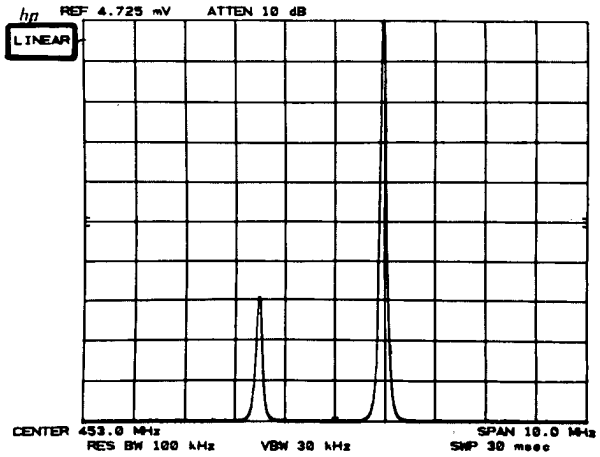


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LIN
[ ] immediately scales the amplitude proportional to input voltage. The top graticule remains the reference level, the bottom graticule becomes zero voltage. Reference level, and all other amplitudes, are read out in voltage. However, other units may be selected. See AMPLITUDE UNITS SELECTION, Chapter 11.

If [ENTER dB/DIV] is pressed when the scale is linear, 10 dB per division is automatically entered.

Press LIN [ ].



In LINEAR, a specific voltage per division scale can be set by entering a voltage reference level value. For example, to set the scale to 3 mV/division, key in 30 mV reference level. (Voltage entries are rounded to the nearest 0.1 dB, so the 30 mV entry becomes 30.16 mV, which equals −17.4 dBm.)

DATA Entry

[ENTER dB/DIV] [knob] [↓] [↑]	Changes scale in allowable increments (1, 2, 5, or 10 dB per division).
[ENTER dB/DIV] [numeric keypad]	Enables direct scale selection of allowed values. Other entries are rounded to an adjacent value.

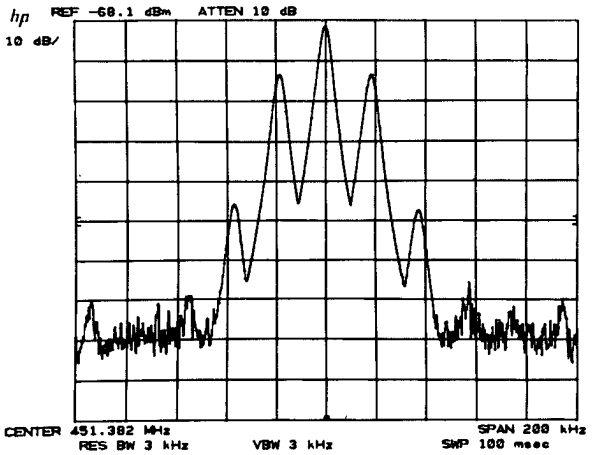
No DATA entry will be accepted with the linear SCALE selection key, LIN [ ].

Example

It is convenient to observe AM sidebands in linear as well as logarithmic scales for analysis of both modulation percentages and distortion products.

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Modulated AM signal displayed in the 10 dB /division scale shows the carrier, its sidebands, and distortion products.



Linear scaling enables observation of the sidebands proportional to the carrier.

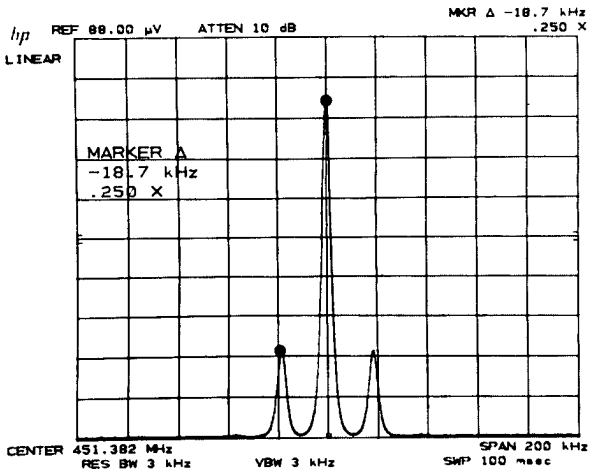
Press LIN .

As in the MARKER Δ example, Chapter 6, a direct readout of the percent modulation can be made.

The fractional readout is one-half the modulation index (only one sideband is measured).

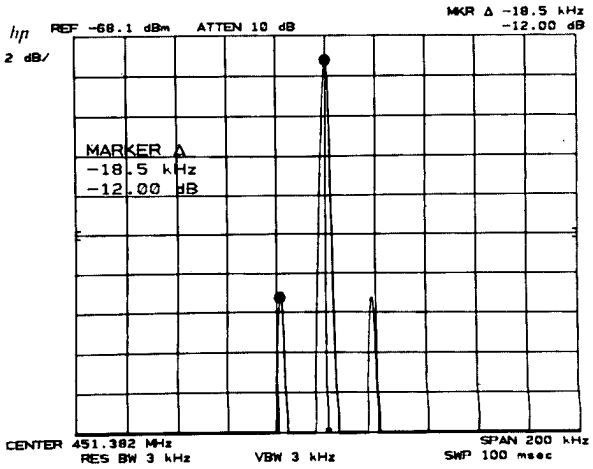
% AM = 2(.25) x 100 = 50%.

Note that the carrier signal need not be placed at the reference level for an index ratio measurement.



Change to a logarithmic scale with LOG (ENTER dB/DIV) and change the dB/ with ⇩ ⇩ .

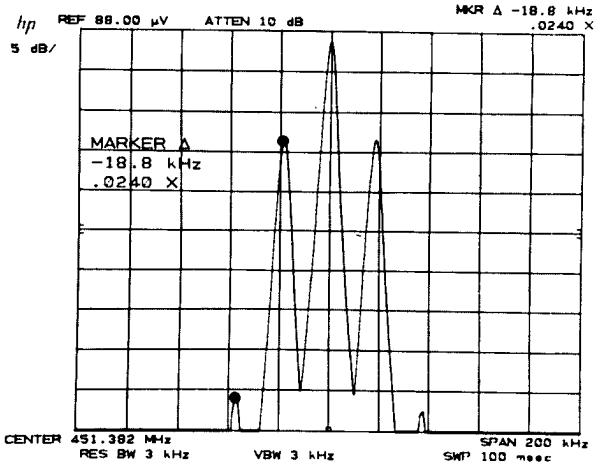
The sidebands are 12 dB down from the carrier, verifying the earlier measurement results.



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Harmonic distortion of the modulating signal can be measured as in MARKER [Δ], Chapter 6.

The modulation frequency is 18.8 kHz and the distortion caused by the second harmonic is 2.4% (read out as .024X).



REFERENCE LINE

The reference line functions DISPLAY LINE (DL) and THRESHOLD (TH) place horizontal reference lines on the display. Their levels are read out.

DISPLAY LINE uses:

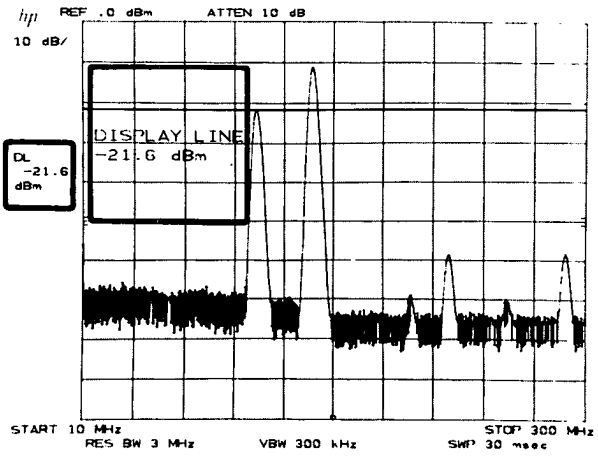
- measure signal levels with direct readout.
- establish a standard for go/no-go test comparisons.
- eliminate or reduce amplitude errors caused by system frequency response uncertainty with TRACE arithmetic.

THRESHOLD provides:

- a base line clipper whose level is read out.

DISPLAY LINE

Display line [ENTER] (DATA entry) places a horizontal reference line at any level on the graticule. The line's amplitude, in reference level units, is read out on the left-hand side of the CRT display.



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The display line can be positioned anywhere within the graticule. When activated after LINE power ON or [INSTR PRESET], the display line is placed 4.5 divisions down from the reference level.

Display line [OFF] erases the line and readout from the CRT display but does not reset the last position. If the display line is activated again before LINE power ON or [INSTR PRESET], it returns to its last position.

Display line position is always accessible for HP-IB and TRACE [E-DL -> E], even if never activated. See Chapter 5, TRACE ARITHMETIC.

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

DATA Entry

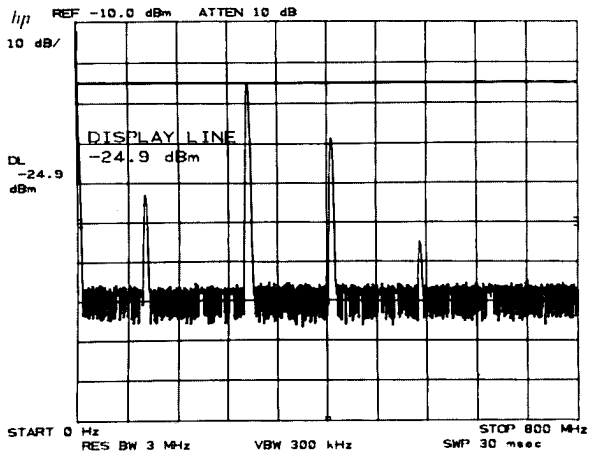
[ENTER] ◎	Moves the line about two divisions for each full turn. The line moves in display unit increments.
[ENTER] ⇩ ⇧	Moves the line one tenth of the total amplitude scale per step.
[ENTER] ▦	Positions the line to the exact entry level. Entry may be in mV, μV, ±dBm, ±dBmV, or ±dBμV, depending upon which units are selected.

Example

When the amplitude of a number of signals in the same span require a quick readout, the display line can be used.

Activate the display line with [ENTER].

With ◎, place the line through the peak of a signal and read out its absolute amplitude level.

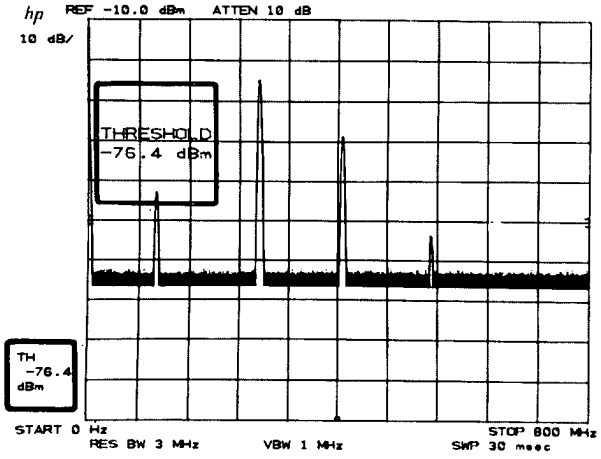


Moving the display line to each signal reads out its peak amplitude.

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THRESHOLD

Threshold [ENTER] (DATA entry) moves a lower boundary to the trace, similar to a base line clipper on direct writing CRT spectrum analyzers. The boundary's absolute amplitude level, in reference level units, is read out on the lower left-hand side of the CRT display.



The threshold can be positioned anywhere within the graticule. It operates on TRACE [CLEAR·WRITE], [MAX HOLD], or [VIEW] for TRACES A, B, and C simultaneously. When activated after LINE power ON or [INSTR PRESET], the threshold is placed 1 division from the bottom graticule.

The threshold level does not influence the trace memory, that is, the threshold level is not a lower boundary for trace information stored and output from the trace memories through the HP-IB. TH [OFF] removes the threshold boundary and readout from the CRT display, but does not reset the position. If threshold is activated again before LINE power ON or [INSTR PRESET], it resumes at its last level.

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

DATA Entry

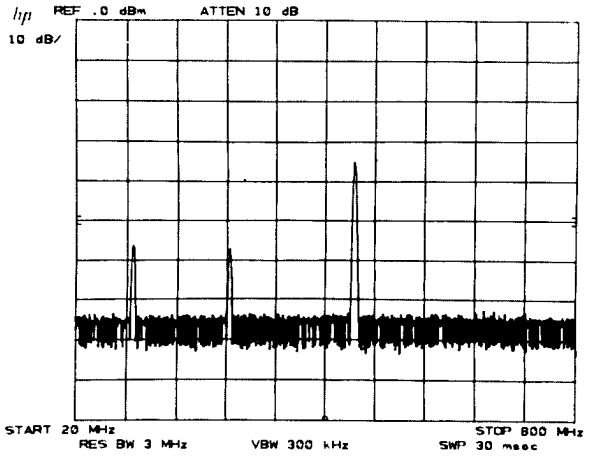
[ENTER] ◯	Moves the THRESHOLD about two divisions per rotation. The line moves display unit increments.
[ENTER] ▽ △	Moves the THRESHOLD one tenth of the total amplitude scale per step.
[ENTER] ▦	Positions the THRESHOLD to the exact entry level. Entry may be in mV, μV, ±dBm, ±dBmV, or ±dBμV, depending upon units selected.

