Notice

Hewlett-Packard to Agilent Technologies Transition

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. To reduce potential confusion, the only change to product numbers and names has been in the company name prefix: where a product name/number was HP XXXX the current name/number is now Agilent XXXX. For example, model number HP 8648 is now model number Agilent 8648.

Contacting Agilent Sales and Service Offices

The sales and service contact information in this manual may be out of date. The latest service and contact information for your location can be found on the Web at:

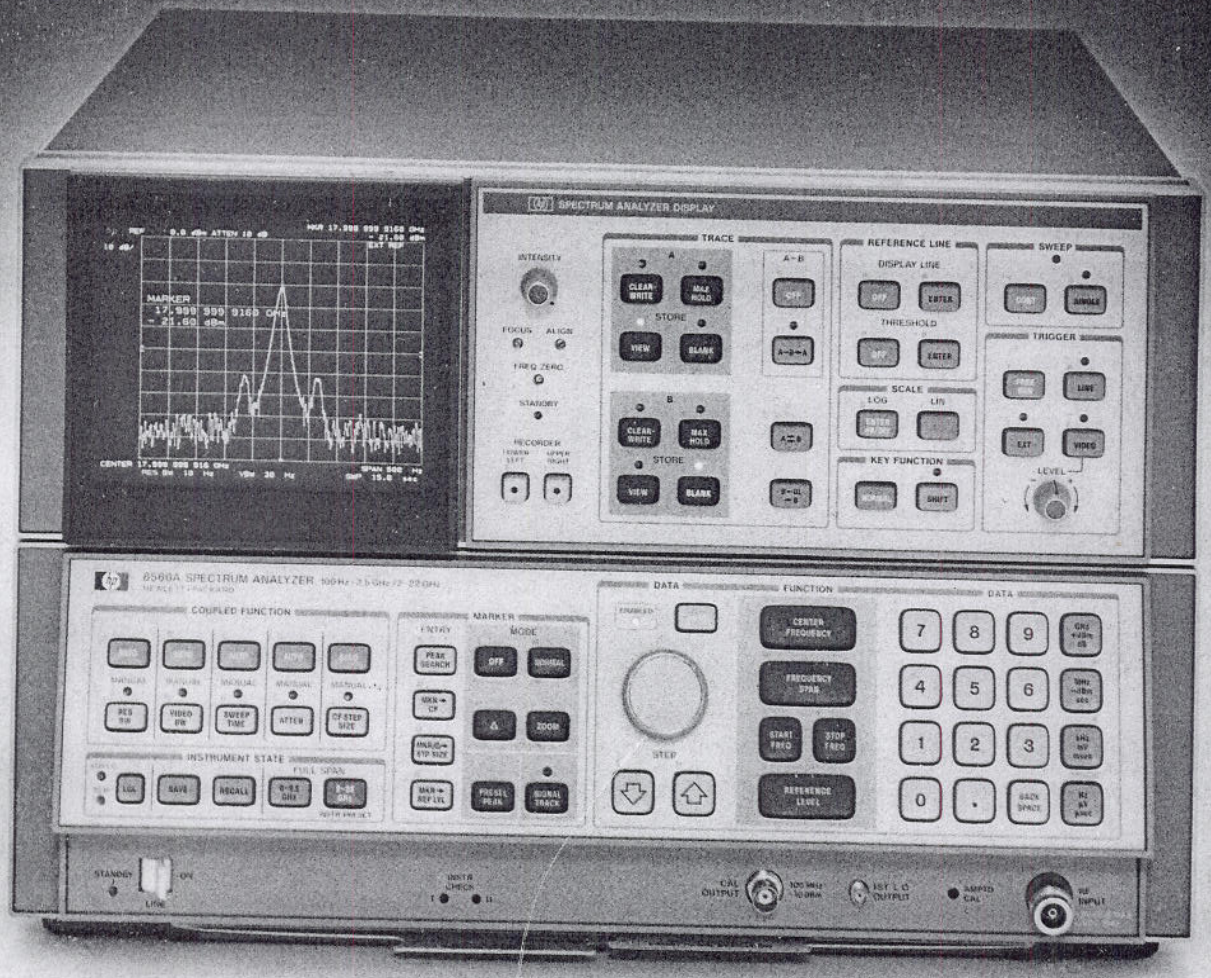
`http://www.agilent.com/find/assist`

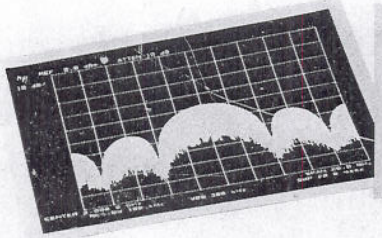
If you do not have access to the Internet, contact your field engineer. In any correspondence or telephone conversation, refer to your instrument by its model number and full serial number.

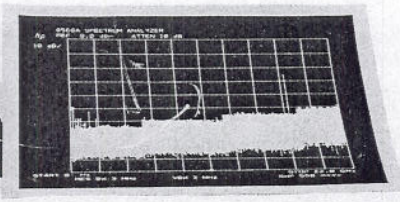
Agilent Technologies

Printed in USA July 2004

8566A Spectrum Analyzer Operation







HEWLETT PACKARD

8566A Spectrum Analyzer Operation

NOVEMBER 1978

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08566-90002

CHAPTERS

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Chapter 1
GENERAL INFORMATION

The HP 8566A is a high-performance spectrum analyzer which operates from 100 Hz to 2.5 GHz in the low frequency band and 2 - 22 GHz in the preselected microwave band. It uses a synthesized LO to provide accurate frequency tuning and an internal micro-computer to automate controls and provide useful operating features.

Performance Summary

Frequency

Range: 100 Hz — 2.5 GHz / 2 — 22 GHz

Resolution: 10 Hz to 3 MHz

Spectral Purity: < – 78 dBc, 300 Hz offset, 5.6 GHz.

Accuracy: Internal frequency standard aging = 1 x 10^{-9} / day. Frequency accuracy is a function of frequency span and center frequency where:
accuracy = ± (center frequency x frequency standard error + 2% frequency span + 10 Hz)
for span <5 MHz.

Amplitude

Range: -137 dBm to +30 dBm with 90 dB calibrated display

Scale Resolution: 10, 5, 2 or 1 dB/Div or linear with amplitude readout in dBm, dBmV, dBμV or volts.

Dynamic Range: Up to 90 dB

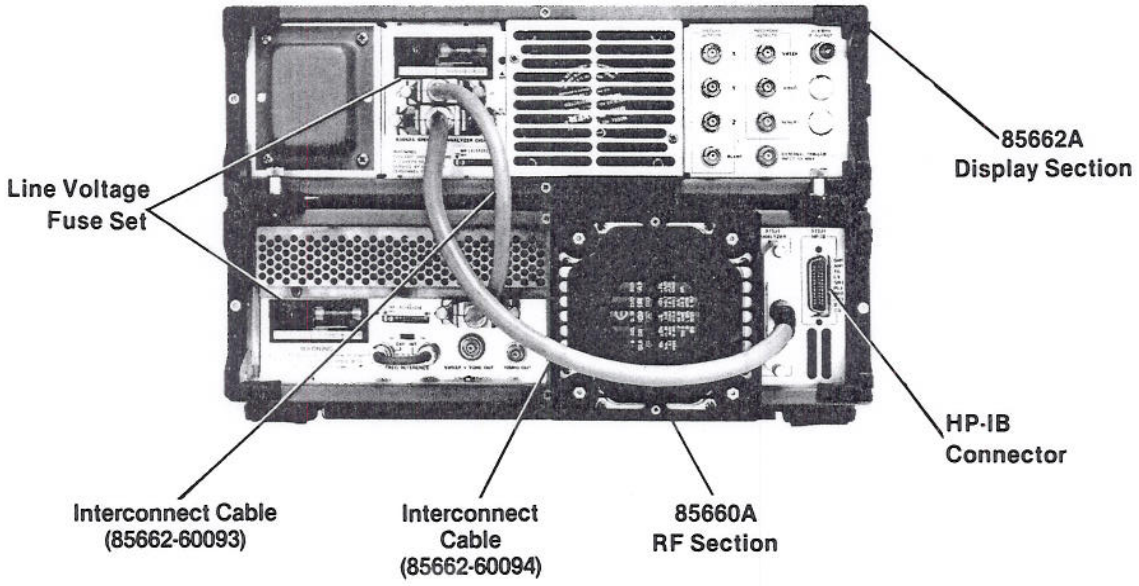
Flatness: ±2.2 dB

HP 8566A Spectrum Analyzer

The HP 8566A consists of an 85662A Display Section and an 85660A RF Section. Connect the two sections along with the inter-connection cables as shown in the illustration below.

> **CAUTION**
> Make sure that the proper line voltage and line fuse have been selected for both the RF and the Display section of the analyzer.

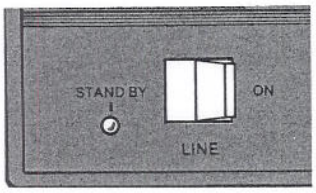
Connect interconnection cables as shown:



Rear Panel Connections

Initial Power On

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 up, such as on-receipt of instrument, the analyzer requires 24 hours to stabilize prior to meeting specified performance.



LINE ON and STANDBY

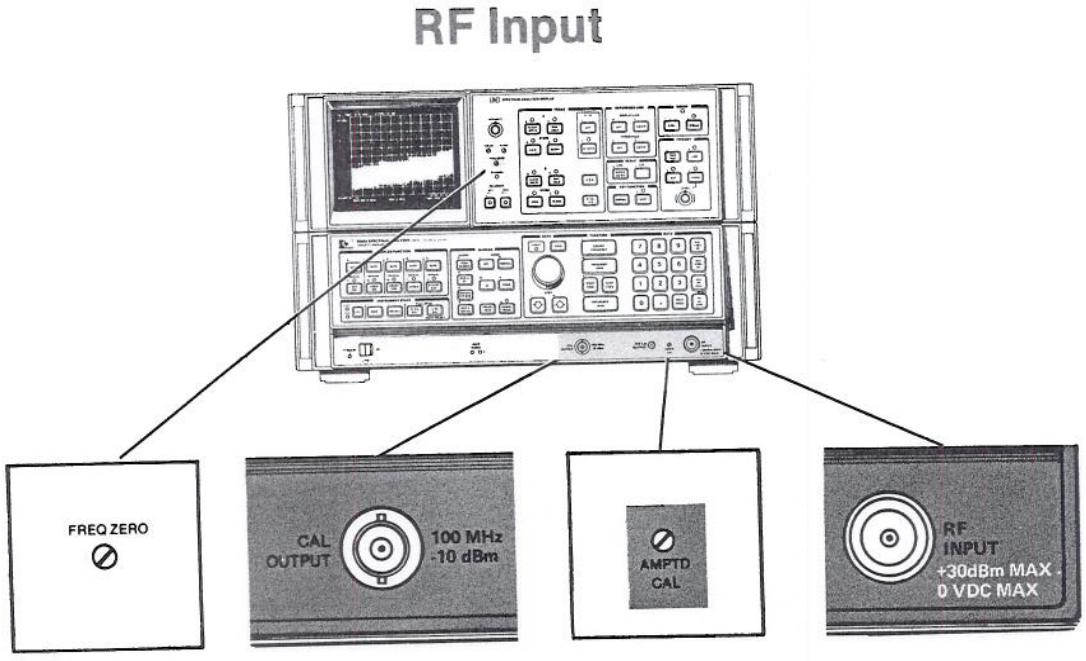
INSTR CHECK LED

Upon LINE ON, the instrument will perform an automatic internal instrument check, designated by the red INSTR CHECK lights. Both lights will turn on momentarily during the brief check routine and, if the instrument is operating properly, will remain off. If one or both LED's remain on, 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	Memory (A14) and Processor (A15)	Check if A14 and A15 are connected tightly in 85660A and that contacts are clean.

Calibration

In order to meet specified frequency and amplitude accuracy, the analyzer's calibration must be checked periodically to insure the highest performance.



Connect cable from CAL OUTPUT signal to RF input to perform initial calibration

CAUTION

Excessive signal input power will damage the input attenuator and the input mixer. The spectrum analyzer total RF power must not exceed + 30 dBm (1 watt).

DC Precaution: The HP 8566A cannot accept DC voltages in 0 dB ATTEN. With 10 dB or greater input attenuation, a maximum of ± 7 Volts DC can be accepted without damage. A blocking capacitor is recommended at the input when DC is present with an RF signal.

Manual Calibration Procedure

1. After instrument has stabilized, press [2-22 GHz]
2. Press [RECALL] **8** ; this recalls the following stored control settings from the analyzer's internal memory:
   - Center Frequency = 100 MHz
   - Frequency Span = 2 MHz
   - Reference Level = −7 dBm
   - Res BW = 1 MHz
   - Scale = 1 dB/Div
   - Marker = Normal
3. Adjust AMPTD CAL for a marker amplitude of −10 dBm.*
4. Press [RECALL] **9** ; this recalls the following
   - Center Frequency = 100 MHz
   - Frequency Span = 0 Hz
   - Reference Level = −7 dBm
   - Res BW = 30 Hz
   - Scale = 1 dB/Div
   - Sweep Time = 10 Sec.
5. Maximize amplitude response with FREQ ZERO adjustment.

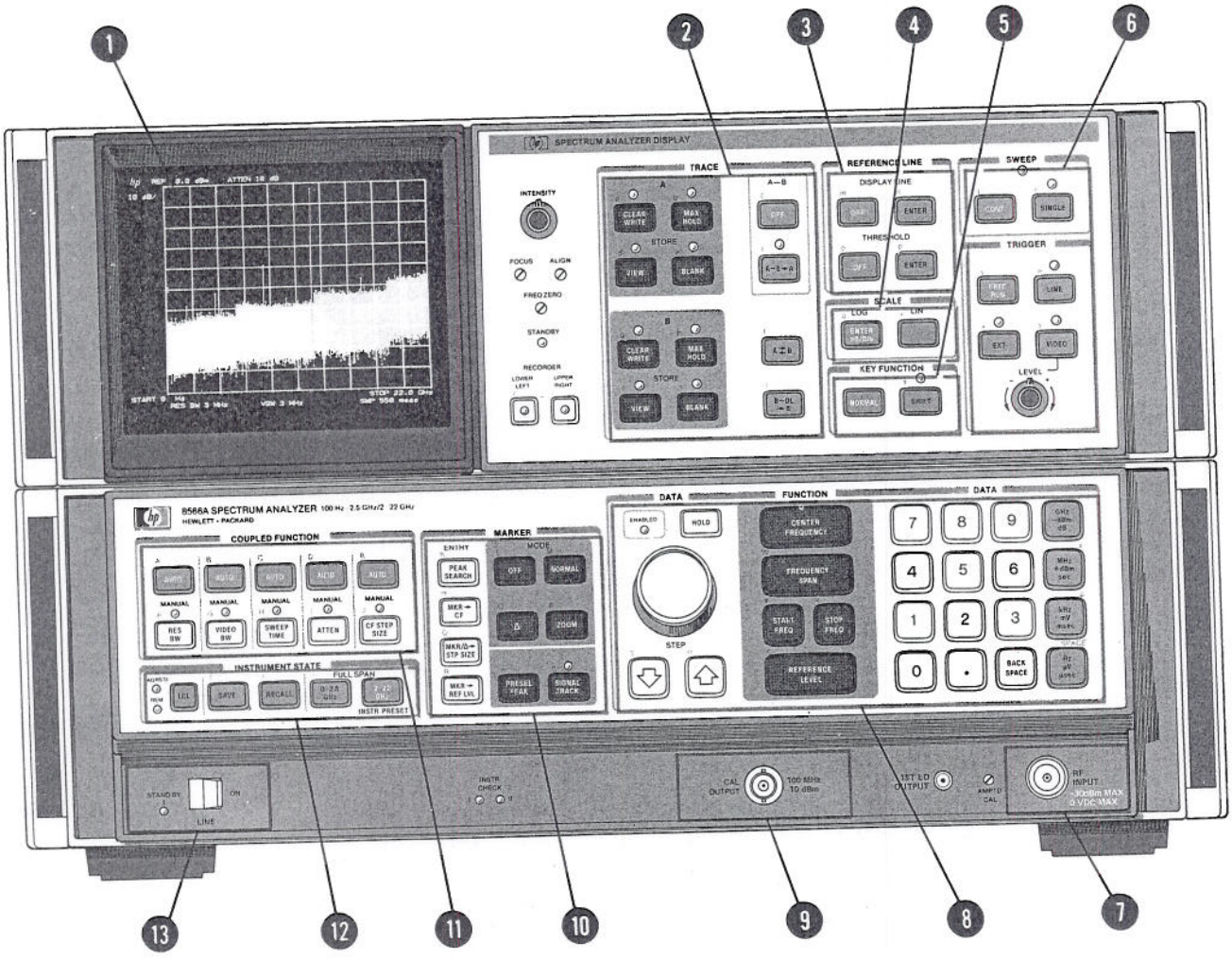
*If connection cable has significant loss it must be accounted for separately.

Error Correction Routine

A 30 second internal error correction routine minimizes uncertainties due to control changes in the analyzer. To start the routine, press [SHIFT] W [FREQUENCY SPAN]

A "CORR'D" readout will appear on the left edge of the CRT upon completion of this routine. If the message "Adjust AMPTD CAL" appears in the display, repeat the manual calibration before running the error correction routine again.

Front Panel Overview

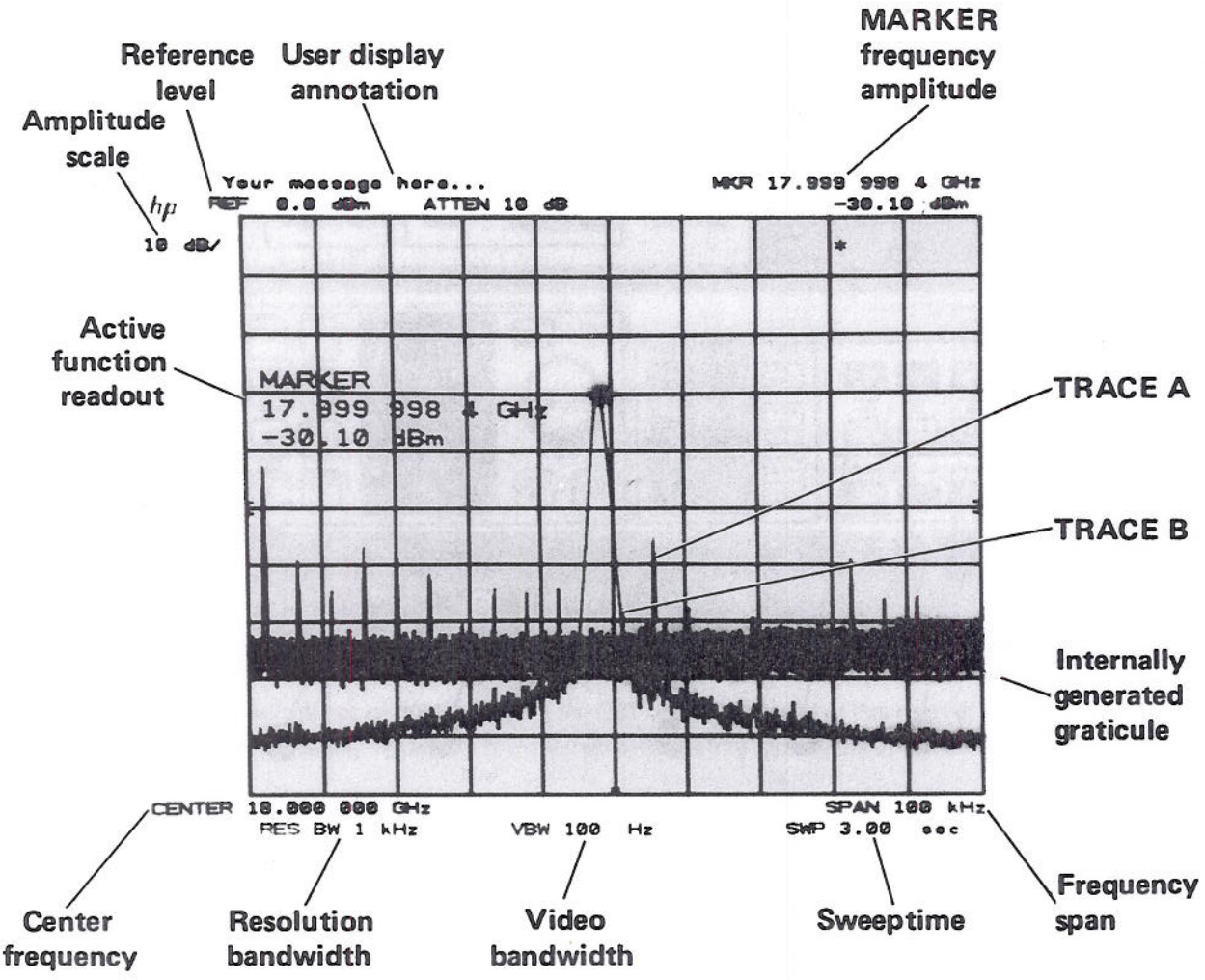


CONTROL GROUPS

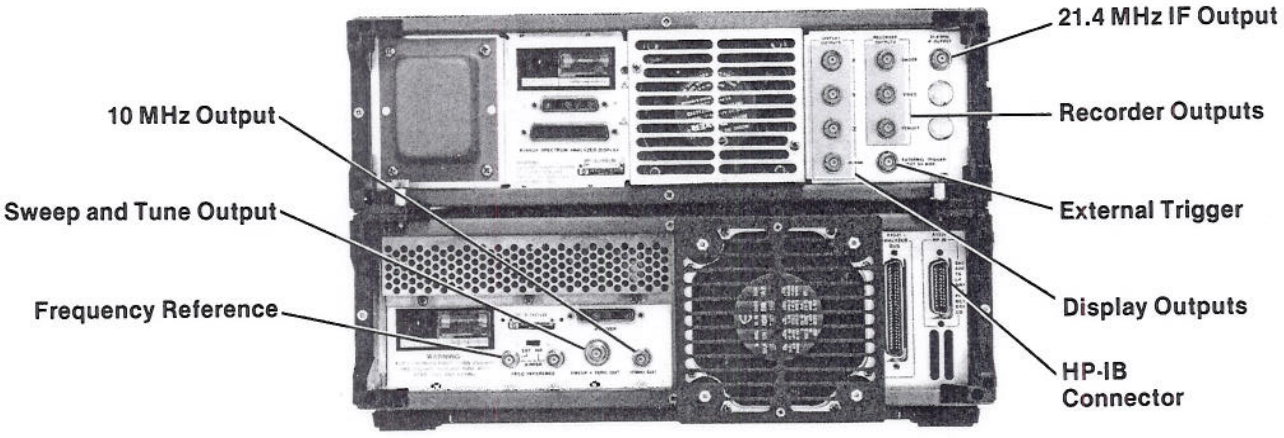
1 CRT DISPLAY:	Signal response and analyzer settings
2 TRACE:	Control of signal response display
3 REFERENCE LINE:	Measurement and display aids
4 SCALE:	Selects logarithmic or linear amplitude scale
5 KEY FUNCTION:	Access to special functions
6 SWEEP and TRIGGER:	Selects trace update trigger
7 RF INPUT:	100 Hz to 22 GHz (+ 30 dBm max. power)
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 (lcl) select key, SAVE and RECALL keys and FULL SPAN keys.
13 LINE ON&STANDBY	Powers instrument and performs instrument check

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.



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	0 to +1 V
Z	Intensity: -1 V blank, 0 to 1 V intensity modulation

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 0 V for the left edge and to +10 V for the right edge.	0 V left	10 V 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 1 V.	0 V lower	+1 V upper
PENLIFT	A blanking output, 15 V, occurs during CRT retrace; otherwise output is low at 0 V (pen down).	+15 V	+15 V

HP-IB Input Output Connector

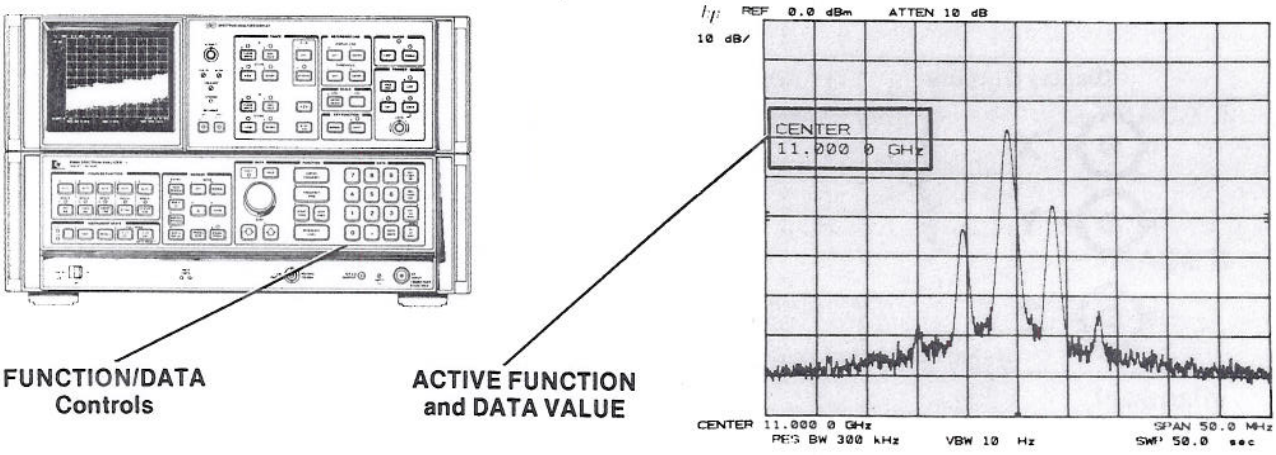
The Hewlett Packard Interface Bus allows remote operation of the analyzer as well as input and output of measurement data. See 8566A Spectrum Analyzer Remote Operation, HP part number 08566-90003.

Chapter 2
GETTING STARTED

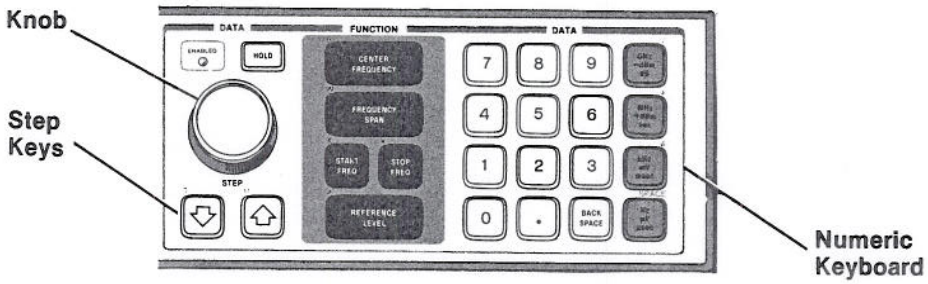
This chapter is intended to provide you with a quick overview of the use and capability of the HP 8566A Spectrum Analyzer. The chapters following provide the details on each aspect of operation.

Front Panel Concept

The basic controls on the HP 8566A front panel consists of FUNCTION keys and DATA control keys. Functions are activated by pressing the appropriate key; its value is then changed via the DATA control knob, step keys or numeric keyboard. The activated FUNCTION will appear on the CRT as well as its current value.



The front panel controls are divided into functional groups. The majority of measurements can be made with only the FUNCTION/DATA group illustrated. The major FUNCTION controls are CENTER FREQUENCY, FREQUENCY SPAN (or START/STOP FREQ) and REFERENCE LEVEL. The value of the activated FUNCTION can be changed continuously with the knob, incrementally with STEP KEYS or exactly with the numeric keyboard.



Making a Measurement

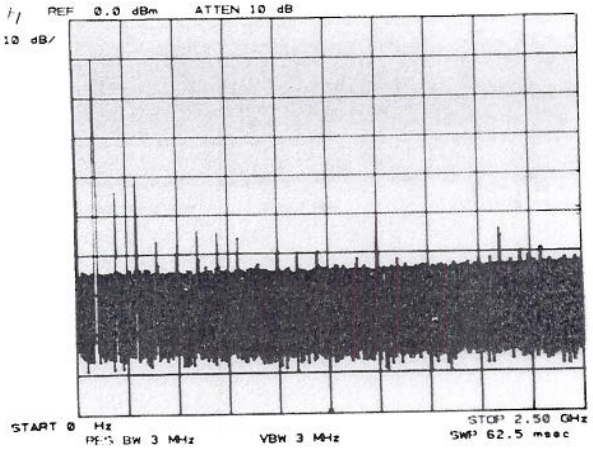
Two FULL SPAN keys allow you to select a wide 0 — 2.5 GHz or 2 — 22 GHz* frequency span. Both keys presets all the analyzer functions to automatically maintain a calibrated display during the course of the measurement.

