495 &495P

SPECTRUM ANALYZERS

User Manual

Tektronix®
COMMITTED TO EXCELLENCE

Part No. 070-6888-01
Product Group 2E

495
&495P
SPECTRUM ANALYZERS

User Manual

For Serial Numbers B020100 and Above

Please check for CHANGE INFORMATION at the rear of this manual.

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Instrument Serial Numbers

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc., Beaverton, Oregon, USA
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

Tektronix, Inc., RO. Box 500, Beaverton, OR 97077

Printed in U.S.A.

WARRANTY

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THIS PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

Preface

This manual is one of a set of product manuals for the Tektronix 495 and programmable 495P Spectrum Analyzers. The manual describes the instrument installation and operation. These instructions assume a thorough knowledge of frequency domain analysis. The purpose of this manual is to explain the operation of the 495 and 495P so that measurements will be meaningful whether made under adverse or laboratory conditions. The manual organization is shown in the *Table of Contents.* The manuals that are available in addition to this *495/495P* ***User Manual*** include the following:

- 495/495P Service Manuals, Volume 1 and 2
- 495P Programmer Manual (standard accessory for 495P Option only)

For manual ordering information, contact your local Tektronix Field Office or representative or refer to the Accessories portion of the *Replaceable* ***Me-****chanical Parts* list in the *495/495P* ***Service Manual, Volume 2.***

Standards and Conventions

Most terminology is consistent with standards adapted by IEEE and IEC. A glossary of terms is provided in Appendix A. Abbreviations in the documentation are consistent with ANSI Y1.1–1972. GPIB functions conform to the IEEE 488-1978 standard. Copies of ANSI and IEEE standards can be ordered from the Institute of Electrical and Electronic Engineers Inc.

Change/History Information

Any change information that involves manual corrections or additional information is located behind the *Change Information* page at the back of this manual.

Unpacking and Initial Inspection

Instructions for unpacking and preparing the instrument for use are described in Section 3.

Storage and Repackaging

Instructions for short- and long-term storage and instrument repackaging for shipment are described in Section 3.

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Safety

Please take a moment to review these safety precautions. They are provided for your protection and to prevent damage to the spectrum analyzer. This safety information applies to all operators and service personnel.

Symbols and Terms

These two terms appear in manuals:

statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

These two terms appear on equipment:

- *CAUTION* indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.
- *DANGER* indicates a personal injury hazard immediately accessible as one reads the marking.

These symbols appear in manuals:

This symbol indicates where applicable cautionary or other information is to be found.

Static-Sensitive Devices

These symbols appear on equipment:

DANGER
High Voltage

Protective
ground (earth)
terminal

ATTENTION
Refer to
manual

Refer to
manual

Specific Precautions

Observe all of these precautions to ensure your personal safety and to prevent damage to either the spectrum analyzer or equipment connected to it.

Power Source

The spectrum analyzer is intended to operate from a power source that will not apply more than 250 V_{RMS} between the supply conductors or between either supply conductor and ground. A protective ground connection, through the grounding conductor in the power cord, is essential for safe system operation.

Grounding the Spectrum Analyzer

The spectrum analyzer is grounded through the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle where earth ground has been verified by a qualified service person. Do this before making connections to the input or output terminals of the spectrum analyzer.

Without the protective ground connection, all parts of the spectrum analyzer are potential shock hazards. This includes knobs and controls that may appear to be insulators.

Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord that is in good condition.

Use the Proper Fuse

To avoid fire hazard, use only the fuse specified in the parts list for your product, matched by type, voltage rating, and current rating.

Do Not Remove Covers or Panels

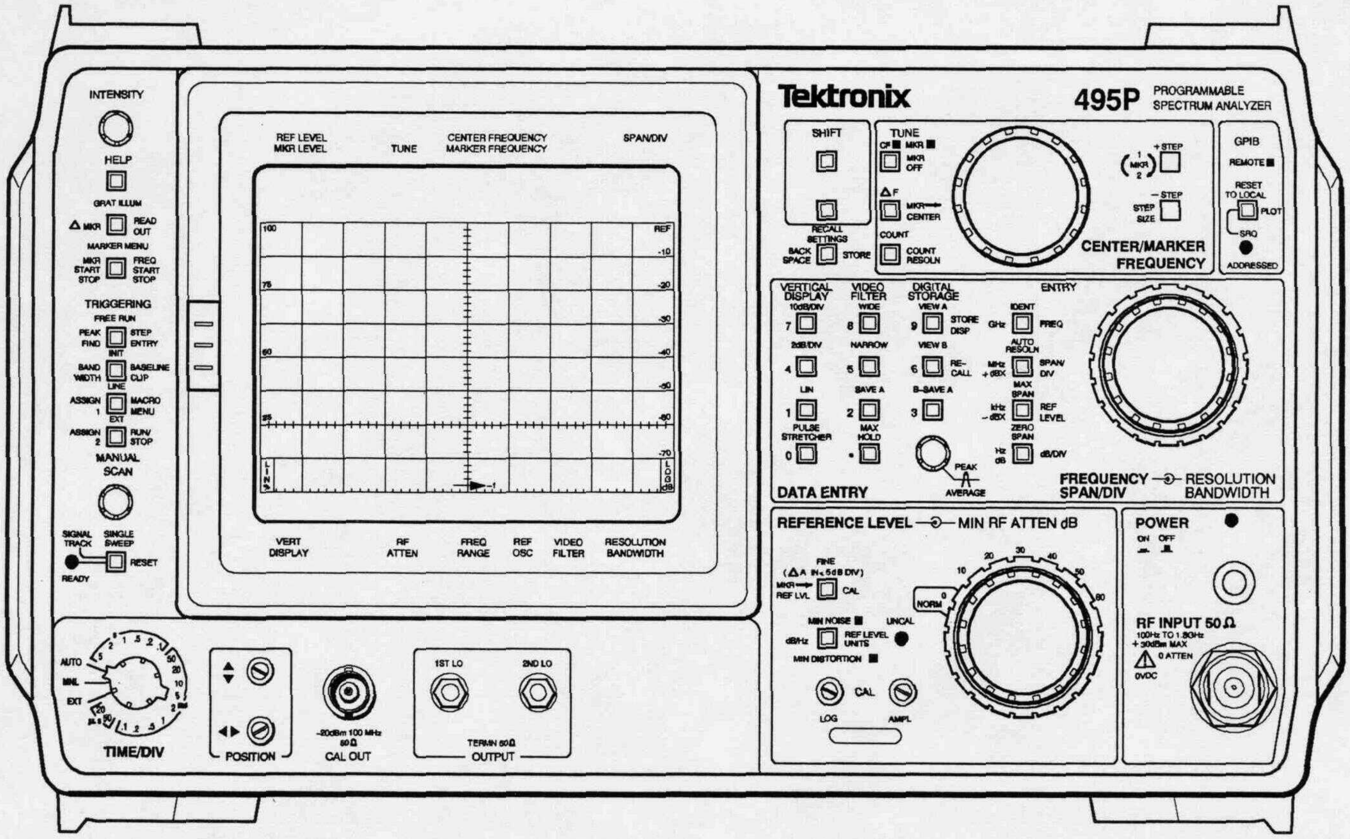
To avoid personal injury, do not operate the spectrum analyzer without the panels or covers.

Electric Overload

Never apply to a connector on the spectrum analyzer a voltage that is outside the range specified for that connector.

Do Not Operate in Explosive Atmospheres

The spectrum analyzer provides no explosion protection from static discharges or arcing components. Do not operate the spectrum analyzer in an atmosphere of explosive gases.



The 495P Spectrum Analyzer

General Information

Product Overview

The TEKTRONIX 495 and programmable 495P Spectrum Analyzers are high performance, compact, portable instruments. Microcomputer control of most functions simplifies and enhances operation.

The following is a list of the main instrument features:

- Single and delta marker modes
- Synthesizer frequency accuracy
- Precision signal counting ability
- Precise amplitude measurement capability
- Digital storage display
- Internal memory to retain front-panel settings and displays
- HELP messages (CRT readout) that describe the function of front-panel keys and controls as well as messages that explain operating errors
- Front-panel DATA ENTRY push buttons
- Ability to plot the display, readout, and graticule
- Ability to hold 8 personalized macros in memory (programmable instruments only)
- 10 Hz to 3 MHz resolution

Basic Features

The frequency range is 100 Hz to 1800 MHz. A minimum resolution bandwidth of 10 Hz, with a minimum span of 10 Hz/Div, provides measurement resolution that is proportional to the frequency accuracy. Digital storage provides flicker-free displays plus SAVE A, B-SAVE A, and MAX HOLD to compare and subtract displays and save maximum values. In addition to conventional digital storage features, internal memory stores up to nine separate displays with their readouts and dot markers, which can be recalled later for additional analysis and comparison. It is also possible to store up to ten different front-panel control setups for future recall. The signal counting feature allows the instrument to selectively count a particular signal out of several that may be present at its input.

Select center frequency either by the front-panel CENTER/MARKER FREQUENCY control or by the Data Entry push buttons. When using the Data Entry push buttons, it is not necessary to alter the Span/Div setting regardless of the frequency selected. Other parameters, such as vertical display and reference level, are push button selectable with the flexibility previously available only under program control of the general purpose interface bus (GPIB).

Markers

The single and delta markers provide direct readout of frequency and amplitude information of any point along any displayed trace. Relative (delta) frequency and amplitude information between any two points along any displayed trace or between traces is also available. The **CENTER/MARKER FREQUENCY** control can move the markers, or it can move the display with a stationary frequency marker. For additional marker information, refer to *Using the Markers Feature* in Section 6 of this manual.

Programmable Instrument Features

The programmable version of the instrument adds remote control capabilities to the manual instrument features. The front-panel controls (except those intended exclusively for local use, such as **INTENSITY)** can be remotely operated through the GPIB port. This allows the spectrum analyzer to be used with a variety of systems and controllers. Refer to the ***495P Programmer Manual*** for additional information.

The programmable instrument also adds the macroinstructions (macros) feature. The instrument memory has 8 kbytes reserved for the construction of made-to-order macros. The macro menu can hold the titles of eight macros for easy access. Specific macro information is located in the **495P *Programmer Manual.***

Firmware Version and Error Message Readout

This feature provides a readout that identifies the version of firmware that is installed. The readout is momentarily displayed when the power is turned on. The programmable instrument will flash the firmware version, in addition to the GPIB address, when the **[RESET TO LOCAL]** key is pressed.

If the instrument fails to complete any routine or function, an error message will flash on the screen explaining the failure.

Accessories

The *Replaceable Mechanical Parts* list in the ***495/495P Service Manual, Volume 2,*** contains the part numbers, descriptions, and ordering information for all standard and optional accessories offered at this time.

The following list includes all standard accessories currently shipped with each instrument. Refer to *Section 7, Options,* for alternate information.

- 50 Ω coaxial cable; N to N connector, 72 inch
- 50 Ω coaxial cable; BNC to BNC connector, 18 inch
- Adapter; N male to BNC female
- 4A fast-blow fuses[1]; 2 each
- Power cord[1]
- Cord clamp
- CRT light filters; 2 - one each amber and grey
- CRT mesh filter
- Rear connector shield
- 495 & 495P User Manual
- 495P Programmer Manual; 495P Only

Options

Section 7, Options contains information on all of the options currently available for the 495 and 495P.

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[1] If the instrument is wired for 220-240 V operation (Options A1, A2, A3, A4, A5) or if Option 52 is installed (North American configuration for 220 V with standard power cord), 2A medium-blow fuses are used.

Specification

This section includes the electrical, physical, and environmental characteristics of this instrument. Any instrument specification changes due to options are listed in *Section 7, Options.*

Electrical Characteristics

The following tables of electrical characteristics and features apply to the spectrum analyzer after a 30-minute warmup, and after performing the front-panel **CAL** adjustments, except as noted.

- The Performance Requirement statements define characteristics that are essential to the intended application of the product. Performance Requirement characteristics are normally verifiable by following the *Performance Check* procedure in the *495/P* ***Service Manual, Volume 1***.
- The Supplemental Information column provides more explanation about related Performance Requirements, or describes typical performance for characteristics not ordinarily verified by the *Performance Check* procedure.

The instrument performs an internal processor system check each time power is turned on. The *Functional or Operational Check* procedure is provided in *Section 5, Instrument Check Out.* This procedure will satisfy most incoming inspections and will help familiarize you with the instrument capabilities. It does not require external test equipment or technical expertise.

Verification of Tolerance Values

Perform compliance tests of specified limits, listed in the Performance Requirement column, only after a 30-minute warm-up time (except as noted) and after doing the front-panel **CAL** procedure. Use measurement instruments that do not affect the values measured. Measurement tolerance of test equipment should be negligible when compared to the specified tolerance. When the tolerance of test equipment is not negligible, the error of the measuring device should be added to the specified tolerance.

Tabie 2-1: Frequency Related Characteristics

Characteristic	Performance Requirement	Supplemental Information
Center/Marker Frequency		
Range		100 Hz to 1.8 GHz. Tuned by the CENTER/MARKER FREQUENCY control or the DATA ENTRY push buttons.
Drift		With constant ambient temperature and fixed center frequency.
After 30 minute warmup		
SPAN/DIV >200 kHz (1st LO Unlocked)		Typically ≤25 kHz per minute.
SPAN/DIV < 200 kHz (1st LO Locked)		Typically < 150 Hz per minute.
After 1 hour warmup		
SPAN/DIV >200 kHz (1st LO Unlocked)		Typically < 5 kHz per minute. Not significant when compared to residual FM per minute of sweep time.
SPAN/DIV < 200 kHz (1st LO Locked)	≤50 Hz per minute	Correction will occur at the end of sweep for sweep times > 5 s/div.
Readout Resolution		At least 10% of SPAN/DIV.
Initial Accuracy		Allow a settling time of one second for each GHz change in CF.
SPAN/DIV >200 kHz (1st LO Unlocked)	±[20%D + (CF x REF) + 15 kHz] where: D=SPAN/DIV or RESOLUTION BANDWIDTH, whichever is greater CF=Center Frequency REF=Reference Frequency Error	
SPAN/DIV < 200 kHz (1st LO Locked)	±[20%D + (CF x REF) + 15 Hz] where: D=SPAN/DIV or RESOLUTION BANDWIDTH, whichever is greater CF=Center Frequency REF=Reference Frequency Error	

Table 2-1: Frequency Related Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information
Reference Frequency Error		
Aging Rate		
Short Term		$\leq 1 \times 10^{-9}$/Day.
First 6 months		$< 1 \times 10^{-7}$ in first 6 months.
After first 6 months		$\times\ 10^{-7}$/Year.
Accuracy During Warmup at +25° C 30 Minutes After Power Up		Within 5×10^{-8} of the frequency after 24 hours.
Temperature Sensitivity		Within 2×10^{-8} over the instrument operating temperature range of -15° C to +55° C (referenced to +25° C).
Setability	$\leq 1 \times 10^{-7}$	+20° C to +30° C temperature range. 100 MHz CAL OUT Reference.
Signal Counter		
Accuracy (After 30 Minute Warmup)	± [Counter frequency x Reference frequency error) + 5 Hz + 1 LSD]	Count at center, marker, or A markers.
Sensitivity	Signal level, at center screen or at marker, must be 20 dB or more above the average noise level and within 60 dB of the reference level.	
Readout Resolution		1 Hz to 100 MHz in decade steps, selectable with COUNT RESOLUTION menu.
Residual FM		Short term, after 1 hour warmup.
SPAN/DIV >200 kHz (1st LO Unlocked)	< 7 kHz total excursion in 20 ms	
SPAN/DIV < 200 kHz (1st LO Locked)	≤ 5 Hz total excursion in 20 ms	
Static Resolution Bandwidth (6 dB down)	Within 20% of selected bandwidth for all but the 1 0 Hz filter	10 Hz to 1 MHz in decade steps, and 3 MHz.
Shape Factor (60 dB/6 dB)	7.5:1 or less for all but the 10 Hz filter	
60 dB Bandwidth for the 10 Hz Filter	< 150 Hz	
Line-related Sidebands	< -55 dBc (47 to 440 Hz)	

Table 2-1: Frequency Related Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information		
Noise Sidebands	< -70 dBc at 30X the selected bandwidth for resolution bandwidths of 10 Hz and 100 Hz < -75 dBc at 30X the selected bandwidth for all other resolution bandwidths			
Video Filter		Normal	Wide	Narrow
		3 MHz	30 kHz	3 kHz
		1 MHz	30 kHz	3 kHz
		100 kHz	3 kHz	300 Hz
		10 kHz	300 Hz	30 Hz
		1 kHz	30 Hz	3 Hz
		100 Hz	3 Hz	0.3 Hz
		10 Hz	3 Hz	0.3 Hz
Pulse Stretcher Fall-Time		30 µs/div of pulse amplitude (typical).		
Frequency Span/Div				
Range		10 Hz/div to 100 MHz/div (in a 1 -2-5 sequence with the SPAN/DIV control), or 10 Hz/div to 170 MHz/div (from the DATA ENTRY push buttons) to two significant digits. In addition, MAX SPAN provides a full-band display, and ZERO SPAN provides a 0 Hz display. With ZERO SPAN, the horizontal axis is calibrated in Time/div instead of Frequency/div.		
Accuracy/Linearity				
Span/Div ≥50 Hz	Within 5% of the selected Span/div	Measured over the center 8 divisions		
Span/Div <50 Hz	Within 10% of the selected Span/div			

Table 2-1: Frequency Related Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information
Marker(s)		When activated, the marker is a bright dot positioned by the CENTER/MARKER FREQUENCY control or the DATA ENTRY push buttons.
Normal Accuracy/Resolution	Identical to Center Frequency accuracy	For the active trace.
Δ MKR Accuracy	±1% of the total span	For the active trace. AMKR activates a second marker at the position of the single marker on the trace. Parentheses appear on the marker display line indicating that the delta mode is active. The display shows the difference in frequency and amplitude. MKR 1↔2 selects which marker is tuned.
A MKR Resolution		< 10% of Span/Div.

Table 2-2: Amplitude Related Characteristics

Characteristic	Performance Requirement	Supplemental Information
Vertical Display Modes		10 dB/div, 2 dB/div, and Linear. Any integer between 1 to 15 dB/div can also be selected via the DATA ENTRY Keypad.
Reference Level (Top of the graticule)		
Range		
Log Mode		From −117 dBm to +50 dBm with no reference offset; +50 dBm includes 20 dB of IF gain reduction (+30 dBm is the maximum safe input). Alternate reference levels are: • dBV (-130 dBV to +37 dBV) • dBmV (-70 dBmV to +97 dBmV) • dBμV (−10 dBμV to + 157 dBμV)
Linear Mode		39.6 nV/div to 2.8 V/div (1 W or $10V_{peak}$ maximum safe input).
Steps		
10 dB/Div Mode		10 dB for the coarse mode. 1 dB for the FINE mode.
2 dB/Div Mode		1 dB for the coarse mode. 0.25 dB for the FINE mode.
LIN Mode		1 -2-5 sequence for coarse mode. 1 dB equivalent steps for FINE mode.
Set via DATA ENTRY Keypad		Steps correspond to the display mode in coarse, except for 2 dB/div where steps are 1 dB. In FINE mode: • 1 dB when the mode is 5 dB/div or more. • 0.25 dB for display modes of 4 dB/div or less (referred to as ΔA mode).

Table 2-2: Amplitude Related Characteristics (Cont.)

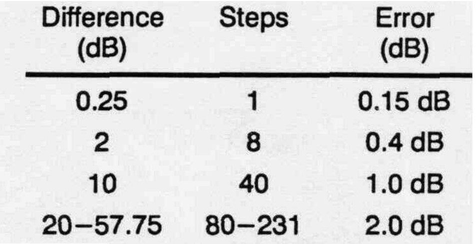
Characteristic	Performance Requirement	Supplemental Information
Marker(s) Accuracy		Identical to REF LEVEL accuracy plus cumulative error of display scale. (Dependent on vertical position.)
Frequency Response and Display Flatness		Frequency response is measured with 10 dB of RF attenuation.
About the mid-point between two extremes	±1.0 dB	Response is affected by: • Input VSWR • Gain variation • Mixer conversion
Accuracy		Dependent on the following characteristics: • RF Attenuation Accuracy • IF Gain Accuracy • Resolution Bandwidth • Display Mode • Calibrator Accuracy • Frequency Response • **[Blue-SHIFT] [CAL]** routine reduces error between resolution bandwidths at -20 dBm REF LEVEL. Other REF LEVELs may have larger errors. • Ambient Temperature Change (±0.15 dB/° C maximum, typically ±0.05 dB/° C)
Display Dynamic Range		90 dB maximum for Log Modes ≥12 dB. 8 divisions for Linear Mode.
Accuracy		
10 dB/div Mode	±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over 80 dB range	Maximum cumulative error of ±4.0 dB over 90 dB range.
2 dB/div Mode	±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over 16 dB range	
LIN Mode	±5% of full scale	

Table 2-2: Amplitude Related Characteristics (Cont.)

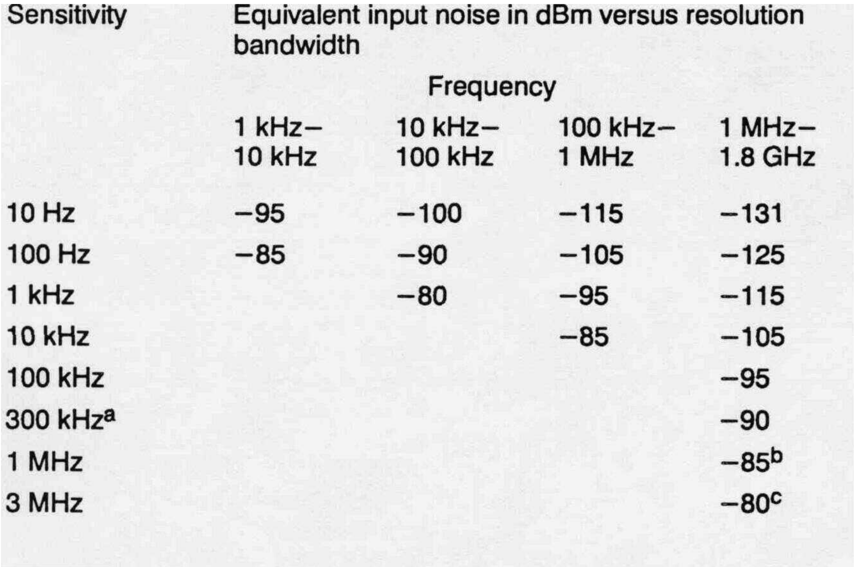
Characteristic	Performance Requirement	Supplemental Information
RF Attenuator		
Range		0-60 dB in 10 dB steps.
Accuracy DC to 1800 MHz	Within 0.5 dB/10 dB to a maximum of 1 dB over the 60 dB range	
Gain Variation Between Resolution Bandwidths		Measured conditions: • Measured at -20 dBm • MIN DISTORTION mode • After CAL routine @ 25° C
With Respect to 3 MHz Filter	≤ ±0.4 dB	
Between Any Two Filters	≤ 0.8 dB	
IF Gain		
Range		87 dB of gain increase, 20 dB of gain decrease (MIN NOISE and REDUCED GAIN modes activated), in 10 dB and 1 dB steps.
Accuracy		
1 dB Step	< 0.2 dB/dB step to 0.5 dB/9 dB steps except at the decade transitions	
Decade Transitions −19 to −20 dBm -29 to -30 dBm -39 to -40 dBm -49 to -50 dBm -59 to -60 dBm	0.5 dB or less	Maximum 1 dB cumulative error over 10 dB.
Maximum Deviation Over the Range	±2 dB	

Table 2-2: Amplitude Related Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information
Differential Amplitude Measurement		AA mode provides differential measurements in 0.25 dB increments. (This is not related to the **ΔMKR** mode.)
Range		Maximum range of 57.75 dB dependent on Reference Level when the AA mode was activated.
Accuracy		



Difference (dB)	Steps	Error (dB)
0.25	1	0.15 dB
2	8	0.4 dB
10	40	1.0 dB
20−57.75	80−231	2.0 dB



Sensitivity Equivalent input noise in dBm versus resolution bandwidth

Frequency

	1 kHz–10 kHz	10 kHz–100 kHz	100 kHz–1 MHz	1 MHz–1.8 GHz
10 Hz	−95	−100	−115	−131
100 Hz	−85	−90	−105	−125
1 kHz		−80	−95	−115
10 kHz			−85	−105
100 kHz				−95
300 kHz[a]				−90
1 MHz				−85[b]
3 MHz				−80[c]

Typical sensitivity **100** Hz to 1 kHz is -75 dBm at 10 Hz Resolution Bandwidth.

Equivalent maximum input noise for each resolution bandwidth.