Example

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

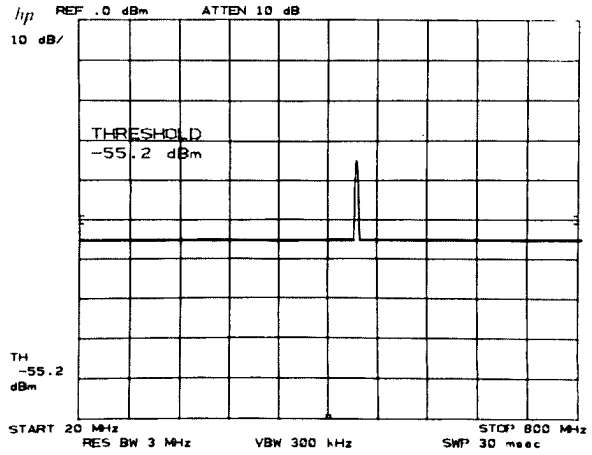
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A series of signals can be tested for a specific threshold level by placing the threshold at the test level.



Press THRESHOLD [ENTER] [5] [5] [.] [2] [MHz -dBm sec]

Only those signals > −55.2 dBm are displayed.



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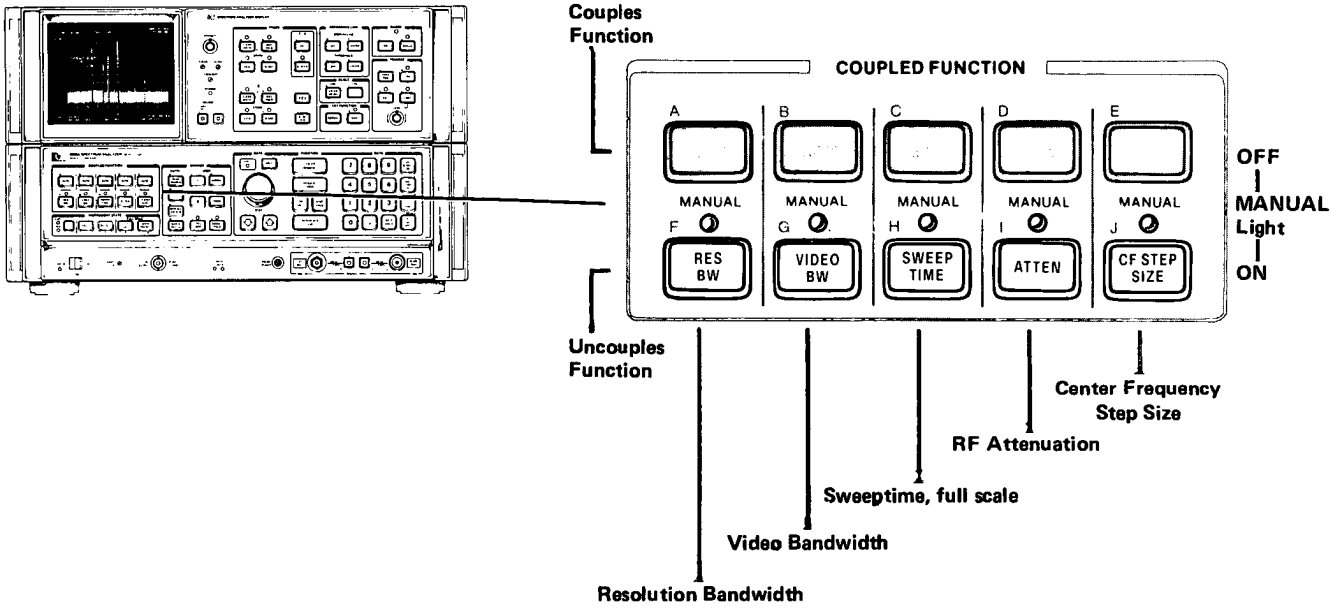
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Chapter 8
COUPLED FUNCTION

GENERAL DESCRIPTION

This chapter describes the COUPLED FUNCTION group and its use in various measurements. The COUPLED FUNCTIONS control the receiver characteristics of the spectrum analyzer.

The values of the COUPLED FUNCTION are automatically selected by the analyzer to keep absolute amplitude and frequency calibration as frequency span and reference level are changed.* The functions are all coupled with LINE power ON, [INSTR PRESET], or when their individual [AUTO] is activated. [0-1.5 GHz] couples all functions but [ATTEN] and [CF STEP SIZE].



For each COUPLED FUNCTION:



Sets the function to the preset value dictated by the analyzer's current state. The function is coupled.



Function value does not change with instrument state. DATA entry changes value. The MANUAL light turns on and stays on until the function is placed in [AUTO] once again.

In most cases the [AUTO] functions change values to maintain amplitude calibration when one or more of the others are manually set. If the amplitude or frequency becomes uncalibrated, "MEAS UNCAL" appears in the right-hand side of the graticule.

*Center frequency step size does not affect amplitude or frequency calibration.

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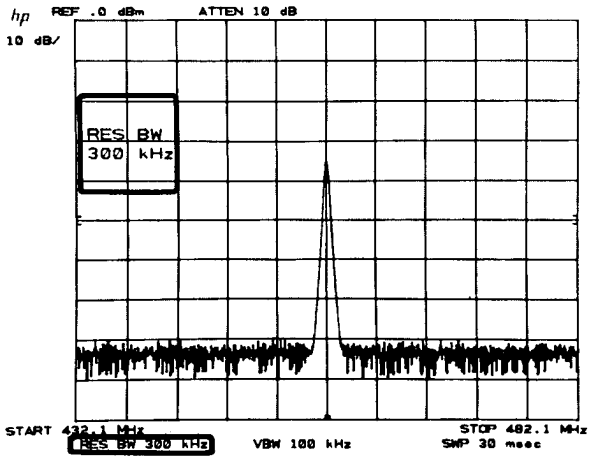
Coupled Function	Selects
RES BW	3 dB resolution bandwidth (IF filter) which largely determines the ability of the analyzer to resolve signals close together in frequency.
VIDEO BW	3 dB bandwidth of the post detection low pass filter that averages noise appearing on the trace.
SWEEP TIME	The total time for the analyzer to sweep through the displayed frequency span or display a detected signal in zero frequency span.
ATTEN	The setting of the input RF attenuator which controls signal level at the input mixer.
CF STEP SIZE	Selects center frequency change for each DATA ▽ △ when CENTER FREQUENCY is activated.

DATA ENTRY FOR COUPLED FUNCTIONS

Discrete values are entered for RES BW , VIDEO BW , SWEEP TIME , and ATTEN . The DATA entry from DATA ◎ and ▽ △ selects these values sequentially from the current value. A keyboard DATA entry that is not exactly equal to an allowable value selects an adjacent value. For example, RES BW 1 5 kHz mV msec selects 30 kHz bandwidth, the next higher IF bandwidth.

RESOLUTION BANDWIDTH

RES BW (DATA entry) sets bandwidth selection to MANUAL and changes the analyzer's IF bandwidth. The bandwidths that can be selected are 10 Hz, 30 Hz, 100 Hz, 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz, 300 kHz, 1 MHz, and 3 MHz.



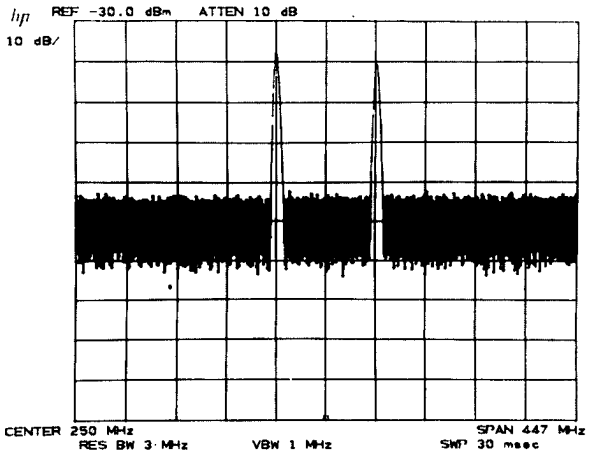
Example

A measurement requiring manual resolution bandwidth selection is the zero span (time domain) observation of modulation waveforms. An example can be found in Chapter 3, ZERO FREQUENCY SPAN – FIXED TUNED RECEIVER OPERATION.

Another use of manual resolution bandwidth is for better sensitivity over a given frequency span.

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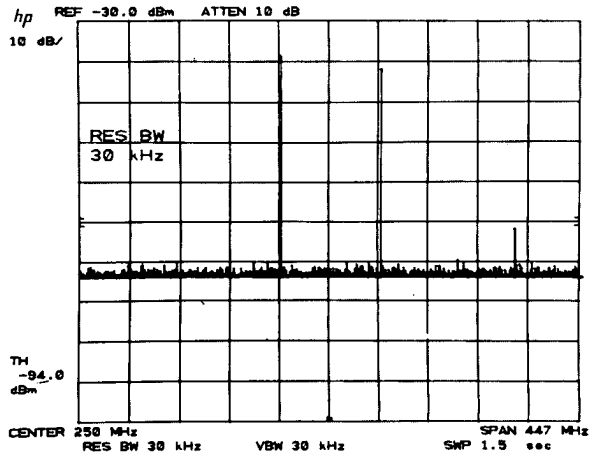
The low-level intermodulation products of two signals spaced 100 MHz apart need to be measured. With the functions coupled, the analyzer noise may mask these distortion products.



Reduction of the noise level by 10 dB (increased sensitivity) is achieved by decreasing the bandwidth by a factor of 10.

RES BW ⇩ ⇩

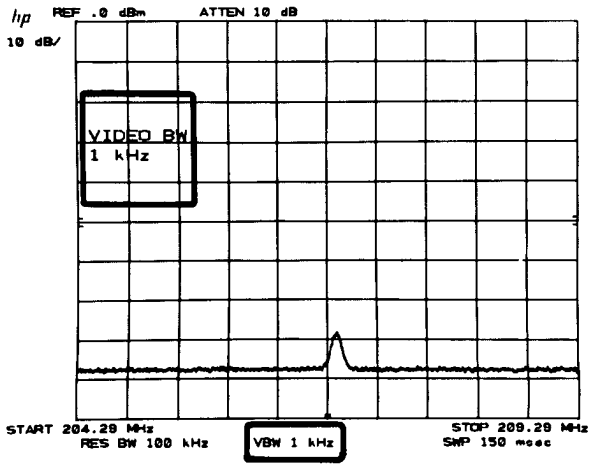
(THRESHOLD has been activated to clarify the display.)



The sweep time automatically slows to maintain absolute amplitude calibration if SWEEP TIME is coupled.

VIDEO BANDWIDTH

VIDEO BW (DATA entry) sets the video bandwidth selection to manual and changes the analyzer's post detection filter bandwidth. The bandwidths that can be selected are 1 Hz, 3 Hz, 10 Hz, 30 Hz, 100 Hz, 300 Hz, 1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz, 300 kHz, 1 MHz, and 3 MHz.

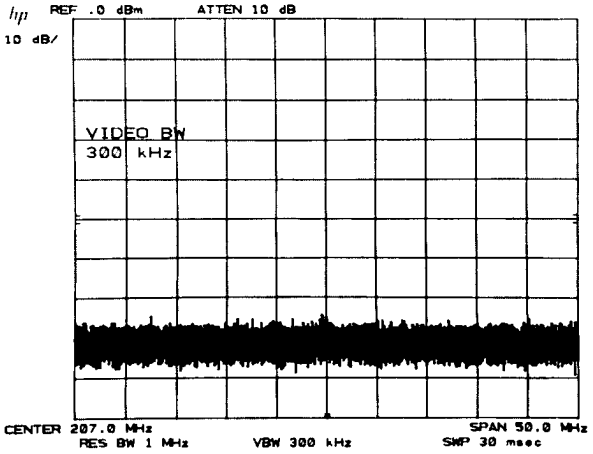


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Example

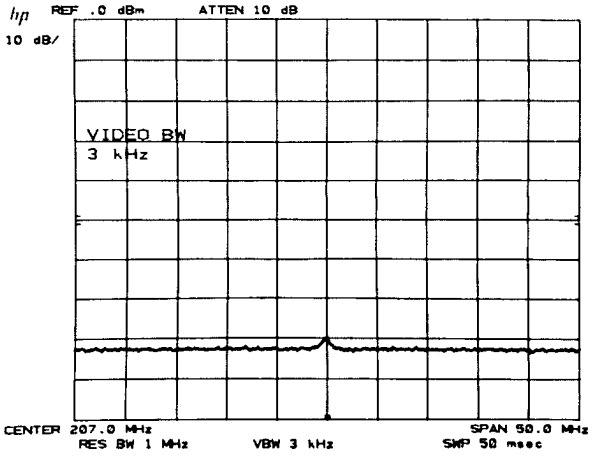
Signal responses near the noise level of the analyzer are visually masked by the noise. The video filter can be narrowed to smooth this noise.

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



Narrowing the video bandwidth clarifies the signal and allows its amplitude measurement.

Press VIDEO BW ⇩ ⇩ ⇩ ⇩



The sweep time increases to maintain amplitude calibration.

NOTE

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

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Video Averaging

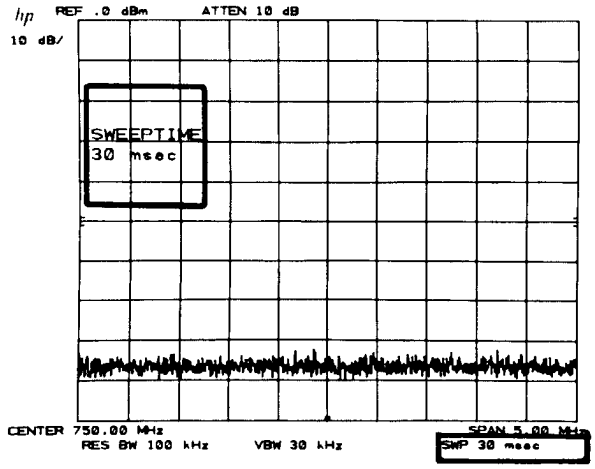
Narrowing the video filter requires a slower sweep time to keep amplitude calibration, since the narrower filter must have sufficient time to respond to each signal response. Video averaging is an internal routine which *digitally* averages a number of sweeps, allowing a more instantaneous display of spectral changes due to center frequency, frequency span or reference level changes. See Chapter 11.