EXAMPLE

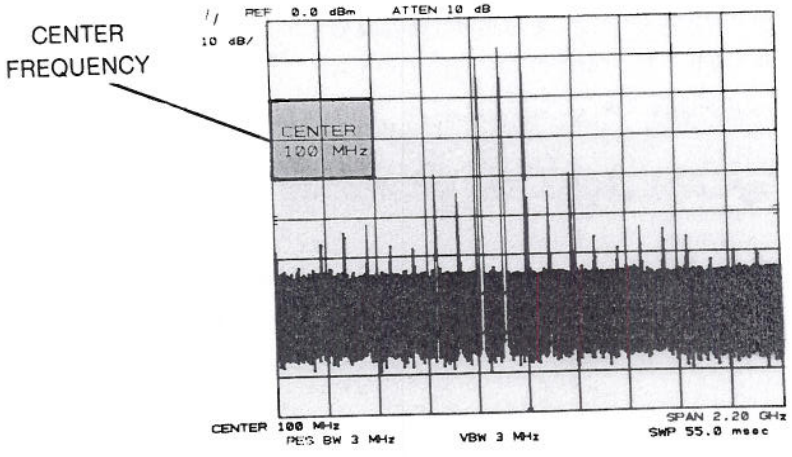
Connect the CAL OUTPUT signal to RF INPUT.

Press [0-2.5 GHz]

This presets the analyzer to a full 0 — 2.5 GHz span with 0 dBm Reference level and automatically couples all secondary receiver functions.

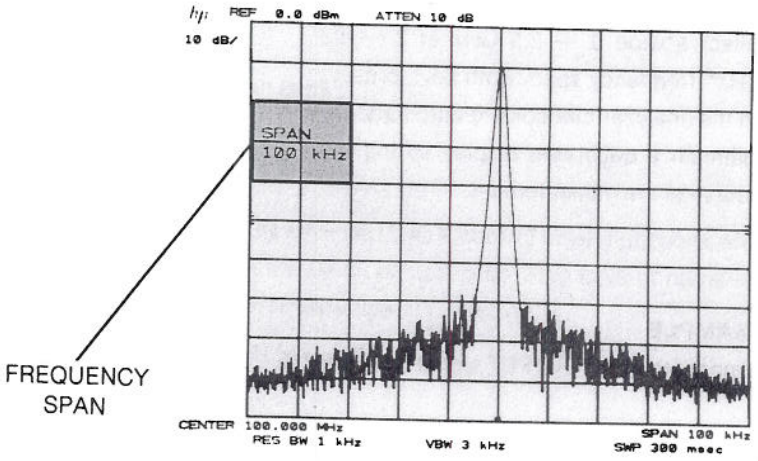


Press [CENTER FREQUENCY] and use the knob step keys [⇩] [⇧] or the numeric keyboard to tune the center frequency to 100 MHz. Note that the activated FUNCTION (CENTER FREQUENCY), appears on the CRT graticule field.

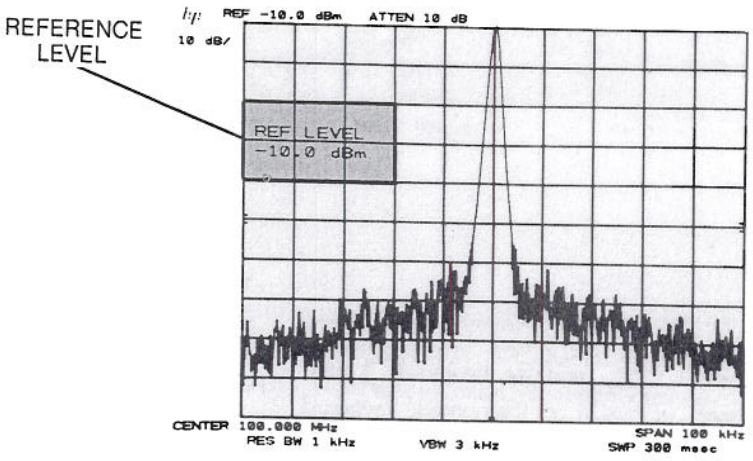


*The [2-22 GHz] key is also activated with LINE ON.

Press [FREQUENCY SPAN] and use the knob , step keys [▽] [△] or numeric keyboard to reduce the frequency span to 100 kHz.



Press [REFERENCE LEVEL] and use the knob , step keys [▽] [△] or numeric keyboard to position the peak of the signal on the top graticule line.



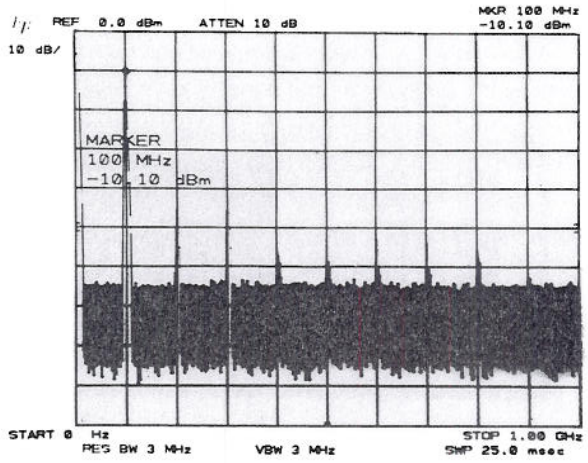
The frequency and amplitude of the signal are read out from the graticule border. All secondary analyzer functions (resolution bandwidth, video bandwidth, sweep time and attenuation) were automatically adjusted to maintain a fully calibrated display. The coupled functions can also be uncoupled to allow manual operation.

For instance, to manually control the resolution bandwidth, press [RES BW] and change bandwidth with any combination of DATA control. The above also applies to [VIDEO BW], [SWEEP TIME], [ATTEN] or [CF STEP SIZE].

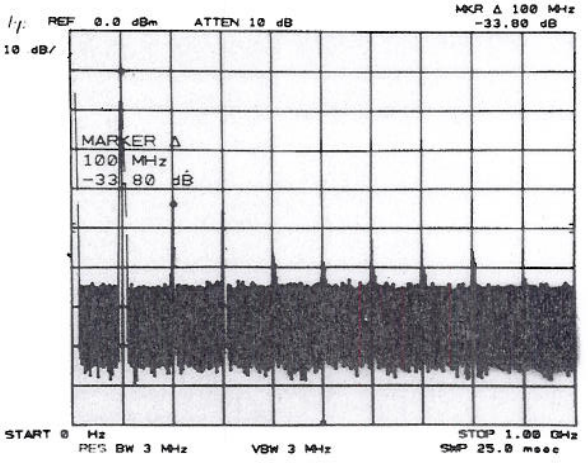
Direct Frequency and Amplitude Readout

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

Activate a marker on the display with NORMAL. Tune marker with ◎ The frequency and amplitude of the signal are read out with the marker.



To measure the harmonic(s) of the signal, press Δ and tune the second marker to the signal's harmonic. The frequency separation and amplitude difference are read out.



SAVE / RECALL

The HP 8566A instrument control settings can be saved in an internal memory and later recalled to make a measurement. [SAVE] / [RECALL] [1] to [6] provide access to the six internal storage registers.

SHIFT Keys

In addition to the front panel functions listed on the keys, another set of functions can be assigned to the same keys by pressing the blue [SHIFT] key prior to activating a front panel key. These will be covered in more detail in Chapter 12.

Automatic Measurements

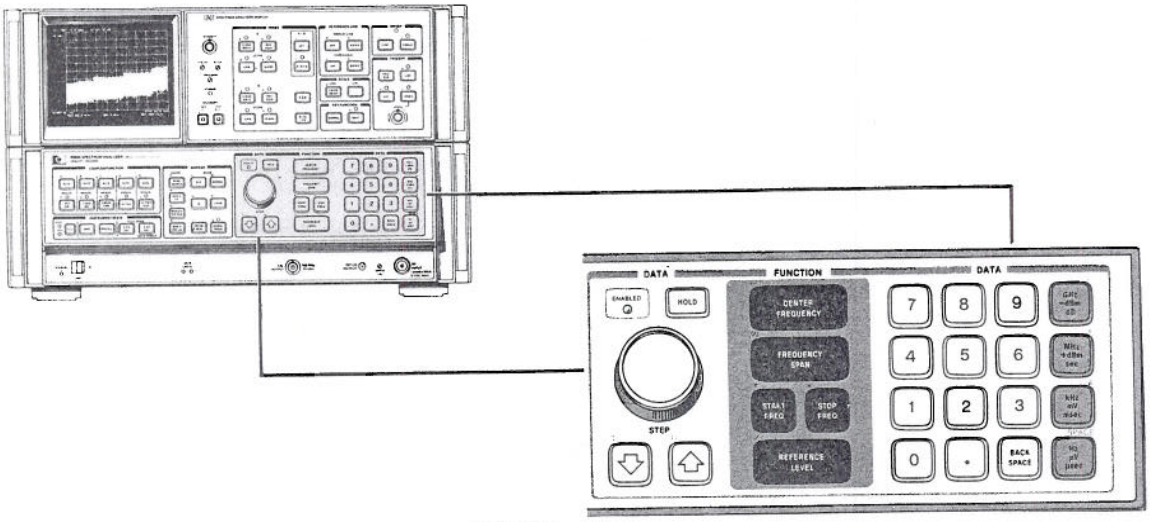
The HP8566A is fully programmable via the Hewlett-Packard Interface Bus (HP-IB) — HP's implementation of IEEE Std 488-1975. Internationally, HP-IB is in concert with the IEC main interface document.

A computing controller/calculator can be used with the HP 8566A to configure an automatic measurement system. Just as the analyzer's front panel is keyed manually to control functions and change values, simple program codes are transmitted via the HP-IB with a controller to make measurements automatically. These program codes are listed in the Remote Operation section of the instrument pull-cards.

Detailed information on remote operation is the subject of another manual entitled "8566A Spectrum Analyzer Remote Operation", HP part number 08566A-90003.

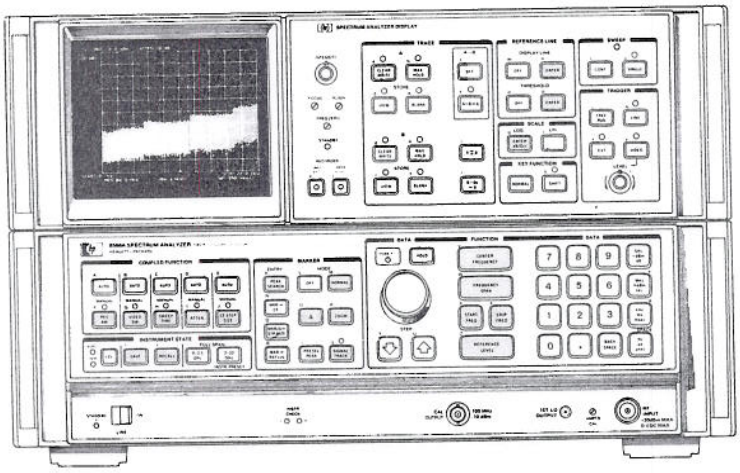
Chapter 3
DATA

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 which "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:



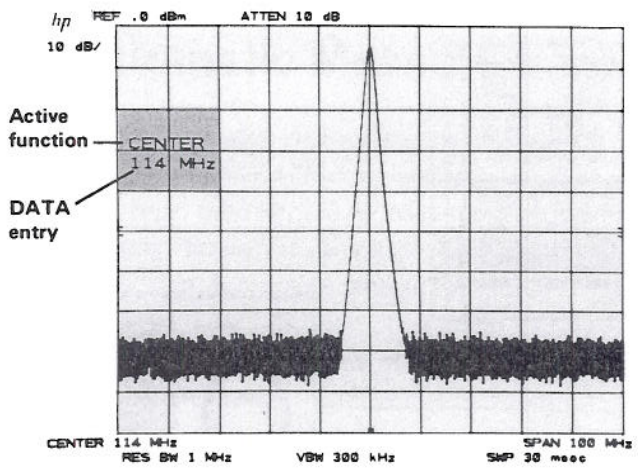
Front Panel Functions Using DATA Controls

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.

The DATA controls will 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 increment the setting from one bandwidth to the next. An entry from the number/units keyboard which may not coincide with an allowable bandwidth will select 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 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 stop/stop frequencies), reference level, and the positions of the marker, display line and threshold. It can also change the function values which are only incremented.

Clockwise rotation of the DATA knob will increase 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, increases the value of the center frequency one horizontal division of span per one quarter turn.

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 [△] will 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, [△] will increase 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 [△] will select 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 and the positions of the markers, 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 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]

will set the center frequency to 1.250 GHz.

If the units key were 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 will enter -dBm, -dBmV or -dBμV. For example in reference level, with the dBmV units, an entry of [5] [0] [MHz -dBm sec] will enter -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 [FREQUENCY SPAN] [SHIFT] [HOLD] [1] [0] [0] [MHz -dBm sec]. This enters the frequency value as -100 MHz.

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

Multiple DATA Changes

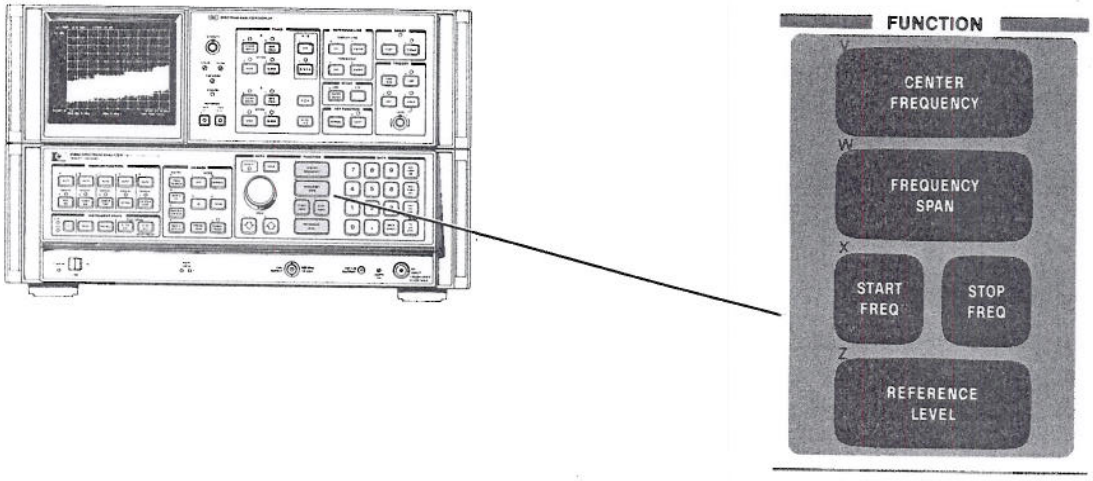
A function, once activated, may be changed as often as necessary without reactivating that function (see Chapter 4, FUNCTION). Any of the DATA controls can be used in any order.*

It is not always necessary to make a DATA entry. For example, start and stop frequency may be activated simply to allow readout of the left and right display reference frequencies as start/stop frequencies.

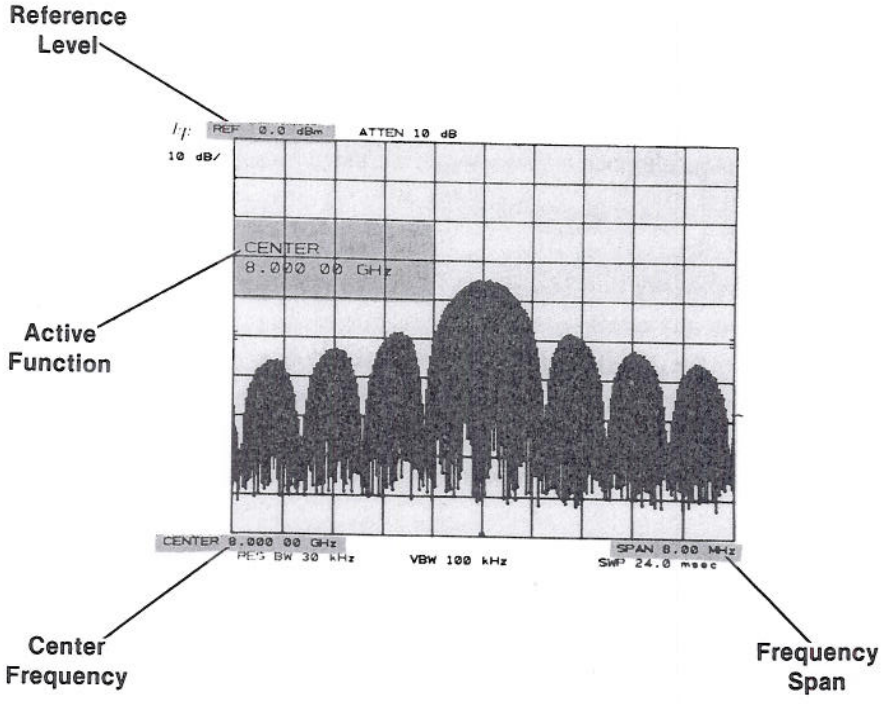
*Exceptions are the SHIFT KEY FUNCTIONS which use only DATA number/units keyboard. See Chapter 12.

Chapter 4
FUNCTION

This chapter describes the use of the major function block — CENTER FREQUENCY, FREQUENCY SPAN (or START/STOP FREQUENCY) and REFERENCE LEVEL.



A FUNCTION is enabled by pressing the desired FUNCTION key. Once enabled, the function along with its current data value is displayed in the active graticule area of the CRT as well as outside the graticule border. To change the value of the active function, use either the DATA knob, step keys, numeric keyboard or a combination of all three. The HOLD key above the DATA knob can be used to retain the present instrument state and prevent inadvertent entry of DATA. HOLD clears the active function area of the CRT as well as de-activates any function.



Center Frequency

The center frequency can be tuned continously from 0 to 22 GHz using any combination of DATA controls. Additional band overlap enables the center frequency to tune up to 24 GHz and below to – 1 GHz.

The center frequency can be set with 1 Hz resolution. Readout resolution is 1% of the frequency span, hence the highest readout resolution is obtained with narrow frequency spans. Data entered however, is always accurate to 1 Hz even though the center frequency readout may display less resolution.

During band crossings (from 0 — 2.5 GHz low band to 2 — 22 GHz microwave band) or at band edges (below 0 Hz or above 22 GHz), the frequency span may change to enable the desired center frequency to be set. (See Appendix for detailed information.)

DATA Entry with CENTER FREQUENCY

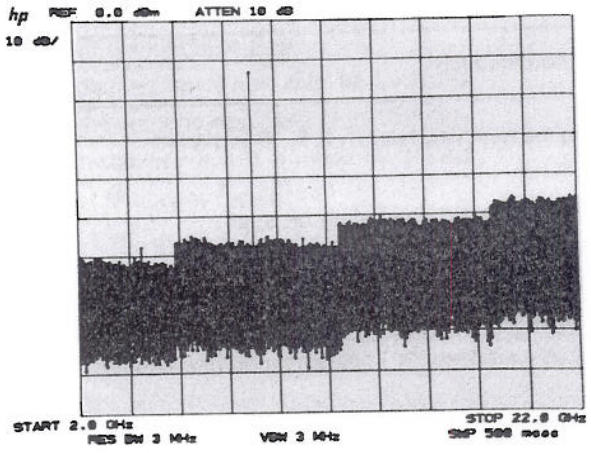
CENTER FREQUENCY 	Changes the center frequency by about one half the total frequency span each full turn.
CENTER FREQUENCY 	Changes the center frequency by one tenth of the frequency span, i.e., by one division. COUPLED FUNCTION [CF STEP SIZE] can be used to change this step size.
CENTER FREQUENCY 	Allows direct center frequency entry. The analyzer will accept a center frequency entry with 1 Hz resolution. Even though the readout may show a fewer number of digits (due to wide frequency span), as the span is narrowed, the full entry will be read out. Abbreviated readouts are not rounded.

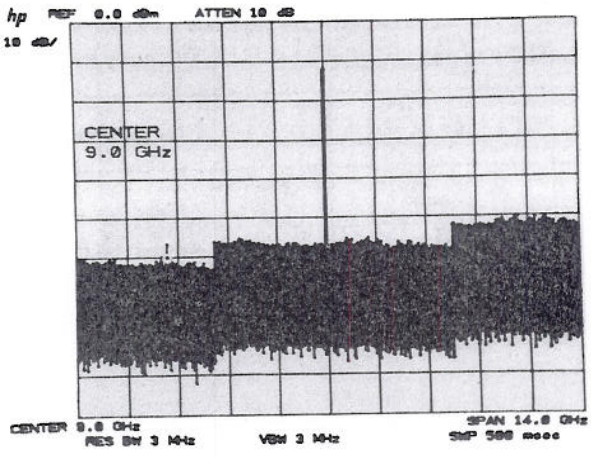
Example:

Once a signal response is placed at the center of the display, the frequency of the signal can be read out from CENTER FREQUENCY. The input signal is an 9 GHz synthesized source.

Press [2–22 GHz] for a full span display.

Tune signal to center of display with [CENTER FREQUENCY] 





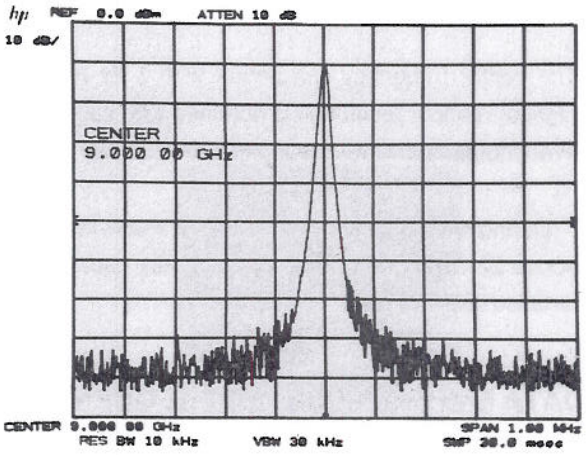
FUNCTION

CENTER FREQUENCY

Reducing the frequency span will increase the center frequency readout resolution.

press FREQUENCY SPAN ⇩ ⇩

then CENTER FREQUENCY



Frequency Span

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

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

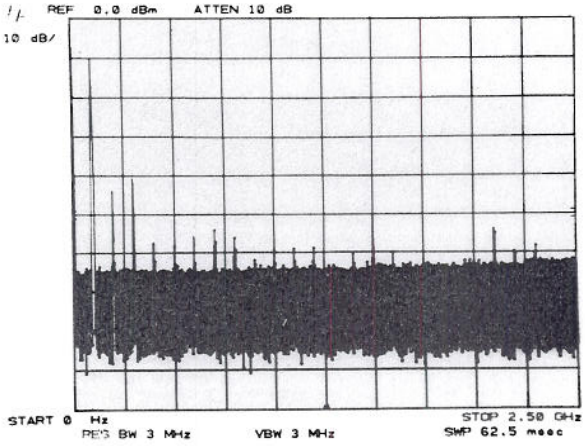
The analyzer can be adjusted to span a maximum of 2.5 GHz in the low band and 22 GHz (2 to 24 GHz range) in the microwave band. A minimum span of 100 Hz is allowed in both bands as well as 0 Hz (zero span) which enables the analyzer to function as a fixed-tune receiver. In zero span, the analyzer can display modulation waveforms in the time domain.

DATA Entry with FREQUENCY SPAN

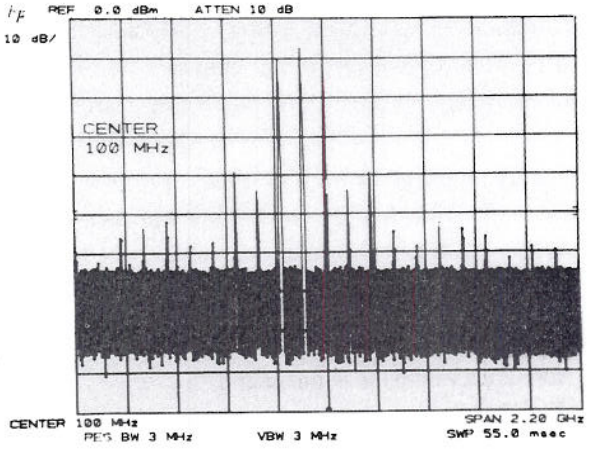
FREQUENCY SPAN ◯	Changes the frequency span continuously.
FREQUENCY SPAN ⇩ ⇧	Changes the frequency span to the next value in a 1, 2, 5, 10 sequence.
FREQUENCY SPAN ▦	Enters an exact value up to three digits, depending on span. Additional digits will be deleted without rounding.

Example:

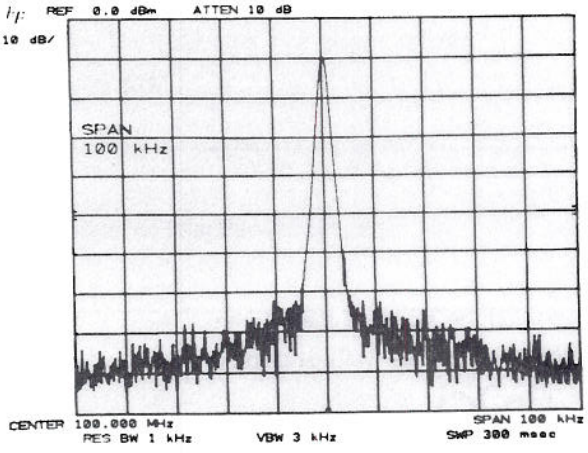
Use FREQUENCY SPAN to zoom-in on signals.



Connect CAL OUTPUT to RF INPUT press [0-2.5 GHz]. This selects a convenient full span display from 0 to 2.5 GHz.



Tune center frequency to 100 MHz with:
[CENTER FREQUENCY] 1 0 0 MHz.



Reduce span with:
[FREQUENCY SPAN] [↓] [↓] or ◎
The desired span can also be selected with the numeric keyboard. Note that narrow frequency spans provide increased center frequency resolution.

In the microwave band, pressing [2-22 GHz] enables a 20 GHz full span.

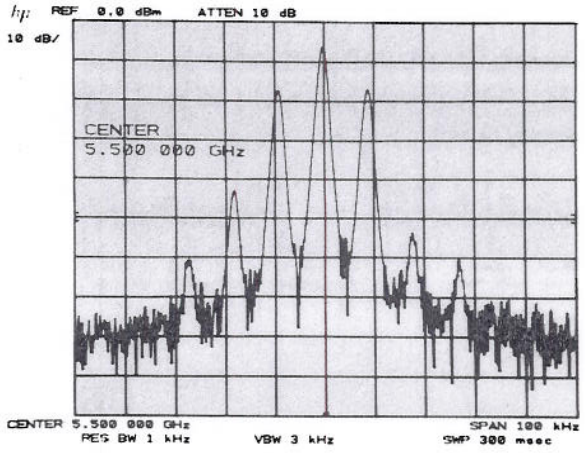
FUNCTION

FREQUENCY SPAN

Example:

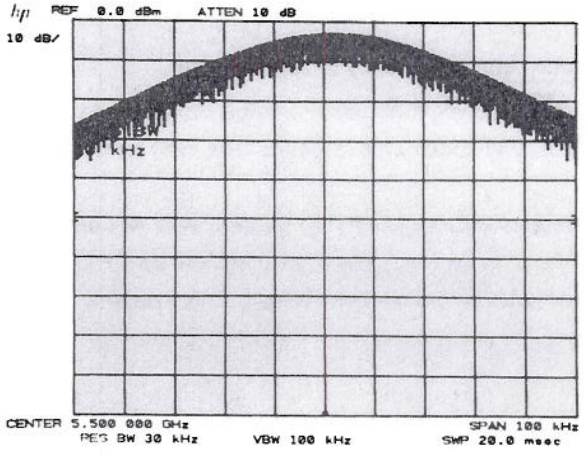
Operating the spectrum analyzer in zero span. The modulation waveform of an AM signal can be displayed in the time domain.

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



To demodulate the AM, increase the resolution bandwidth to include both sidebands within the IF passband.

RES BW

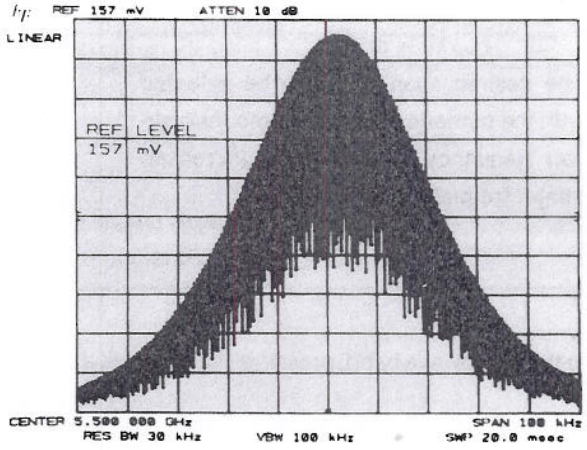


Position the signal at the reference level and select a linear voltage display.