Measured at 25° C with:

- 0 dB RF attenuation (Min **Atten 0 dB)**
- Narrow Video Filter On
- Vertical Display 2 **dB/div** (5 **dB/div in 10 Hz RBW)**
- Digital Storage On
- Max Hold Off
- **Peak/Average** in Average
- 1 sec **Time/Div**
- Zero Span
- Input Terminated in 50 **Ω**

Characteristic	Performance Requirement	Supplemental Information
Spurious Responses		
Residual	**– 100 dBm** or less	With no input signal.
3rd Order **Intermodulation** Products	-70 dBm or less	From any two on-screen signals within any frequency span. In MIN DISTORTION mode.
Harmonic Distortion	-60 dBc or less	Measured across the entire band, with -30 dBm input and 0 dB attenuation.
LO Emission	-70 dBm or less	With 0 dB RF Attenuation.

[a] **Option** 07 only. [b] **Above** 5 **MHz.** [c] **Above** 10 MHz.

Table 2-3: Input Signal Characteristics

Characteristic	Performance Requirement	Supplemental Information
RF INPUT		Type N female connector. (See Option 07 characteristics at the end of this section for supplemental specifications concerning an additional 75 Ω input.)
Impedance		50 Q.
VSWR with ≥10 dB RF Attenuation		1.3:1 maximum (typically 1.2:1).
VSWR with 0 dB RF Attenuation		2.0:1 maximum (typically 1.9:1).
Maximum Safe Input (With 0 dB RF Attenuation)		+30 dBm (1 W) continuous or 75 W peak, pulse width of 1 us or less with a maximum duty factor of 0.001 (attenuator limited).
1 dB Compression Point (Minimum)	0 dBm	Measured in MIN NOISE mode with no RF Attenuation.
EXT REF IN		
Frequency	1, 2, 5, or 10 MHz ±5 PPM	
Power	–15 dBm to +15 dBm	
Waveshape		Sinewave, ECL, or TTL, with a duty cycle of 40%–60%.
Input Impedance		AC=50 Q, DC=500 Ω.
HORIZ | TRIG (rear panel)		DC coupled input for external horizontal drive (selected by the EXT position of the TIME/DIV control) and AC coupled input for external trigger signals (selected at other positions of the TIME/DIV control).
Sweep Input Voltage Range		0 to +10 V (DC + Peak AC) for full-screen deflection.
Trigger Input Voltage Range		
Minimum	At least 1.0 V_{p-p} from 15 Hz to 500 kHz	Typically 1 MHz at 1.5V_{peak}.
Maximum		
DC + Peak AC		50 V.
AC		30 V_{RMS} to 10 kHz, then derate linearly to 3.5 V_{RMS} at 100 kHz and above.
Pulse Width		0.1 µs minimum.

Table 2-3: Input Signal Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information
MARKER | VIDEO (rear panel)		External Video input or External Video Marker input, switched by pin 1 of the ACCESSORIES connector.
VIDEO Input Level		0 to +4 V for full-screen display with pin 1 of the ACCESSORIES connector low.
MARKER Input Level		0 to −10 V. Interfaces with TEKTRONIX 1405 TV Sideband Adapter.
ACCESSORY Connector (J104)		25-pin connector (not RS-232 compatible). Provides bi-directional access to the instrument bus. Also provides External Video select. All lines are TTL compatible. Maximum voltage on all lines is ±15 V.
Pin 1		External Video Select. Low selects **External VIDEO** Input. High (default) selects **Video MARKER** Input.
Pin 2		Not used.
Pin 3		Not used.
Pin 4		Internal Control. High (default) selects internal control. Instrument bus lines are output at the **ACCESSORIES** connector. Low selects External control. Instrument bus lines at the **ACCESSORIES** connector accept input from an external controller.
Pin 5		Chassis Ground.
Pins 6–13[a]		Instrument Bus Address Lines 7-0.
Pin 14[a]		Instrument Bus Data Valid signal.
Pin 15[a]		Instrument Bus Service Request signal.
Pin 16[a]		Instrument Bus Poll signal.

[a] Output when Internally controlled (pin 4 high) and Input when externally controlled (pin 4 low).

Table 2-3: Input Signal Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information
Pin 17		Data Bus Enable input signal for external controller. High (unasserted) disables external data bus. Low enables external data bus.
Pins 18–25[a]		Instrument Bus Data lines 0-7. Active when External Data Bus Enable (pin 17) is low.

[a] Output when internally controlled (pin 4 high) and input when externally controlled (pin 4 low).

Table 2-4: Output Signal Characteristics

Characteristic	Performance Requirement	Supplemental Information
Calibrator (CAL OUT)	-20 dBm ±0.3 dB at 100 MHz	100 MHz (phase locked to reference oscillator).
1st LO and 2nd LO OUTPUTS		Provide access to the output of the respective local oscillators. *These ports must be terminated in 50 Ω at all times.*
1st LO OUTPUT Power		+6 dBm to +20 dBm.
2nd LO OUTPUT Power		−10 dBm to +15 dBm.
VERT Output		Provides 0.5 V ±5% (open circuit) of signal per division of video that is above and below the center line. Full range is -2.0 V to +2.0 V. 250 mV maximum ripple. Source impedance is approximately 1 kΩ.
HORIZ Output		Provides 0.5 V/div (open circuit) either side of center. Full range -2.5 V to +2.5 V. Source impedance is approximately 1 kQ.
PEN LIFT		TTL compatible, nominal +5 V to lift plotter pen.
10 MHz IF output		Output level is approximately -5 dBm for a full-screen signal at -30 dBm reference level. Nominal impedance is approximately 50 Ω.

Table 2-4: Output Signal Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information
IEEE STD 488 PORT		In accordance with IEEE 488-78 standard and Tektronix Codes and Formats standard (version 81.1).
P-Version		Implemented as SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, and CO.
Non-P Version (Plotter Output)		Implemented as SH1, AH0, T3, LO, SRO, RLO, PPO, DCO, DTO, and CO.
PROBE POWER (rear panel)		Provides operating voltages for active probes.
Outputs		
Pin 1		+5 V at 100 mA maximum.
Pin 2		Ground.
Pin 3		−15 V at 100 mA maximum.
Pin 4		+15 V at 100 mA maximum.
ACCESSORIES (J104)		All inputs and outputs are listed in Table 2-3, Input Signal Characteristics.

Table 2-5: General Characteristics

Characteristic	Performance Requirement	Supplemental Information
Sweep		Triggered, auto, manual, single sweep, and external.
Sweep Time	20 µs/div to 5 s/div in 1 -2-5 sequence (10 s/div available in AUTO)	
Accuracy	±5% over center 8 divisions	
Triggering		INTERNAL, EXTERNAL, FREE RUN, and LINE.
Internal Trigger Level	2 divisions or more of signal	
EXTERNAL Trigger Input Level	1.0 V_{p-p} minimum	**EXTERNAL** is AC-coupled (15 Hz to 500 kHz). Maximum external trigger input is 50 V (DC + Peak AC).
CRT Readout		Displays all parameters listed on the CRT bezel, plus operating messages.

Table 2-5: General Characteristics (Cont.)

Characteristic	Performance Requirement	Supplemental Information
Battery-Powered Memory		Instrument settings, macros, displays, and calibration offsets are stored in battery-powered non-volatile RAM.
Battery LIfe		
At +55° C Ambient Temperature		1 -2 years.
At +25° C Ambient Temperature		
Lithium (Standard)		At least 5 years.
Silver (Option 39)		2-5 years.
Temperature Range for Retaining Data		
Operating		-15° C to +55° C.
Non-Operating		-30° C to +85° C.

Table 2-6: Power Requirements

Characteristic	Performance Requirement	Supplemental Information
Line Frequency Range	47 to 440 Hz	
Line Voltage Range	90 VAC to 132 VAC	115 V nominal.
	180 VAC to 250 VAC	230 V nominal.
Line Fuse		
115 V Nominal	4A Fast-Blow	
230 V Nominal	2A Slow-Blow	
Input Power	210 W maximum (3.2 A)	At 115 V and 60 Hz.
Leakage Current		
47-63 Hz		3.5 mA maximum.
Else		5 mA maximum.

Table 2-7: Environmental Characteristics

Characteristic	Description	
Meets MIL-T-28800C, type III class 3, style C specifications as follows:		
Temperature		
Operating	−15°C to +55°C.	
Non-Operating[a]	−62°C to +85°C.	
Humidity		
Operating	95% (+5%, -0%) relative humidity.	
Non-Operating	Five cycles (120 hours) in accordance with MIL-Std-810D, Procedure 3 (modified).	
Altitude		
Operating	15,000 feet, tested to 25,000 feet.	
Non-Operating	40,000 feet, tested to 50,000 feet.	
Vibration, Operating (instrument secured to a vibration platform during test)	MIL-Std-810D, Method 514 Procedure I (modified). Resonant searches in all three axes from 5 Hz to 15 Hz at 0.060" displacement for 7 minutes, 15Hz to 25 Hz at 0.040" displacement for 3 minutes, and 25 Hz to 55 Hz at 0.020" displacement for 5 minutes (tested to 0.025"). Dwell for an additional 10 minutes in each axis at the frequency of the major resonance or at 55 Hz if none was found. Resonance is defined as twice the input displacement. Total vibration time is 75 minutes.	
Shock (Operating and Non-Operating)	Three guillotine-type shocks of 30 g, one-half sine, 11 ms duration each direction along each major axis; total of 18 shocks. Tested to 50 g.	
Transit Drop (free fall)	8 inch, one per each of six faces and eight corners (instrument is tested and meets drop height of 12 inches).	
Electromagnetic Interference (EMI)	Meets requirements described in MIL-Std-461B Part 4, except as noted.	
	Test Method	Remarks
Conducted Emissions	CE01−60 Hz to 15 kHz	1 kHz to 15 kHz only
	CE03−15 kHz to 50 MHz power leads	15 kHz to 50 kHz, relaxed by 15 dB

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[a] After storage at temperatures below -15° C, the instrument may not reset when power is first turned on. If this happens, allow the instrument to warm up for at least 15 minutes, then turn POWER OFF for 5 seconds and back ON.

Table 2-7: Environmental Characteristics (Cont.)

Characteristic	Description	
	Test Method	Remarks
Conducted Susceptibility	CS01 -30 Hz to 50 kHz power leads	Full limits
	CS02-50 kHz to 400 MHz power leads	Full limits
	CS06-spike power leads	Full limits
Radiated Emissions	RE01 -30 Hz to 50 kHz magnetic field	Relaxed by 10 dB for fundamental to 10th harmonic of power line Exceptioned, 30 kHz to 36 kHz
	RE02 – 14 kHz to 10 GHz	Full limit
Radiated Susceptibility	RS01 -30 Hz to 50 kHz	Full limit
	RS02-Magnetic Induction	To 5 A only, 60 Hz
	RS03 – 14 kHz to 10 GHz	Up to 1 GHz

Table 2-8: Physical Requirements

Characteristic	Description
Weight	42 lbs 13 oz (19.3 kg) maximum. Including cover and standard accessories, except manuals. See the Options Characteristics for alternate specifications.
Dimensions	
Without Front Cover, Handle, or Feet	**6.9 x 12.87 x 19.65 inches (175 x 327 x 499 mm).**
With Front Cover, Feet, and Handle	
Handle Folded Back Over the Instrument	**9.15 x 15.05 x 23.1 inches (232 x 382 x 587 mm).**
Handle Fully Extended	**9.15 x 15.05 x 28.85 inches (232 x 382 x 732.8 mm).**

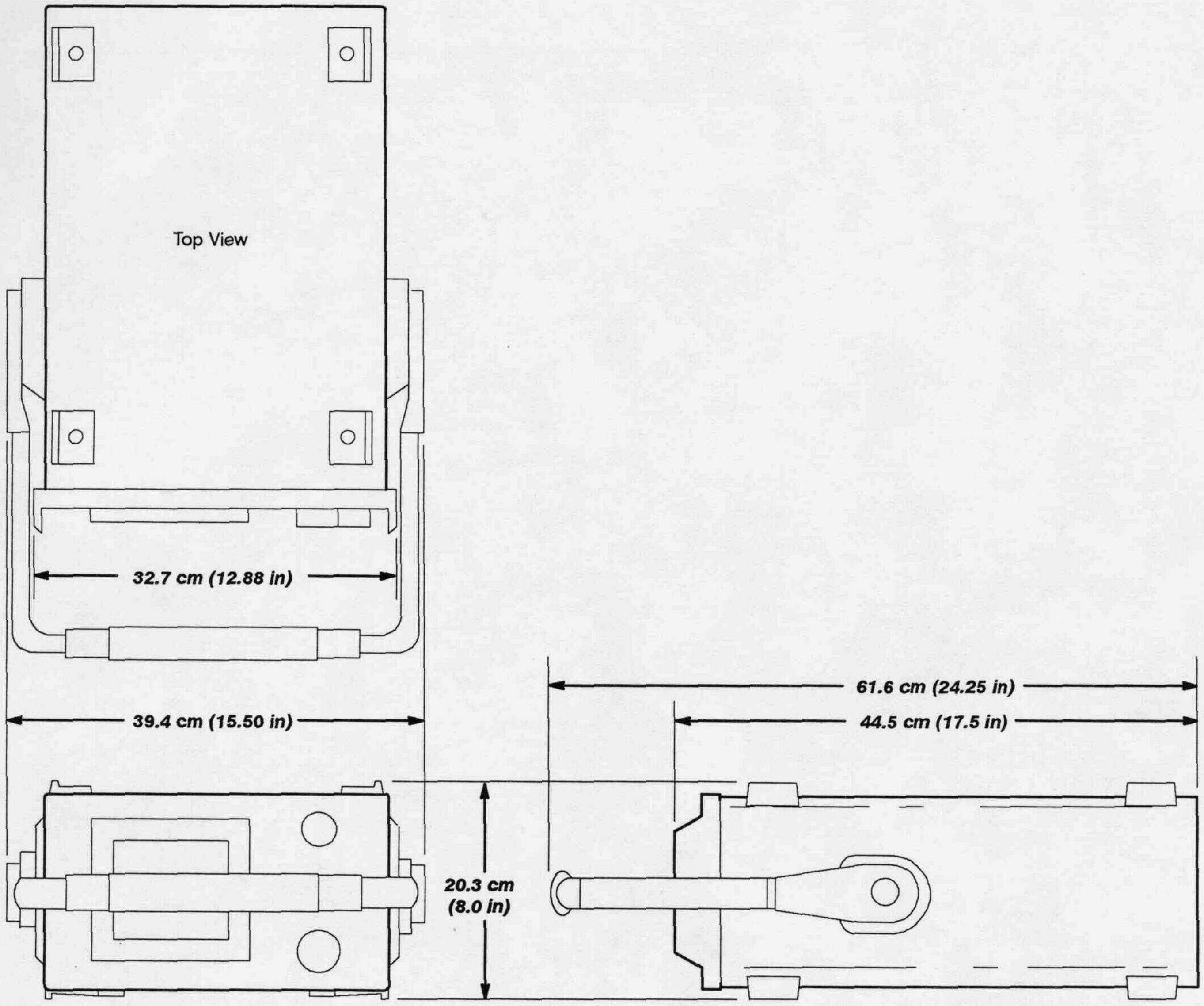


Figure 2-1: Dimensions

Preparation for Use

This section describes spectrum analyzer unpacking, installation, power requirements, storage information, and repackaging.

Unpacking and Initial Inspection

Before unpacking the spectrum analyzer, inspect the shipping container for signs of external damage. If the container is damaged, notify the carrier as well as Tektronix, Inc. The shipping container contains the basic instrument and its standard accessories. For a list of the standard accessories, refer to *Section 1, General Information.* For ordering information, refer to the list following the *Replaceable Mechanical Parts* list in the *495/P* ***Service Manual, Volume 2.***

If the contents of the shipping container are incomplete, if there is mechanical damage or defect, or if the instrument does not meet operational check requirements, contact your local Tektronix Field Office or representative.

Keep the shipping container if the instrument is to be stored or shipped to Tektronix for service or repair. Refer to *Storage and Repackaging for Shipment* later in this section.

Functional Check

The instrument was inspected both mechanically and electrically before shipment, and it should be free of mechanical damage and meet or exceed all electrical specifications. *Section 5, Instrument Check Out* contains procedures to check functional or operational performance. Perform the functional check procedure to verify that the instrument is operating properly. This check is intended to satisfy the requirements for most receiving or incoming inspections. A detailed electrical performance verification procedure in the **495/P *Service Manual, Volume 1*** provides a check of all specified performance requirements, as listed in the *Specification* section.

Air Flow Considerations

The instrument can be operated in any position that allows air flow into the bottom and out the rear of the instrument. Feet on the four corners allow ample clearance even if the instrument is stacked with other instruments. The air is drawn in by a fan through the bottom and expelled out the back. Avoid locating the instrument where paper, plastic, or any other material might block the air intake.

Front Cover and Accessories Pouch

The front cover provides a dust-tight seal and a convenient place to store accessories. Use the cover to protect the front panel when storing or transporting the instrument. To remove the cover, stand the instrument on the two back feet so the name on the handle is facing up and towards you. Pull slightly out and up on the sides of the cover.

Attached to the inside of the cover is the accessories pouch. To open the accessories pouch, pull up evenly on the flap.

Handle Position

You can position the handle of the spectrum analyzer at several angles to serve as a tilt stand. To stack instruments, position the handle at the top rear of the instrument. To change the handle position, press in at both pivot points and rotate the handle to the desired position.

WARNING

Removing or replacing the cabinet on the instrument can be hazardous. Only qualified service personnel should attempt to remove the instrument cabinet.

Rack Adapter Kit

A field-installation kit is available to permit the spectrum analyzer to be rack mounted in a standard 19-inch-wide rack on a non-tilting slide-out track. We recommend fan-forced ventilation of the rack enclosure. If the rack-adapter assembly is installed in an enclosed rack, a minimum depth of 25 inches behind the front panel is recommended for proper air circulation. The rack adapter kit comes complete with the slide-out tracks and all necessary mounting hardware. Contact your local Tektronix Field Office or representative for additional information and ordering instructions.

Power Requirements

WARNING

Changing the power input can be dangerous.

Work safely

Know the intended power source

Set the instrument for the power source

Check the fuse for proper ratings

Use the power cord and plug intended for the power source

The 495/P operates from a single-phase power source that has one of its current-carrying conductors (neutral) at ground (earth) potential. Do not operate the 495/P from power sources where both current-carrying conductors are isolated or above ground potential (such as phase-to-phase on a multi-phase system or across the legs of a 110–220 V single-phase, three-wire system). In this method of operation, only the line conductor has over-current (fuse) protection within the unit. Refer to the *Safety Summary* at the front of this manual.

The AC power connector is a three-wire, polarized plug with the ground (earth) lead connected directly to the instrument frame to provide electrical shock protection. If the unit is connected to any other power source, connect the unit frame to an earth ground.

WARNING

Do not attempt to change the power input requirements. Unfamiliarity with safety procedures can result in personal injury. Refer all power input changes to qualified service personnel. Refer to the Safety Summary at the front of this manual.

Operate the spectrum analyzer from either 115 VAC or 230 VAC nominal line voltage with a range of 90 to 132 or 180 to 250 VAC, at 48 to 440 Hz. Power and voltage requirements are printed on a back-panel plate mounted below the power input jack. Refer power input changes to qualified service personnel. The *495/495P Service Volume 1* contains instructions to change the input voltage range.

The international power cord and plug configurations are shown in Section *7, Options.*

Short Term (less than 90 days)

For short term storage, store the instrument in an environment that meets the non-operating environmental specifications in Section 2 of this manual.

Long Term

For instrument storage of more than 90 days, retain the shipping container to repackage the instrument. The battery in the instrument does not require removal. Package the instrument in a vapor barrier bag with a drying agent and store in a location that meets the non-operating environmental specifications in Section 2 of this manual.

If you have any questions, contact your local Tektronix Field Office or representative.

Repackaging for Shipment

When the spectrum analyzer is to be shipped to a Tektronix Service Center for service or repair, please attach a tag that provides the following information:

- Owner's name and address
- The name of the individual at your firm who can be contacted
- Complete instrument serial number
- Description of the service required.

If the original package is unfit for use or not available, use the following repackaging information:

1. To allow for cushioning, use a corrugated cardboard container with a test strength of 375 pounds (140 kilograms) and inside dimensions that are at least six inches more than the equipment dimensions (refer to *Physical Characteristics* in Section 2).
2. Install the instrument front cover, and surround the instrument with plastic sheeting to protect the finish.
3. Cushion the 495/P on all sides with packing material or plastic foam.
4. Seal the container with shipping tape or a heavy-duty, industrial stapler.

Transit Case

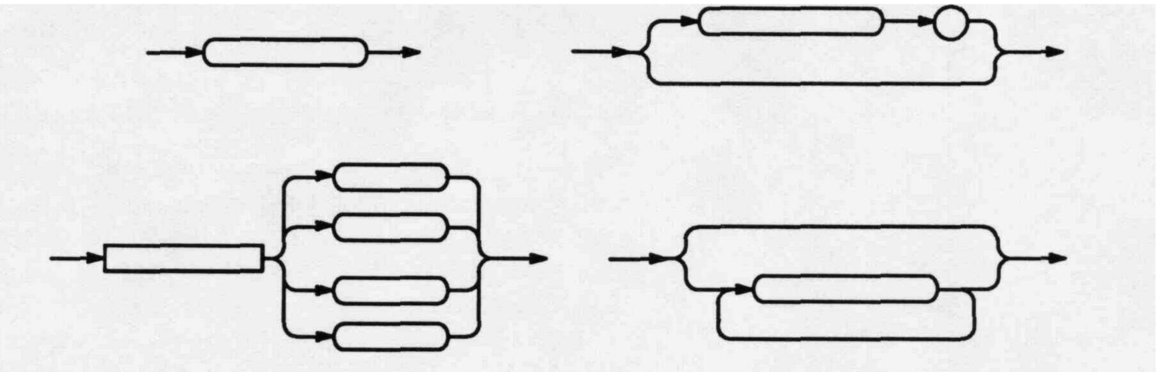
A high-impact, ruggedized transit case is recommended if you require your spectrum analyzer to be frequently shipped between sites. A hard transit case that meets these requirements and has space to hold the instrument's standard accessories is provided as an optional accessory for the spectrum analyzer. Contact your local Tektronix representative for additional information and ordering assistance.

1 Controls, Connectors and Indicators

This section includes the descriptions of the instrument's main operating modes. It also covers the functions of the controls, selectors, indicators, and connectors for the 495/P, which are all shown and identified in Figures 4-1 through 4-3 and 4-11 through 4-16. Some of the functions are described in greater detail in *Section 5, Instrument Check Out.*

Included with many of the descriptions are syntax diagrams that graphically display the function. The ovals and circles indicate a literal element that must be sent (i.e., push button pressed) exactly as shown. Boxes contain a name for an element (for example, DATA ENTRY represents numbered push buttons [0] through [9], units terminators, [.], and [BACKSPACE]). The arrows that connect the elements of the syntax diagrams show the possible paths through the diagram. Parallel paths mean that one, and only one, of the paths must be followed. A path around an element or group of elements indicates an optional skip. Arrows indicate the direction that must be followed (usually the flow is to the right; but, if an element may be repeated, an arrow returns from the right to the left of the element).

The following examples illustrate basic syntax diagram structure.



When DATA ENTRY boxes are part of a command's syntax diagram, there are numbers shown with the boxes. These numbers represent the valid range available for that particular command.

Operating Modes

Initial Entry Functions (Black-Labels)

Most of the 495P operating modes are selected by a single push button press or control turn; i.e., **[FREE RUN], TIME/DIV, [PULSE STRETCHER], [MAX HOLD], PEAK/AVERAGE.** Generally, these selections are the same with all Tektronix 49x-Series Spectrum Analyzers.

Multiple Push Button Sequence Functions ([SHIFT] push buttons)

[Blue–SHIFT] Functions — There are many general operating modes and two marker operating modes selected with multiple push button presses. Press the [Blue-SHIFT] push button before selecting a blue-labeled function; i.e., **[PLOT]**, [STORE **DISP]**, [CAL]. For many of these functions, menu prompts appear on the screen to guide you.

[Green–SHIFT] Functions — Most of the operating modes selected with **[Green–SHIFT]** multiple-push button presses are marker related. Press the **[Green–SHIFT]** push button before selecting a green-labeled function such as [ASSIGN 1], [PEAK **FIND]**. For many of these functions, menu prompts appear on the CRT readout to guide you.

There are also additional marker functions that can be assigned to either push button [ASSIGN **1]** or [ASSIGN 2] and then selected in the same manner as the labeled functions. The MARKER MENU also has additional marker functions that can be selected directly from the menu.

Terminating Multiple Push Button Sequences

A [SHIFT] multiple-push button sequence can be terminated at any time. Push either the **[Blue-SHIFT] or [Green-SHIFT]** push button once to stop the sequence and return the 495/P to the previous activity.