SWEEP TIME

SWEEP TIME (DATA entry) sets the sweep time selection to manual and changes the rate at which the analyzer sweeps the displayed frequency or time span.

The sweep times that can be selected are:

	SWEEP TIME	SEQUENCE
FREQUENCY SPAN ≥ 100	20 msec to 1500 sec	1,1.5,2,3,5, 7.5 and 10
ZERO FREQUENCY SPAN	1 μsec to 10 msec	1, 2, 5, and 10
	20 msec to 1500 sec	1,1.5,2,3,5, 7.5 and 10

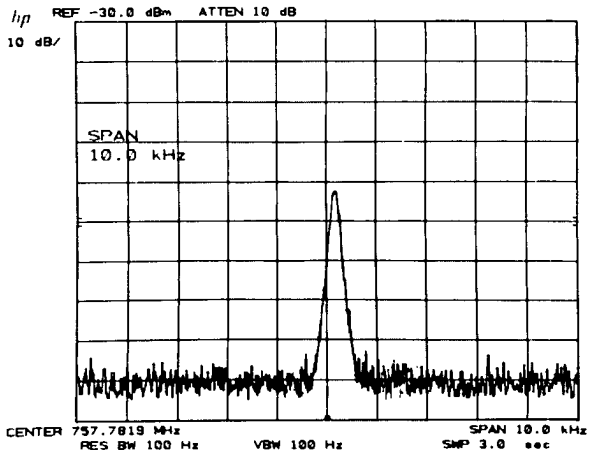


Example

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

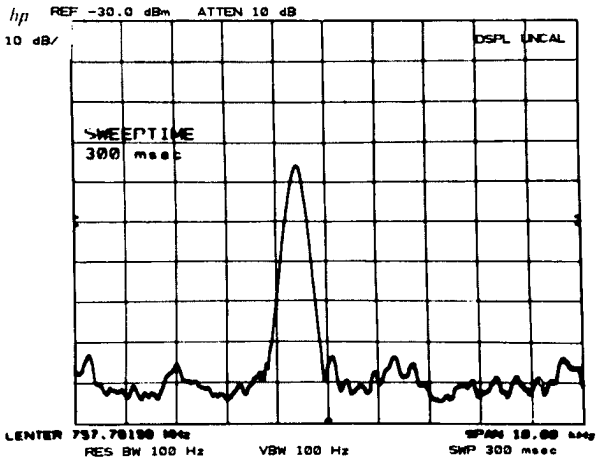
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A frequency span of 10 kHz has selected resolutions and video bandwidths of 100 Hz, and a sweep time of 3 seconds.



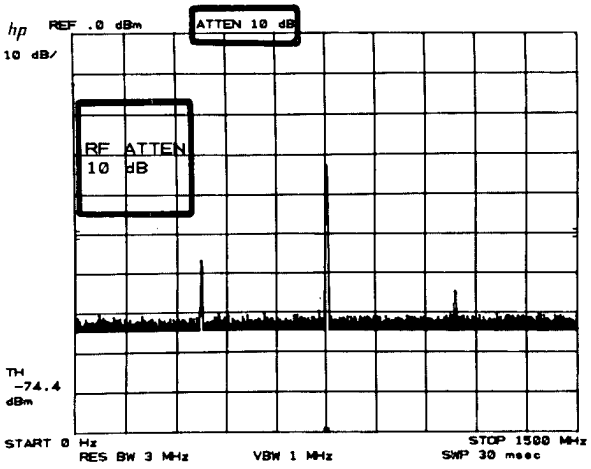
To quickly see signals present in the span, press SWEEP TIME and ⇩ several times. When the sweep completes its span, couple sweep time again with AUTO.

Note that the DISPL UNCAL message appears automatically, as the faster sweep time causes some distortion of the spectral response.



INPUT ATTENUATION

ATTEN (DATA entry) sets the attenuation function to MANUAL and changes the analyzer's RF input attenuation. The levels of attenuation that can be selected are 10 dB to 70 dB in 10 dB steps, or 0 dB under special conditions. Generally, the reference level does not change with attenuator settings.



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When the RF input attenuator function is coupled (AUTO), the value selected makes sure the level at the input mixer is less than −10 dBm (the 1 dB compression point) for on-screen signals. For example, if the reference level is +28 dBm, the input attenuator is set to 40 dB: +28 dBm − 40 dB = −12 dBm at the mixer.

The input mixer level can be changed to ensure maximum dynamic range. See INPUT MIXER LEVEL, Chapter 11.

CAUTION

Greater than +30 dBm total input power will damage the input attenuator. Input powers greater than +13 dBm at the input mixer will be reduced by an internal limiter.

Zero Attenuation

As a precaution to protect the spectrum analyzer's input mixer, 0 dB RF attenuation can be selected from the number/units keyboard only by pressing [ATTEN] [0] [GHz +dBm dB] .

Reference Levels ≤ −100 dBm and > +30 dBm

Reference levels ≤ −100 dBm or between +30 dBm and +60 dBm can be called when the reference level extended range is activated. Low reference level limits depend on resolution bandwidth and scale.

Press [SHIFT] [ATTEN] to extend the reference level range.

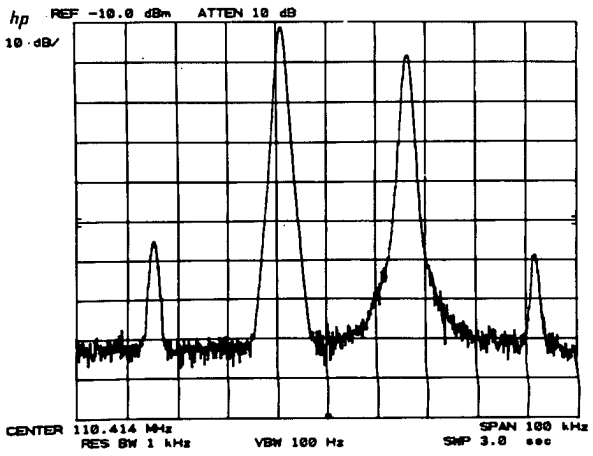
See Chapter 3, FUNCTION [REFERENCE LEVEL], and Chapter 11, [SHIFT] KEY FUNCTIONS.

Determining Distortion Products

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

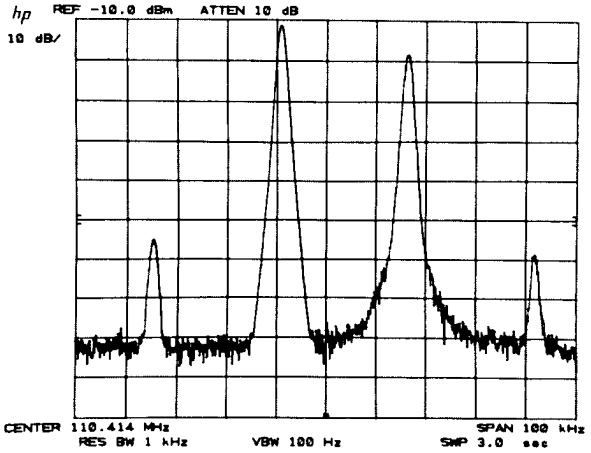
Example

The two main signals shown are producing intermodulation products because the analyzer's input mixer is overloaded.

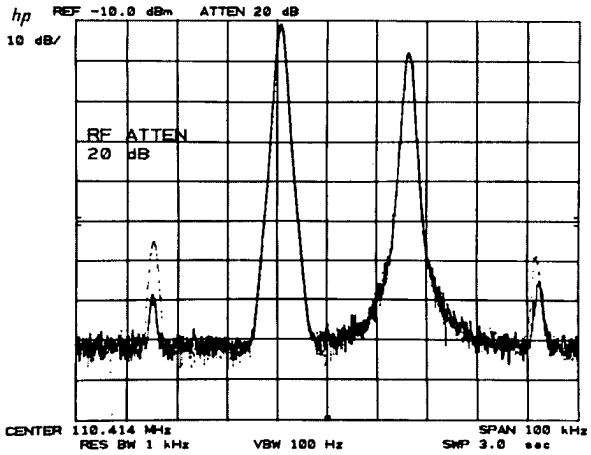


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To determine whether these intermodulation products are generated by the analyzer, first save the spectrum displayed in B with [CLEAR WRITE] B [VIEW] B.



Increase the RF attenuation by 10 dB. Press [ATTEN] [↑] . (If the reference level changes, it is necessary to return it to its original value.)



Since some of the signal responses decrease as the attenuation increases (by comparing the response in A with the stored trace in B), distortion products are caused by an overloaded input mixer. The high level signals causing the overload conditions must be attenuated to eliminate this condition.

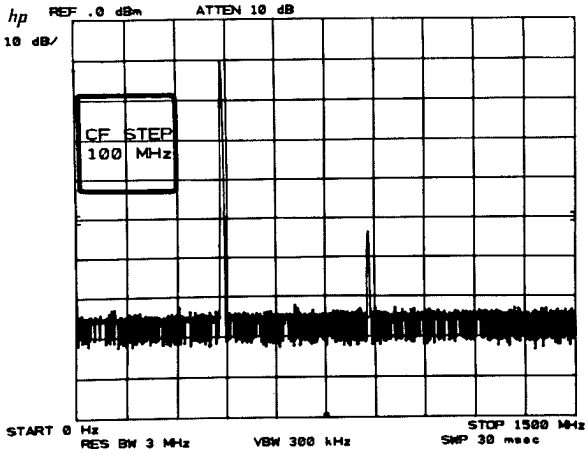
CENTER FREQUENCY STEP SIZE

[CF STEP SIZE] (DATA entry) sets step size to MANUAL. The step size can now be changed and stored. While [CF STEP SIZE] is in MANUAL, [CENTER FREQUENCY] [↑] and [↓] changes center frequency by the step size value stored in the register. Several functions can be used to enter step size value to the register. When a CF step size is AUTO, the center frequency steps are 10% of the frequency span, even through the CF step size register contains another value.

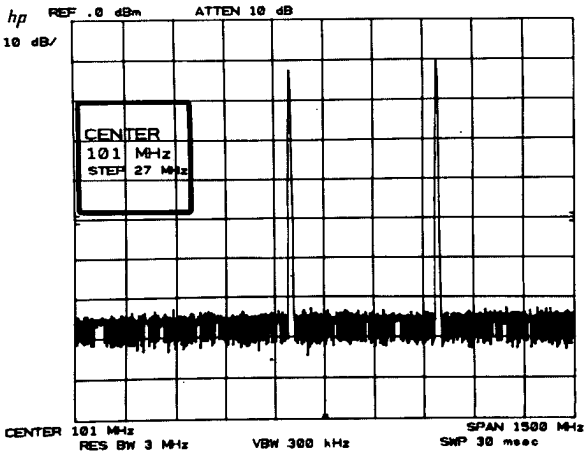
	Entry Value	[CF STEP SIZE] State
step size [AUTO] , [INSTR PRESET] FULL SPAN or LINE power ON	100 MHz	coupled (AUTO)
[CF STEP SIZE] (DATA entry)	DATA entry value	uncoupled (MANUAL)
MARKER [MKR/Δ→ STP SIZE]	marker frequency readout	uncoupled (MANUAL)

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The step size can be varied from 0 Hz to 1500 MHz to a resolution equal of 1 Hz. It is displayed with the same resolution as center frequency.



When the center frequency is activated with step size in MANUAL, the active function readout includes both the center frequency and the step size value.



DATA Entry

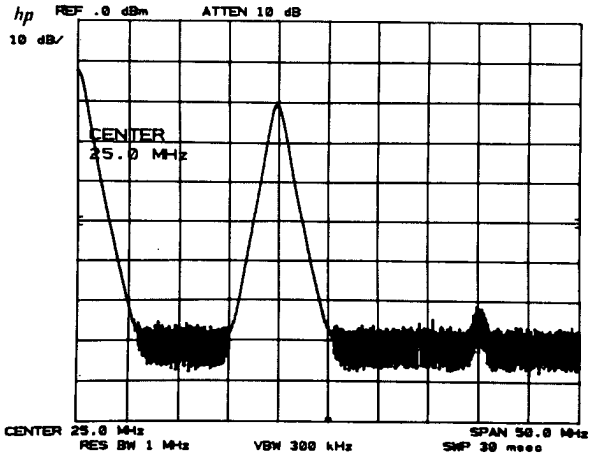
CF STEP SIZE ◎	Changes the step size in display unit increments.
CF STEP SIZE ⇩ ⇧	Changes the step size in steps equal to one tenth of the frequency span.
CF STEP SIZE ▦	Selects a specific step size to a resolution equal to the current center frequency readout.

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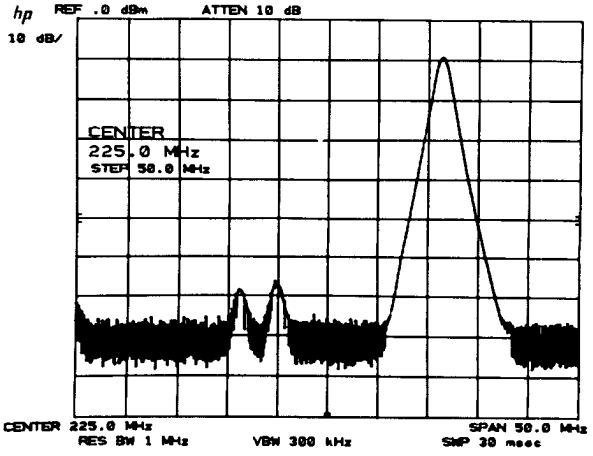
Example

Surveillance of a wide frequency span sometimes requires high resolution. One fast way to achieve this is to take the span in sequential pieces using a tailored center frequency step. This example looks from 0 Hz to 1500 MHz in 50 MHz spans.