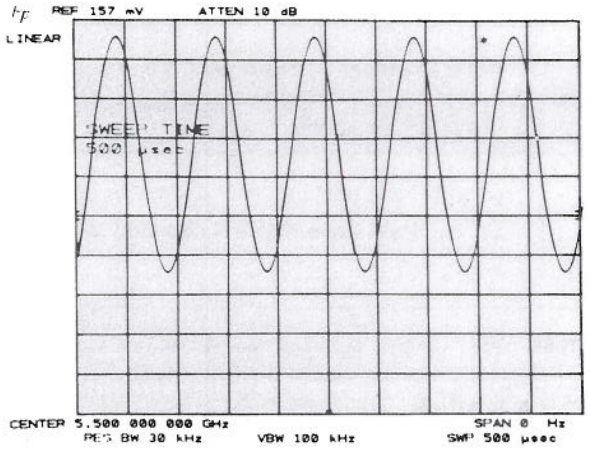
REFERENCE LEVEL

LIN

SCALE



To select zero span, press FREQUENCY SPAN | 0 | Hz μV μsec
Video trigger can be used to trigger on the waveform. The sweep time control can be adjusted to change the horizontal scale.



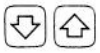
START/STOP Frequency

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

The INSTRUMENT STATE keys, 0-2.5 GHz and 2-22 GHz select a start/stop frequency from 0 to 2.5 GHz and 2 to 22 GHz respectively. Additional over-range allows start frequency setting of −1 GHz and stop frequency of 24 GHz. The maximum start/stop frequency span allowable is 22 GHz; the minimum span is 100 Hz and zero span (START FREQ = STOP FREQ).

Start/Stop frequency readout resolution is 1% of the span (span = stop frequency − start frequency). Both start or stop frequencies can be entered with 1 Hz resolution.

DATA Entry with START/STOP Frequency

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 readout depends upon the frequency span.

FUNCTION

START FREQ | STOP FREQ | REFERENCE LEVEL

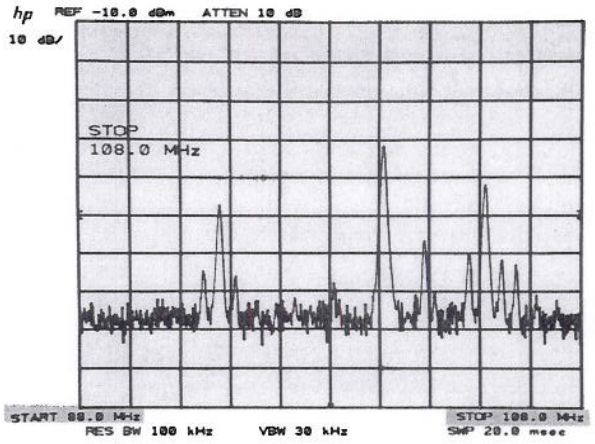
Example:

Set start/stop frequency to monitor FM broadcast band.

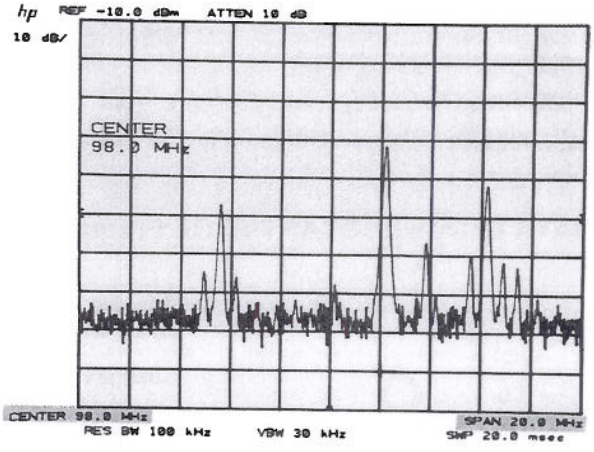
Press: 0-2.5 GHz

START FREQ | 8 | 8 | MHz -dBm sec

STOP FREQ | 1 | 0 | 8 | MHz -dBm sec



Press CENTER FREQUENCY . Note that horizontal scaling is unchanged although the START/STOP frequency readouts are replaced by center frequency and span (108 − 88 = 20 MHz)



Reference Level

The REFERENCE LEVEL function changes the absolute amplitude level of the top graticule line. The vertical scale (amplitude units per division) is selected from the SCALE control group. To measure signal level, the peak of the signal's response is positioned on the top graticule line and its amplitude is read out from REF LEVEL.

The reference level can be adjusted from − 89.9 dBm to + 30 dBm (− 139.9 dBm to + 60 dBm with extended range) with 0.1 dB resolution. The input attenuator is automatically coupled with the reference level to prevent gain compression; signals which are above the gain compression point will be displayed above the reference level line. Different mixer input levels as well as amplitude units can be selected (see SHIFT FUNCTIONS Chapter 12).

DATA Entry with REFERENCE LEVEL

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.

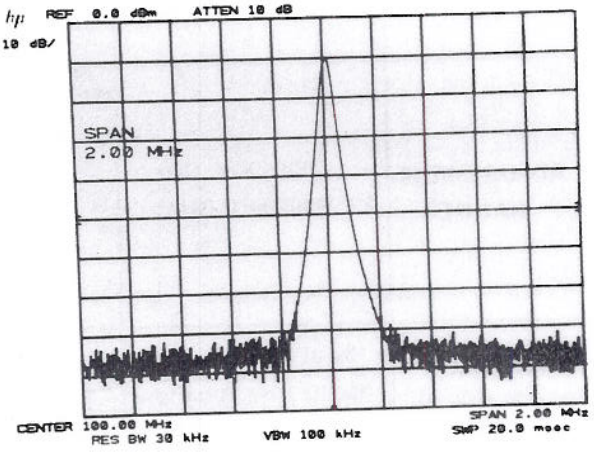
Example:

Measure amplitude of calibration signal.

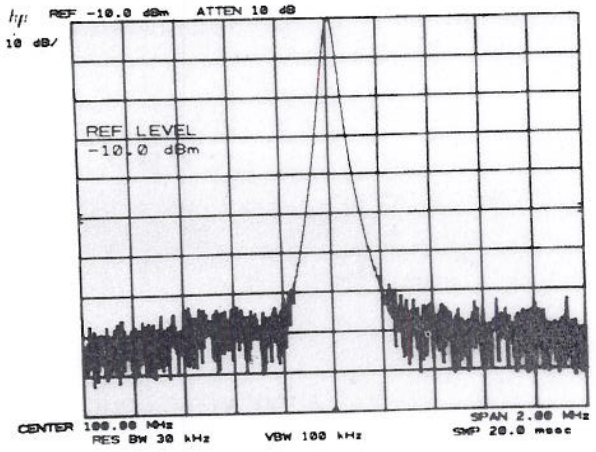
Press 0-2.5 GHz

CENTER FREQUENCY 100 MHz

FREQUENCY SPAN 2 MHz



To measure signal amplitude, press REFERENCE LEVEL and position signal peak to top graticule line. Read amplitude from REF LEVEL.



Function/Data Summary

FUNCTION / DATA	CENTER FREQUENCY	FREQUENCY SPAN	START/STOP FREQUENCY	REFERENCE LEVEL
KNOB	Change continuously with up to 1 Hz resolution in narrow spans.	→	Change continuously with n x 2Hz resolution*	Continuous with 0.1 dB tuning resolution
STEP KEYS	Change frequency in one division steps, (i.e. 10% of frequency span.)	→	Change span in 1, 2, 5, 10 sequence	Incremental change in accordance with log scale. In Linear, changes incrementally in 1 dB steps.
NUMERIC KEYBOARD	Enter exact frequency with up to 1 Hz resolution	→	Enter exact frequency with n x 2Hz resolution*	Enter exact reference level. Digits entered beyond last displayed digit are deleted.
ADJUSTMENT RANGE	−1.000000000 GHz to 23.999999950 GHz	0-2.5 GHz: −1 to 2.5 GHz 2-22 GHz: 2 to 24 GHz	2-22 GHz: 100 Hz to 22 GHz and zero span 0-2.5 GHz: 100 Hz to 2.5 GHz *and zero span*	−139.9 dBm to +60 dBm
READOUT RESOLUTION	1% of SPAN (Up to 1 Hz in narrow span)	→	→	0.1 dB in log; 4 significant digits in linear.

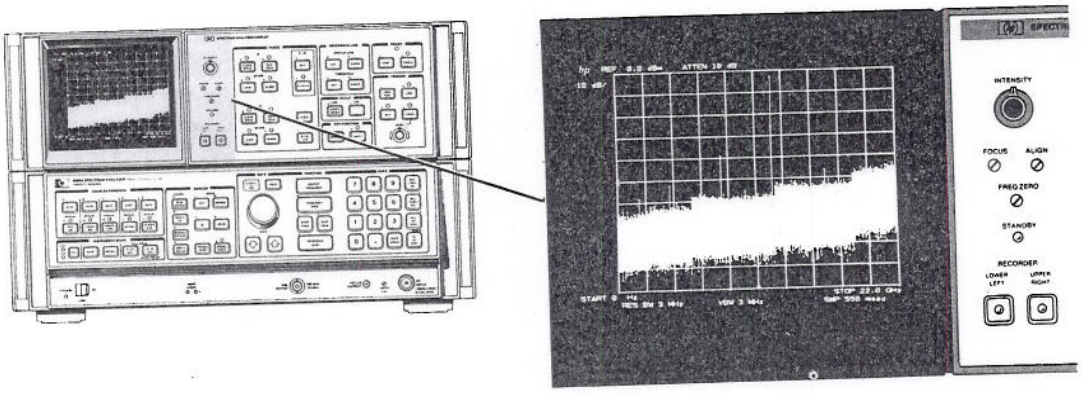
*where n = harmonic number

Chapter 5
CRT DISPLAY

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

Adjustment of the Display

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



CRT Display and Adjustments

INTENSITY

Controls intensity for all the CRT writing.

FOCUS

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

ALIGN

A screwdriver adjustment which tilts all the displayed CRT information.

Display Section Line Power

STANDBY

The light indicates power condition of the Spectrum Analyzer Display section as dictated by the LINE power switch on the 85660A RF section.

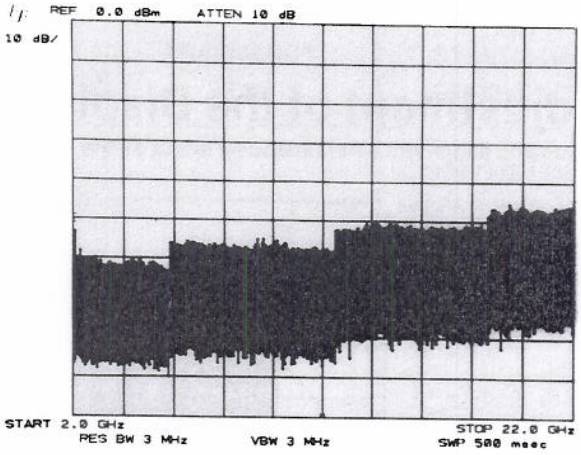
CRT Display Overview

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 which has been activated for DATA entry is read out in the graticule area shown.



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 the front panel designated active functions after an INSTRUMENT PRESET.

Function	Examples of Active Function Readout
FUNCTION	
CENTER FREQUENCY	CENTER 12.0 GHz
FREQUENCY SPAN	SPAN 20 GHz
START FREQ	START 2 GHz
STOP FREQ	STOP 22 GHz
REFERENCE LEVEL	REF LEVEL .0 dBm

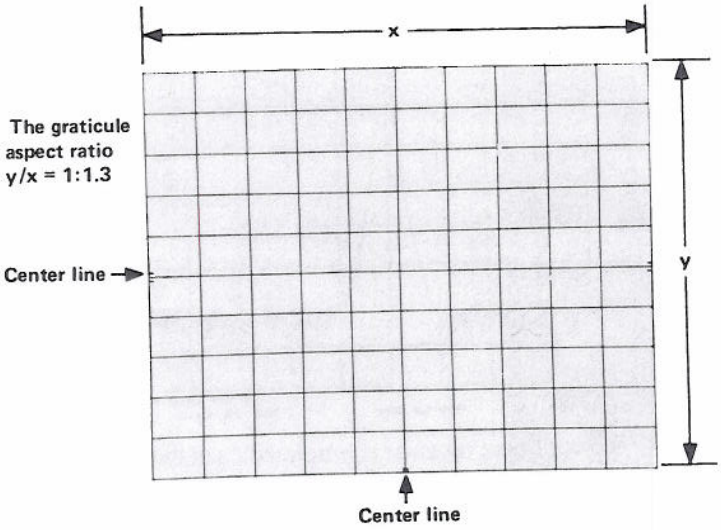
HOLD deactivates the active function and blanks the active readout.

Function	Examples of Active Function Readout
COUPLED FUNCTION	
RES BW	RES BW 3 MHz
VIDEO BW	VIDEO BW 3 MHz
SWEEP TIME	SWEEPTIME 500 msec
ATTEN	RF ATTEN 10 dB
CF STEP SIZE	CF STEP 100 MHz

Function	Examples of Active Function Readout
MARKER	
NORMAL	MARKER 12.0 GHz 19.8 dBm
Δ	MARKER Δ 20.0 MHz -12.4 dB
ZOOM	MARKER ZOOM 12.0 GHz -32.8 dBm
NORMAL SHIFT M	MARKER 12.0 GHz -140.4 dBm (1 Hz)
REFERENCE LINE	
ENTER	DISPLAY LINE -45.0 dBm
ENTER	THRESHOLD -90.0 dBm
SCALE	
ENTER dB/Div	LOG 10 dB/
KEY FUNCTION	
	(See KEY FUNCTION, Chapter 12.)

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

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

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

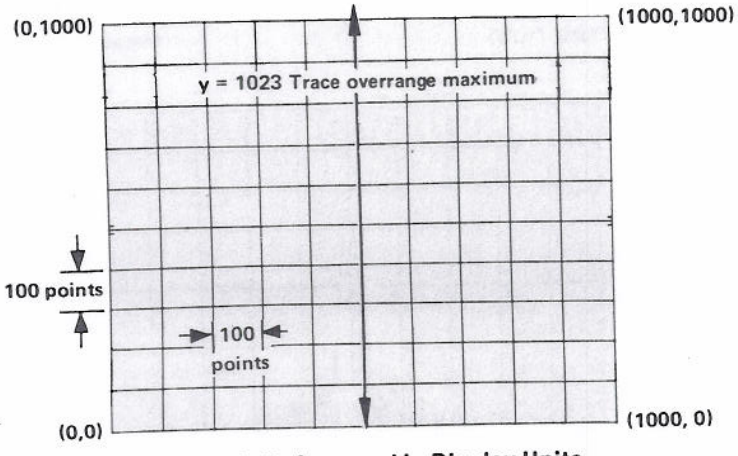
[SHIFT] | [1] [1] [6] [3] [Hz μV μsec]

[2] [1] [1] [5] [Hz μV μsec]

For more intensity, repeat the last two number entries, 1163 Hz and 2115 Hz. [2-22 GHz] returns the graticule to normal.

Traces

Three separate traces, A, B and C, can be written onto the display. Each trace is generated from 1001 points across the graticule, connected by 1000 point-to-point straight line vectors. The location of each point is designated by an x and y location using the graticule as rectangular coordinates.



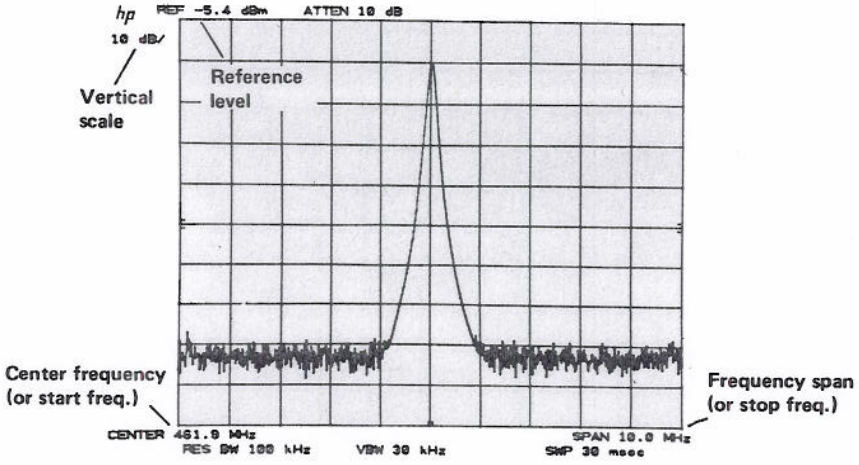
Graticule Referenced in Display Units

Display locations may be referenced in terms of these display units for HP-IB input and output. See Chapter 6 and 8566A Spectrum Analyzer Remote Operation, HP part number 08566-90003.

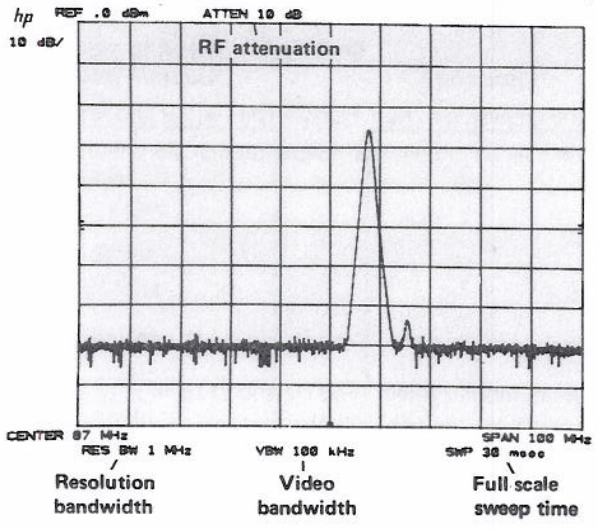
Trace overrange is an additional 23 display units above the top reference level graticule. This display area is not calibrated.

Locations of Permanent Readouts

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

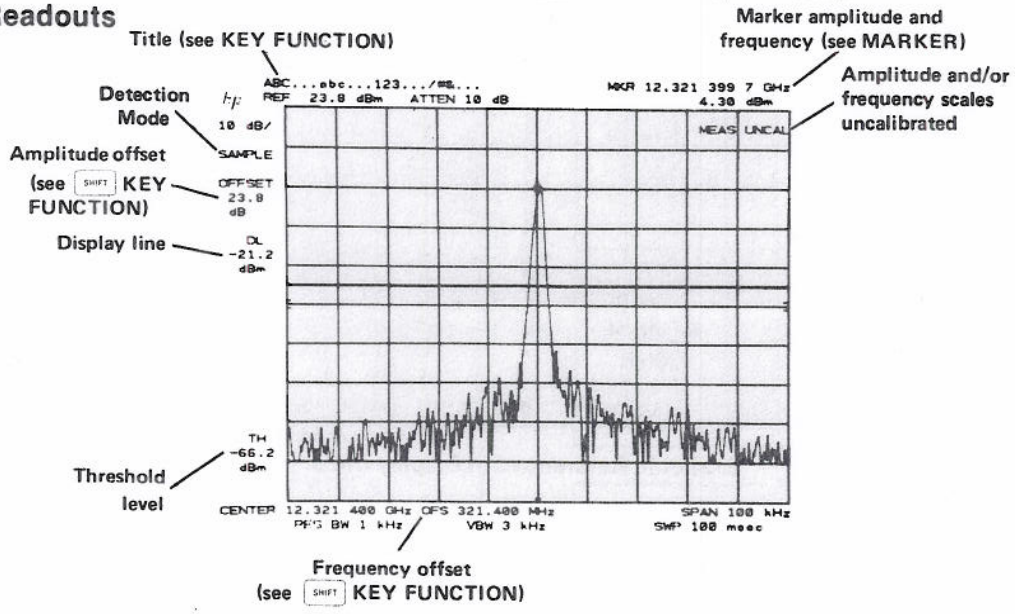


The COUPLED FUNCTIONS that describe the swept receiver characteristics of the spectrum analyzer are:



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

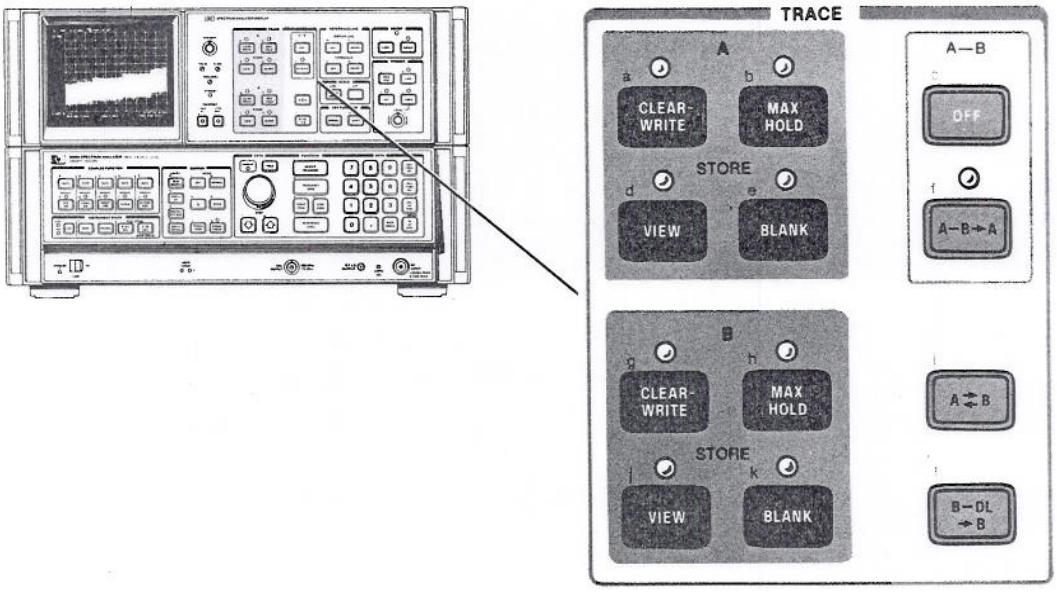
Other Readouts



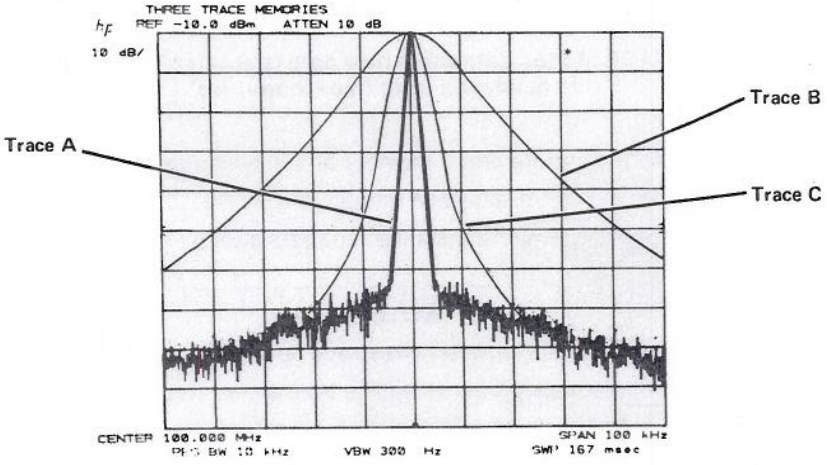
A number of other special function readouts can be activated. These are covered in chapter 12.

Chapter 6
TRACE

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 and trace C are dim. [VIEW] and [BLANK] allow positive identification.

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):

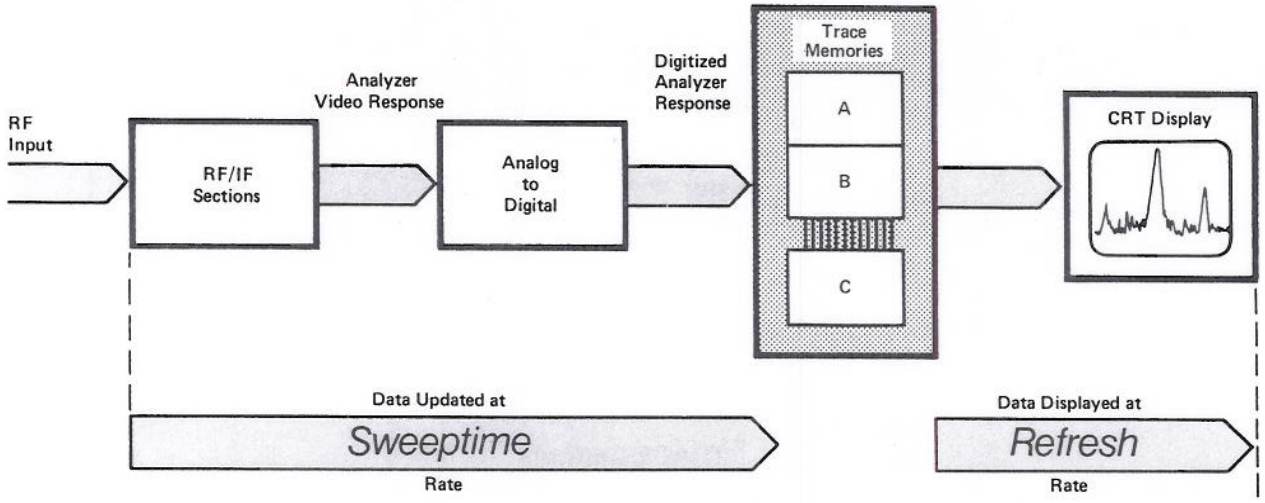
[VIEW] Stores the current trace and displays it on the CRT display.

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

Trace Memory

An understanding of the TRACE modes requires a description of the trace memory and trace data transfer within the analyzer.

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 which 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, its sweep time. The trace memory is written onto the CRT display at a refresh rate of about 50 Hz, rapid enough to prevent flickering of the trace on the CRT. Trace intensities remain constant as analyzer sweep times are changed.

> **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

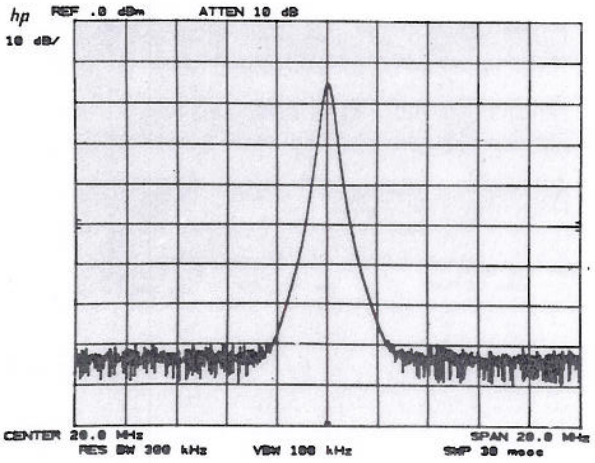
In the STORE modes, no updating of the trace memory is made. The current memory data is saved.

VIEW A(B) — The trace A(B) data are displayed on the CRT (that is, the refresh is enabled).

BLANK A(B) — The trace A(B) data are not displayed on the CRT (that is, the refresh is disabled).

Example

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

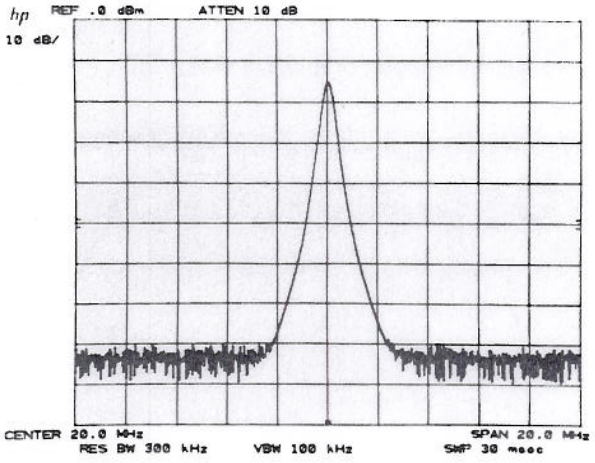


Center and zoom in on a 20 MHz signal:

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

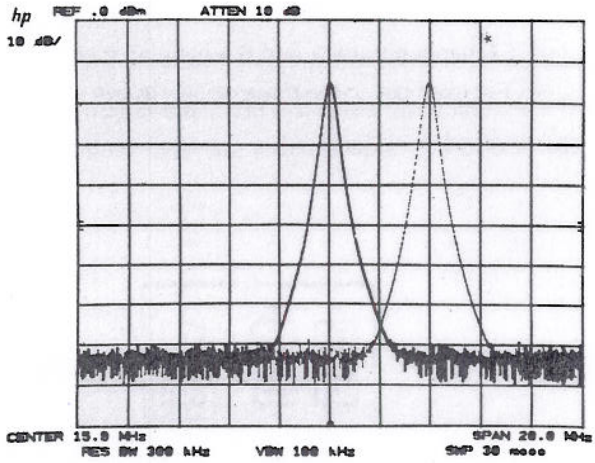
[FREQUENCY SPAN] [2] [0] [MHz -dBm sec]

Since [2-22 GHz] has set [CLEAR-WRITE] A and [BLANK] B, only A is displayed.