DATA ENTRY Functions (Orange Labels)

Some operations require the entry of numerical data; for example, to set frequency or enter a number to select a choice from a menu. This will be as part of a multiple-push button sequence. The screen will prompt you when a number is required. Numbers are entered with the orange-labeled DATA ENTRY push buttons. Numerical data is entered first, with a units terminator entered last; for example, [1] [0] [MHz] for 10 MHz or [2] [0] [-dBx] for -20 dBm.

Correcting Numerical Entry Errors

Use the [BACKSPACE] push button to correct errors in numerical data that have been entered with the orange-labeled DATA ENTRY push buttons. Each push button press backs the cursor up one space, erasing the number in that location. You can then enter the correct numerical data and end the sequence with a units push button.

Instrument Power Control and Frequency

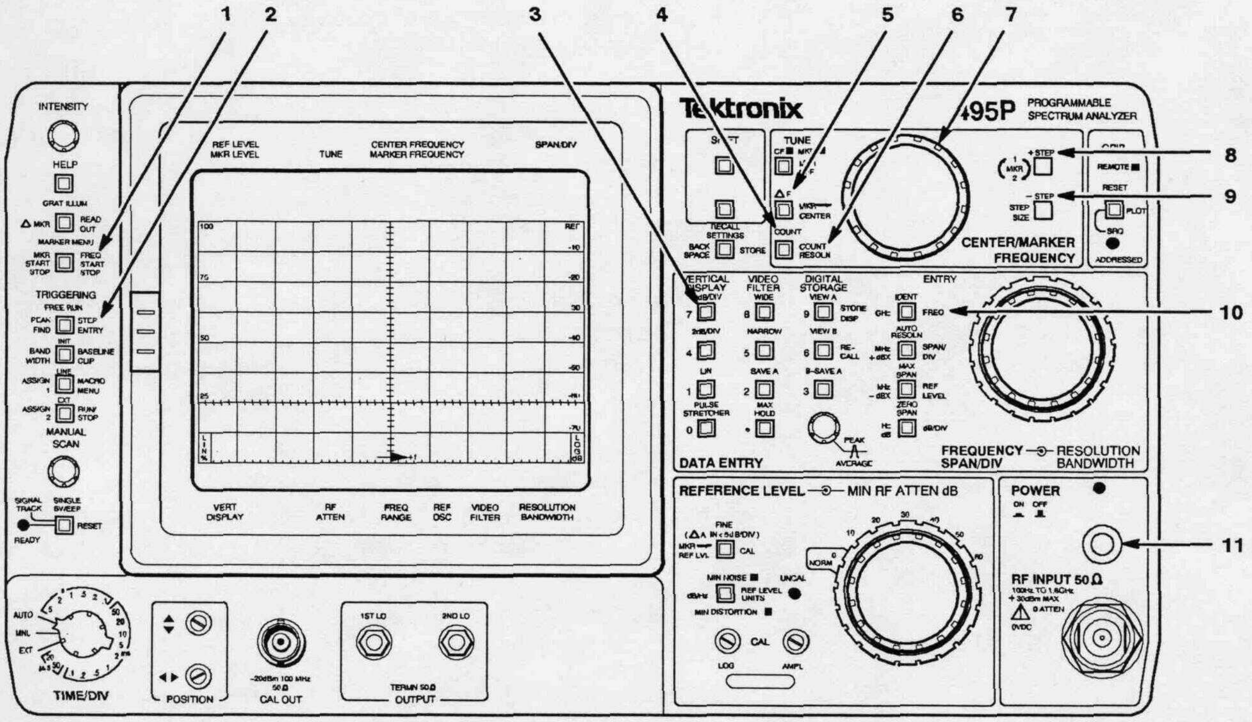


Figure 4-1: Instrument Power Control and Frequency Controls

4 COUNT — When this push button is pressed, the signal at the dot position is counted with up to 1 Hz resolution at any FREQUENCY SPAN/DIV setting. The resolution is selected with [Blue–SHIFT] [COUNT RESOLN]. The signal must be 20 dB or more above the noise level and above a level that is 60 dB down from the REFERENCE LEVEL setting.

5 AF — This push button allows measurement of the frequency differences. When pressed (lit), the frequency readout goes to zero. The readout now shows only the offset, or deviation, from this reference as the CENTER FREQUENCY is changed. The resolution of the readout will be the less accurate of either the current CENTER FREQUENCY resolution or the CENTER FREQUENCY resolution when [AF] was activated. Do not confuse this push button with [Green–SHIFT] [A MKR], which is described later in this section under *Marker Functions.*

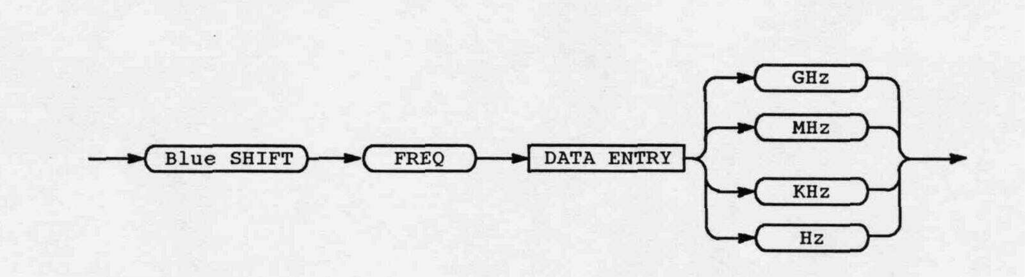
6 [Blue-SHIFT] COUNT RESOLN — This push button sequence allows you to select the desired counter resolution with the DATA ENTRY push buttons. Terminate with one of the unit ([GHz], [MHz], [kHz], or [Hz]) push buttons. The counter resolution will be truncated to the decade that is less than or equal to the selected resolution.

7 CENTER/MARKER FREQUENCY — This control tunes the center frequency or marker, if selected. Tuning of center frequency is done in 0.1 division increments, regardless of the selected FREQUENCY SPAN/DIV setting. For marker frequency, tuning is either 0.01, 0.033, or 0.1 division increments, depending on how fast the control is turned. In MAX SPAN mode, the center frequency is fixed, and only the frequency dot is tuned. The tuning range in narrow spans is identical to wide spans.

8 +STEP — When the instrument is in the Tune Center Frequency mode ([TUNE CF/MKR] push button unlit), this push button increases the CENTER FREQUENCY by steps. The step size is determined by [Blue-SHIFT] [STEP ENTRY] or [Green-SHIFT] [STEP SIZE]. See [+STEP] later in this section under *Marker Functions* for alternate operation.

9 -STEP — When the instrument is in the Tune Center Frequency mode ([TUNE CF/MKR] push button unlit), this push button increases the CENTER FREQUENCY by steps. The step size is determined by [Blue-SHIFT] [STEP ENTRY] or [Green-SHIFT] [STEP SIZE]. See [–STEP] later in this section under *Marker Functions* for alternate operation.

10 **[Blue–SHIFT] FREQ** — This push button sequence allows direct entry of center or marker frequency to 1 Hz resolution (it will be displayed to 100 Hz) using the DATA ENTRY push buttons. If the center frequency entered is not in the current frequency range, the nearest frequency range that contains the frequency will be automatically selected. The center frequency range that can be selected is 0 Hz to 1800 MHz. Values that are entered outside this range will be ignored. Frequency digits that are entered from the DATA ENTRY push buttons are terminated with one of the four unit push buttons (**[GHz]**, **[MHz]**, **[kHz]**, or **[Hz]**).



11 **POWER** — This push-push switch turns the main power supply ON (green light on) and OFF (in=ON, out=OFF). When power is switched off, the current instrument front-panel set-up is stored in memory register 0 (see *Using the Store and Recall Features* in Section 5) so this set-up can be easily recalled. Full RF Attenuation is switched in when power is switched off to protect the 1st mixer from overload and damage.

Frequency Span and Resolution

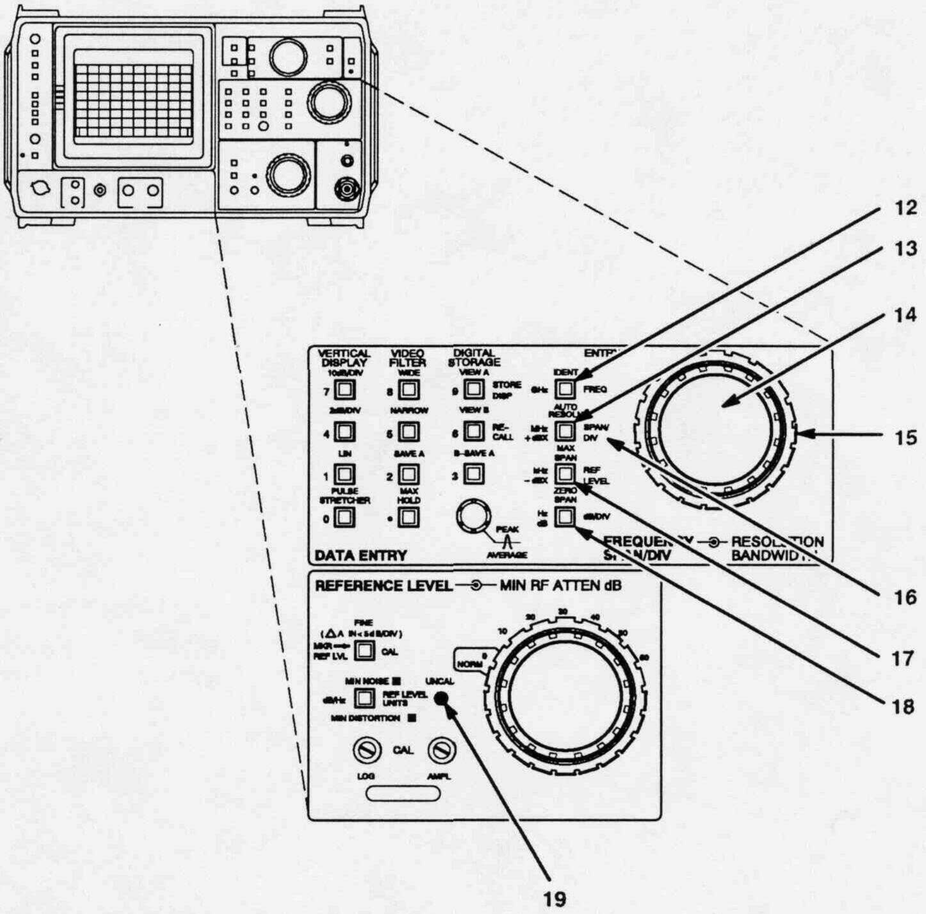


Figure 4-2: Frequency Span and Resolution Controls

12 **IDENT** — The IDENT mode allows identification of unwanted, internally-generated mixing products, as is generally the case when power at the input exceeds the reference level by >30 dB. This push button causes every other trace to be displaced vertically. The 1st and 2nd local oscillator frequencies shift so that real, or true, signals are not displaced horizontally on alternate sweeps, while spurious signals can be shifted. The **FREQUENCY SPAN/DIV** must be **50 kHz** or less.

13 **AUTO RESOLN** — When this function is on, RESOLUTION BANDWIDTH is automatically selected to maintain a calibrated display for, if possible, the selected FREQUENCY SPAN/DIV, TIME/DIV, VIDEO FILTER, and VERTICAL DISPLAY modes. When the **TIME/DIV** control is in the **AUTO** position, RESOLUTION BANDWIDTH is selected as a function of FREQUENCY SPAN/DIV only, and TIME/DIV is selected to maintain a calibrated display at the highest sweep rate. The **RESOLUTION BANDWIDTH** control will not operate when AUTO RESOLN mode is on (the message TO CHANGE RESOLUTION AUTO RESOLN MUST BE OFF will appear on the screen).

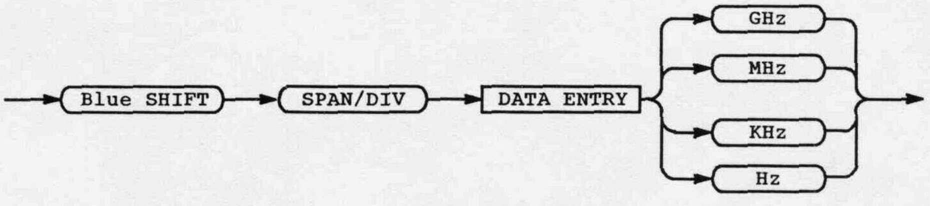
14 **FREQUENCY SPAN/DIV** — This control selects the frequency span swept by the instrument. The range of this control is 10 Hz/Div to 100 MHz/Div. The FREQUENCY SPAN/DIV setting is indicated by the CRT readout. Selection is in a 1 -2-5 sequence plus MAX SPAN mode and ZERO SPAN mode, or time domain. FREQUENCY SPAN/DIV can also be entered with the **[Blue–SHIFT] [SPAN/DIV]** push button sequence and the DATA ENTRY push buttons. The 495/P will try to maintain a calibrated display if the **TIME/DIV** control is in the **AUTO** position or the **[AUTO RESOLN]** push button is active (lit).

When the FREQUENCY SPAN/DIV is in the MAX SPAN mode, the full band is displayed. A dot near the top of the screen indicates the CENTER FREQUENCY readout position on the span. This dot and the center frequency position will be center screen when the FREQUENCY SPAN/DIV is reduced from the MAX SPAN position. When the markers are on, they show the frequency position, and the dot goes to center-screen.

When the FREQUENCY SPAN/DIV is set to ZERO SPAN mode, the 495/P operates like a tunable receiver. The 495/P displays signals within the resolution bandwidth in the time domain, with the CRT reading out TIME/DIV instead of FREQUENCY SPAN/DIV.

15 **RESOLUTION BANDWIDTH** — This control selects the bandwidth of the 495/P. Selected bandwidth is indicated on the CRT readout. The bandwidth selections are 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, and 3 MHz. TIME/DIV is automatically selected to match the selected bandwidth when the **TIME/DIV** control is in the **AUTO** position.

16 **[Blue-SHIFT] SPAN/DIV** — This push button sequence allows direct entry of FREQUENCY SPAN/DIV with two significant digits of resolution. The FREQUENCY SPAN/DIV range that can be selected is 10 Hz/Div to 170 MHz/Div. If a value outside the allowable range is entered, the FREQUENCY SPAN/DIV will switch to 10 Hz if the selected value is less than 10 Hz, or to MAX SPAN mode if the selected value is greater than 170 MHz. Spans entered from the DATA ENTRY push buttons are terminated with one of the four unit push buttons (**[GHz]**, **[MHz]**, **[kHz]**, or **[Hz]**).



17 **MAX SPAN** — When activated, the 495/P sweeps the entire frequency range. The position of the 495/P's CENTER FREQUENCY is shown with a dot near the top of the screen. When this function is turned off, the span returns to the previous FREQUENCY SPAN/DIV setting. When the markers are on, they show the frequency position, and the dot goes to center.

18 **ZERO SPAN** — This push button switches the span to zero for time domain display. When ZERO SPAN mode is turned off, the FREQUENCY SPAN/DIV returns to its previous value.

19 **UNCAL** — This indicator lights when the display amplitude or frequency is no longer calibrated; e.g., the sweep rate is not compatible with the FREQUENCY SPAN/DIV and RESOLUTION BANDWIDTH. Select a slower sweep rate or larger RESOLUTION BANDWIDTH to return to calibrated operation.

Marker Functions

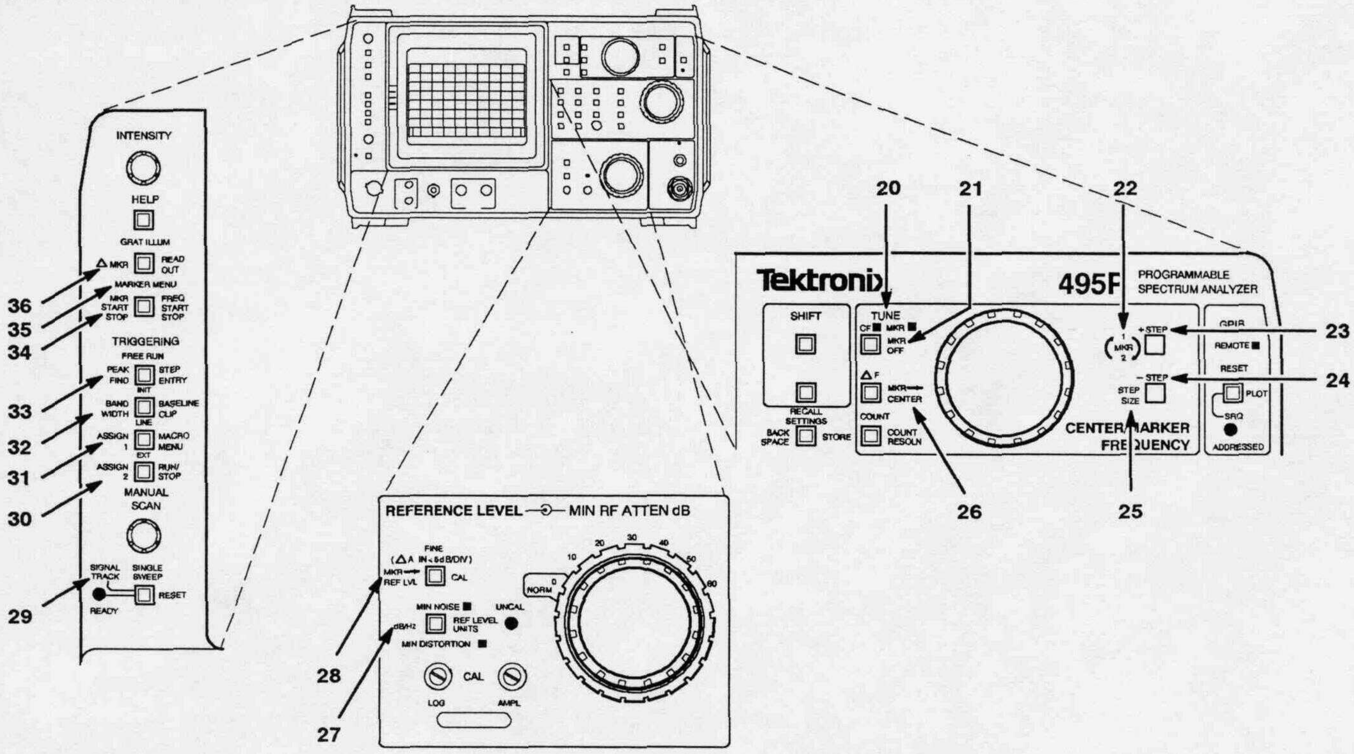


Figure 4-3: Marker Functions

20 **TUNE CF/MKR** — When this push button is lit, a single marker appears on the trace of highest priority. The marker can be moved with the **CENTER/MARKER FREQUENCY** control. When the push button is pressed again, the marker remains and does not change its horizontal position. The **CENTER/MARKER FREQUENCY** control now adjusts the center frequency.

21 **[Blue−SHIFT] MKR OFF** — This push button sequence turns the marker(s) off.

22 **[Green−SHIFT] 1←MKR→2** — This push button sequence alternately selects which marker will be tuned when **[Green-SHIFT]** [A **MKR]** is on.

23 **+STEP** — When the instrument is in the tune marker mode (the **[TUNE CF/MKR]** push button is lit), this push button increases the marker frequency by steps (this function is limited to the edge of the screen when not on an active trace). The step size is determined by **[Green-SHIFT] [STEP SIZE]** or **[Blue-SHIFT] [STEP ENTRY]. See [+STEP]** earlier in this section under Frequency for alternate operation.

24 **-STEP** — When the instrument is in the tune marker mode (the **[TUNE CF/MKR]** push button is lit), this push button decreases the marker frequency by steps (this function is limited to the edge of the screen when not on an active trace). The step size is determined by **[Green-SHIFT] [STEP SIZE]** or **[Blue–SHIFT] [STEP ENTRY]**. See **[–STEP]** earlier in this section under *Frequency tor* alternate operation.

25 **[Green-SHIFT] STEP SIZE** — This push button sequence defines the frequency step of the CENTER FREQUENCY, MARKER FREQUENCY, or the DELTA MARKER FREQUENCY, whichever mode is active.

26 **[Blue-SHIFT] MKR → CENTER** — This push button sequence centers the signal at the active marker by setting the CENTER FREQUENCY equal to the MARKER FREQUENCY (this function is not available with a stored trace).

27 **[Green-SHIFT] dB/Hz** — This push button sequence mathematically figures the average noise power in a bandwidth at the current marker position.

28 **[Green-SHIFT] MKR → REF LVL** — This push button sequence changes the reference level of the top graticule to the present marker amplitude (this function is not available with a stored trace).

29 **[Green-SHIFT] SIGNAL TRACK** — This push button sequence automatically maintains tuning of a drifting signal within limits. While this mode is active, SIGNAL TRACK will be displayed on the screen. SIGNAL TRACK IDLE will be displayed when there is no signal above the threshold. Excessive drift will disable this function. Select SET SIGNAL THRESHOLD from the MARKER Menu to set the threshold.

30 **[Green-SHIFT] ASSIGN 2** — This push button sequence turns on the assigned function.

31 **[Green-SHIFT] ASSIGN 1** — This push button sequence turns on the assigned function.

32 **[Green-SHIFT] BANDWIDTH** — This push button sequence places markers on a selected signal and displays the X dB bandwidth (select ENTER BANDWIDTH NUMBER from the marker menu to set X). The screen will display NO SIGNAL — BW IDLE when there is no signal at the marker that meets threshold and bandwidth parameters. Set the parameters by selecting SET SIGNAL THRESHOLD and ENTER BANDWIDTH NUMBER after calling up the MARKER Menu each time.

33 **[Green–SHIFT] PEAK FIND** — This push button sequence places the Primary marker at the peak of the highest on-screen signal. **[Green-SHIFT] [PEAK FIND]** locates the left-most peak (orthe center peak of a cluster), but it is not a signal processing command with the built-in intelligence. Peak B would be selected from the cluster in Figure 4-5A; peak A would be selected in Figure 4-5B because the low point (B) would stop a search from continuing to the cluster (C).

34 **[Green-SHIFT] MKR START STOP** — This push button sequence allows you to set the start and stop frequencies directly from the delta marker position (this function is not available with a stored trace). **[Green-SHIFT] [A MKR]** must be on for this function to operate.

35 **MARKER MENU** — This push button calls up a menu display on the screen that allows selection of one of the available marker commands that are not permanently assigned to a front-panel push button.

RIGHT NEXT — This moves the Primary marker to the next visible signal higher than the present marker frequency. If there is no signal to the right of the Primary marker that meets threshold and signal type parameters, one of the following messages will be displayed on the screen (depending on whether CW, PULSE, or SPURS has been selected as the signal type):

NO CW TO THE RIGHT ABOVE THRESHOLD

NO PULSE TO THE RIGHT ABOVE THRESHOLD

NO SPUR TO THE RIGHT ABOVE THRESHOLD

Select SET SIGNAL THRESHOLD and SET SIGNAL TYPE from the Marker Menu to set the parameters.

LEFT NEXT — This moves the Primary marker to the next visible signal lower than the present marker frequency. If there is no signal to the left of the Primary marker that meets threshold and signal type parameters, one of the following messages will be displayed on the screen (depending on whether CW, PULSE, or SPURS has been selected as the signal type):

NO CW TO THE LEFT ABOVE THRESHOLD

NO PULSE TO THE LEFT ABOVE THRESHOLD

NO SPUR TO THE LEFT ABOVE THRESHOLD

Select SET SIGNAL THRESHOLD and SET SIGNAL TYPE from the MARKER MENU to set the parameters.

NEXT LOWER PEAK — This moves the Primary marker to the signal with the next lower amplitude, either left or right of the present marker position. If there is no signal lower than the Primary marker that meets threshold and signal type parameters, one of the following messages will be displayed on the screen (depending on whether CW, PULSE, or SPURS has been selected as the signal type):

NO LOWER CW SIGNAL ABOVE THRESHOLD

NO LOWER PULSE SIGNAL ABOVE THRESHOLD

NO LOWER SPUR ABOVE THRESHOLD

Select SET SIGNAL THRESHOLD and SET SIGNAL TYPE from the MARKER MENU to set the parameters.

NEXT HIGHER PEAK — This moves the Primary marker to the signal with the next higher amplitude, either left or right of the present marker position. If there is no signal higher than the Primary marker that meets threshold and signal type parameters, one of the following messages will be displayed on the screen (depending on whether CW, PULSE, or SPURS has been selected as the signal type):

NO HIGHER CW SIGNAL ABOVE THRESHOLD

NO HIGHER PULSE SIGNAL ABOVE THRESHOLD

NO HIGHER SPUR ABOVE THRESHOLD

Select SET SIGNAL THRESHOLD and SET SIGNAL TYPE from the MARKER MENU to set the parameters.