First, set a span and start frequency. For a span of 50 MHz press [FREQUENCY SPAN] [5] [0] [MHz -dBm sec] . Set the center frequency to 25 MHz with [CENTER FREQUENCY] [2] [5] [MHz -dBm sec] .



Set the step size to 50 MHz, [CF STEP SIZE] [5] [0] [MHz -dBm sec] , and reactivate center frequency with [CENTER FREQUENCY] .



Now each [⇧] sets the center frequency to the next 50 MHz span for a span-by-span surveillance of the spectrum. (Center frequency = 25 MHz, 75 MHz, 125 MHz, etc.) Center frequency step size can also be defined by the marker. See the MARKER ENTRY portion of Chapter 6.

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Chapter 9
SWEEP AND TRIGGER

GENERAL DESCRIPTION

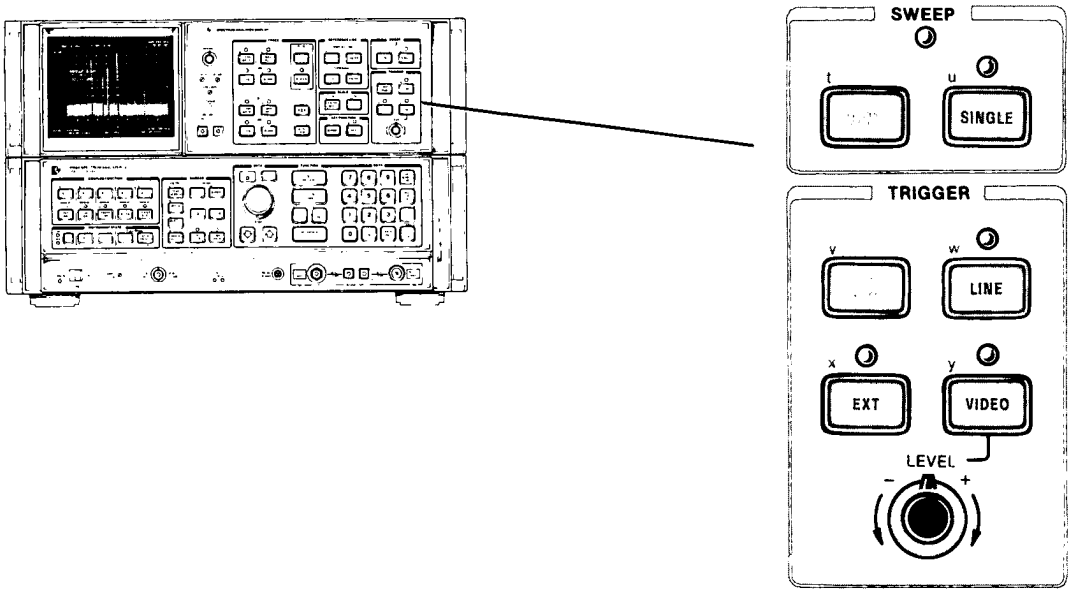
This chapter describes the use of SWEEP and TRIGGER control functions.

SWEEP controls enable:

CONT continuous, or repetitive sweeping (sweep time ≥20 msec).
SINGLE a single sweep, which will repeat only on demand (sweep time ≥20 msec).

TRIGGER controls select the function that begins a sweep:

FREE RUN as soon as possible,
LINE line voltage passes through zero on a positive swing,
EXT an external signal voltage passes through ~1.5V on a positive swing.
VIDEO the level of a detected RF envelope reaches up to the level on the CRT display determined by the LEVEL knob.



SWEEP AND TRIGGER CONTROLS

SWEEP

The spectrum analyzer frequency sweep (sweep times ≥20 msec), once triggered, continues at a uniform rate from the start frequency to the stop frequency unless new data entries are made to the analyzer from the front panel or the HP-IB. With faster sweeps, for example, changes to center frequency appear continuous. With long sweep times, a change in center frequency noticeably suspends the sweep while the analyzer updates its state and readout, then the sweep continues from where it was, tracing out the new spectrum.

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The SWEEP light indicates a sweep is in progress. The light is out between sweeps, during data entry and during [FREQ COUNT] gating. (The light is out for sweep times ≤10 msec.)

After a sweep, the next sweep is initiated only if:

- continuous sweep mode is selected or a single sweep demand is made,
- the trigger conditions are met,
- data is not entered continuously from the front panel DATA controls or the HP-IB.

Continuous Sweep

[CONT] enables the continuous sweep mode. Provided the trigger and data entry conditions are met, one sweep follows another as soon as triggered. Pressing [CONT] initiates a new sweep.

Single Sweep

[SINGLE] enables the single sweep mode. Each time [SINGLE] is pressed (including when the SWEEP mode is changed from continuous), one sweep is initiated, provided the trigger and data entry conditions are met. A sweep in progress is terminated and restarted upon [SINGLE] .

Zero Frequency Span Sweep

In zero frequency span, sweep times from 1 μsec to 10 msec are also available. In these sweep times the SWEEP [CONT] and [SINGLE] are disabled. The video signal response is *not* digitally stored (trace modes also disabled), but multiplexed directly onto the display along with the graticule and readouts. The graticule and readouts are refreshed following each fast sweep.

To avoid flicker of the display when external or video triggers are less frequent than once every 25 msec, the analyzer triggers internally. If *only* an external or video trigger is required, press

[SHIFT] [EXT] (x) disables "auto" external trigger feature

or [SHIFT] [VIDEO] (y) disables "auto" video trigger feature

NOTE

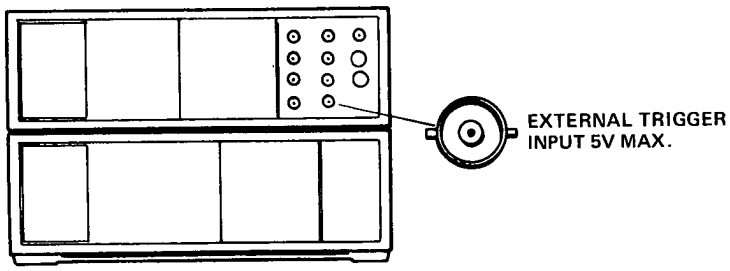
For zero frequency span sweep times ≤10 msec and [SHIFT] x or [SHIFT] y, the CRT display graticule and readout depend on triggering. If no trigger is present, the CRT display is blank.

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TRIGGER

The analyzer sweep is triggered in one of four selectable modes.

- [FREE RUN] allows the next sweep to start as soon as possible after the last sweep.
- [LINE] allows the next sweep to start when the line voltage passes through zero, going positive.
- [EXT] allows the next sweep to start when an external voltage level passes through ≈1.5V, going positive. The external trigger signal level must be between 0V and +5V.



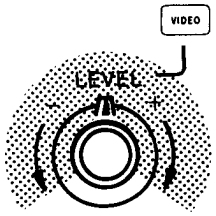
EXTERNAL TRIGGER INPUT

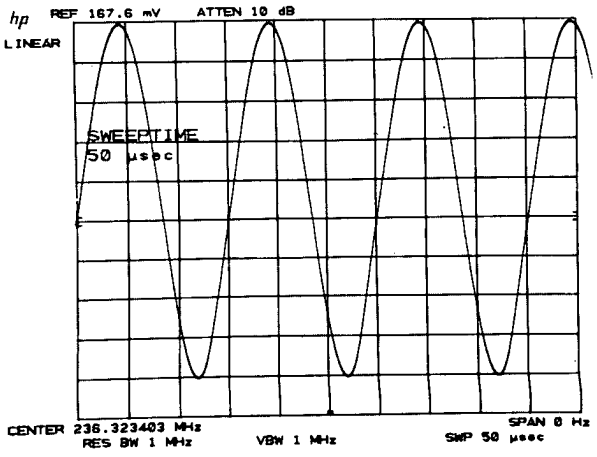
- [VIDEO] allows the next sweep to start if the detected RF envelope voltage rises to a level set by the LEVEL knob. The LEVEL corresponds to detected levels displayed on the CRT between the bottom graticule (full CCW) and the top graticule (full CW).

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

Example

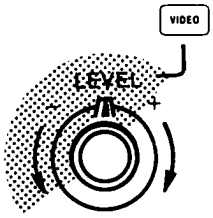
A zero span display of this video waveform will trigger for all LEVEL knob settings.

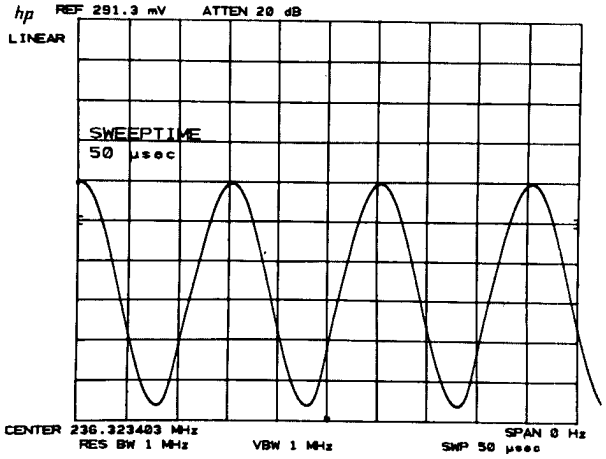




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If the video signal lowers on the display, the LEVEL must be set towards the minus side.





If the level does not cause a trigger within 25 msec, the sweep is triggered anyway to ensure a display. Note that this is true only for sweep times ≤10 msec.

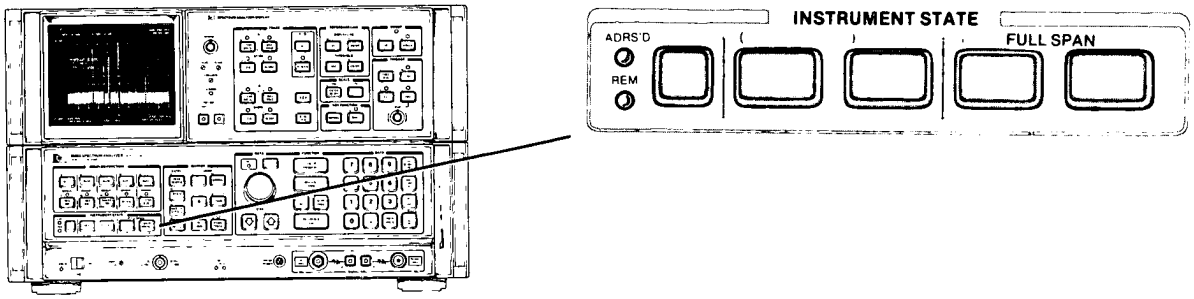
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Chapter 10
INSTRUMENT STATE

GENERAL DESCRIPTION

This chapter describes the INSTRUMENT STATE keys. Each key allows access to or activation of a specific set of functions and their values. Some of the sets are built in to the analyzer and some are user defined.



Instrument states that can be selected:

FULL SPAN
[INSTR PRESET] A full 0 Hz to 1500 MHz span with coupled operation and *all* the functions set to known states and values.

FULL SPAN
[0-1.5 GHz] A full 0 Hz to 1500 MHz span with a minimum of other front panel functions changed.

[SAVE] [1] Saves the complete set of current front panel function states and values for later recall. Registers 1 through 6 are available for storage.

[RECALL] [1] Recalls the complete instrument state saved in the register called.

[LCL] Calls for front panel control after the analyzer has been placed in a remote state by an HP-IB controller.

FULL SPAN INSTRUMENT PRESET

[INSTR PRESET] provides a convenient starting point for making most measurements. It calls for a full 1500 MHz span, coupled functions, and a 0 dBm reference level, to name a few. LINE power ON automatically calls for an instrument preset.

The states that are set include all the functions and values of

- front panel functions,

and

- [SHIFT] KEY FUNCTIONS,

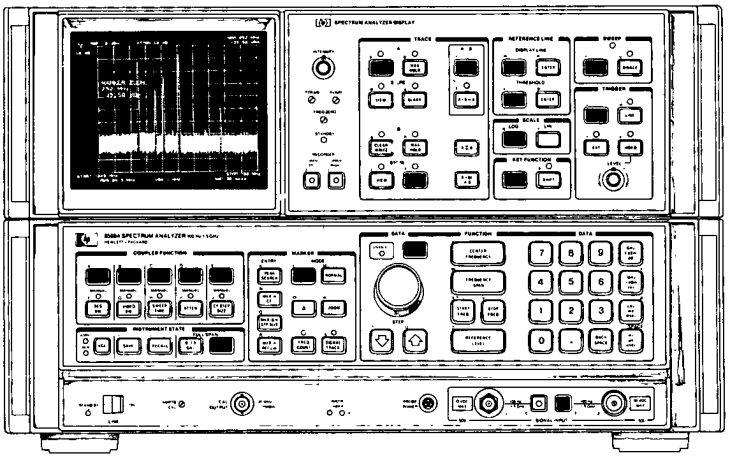
and

- functions accessible only by the HP-IB.

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Front Panel Preset

[INSTR PRESET] enables all the front panel functions designated by keys with white lettering. It saves a trace response in TRACE B, but not in A or C.