This response can be stored:

Press [VIEW] A.



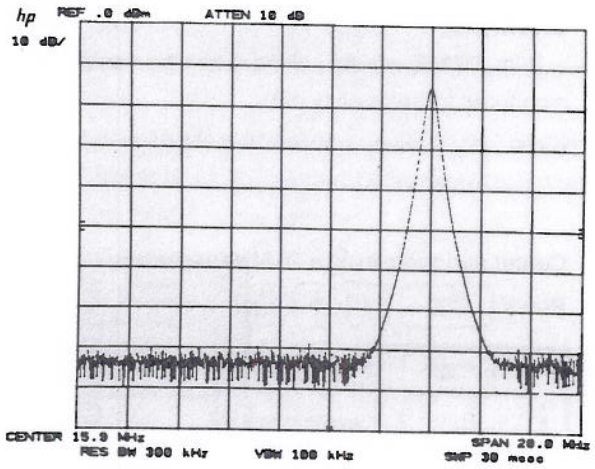
Write the same signal with B and change its position relative to trace A:

Press [CLEAR-WRITE] B

[CENTER FREQUENCY] 

NOTE

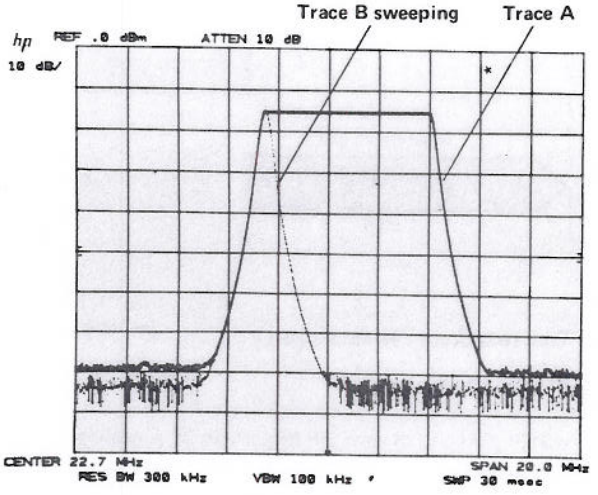
The * on the top right corner of the CRT indicates that the CRT readouts may not correspond to the trace(s). In this case the readouts apply only to TRACE B and not TRACE A.



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.

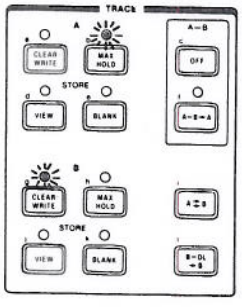


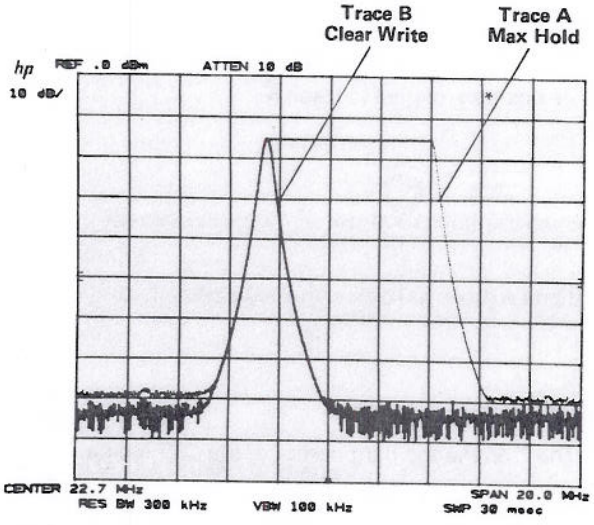
To display the drift of a signal press [MAX HOLD] A.

(Simulate frequency drift with [CENTER FREQUENCY] .)

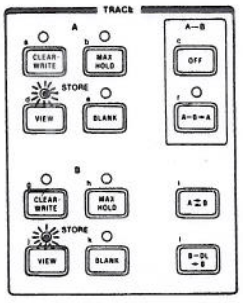
TRACE Exchange

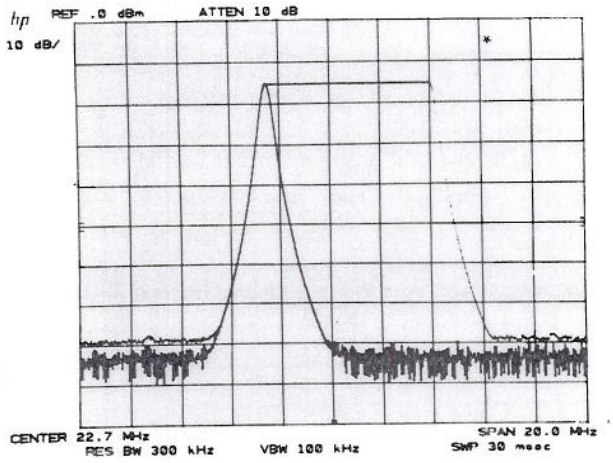
[A⇄B] Exchanges trace A and B, changing their relative intensities and storage memory locations and enables A and B [VIEW]. For example, in the trace display above, the modes and display appear.





Press [A⇄B]





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 was blanked it remains blanked.

B ⇆ C: [SHIFT] i — Exchanges traces B and C. If trace B is not blanked, trace C will not be blanked. If trace C is blanked trace B will be blanked.

TRACE Arithmetic

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

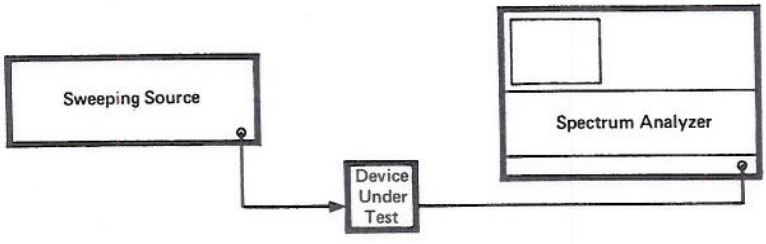
A-B [A-B→A] — Trace B amplitude (measured in divisions from the bottom graticule) is subtracted from trace A and the result written into trace A from sweep to sweep. Trace B is placed or kept in a STORE mode.

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 8, 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:

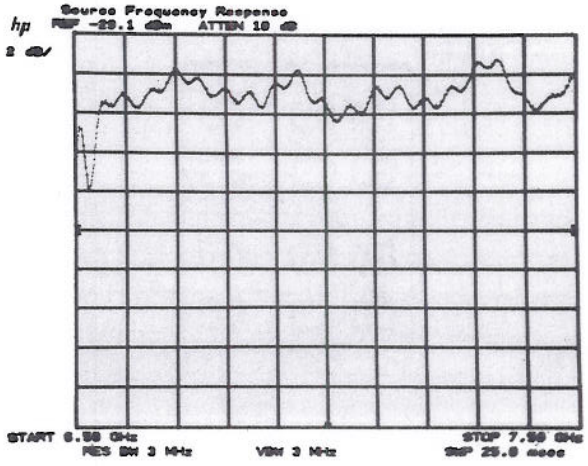


where the device under test is to be characterized for insertion loss over a specific frequency range.

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

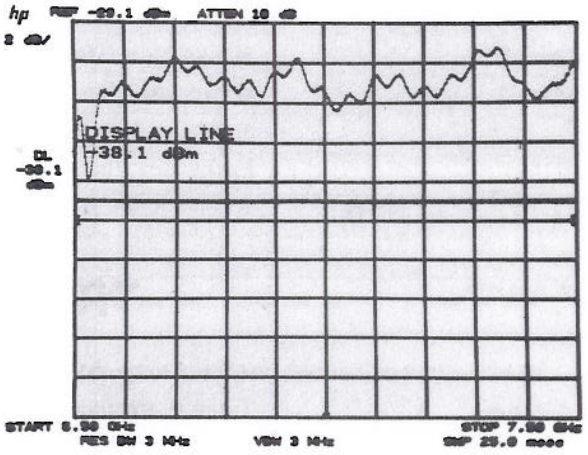
MAX HOLD B, sweep source then

VIEW B.



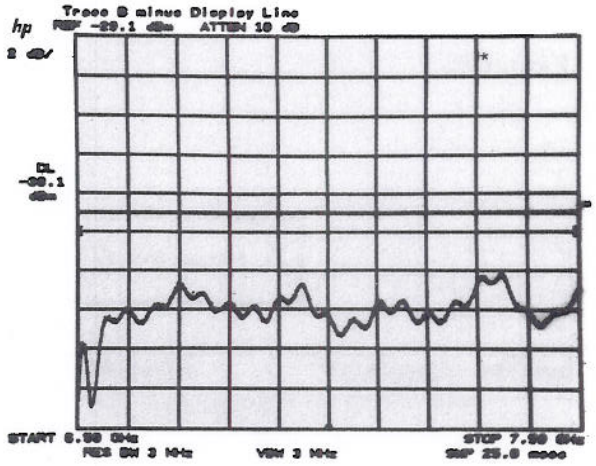
The display line is activated and set below the source/analyzer response.

DL ENTER



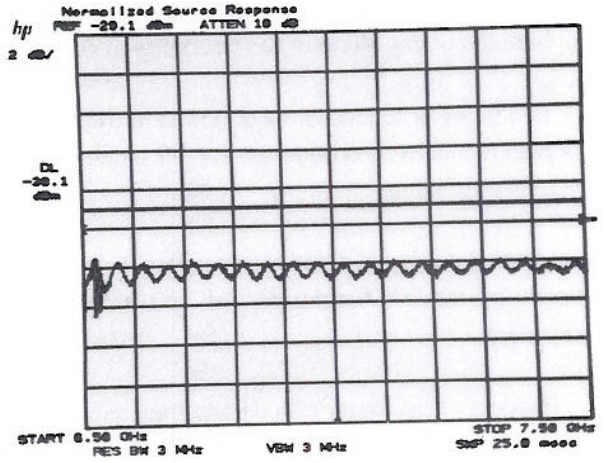
The difference between the display line (in display units) and the source/analyzer response is stored in trace B with B-DL →B

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



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-B→A]



Trace Priority

Functions which 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 7.

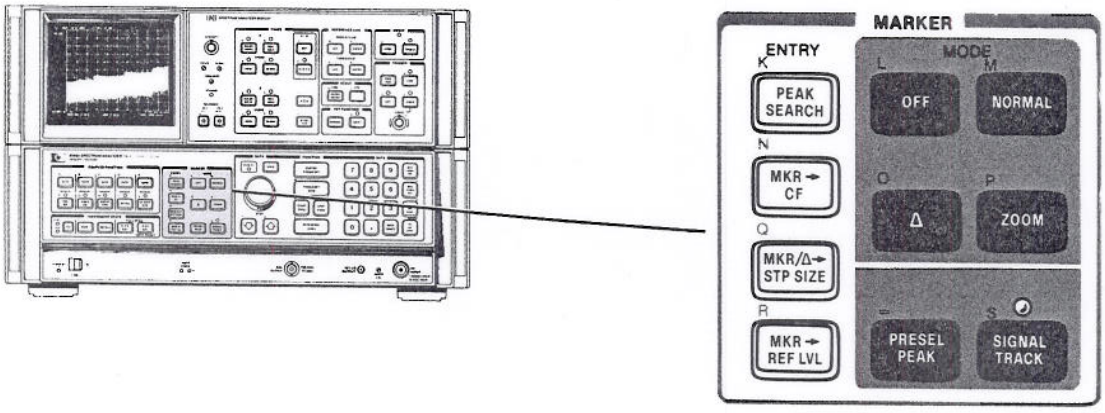
Chapter 7
MARKER

This chapter describes the use of the MARKER and DATA controls for making many measurements faster and with greater accuracy. Markers can be displayed only on TRACE A and TRACE B.

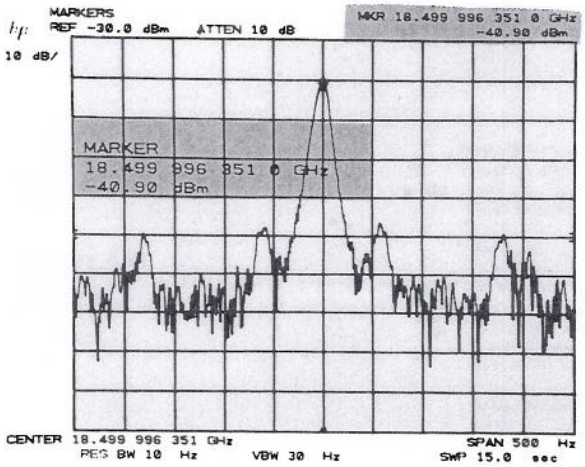
Two types of functions make up the MARKER group: MARKER MODEs, which enable or disable markers and their related functions; and MARKER ENTRY functions which allow the scaling of the display frequency and amplitude using marker information.

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

MARKER Overview

- Direct readout of the amplitude and frequency of a point along the trace
- Direct readout of amplitude and frequency differences between points on the trace.
- Expansion of the span about a specific frequency.
- Placing a single marker at the highest response.
- Automatic peaking of preselector.
- Direct noise level readout.
- Analysis of stored traces.
- Amplitude and frequency display scaling.

FUNCTION

NORMAL
Δ
ZOOM
PEAK SEARCH
PRESEL PEAK
SHIFT M

MARKER with VIEW
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, 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 which are nonperiodic or unstable.

The markers will be placed on a viewed trace according to the priority defined in Chapter 6, 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 6. The marker will not activate on the TRACE modes BLANK A, BLANK B, view C or blank C.

Measurement and Readout Range

Marker frequency has one digit more resolution than center frequency and marker amplitude has one digit more resolution than reference level.

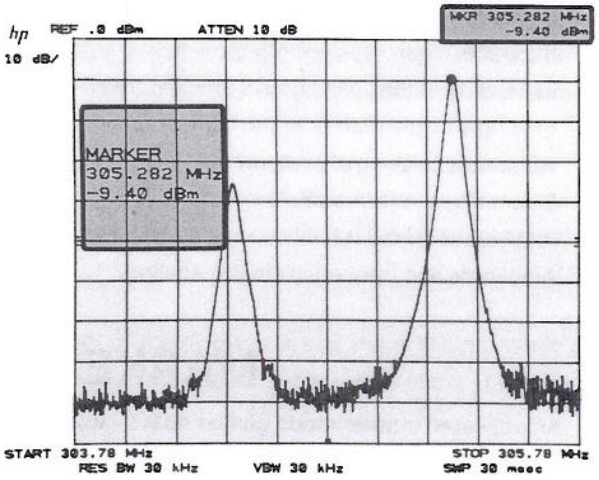
DATA Entry

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

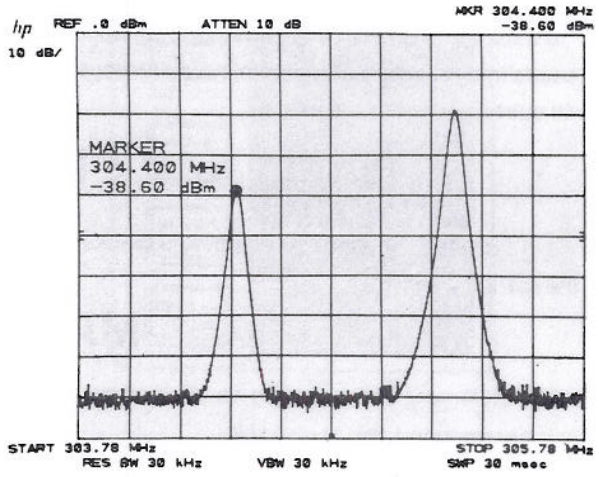
Reading frequencies and amplitudes of signals is greatly simplified using MARKER NORMAL.

For a given display activate the single marker with NORMAL then tune the marker with the knob 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 knob.

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



Differential Markers - Δ

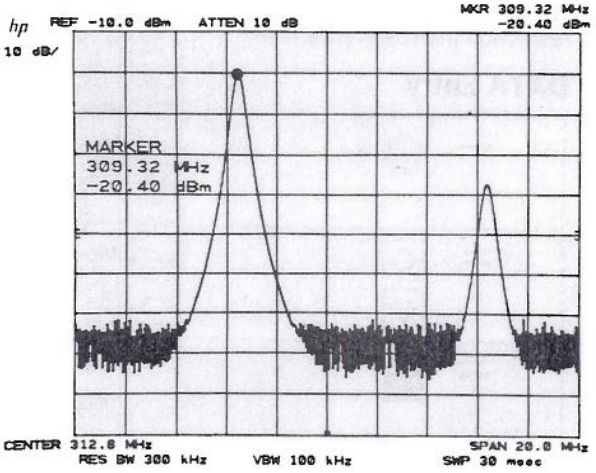
Δ activates a second marker at the position of a single marker already on the trace. (If no single marker has been activated, Δ places two markers at the center of the display.) The first marker's position is fixed. The second marker's position is under DATA control.

- The display readout shows the difference in frequency and amplitude.

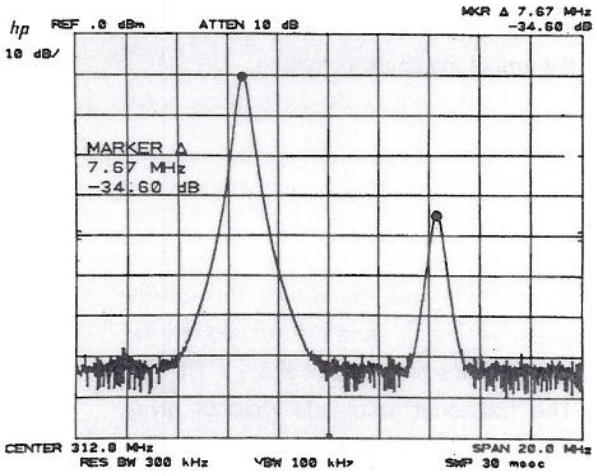
Example

Measuring the differences between two signals on the same display.

First set the marker on one of the signal peaks with NORMAL and the knob.



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.

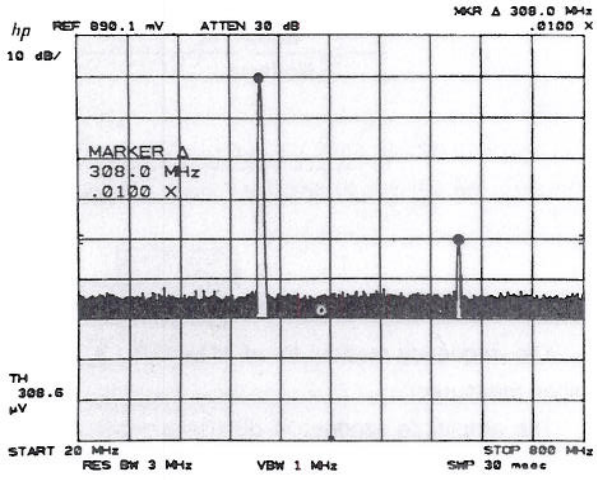
With *logarithmic* amplitude scale and the reference level in voltage, the fraction is based on the equation

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

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

Example

Set up [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%.

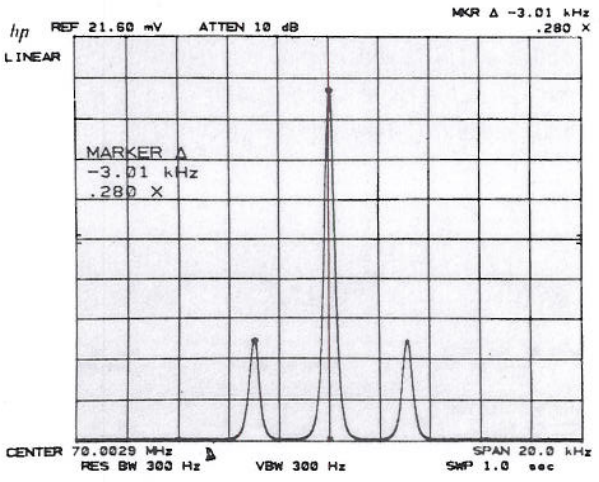
With a *linear* amplitude scale and a reference level calibrated in voltage, the fractional amplitude readout is the simple linear ratio of the two markers.

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%



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 upon 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 upon 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

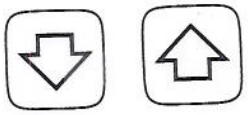
The minimum incremental change for Δ frequency is 0.1% of the frequency span.

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 will 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.

MARKER ZOOM

ZOOM activates a single marker on the trace of highest priority (see TRACE PRIORITY, Chapter 6).
In ZOOM the DATA knob and STEP keys change the values of *different functions*.

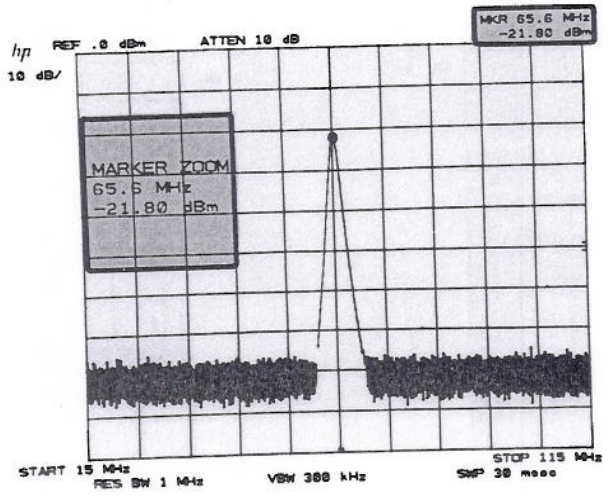
Positions Marker



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].

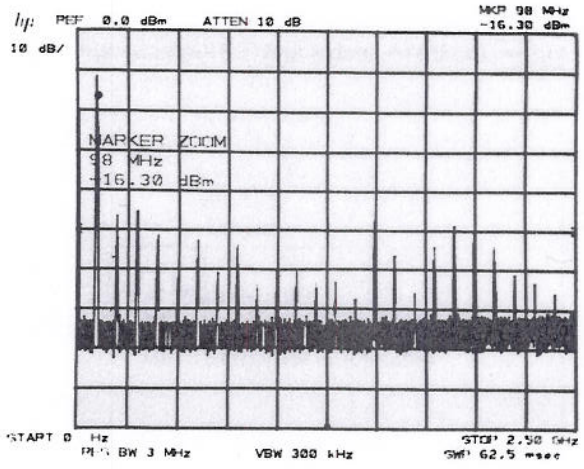
DATA Entry

[ZOOM] ◯	Moves the marker continuously along the trace. Rate 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.

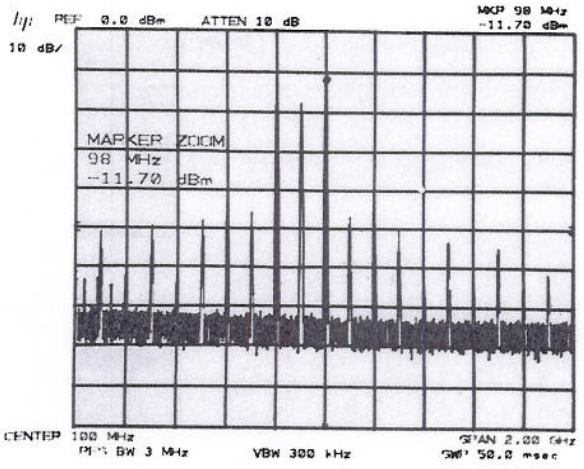
Example

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.

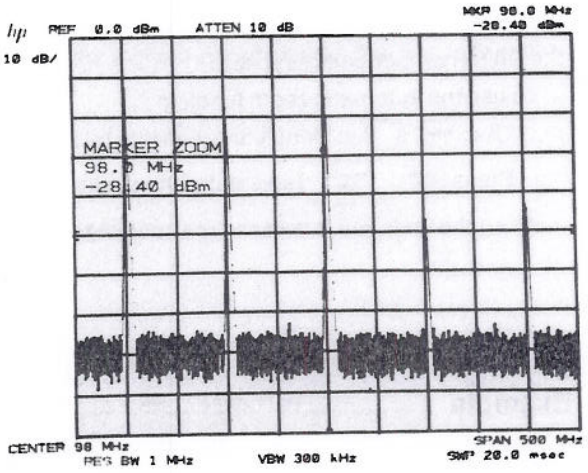
From a full span, select a signal using the marker with [ZOOM] ◯.



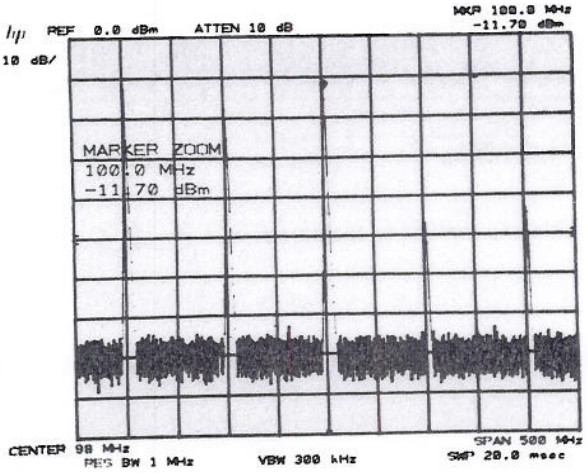
To center the marker and signal *and* expand the frequency span in one step, press [⇩].



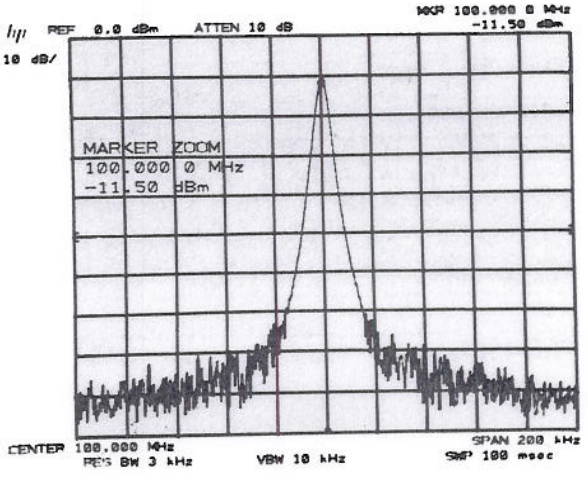
Expanding twice more with ⇩ ⇩ shows the marker requires recentering on the signal.



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 input from the DATA number/units keyboard.

To use the automatic zoom function

Use NORMAL ◯ to identify the signal to be zoomed in on.

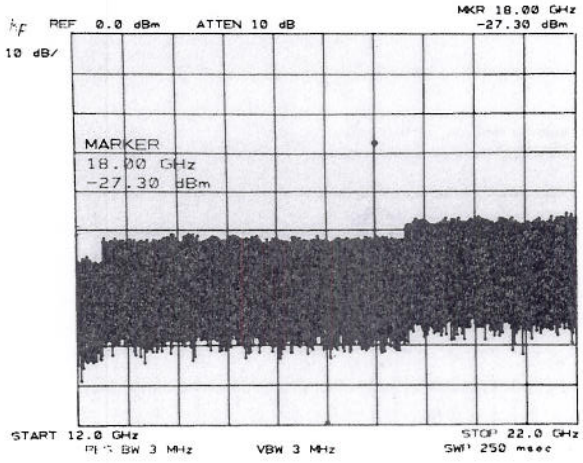
Press SIGNAL TRACK FREQUENCY SPAN and enter the desired span with the DATA number/units keyboard.

When the units key is pressed the zooming process will begin.

Example

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

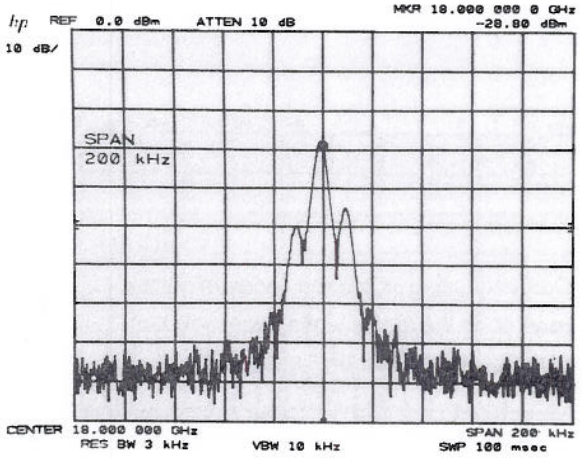
Place a marker on the carrier with NORMAL ◯



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

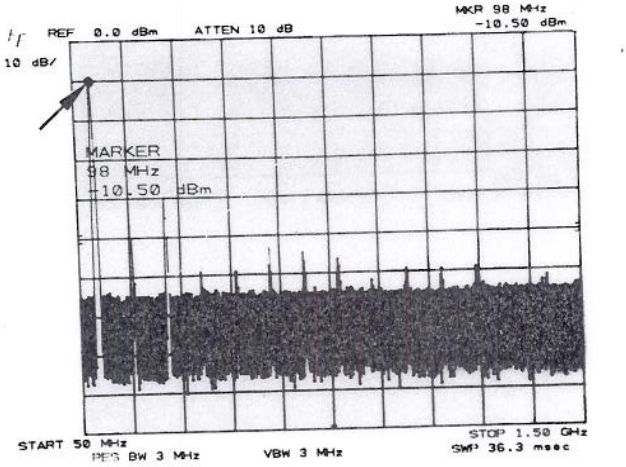
Peak search places a single marker at the highest trace position of the highest priority trace. The active function is not changed.