SET SIGNAL TYPE — This alters the marker functions to recognize one of three signal types above the threshold (select SET SIGNAL THRESHOLD from the MARKER MENU to set the threshold).

CW — Identifies continuous wave signals and ignores spurious signals and impulses.

PULSE — Identifies the peak of pulsed RF lobes for either line (lines must be <2 minor divisions apart) or dense spectra.

SPURS — Identifies all signals.

Figure 4-4 is a signal enlarged to show how the 495/P locates the signal peak with one of the signal processing functions. The signal processing functions are RIGHT NEXT, LEFT NEXT, NEXT LOWER PEAK, NEXT HIGHER PEAK. The 495/P measures both the individual left-most and right-most peaks of a signal. From this reading, the 495/P calculates the exact center of the signal. If this location is a digital storage point, the marker is positioned here. If, as in Figure 4-4, the calculated center of the signal is not equal to the maximum digital storage point, the marker is positioned on the closest point to the center. At the end of this section are five illustrations (Figure 4-6 through Figure 4-10) showing the use of this signal finding command.

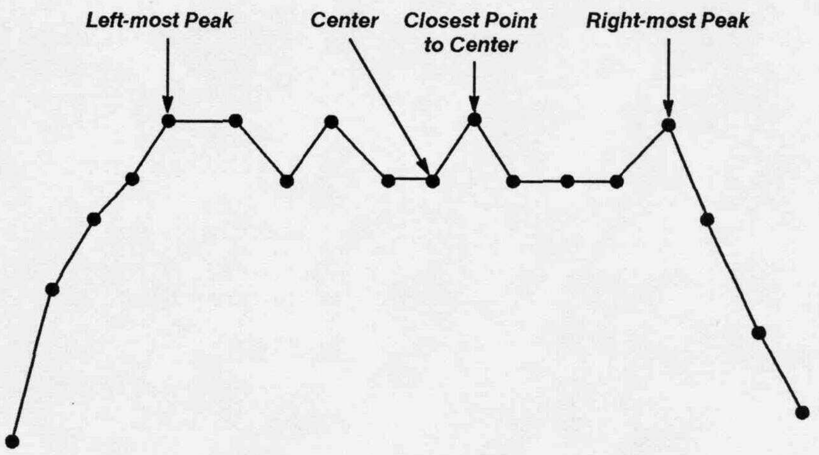


Figure 4-4: Locating the Signal Peak

SET SIGNAL THRESHOLD — This changes the minimum visible signal level for the marker functions of Right Next, Left Next, Next Lower Peak, Next Higher Peak, Peak Find, Bandwidth Mode, and Signal Track. Select AUTO to automatically set the threshold above the noise floor.

ASSIGN FUNCTION TO KEY — This displays a menu (ASSIGN Menu) of additional marker functions that can be assigned to either the **[Green–SHIFT]** [ASSIGN 1] or **[Green–SHIFT]** [ASSIGN 2] push buttons. Call up HELP mode for the assigned push button to get a description of the assigned function. The function will remain assigned to the push button, even with power off, until another function is assigned. The ASSIGN Menu accesses the following functions as well as RIGHT NEXT, LEFT NEXT, NEXT LOWER PEAK, and NEXT HIGHER PEAK, which are described under MARKER MENU.

MOVE RIGHT X dB — This allows you to select the number of dB to move the Primary marker while staying on the trace (horizontal movement to the right). If there is no level to the right of the Primary marker that meets threshold, the message NO POINT TO THE RIGHT TO MOVE TO will be displayed on the screen.

MOVE LEFT X dB — This allows you to select the number of dB to move the Primary marker while staying on the trace (horizontal movement to the left). If there is no level to the left of the Primary marker that meets threshold, the message NO POINT TO THE LEFT TO MOVE TO will be displayed on the screen.

FIND PEAK AND CENTER — This places the active marker at the peak of the highest on-screen signal (refer to the **[Green–SHIFT]** [PEAK FIND] description later in this section). If a signal is present, the CENTER FREQUENCY is set equal to the marker frequency. This centers the signal of interest (this is useful when reducing FREQUENCY SPAN/DIV by several settings at once). If there is no signal above the threshold, the message NO POINT FOUND ABOVE THE THRESHOLD will be displayed on the screen and the marker will not move.

ENTER BANDWIDTH NUMBER —This sets the number of dB below the signal peak at which bandwidth will be calculated when in the marker BANDWIDTH mode. The number is stored in memory.

GREEN–SHIFT LOCK — This locks **[Green–SHIFT]** on so all green-labeled functions can be directly selected. When GREEN-SHIFT LOCK is on, the black-labeled functions associated with green-labeled functions cannot be accessed. Blue-labeled functions operate normally. Press **[Green–SHIFT]** to exit this mode.

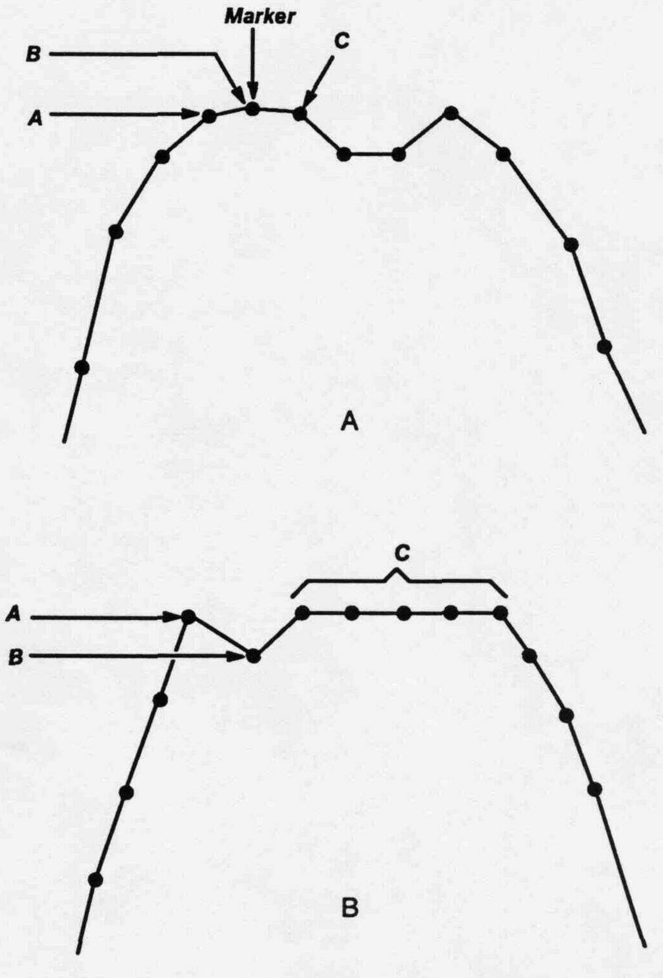


Figure 4-5: Using [Green–SHIFT] PEAK FIND

36 **[Green–SHIFT]** A **MKR** — This push button sequence is the on-off switch for the Delta Marker mode. When activated, a second marker appears at the position of the single marker on the trace. The symbols ( ) will appear on the screen on the marker frequency readout line to indicate delta frequency and delta amplitude. To use Delta Marker, press [TUNE **CF/MKR]** and set the marker to one point of interest on the trace using the CENTER/MARKER FREQUENCY control. Press [Green-SHIFT] [A MKR] to activate the Delta Marker Mode, and move one of the markers to the second point of interest. Press [Green-SHIFT] [A MKR] again to turn delta markers off.

Signal Finding

To the finding routine, a signal consists of a peak above threshold and two points (one on each side of the peak) that are 3 dB below the peak. The location of the signal is the highest amplitude point on the signal. Figures 4-6 through 4-10 illustrate the use of SET SIGNAL TYPE that can be selected from the MARKER Menu. All of the figures use the signal processing function RIGHT NEXT. Any of the other signal processing functions (LEFT NEXT, NEXT LOWER PEAK, NEXT HIGHER PEAK work in a similar manner, according to their specific function. The minimum bandwidth criteria for CW is defined as the two 3 dB down points that must be <5 kHz (1/2 a RESOLUTION BANDWIDTH) apart.

Figures 4-6, 4-7, **and 4-8** — If CW is selected, the 495/P will not identify any signal because none of the signals displayed meets the minimum bandwidth criteria. If PULSE is selected, the signals labeled D, E, and F would be identified because the other signals in the display are less than 2 minor divisions apart. If the signals were greater than 2 minor divisions apart, PULSE would identify all labeled signals (A, B, C, etc.). If SPURS is selected, all signals would be identified (A, B, C, etc.).

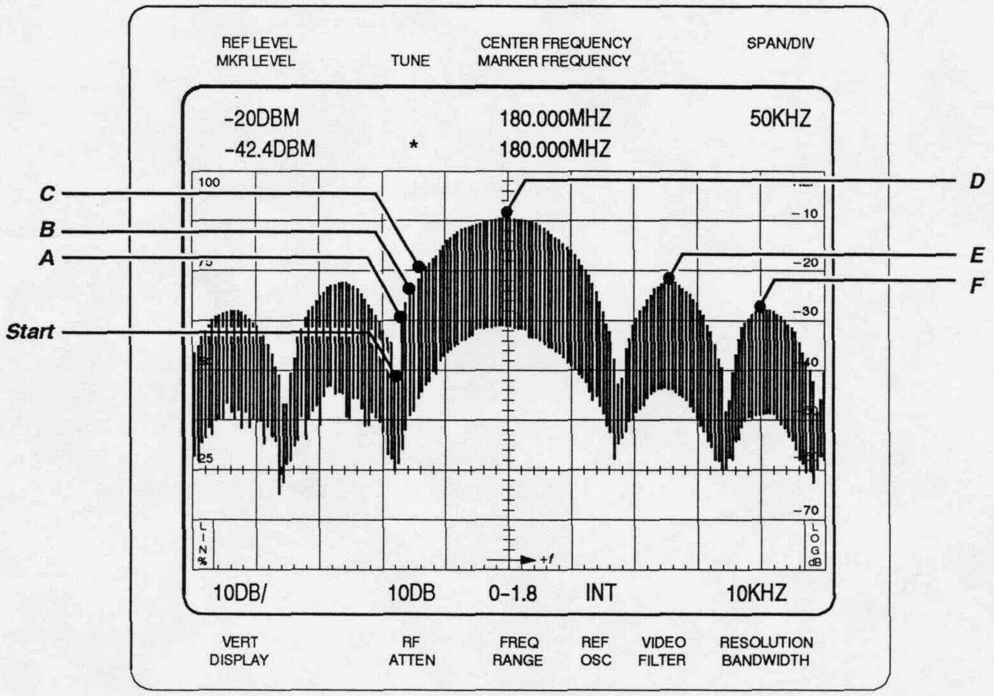


Figure 4-6: Signal Finding Example #1

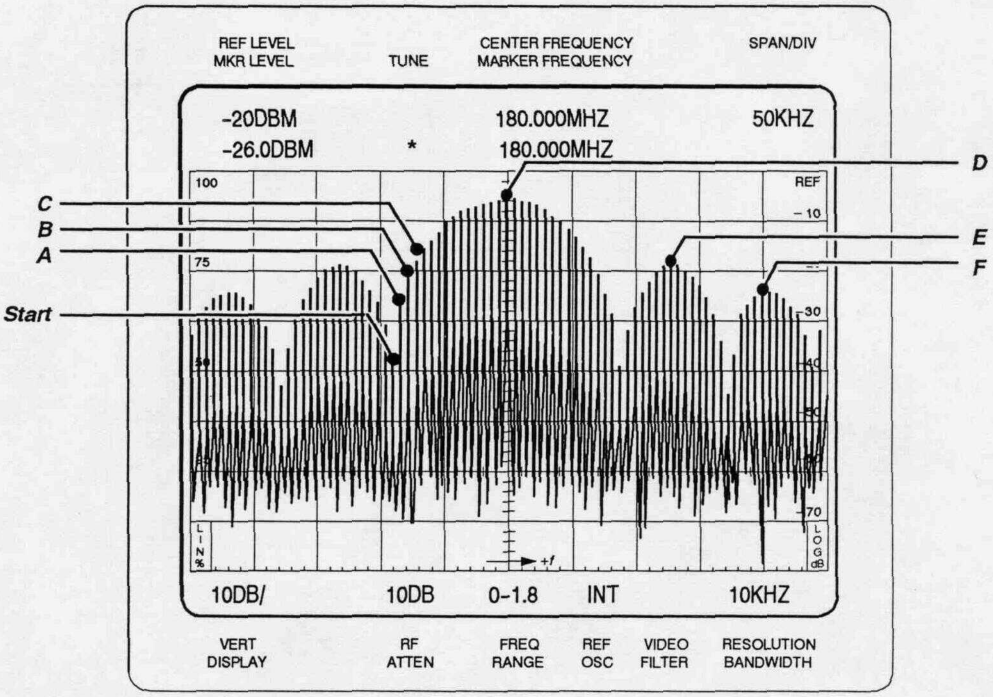


Figure 4-7: Signal Finding Example #2

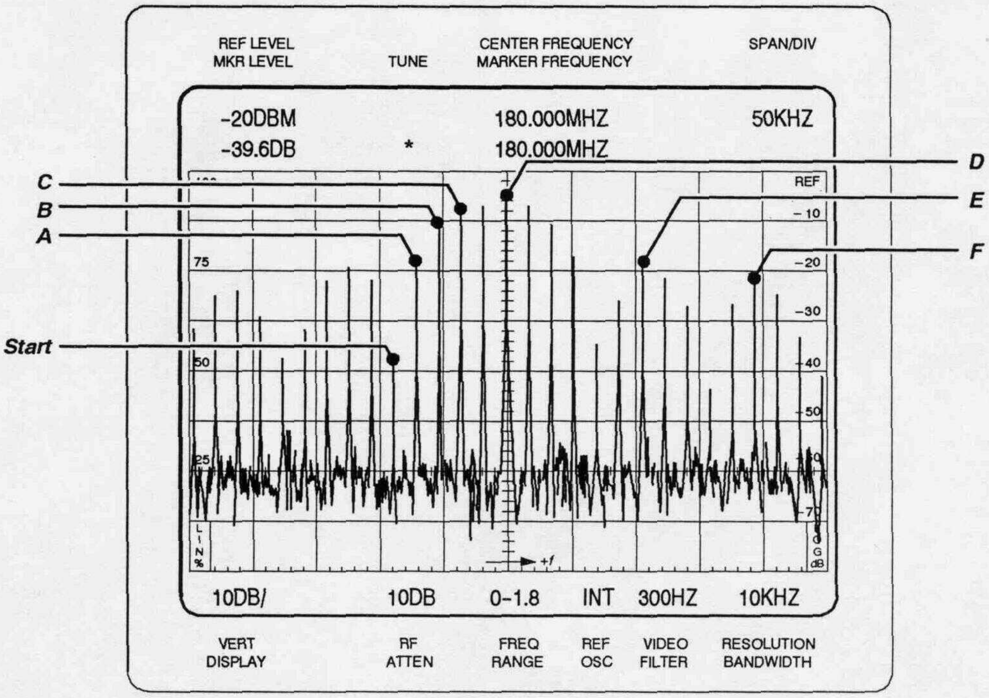


Figure 4-8: Signal Finding Example #3

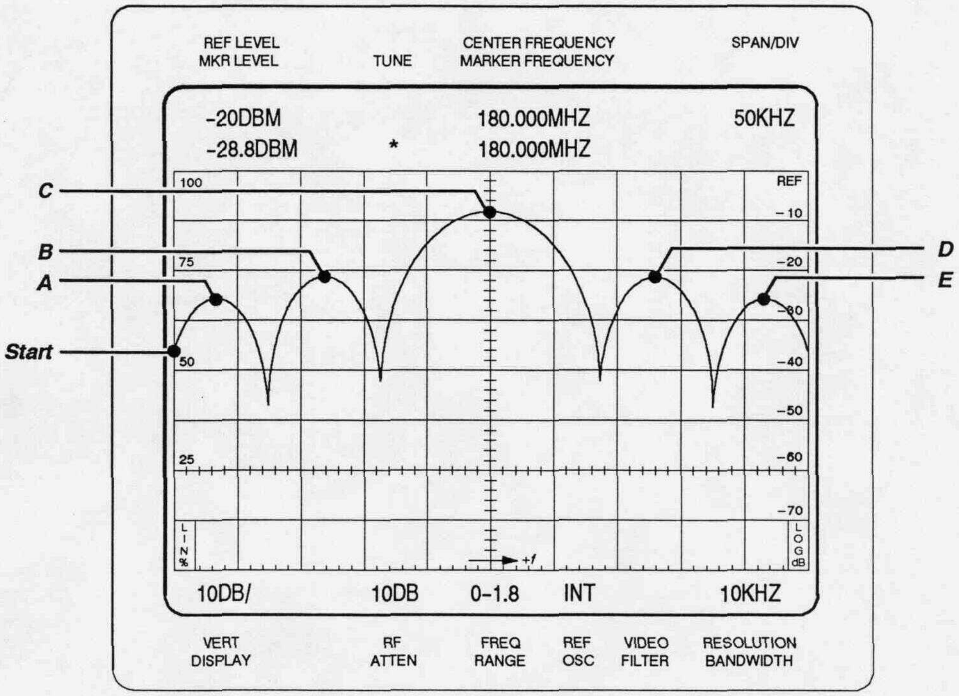


Figure 4-9: Signal Finding Example #4

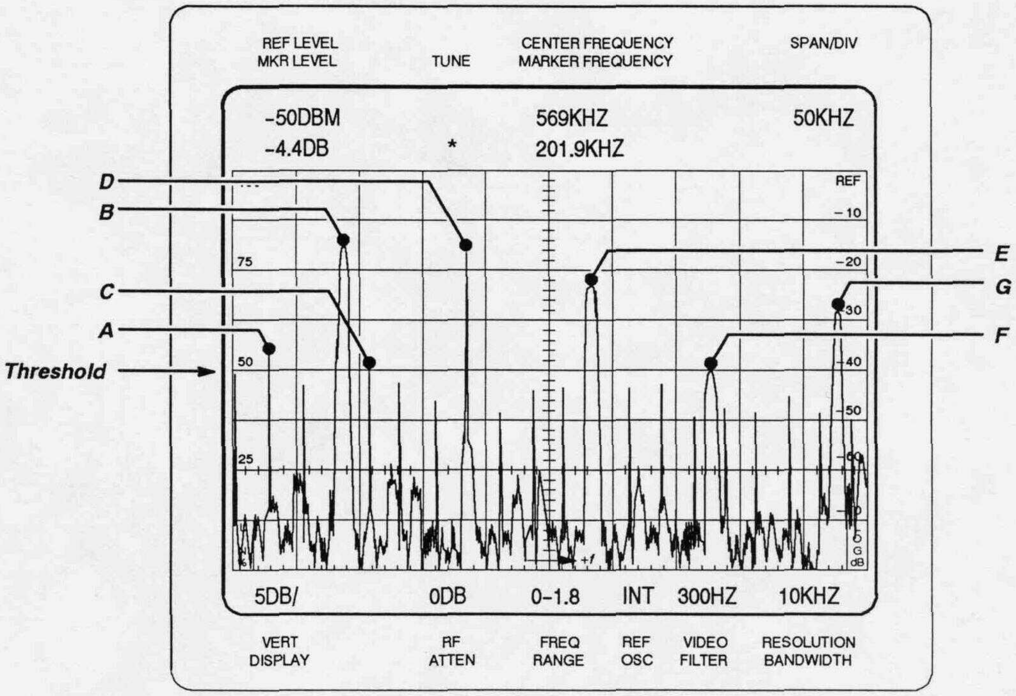


Figure 4-10: Signal Finding Example #5

Figure 4-9 — The NEXT RIGHT function begins at the left screen margin. With this display, all signals are identified by CW, PULSE, and SPURS modes because the signals meet the minimum bandwidth criteria (i.e., the selections would be A, B, C, D, and E).

Figure 4-10 — In this example, assume that the threshold is -70 dBm. If CW is selected, signals B, E, F, and G would be identified. The other signals do not meet the minimum bandwidth criteria, and would be ignored. If PULSE is selected, signals A, B, D, E, F, and G would be identified. Signal C would be skipped because it is located within 2 minor divisions of signal B. The PULSE algorithm would not be able to identify signals B and C separately. If SPURS is selected, all signals would be identified.

Display Parameters

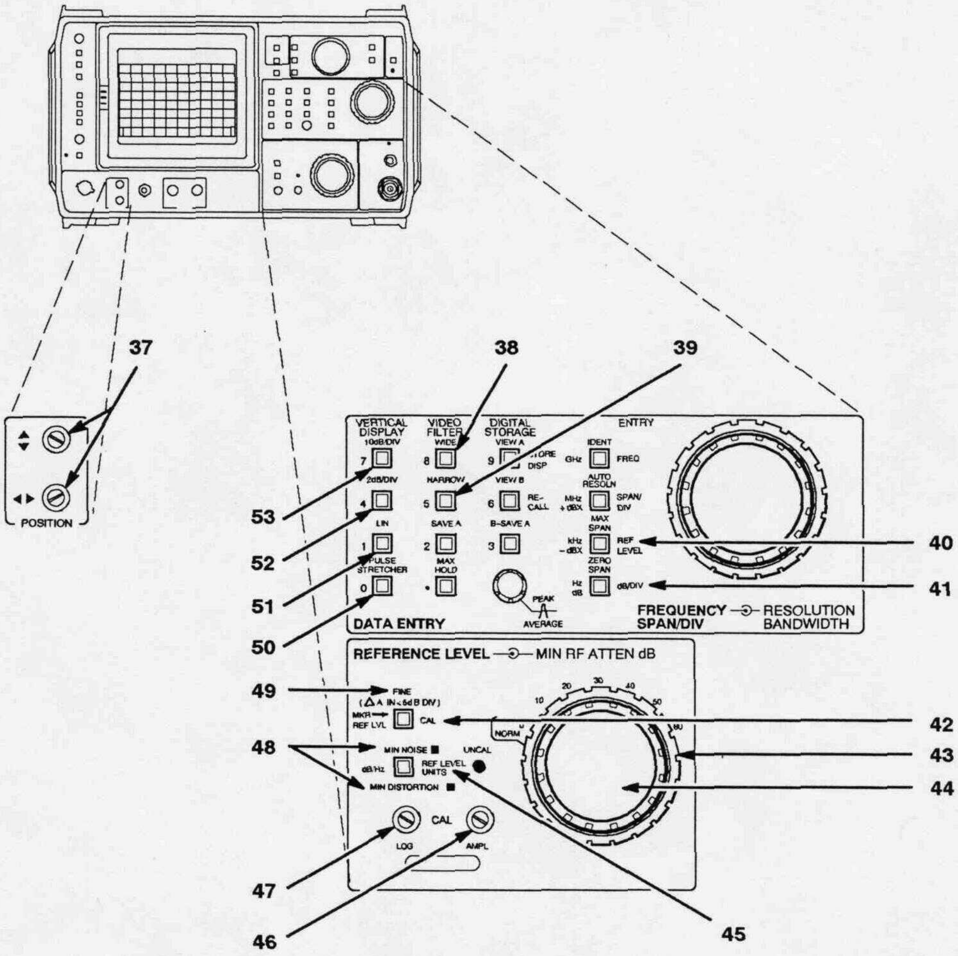


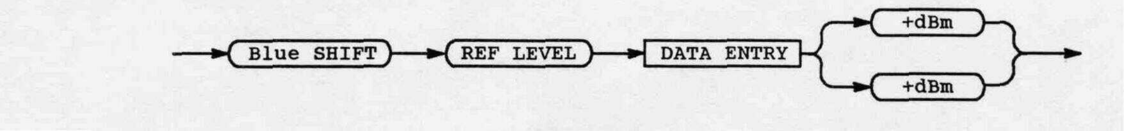
Figure 4-11: Display Parameter Controls

37 **POSITION** T ◄► — These screwdriver adjustments position the display along the horizontal and vertical axes. The **[Blue−SHIFT] [CAL]** push button sequence will guide you through the adjustment of these controls. Refer to **[Blue-SHIFT] [CAL]** for additional information.

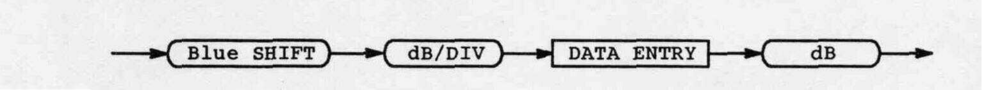
38 **VIDEO FILTER WIDE** — This push button reduces video bandwidth and high-frequency components for display noise averaging. The video bandwidth selected is approximately 1/30th of the selected RESOLUTION BANDWIDTH (1/100 for 3 MHz). Selecting **[VIDEO FILTER WIDE]** cancels **[VIDEO FILTER NARROW]**. The filter value is displayed in the lower readout.