■ FUNCTIONS ACTIVATED WITH [INSTR PRESET]

To be precise:

SIGNAL INPUT:	Input 2 selected	100 kHz – 1.5 GHz
FUNCTION:	Start Frequency	0 Hz
	Stop Frequency	1500 MHz
	Reference Level	0 dBm
DATA:	Hold	
COUPLED FUNCTION:	All set to [AUTO], which corresponds to the following values:	
	Resolution Bandwidth	3 MHz
	Video Bandwidth	1 MHz
	Sweep time	20 msec full scale
	Attenuator	10 dB, coupled to maintain < – 10 dBm at input mixer
	Center Frequency Step Size	100 MHz entered in register
TRACE:	A	Clear-Write
	B	Blanked but information in memory saved
	A – B	Off
MARKER:	Off	
INSTRUMENT STATE [SAVE] and [RECALL]	States are saved, including the current state. See [RECALL] [7] below.	
SCALE:	Logarithmic, 10 dB/division	
REFERENCE LINE:	Display line off	5.5 divisions up
	Threshold off	1.0 divisions up

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SWEEP: Continuous

TRIGGER: Free run

INSTR CHECK: An internal instrument check routine is run. If a failure is detected, one or both INSTR CHECK LEDs remain lit.

KEY FUNCTION: Normal

[SHIFT] FUNCTIONS: All [SHIFT] functions are disabled. For example, all titling is erased after an instrument preset. Chapter 11, [SHIFT] KEY FUNCTIONS, discusses the implications of activating instrument preset during [SHIFT] FUNCTION use.
If the key is activated (shift light on), [INSTR PRESET] unshifts the key. This is equivalent to pressing [NORMAL].

HP-IB FUNCTIONS:

"D1"	Display size normal
"EM"	Erase trace C memory
"03"	Output format ASCII absolute
"PD"	Pen down
"DA"	Display address set to 3072

Graphic information or control language written into the analyzer memory by HP-IB functions such as graph (GR), plot (PA), label (LB), or display write (DW) is erased unless stored in trace memory B. Instrument preset also rewrites all the display graticule and character readouts into the appropriate section of the display memory.

FULL SPAN 0 – 1.5 GHz

[0-1.5 GHz] immediately sets the COUPLED FUNCTIONs [RES BW], [VIDEO BW] and [SWEEP TIME] to automatic, the start frequency to 0 Hz, and the stop frequency to 1500 MHz. The other front panel functions, [SHIFT] KEY FUNCTIONS or HP-IB only states, are not changed.

SAVING AND RECALLING INSTRUMENT STATES

[SAVE] (DATA keyboard entry) and [RECALL] (DATA keyboard entry) save and recall complete sets of user defined front panel function values. The DATA entry from the keyboard names the register that stores the instrument state. Six registers, [1] through [6], can be saved and recalled. Only another [SAVE] can erase a saved register. The registers contain the last instrument states received, even with a loss of line power (power failure). The registers are maintained with an internal battery supply for about 30 days after a line power failure.

[RECALL] [7] is a special recall function which recalls the instrument state prior to the *last* instrument preset or single function value change, whichever has most recently occurred. It aids in recovering from inadvertent entries.

The current instrument state, if the POWER switch is turned to STANDBY (or if there is a short-term loss of ac line power), can be recovered at POWER ON if [SHIFT] f is activated previous to a power loss.

Some [SHIFT] *KEY FUNCTION values or states cannot be saved. Neither can information in the display memories, such as a title or trace.*

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The [0] register is a buffer for instrument state transfer under remote operation. The [8] and [9] states are for calibration signal adjustments.

Example

When a test sequence is used over and over, the instrument states can be set up in the registers prior to testing for recall during the procedure.

Keying in a specific state:

[INSTR PRESET]

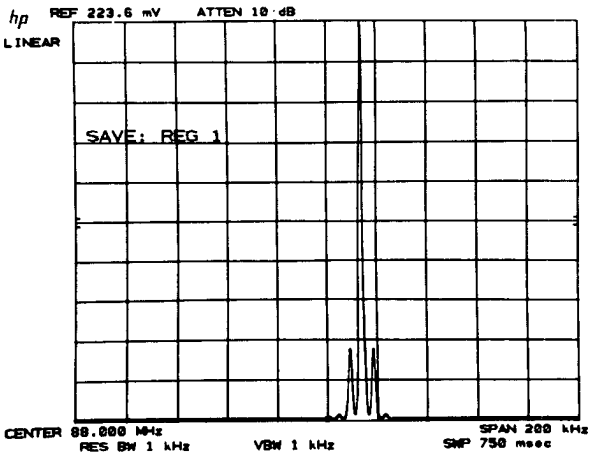
[CENTER FREQUENCY] [8] [8] [MHz -dBm sec]

[FREQUENCY SPAN] [2] [0] [0] [kHz mV msec]

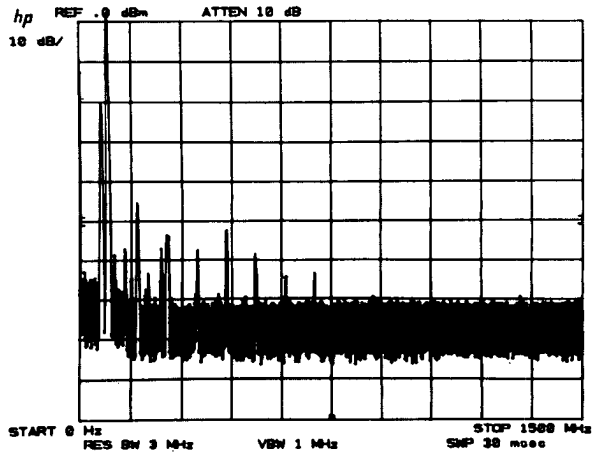
[RES BW] [↓]

LIN [ ] SCALE

Then save with [SAVE] [1] .

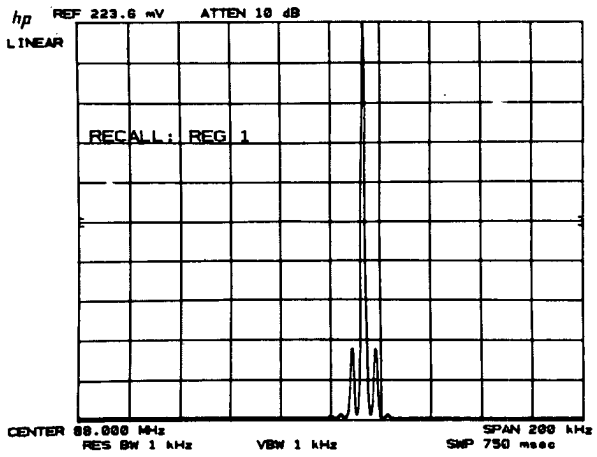


Press [INSTR PRESET] .



And recall the last state with [RECALL] [1] . Once the state has been recalled, any function can be used for more detailed measurements.

Note that in this case, the state could also have been recalled with [RECALL] [7] .



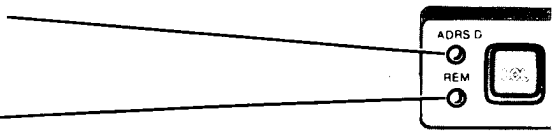
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LOCAL OPERATION

[LCL] enables front panel control after an HP-IB remote LISTEN command has been executed. An HP-IB local lockout will disable [LCL] until an HP-IB REN false command is executed, or the LINE power switch is set to STANDBY then back to ON.

Indicates instrument has been addressed through HP-IB.

Indicates instrument is in remote operation.



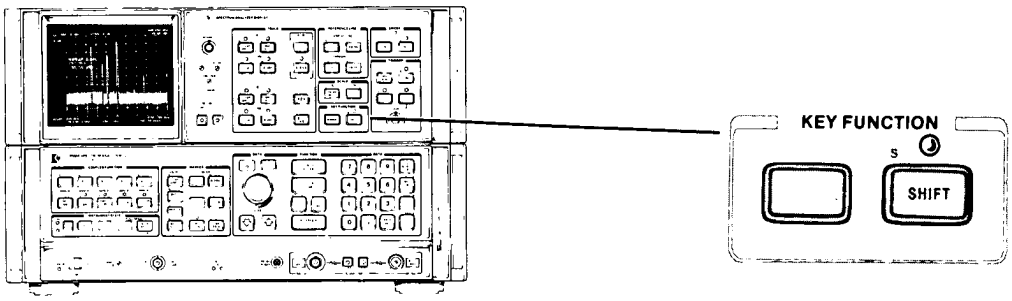
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Chapter 11
SHIFT KEY FUNCTIONS

GENERAL DESCRIPTION

This chapter describes access and use of the SHIFT KEY FUNCTIONS.



Shift functions supplement a front panel function or provide unique measurement capabilities. The SHIFT functions are not named on the front panel but are coded by the blue characters beside the keys. For example, the frequency offset function is designated by the code V. On the front panel, the code V is found in the FUNCTION section: V (CENTER FREQUENCY)

The shift functions are activated by pressing SHIFT and then the front panel key with the appropriate blue code. A complete summary of shift FUNCTIONS is on the facing page. There is an index to all shift functions at the end of this chapter.

Example

Activate the shift function V (frequency offset) with:

Press SHIFT — shift light on

Press V (CENTER FREQUENCY) — shift light off and offset function activated

The shift light can always be turned off with NORMAL, which returns the front panel keys to their designated function. NORMAL does not disable the selected shift function (except for title).

DATA Entry

An active shift function value is read out and identified in the active function area of the display, the same as any other function using DATA entry. Once the data has been entered, any other function can be activated. The shift function retains its last value until INSTR PRESET or the LINE power switch is set to STANDBY.

DATA entries to shift functions are made only from the number/units keyboard. The ENABLED light remains off even though data may be entered.

Data is entered (that is, changes the instrument state) only when a units key is pressed. If the entry has no units (an address, for example), use the Hz μV μsec key as the terminator. See Chapter 12 of this manual for further information about the terminator key.

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FUNCTION SUMMARY

Amplitude

Amplitude offset	Z
Units: dBm	A
dBmV	B
dBμV	C
voltage	D
Extended reference level range	I
Negative entry	–
Preamp gain, input 1	<
Preamp gain, input 2	>

Diagnostics

Count pilot IF at marker	K
Count signal IF at marker	Q
Count VTO at marker	N
Disable step gain	q
Frequency diagnostic on	R
Inhibit phase lock flags	v
Manual DACS control	J
Measure sweeptime	F
Second LO auto	S
Second LO shift down	T
Second LO shift up	U
Display correction data	w

Instrument State

Save registers locked	(
Save registers unlocked	)

Display

Annotation blanked	o
Annotation on	p
Display correction data	w
CRT beam off	g
CRT beam on	h
Graticule blanked	m
Graticule on	n
Title	E

Error Correction

Execute routine	W
Use correction data	X
Do not use correction data	Y
Display correction data	w

Frequency

Counter resolution	=
Frequency offset	V
Negative entry	–

General

HP-IB Service request	r
Enter HP-IB address	P
Power on in last state	f
Display Address	z
Display Write	|
Max mixer input level	,

Marker

Counter resolution	=
Continue sweep from marker	t
Enter Δ → span	O
Noise level on	M
Noise level off	L
Stop single sweep at marker	u

Trace

A + B → A	c
Detection:	
normal	a
positive peak	b
negative peak	d
sampling	e
Trace C:	
blank trace C	k
B ⇄ C	i
B → C	l
view trace C	j
Video averaging on	G
Video averaging off	H

Trigger-Zero Span

[EXT] Without 25 msec triggering	x
[VIDEO] Without 25 msec triggering	y

ALPHABETICAL KEY CODE SUMMARY

A Amplitude in dBm
B Amplitude in dBmV
C Amplitude in dBμV
D Amplitude in voltage
E Title
F Measure sweep time
G Video averaging on
H Video averaging off
I Extended reference level range
J Manual DACS control
K Count pilot IF at marker
L Noise level off
M Noise level on
N Count VTO at marker
O Enter Δ → span
P Set HP-IB address
Q Count signal IF at marker
R Frequency diagnostic on
S Second LO auto
T Second LO shift down
U Second LO shift up
V Frequency offset
W Execute error correction routine
X Use correction data
Y Do not use correction data
Z Amplitude offset
a Normal detection
b Positive peak detection
c A + B → A
d Negative peak detection
e Sample detection
f Power on in last state
g CRT beam off
h CRT beam on
i B ⇄ C
j View trace C
k Blank trace C
l B → C
m Graticule blanked
n Graticule on
o Annotation blanked
p Annotation on
q Disable step gain
r HP-IB service request
t Continue sweep from marker
u Stop single sweep at marker
v Inhibit phase lock flags
w Display correction data
x [EXT] without 25 msec triggering
y [VIDEO] without 25 msec triggering
z Display address
– Negative entry
= Counter resolution
(Save registers locked
) Save registers, unlocked
< Preamp gain, input 1
> Preamp gain, input 2
| Display write
, Max mixer input level

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NEGATIVE DATA KEYBOARD ENTRY

Entering negative data from the DATA keyboard requires the use of a negative symbol prefix on the number entry.

Negative entry: SHIFT (–)

For example, to enter a negative 100 MHz offset frequency:

Press SHIFT (V) CENTER FREQUENCY to activate frequency offset

Press SHIFT (–) 1 0 0 (MHz –dBm sec) to enter a negative frequency.

Not all values can be entered with a negative prefix. For example, a negative entry to a voltage reference level enters the positive value.

Negative entries in dB can be made with the –dBm units key or the negative prefix with the +dBm units key. If both negative prefix and (Hz µV µsec) are used, the value is entered as positive.

FREQUENCY AND AMPLITUDE OFFSET

The CRT display amplitude and frequency readout can be offset. Entering an offset does not affect the trace.