Example

Use PEAK SEARCH to position the marker at the peak of the signal response.

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

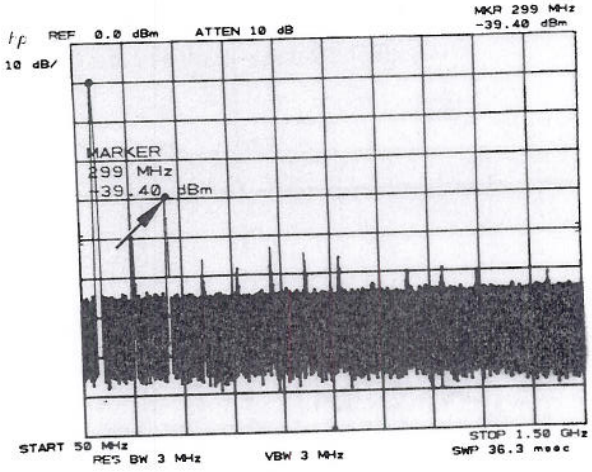
Press PEAK SEARCH.



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 have attracted the marker.

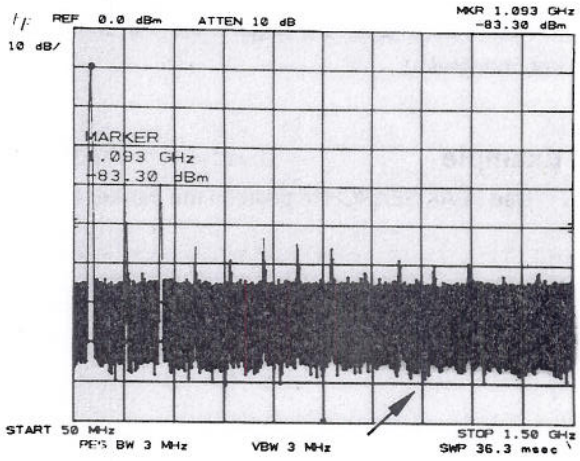
MARKER to Next Peak

The marker can also find the next highest peaks by successively pressing SHIFT K PEAK SEARCH.



Marker to Minimum

The minimum trace value can be located by pressing SHIFT N.



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 SHIFT 0 Δ MKR→ REF LVL	marker frequency into CENTER FREQUENCY marker Δ frequency into FREQUENCY SPAN or START FREQ / STOP FREQ, 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 ⇧ ⇩.

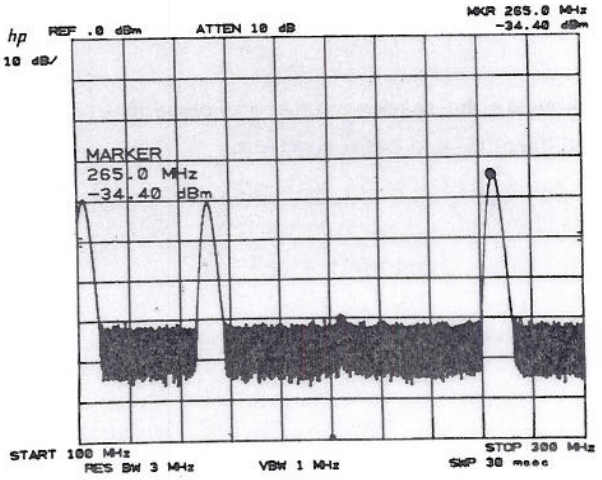
A marker entry can be made any time a marker is on the trace. (SHIFT 0 Δ with only one marker displayed takes 0 Hz as the lower frequency.) The active function will not be changed.

Example

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

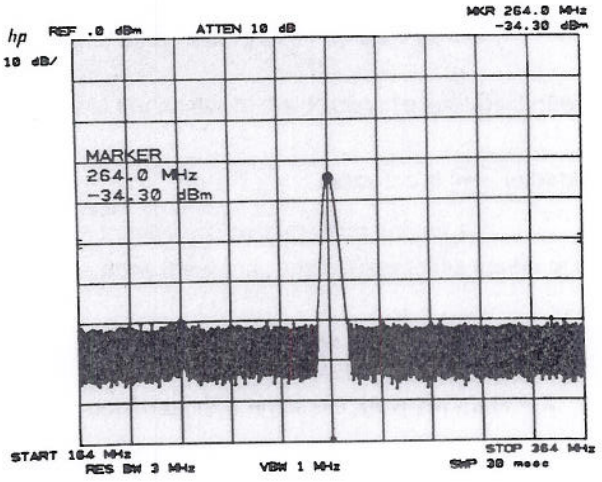
Activate a single marker and tune it to the desired signal:

NORMAL ◯



Change the center frequency to the marker frequency.

MKR→ CF

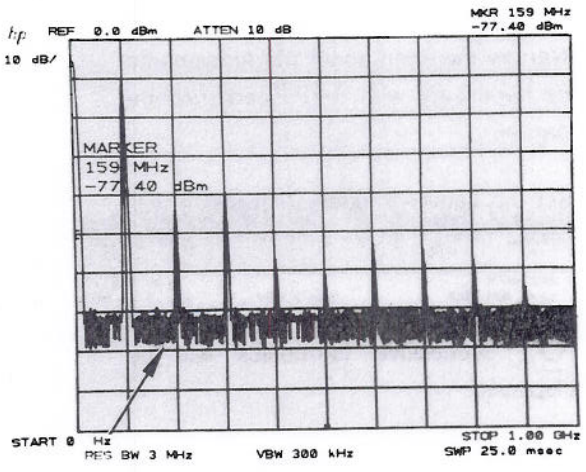


MKR→ CF will also work if start/stop frequencies are read out.

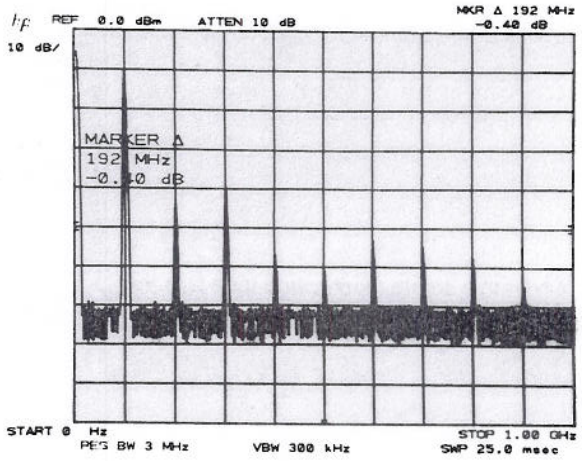
Example

One way to tune to a particular portion of a spectrum being displayed is to use the Δ→ span function.

Activate the single marker and place it at either end of the desired frequency span with NORMAL ◯.

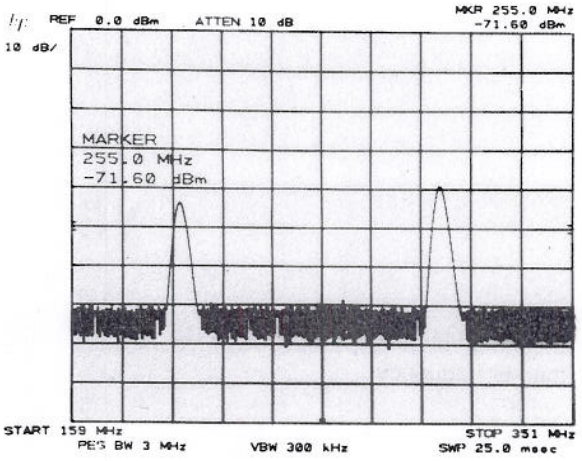


Activate the second marker and place it at the other end of the span with
Δ .



Set the start and stop frequencies equal to the left and right marker frequencies with SHIFT O Δ .

Marker NORMAL is activated.



Δ→ span will work the same with start/stop frequency readout. Note that the markers can be placed at either end of the span.

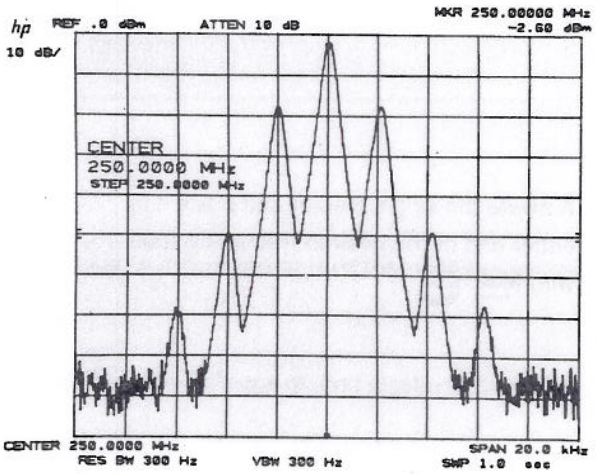
Example

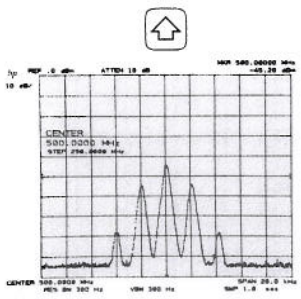
Here is a technique for viewing a fundamental and its harmonics (or any evenly spaced portions of the spectrum) with high resolution.

Narrow the span about the fundamental as necessary with ZOOM , centering the carrier.

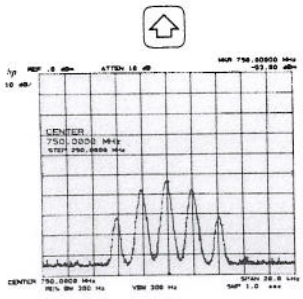
Set the center frequency step size with MKR/Δ→ STP SIZE .

Now enable center frequency. With each ⇧, successive harmonics will be displayed.

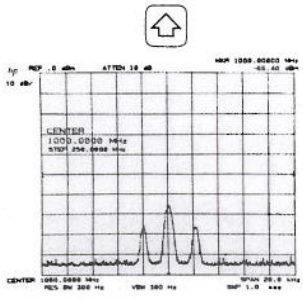




Second Harmonic



Third Harmonic



Fourth Harmonic

Similar stepping can be accomplished using marker [Δ] into step size for intermodulation products or other evenly spaced signals such as communication channels.

SIGNAL TRACK - Automatic Frequency Control

The analyzer is capable of automatically maintaining a drifting signal at the center of the display. To operate SIGNAL TRACK:

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

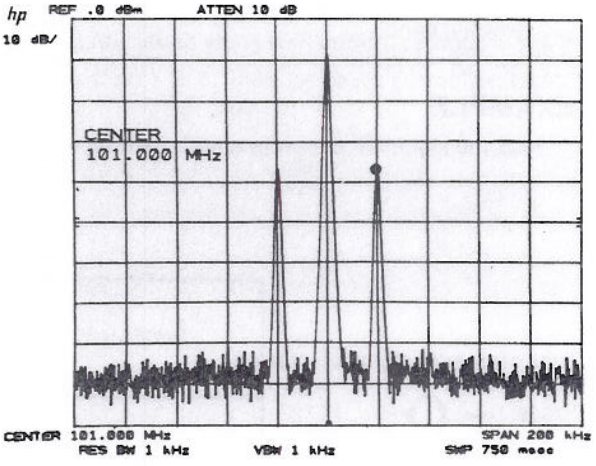
Press [SIGNAL TRACK] to initiate the tracking. The light above the key indicates tracking. (Press again to turn off.)

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

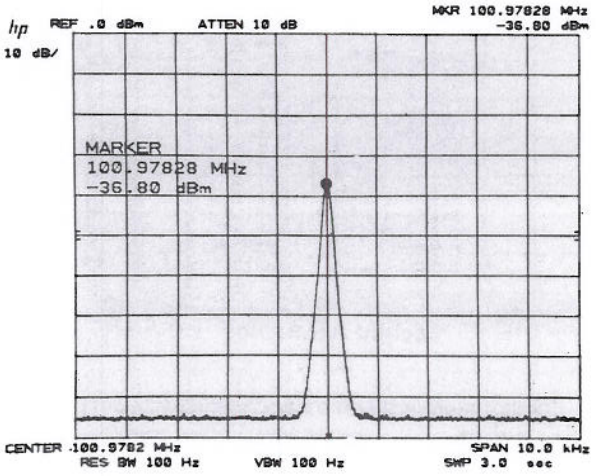
MARKER [OFF], any other MARKER mode or the instrument preset turns the tracking function off.

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 tend to remain in the center of the display. The center frequency and marker frequency reads out the sideband's frequency.

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

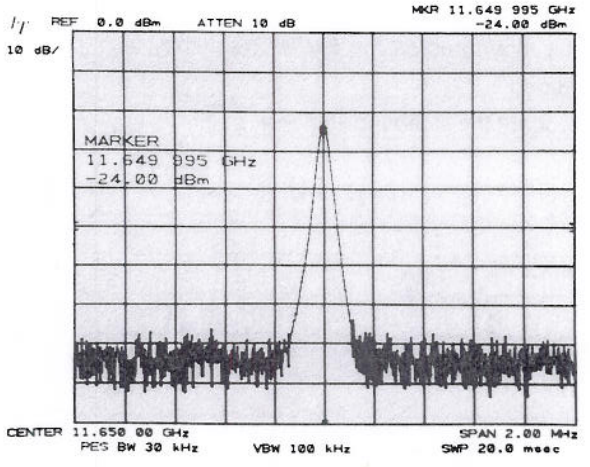
PRESELECTOR PEAK

Preselector peak automatically adjusts the preselector tracking to peak the signal at the active marker. When the marker is tuned to a signal and [PRESEL PEAK] is pressed, an internal routine searches for the peak response of the preselector and adjusts the tracking accordingly. Using preselector peak prior to measuring a signal yields the most accurate amplitude reading.

Preselector peak operates with the [NORMAL], [ZOOM] or [Δ] markers. If the marker is OFF, pressing [PRESEL PEAK] will initiate a peak search routine and then peak the response at that marker. A "PEAKING!" message appears on the active graticule area to indicate operation of the peaking routine. PRESELECTOR PEAK only operates in the 2 — 22 GHz preselected band.

EXAMPLE

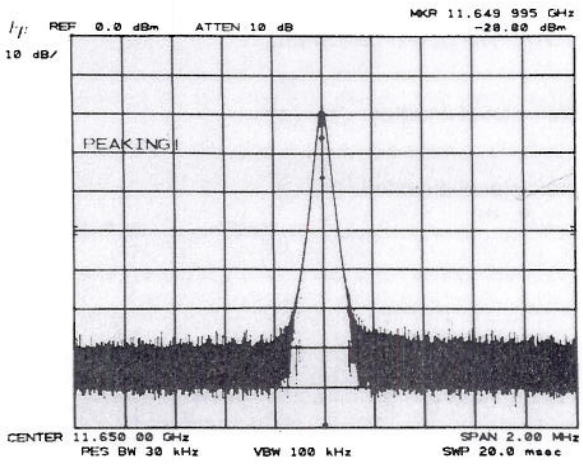
Peak the signal for accurate amplitude measurement.



Tune marker to signal of interest.

Press [NORMAL] ◯.

Press [PRESEL PEAK] to peak preselector tracking.
Measure amplitude by reading marker.



The specific preselector correction factor applied in the example above is stored. A [2-22 GHz] INSTRUMENT PRESET will not erase the correction factor, however, another PEAKING routine in the same band will store a new correction factor in that band.

The factory set preselector tracking can be recalled with [SHIFT] = [PRESEL PEAK]. The preselector can be manually adjusted by pressing [SHIFT] / [GHz +dBm dB]. (See page 12.5).

How It Works

The internal preselector peaking routine automatically searches and sets the peak response of the YIG filter at the marker frequency. Each peaking operation only affects the frequency band in which the signal is located (4 possible bands). A correction factor, representing the tracking offset, is stored in memory for that particular band each time the peaking routine is used. Correction factors (one per band) remain in memory unless a new peaking routine is initiated that may result in a different number. The last [PRESEL PEAK] correction factors are saved along with control settings in the internal storage registers upon execution of a [SAVE] followed by a number from 1 to 6. Thus, up to six correction factors could be saved for any of the frequency ranges listed in the chart below:

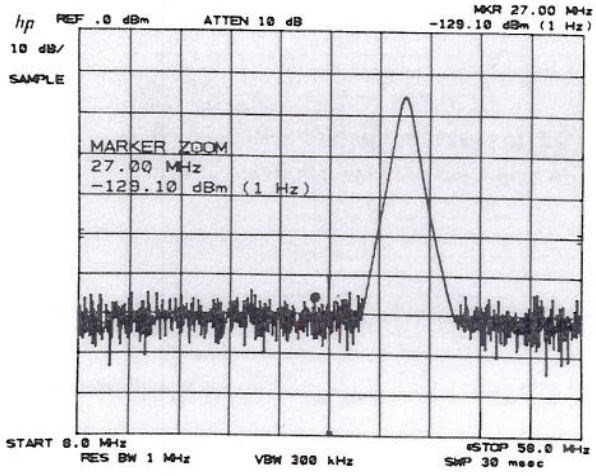
BAND	FREQUENCY RANGE
1	2.0 — 5.8 GHz
2	5.8 — 12.5 GHz
3	12.5 — 18.6 GHz
4	18.6 — 22 GHz

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 the 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

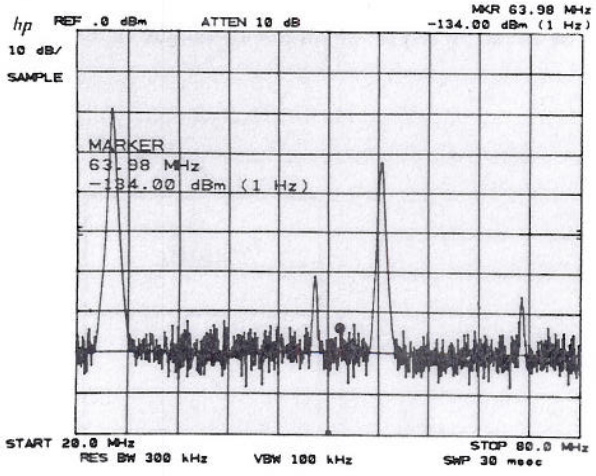
See MARKER [NORMAL], [Δ] and [ZOOM].

Example

In a communication system the baseband noise level as well as signal to noise ratio measurements are required.

Select a frequency in the baseband spectrum clear of signals with a single marker.

Press [NORMAL] ◯ .

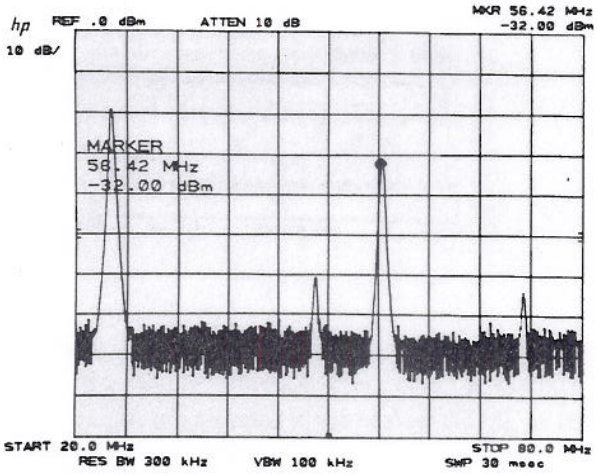


Read the noise at the marker by pressing [SHIFT] [M NORMAL].

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 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 L SHIFT OFF and read the power level.

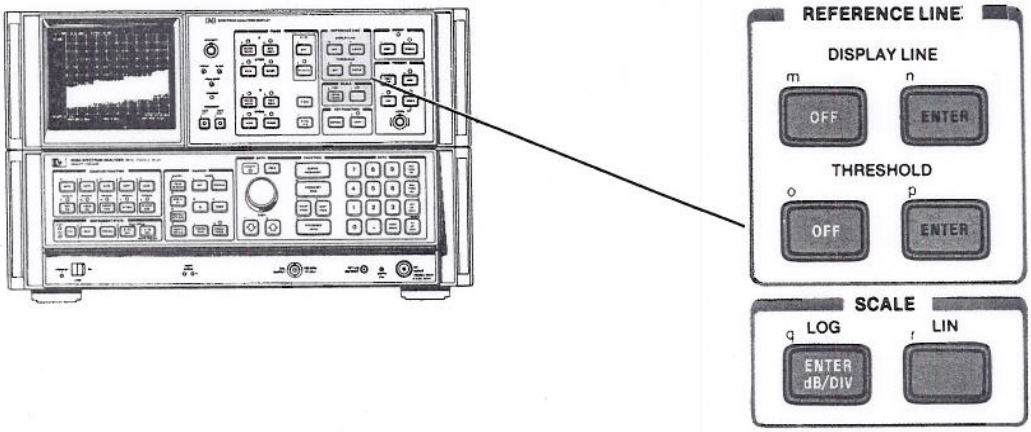


The signal to noise ratio referenced to 4 kHz bandwidth is − 32 dBm − (− 98 dBm) = 66 dB.

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

Chapter 8
SCALE AND REFERENCE LINE

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.

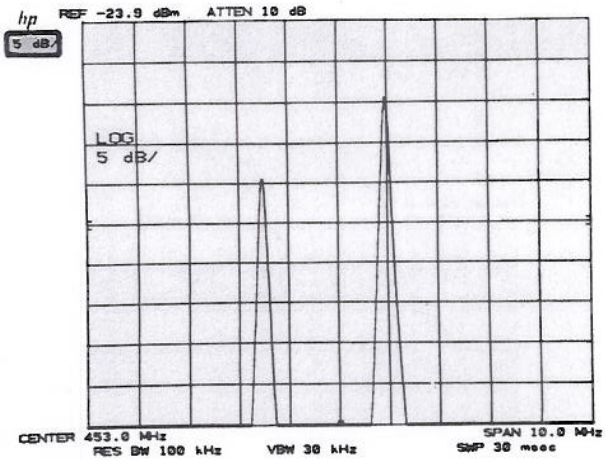
LOG

[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 will be automatically entered. The subsequent (DATA), if any, will then replace the automatic 10 dB/div.

LOG

Press [ENTER dB/DIV] [5] [GHz +dBm dB]

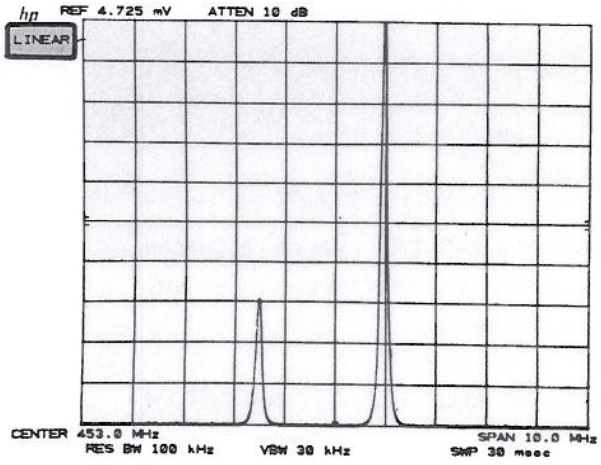


LIN

[ ] 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 12.

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

LIN
Press ☐



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

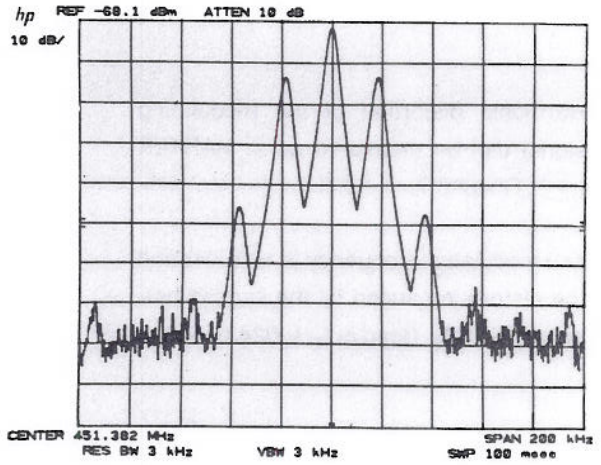
ENTER dB/DIV ◯ ⇩ ⇧	Changes scale in allowable increments (1, 2, 5 or 10 dB per division).
ENTER dB/DIV ▦	Enables direct scale selection of allowed values. Other entries are rounded to an adjacent value.

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.

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



SCALE

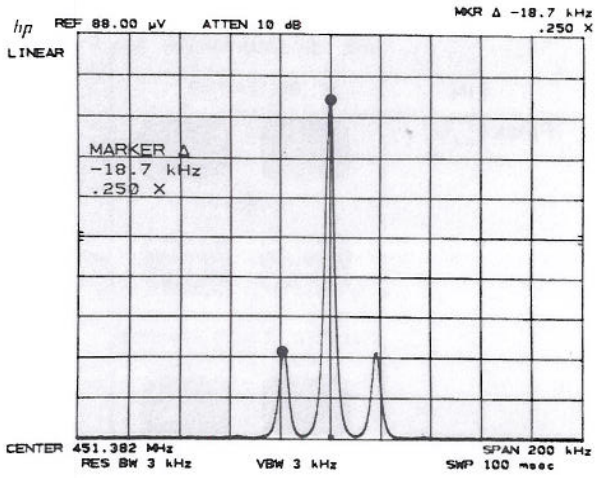
Linear scaling enables the observation of the sidebands proportional to the carrier.

LIN

Press [ ] .

As in the MARKER [Δ] example, Chapter 7, a direct readout of the percent modulation can be made.

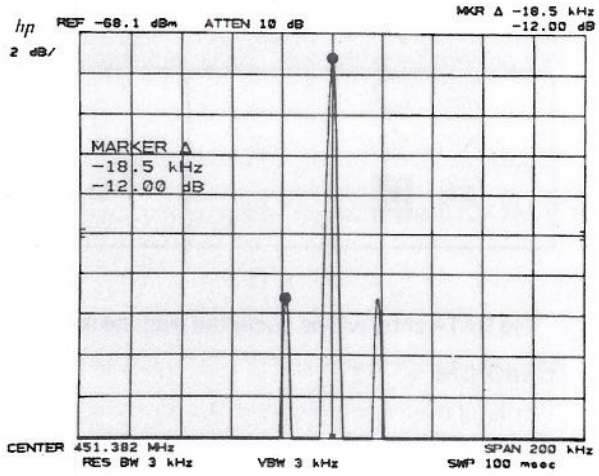
The fractional readout is one half the modulation index (only one sideband is measured).
% AM = 2 (.25) X 100 = 50%.
Note that the carrier signal need not be placed at the reference level for an index ratio measurement.



LOG

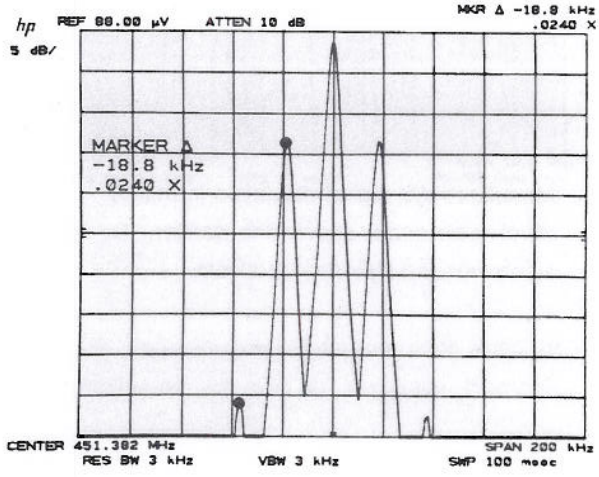
Change to a logarithmic scale with [ENTER dB/DIV] and change the dB/ with [▽] [△].

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



Harmonic distortion of the modulating signal can be measured as in MARKER [Δ], Chapter 7.

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 in absolute amplitude units.