39 **VIDEO FILTER NARROW —** This push button reduces video bandwidth and high-frequency components for display noise averaging. The video bandwidth selected is approximately 1/300th of the selected RESOLUTION BANDWIDTH (1/30 for 10 Hz). Selecting **[VIDEO FILTER NARROW]** cancels **[VIDEO FILTER WIDE].** The filter value is displayed in the lower readout.

40 **[Blue−SHIFT] REF LEVEL** — This push button sequence allows direct entry of reference level, with 1 dB resolution. The range is +30 dBm to −117 dBm (+50 dBm if the MINIMUM NOISE and REDUCED GAIN modes are selected). Values entered outside this range are ignored (values will be in the selected units; dBm, dBV, dBmV, or dBμV). The **[+dBx]** or **[−dBx]** push buttons terminate the reference level numbers entered.



41 **[Blue-SHIFT] dB/DIV** — This push button sequence allows direct entry of the desired amplitude display factor. The range is 1 to 15 dB/Div in 1 dB increments. Numbers outside the allowable range will be ignored. Terminate the dB/div number entered with the **[dB]** push button.



42 **[Blue-SHIFT] CAL** — This push button sequence starts a frequency and reference level measurement procedure that uses the 495/P CAL OUT signal. Messages on the screen guide the user through a procedure to adjust the **Vertical** and **Horizontal POSITION,** and **LOG** and **AMPL CAL** front panel adjustments. The 495/P then runs an automatic frequency, bandwidth, and relative amplitude measurement routine for the resolution bandwidth filters.

The frequency measuring routine adjusts CENTER FREQUENCY. It measures the frequency of each resolution bandwidth filter to reduce CENTER FREQUENCY variation when changing RESOLUTION BANDWIDTH settings. The relative amplitude measuring routine reduces REFERENCE LEVEL variation when changing RESOLUTION BANDWIDTH settings. To ensure that the 495/P meets frequency and amplitude performance characteristics, run these routines whenever the instrument's surrounding temperature changes significantly. Cal factors that are used internally to correct for the errors measured by this function are retained in memory when the instrument power is off. To display these factors, press **[Blue-SHIFT] [LIN]**.

43 **MIN RF ATTEN dB** — This control specifies the lowest value of input attenuation that will be used when REFERENCE LEVEL is selected. This allows operator-control to protect the front end of the 495/P against overload or damage from excessive signal level into the 1st mixer. Actual attenuation is set according to the **MIN RF ATTEN dB, REFERENCE LEVEL,** and **[MIN NOISE/MIN DISTORTION]** selections. It is displayed on the CRT readout. If the **MIN RF ATTEN dB** setting is increased, the IF gain is automatically changed to maintain the current REFERENCE LEVEL, if possible. The normal position is 0 to obtain the best noise level performance.

44 **REFERENCE LEVEL** — This control changes the reference level one step for each stop. Automatic selection of the IF gain and RF Attenuation provide for the best overall noise and distortion performance. In the LOG VERTICAL DISPLAY mode (FINE mode off), the step size equals the selected dB/Div factor, except for 2 dB/Div, where step size is 1 dB. When FINE mode is on, the step size is 1 dB for scale factors of 5 dB/Div or more and 0.25 dB for VERTICAL DISPLAY factors of less than 5 dB/Div. When the display factor is less than 5 dB/Div and FINE mode is on, the Delta A mode is selected. Refer to *Section 6, Operation* for a description of the Delta A mode.

45 **[Blue–SHIFT] REF LEVEL UNITS —** This push button sequence allows the selection of reference level units to be dBm, dBV, dBmV, or dBuV.

46 **AMPL CAL** — This screwdriver adjustment, and the **LOG CAL** adjustment, calibrates the vertical portion of the display. **AMPL CAL** adjusts the display amplitude. Press **[Blue-SHIFT] [CAL]** to initiate a procedure that will guide you through these adjustments. Refer to **[Blue-SHIFT] [CAL]** for additional information.

47 **LOG** CAL — This screwdriver adjustment, and the **AMPL CAL** adjustment, calibrates the vertical portion of the display. **LOG CAL** adjusts the logarithmic gain in dB/Div. Press **[Blue-SHIFT] [CAL]** to initiate a procedure that will guide you through these adjustments. Refer to **[Blue-SHIFT] [CAL]** for additional information.

48 **MIN NOISE/MIN DISTORTION**

MIN NOISE — (push button lit) — In this mode, the noise level is reduced by changing the RF Attenuation and IF gain used for a particular reference level. Both are reduced 10 dB so noise generated in the IF stages is decreased. However, intermodulation distortion products will increase. RF Attenuation must be at least 10 dB for this control to have any effect.

MIN DISTORTION — (push button not lit) — In this mode, intermodulation distortion products are minimized.

49 FINE (A A IN <5 **dB/DIV)** — This push button selects step size for the REFERENCE LEVEL control. When FINE mode is off, the step size equals the selected dB/Div factor, except for 2 dB/Div, where step size is 1 dB. When FINE mode is on, the step size is 1 dB for scale factors of 5 dB/Div or more and 0.25 dB for VERTICAL DISPLAY factors of less than 5 dB/Div. When the display factor is less than 5 dB/Div and FINE mode is on, the Delta A mode is selected.

In the Delta A mode the REFERENCE LEVEL readout goes to 0.00 dB, and the REFERENCE LEVEL control steps in 0.25 dB increments. These fine steps provide the means to make accurate relative amplitude measurements over a 48 dB measurement range. Refer to Delta A mode operation in *Section 6, Operation* for more details.

50 PULSE STRETCHER — This push button causes the fall-time of pulse signals to be increased so very narrow pulses can be seen. The effect is most apparent for pulsed RF signals where pulse width is small compared to one division of sweep time. Pulse stretcher operation may be necessary for a digital storage display of such signals, to ensure that the correct amplitude is displayed.

VERTICAL DISPLAY — These three push buttons select the vertical display factors. The CRT readout indicates the selection. The vertical display factor, in the LOG mode, can also be entered with the DATA ENTRY push buttons.

51 **LIN** — With this push button activated, a linear display between zero volts (bottom graticule line) and the reference level (top graticule line), scaled in volts/division, is selected (see the REFERENCE LEVEL description).

NOTE

*The sequence **[Blue–SHIFT]**[UN] displays a list of the factors used to internally correct for frequency and amplitude errors. The factors shown are as measured with the last **[Blue–SHIFT]**[CAL] operation. If one of the factors could not be measured at the last operation, the old value will be noted. This means that the previously measured value is used. If [or] appears next to the amplitude calibration factor, it means that this filter's amplitude related to the 3 MHz filter is outside the range of correction (correction is set to the limit). Press [Blue-SHIFT] to exit this display.*

52 2 dB/DIV — This push button increases resolution so that each major graticule division represents 2 dB. Display dynamic range is 16 dB.

53 **10** dB/DIV — With this push button activated, the dynamic range of the display is a calibrated 80 dB with each major graticule division representing 10 dB.

Sweep

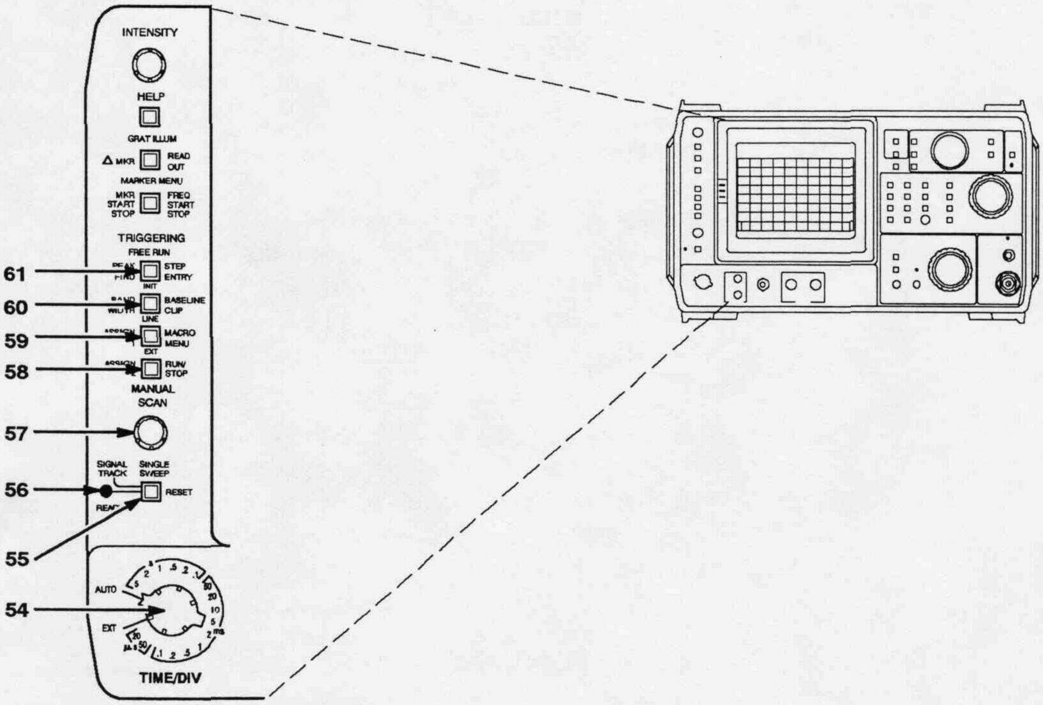


Figure 4-12: Sweep Controls

TRIGGERING

54 **TIME/DIV** — This control selects sweep rates from 5 s/Div to 20 µs/Div in a 1 -2-5 sequence in addition to AUTO, MNL, and EXT sweep modes.

AUTO — (automatic) — This position allows the sweep rate to be selected automatically to maintain a calibrated display for most FREQUENCY SPAN/DIV, RESOLUTION BANDWIDTH, VIDEO FILTER, and VERTICAL DISPLAY selections.

EXT — (external sweep) — This position allows the sweep circuit to be driven by a signal applied to the rear-panel **HORIZ|TRIG** (EXT IN) connector. A voltage ramp of 0 to +10 V will sweep 10 divisions of horizontal (X) axis.

MNL — (Manual) — This position allows the spectrum or display to be manually swept with the MANUAL SCAN control.

55 **SINGLE SWEEP** — When first pressed, this push button activates the SINGLE-SWEEP mode and stops the current sweep. When pressed again, the sweep trigger circuit is armed and the READY indicator is lit. The sweep will run only after it receives a trigger signal. When SINGLE SWEEP mode is selected, the TRIGGERING selection (i.e., FREE RUN, INTernal, LINE, or EXTernal) is not changed. Select any TRIGGERING selection to cancel SINGLE SWEEP mode.

56 **READY** — (only used in the SINGLE SWEEP mode) — This indicator lights when the trigger circuit is armed and ready for a trigger signal. It remains lit until the sweep ends.

57 **MANUAL SCAN** — With **TIME/DIV** set to the **MNL** position, rotate this control to manually scan the spectrum.

58 EXT — This push button allows the sweep to be triggered by signals that are applied through the rear-panel **HORIZ|TRIG** (EXT **IN)** connector. Other TRIGGERING selections are cancelled, including SINGLE-SWEEP mode.

59 LINE — This push button allows a sample of the AC power line voltage to trigger the sweep. Other TRIGGERING selections are cancelled, including SINGLE-SWEEP mode.

60 **INT** — This push button allows the sweep to be triggered by any signal at the left edge of the display that has an amplitude of 2.0 divisions or more. Other TRIGGERING selections are cancelled, including SINGLE-SWEEP mode.

61 **FREE RUN** — This push button allows the sweep to free run without regard to trigger source. Other TRIGGERING selections are cancelled, including SINGLE-SWEEP mode.

Digital Storage

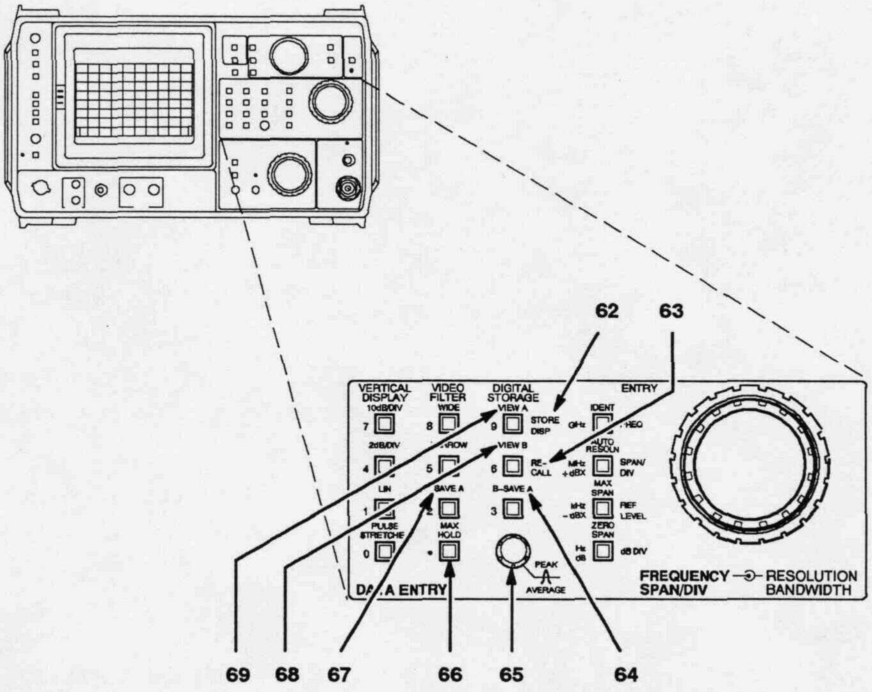
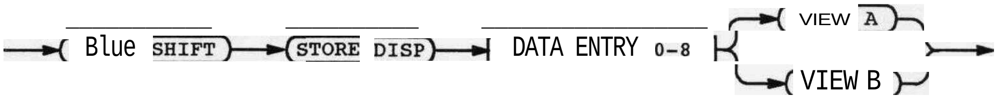


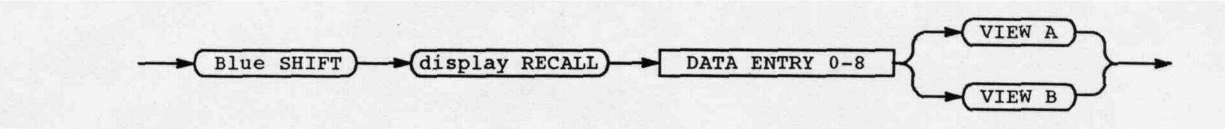
Figure 4-13: Digital Storage Controls

Store/Recall

62 **[Blue–SHIFT] STORE DISP** — This push button sequence starts a multiple-push button sequence that stores either the A or B waveform and its associated readout and marker(s) in a numbered (**[0]** through **[8]**) memory register. Information is held in memory while instrument power is off. Messages displayed on the screen aid in completing the multiple-push button sequence. After pressing **[Blue-SHIFT] [STORE DISP]**, a list of the stored displays is shown. Each stored display is identified by its CENTER FREQUENCY. The number of digits in a CENTER FREQUENCY in the menu list is an indication of the FREQUENCY SPAN/DIV of that stored display (a larger number of digits indicates a narrower span). This display includes a prompt asking for the register number (**[0]** through **[8]**) into which the display will be stored. Select the register from the DATA ENTRY push buttons. When SAVE A mode is on, there is an operator prompt that asks whether the A or B waveform is to be saved.



63 **[Blue–SHIFT]** RECALL — This push button sequence starts a multiple-push button sequence that recalls a selected waveform, with its readout and marker(s) from one of the memory registers ([0] through [8]). The waveform is placed in either the A or B display for viewing. Information is held in memory while the instrument is off. After pressing [Blue-SHIFT] [STORE DISP], a list of the stored displays is shown. Each stored display is identified by its CENTER FREQUENCY This display includes a prompt asking for the register number ([0] through [8]) from which the display will be recalled. Select the register from the DATA ENTRY push buttons.



The readout for a recalled A waveform will only be displayed if VIEW B and B-SAVE A modes are off and VIEW A mode is on. The readout for a recalled B waveform will only be displayed if both VIEW B or B-SAVE A modes are on and SINGLE SWEEP mode is selected. The marker(s) will only be displayed if markers are turned on.

SAVE A mode is activated to allow the separate display of the A or B waveform. Remember to turn on SINGLE SWEEP mode before recalling a waveform to B to prevent overwrite by the sweep. The waveform cannot be recalled into B when in MANUAL or EXTERNAL sweep modes. Press [Blue-SHIFT] to exit during the sequence.

Digital Storage — These push buttons allow either or both sections of memory to be selected to provide digital storage. When [VIEW A] and [VIEW B] are activated, contents of both the A and B memories are displayed on the screen. Both sections are updated with each sweep.

64 B-SAVE A — When activated, the 495/P displays the difference between the B waveform and the A waveform, and automatically turns on SAVE A mode. The factory-set zero reference line is mid-screen. Positive differences are displayed above this line and negative differences appear below the line. Refer any change in the position of the zero reference line to authorized service personnel.

65 PEAK/AVERAGE — This control selects the vertical position (shown on the screen by a horizontal line) at which digital storage switches from peak detection to signal averaging. Signals displayed above the cursor are peak detected. Signals displayed below the cursor are digitally averaged.

66 **MAX HOLD** — This push button causes digital storage to retain the maximum signal amplitude at every storage location (500 locations; or 1000 locations if SAVE A mode is off). If SAVE A mode is on, the A waveform is not affected. Use **[MAX HOLD]** to measure frequency drift or peak amplitude excursions of a signal.

67 **SAVE A** — This push button saves the A waveform and its readout. The readout stored with the waveform is displayed if both **[SAVE A]** and **[VIEW A]** are on, and **[VIEW B]** and **[B-SAVE A]** are off. If either **[VIEW B]** or **[B-SAVE A]** is on, the readout reflects the current settings. Turning SAVE A mode off cancels B–SAVE A mode if it is on. If SAVE A mode is off and either **[VIEW A]** or **[VIEW B]** is on, both waveforms will be displayed. The A waveform is not updated by the sweep if SAVE A mode is on.

68 **VIEW B** — This push button causes the B waveform to be displayed.

69 **VIEW A** — This push button causes the A waveform to be displayed. If SAVE A mode is on and only the A waveform is being viewed, the CRT readout will show the settings when the A waveform was stored.

Display And General Purpose

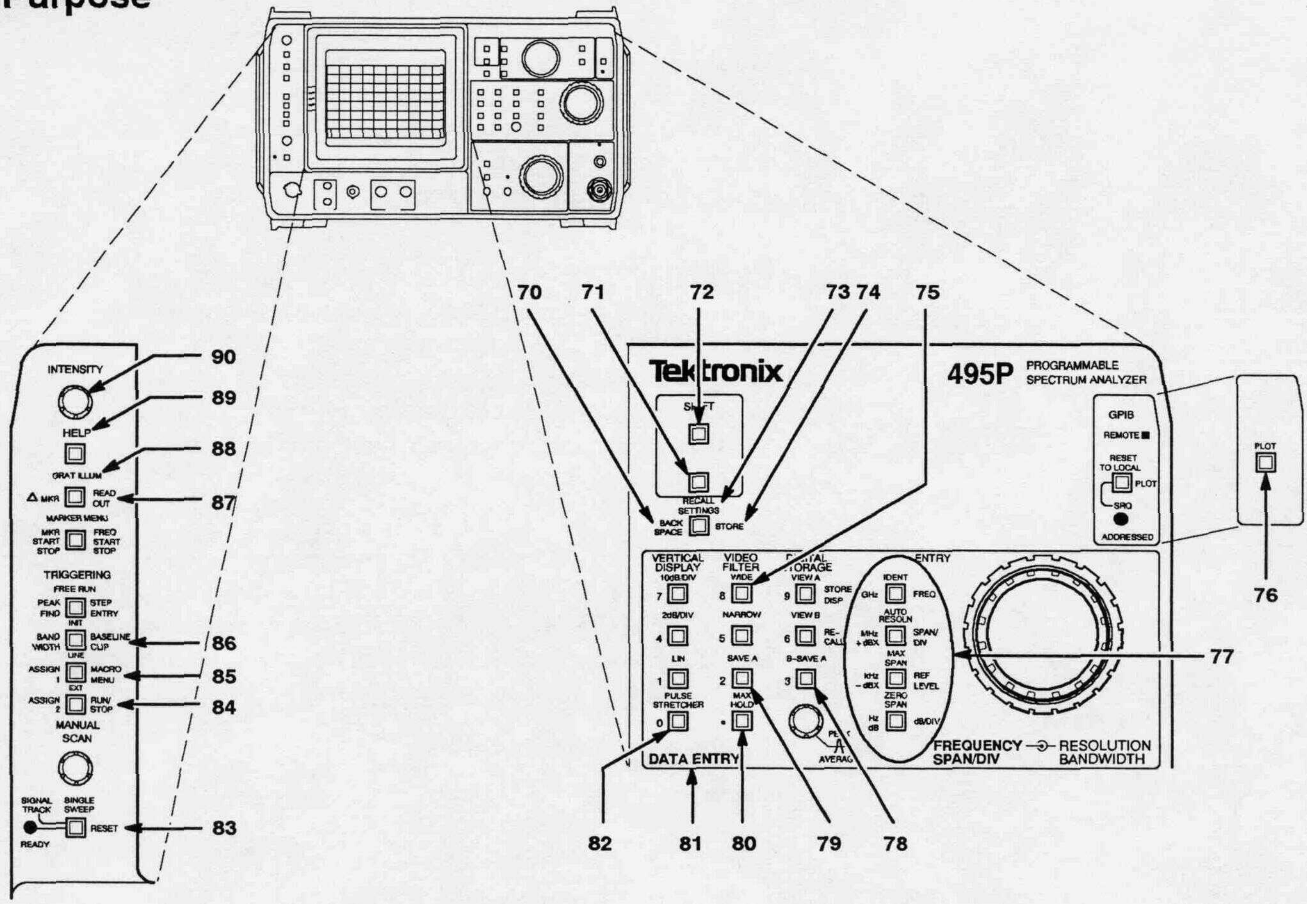


Figure 4-14: Display and General Purpose Controls

70 **BACKSPACE** — This push button backs the cursor up one space each time it is pressed, erasing the number in that location. This allows you to enter correct numerical data before finishing the sequence with a units push button.

71 **Green–SHIFT** — This push button allows selection of the green-labeled front-panel push button functions. Press **[Green–SHIFT]** each time before selecting a green-lettered function. **[Green–SHIFT]** also cancels multiple push button sequence operations.

72 **Blue–SHIFT** — This push button allows selection of the blue-labeled front-panel push button functions. Press **[Blue-SHIFT]** each time before selecting a blue-lettered function. **[Blue-SHIFT]** also cancels multiple push button sequence operations.

73 **RECALL SETTINGS** — This push button recalls an instrument front-panel setup from memory. The screen displays the CENTER FREQUENCY of each stored setup as an aid in identifying the contents of each register (0-9). The time and minimum RF Attenuation settings stay at the knob values. Select the desired register number, and the front-panel controls automatically switch to that setup. The instrument settings are automatically stored in register 0 when the 495/P is turned off, overwriting the settings previously stored there. To return to these settings, press **[RECALL SETTINGS] [0]**.

74 **[Blue−SHIFT] STORE** — This push button sequence allows a front-panel setup to be stored in memory. Up to ten settings can be stored in registers 0-9. The screen displays the CENTER FREQUENCY of each setup as an aid in identifying the contents of each register. Select the desired register, and the setup is stored. The instrument settings are automatically stored in register 0 when the495/P is turned off, overwriting the settings previously stored there.

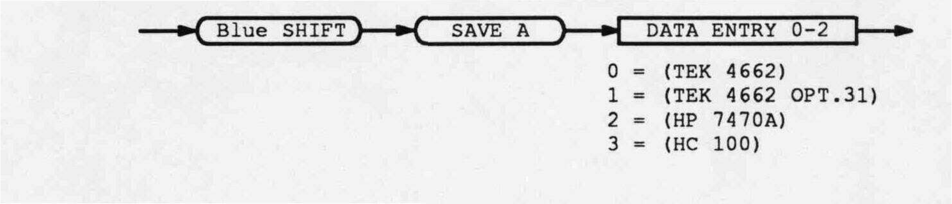
75 **[Blue-SHIFT] VIDEO FILTER WIDE —** (Special Modes Menu; not identified on the front panel) — This push button sequence brings up a menu from which these special modes may be selected:

- [0] Tracking Generator Mode
- [1] Sideband Analyzer Mode
- [2] Reduced Gain Mode
- [3] EOS Corrections Mode
- [4] Zero−Span Time Mode

76 **PLOT** — (495 Only) This push button causes display information to directly drive a plotter. The plotters that can be driven include the following:

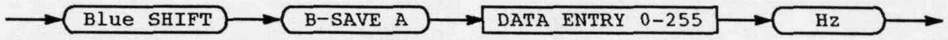
- Tektronix HC 100, 4662 Option 01, 4662 Option 31, or 4663 (emulating the 4662)
- Hewlett Packard HP7470A, HP7475A, HP7580B, HP7585B, or HP7486B
- Gould 6310 or 6320

Press the **[Blue-SHIFT] [SAVE A]** push button sequence to select the plotter type. Refer to *Plotting the Display* in Section 6 for details.