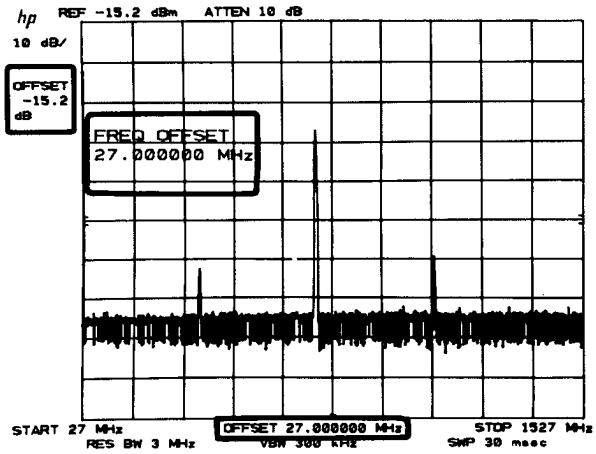
Frequency offset: SHIFT (V) CENTER FREQUENCY (DATA keyboard entry)

Amplitude offset: SHIFT (Z) REFERENCE LEVEL (DATA keyboard entry)

Offset entries are added to all the frequency or amplitude readouts on the CRT display, including marker, display line, threshold, start frequency, and stop frequency.

Function

To eliminate an offset, activate the offset and enter zero. INSTR PRESET also sets the offsets to zero. Offsets are stored with the SAVE functions for recall with RECALL. When an offset is entered, its value is displayed on the CRT.



DATA entry from the keyboard can be in Hz, kHz, MHz, or GHz for frequency offset and in dB, –dB, mV, or µV for amplitude offset. The amplitude offset readout is always in dB. An amplitude offset entry in voltage is converted to dB offset.

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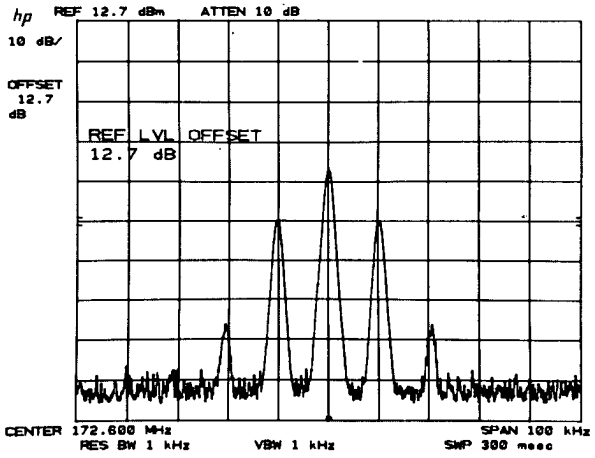
The offset range for frequency is −99.999999990 GHz to +99.999999999 GHz in 1 Hz steps. The amplitude offset range is greater than ±100 dB in 0.1 dB steps. Least significant digits are rounded for frequency offset entries and dropped for amplitude offset entries.

Example

An 102.6 MHz up converter with 12.7 dB attenuation is placed between a signal source and the spectrum analyzer. The offsets can be set so that the CRT display shows the trace referenced to the signal as input to the converter.

Amplitude offset is entered as a positive value to compensate (offset) the loss of the converter.

Press SHIFT Z (REFERENCE LEVEL) 1 2 . 7 (GHz +dBm dB)



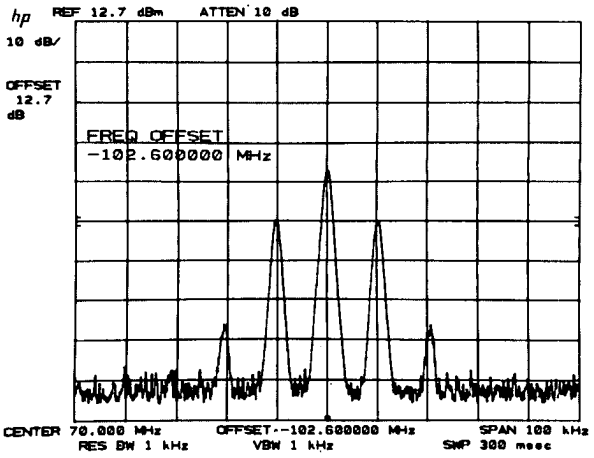
Note that the original REF LEVEL of 0 dBm is now changed to 12.7 dBm also.

Frequency offset is entered as a negative value since the input frequency to the converter is lower than the output.

Press SHIFT V (CENTER FREQUENCY) SHIFT

HOLD 1 0 2

. 6 (MHz −dBm sec)



INPUT MIXER LEVEL

As the reference level is changed, the coupled input attenuator is changed to keep the power levels of on-screen signals below −10 dBm at the input mixer. (The input mixer level is the input signal level minus the attenuator setting.) This input mixer level can be changed in 10 dB steps by pressing

SHIFT , (0-2.5 GHz) (DATA keyboard entry)

An input mixer level of −50 dBm ensures that the analyzer has best dynamic range, as long as the input signal's total power level is below the analyzer's reference level. Also see Appendix D.

Instrument preset resets the input mixer level to −10 dBm.

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PREAMPLIFIER GAIN

Similar to the amplitude offset functions, the preamplifier gain function allows a positive or negative amplitude offset to all the amplitude readouts. The offsets are *subtracted* from the amplitude readouts so that the displayed amplitudes represent the power levels at the *input* of the preamplifier. Each signal input can be offset by different amounts.

Preamp gain, input 1: SHIFT < (DATA keyboard entry)

Preamp gain, input 2: SHIFT > (DATA keyboard entry)

The < key is beside Input 1, and the > key is beside the Input 2.

The offset is not read out on the CRT. Instrument preset resets the gains to 0 dB.

AMPLITUDE UNITS SELECTION

Shift key codes A through D each select a particular amplitude unit for the reference level scale, marker, display line, and threshold readouts. An amplitude units change does not affect the absolute power level calibration.

SHIFT KEY FUNCTION		AMPLITUDE UNITS
SHIFT A	or INSTR PRESET	dBm
SHIFT B		dBmV
SHIFT C		dBμV
SHIFT D		voltage

The keys for these functions are located in the COUPLED FUNCTION group.

EXTEND REFERENCE LEVEL RANGE

Normally the reference level can be set from −89.9 dBm to +30.0 dBm in coupled operation. The limits of the range can be extended to a maximum of −139.9 dBm and +60.0 dBm.

Press SHIFT I ATTEN.

The lower limit of reference level depends on resolution bandwidth, scale, and attenuation.

Scale	Resolution Bandwidth	Minimum reference level with extended reference level	
		10 dB attenuation	0 dB attenuation
log	≤1 kHz	−129.9 dBm	−139.9 dBm
log	≥3 kHz	−109.9 dBm	−119.9 dBm
linear	≤1 kHz	−109.9 dBm	−119.9 dBm
linear	≥3 kHz	−89.9 dBm	−99.9 dBm

When the reference level is set at a minimum, the level may change if either scale or resolution bandwidth is changed. The extended range is disabled with instrument preset.

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COUNTER RESOLUTION

When FREQ COUNT is activated, the frequency of the signal marked by the active marker is counted. For more details, see MARKER FREQ COUNT, Chapter 6. In this mode, the resolution of the count is the same as the center frequency readout. To increase the resolution,

press SHIFT FREQ COUNT (DATA keyboard entry)

For spans ≤2 MHz, the data entry sets the least frequency digit to be counted. For example:

DATA entry	Readout for 100 MHz
100 kHz	100.0 MHz
10 kHz	100.00 MHz
1 kHz	100.000 MHz
100 Hz	100.0000 MHz
10 Hz	100.00000 MHz
1 Hz	100.000000 MHz

Counter resolution can be set between 1 Hz and 100 kHz. The resolution of the counter frequency will remain fixed until changed with a counter resolution data entry or until INSTR PRESET is used. The counter resolution cannot be stored with SAVE.

Values entered other than decade numbers, such as 25 Hz and 326 kHz, will be rounded to the next legal value. For example, a counter resolution data entry of 25 Hz will be entered as 10 Hz, and 326 kHz will become 100 kHz resolution.

MARKER SWEEPS

When a marker is displayed, the sweep can be made to stop at the active marker and to continue from the active marker. The front panel continuous sweep function is suspended, but the sweep trigger and data conditions must still be met. See Chapter 9, SWEEP AND TRIGGER.

Stop Sweep at Marker, TALK after Marker

To stop the sweep at the marker,
press MARKER NORMAL and
press SHIFT u.
A marker must be activated to enter this sweep function.

Each time a sweep is triggered, it stops at the marker, even if the marker has been moved. A marker being moved when the sweep passes may not stop the sweep.

To disable the stop sweep at marker functions,
press MARKER OFF or INSTR PRESET.

In remote operation, the analyzer will not TALK until the trace sweep stops at the marker. TALK is suspended by keeping the HP-IB Data-Valid line not true until the marker is placed.

Continue Sweep from Marker

To start the sweep at the active marker, it is first necessary to activate the stop-sweep-at-marker function above. Then
press SHIFT t.

Each time SHIFT t is pressed, the sweep will start at the active marker, continue through a full sweep back to the same marker, and stop.

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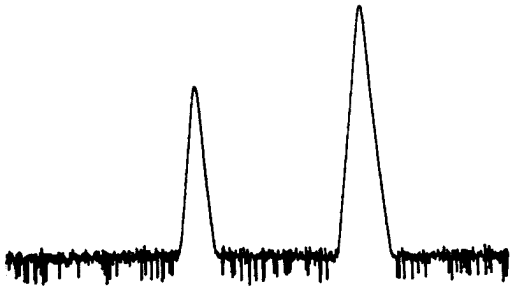
GRATICULE AND ANNOTATION ON/OFF

The graticule and character readouts can be selectively blanked with key functions. This is valuable when alternative graphics are drawn on the CRT through the HP-IB.

Graticule

Annotation

Blank: press SHIFT m
On: press SHIFT n
Blank: press SHIFT o
On: press SHIFT p



Display with annotation (characters) and graticule blanked.

Display blanking does not affect HP-IB input/output of instrument function values or trace information.

CRT BEAM ON/OFF

The CRT beam power supply can be turned off to avoid unnecessary wear on the CRT if the analyzer is operated unattended. *Reducing intensity* or *blanking* the trace does *not* reduce wear.

Beam off: press SHIFT g
Beam on: press SHIFT h

CRT beam power does not affect HP-IB input/output of instrument function values or trace information.

DISPLAY CORRECTION DATA AND SPECIAL MESSAGES

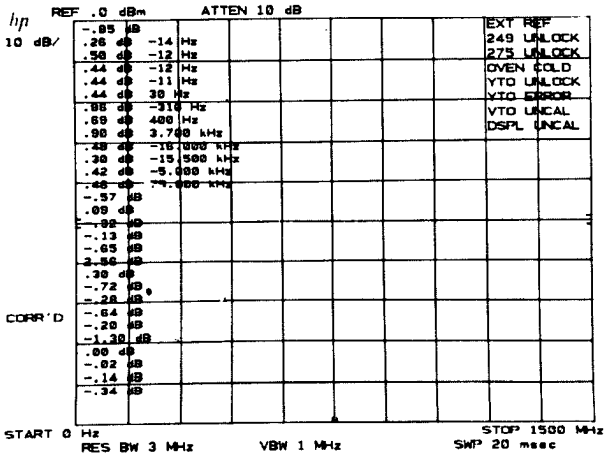
The correction data generated from the error correction routine can be displayed.

Display correction data: press SHIFT w (lower case)
Do not display correction data: press INSTR PRESET

The readout is detailed in this chapter under ERROR CORRECTION ROUTINE.

The instrument operating special messages can be displayed by disrupting the analyzer's operation.

Display warning messages: press SHIFT v (by inhibiting phase lock flag)
Do not display special messages: press INSTR PRESET



BOTH CORRECTION DATA AND SPECIAL MESSAGES DISPLAYED

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TITLE

The user can write a message in the top CRT display line. When the title is activated, the front panel blue characters, number keyboard numbers, decimal, backspace, and space can be typed onto the top line starting at the left of the display. The full width of the display can be used; however, marker readout may interfere with the last 16 characters of the title.

Activate title: SHIFT E (shift light on)

Enter text
abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
/#& = (),><
0123456789. [space]

To end a title: press NORMAL (shift light off)

A title will remain on the display until the title function is activated again, INSTR PRESET is pressed, or an instrument state is recalled with RECALL.

To erase a title without changing the instrument state, end the title function if still active, then press SHIFT E NORMAL

A + B → A

A + B → A enables the restoration of the original trace A after a A–B→A has been activated. A + B →A is executed with both Trace A and Trace B in VIEW :
press SHIFT c.

When executed, A–B→A is turned off and the amplitude in trace B is added to the amplitude in trace A (in display units). The result is then written into trace A.

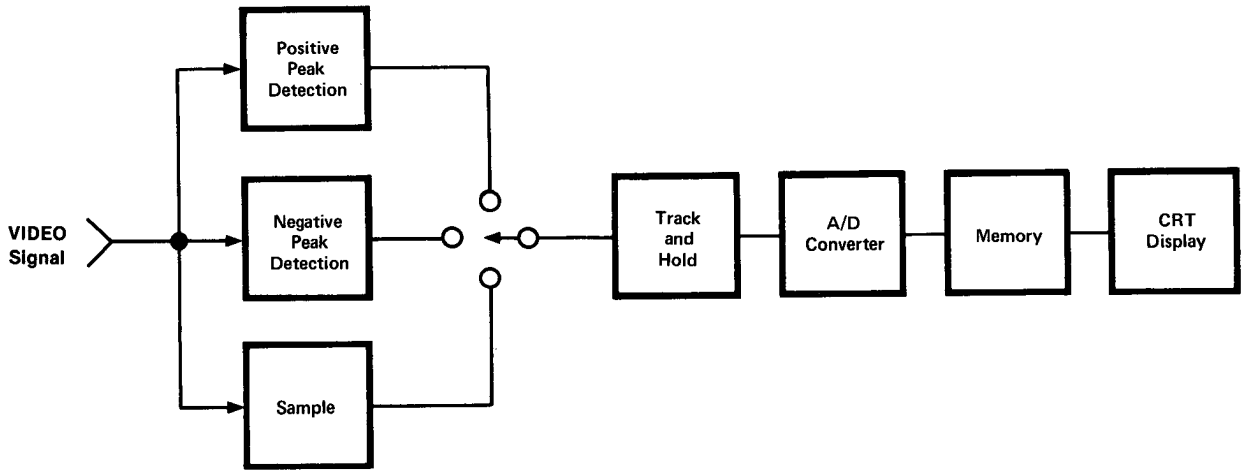
Additional A + B → A executions will each add another trace B response to the cumulative trace A.