DISPLAY LINE uses:

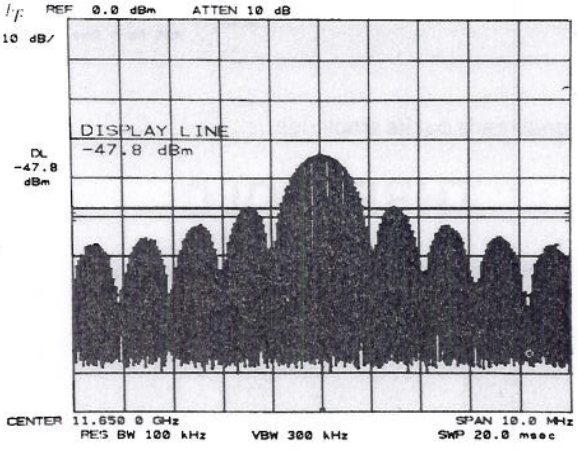
- measure signal levels with direct readout.
- establish a standard for go/no go test comparisons.
- eliminate or reduce amplitude errors due to system frequency response uncertainty.

THRESHOLD provides:

- a base line clipper whose level is read out.
- a minimum threshold level that can be set.

DISPLAY LINE

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.



The DISPLAY LINE can be positioned anywhere within the graticule. When activated after LINE power ON or [2-22 GHz] 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 [2-22 GHz], it will return to its last position.

DISPLAY LINE position is always accessible for HP-IB and TRACE [B→DL ←B], even if never activated. See Chapter 6, TRACE arithmetic.

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

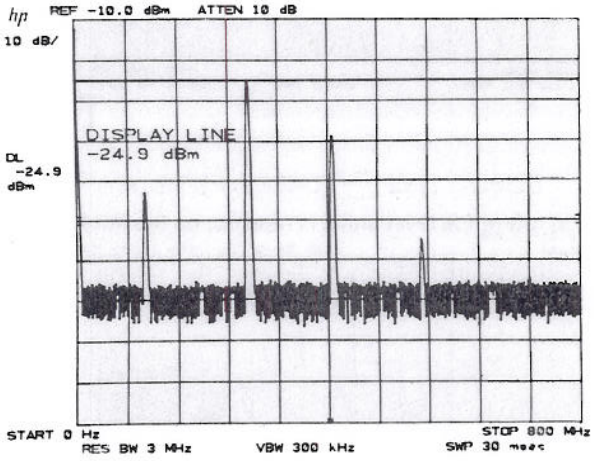
DATA Entry

ENTER ◯	Moves the line about one division 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.

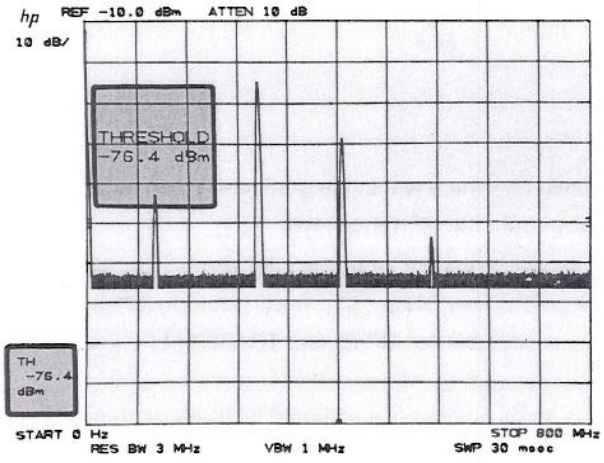
Activate the DISPLAY LINE with ENTER. With ◯ place the line through the peak of a signal and read out its absolute amplitude level.



Moving the DISPLAY LINE to each signal reads out its amplitude.

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 [2-22 GHz], 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 [2-22 GHz] it will resume at its last level.

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

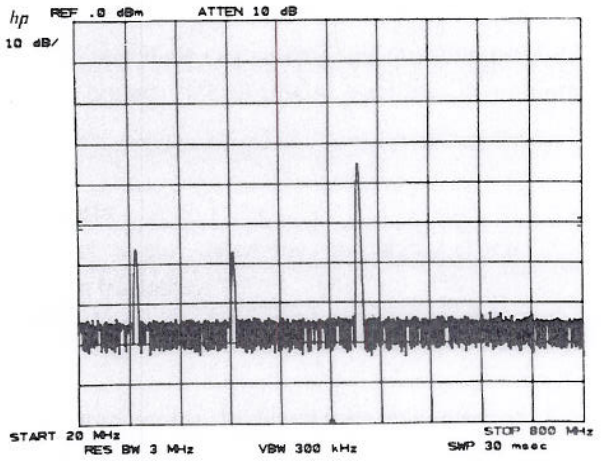
DATA Entry

[ENTER] ◎	Moves the THRESHOLD about one division per rotation. The line moves in 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, ± dBm, ± dBmV, or ± dBμV depending upon units selected.

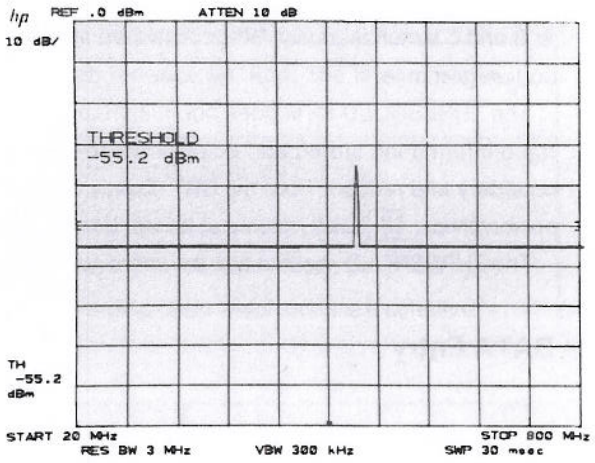
Example

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

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



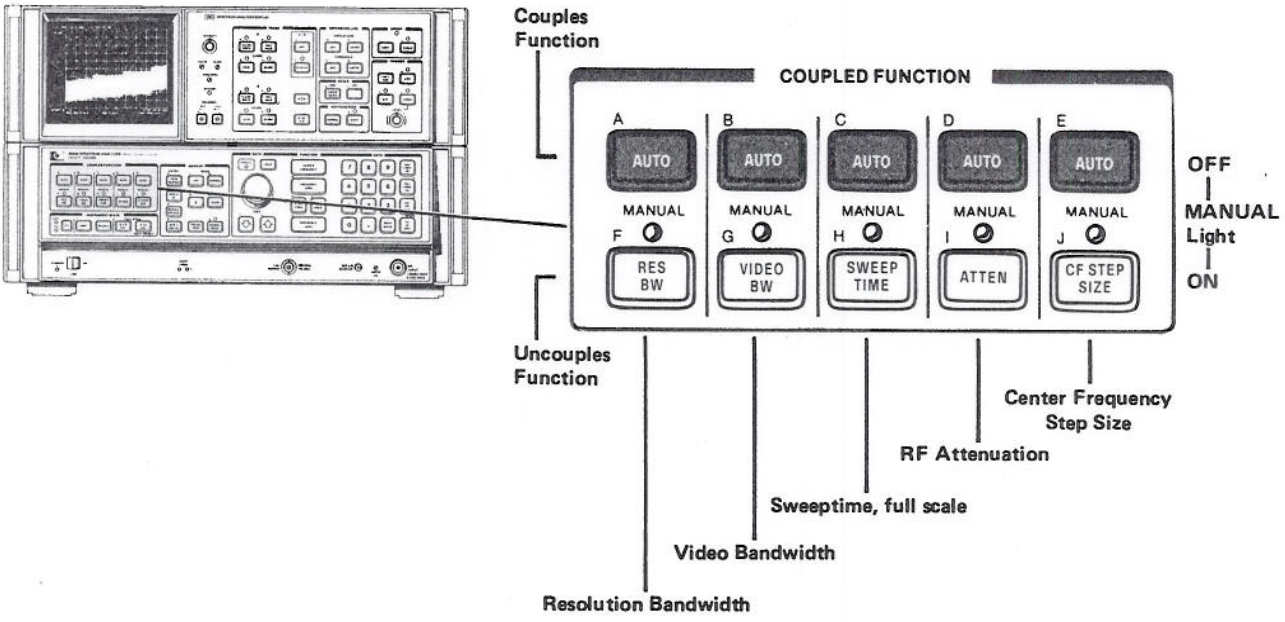
Press THRESHOLD [ENTER] 55.2 dBm. Only those signals > −55.2 dBm will be displayed.



Chapter 9
COUPLED FUNCTION

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, a [2-22 GHz] or [0-2.5 GHz] FULL SPAN key, or when their individual [AUTO] is activated.



For each COUPLED FUNCTION:

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

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

In most cases the [AUTO] coupled functions will 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.

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.

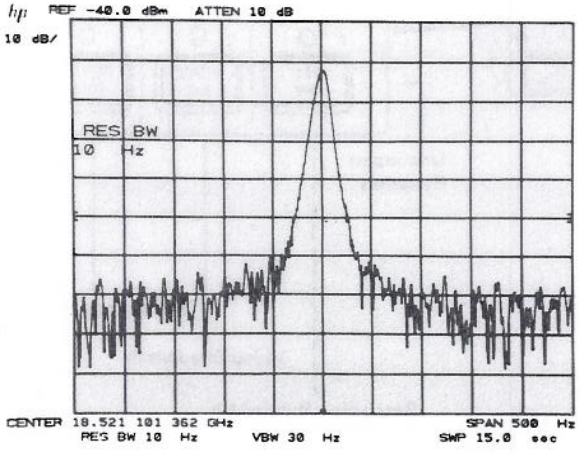
*Center frequency step size does not affect amplitude or frequency calibration.

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 DATA entry from the keyboard which is not exactly equal to an allowable value will select an adjacent value. For example, [RES BW] [1] [5] [kHz mV msec] will select 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.

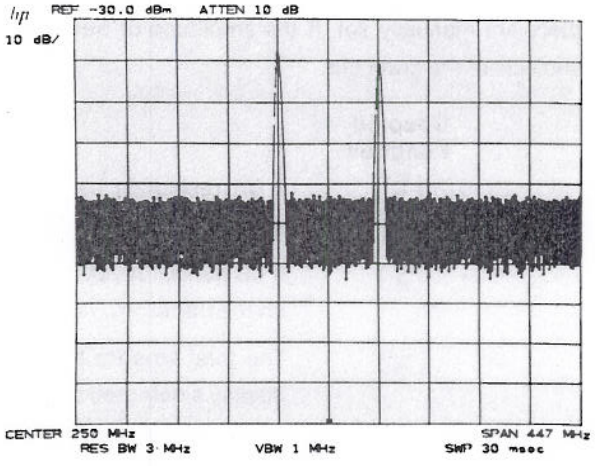


Example

A measurement requiring manual resolution bandwidth selection is the zero span (time domain) observation of modulation waveforms. An example can be found in Chapter 4, Zero Frequency Span - Fixed Tuned Receiver Operation.

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

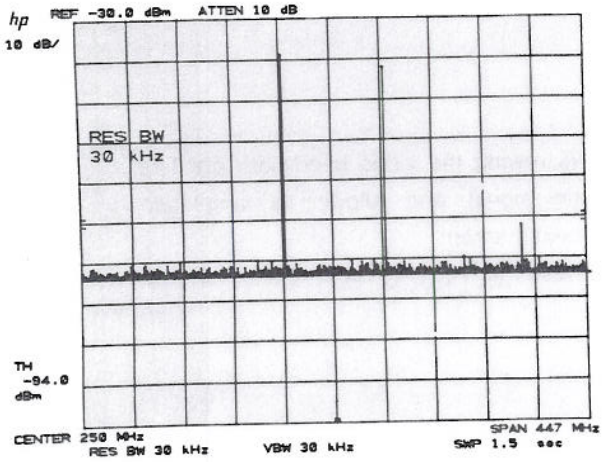
The low level intermodulation products of a signal needs to be measured. With the functions coupled the analyzer noise may mask the distortion products.



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

[RES BW] [⇩] [⇩]

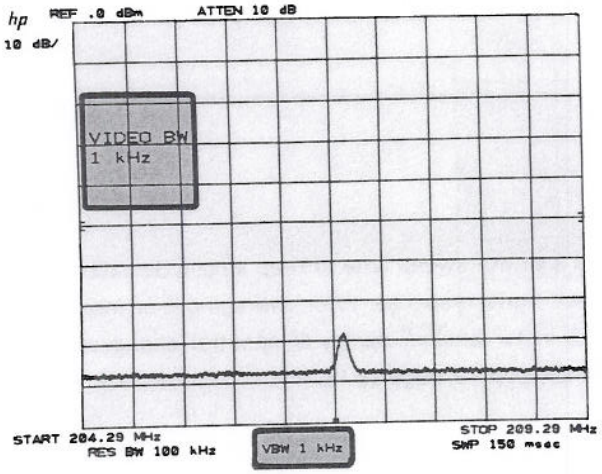
(THRESHOLD has been activated to clarify the display.)



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

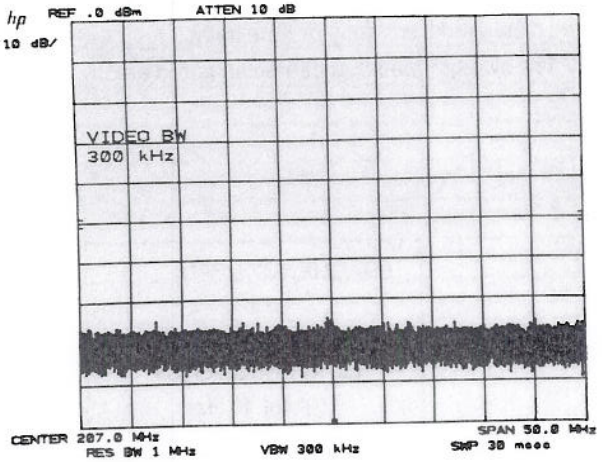
Video Bandwidth

[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.



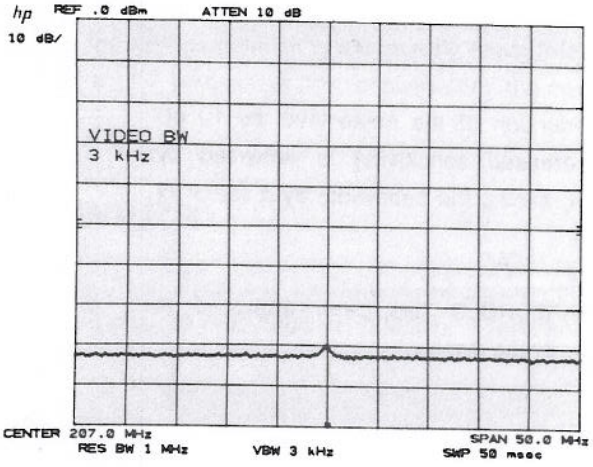
Example:

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



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

Narrowing the video bandwidth clarifies the signal and allows its amplitude measurement.
Press [VIDEO BW] [⇩] [⇩] [⇩] [⇩]



The sweep time will increase to maintain amplitude calibration.

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

Video Averaging

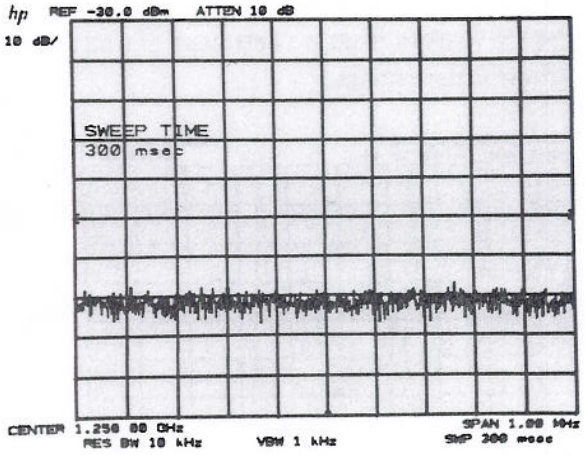
Narrowing the video filter requires a slower sweep time to keep amplitude calibration since the narrower filter must have sufficient time to respond to each signal response. Video averaging is an internal routine which *digitally* averages a number of sweeps, allowing a more instantaneous display of spectral changes due to center frequency, frequency span or reference level changes. See Chapter 12, page 12.11.

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:

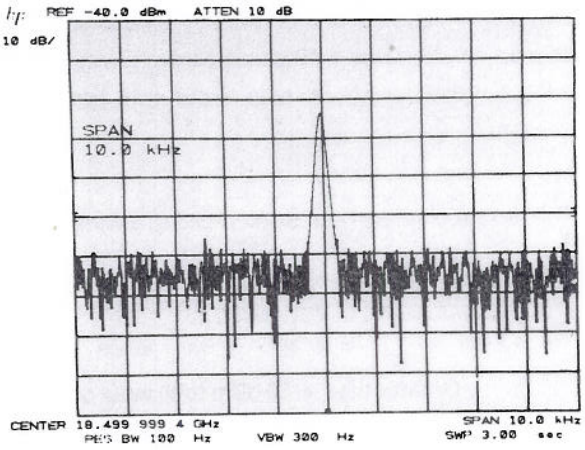
	SWEEP TIME	SEQUENCE
FREQUENCY SPAN (≥100 Hz)	20 ms to 1500 sec	continuously
ZERO FREQUENCY SPAN (0 Hz)	1 μs to 10 ms	1, 2, 5 and 10
	20 ms to 1500 sec	continuously



Example

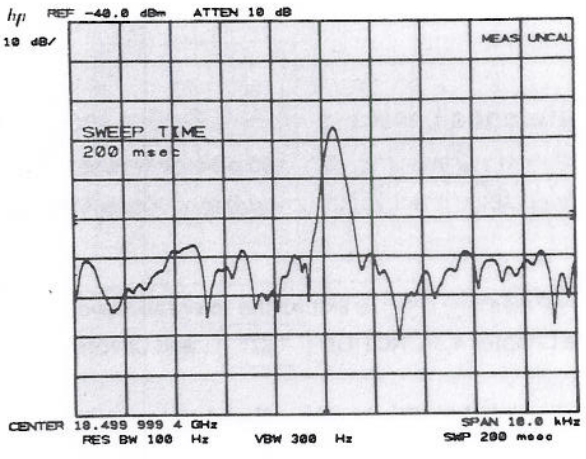
To identify signals quickly in a very narrow frequency span (where the resolution bandwidth would be narrow) the sweep time can be temporarily reduced. (e.g. speed up sweep rate).

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



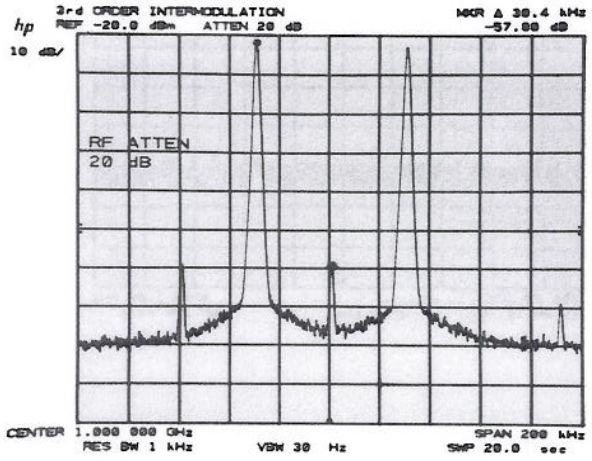
To quickly see signals present in the span press [SWEEP TIME] and [⇩] several times. When the sweep completes its span, couple sweep time again with [AUTO].

Note the MEAS 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.



When the RF input attenuator function is coupled (AUTO), the value selected assures that 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 will be set to 40 dB: +28 dBm -40 dB = -12 dBm at the mixer.

The input mixer level can be changed to assure maximum dynamic range. See Input Mixer Level, Chapter 12.

CAUTION

Greater than +30 dBm total input power will damage the input attenuator and the input mixer.

Zero Attenuation

As a precaution to protect the spectrum analyzer's input mixer, 0 dB RF attenuation can only be selected from the number/units keyboard, press [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 upon resolution bandwidth and scale.

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

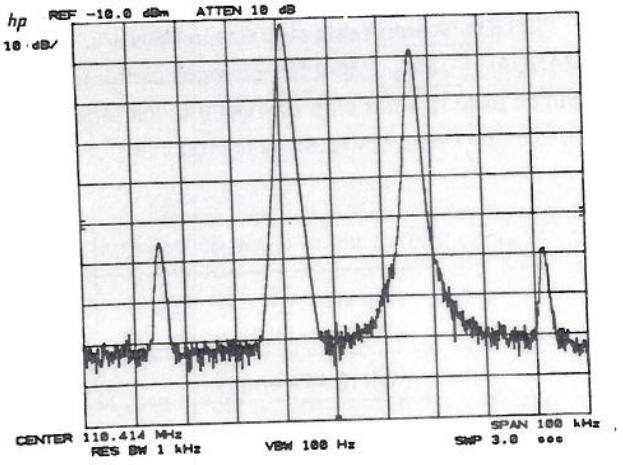
See Chapter 4, FUNCTION [REFERENCE LEVEL], and Chapter 12, KEY FUNCTION, page 12.5.

Determining Distortion Products

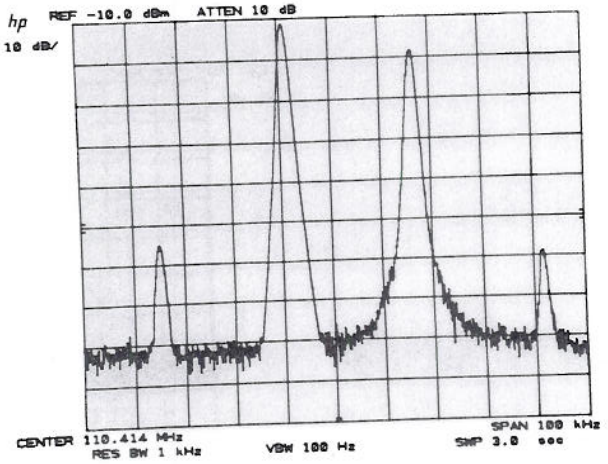
If the total power to the analyzer is overloading the input mixer, distortion products of the input signals can be displayed as real signals. The RF attenuator can be used to determine which signals, if any, are internally generated distortion products.

Example

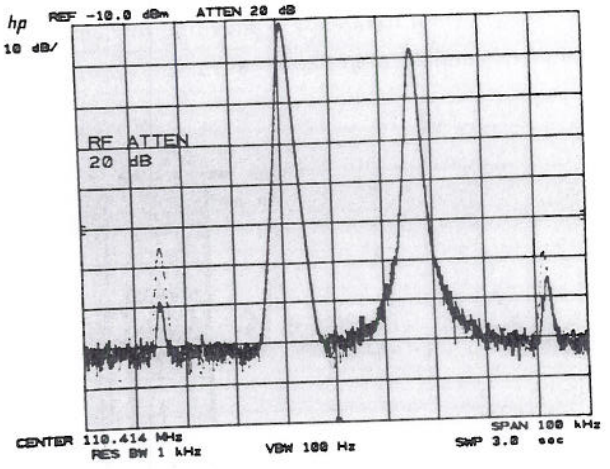
The two main signals shown are producing intermodulation products because the analyzer's input mixer is overloaded.



To determine whether these intermod 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 will be necessary to return it back to its original value.)



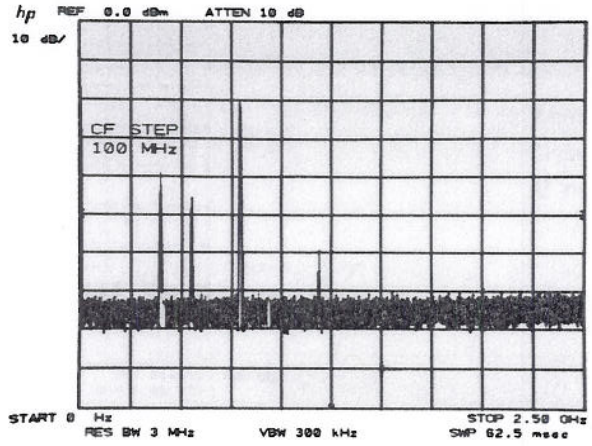
Since some of the signal responses decrease as the attenuation increases (by comparing the response in A with the stored trace in B), distortion products are caused by an overloaded input mixer. The high level signals causing the overload conditions must be attenuated to eliminate this condition.

[⇧] CENTER FREQUENCY STEP SIZE

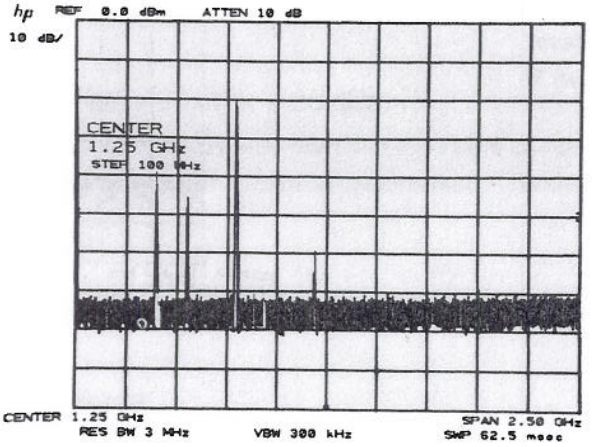
[CF STEP SIZE] (DATA entry) sets step size to MANUAL, changes and stores the step size entered into a register. While [CF STEP SIZE] is in MANUAL, [CENTER FREQUENCY] and [⇩] changes center frequency by the step size value stored in the register.. Several functions can be used to enter step size value to the register. When a CF STEP SIZE is AUTO, the center frequency steps will be 10% of the frequency span, even though the CF STEP SIZE register contains another value.

	Entry Value	[CF STEP SIZE] State
step size [AUTO], [2-22 GHz] 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)

The step size can be varied from 0 Hz to greater than 20 GHz with 1 Hz resolution. It is displayed with the same resolution as center frequency.



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.



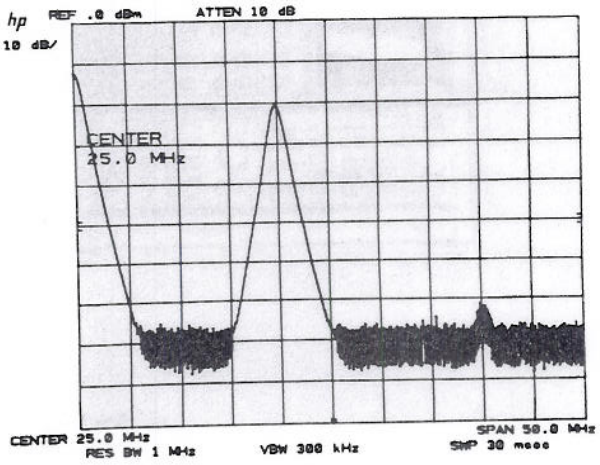
DATA Entry

[CF STEP SIZE] [knob]	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] [keypad]	Selects a specific step size to a resolution equal to the current center frequency readout.

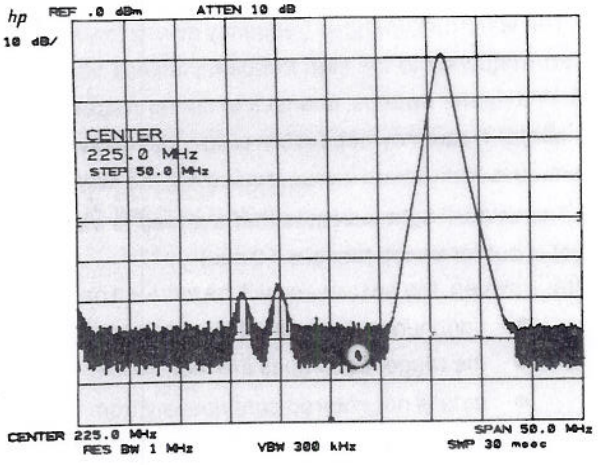
Example

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

First set the span and center frequency: For a span of 50 MHz press [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] ; reactivate center frequency with [CENTER FREQUENCY] and step to 225 MHz.



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 7, page 7.11.

Chapter 10
SWEEP and TRIGGER

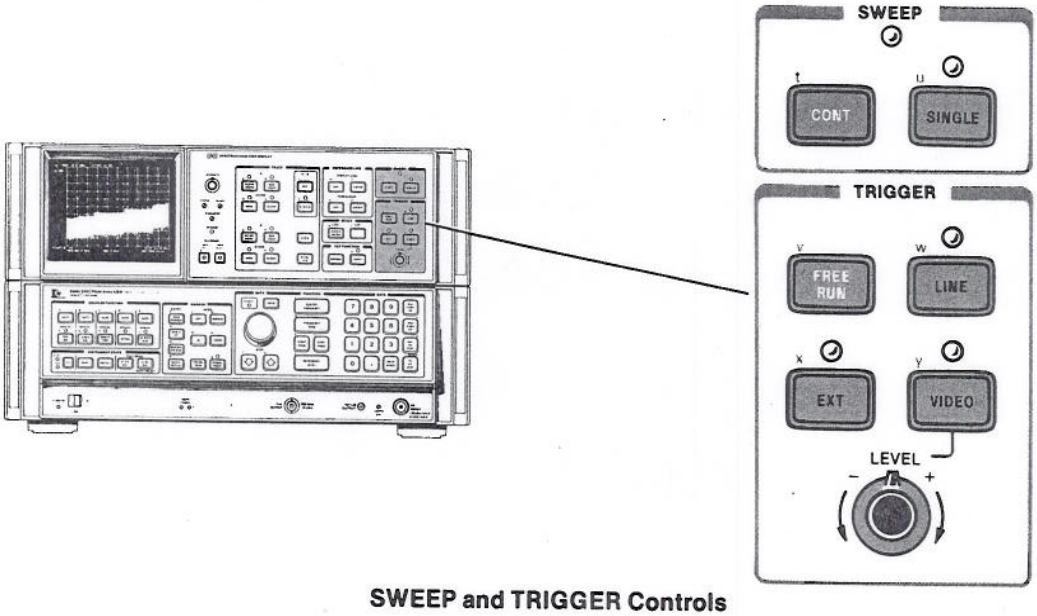
This chapter describes the use of SWEEP and TRIGGER control functions.