77 **Units** — The units GHz, MHz, kHz, Hz, +dBx, -dBx, and dB are available to complete a number-entry function from the front panel.

78 **[Blue–SHIFT] B–SAVE A** — (Plot B–Save A Offset; not identified on the front panel) — The vertical position of the zero reference line for the B-SAVE A display is set with an internal switch selection. However, when using the **[PLOT]** function, the position of zero reference for the plot must be entered using this function. The range for the position is 0 to 255 with 125 representing center screen. Enter the position with the DATA ENTRY push buttons when prompted by the CRT message, and terminate with the **[Hz]** push button. The entered position is stored in memory.



79 **[Blue–SHIFT] SAVE A** — (Select Plotter Type; not identified on the front panel) — This push button sequence displays the list of the plotter types available for use with the **[PLOT]** push button (495 only) and **[Blue-SHIFT] [PLOT]** push button sequence (495P only). Select the desired plotter type by choosing one of the menu items and entering the number on the DATA ENTRY push buttons. The choices are listed below:

- 0=Tektronix 4662 Option 01 or the 4663 in a one-pen setup
- 1 =Tektronix 4662 Option 31 or the 4663 in a two-pen setup
- 2=HP7470A
- 3=Tektronix HC 100, HP7475A, HP7580B, HP7585B, or HP7586B, Gould

Any plotter that is compatible with one of these can also be used. The selected plotter type is stored in memory.

80 **[Blue-SHIFT] MAX HOLD** — (Instrument Errors; not identified on the front panel) — This push button sequence displays all the detected instrument errors; for use while troubleshooting.

81 **DATA ENTRY** — These orange push buttons are used to enter data directly from the front panel when directed by a message on the CRT.

Numbers — The numbers **[0]** through **[9]** and a decimal point are available to enter data from the front panel.

82 **[Blue–SHIFT] PULSE STRETCHER —** (Diagnostic Aids; not identified on the front panel) — This push button sequence displays a menu of all the available diagnostic aids for use while troubleshooting.

WARNING

*MOST OF THE INFORMATION ACCESSED BY PRESSING THE SEQUENCE **[Blue-SHIFT] [PULSE STRETCHER]** IS FOR QUALIFIED SERVICE PERSONNEL ONLY. UNFAMILIARITY WITH SAFETY PROCEDURES CAN RESULT IN PERSONAL INJURY. PERFORM ONLY THE OPERATIONS THAT CAN BE COMPLETED FROM THE INSTRUMENT FRONT PANEL. DO NOT ATTEMPT TO REMOVE THE INSTRUMENT PANELS OR PERFORM ANY INTERNAL OPERATIONS; CONTACT QUALIFIED SERVICE PERSONNEL.*

83 **[Blue-SHIFT] RESET** — This push button sequence resets all front-panel settings to their original condition as if power was just turned on.

84 **[Blue-SHIFT] RUN/STOP —** This push button sequence has three functions, depending on the status of macros.

- If a macro is running, press **[Blue-SHIFT] [RUN/STOP]** to stop the macro.
- If a macro is stopped, press **[Blue-SHIFT] [RUN/STOP]** to restart the macro.
- If no macro is running or stopped, press **[Blue-SHIFT] [RUN/STOP]** to run the last macro that was executed.

85 **[Blue-SHIFT] MACRO MENU —** This push button sequence selects a macro to be executed. The title of the macro is displayed next to the macro number.

86 **[Blue-SHIFT] BASELINE CLIP —** This push button sequence clips, or blanks, about one graticule division of the spectrum trace at the baseline of the display. Use BASELINE CLIP mode to observe the readout at the bottom of the screen or to eliminate the bright baseline when photographing displays.

87 **[Blue-SHIFT] READOUT** — This push button turns CRT readout on and off. The brightness is proportional to the trace brightness. This sequence does not affect prompt or help messages.

88 **GRAT ILLUM** — This push button switches the graticule lights from dim for low-light viewing to bright for photographing displays.

89 **HELP** — This push button causes text to be displayed on the CRT to explain the function of a selected front-panel control or push button. Press the **[HELP]** push button; then press any push button or turn most controls for an explanation of their function. Explanations are not available for the **PEAK/AVERAGE, INTENSITY, or MANUAL SCAN** controls. Press **[HELP]** again to exit this mode.

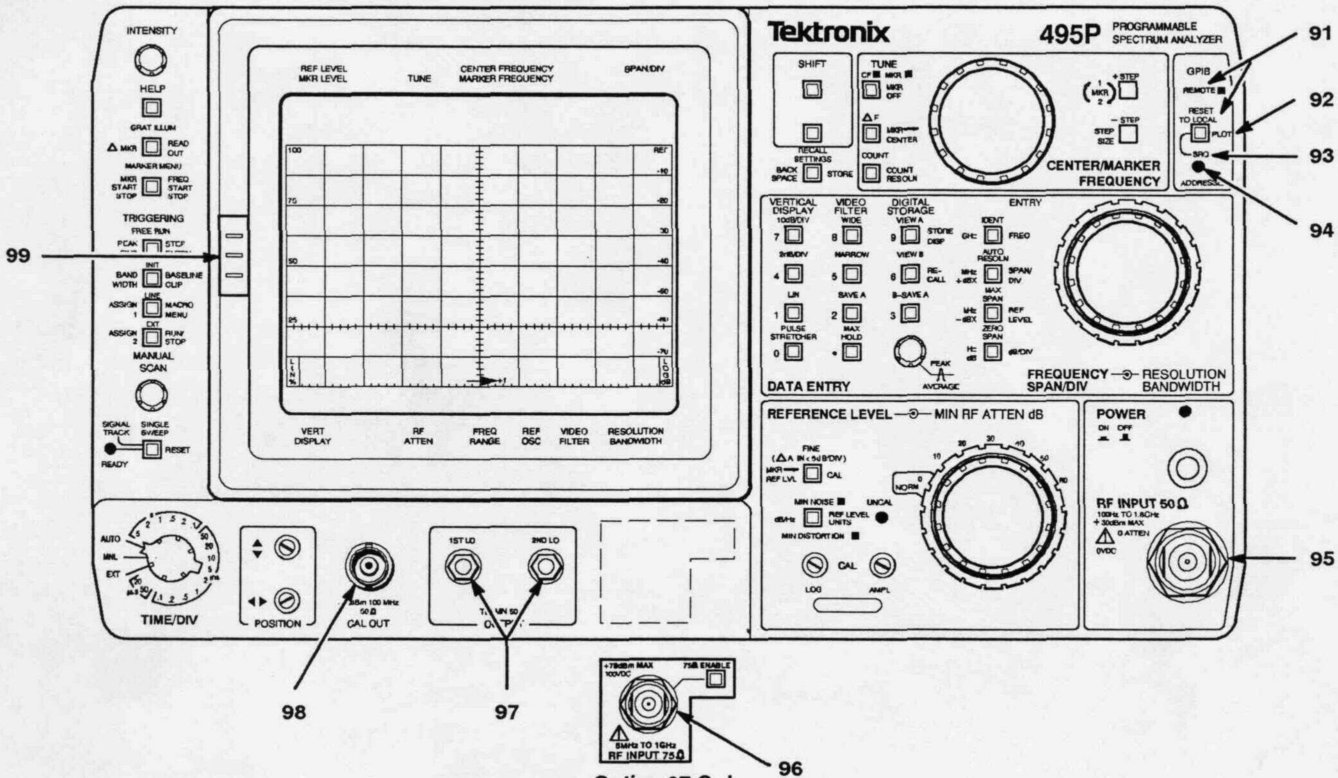
[Blue–SHIFT] HELP — This push button sequence allows selection of all explanations for functions called out on the front panel in blue. **[Blue-SHIFT] [HELP]** only needs to be pressed once to begin the selection (i.e., **[Blue-SHIFT] [HELP], [REF LEVEL], [PLOT], [READOUT]).** Press **[HELP]** again to exit this mode.

[Green–SHIFT] HELP — This push button sequence allows selection of all explanations for functions called out on the front panel in green. **[Green-SHIFT] [HELP]** only needs to be pressed once to begin the selection (i.e., **[Green-SHIFT] [HELP], [SIGNAL TRACK], [PEAK FIND], [MKR START STOP]).** Press **[HELP]** again to exit this mode.

For additional information on HELP mode, see *Using the HELP Feature* in Section 6.

90 **INTENSITY** — This control adjusts the brightness of the CRT trace, readout, and text. Beam focus is automatically controlled.

Front-Panel Input/Output And GPIB



Option 07 Only

Figure 4-15: Front-Panel, Input/Output, and GPIB Controls

91 **RESET TO LOCAL/REMOTE** — (495P Only) This push button is lit when the 495P is in the remote state. While the instrument is remote, the other front-panel controls are not active except for **PEAK/AVERAGE**, **INTENSITY,** and **MANUAL SCAN.** Indicators still reflect the current state of front-panel functions. This push button is not lit when the 495P is in the local state. While the 495P is under local control, no GPIB messages are executed that would conflict with front-panel controls or change the waveforms in digital storage. See *Programming Features* in Section 6 for additional information.

92 **[Blue–SHIFT] PLOT** — (495P Only) This push button sequence causes display information to be sent over the GPIB port to directly drive a plotter. The plotters that can be driven are listed below:

- Tektronix HC 100, 4662 Option 01, 4662 Option 31, or 4663 (emulating the 4662)
- Hewlett Packard HP7470A, HP7475A, HP7580B, HP7585B, or HP7486B

- Gould 6310 or 6320

Press the push button sequence **[Blue–SHIFT]** to select the plotter type. Refer to *Plotting The Display* in Section 6 for details. This push button also causes the 495P to update the GPIB address.

93 **[Green–SHIFT]** SRQ — (495P Only) This push button sequence sends a service request over the GPIB bus to the controller.

94 ADDRESSED — (495P Only) This indicator lights when the 495P is addressed to either talk or listen. The characters T, L, and/or S appear in the CRT readout to indicate talk, listen, and/or SRQ, respectively.

95 ⚠ RF INPUT 50 Ω - This 50 Ω coaxial input connector is for RF signals to 1.8 GHz. If the input signal has a DC component, use a blocking capacitor in line with the signal.

CAUTION

The maximum, non-destructive input signal level to the input mixer is +30 dBm or 1 W.

The maximum rating of the RF attenuator is +30 dBm (1 W average, 75 W peak pulse width 1 ms or less, with a duty cycle that does not exceed 0.001). Burn-out occurs above 1 W. If MINNOISE is activated and the RF ATTEN is 60 dB, the +30 dBm rating will be exceeded if the signal level is increased to a full-screen display. Under these conditions the input level will be +40 dBm. Reduce the level of high-powered signals with external attenuators.

Input signals to the mixer must not contain any DC component. Refer to Signal Application in Section 6.

96 ⚠ RF INPUT 75 Ω — (Option 07 instruments only) — This connector provides calibrated 75 Q measurement capability.

97 OUTPUT (1ST LO/2ND LO) — These connectors are the outputs of the respective local oscillators. The connectors must be terminated into 50 Q when they are not connected to an external device.

98 CAL OUT (Calibrator output) — This connector is the source of a calibrated -20 dBm (±0.3 dB), 100 MHz signal and a comb of frequency markers 100 MHz apart. This 100 MHz source is the instrument reference frequency.

For Option 07 instruments using the 50 Q input, the signal is the same as the standard instrument. The signal is +20 dBmV (±0.5 dB) when using the 75 Q input.

99 Camera Power — This connector is the source of power for the Tektronix cameras that have electrically-actuated shutters (either the C-30BP Option 01 or the C-9 Option 07 is recommended). Single-sweep reset is not provided.

Rear-Panel Input/Output And GPIB

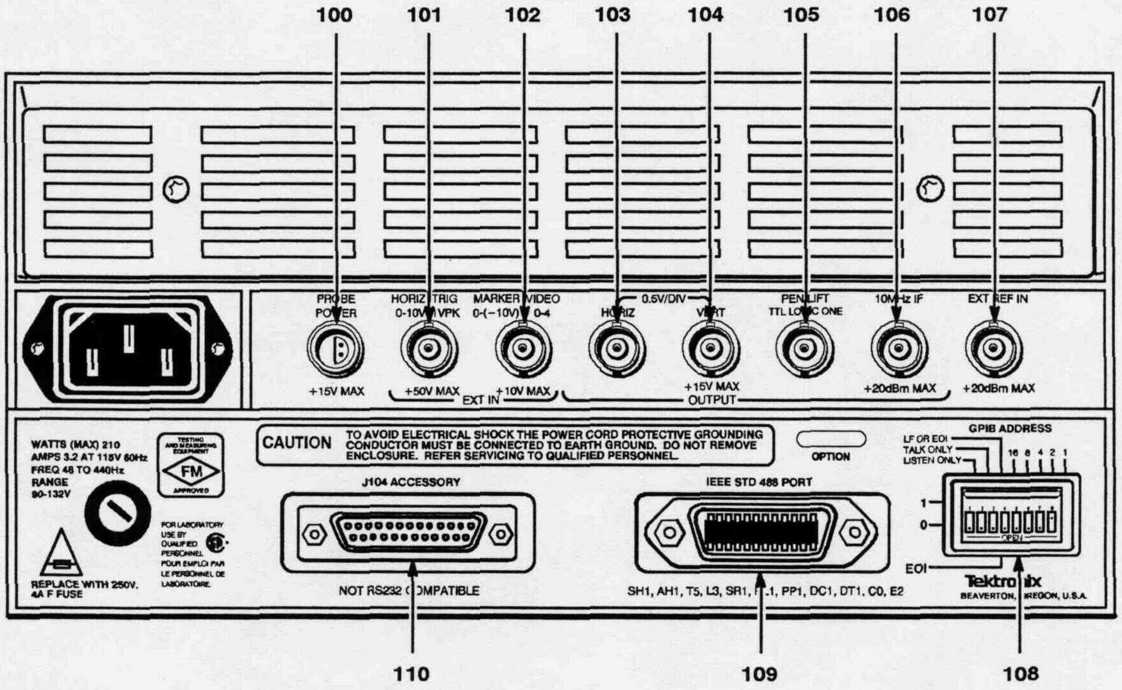


Figure 4-16: Rear-Panel Input/Output and GPIB Connectors

100 **PROBE POWER** — This connector provides operating power for active probe systems. This connector should be used only with compatible probes or accessories specifically designed for use with this power source.

101 **HORIZ|TRIG (EXT IN)** — Horizontal or triggering modes depend on the **TRIGGERING and TIME/DIV** selections. In the EXTERNAL TRIGGERING mode, the connector is an AC coupled input for trigger signals. Trigger amplitudes from 1.0 V to 50 V_{p-p}, with a 0.1 us minimum pulse width or within the frequency range of 15 Hz to 1 MHz, are required for triggering. When the **TIME/DIV** selection is EXT, the connector is a DC coupled input for horizontal sweep voltages. Deflection sensitivity is 1 V/Div. A 0 to +10 voltage will deflect the beam across the screen from left to right.

102 **MARKER|VIDEO (EXT IN)** — (Available on instruments without Option 42 only. See 110 MHz IF for Option 42 instruments.) This connector interfaces the 495/P with a Tektronix 1405 TV Adapter to display an externally-generated marker.

In Option 42 instruments, the **MARKER |VIDEO (EXT IN)** port is changed to **110 MHz IF.** It provides a 110 MHz IF output with a bandwidth greater than 4.5 MHz. External video signals used for calibration may be injected into the **PEN LIFT** connector (see the PEN LIFT description. This port is not compatible with a TV sideband adapter.

103 **HORIZ (OUTPUT)** — This connector supplies a 0.5 V/Div horizontal signal. Full range is -2.5 V to +2.5 V. Source impedance is approximately 1 kΩ.

104 **VERT (OUTPUT)** — This connector provides access to the video signal with 0.5 V for each division of displayed video that is above and below the center line. Source impedance is approximately 1 kΩ.

NOTE

Both HORIZ and VERT output signals are driven from digital storage if it is on. Both signals are driven from the 495/P *sweep and video amplifier stage if digital storage is off.*

105 **PEN LIFT (OUTPUT)** — This connector provides access to a TTL compatible signal to lift the pen of a chart recorder during 495/P sweep retrace. This signal is always derived from the 495/P sweep, regardless of the selection of the digital storage.

In Option 42 instruments, use this connector to input external video signals if pin 1 of the **ACCESSORIES** connector is grounded (refer any questions about this connection to qualified service personnel).

106 **10 MHz IF (OUTPUT)** — This connector provides access to the output of the 10 MHz IF. The signal amplitude is about -30 dBm for a full-screen display.

107 **EXT REF IN (EXT IN)** — A 50 Ω input for 1, 2, 5, or 10 MHz external reference signals, within the -15 dBm to +15 dBm level. Phase noise should be no greater than −110 dBc in a 1 Hz bandwidth at 10 Hz offset, referenced to 10 MHz. The input signal must be a sinewave with a duty cycle symmetry of 40% to 60%, ECL or TTL.

108 **GPIB ADDRESS** — (495P Only) These switches set the value of the lower five bits of the instrument GPIB address. This value is the instrument's primary address. These switches also select the Talk Only and Listen Only operating modes, and the message terminator for input and output. Address 31 (11111) logically disconnects the 495P from the bus. Address 0 (00000) is reserved for Tektronix 4050-Series controllers. If these switches are changed after the instrument is already active, press **[RESET TO LOCAL]** or **[Blue–SHIFT] [PLOT]** to cause the 495P to read them again.

109 **IEEE STD 488 PORT (GPIB)** — This connector interfaces the 495 to the selected plotter, and interfaces the 495P to the GPIB bus. The interface functions provided in the 495 are SH1, AHO, T3, LO, SRO, RLO, PPO, DCO, DTO, and CO. The interface functions provided in the 495P are SH1, AH1, T5, L3, SR1, RL1, PP1, DC1, DT1, and CO.

Details of how the switches are used in remote control are in the ***495P Programmer*** manual.

110 **J104 ACCESSORY** — This connector provides bi-directional access to the instrument bus. It is not RS 232 compatible. A TTL0 applied to pin 1 selects EXTERNAL VIDEO. Video signals, which are applied to rear-panel **MARKER |VIDEO**, are connected to the video path ahead of the video filters.

Instrument Check Out

This section includes the basic instrument check-out procedures and preparation for first-time use. An operational check is included for the front-panel push buttons and controls, and some of the operating functions. No extra equipment is required to perform these check-out procedures, and the instrument cabinet does not need to be removed. Refer any additional instrument check out to qualified service personnel.

Firmware Version Readout

When the instrument is first turned on, all of the front-panel LEDs will light up. The front-panel processor firmware versions are then displayed on the screen for approximately two seconds.

Error Message Readout

There are error messages to report the following failure conditions:

- Calibration failure
- Power supply failure
- Battery-operated RAM checksum error

Promptly report any error messages to qualified service personnel.

If the instrument detects an internal hardware failure, a failure report comes on screen and remains for approximately 2 seconds. A status message then appears and remains for as long as the failure exists. Press **[HELP]** to bring error messages to the screen that explain the impact of the failure on instrument operation.

If you attempt to recall a display or setting from a location where nothing is stored, you will get a checksum error message even though there is not really an error. This need not be reported to service personnel.

Frequency Corrections

If the oscillator frequency cannot be set due to a hardware failure, the instrument will attempt to set the oscillator frequency before each sweep. The sweep holdoff time will increase with each try. To disable the oscillator corrections, press **[Blue–SHIFT] [10 dB/DIV]**.

NOTE

Center frequency accuracy specifications will not be met in this mode.

Press **[Blue–SHIFT]** [10 **dB/DIV]** again to enable the oscillator correction routines. Another failure message will appear if the failure has not been corrected.

Preparation for Use

The following procedure creates a display and calibrates center frequency readout, display reference level, and bandwidth. Whenever a [SHIFT] push button is required in this procedure to precede a multiple-push button sequence, it is enclosed in brackets; i.e. **[Blue–SHIFT]**.

Initial Turn On

1. Connect the spectrum analyzer power cord to an appropriate power source (see *Power Source and Power Requirements* in Section 3 of this manual) and push the **[POWER]** switch ON.

   When **[POWER]** is switched **ON** (power-up), the processor runs a memory and I/O test. If no processor system problems are found, the power-up program will complete in approximately 7 seconds. The instrument is now ready to operate.

   Figure 5-1 shows the normal CRT readouts following the 7-second power-up period. If a problem does exist within the instrument, a message will appear on the screen. To bypass the failed test and attempt to use the instrument, press the push button as directed in the error message. However, performance may not be as specified.

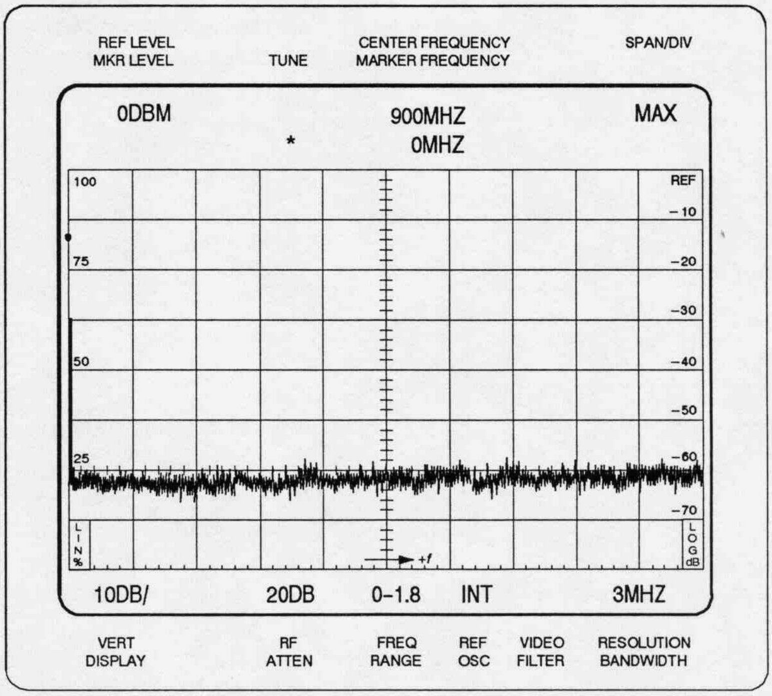


Figure 5-1: CRT Display and Readout at Initial Turn On

The 495/P operating functions and modes will initialize to the following power-up states.

READOUT	ON
REFERENCE LEVEL	ODBM
CENTER FREQUENCY	900MHZ
MARKER FREQUENCY	OMHZ
SPAN/DIV	MAX
VERTICAL DISPLAY	10DB/
RF ATTEN	20DB
FREQ RANGE	0-1.8
RESOLUTION BANDWIDTH	3MHZ
TRIGGERING	FREE RUN
AUTO RESOLN	ON
DIGITAL STORAGE	VIEW A & VIEW B ON
MIN NOISE/MIN DISTORTION	MIN NOISE
ALL OTHER PUSH BUTTONS	INACTIVE OR OFF

2. **Set the MIN RF ATTEN dB control to 0 (NORM) and the PEAK/AVERAGE control fully counterclockwise.**
3. Set the TIME/DIV control to AUTO, REF LEVEL to -20 dBm, and adjust the INTENSITY for the desired brightness. Note that the RF ATTEN readout is now ODB.