TRACE DETECTION MODES

One of four detection techniques can be selected for displaying trace information.

Mode	Access	Use
normal	INSTR PRESET **or** SHIFT a	• Most measurements
sample	SHIFT e	• Noise Level measurements • Zero frequency span waveforms for sweep times ≥ 20 msec • Video averaging
positive peak **negative peak**	SHIFT b SHIFT d	• Diagnostic aids for servicing

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During a sweep, only a specified amount of time is available for writing data into each of the 1001 trace memory addresses. In two of these time periods, the positive and negative peak detectors obtain the maximum and minimum IF signal excursions, respectively, and store these values in *alternate* trace memory addresses. This technique allows a graphic presentation of noise on the CRT display.

Normal Mode

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

Data from the positive peak detector (signal maximums) will always be displayed in the odd addresses trace memories (1, 3, ...1001). If, within the time period following the storage of a value in an odd address memory, there is no change in VIDEO signal level, the positive peak detector value will also be stored in the even address. In other words, the even addressed memory will also contain positive peak detection data if the signal during that time period is monotonic. Negative peak detector data (VIDEO signal minimum) will be stored in the even addressed trace memory if the signal has a point of inflection during the time period.

Normal mode is selected with instrument preset.

Sample Mode

In the sample mode, the *instantaneous* signal value of the final analog-to-digital conversion for the time period is placed in memory. (As sweep time increases, many analog-to-digital conversions occur in each time period, but only the final, single value can be stored.)

Sample mode is selected automatically for video averaging and noise level.

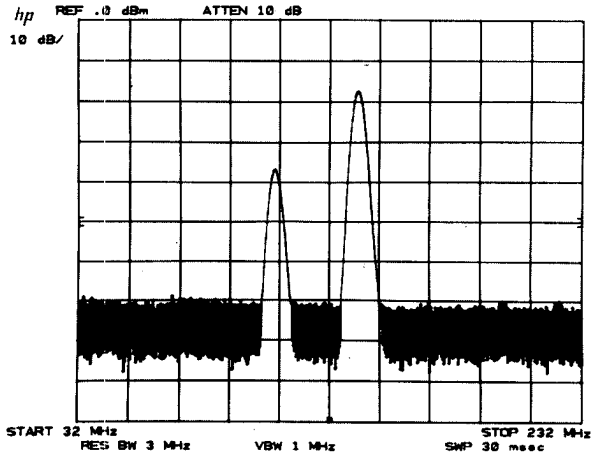
Positive and Negative Peak Modes

Positive and negative peak modes store signal maximums and minimums, respectively, in all trace memories.

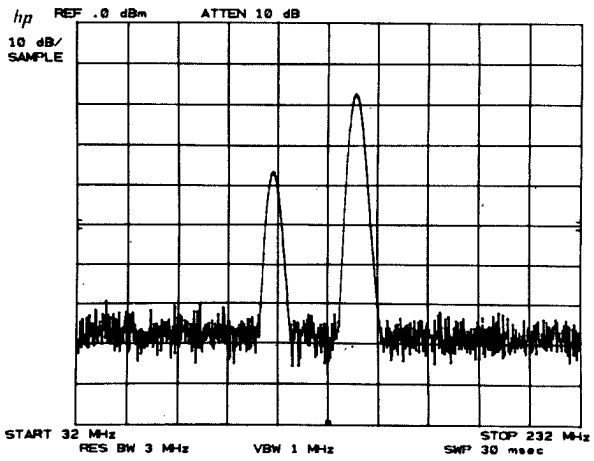
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Readout

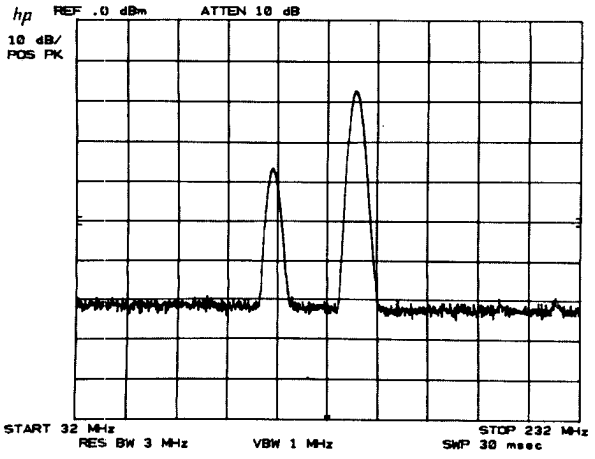
Here, the same signal response is displayed with each trace detection mode.



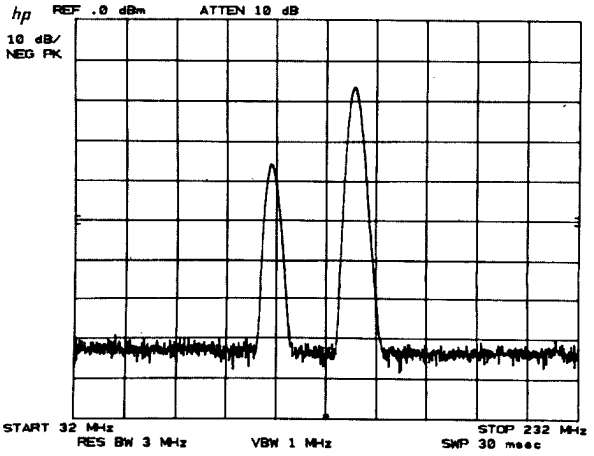
NORMAL



SAMPLE



POSITIVE PEAK



NEGATIVE PEAK

TRACE C

A third trace memory is available for the storage and display of trace information. Only the storage modes (view and blank) can be used.

View C: SHIFT j
Blank C: SHIFT k

These are analogous to the TRACE A and B modes discussed in Chapter 5.

Trace C cannot be written into directly from the analyzer except when video averaging is used.

Trace information from B can be transferred to C. To transfer from TRACE B to TRACE C, use

B → C: SHIFT B→C

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The sweep will be suspended, the trace in memory B will be read and written into trace C from left to right in about 20 msec. Trace C is viewed. Sweeping will then resume from where it was suspended. The trace information in B is not changed.

To exchange traces B and C,

B ⇄ C: SHIFT i

The trace information in B and C is interchanged point for point from left to right in about 20 msec. If trace B was not displayed, it remains undisplayed. If trace C was not displayed, it remains undisplayed.

To store TRACE A into trace C, the trace A data must first be transferred into trace B:

press A⇄B SHIFT l (which also erases last trace C)
or press A⇄B SHIFT i (which also saves last trace C in B)

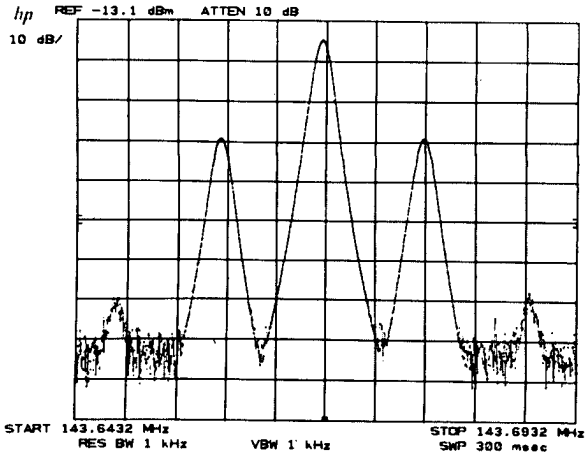
Example

Comparisons of up to three different signal traces can be made simultaneously using traces A, B, and C. In this example, the modulation level of a signal will be changed for each trace. To start, clear the display with BLANK A, BLANK B, and SHIFT k.

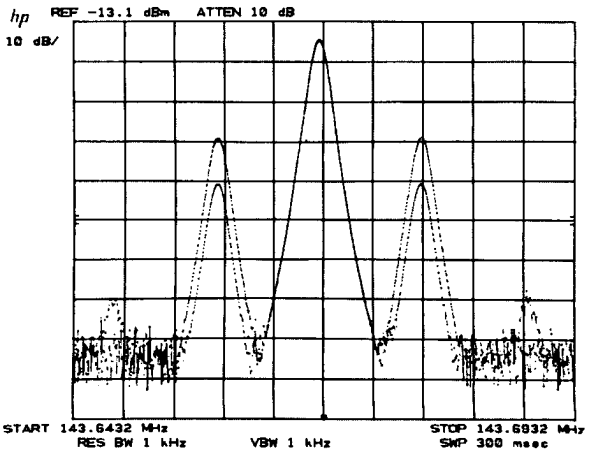
The signal with the desired level of modulation will be stored in trace C:

Press CLEAR WRITE B and allow one sweep.

Press SHIFT l which writes the trace from B into C.

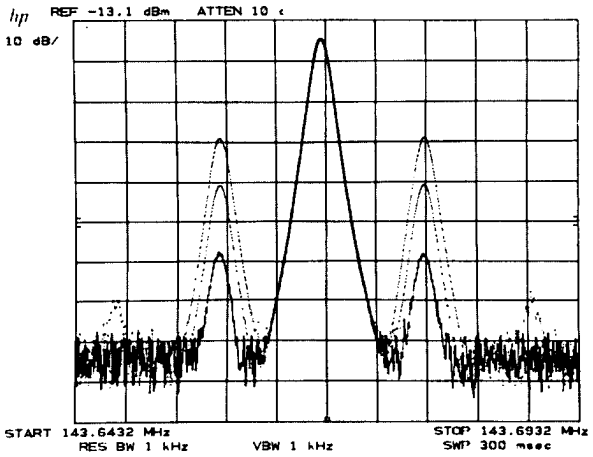


Change the modulation level, allow one sweep, and store in B with VIEW B.



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Change the modulation level again and store in A, press CLEAR-WRITE A, allow one sweep, and press VIEW A. The three traces are differentiated by intensity.



VIDEO AVERAGING

Video averaging is a trace display routine that averages trace responses from sweep to sweep without requiring a narrow video bandwidth. (Averaging with the video bandwidth is discussed in Chapter 8, COUPLED FUNCTION VIDEO BW). Both video averaging and reducing video bandwidth are primarily used to improve the analyzer's ability to measure low level signals by smoothing the noise response.

To activate video averaging (and sample detection mode),

press SHIFT G (VIDEO BW) (DATA keyboard entry)

To disable video averaging, press SHIFT H (SWEEP TIME)

CAUTION

Video averaging may result in an uncalibrated amplitude display when

$$\frac{\text{frequency span}}{\text{Resolution Bandwidth}} > 1000$$

Readout in the active function display is "VID AVG 100." The number represents the maximum number of samples (or sweeps) for complete averaging. The DATA entry can be used to change the maximum sample number in integers from 0 to 32767. A unity sample limit allows direct writing of analyzer response into Trace C (see Trace C below). A 100 sample limit is selected upon instrument preset. The higher the sample limit, the more smoothing possible. Averaging with high sample limits can provide more smoothing than the 1 Hz video bandwidth.

During video averaging, the current sample being taken is read out at the left of the display.

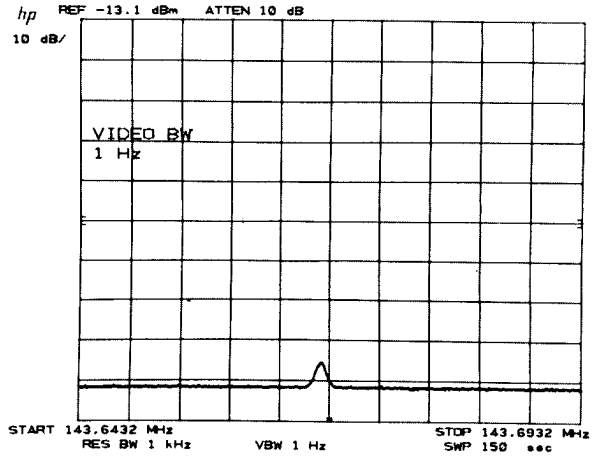
The advantage of video averaging over narrowing the video filter is the ability of the user to see changes made to the amplitude or frequency scaling of the display while smoothing the noise response. For example, when a 100 Hz video bandwidth is used with a 200 kHz frequency span, the sweep time is 2 seconds. With this sweep time almost a full sweep has to pass before any center frequency change can be seen on the trace. If video averaging is used instead of the narrow video bandwidth, any change to center frequency will be seen immediately, even though full averaging will take roughly 6 seconds. (Any change to control settings such as CENTER FREQUENCY, FREQUENCY SPAN, etc., will cause the video averaging process to be restarted.)