SWEEP controls enable:

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

TRIGGER controls select the function which will begin 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 ~ 1.5 volts 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 ms), 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, changes to center frequency, for example, 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.

The SWEEP light indicates that a sweep is in progress. The light is out between sweeps and during data entry. (The light is out for sweep times ≤ 10 ms.)

After a sweep, the next sweep will be 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 will follow 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 will be 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 25 msec, the analyzer will trigger internally. If triggers dependent *only* on external or video trigger are required press

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

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

NOTE

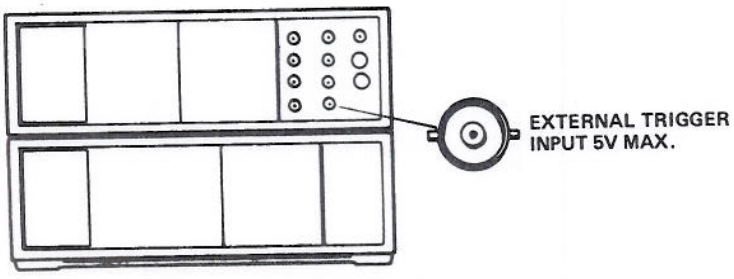
For zero frequency span sweep times ≤ 10 msec and [SHIFT] x or [SHIFT] y, the CRT display graticule and readout depend upon triggering. If no trigger is present the CRT display will be blank.

TRIGGER

The analyzer sweep is triggered by one of four modes selected.

- [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 ≈ 1.5 volts, going positive.

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



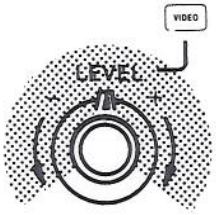
External TRIGGER Input

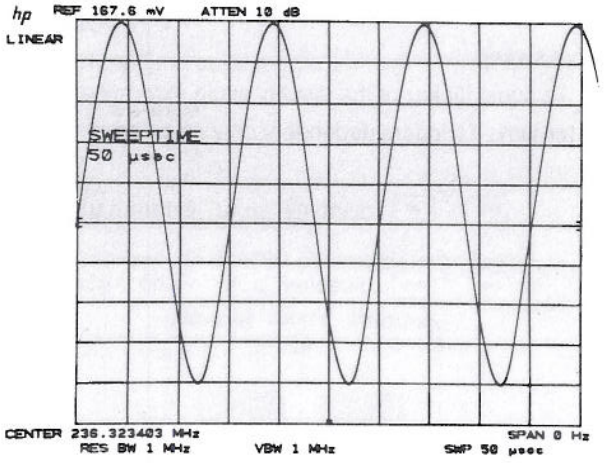
- [VIDEO] allows the next sweep to start if the detected RF envelope voltage rises to a level set by the LEVEL knob. The LEVEL corresponds to detected levels displayed on the CRT between the bottom graticule (full CCW) and the top graticule (full CW).

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

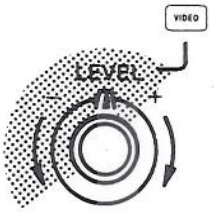
Example

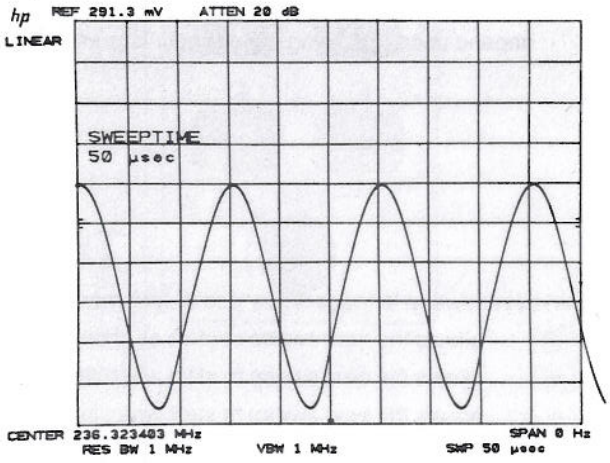
A zero span display of this video waveform will trigger for all LEVEL knob settings.





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

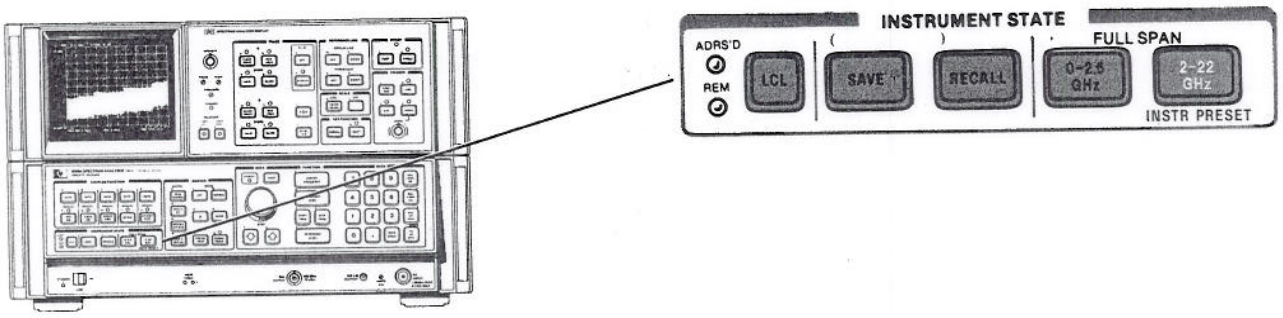




If the level does not cause a trigger within 25 msec, the sweep will be triggered anyway to insure a display. Note that this is true only for sweep times ≤10 msec.

Chapter 11
INSTRUMENT STATE

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

[2-22 GHz] A full 2 — 22 GHz span with coupled operation and *all* the functions set to known states and values.

FULL SPAN

[0-2.5 GHz] A full 0 Hz to 2.5 GHz span with coupled operation and all the functions set to known states and values.

[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 (2 - 22 GHz)

[2-22 GHz] provides a convenient starting point for making most measurements. That is, it calls for a full 2 — 22 GHz 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

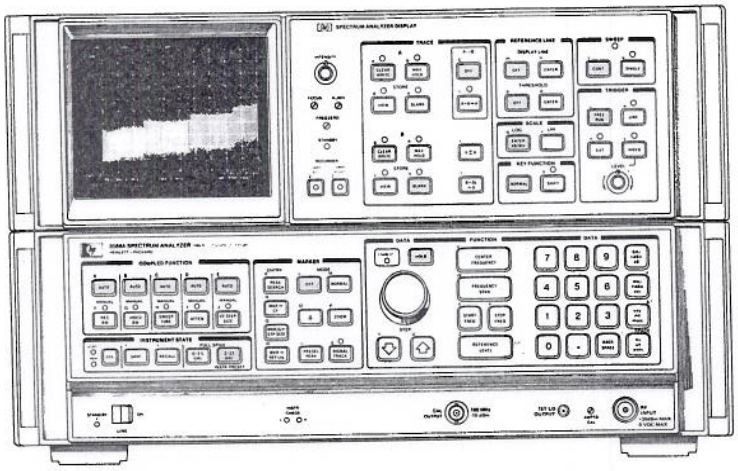
- [SHIFT] KEY FUNCTIONs,

and

- functions accessible only by the HP-IB.

Front Panel Preset

[2-22 GHz] enables all the front panel functions designated by keys with white lettering. It will save a trace response in TRACE B, but not A or C.



Functions Activated with FULL SPAN key

INSTRUMENT STATE

To be precise:

FUNCTION:	Start Frequency	2 GHz
	Stop Frequency	22 GHz
	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	500 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
SWEEP:	Continuous	
TRIGGER:	Free run	
INSTR CHECK:	An internal instrument check is made. If the check is false, lights will stay on.	
KEY FUNCTION:	Normal	

[SHIFT] FUNCTIONS: Chapter 12 [SHIFT] KEY FUNCTION, discusses the implications of activating instrument preset during [SHIFT] FUNCTION use.

If the key is activated (shift light on), [2-22 GHz] 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) will be 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.

See 8566A Spectrum Analyzer Remote Operation (HP part number 8566-90003) for further information.

FULL SPAN 0 - 2.5 GHz

The 0 - 2.5 GHz FULL SPAN key selects a start/stop frequency of 0 Hz and 2.5 GHz respectively, a reference level of 0 dBm and sets all the COUPLED FUNCTIONS to AUTO. Basically, [0-2.5 GHz] is the equivalent of an instrument preset in the low band. It presets everything that [2-22 GHz] does except that [0-2.5 GHz] will not execute the instrument check sequence.

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 which stores the instrument state. Six registers, [1] through [6], can be saved and recalled. Only another [SAVE] will erase a saved register. The registers contain their last states even with a loss of line power (power failure). The registers are maintained with an internal battery supply for about a 30 day period after 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, which ever has most recently occurred. It aids in recovering from inadvertent entries.

Registers 8 and 9 contain preset control settings that are used for calibration purpose. (See Calibration procedure in Chapter 1). Register 0 restores the current state of the analyzer which is useful for servicing.

The current instrument state, if the POWER switch is turned to STANDBY, (or 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.

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:

[0-2.5 GHz]

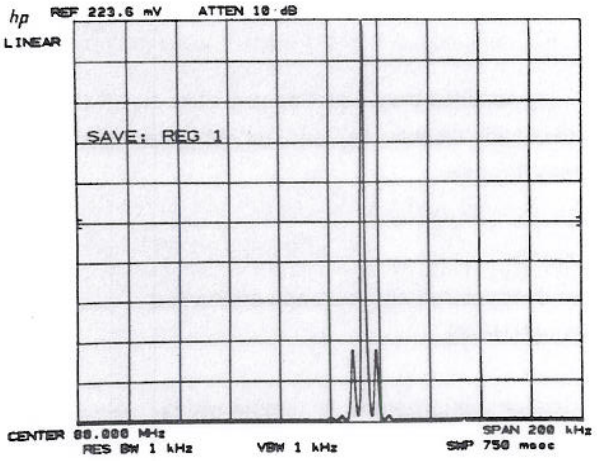
[CENTER FREQUENCY] [8] [8] [MHz -dBm sec]

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

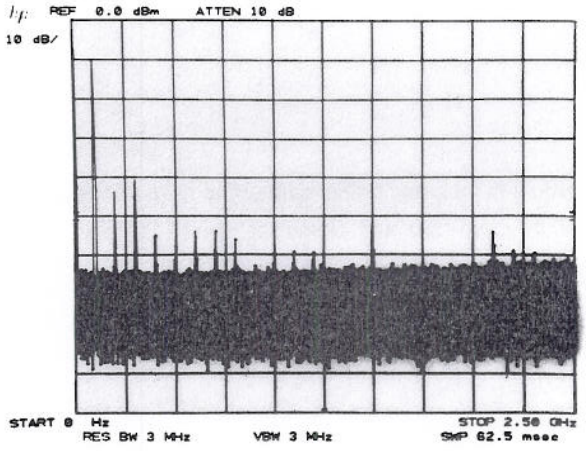
[RES BW] [⇩]

LIN [ ] SCALE

Then save with [SAVE] [1].

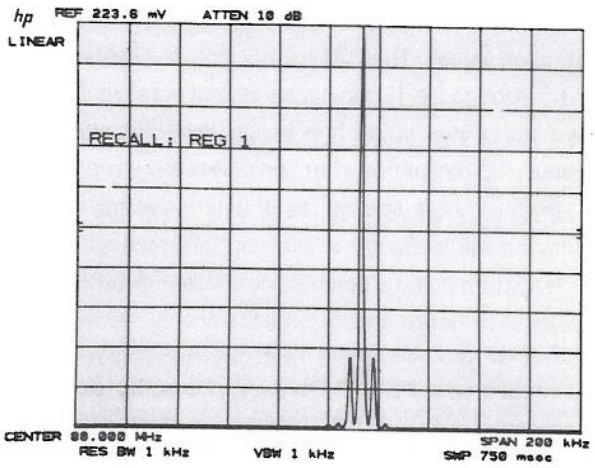


Press [0-2.5 GHz].



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 by [RECALL] [7].

Registers 1-6 can also be locked to prevent any loss or change in the contents of the storage registers. [SHIFT] [SAVE] locks the registers and [SHIFT] [RECALL] unlocks the the registers.

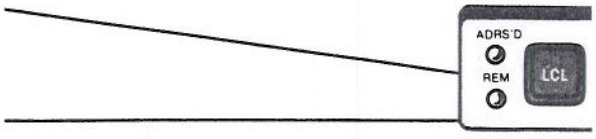


Local Operation

[LCL] enables front panel control after an HP-IB remote LISTEN or TALK command has been executed. An HP-IB local lockout will disable [LCL] until an HP-IB return to local command is executed or the LINE power is turned to STANDBY then ON again.

Indicates instrument has been addressed through HP-IB

Indicates instrument is in remote operation



The addressed light remains on until an HP-IB device clear command or any unlisten command is executed.
See 8566A Spectrum Analyzer Remote Operation, HP part number 8566-90003, for more detailed information.

And recall the last state with [RECALL] [1].
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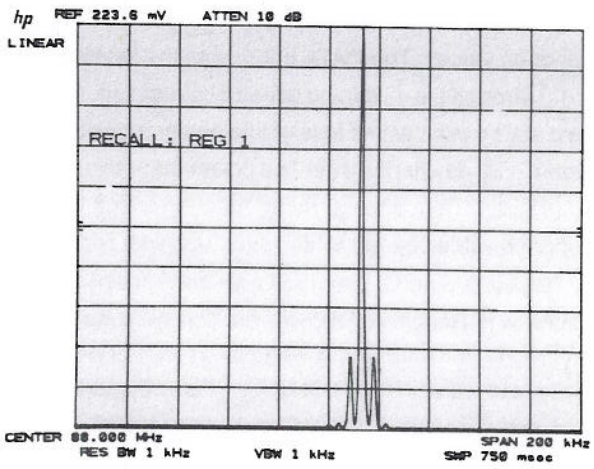

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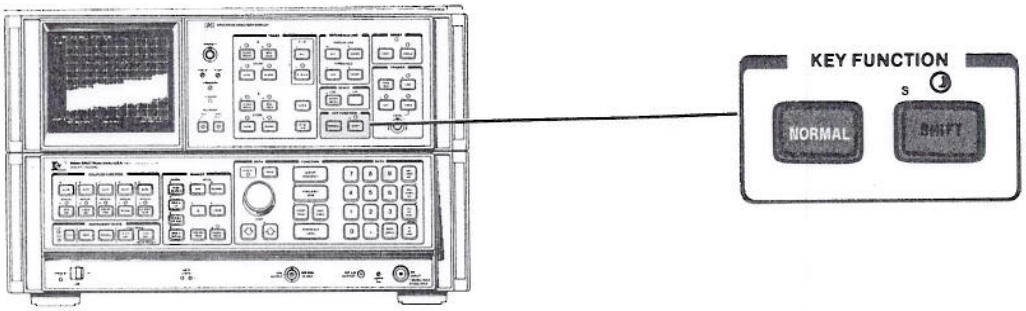
Chapter 12
[SHIFT] KEY FUNCTIONS

This chapter describes access and use of the [SHIFT] KEY FUNCTION



General Description

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 page 12.2. An index to all shift functions is on page 12.16.

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 readout 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 will retain its last value until [2-22 GHz] or LINE power 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.

FUNCTION SUMMARY

General
- r HP-IB Service request
- P Enter HP-IB address
- f Power on in last state
- z Display Address
- | Display Write

Frequency
- V Frequency offset
- - Negative entry
- v Signal identifier ext. mixer

Amplitude
- Z Amplitude offset
- A Units: dBm
- B dBmV
- C dBμ
- D voltage
- I Extended reference level range
- - Negative entry
- . Mixer level

Marker
- K Marker to next peak
- N Marker to minimum
- O Enter Δ→ span
- M Noise level on
- L Noise level off
- u Stop single sweep at marker
- = Factory preselector setting
- / Manual preselector setting

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

Trace
- c A + B → A

Detection:
- a normal
- b positive peak
- d negative peak
- e sampling

Trace C:
- k blank trace C
- i B ⇄ C
- l B → C
- j view trace C
- G Video averaging on
- H Video averaging off

Trigger - Zero Span
- x Without 25 msec triggering
- y Without 25 msec triggering

Instrument State
- (Save registers locked
-) Save registers unlocked
- T Fast preset 2 - 22 GHz
- U Fast preset external mixer
- S Fast HP-IB operation
- t Band lock
- Q Band unlock

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

Diagnostics
- w Display correction data
- q Disable step gain
- R Frequency diagnostic on
- F YTO pretest mode
- J Manual DACS control

ALPHABETICAL KEY CODE SUMMARY

- *A Amplitude in dBm
- B Amplitude in dBmV
- C Amplitude in dBμV
- D Amplitude in voltage
- E Title
- F YTO pretest mode
- G Video averaging on
- *H Video averaging off
- I Extended reference level range
- J Manual DACS control
- K Marker to next peak
- *L Noise level off
- M Noise level on
- N Marker to minimum
- O Enter Δ → span
- P Set HP-IB address
- *Q Band unlock
- R Frequency diagnostic on
- S Fast HP-IB operation
- T Fast preset 2-22 GHz
- U Fast preset external mixer
- 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 Band lock
- u Stop single sweep at marker
- v Signal identifier ext. mixer
- w Display correction data
- x Without 25 msec triggering
- y Without 25 msec triggering
- z Display address
- - Negative entry
- = Factory preselector setting
- / Manual preselector setting
- (Save registers locked
-) Save registers, unlocked
- | Display write
- , Mixer level

*These functions selected with [2-22 GHz] INSTRUMENT PRESET

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 HOLD

For example to enter a negative 100 MHz offset frequency:

Press SHIFT CENTER FREQUENCY to activate frequency offset

Press SHIFT HOLD 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 will result in entering 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 MHz -dBm sec are used, the value will be 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 CENTER FREQUENCY (DATA keyboard entry)

Amplitude offset: SHIFT REFERENCE LEVEL (DATA keyboard entry)

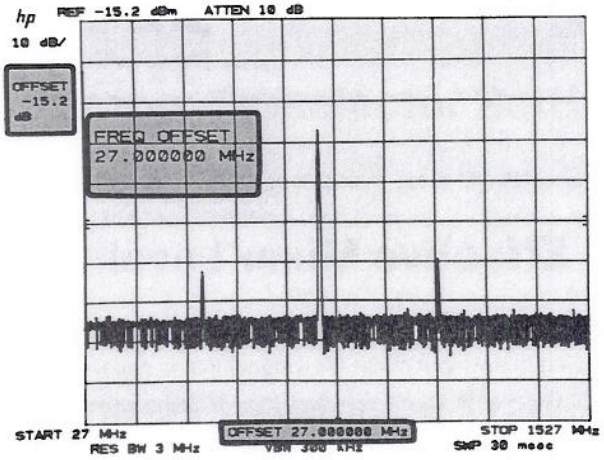
Offset entries are added to all the frequency or amplitude readouts on the CRT display including marker, display line, threshold, start frequency and stop frequency.

FUNCTION

To eliminate an offset, activate the offset and enter zero. A FULL SPAN key 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 and dB, -dB, mV and μV for amplitude. The amplitude offset readout is always in dB. An entry in voltage can be made and will be converted to dB offset.

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 will be truncated for frequency and amplitude offset entries.

Example

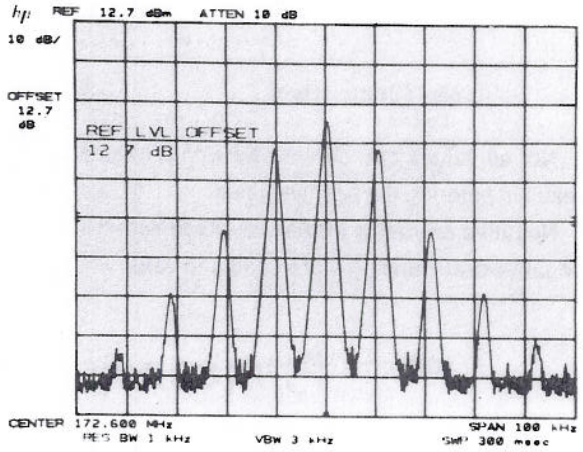
An 102.6 MHz up converter with 12.7 dB attenuation is placed between a signal source and the spectrum analyzer. The offsets can be set so that the CRT display shows the trace referenced to the signal as input to the converter.

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

Z

Press [SHIFT] [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.

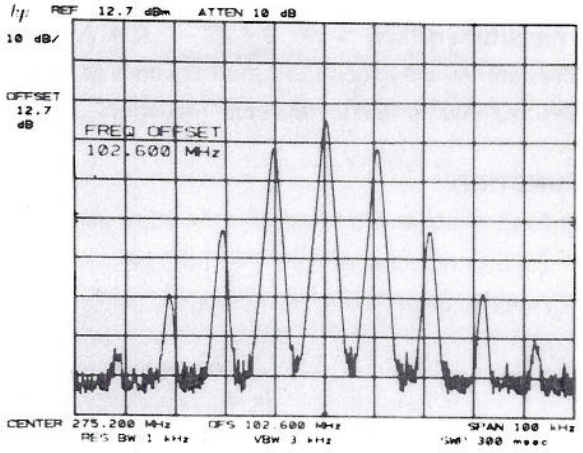


Frequency offset is entered as a negative value since the input frequency to the converter is lower than the output.

V

Press [SHIFT] [CENTER FREQUENCY]

[SHIFT] [HOLD] 1 0 2 . 6 [MHz -dBm sec]



Effective Mixer Level

The effective mixer level is equal to the REFERENCE LEVEL minus the INPUT ATTENUATOR setting. It specifies the maximum signal level that will be applied to the input mixer for a signal that is equal to or below the REFERENCE LEVEL. A FULL SPAN key (0-2.5 GHz or 2-22 GHz) sets the mixer level to −10 dBm which is 5 dB below the analyzer's 1 dB compression point. The effective mixer level can be manually set from −10 dBm* to −70 dBm in 10 dB steps by pressing [SHIFT] , (comma sign) and entering the desired level through the numeric keyboard. For instance, to set a mixer level at −40 dBm, press: [SHIFT] , 4 0 [MHz -dBm sec]. As the analyzer's REFERENCE LEVEL is changed, the coupled input attenuator will automatically change to limit the maximum signal at the mixer to −40 dBm for signals ≤ REFERENCE LEVEL.

*In the Extended Reference Level Range (Shift I, page 12.5) the effective mixer level can be set to 0 dBm.

Amplitude Units

The following shift key codes immediately select the corresponding units for all the amplitude readouts: reference level, marker, display line and threshold.

When a units change is made, all readouts are converted so as to preserve the absolute power levels of all the readouts. For example, a 0 dBm threshold level converts to 47.0 dBmV (50 ohm input) when dBmV units are called.

SHIFT KEY FUNCTION		AMPLITUDE UNITS
SHIFT	A. . . . . (or FULL SPAN key)	dBm
SHIFT	B.	dBmV
SHIFT	C	dBμV
SHIFT	D.	volts

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

Extend Reference Level Range

Normally the reference level can be set to from -89.9 dBm to + 60.0 dBm in coupled operation. The limits of the range can be extended to a maximum of − 139.9 dBm and + 30 dBm.

Press SHIFT ATTEN

The lower limit of reference level depends upon resolution bandwidth and scale.

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.

Factory Preselector Setting

Activating SHIFT = will reset the internal preselector to a factory set 2 - 22 GHz tracking range. The factory setting provides a preset adjustment for each of the four frequency bands in the 2 - 22 GHz range. These preset adjustments optimize the preselector tracking over the full 2 - 22 GHz frequency range. The tracking can be optimized at any single frequency with the PRESEL PEAK key. A PRESEL PEAK adjustment in one band will not affect the preselector tracking in the other three bands. (See page 7.15 for more information).

Manual Preselector Tracking

The internal preselector can be manually adjusted for a peak response in the 2 - 22 GHz band. SHIFT / GHz +dBm dB enables manual entry of a DAC number from 0 - 63 with the DATA knob, step keys or numeric keyboard. The DAC reading corresponds to a voltage which sets a particular preselector tracking offset. The location of the MARKER determines the band (four independently adjustable bands) to be adjusted.

The Manual Preselector Tracking function is useful for peaking the preselector at locations where a stable CW signal is absent. For instance, drifting signals or pulse modulated signals do not easily lend themselves to the use of PRESEL PEAK. The automatic preselector peak routine depends on a stable CW signal. In this situation, a means for manually tracking the preselector may provide a more reliable setting.

Marker Sweeps

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 will stop 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 [2-22 GHz].

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.

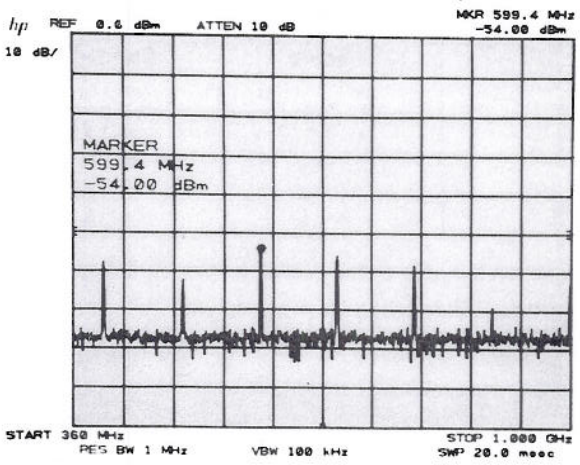
Marker to Next Peak/Marker to Minimum

Successive peaks can be identified by continuously using [SHIFT] K If a trace displays many different signal levels, a [PEAK SEARCH] can be used to find the largest signal. Then [SHIFT] K can be used successively to find the next largest signal.

Example

Press [PEAK SEARCH] to find largest signal

[SHIFT] K to find next largest signal



Marker to Minimum

The minimum data value in a trace can be quickly located with [SHIFT] N

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

Blank: press [SHIFT] m

On: press [SHIFT] n

Annotation

Blank: press [SHIFT] o

On: press [SHIFT] p

CRT Beam On/Off

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

Beam off: press [SHIFT] g

Beam on: press [SHIFT] h

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

Display Correction Data

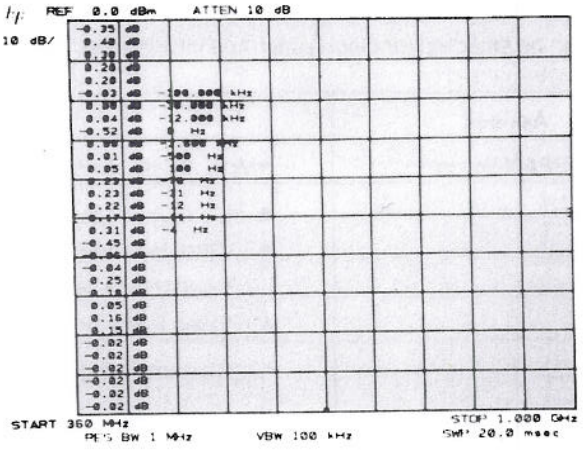
The correction data generated from the error correction routine, can be displayed.

Display correction data: press [SHIFT] w

Do not display correction data: press [2-22 GHz]

The readout is detailed on page 12.14.

More on the meaning of these messages can be found in the 8566A Operating and Service Manual, Section VIII.



Correction Data Displayed

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, [2-22 GHz] 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.