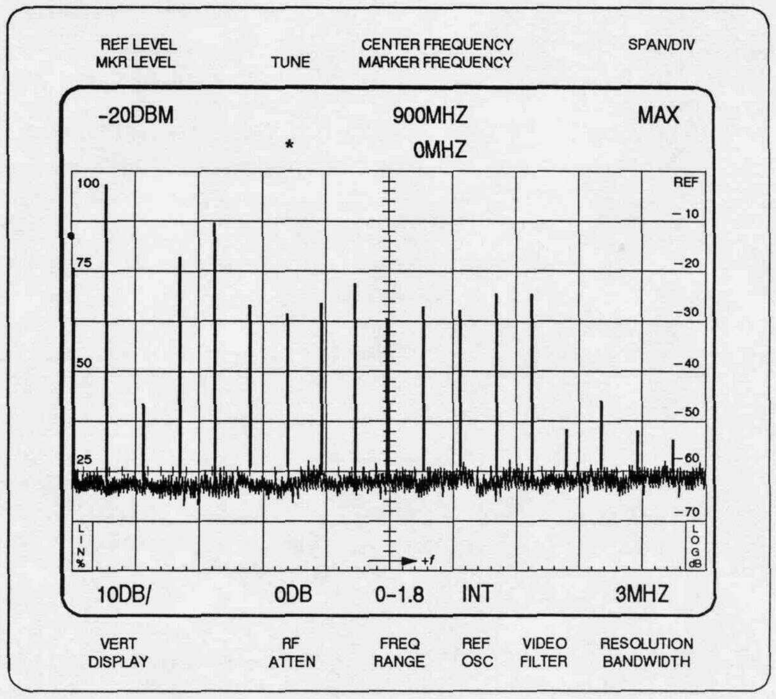


Figure 5-2: Typical Display of the CAL OUT Signal in Maximum Span/Div Mode

4. Apply the **CAL OUT** signal to the **RF INPUT** through a 50 Ω cable. A dot marker appears in the upper portion of the screen in the MAX frequency span/division mode. This marker indicates the location on the display to which the 495/P frequency is tuned. With a frequency readout of 0MHZ, the marker is located in the top left portion of the screen.
5. Rotate the **CENTER/MARKER FREQUENCY** control and watch the dot marker move across the display. Notice that the CENTER FREQUENCY readout (top line) remains at 900 MHz, and the MARKER FREQUENCY readout (second line) changes according to the position of the marker (dot).
6. Harmonics of the 100 MHz CAL OUT signal will be displayed as shown in Figure 5-2. To select 100 MHz center frequency, press the key sequence **[Blue–SHIFT] [FREQ] [1] [0] [0] [MHz]**.
7. Press the push button sequence **[Blue-SHIFT] [SPAN/DIV] [1] [0] [0] [MHz]** to change the SPAN/DIV to 100 MHz. The dot marker is now horizontally centered, and the 100 MHz CAL OUT signal is at center screen.
8. If a message appears on the screen, press **[FINE]** to continue the calibration or **[Blue-SHIFT]** to exit the routine.

Display Calibration

When the **[Blue-SHIFT] [CAL]** push button sequence is pressed, the instrument performs a center frequency and reference level calibration. Prompts appear on the screen to guide the user through each procedure step. The routine optimizes horizontal and vertical position, center frequency, reference level, and dynamic range.

This calibration should be done at regular intervals so the instrument can meet its center frequency and reference level accuracy performance specifications. It should also be performed any time the instrument ambient temperature is substantially different from the last calibration. An explanation of reference level accuracy with respect to ambient temperature is described in *Section 2, Specification.*

To observe the results after a calibration is completed, press the push button sequence **[Blue-SHIFT] [LIN]**. A table appears on the screen that shows the correction factor used to center the resolution bandwidth filters to produce a calibrated center frequency. It also shows the correction that was required to bring the amplitude of each filter within 0.4 dB of the 3 MHz filter.

1. To begin the calibration procedure, press the push button sequence **[Blue-SHIFT] [CAL]**.
2. A prompt message on the screen guides you through setting the four front-panel adjustments: **Vertical** and **Horizontal POSITION,** and **AMPL** and **LOG CAL.** This sets the absolute reference level for the 3 MHz resolution bandwidth filter.

3. Next the instrument performs an automatic calibration that measures and corrects for the absolute frequency and amplitude errors of the filters (relative to 3 MHz). This takes approximately 60 seconds.
4. If a message appears on the screen, refer to *Error Message Readout* earlier in this section. The correction factors are held in memory. Press either **[FINE]** to continue calibration as instructed, or **[SHIFT]** to exit the routine.

Functional or Operational Check

This procedure uses minimum test equipment to check instrument operating modes, functions, and basic performance. The procedure checks that the instrument is operating properly. The internal calibrator and attenuator are used as the source to check most of the operational characteristics. Since both are very accurate, this check should satisfy most incoming inspection or pre-operational check-out requirements. This check will also help familiarize you with the instrument operation. A detailed Performance Check that verifies all performance requirements in *Section 2, Specification* is included in the ***Service Manual, Volume 1***.

Equipment Required

The only external equipment used is an N-male-to-BNC-female adapter and the 50 Ω coaxial cable, which are supplied as standard accessories.

Preliminary Preparation

Perform the procedure described under *Preparation for Use;* then allow the instrument to warm up for at least 15 minutes before proceeding with this check.

Check Operation of Front-Panel Push Buttons and Controls

This procedure checks the operation of all front-panel push buttons and controls, and ensures that the buttons illuminate when the function is active.

The LED lights on the push button when the function is active. Lighted LEDs also indicate the allowable selections for any of the multiple function push buttons. For example, all DATA ENTRY push buttons light after **[Blue−SHIFT] [FREQ]**, **[Blue−SHIFT] [SPAN/DIV]**, **[Blue−SHIFT] [REF LEVEL],** or **[Blue-SHIFT] [dB/DIV]** shift functions have been selected. Any lighted push button can enter data for that selection. Messages are displayed on the screen as guides to the entry sequence of these selections.

Perform these steps before beginning this procedure:

1. Connect the **CAL OUT** signal to the **RF INPUT** with the 50 Q cable and BNC-to-N adapter.
2. Press **[Blue–SHIFT] [RESET]**; then set the 495/P controls as follows:

CENTER/MARKER FREQUENCY	100MHZ
REFERENCE LEVEL	-20DBM
SPAN/DIV	20KHZ
VERTICAL SCALE	2DB/
MIN RF ATTEN dB	0 (NORM)
TIME/DIV	AUTO

3. Press or change the following push buttons and controls and note their effect on the operation.

INTENSITY — Rotate the control through its range and note the CRT beam brightness change.

HELP — When this mode is activated, press or operate any push button and most controls to produce a help message on the CRT that explains the function of that push button or control. Help messages explain any error message that may appear. Activate this mode, press various push buttons, and observe the CRT message for each. Press the [HELP] push button again to cancel. To get HELP messages for shifted functions, press the desired **[SHIFT]** push button, press **[HELP],** then press the desired push button.

GRAT ILLUM — When activated, the graticule is illuminated.

MARKER MENU — Press this push button to display a menu of available marker commands that are not permanently assigned to a front-panel push button.

TRIGGERING —To activate the TRIGGERING mode, press one of four push buttons. The push button illuminates when in the active state. Press any one of the push buttons to cancel or deactivate any other mode. Turn VIEW A and VIEW B off to better observe the triggering effect.

- **FREE RUN** — In the active state, the trace free runs.
- **INT** — When active, the sweep is triggered when the signal or noise level at the left edge is > 2.0 division.
  1. **Use** the **CENTER/MARKER FREQUENCY** control to tune one of the 100 MHz CAL OUT signals to the left edge of the display.
  2. Adjust the **REFERENCE LEVEL** control so that the amplitude of the signal is 2 or more divisions.

3. Press **[INT]** to activate INT TRIGGERING to trigger the sweep.
4. Press **[FREE RUN]**.
5. Adjust the REFERENCE LEVEL control so that the amplitude of the signal is less than 2 divisions.
6. Press **[INT]** to activate INT TRIGGERING. The sweep is no longer triggered.

- **LINE** — When active, the trace is triggered at power line frequency. Press **[LINE]** and the sweep will be triggered.
- EXT — When this function is active, the trace runs only when an external signal $> 1.0 V_{p\text{-}p}$ is applied to the rear-panel **EXT IN** connector. Since external test equipment is required to check this function, a check cannot be made with this procedure.

SINGLE SWEEP — When this function is active, single sweep aborts the current sweep. Press **[SINGLE SWEEP]** once to enter SINGLE SWEEP mode. Press **[SINGLE SWEEP]** again to arm the sweep generator and light the READY indicator. When triggering conditions are met after the circuit is armed, the 495/P makes only one sweep. The indicator remains lit until the sweep has run. The single sweep mode is cancelled when any TRIGGERING push button is pressed. The effect of SINGLE SWEEP mode is more apparent with VIEW A and VIEW B off.

1. Press **[VIEW A]** and **[VIEW B]** to turn these displays off.
2. Press **[FREE RUN]** and set the **TIME/DIV** to **0.5 s.**
3. Press **[SINGLE SWEEP]** to abort the sweep.
4. Press **[SINGLE SWEEP]** again. The READY indicator lights and the sweep runs.
5. Press **[FREE RUN]** to cancel single sweep.
6. Return the **TIME/DIV** to **AUTO.**

TIME/DIV — This control selects sweep rate, manual scan, and external sweep operation. In the MNL position, the **MANUAL SCAN** control moves the CRT beam across the horizontal axis of the CRT graticule. In the EXT position, a voltage of 0 to +10 V, applied to the rear-panel **HORIZ|TRIG** connector, deflects the CRT beam across the full 10-division screen.

VERTICAL DISPLAY — Display modes are activated by three push buttons. Press any of these push buttons to cancel any other mode.

- **10 dB/DIV** — When this push button is activated, the display is a calibrated 10 dB/division with an 80 dB dynamic range.
  1. Press **[VIEW A]** and **[VIEW B]** to turn these displays on.
  2. **Set** the **REFERENCE LEVEL** to **-20 dBm**.

   3. Press [10 dB/DIV].
   4. Set the FREQUENCY SPAN/DIV to 20 kHz.
   5. Use the CENTER/MARKER FREQUENCY control to tune the CAL OUT signal to center screen.
   6. Use the REFERENCE LEVEL control to reduce the REFERENCE LEVEL in 10 dB steps. The display steps in 1 division increments, representing 10 dB/division.
   7. Return the REFERENCE LEVEL readout to -20 dBm.

- 2 **dB/DIV** — When this push button is pressed, the display is a calibrated 2 dB/division with 16 dB of dynamic range.
   1. Press [2 dB/DIV].
   2. Use the REFERENCE LEVEL control to reduce the REFERENCE LEVEL readout to -6 dBm. The display now steps 1.0 division for each two steps of the REFERENCE LEVEL control.
   3. Return the REFERENCE LEVEL readout to -20 dBm.
- **LIN** — When this push button is pressed, the display is linear between the reference level (top of the graticule) and zero volts (bottom of the graticule), and the CRT VERTICAL DISPLAY reads out in volts/division.
   1. Press [LIN]. The Vertical Display readout changes to mV/division.

PULSE STRETCHER — When this push button is pressed, the fall-time of video signals increases so narrow video pulses will show on the display.

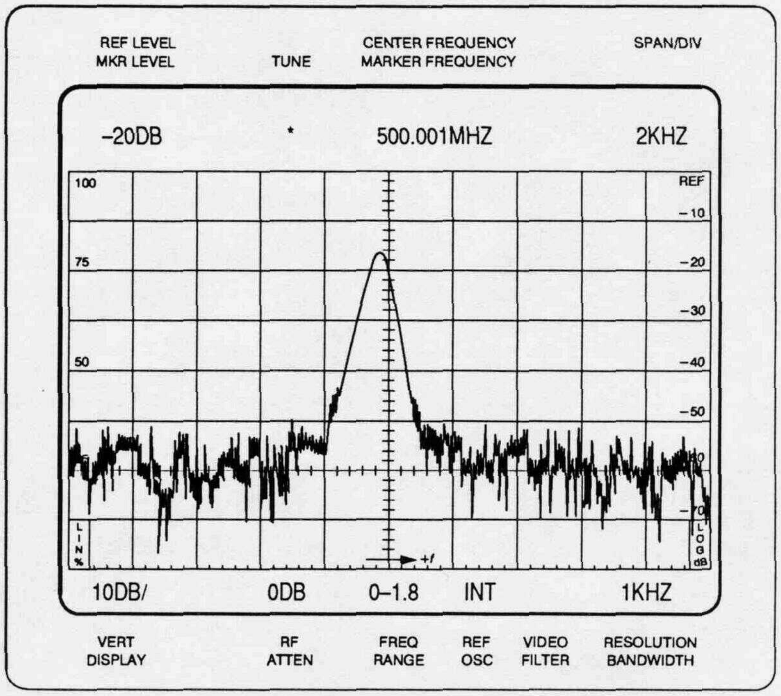
1. Select these front-panel control settings:

FREQUENCY SPAN/DIV	100MHZ
VERTICAL DISPLAY	10DB/
TIME/DIV	1 MS
VIEW A and VIEW B	OFF

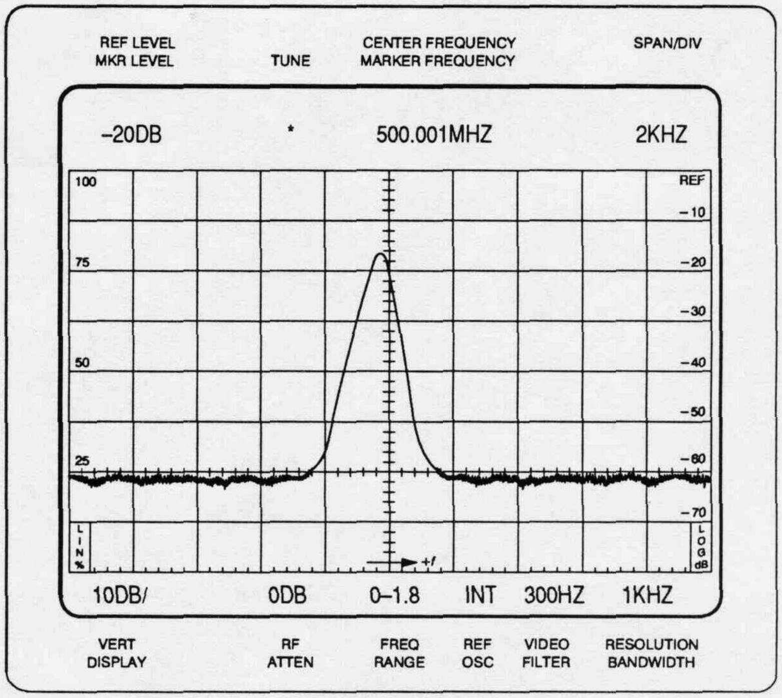
2. Press [PULSE STRETCHER]. The signal peaks should increase in brightness.
3. Press [PULSE STRETCHER] to turn off the PULSE STRETCHER mode.
4. Set the TIME/DIV to AUTO.
5. Press [VIEW A] and [VIEW B] to turn these displays on.

VIDEO FILTER — Two filters can be independently selected to provide WIDE or NARROW (approximately 1/30th or 1/300th of the resolution bandwidth) filtering to reduce noise.

1. Use the CENTER/MARKER FREQUENCY control to tune the 500 MHz CAL OUT signal to center screen.
2. Change the FREQUENCY SPAN/DIV readout to 2 kHz.



A. Spurii and IM obscured in the noise



B. Same display with Video Filter activated

Figure 5-3: Integrating a Display With the VIDEO FILTER

3. Adjust the REFERENCE LEVEL as needed to view the noise floor.
4. Alternately press the [WIDE] and [NARROW] Video Filter push buttons. The noise is reduced as the filter is turned on (see Figure 5-3). The NARROW filter has a more pronounced effect on noise reduction. Note the change in sweep rate when the **TIME/DIV** selector is in the AUTO position.
5. Turn both Video Filters off.

DIGITAL STORAGE — Select either one or both of the A and B waveforms from digital storage. The amplitude of a signal should remain constant when digital storage is turned on (VIEW A or VIEW B activated). The **PEAK/AVERAGE** control positions a cursor over the vertical window of the screen. Noise and signal levels are averaged below the cursor and peak-detected above the cursor.

- VIEW A — When this push button is pressed, the A waveform from digital storage is displayed. With SAVE A mode off, the A waveform is updated each sweep as the beam travels from left to right. With SAVE A mode on, the waveform is not updated.
- VIEW B — When this push button is pressed, the B waveform is displayed. When both VIEW A and VIEW B modes are active, the A and B waveforms are interlaced and displayed. Both waveforms are updated each sweep. Update of the A waveform depends on the state of SAVE A mode.
- SAVE A — When SAVE A mode is activated, the A waveform with its readout is saved. In this mode, the data for the A waveform is not updated each sweep. If either VIEW B mode or B-SAVE A mode is on, the readout reflects the current 495/P setup. The readout for the saved waveform will be displayed any time SAVE A mode is on, and the VIEW B and B-SAVE A modes are off.
    1. Press [SAVE A] to store the waveform in the A register.
    2. Press [VIEW B] to turn it off.
    3. Change the setting of the REFERENCE LEVEL control. The A display will not change.
    4. Press [SAVE A] to turn this mode off.
- MAX HOLD — When this push button is pressed, the maximum signal amplitude at each memory location is stored. The waveform is updated only when signal data is greater than that previously stored. To verify operation, perform the following procedure:
    1. Return the REFERENCE LEVEL readout to -20 dBm.
    2. Press [MAX HOLD] to turn this mode on.
    3. Change the setting of the CENTER/MARKER FREQUENCY control. The maximum level at each screen location will be retained.
    4. Press [MAX HOLD] to turn this mode off.

- **B-SAVE A** — Press this push button to display the arithmetic difference between an updated B waveform and a SAVE A waveform. The SAVE A function is automatically activated when **[B-SAVE A]** is pressed.

  The reference (zero difference) level is factory set at graticule center. The position of this reference level can be changed by qualified service personnel. Positive differences between the two displays appear above this line and negative differences below the line.

  1. Press **[VIEW A] and [VIEW** B] to turn these displays on.
  2. Press **[SAVE** A] to store the waveform in the A register.
  3. Press **[B-SAVE A]** to view the difference between the B and SAVE A waveforms.
  4. Press **[SAVE A]** to turn this mode off.

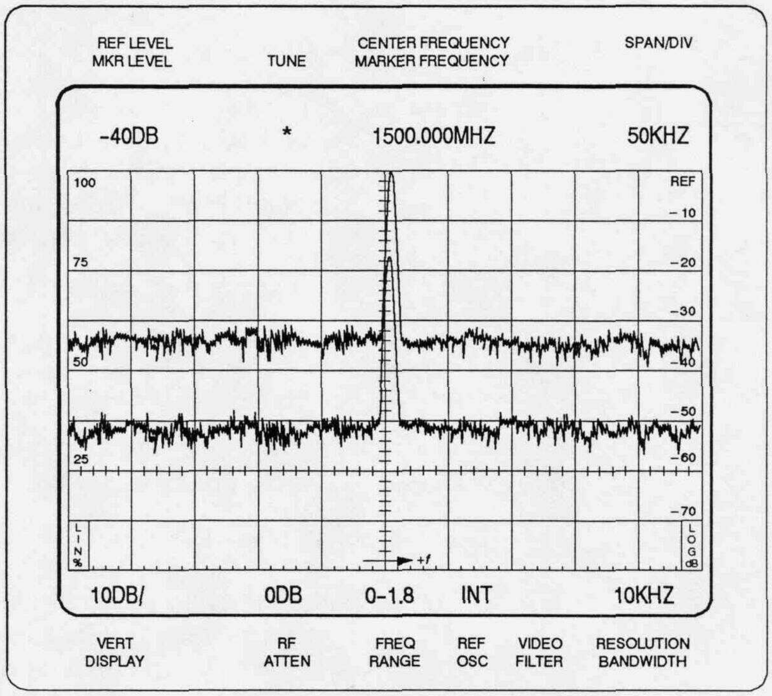
- **PEAK/AVERAGE** — When digital storage is on, this control positions a horizontal line, or cursor, anywhere within the graticule window. Signals above the cursor are peak detected. Signals below the cursor are averaged by the digital storage. To verify operation, move the cursor within the noise level. The noise amplitude will change as the cursor is positioned.

IDENT — When the identify function is turned on, the waveform is vertically displaced on alternate sweeps. The frequencies of the 1st and 2nd local oscillators are moved so that true signals are not displaced horizontally on alternate sweeps while spurious signals are shifted significantly, or off screen. The **FREQUENCY SPAN/DIV** setting must be **50 kHz** or less before IDENTIFY mode can be turned on. Refer to *Using the Signal Identifier* in *Section 6, Operation,* for more details.

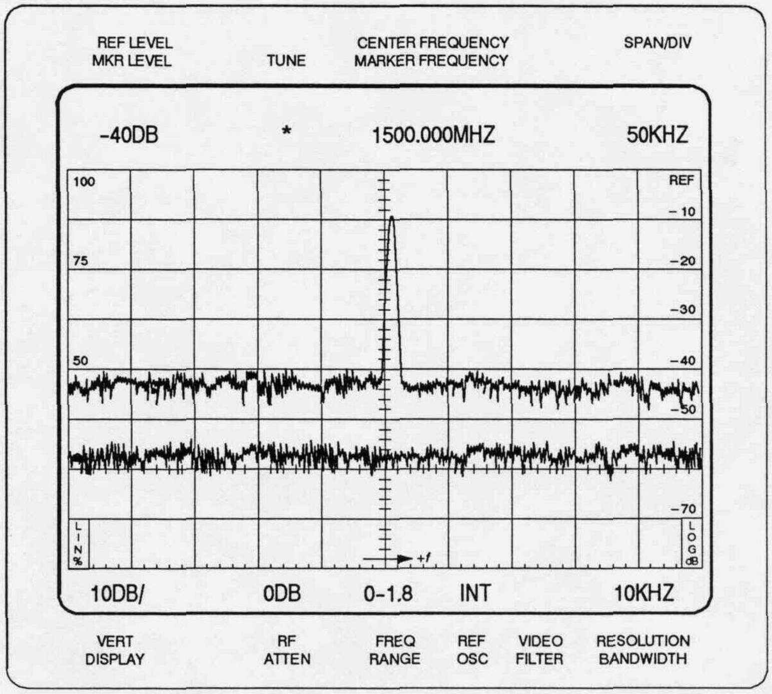
1. Select these front-panel control settings:

   CENTER/MARKER FREQUENCY 1500MHZ
   FREQUENCY SPAN/DIV 50KHZ
   REFERENCE LEVEL .... -40DBM
   VERTICAL DISPLAY 10DB/

2. Press **[IDENT]** to turn the IDENTIFY mode on.
3. There will be no horizontal displacement of the 100MHz signal on alternate sweeps. To help determine if the signal is true or spurious (see Figure 5-4), decrease the sweep rate or push **[SAVE A]** with both VIEW A and VIEW B on, so a comparison can be made.
4. Press **[IDENT]** to turn the IDENTIFY mode off.



A. Typical response of a true or real signal



B. Typical response from a false signal. Signal for bottom sweep is off screen

Figure 5-4: Using the IDENT Feature to Identify a Real or True Response

AUTO RESOLN — When this push button is pressed and FREQUENCY SPAN/DIV and TIME/DIV settings are changed, resolution bandwidth is automatically selected by the processor to maintain a calibrated display. The UNCAL indicator should not light over the FREQUENCY SPAN/DIV range if the TIME/DIV selector is in the AUTO position.

1. To check operation, change **FREQUENCY SPAN/DIV or TIME/DIV** settings. The **RESOLUTION BANDWIDTH** will change automatically.
2. Return the **TIME/DIV** control to **AUTO.**

MAX SPAN — When activated, the span switches to maximum and the 495/P sweeps the full band. When deactivated, the FREQUENCY SPAN/DIV returns to its previous setting.

ZERO SPAN — When activated, the FREQUENCY SPAN/DIV shifts to zero for a time-domain display. When deactivated, the FREQUENCY SPAN/DIV returns to its previous setting.

FREQUENCY SPAN/DIV — As this control is rotated, the FREQUENCY SPAN/DIV changes between 0 and MAX. The display indicates the change.

RESOLUTION BANDWIDTH — As this control is rotated, the resolution bandwidth changes in decade steps from 10 Hz to 1 MHz, and then to 3 MHz. The AUTO RESOLN mode must be off to change resolution bandwidth with the RESOLUTION BANDWIDTH control.

REFERENCE LEVEL — With 10 dB/DIV VERTICAL DISPLAY active and FINE mode off, the REFERENCE LEVEL readout steps in 10 dB increments as the control is rotated. When FINE mode is activated, the steps are 1 dB.

In the 2 dB/DIV mode, the steps are 1 dB with FINE mode off and 0.25 dB with FINE mode on.

When the Vertical Display factor is 4 dB/div or less with FINE mode on, the 495/P switches to the delta A mode. In the delta A mode, the REFERENCE LEVEL readout goes to 0.00 dB, then steps in 0.25 dB increments as the **REFERENCE LEVEL** control is rotated.

1. **Set** the **MIN RF ATTEN dB** control to **0 dB** and **VERTICAL DISPLAY to 10 dB/DIV.**
2. Rotate the **REFERENCE LEVEL** control counterclockwise to **40 dBm,** then clockwise to **−110** dBm. The REFERENCE LEVEL readout changes in 10 dB increments.
3. Press **[FINE]**.
4. Change the setting of the **REFERENCE LEVEL** control. The REFERENCE LEVEL readout now steps in 1 dB increments.