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Example

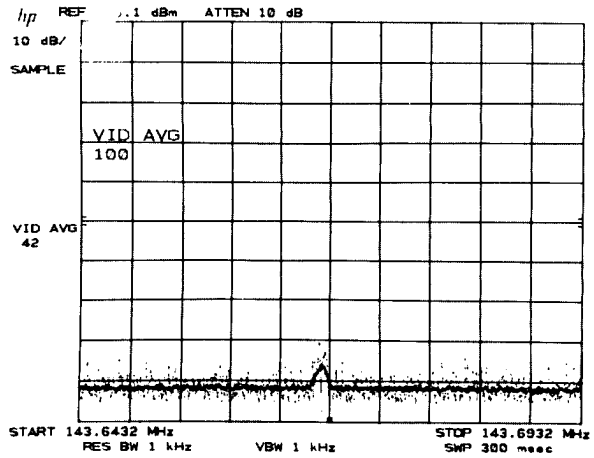
To display very low level signal responses, very narrow resolution and video bandwidths are required. The accompanying increase in sweep time can make measurements cumbersome. Video averaging allows the display of low level signals without the long sweep time.

Viewing a low level signal with a video bandwidth of 1 Hz requires a 150 second sweep.



Disable the narrow resolution and video filters by pressing the AUTO key (above VIDEO BW) and start video averaging by pressing SHIFT G VIDEO BW.

Now the low level signals begin to show quickly. Changes to the frequency range or amplitude scale will restart the sampling to show the signals quickly, without having to wait 150 seconds. In fact, the video averaging shown took 42 x 300 msec = 12.6 sec, plus the internal computation time, 42 x 100 msec = 4.2 sec, for a total of 16.8 sec.



Video Averaging Algorithm

The averaging of *each* amplitude point depends upon the number of samples already taken and last average amplitude.

$$\overline{y_n} = \frac{n-1}{n} \times \overline{y}(n-1) + \frac{1}{n} y_n$$

where $\overline{y_n}$ latest average amplitude value in display units
n current sample number

$\overline{y_n - 1}$ last average amplitude in trace memory (TRACE A or B)
y_n new amplitude entry from analyzer (Trace C)

The new amplitude value, $\overline{y_n}$, is weighted more heavily by the last average amplitude $\overline{y_n - 1}$ than the new amplitude entry, y_n.

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When n equals the limit set (e.g. 100, the preset limit), the last average amplitude is gradually replaced with new data. Thus, the average will follow a slowly changing signal response, particularly if the sample limit is small.

Trace C

Video averaging requires the use of trace memory C. When video averaging is activated, the input signal response is written into trace C, the averaging algorithm is applied to these amplitudes and the results written into TRACE A. Thus, two traces are displayed: the input signal in C and the averaged signal in A.

Trace C may be blanked without affecting the operation of video averaging.
Press [SHIFT] k
Trace C may be written into as traces A and B if a video average sample limit of one is selected.

Press [SHIFT] G [VIDEO BW] [1] [Hz μV μsec]

If either trace A or B is in a write trace mode, the analyzer response will also be written into trace C.

EXTERNAL AND VIDEO TRIGGER

The front panel [EXT] and [VIDEO] trigger modes automatically keep the display refreshed in zero frequency spans for sweep times less than 20 msec. To eliminate the automatic refresh feature:

For external triggering, press [SHIFT] x [EXT]

For video triggering, press [SHIFT] y [VIDEO]

LOCKING SAVE REGISTERS

After saving instrument states in one or more of the six registers, 1 through 6, the registers can be secured from being written over and destroyed. The recall function is not affected.

Lock: [SHIFT] ([SAVE]

Unlocked: [SHIFT]) [RECALL] or [INSTR PRESET]

When locked, an attempt to [SAVE] will write "SAVE LOCKED" on the CRT and no DATA entry can be made.

ERROR CORRECTION ROUTINE

A built-in analyzer routine measures and records the amplitude and frequency error factors due to a number of parameters, then corrects the display for them. The routine takes about 1½ minutes to run. When complete, instrument preset will be called and the correction factors applied.

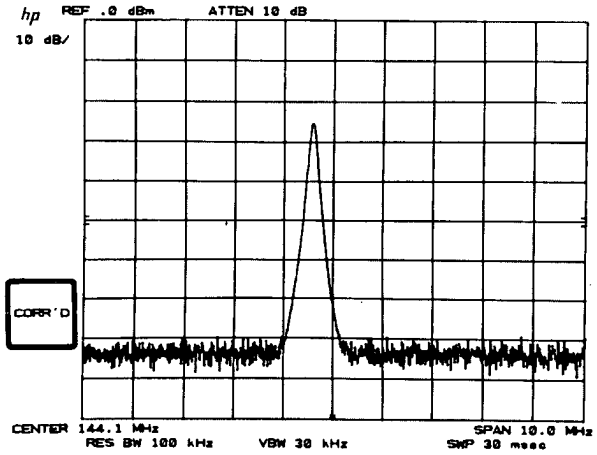
Connect CAL OUT to SIGNAL INPUT 2.
Execute the routine: [SHIFT] W
Use correction factors: [SHIFT] X
Do not use correction factors: [SHIFT] Y
Display correction factors: [SHIFT] w

If "ADJUST FREQ ZERO" appears on the CRT, manual calibration adjustment is necessary before the routine can be successfully run. See GENERAL INFORMATION for the manual calibration procedure.

The correction factors are saved using an internal battery supply for about a 30-day period after line power failure. If the battery supply should be exhausted, all the values will be set to zero.

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Indicates that the routine has been run and the display is corrected.



Correction can be turned on or off using SHIFT X and SHIFT Z after the routine has been successfully completed.

For more information on accuracy, see the HP 8568B Spectrum Analyzer Data Sheet.

The readout of the correction factors is as follows:

Line (top to bottom)	Parameter	Correction Values Displayed
1	LOG and LIN scale, BW <100 kHz	Amplitude
2	RES BW = 10 Hz	Both Amplitude (dB) and Frequency (Hz)
3	30 Hz	
4	100 Hz	
5	300 Hz	
6	1 kHz	
7	3 kHz	
8	10 kHz	
9	30 kHz	
10	100 kHz	
11	300 kHz	
12	1 MHz	
13	3 MHz	
14	LOG and LIN scale, BW ≥ 100 kHz	Amplitude
15	2nd local oscillator frequency shift	
16	30 dB gain }	
17	20 dB gain } LIN operation only	
18	10 dB gain }	
19	50 dB step gain errors	
20	40 dB	
21	30 dB	
22	20 dB	
23	10 dB	
24	0 dB	
25	−10 dB	
26	−20 dB	
27	offset error 2 dB/ LOG	
28	offset error 5 dB/ LOG	
29	offset error 10 dB/ LOG	

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SHIFT FUNCTION Index

All the shift functions are listed below. (DATA) indicates the functions that use a number and unit entry.

	CODE	DISABLE CODE OR KEY	PAGE
GENERAL			
Display Address (DATA)	z		*
Display Write (DATA)	|		*
HP-IB service request	r		*
HP-IB address (DATA)	P		*
Power on in last state	f		89
Max. mixer input level	,		96
FREQUENCY AND AMPLITUDE			
Amplitude offset	Z		95
Amplitude units selection			
dBm	A		97
dBmV	B		97
dBμV	C		97
voltage	D		97
Extended reference level range (DATA)	I		97
Frequency offset (DATA)	V		95
Input mixer level	,		96
Negative entry (DATA)	–		95
Preamp gain, Input 1 (DATA)	<		97
Preamp gain, Input 2 (DATA)	>		97
MARKER			
Counter resolution	=	=	98
Continue sweep from marker	t	MARKER OFF	98
Enter Δ → Span	O		57
Noise Level on	M		63
Noise Level off	L		63
Stop single sweep at marker, TALK after marker	u	MARKER OFF	98
DISPLAY			
Annotation blanked	o		99
Annotation on	p		99
CRT beam off	g		99
CRT beam on	h		99
Display correction data	w		99
Frequency diagnostic on	R		*
Graticule blanked	m		99
Graticule on	n		99
Title	E	NORMAL	100
TRACE			
A + B → A	c		100
Detection Modes:			
normal	a		100
positive peak	b		100
negative peak	d		100
sample	e		100
Trace C			
blank C	k		102
B ⇄ C	i		103
B → C	l		102
view C	j		102
Video averaging on	G		104
Video averaging off	H		104
TRIGGER, ZERO SPAN, SWEEP <20 msec			
EXT without 25 msec trigger	x	EXT	106
VIDEO without 25 msec trigger	y	VIDEO	106
INSTRUMENT STATE			
Save Registers locked	(		106
Save Registers unlocked	)		106
ERROR CORRECTION			
Execute Routine	W		106
Use data (display corrected)	X		106
Do not use data (display not corrected)	Y		106
Display correction data on CRT	w		106

DIAGNOSTIC AIDS

To aid in servicing the spectrum analyzer, there are a number of diagnostic shift functions. These functions are listed here. Their operation and use are covered in the HP 8568B Service Manual.

	CODE		CODE		CODE
Count pilot IF at marker	K	Inhibit phase lock flags	v	Second LO auto	S
Count signal IF at marker	Q	Disable step gain	q	Second LO shift down	T
Count VTO at marker	N	Manual DACS control	J	Second LO shift up	U
Frequency diagnostic on	R	Scan time measure	F		

* See Section II of this manual.

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Chapter 12
USER DEFINED KEYS

GENERAL DESCRIPTION

This chapter describes the procedure for defining a numeric key(s) to allow the storage and execution of command strings. The procedure for remote storage and execution of command strings is contained in Section II of this manual.

ENTERING A COMMAND STRING

The title mode must be activated to enter a command string. When the title mode is activated, the front panel blue characters, numeric keys, decimal, backspace, and space can be entered onto the top line starting at the upper left corner of the display. The full width of the display can be used (58 characters total).

Activate title: [SHIFT] E (shift light on)

Enter command string: CF20MZSP2MZST50MS (up to 58 characters)

center frequency = 20 MHz
frequency span = 2 MHz
scan time = 50 msec

To end a command string: [NORMAL] (shift light off)

KEY DEFINITION

After a command string is entered into the title block, it is stored under a defined numeric key(s):

Press: [SHIFT] (shift light on)

Select any numeric key(s) (0 – 999): 10 (shift light off)

Terminate by pressing: [kHz mV msec]

NOTE

The [kHz mV msec] key must be pressed to terminate the key definition procedure. If it is not, the command string will not be stored under the numeric key(s).

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EXECUTING A SOFT KEY

After a command string is stored under a numeric key(s), it can be executed.

Press:	SHIFT (shift light on)
Enter defined numeric key(s):	10 (shift light off)
Terminate by pressing:	Hz µV µsec

NOTE

The Hz µV µsec key must be pressed to terminate this execution procedure. If it is not, the command string will not be executed.

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Chapter 13
PLOTTER OUTPUT

GENERAL DESCRIPTION

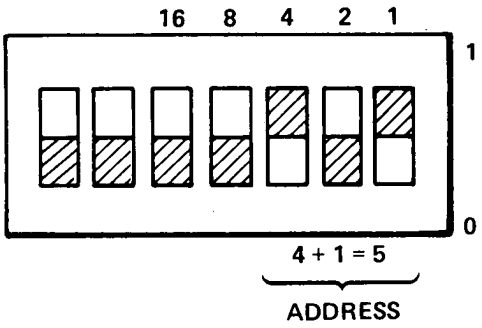
This chapter describes the procedure for executing the PLOTTER OUTPUT function, and provides information for preventing problems that may arise while attempting to execute it.

EXECUTING PLOTTER OUTPUT

Connect an HP plotter via HP-IB to the spectrum analyzer:



Set the HP-IB address on the plotter to address 5:



If the address switch on the plotter cannot be located, refer to the plotter's operation manual.

Press the lower left recorder key (LOWER LEFT) to execute the PLOTTER OUTPUT function.

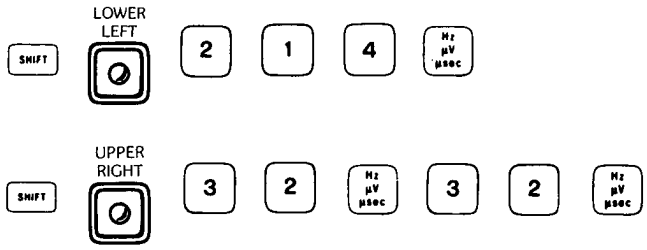
The function plots everything that is displayed on the CRT. If desired, traces A, B, and C, the annotation and the graticule can be individually blanked from the CRT using front-panel functions (refer to Chapters 5 and 11).

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You can also blank the HP logo from the display. To do this from a computer, execute:

```
OUTPUT 718; "DA 2174; DW 32;32;"
```

Or, to execute it from the front panel, press:



PLOTTER PENS

Traces A, B, and C, and the annotation and graticule are individually plotted with four different pens, provided there are four pen locations in the plotter. Pens 1, 2, and 4 plot traces A, B, and C, respectively, and pen 3 plots the annotation and graticule. For a two-pen plotter, pens 1 and 2 take the place of pens 3 and 4, respectively.

NOTE

There are certain types of equipment that prevent the PLOTTER OUTPUT function from being executed correctly. They are discussed in the next two sections.

CONTROLLER

The analyzer should not be connected via HP-IB to an active controller while attempting to execute the PLOTTER OUTPUT function from the front panel. This is because the analyzer will abort any attempts to execute the function from the front panel when an active controller is on the bus.

PLOTTER

The 7245A/B, 7240A, 9872C, and 7550 Graphics Plotters work readily for executing the PLOTTER OUTPUT function. However, the HP 7570A, 7585, 7470A, and 7475A plotters require special operating instructions. The HP 7570 and 7585 plotters work only in EMULATE MODE. For more information on EMULATE MODE, refer to the plotter's operating manual. On the HP 7470A plotter, set the US/A4 rocker switch to the US position. For the HP 7475 plotter, the US/MET and A4/A3 rocker switches must be set to the US and A4 positions.

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