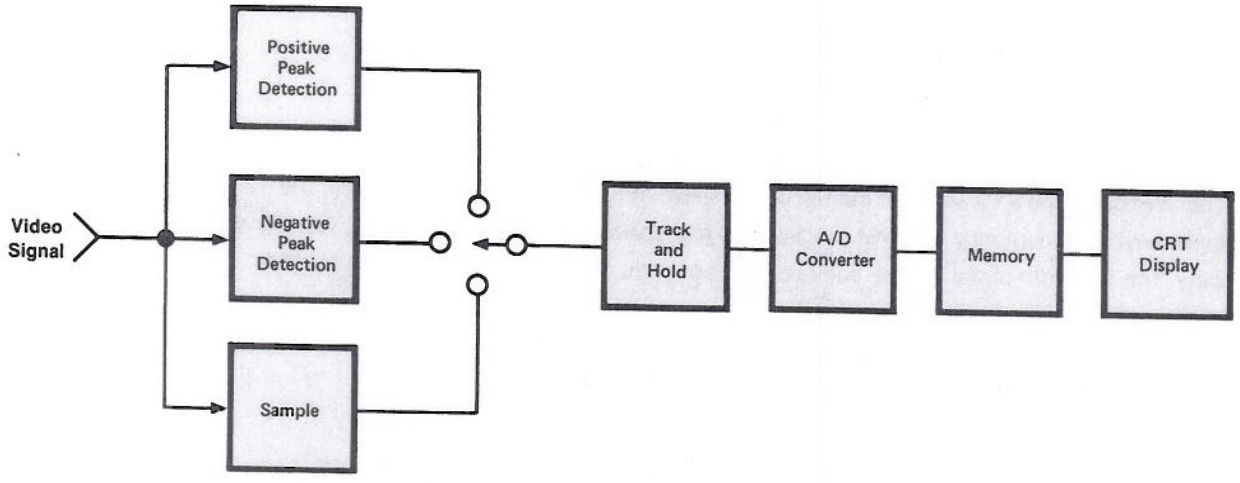
When executed, A-B→A is turned off and the amplitude in trace B is added to the amplitude in trace A (in display units) and the result is written into trace A.

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	**FULL SPAN key or** SHIFT a	•Most measurements.
sample	SHIFT e	• Noise Level Measurements • Zero frequency span waveforms for sweeptimes ≥ 20 msec • Video averaging
positive peak **negative peak**	SHIFT b SHIFT d	• Diagnostic aids for servicing.



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 video 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 addressed 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 sweeptime increases, many analog-to-digital conversions occur in each time period but only the final, single value can be stored.)

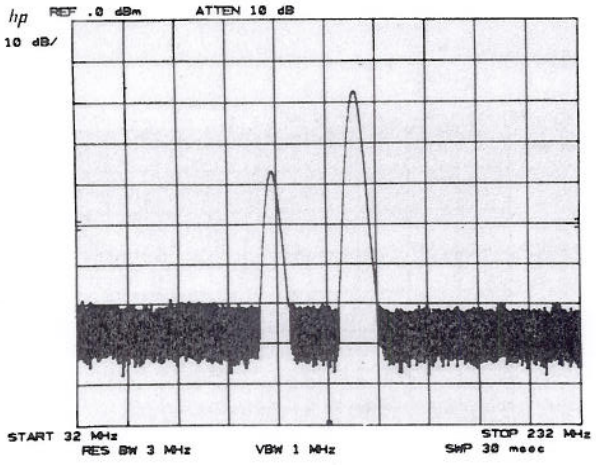
Sample mode is selected automatically for video averaging and noise level.

Positive and Negative Peak Modes

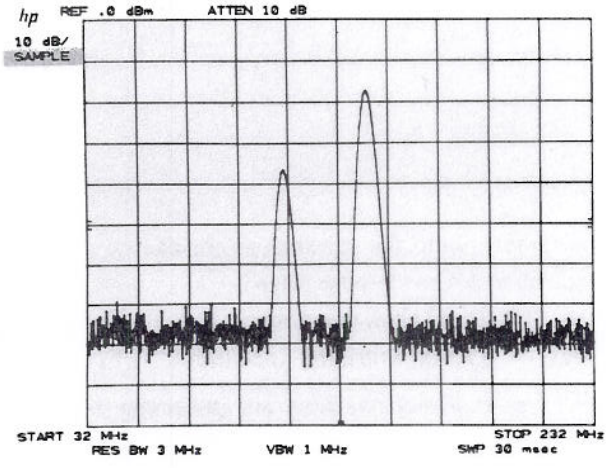
Positive and negative peak modes store signal maximums and minimums respectively, in all trace memories.

Readout

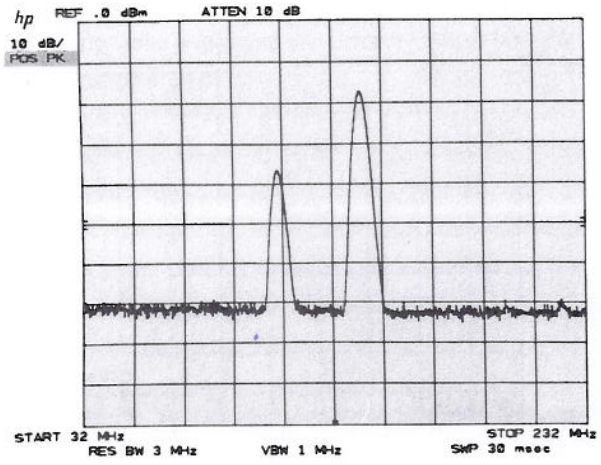
Here, the same signal response is displayed with each trace detection mode.



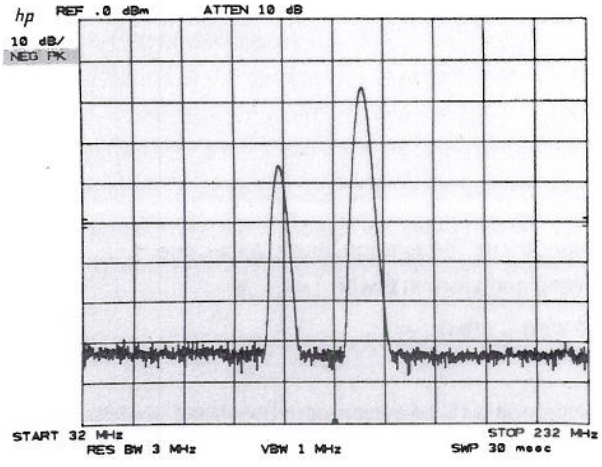
Normal



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 6.

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]

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 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 blanked, it stays blanked. If trace C was blanked, it stays blanked.

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

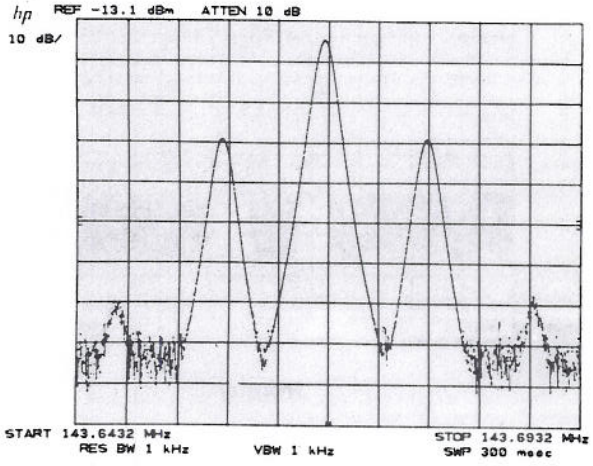
press [A⇄B] [SHIFT] I (which also erases last trace C)

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

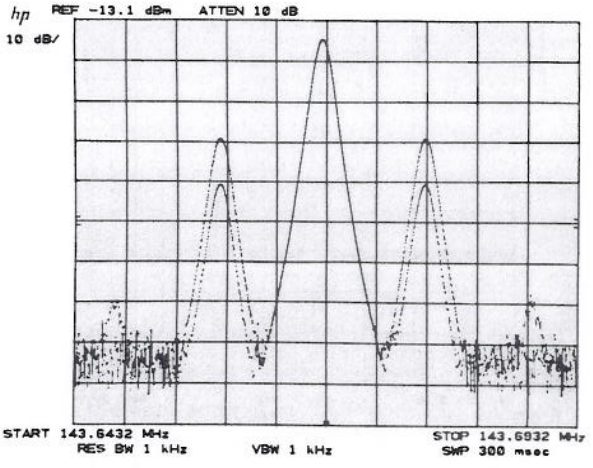
Example

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 and, [BLANK] B.

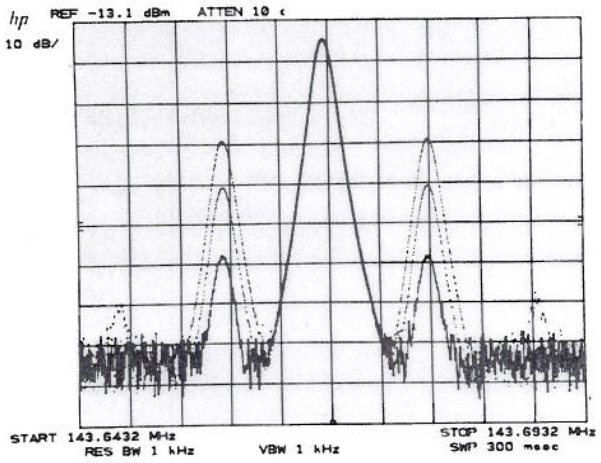
The signal with the desired level of modulation will be stored in trace C:
Press [CLEAR-WRITE] B and allow one sweep.
Press [SHIFT] I which writes the trace from B into C.



Change the modulation level, allow one sweep and store in B with [VIEW] B.
To view C press [SHIFT] j.



Change the modulation level again and press CLEAR WRITE A, and store with 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 9, 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 area 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 1000. 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.

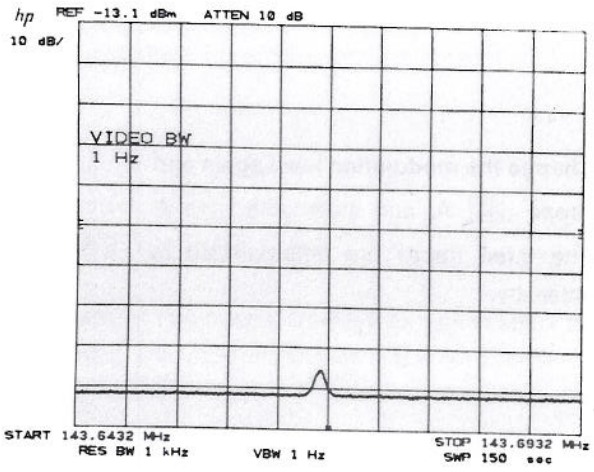
During video averaging the current sample being taken is read out at the left of the display.

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 sweeptime is 2 sec. Almost a full sweeptime duration would have to pass before any center frequency change effect on the trace could be seen. 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 sec. (Any change to control settings such as CENTER FREQUENCY, FREQUENCY SPAN, etc., will cause the video averaging process to be restarted.)

Example

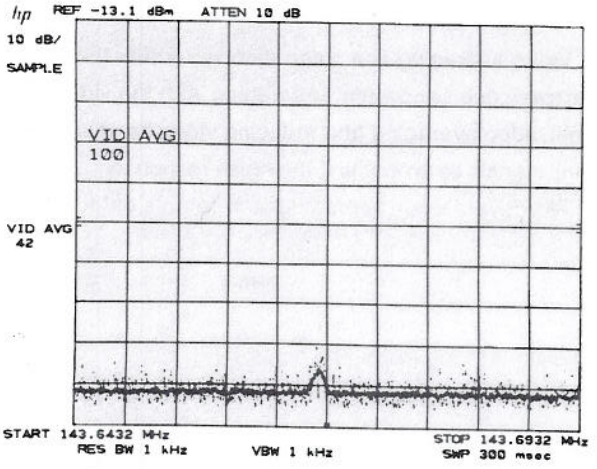
To display very low level signal responses, very narrow resolution and video bandwidths are required. The accompanying increase in sweep time can make measurements cumbersome. Video averaging allows the display of low level signals without the long sweep time.

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



Take out the narrow video filter with video bandwidth [AUTO] and start video averaging, press [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 ms = 12.6 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.

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.

G

Press SHIFT 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 sweeptimes less than 20 ms. To eliminate the automatic refresh feature:

For external triggering

x

Press SHIFT EXT

For video triggering

y

Press SHIFT 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

When locked, an attempt to SAVE will write "SAVE LOCK" 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 30 seconds to run. When complete, instrument preset will be called and the correction factors applied.

Connect CAL OUT to RF INPUT.

Execute the routine: SHIFT W

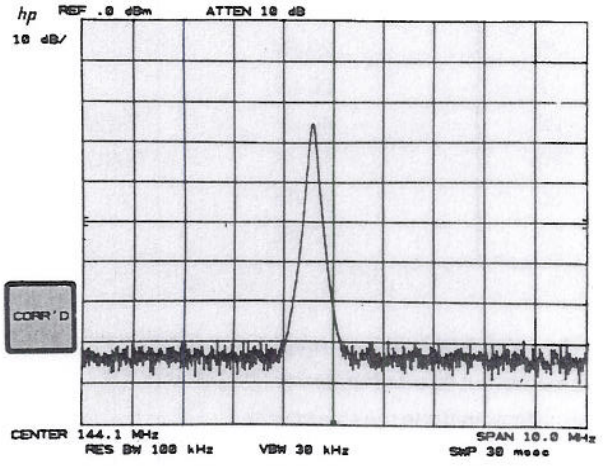
Use Correction factors: SHIFT X

Do not use correction factors: SHIFT Y

Display correction factors: SHIFT W

If "ADJUST AMP'TD CAL" appears on the CRT, manual calibration adjustment is necessary before the routine can be successfully run. See Chapter 1 for the manual calibration procedure.

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



Correction can be turned on or off using [SHIFT] X and [SHIFT] Y after the routine has been successfully completed. Display of the correction factors is discussed on page 12.7 in this chapter.

For more information on accuracy, see the 8566A Spectrum Analyzer Data Sheet.

The readout of the correction factors is as follows:

Line	Parameter		Correction Values Displayed
1	LOG and LIN scale (Res BW ≥ 100 kHz)		Amplitude offset error between log and linear scale. Reference at 1 dB log.
2 3 4 5	10 dB/ 5 dB/ 2 dB/ 1 dB/	LOG SCALE	Amplitude errors due to changing log scale. Reference to −10 dBm CAL OUTPUT signal.
6 7 8 9 10 11 12 13 14 15 16 17	3 MHz 1 MHz 300 kHz 100 kHz 30 kHz 10 kHz 3 kHz 1 kHz 300 Hz 100 Hz 30 Hz 10 Hz	RESOLUTION BANDWIDTH	Amplitude errors due to switching bandwidths. Reference to 1 MHz resolution bandwidth. Frequency offset errors due to center frequency tuning inaccuracies of resolution bandwidth.
18	LOG and LIN Scale (Res BW < 100 kHz)		Same as line 1.
19 20 21 22 23 24 25	A20 A10 SG 20-2 SG 20-1 SG 10 LG 20 LG 10	STEP GAIN AMPLIFIERS	Amplitude error due to changing IF step gain. Reference to −10 dBm REFERENCE LEVEL.
26 27 28 29 30 31	20 dB 30 dB 40 dB 50 dB 60 dB 70 dB	INPUT ATTENUATOR	Amplitude error due to switching attenuator. Reference to 10 dB Attenuator position.

The total amplitude correction value composed of linear/log scale offsets, bandwidth errors, and attenuator errors can be output to a computer/controller with KS <91>. This error can then be corrected with software to yield a more accurate amplitude measurement.

Correction values are stored in memory for a 30 day period in the event of power line failure.

Fast Preset/HP-IB

A partial instrument preset can be initiated with [SHIFT] T or [SHIFT] U. These key functions operate essentially the same as the [2-22 GHz] instrument preset in that a specific full span is set, functions automatically coupled and shift functions turned-off. The difference is that the fast presets do not exercise the instruments internal self-test routine which control the two check LEDs and as a result, can be executed much faster.

Fast preset 2 — 22 GHz: press [SHIFT] T

Fast preset external mixer: press [SHIFT] U*

Under remote operation, an HP-IB operation mode can be set which allows the analyzer to operate faster than normal. The Fast HP-IB mode is enabled with a [SHIFT] S. A [2-22 GHz] instrument preset will disable the Fast HP-IB mode whereas the Fast presets will not disable the Fast HP-IB mode.

Fast HP-IB: press [SHIFT] S

Band Lock

If desired, the analyzer can be locked on either the low band (0 - 2.5 GHz) or the microwave band (2 — 22 GHz). In normal operation, CENTER FREQUENCY enables the analyzer to tune continuously from 0 to 22 GHz (– 1 to 24 GHz overrange). By executing a band lock, the analyzer's tuning range will be restricted to the band selected. To execute band lock, select frequency range with [0-2.5 GHz] or [2-22 GHz]:

Band lock: [SHIFT] t

Band unlock: [SHIFT] Q or FULL SPAN key

External Mixer*

Two shift functions are available to specific usage with an external mixer. Shift U selects an LO tuning range for external mixer operation. Shift v enables a signal identifier routine which uses the marker to automatically identify the signal under observation.

Fast preset external mixer: [SHIFT] U

Signal identifier external mixer: [SHIFT] v

*for future option

SHIFT FUNCTION Index

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

DIAGNOSTIC AIDS

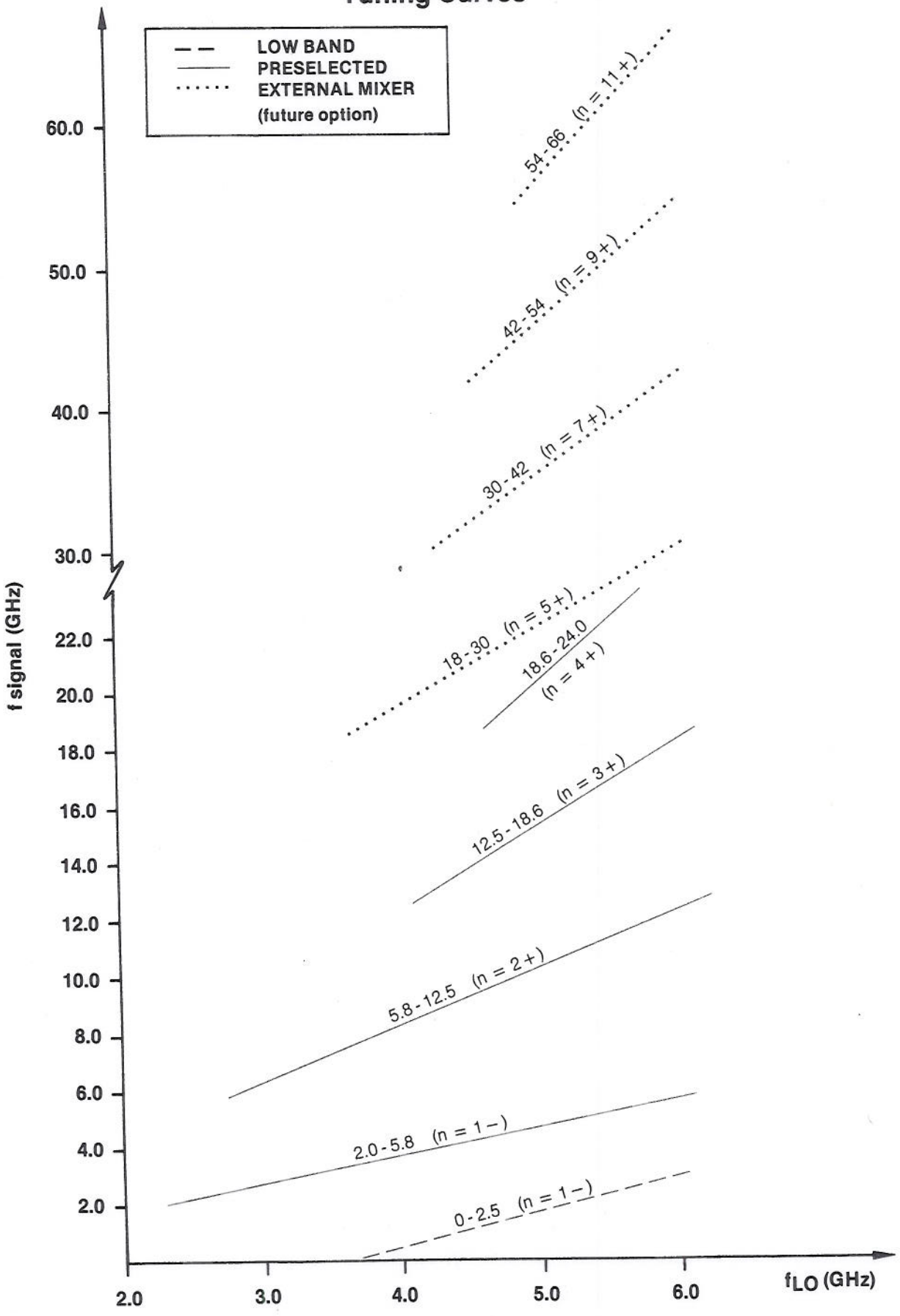
To aid in servicing the spectrum analyzer, there are a number of diagnostic shift functions. These functions are listed here, their operation and use is covered in the 8566A Operating and Service Manual, Section VIII.

	CODE
Frequency diagnostic on	R
Disable step gain	q
Manual DACS control	J
Display correction data	w
YTO pretest mode	F

*See 8566A Spectrum analyzer Remote Operation, HP part number 08566-90003.

Appendix A

Tuning Curves



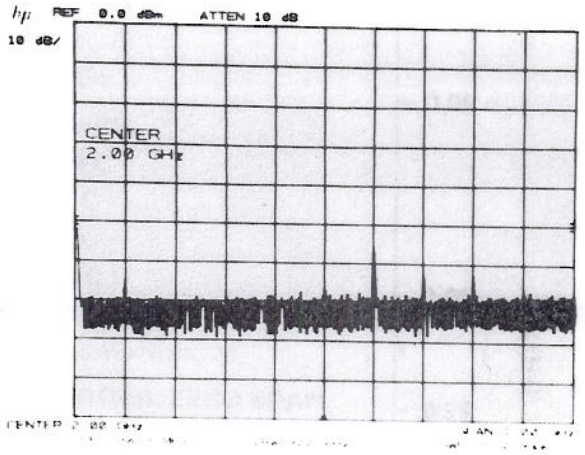
Appendix B

Center Frequency/Span Tuning Characteristics

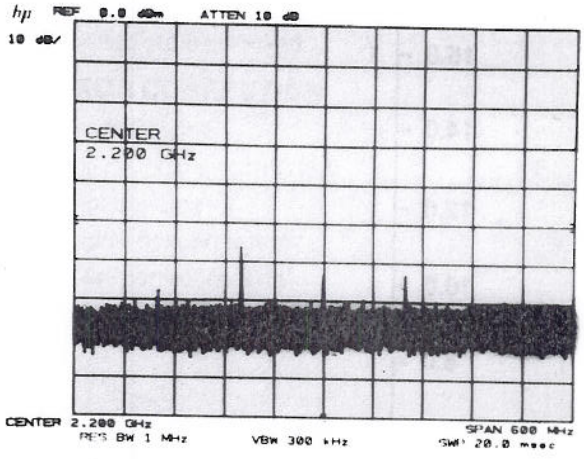
At the location of the band overlap (2.0 - 2.5 GHz) or on band edges (– 1.0 GHz and 24 GHz), the frequency span may change as center frequency is tuned near the above locations. This situation occurs when the frequency span is such that the equivalent start/stop frequency exceeds the tuning range of the analyzer.

Example

Analyzer Settings: 0 - 2.5 GHz Band
FREQUENCY SPAN = 1 GHz
CENTER FREQUENCY = 2 GHz



Note that the equivalent Start/Stop Frequency are 1.5 GHz and 2.5 GHz.

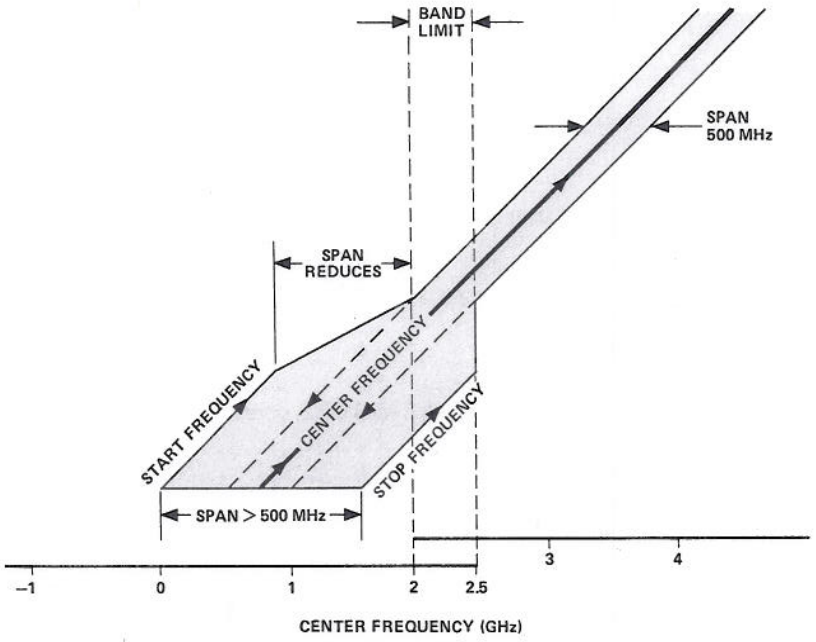


Now tune to 2.2 GHz

CENTER FREQUENCY 2.2 GHz

Since the maximum stop frequency in low band is 2.5 GHz, the analyzer will reduce the span by changing the START FREQ in order to enable the center frequency to be tuned to 2.2 GHz. Hence, the equivalent START/STOP FREQ is now 1.9 GHz/2.5 GHz which yields a 600 MHz span. If the CENTER FREQUENCY is tuned to 2.25 GHz, the SPAN will be reduced to 500 MHz, a CENTER FREQUENCY greater than 2.25 GHz will automatically switch the analyzer to the microwave (2 - 22 GHz) band while maintaining a 500 MHz span.

The CENTER FREQUENCY/SPAN TUNING CHART below graphically illustrates the aforementioned tuning characteristics.

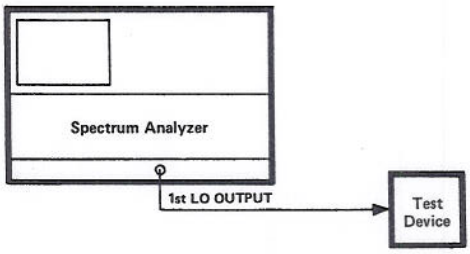


Appendix C
1st LO Output

The 1st LO OUTPUT provides a nominal + 5 dBm signal that is tunable from 2.3214 - 6.1214 GHz. Since the HP 8566A is synthesized, the 1st LO can be used as a precise tunable microwave source.

Example

Using the 1st LO OUTPUT as a precision source. Connect equipment as shown:



Instrument Preset: [2-22 GHz]

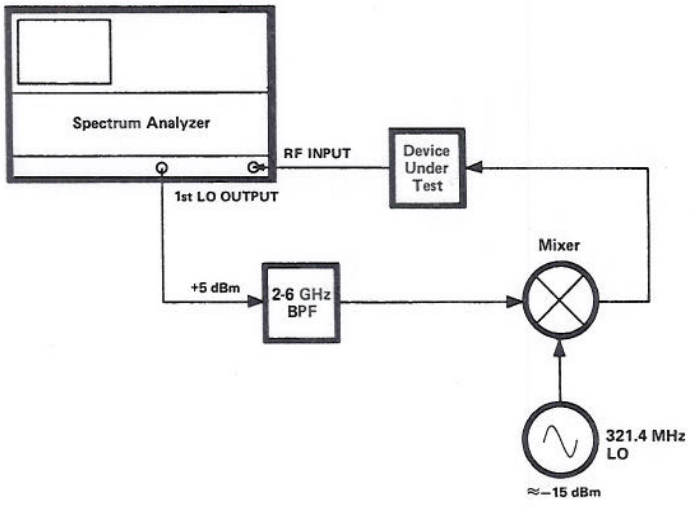
Select zero span with: [FREQUENCY SPAN] 0 Hz

Offset IF with: [SHIFT] F. This removes the 321.4 MHz IF offset.

By pressing [CENTER FREQUENCY], you now have a precision source that can be tuned from 2.3214 - 6.1214 GHz with 1 Hz resolution.

Example

Using the 1st LO OUTPUT as a tracking signal source from 2 - 5.8 GHz; connect equipment as shown:



Instrument Present: [2-22 GHz]

Set START/STOP FREQ: [START FREQ] 2 GHz, [STOP FREQ] 5.8 GHz

The dynamic range will depend on the conversion loss and isolation characteristics of the mixer. Flatness variations can be normalized through trace arithmetic.

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For more information, call your local HP Sales Office or East (301)258-2000 • Midwest (312) 255-9800 • South (404) 955-1500 • West (213) 877-1282; Or write, Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. **In Europe,** Hewlett-Packard S.A., 7, rue du Bois-du-lan, P.O. Box CH-1217 Meyrin 2-Geneva, Switzerland. **In Japan,** Yokogawa-Hewlett-Packard Ltd., 29-21, Takaido-Higashi 3-chome, Suginami-ku, Tokyo 168.

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