5. Press **[Blue–SHIFT] [dB/DIV]** and enter 4 dB (press [4] **[dB]**) with the DATA ENTRY push buttons. The REFERENCE LEVEL readout goes to 0.00 dB.
6. Rotate the **REFERENCE LEVEL** control. The REFERENCE LEVEL now steps in 0.25 dB increments from the 0.00 dB reference.

MIN RF ATTEN dB — This control sets the minimum amount of RF attenuation in the signal path, regardless of the REFERENCE LEVEL control setting.

1. To check operation, select these front-panel control settings:

CENTER/MARKER FREQUENCY	100MH2
FREQUENCY SPAN/DIV	500KHZ
REFERENCE LEVEL	−20DBM
VERTICAL DISPLAY	10DB/
FINE	OFF

2. **Set** the **MIN RF ATTEN dB** selector to **20.**
3. Change the **REFERENCE LEVEL** setting to **-50 dBm.** The RF ATTENUATION readout will not go below 20 dB.

FINE — When activated, the **REFERENCE LEVEL** control steps decrease. Refer to the REFERENCE LEVEL check earlier in this section.

MIN NOISE/MIN DISTORTION — This push button selects one of two methods that select RF attenuator and IF gain. MIN NOISE mode (button illuminated) reduces the noise level by reducing attenuation 10 dB and decreasing IF gain 10 dB. MIN DISTORTION mode reduces IM distortion due to input mixer overload. To observe any change, the amount of RF ATTENUATION displayed by the CRT readout must be 10 dB higher than the MIN RF ATTEN dB selector setting.

1. To check operation, select these front-panel control settings:

CENTER/MARKER FREQUENCY	100MHZ
FREQUENCY SPAN/DIV	500KHZ
REFERENCE LEVEL	-20DBM
VERTICAL DISPLAY	10DB/
MIN RF ATTEN dB	0 (NORM)

2. **The RF ATTENUATION** readout will indicate 0 dB.
3. Press **[MIN NOISE/MIN DISTORTION]** to turn on MIN DISTORTION mode. The noise floor will rise approximately 10dB, and the **RF ATTENUATION** readout will change to 10 **dB.**
4. Press **[MIN NOISE/MIN DISTORTION]** to turn on MIN NOISE mode.

UNCAL — This indicator lights when the display is uncalibrated.

1. **Set** the **TIME/DIV** control to 5 **ms**.
2. Press **[AUTO RESOLN]** to turn the AUTO RESOLUTION mode off.
3. **Set** the **RESOLUTION BANDWIDTH to 10 kHz.**
4. The UNCAL indicator should light and remain lit until the **FREQUENCY SPAN/DIV** readout is reduced to **50 kHz,** or the **RESOLUTION BANDWIDTH** is increased to **100 kHz.**
5. Select these front-panel control settings before proceeding:

CENTER/MARKER FREQUENCY	100MHZ
FREQUENCY SPAN/DIV	100MHZ
REFERENCE LEVEL	-20DBM
AUTO RESOLN	ON
TIME/DIV	AUTO

SHIFT — These push buttons shift multiple-function push buttons to their alternate function. The names of most of these alternate functions are printed in blue or green lettering next to the push button. The shift mode deactivates after the function has been performed.

DATA ENTRY push buttons for the shift mode are labeled with orange lettering.

RECALL SETTINGS/STORE — When this push button is pressed, the 495/P lists the settings, with their center frequency, that are stored in memory (registers 0-9). The 0 register holds the power-down settings so they can be recalled after power-up. Press **[Blue-SHIFT] [STORE]** to store the existing front-panel setup in one of the available registers.

1. Press **[Blue-SHIFT] [STORE]** and select register number 1 with the DATA ENTRY push buttons to store the current front-panel setup.
2. Change front-panel push button and control settings.
3. Press **[RECALL SETTINGS] [1]** to recall the setup.
4. The instrument front-panel set-up returns to that previously entered, with the exception of the TIME/DIV and RF ATTENUATION settings.

COUNT and [Blue-SHIFT] COUNT RESOLN — Press **[COUNT]** to activate a count for any signal within the center two divisions of the screen, or below the dot marker. The signal to be counted must be 20 dB above the noise floor and greater than 60 dB below the reference level. The resolution of the counter is selected when in the Count Resolution mode. Press **[Blue-SHIFT] [COUNT RESOLN]** to set counter resolution to 1 Hz using the DATA ENTRY push buttons and the units terminator push button.

1. To check the counter operation, select these front-panel control settings:

CENTER/MARKER FREQUENCY	100MHZ
FREQUENCY SPAN/DIV	10KHZ
REFERENCE LEVEL	+30DBM
RESOLUTION BANDWIDTH	10KHZ
VERTICAL DISPLAY	10DB/
FINE	OFF

2. Adjust **CENTER/MARKER FREQUENCY** to position the 100MHz signal so the 20 dB level, above the noise floor, crosses the center graticule line.
3. Press **[Blue−SHIFT] [COUNT RESOLN] [1] [0] [0] [Hz]** to establish a counter resolution of 100 Hz.
4. Press **[COUNT]** to display the counted frequency to 100 Hz resolution.
5. Press **[COUNT]** again to turn off the COUNT mode.

A F — When the delta F function is activated, FREQUENCY readout initializes to 0. The frequency difference, to a desired signal or point on the display, can be determined by tuning that point to center screen and noting the readout. If the delta frequency is tuned below 0, the readout will include a minus sign.

1. To check the operation, select these front-panel control settings:

CENTER/MARKER FREQUENCY	500MHZ
FREQUENCY SPAN/DIV	50MHZ
REFERENCE LEVEL	-20DBM
RESOLUTION BANDWIDTH	AUTO
VERTICAL DISPLAY	10DB/

2. Press **[ΔF]**. The FREQUENCY readout resets to 0 MHz.
3. Rotate the **CENTER/MARKER FREQUENCY** clockwise to position the next signal peak at center screen. The FREQUENCY readout should not read **100 MHz.**
4. Press **[AF]** to turn off the AF mode.

TUNE CF/MARKER — When this push button is lit, a marker appears as a bright spot on the screen and the CENTER/MARKER FREQUENCY control tunes the marker. The FREQUENCY readout remains constant. An asterisk (*) between the FREQUENCY and REFERENCE LEVEL readout indicates that the CENTER/MARKER FREQUENCY control is tuning the Marker Frequency. The marker level and marker frequency appear on the second readout line on the screen.

+STEP/-STEP — When one of these push buttons is pressed, the MARKER or CENTER FREQUENCY is increased or decreased by increments. The increment is set with the **[Blue–SHIFT]** [STEP ENTRY] (CENTER FREQUENCY) or **[Green–SHIFT]** [STEP SIZE] (MARKER) push button sequence. Perform the following steps while in the TUNE CF mode (LED not lit):

1. Select these front-panel control settings:

CENTER/MARKER FREQUENCY	OOMHZ
FREQUENCY SPAN/DIV	50MHZ
REFERENCE LEVEL	-20DBM
RESOLUTION BANDWIDTH	AUTO
VERTICAL DISPLAY	10DB/

2. Press [Blue-SHIFT] [STEP ENTRY], and enter 25 MHz with the DATA ENTRY push buttons (press [2] [5] **[MHz]**).
3. Press **[+STEP]**; the FREQUENCY readout increases to **125** MHz.
4. Press [+STEP] again and the FREQUENCY readout increases to 150 MHz.
5. Push **[–STEP]** twice and the FREQUENCY readout decreases to **125** MHz and **100** MHz, respectively.

[Blue-SHIFT] MACRO MENU — (495P Instruments Only) This push button is used to select a macro to be run. The title of the macro is displayed next to the macro number (0-7) . Perform the following steps to check out the operation of the [MACRO MENU] push button.

With the instrument under remote control, enter the following 4041 test program to enter a macro into menu location 5:

```
 80 Z=1 ! ADDRESS OF SPECTRUM ANALYZER
100 Print #z:KILL 5
110 Print #z:STMAC 5,"return test"
120 Print #z:FREQ 100M; GOSUB 1; FREQ 200M; GOSUB 1;
      FREQ 300M; GOSUB 1; DONE
130 Print #z:LABEL 1; SWEEP; MFGIB; MCSTOP; RETURN
140 Print #z:EMAC
```

Line 80 defines z as the spectrum analyzer address. Line 100 clears out location 5 in case there was already a macro there. Line 110 gets the spectrum analyzer ready to store macro in location 5 with the title of "return test." Line 120 sets the CENTER FREQUENCY to 100 MHz and prepares the spectrum analyzer to check the CENTER FREQUENCY again at 200 MHz and 300 MHz. Line 130 starts a new sweep and waits until the sweep has finished before executing the next command; moves the primary marker to the peak of the largest on-screen signal; stops the macro to wait for you to press [RUN/STOP] on the instrument front panel to continue; and returns to line 120 to find the next CENTER FREQUENCY setting (200 MHz). This sequence is followed for the 200 MHz and 300 MHz settings. Line 140 tells the spectrum analyzer that this is the end of the macro and to quit storing.

1. Press **[RESET TO LOCAL]** to exit remote control and return the instrument to local control.
2. Press **[Blue−SHIFT] [MACRO MENU].** The current macro menu will appear on the screen with the titles of all stored macros and the menu locations where they are stored.
3. To select the test program just entered into location 5, press DATA ENTRY push button 5. The macro will begin running.
4. When the macro has moved the primary marker to the peak of the 100 MHz signal, the macro will wait (MCSTOP) for you to push **[RUN/STOP]** to run another sweep at 200 MHz.
5. When the macro has moved the primary marker to the peak of the 200 MHz signal, the macro will wait (MCSTOP) for you to push **[RUN/STOP]** to run another sweep at 300 MHz.
6. If you press **[RESET TO LOCAL]** at any time, the message MACRO=STOP(5) will appear on the right-center of the screen. This means that the macro in menu location 5 is now running. This will not interrupt the macro.
7. When the macro has moved the primary marker to the peak of the 300 MHz signal, the macro will know that it is done.
8. If you press **[RESET TO LOCAL]** now, the message MACRO=OFF(5) will appear on the screen. This means that the last macro you were running was from menu location 5 and it is now off.

[Blue-SHIFT] RUN/STOP — (495P Instruments Only) This push button has three different functions, depending on the current status of the macros.

1. If a macro is running, pressing **[RUN/STOP]** will stop the macro.
2. If a macro is stopped (because **[RUN/STOP]** was pressed or because of the MCSTOP command as in the MACRO MENU example), pressing **[RUN/STOP]** restarts the macro.
3. If there is no macro running or stopped, pressing **[RUN/STOP]** will cause the last macro that was run to be run again.

RESET TO LOCAL — (495P Instruments Only) The **[RESET TO LOCAL]** push button is lighted when the 495P is under control of a GPIB controller. While under remote control, the other front-panel controls are not active, but indicators will still reflect the current state of all front-panel functions, except TIME/DIV, PEAK/AVERAGE and MIN RF ATTEN dB.

This push button is not lighted when the 495P is under local operator control. While under local control, the 495P does not execute GPIB messages that would conflict with front-panel controls or change the waveforms in digital storage.

When the push button is pressed, local control is restored to the operator unless the controller prevents this with the local lockout message. Programmable functions do not change when switching from remote to local control, except as necessary to match the settings of front-panel controls for TIME/DIV, MIN RF ATTEN dB, and PEAK/AVERAGE.

The internal instrument and front-panel firmware version numbers and the GPIB address are flashed on the CRT when the push button is pressed. The GPIB primary address is updated if the GPIB ADDRESS switches have been changed.

For another function of this push button when in the talk-only mode, refer to *Talk-Only/Listen-Only Operation* in Section 6 of this manual.

GPIB Function Readout — (495P Instruments Only) A single character appears in the lower CRT readout when the 495P is talking (T), listening (L), or requesting service (S). Two characters will appear in this location if the 495P is talking or listening and also requesting service, or is in the talk/listen mode.

DATA ENTRY — Some functions require a parameter or command to be entered that includes numerical data. This data is entered with the DATA ENTRY push buttons as follows:

1. Select these front-panel control settings:

CENTER/MARKER FREQUENCY	500MHZ
FREQUENCY SPAN/DIV	50KHZ
REFERENCE LEVEL	-20DBM
RESOLUTION BANDWIDTH	AUTO
VERTICAL DISPLAY	10DB/

2. Press the push button sequence **[Blue−SHIFT] [FREQ] [5] [0] [0] [MHz]** using the DATA ENTRY push buttons. This sets the FREQUENCY to 500.000 MHz. (The displayed readout resolution is a function of the current FREQUENCY SPAN/DIV setting.)

3. With the DATA ENTRY push buttons, set the SPAN/DIV readout to any desired setting (press **[Blue-SHIFT] [SPAN/DIV] [5] [2] [MHz]** for a **52** MHz/DIV setting as an example). The FREQUENCY SPAN/DIV readout will be set to the figures entered with the DATA ENTRY push buttons (rounded to 2 digits).

4. Enter a reference level with the DATA ENTRY push buttons (press **[Blue-SHIFT] [REF LEVEL] [3] [2] [−dBx]** for a -32 dBm setting as an example). The REFERENCE LEVEL readout will be set to the figures entered with the DATA ENTRY push buttons.

5. Enter a desired VERTICAL DISPLAY factor with the DATA ENTRY push buttons (press **[Blue-SHIFT] [dB/DIV] [5] [dB]** for a 5dB/DIV setting as an example). The VERTICAL DISPLAY readout will be set to the figures entered with the DATA ENTRY push buttons (rounded to 2 digits).

STORE DISP — Press **[Blue–SHIFT] [STORE DISP], the** register number where you want to store the display, and the display (A or B) you want stored (only if SAVE A mode is on).

RECALL — Press **[Blue-SHIFT] [RECALL],** the register number from the displayed menu, and the part of digital storage (A or B) where you want to have the recalled waveform placed.

SAVE A mode is automatically activated to prevent an overwrite. If A is selected, VIEW A must be on to observe the recalled waveform and VIEW B must be off to see the readout that applies to the recalled waveform. If VIEW B and VIEW A are on, both the recalled waveform in A and the current waveform in B will be displayed. Readout will apply to the current B waveform.

If B is selected, the next sweep will overwrite the display unless SINGLE SWEEP mode was activated before selecting B. A message will appear on the screen as a reminder of this. VIEW B must be on to observe the recalled waveform and its readout. Remember to deactivate SINGLE SWEEP mode when leaving this recalled mode.

1. Establish a display on the screen.
2. Press **[Blue-SHIFT] [STORE DISP]** followed by the memory register number (0-8) to place the display in a memory register, and the display (A or B) you wish stored (only if SAVE A mode is on).
3. Change the characteristics of the current display with either the **REFERENCE LEVEL** or **FREQUENCY SPAN/DIV** control.
4. Press **[Blue-SHIFT] [RECALL]** followed by the register number where the display was stored (note the center frequency listing of the stored displays in each register); then press **[VIEW A]** so the recalled waveform is placed in the A storage register.
5. If VIEW A is on and VIEW B off, the recalled display with its readout will now become the A display. SAVE A mode will activate to prevent overwrite. If VIEW A and VIEW B are on, both the recalled display and the current B display will be on screen. Since the most current display is the B waveform, the readout will show the parameters for the B display. Switch VIEW B off to see the readout applicable to the recalled A waveform.
6. Recall a stored display into the B section by repeating the process just described. Before starting the process, press **[SINGLE SWEEP]** so the recalled waveform will not be overwritten by the next sweep. A message will appear when you select the B section to remind you of this. When returning to normal operation, remember to turn off SINGLE SWEEP mode if you have not already done so.

NOTE

If an attempt is made to recall a display from an empty location, error message NON-VOLATILE RAM will be displayed.

MKR OFF — Press **[Blue–SHIFT] [MKR OFF]** to turn off the markers.

MKR → CENTER — Press **[Blue-SHIFT] [MKR → CENTER]** to bring a marker signal to center screen.

1. Select these front-panel control settings:

CENTER/MARKER FREQUENCY	100MHZ
FREQUENCY SPAN/DIV	200KHZ
REFERENCE LEVEL	-20DBM
RESOLUTION BANDWIDTH	100KHZ
VERTICAL DISPLAY	10DB/

2. **Use** the **CENTER/MARKER FREQUENCY** control to tune the signal two divisions from center-screen.
3. Press **[TUNE MKR]** to turn on a marker.
4. **Use the CENTER/MARKER FREQUENCY** control to tune the Marker to the top of the signal.
5. Press **[Blue-SHIFT] [MKR CENTER]**. The signal and Marker should move to center screen.

READOUT — Press **[Blue-SHIFT] [READOUT]** to turn off the CRT readout of the REFERENCE LEVEL, FREQUENCY, SPAN/DIV, VERTICAL DISPLAY, RF ATTENUATION, FREQ RANGE, RESOLUTION BANDWIDTH, VIDEO FILTERS, MKR LEVEL, and MARKER FREQUENCY.

Press **[Blue-SHIFT] [READOUT]** to activate the readout on the display.

FREQ START STOP — Activating **[Blue-SHIFT] [FREQ START STOP]** allows you to enter a start and stop frequency with the DATA ENTRY push buttons. Use the following example:

1. Enter a start frequency of 90 MHz with the DATA ENTRY push buttons (press **[Blue-SHIFT] [FREQ START STOP] [9] [0] [MHz]**).
2. Enter stop frequency 210 MHz with the DATA ENTRY push buttons (press **[2] [1] [0] [MHz]**).
3. The signals at the 1st and 9th graticule line should be 100 MHz apart. Set the **VERTICAL DISPLAY** to **10 dB/DIV** and observe that the **FREQUENCY SPAN/DIV** readout is **12 MHz.**

STEP ENTRY — Activate **[Blue-SHIFT] [STEP ENTRY]** to set the step to a desired amount. Perform the following steps while in the TUNE MARKER mode (TUNE CF/MKR LED lit).

1. Press **[Blue-SHIFT] [STEP ENTRY]** and enter a step frequency of 10 MHz with the DATA ENTRY push buttons (press **[Blue-SHIFT] [FREQ START STOP] [1] [0] [MHz]**).

2. Press **[+STEP]** and note that the MARKER FREQUENCY readout increases by 10 MHz (160 MHz).
3. Press **[−STEP]** to return the MARKER FREQUENCY setting to 150 MHz.
4. Press **[TUNE MKR]** to turn the marker off.

BASELINE CLIP — Press **[Blue−SHIFT] [BASELINE CLIP]** to clip (blank) the baseline of the display up to about one graticule division.

RESET — Press **[Blue-SHIFT] [RESET]** to return the instrument to the original power-up state.

REFERENCE LEVEL UNITS — Use this feature to change the REFERENCE LEVEL readout units, or to apply an offset value.

1. Change the **REFERENCE LEVEL** readout to 0 dBm.
2. Press **[Blue-SHIFT] [REFERENCE LEVEL UNITS]**.
3. Select item 1 (DBV). The REFERENCE LEVEL readout changes to −13 dBV.
4. Press **[Blue-SHIFT] [REFERENCE LEVEL UNITS] [0]** to return to dBm units.

Green−SHIFT Functions — Press **[Green−SHIFT]** to change the push buttons that have more than one function. Some functions require a parameter or command to be entered that includes numerical data. This data is entered with the DATA ENTRY push buttons. Most green-shifted functions are marker related.

Markers — The markers provide direct readout of frequency and amplitude information of any point along any displayed trace or relative (delta frequency), and amplitude information between any two points along any displayed trace or traces (in delta only). In the delta mode, only the difference in frequency and amplitude will be displayed. Two independent marker frequencies and amplitudes cannot be displayed at the same time.

1. Select these front-panel control settings:

CENTER/MARKER FREQUENCY	100MHZ
FREQUENCY SPAN/DIV	5MHZ
REFERENCE LEVEL	-10DBM
RESOLUTION BANDWIDTH	AUTO
VERTICAL DISPLAY	10DB/

2. Press **[TUNE CF/MKR].** A bright dot, the marker, appears on screen, as well as a second line of readout with an asterisk between the MKR LEVEL and MARKER FREQUENCY readout.

3. Rotate the **CENTER/MARKER FREQUENCY** knob, and note that the marker tunes.
4. Press **[TUNE CF/MKR]** again. The indicator button will not be lit, but the marker remains on screen.
5. Rotate the **CENTER/MARKER FREQUENCY** control and note that the signal tunes. The marker does not move, but both the CENTER FREQUENCY and the MARKER FREQUENCY readouts change. Also, the asterisk has now moved to the first readout line, indicating that the center frequency is being tuned.
6. Return the **FREQUENCY** readout to **100 MHz and** press **[TUNE CF/ MKR]** to activate the marker.

PEAK FIND — Press **[Green–SHIFT] [PEAK FIND]** to move the marker to the top of the signal.

D MKR, 1←MKR→2, MKR START STOP, MKR → REFERENCE LEVEL, ASSIGN 1, ASSIGN 2 — Press **[Green–SHIFT] [A MKR]** to activate a second marker at the position of the single marker on the trace. Parentheses will be added to the second line readout.

1. Rotate the **CENTER/MARKER FREQUENCY** control. Two markers will be on screen. Set the delta marker readout to 5 MHz.
2. Press **[Green-SHIFT] [1←MKR→2].** The left marker is now brighter. This indicates that it will be tuned.
3. Rotate the **CENTER/MARKER FREQUENCY** control to tune the marker until the readout shows **-10 MHz.** This is the difference in frequency between the two markers (the delta marker frequency).
4. Press **[Green-SHIFT] [MKR START STOP].** The markers now appear at the left and right edge of the screen. The waveform will be scaled to the marker locations.
5. Press **[Green-SHIFT] [A MKR]** again. There will be just a single marker now, and the parentheses around the second line of readout will disappear.
6. Press **[Green-SHIFT] [PEAK FIND]**; then **[Blue–SHIFT] [MKR→CENTER].** The signal is now at center screen.
7. Press **[Green-SHIFT] [MKR→REFERENCE LEVEL].** The signal and the marker move to the top of the screen.
8. **Set the FREQUENCY SPAN/DIV** readout to **500 kHz.**
9. **Set the RESOLUTION BANDWIDTH** to **1 MHz** (press **[AUTO RESOLN]** first).
10. Press **[MARKER MENU].** Nine menu items are displayed.
11. Press **[7]** and you will be prompted to enter the bandwidth number.
12. Enter **10 dB** with the DATA ENTRY push buttons (press **[1]** [0] [dB]).

13. Press **[Green–SHIFT] [BANDWIDTH MODE]** and observe that the Delta Markers have moved down 10 dB from the top of the signal. Delta frequency is slightly greater than 1 MHz wide.
14. Press **[Green-SHIFT] [BANDWIDTH MODE]** again to exit BANDWIDTH MODE.
15. **Press [Blue–SHIFT] [MKR OFF]**.
16. Use the DATA ENTRY push buttons to set the **FREQUENCY** readout to **200 MHz** and the **FREQUENCY SPAN/DIV** readout to **25 MHz.**
17. Set the **Peak/Average** cursor to the bottom of the screen.
18. **Press [TUNE CF/MKR].**
19. Press **[Green-SHIFT] [PEAK FIND].** The marker will now be located on the 100 MHz CAL OUT (the signal nearest the left edge of the screen).
20. Press **[MARKER MENU]**. Nine menu items are displayed.
21. Press [6] and the ASSIGN MENU is displayed with seven menu items.
22. Press [3] and note that both **[ASSIGN]** push buttons light.
23. Press **[Green-SHIFT] [ASSIGN** 1] to assign the Next Lower Peak function.
24. Press **[MARKER MENU]** again.
25. Press [6] to get the ASSIGN MENU.
26. Press **[2]**.
27. Press **[Green-SHIFT] [ASSIGN 2]** to assign the Next Higher Peak function.
28. Press **[Green-SHIFT] [ASSIGN 2]**. The marker will move to the 300 MHz CAL OUT harmonic.
29. Press **[Green-SHIFT] [ASSIGN 2]** one more time. The marker will move to the 200 MHz CAL OUT harmonic.
30. Press **[Green-SHIFT] [ASSIGN** 1] twice to return the marker to the original 100 MHz signal.
31. Press **[TUNE CF/MKR]** to turn the marker off.

SIGNAL TRACK — Press the **[Green-SHIFT] [SIGNAL TRACK]** sequence to keep a drifting signal on screen.

1. Select these front-panel control settings:

CENTER/MARKER FREQUENCY 100MHZ
FREQUENCY SPAN/DIV 5KHZ
REFERENCE LEVEL .... -20DBM
RESOLUTION BANDWIDTH 1KHZ

VERTICAL DISPLAY	10DB/

2. **Use** the **CENTER/MARKER FREQUENCY** control to tune the signal away from center-screen. The signal should be on screen.
3. Press **[Green−SHIFT] [SIGNAL TRACK]**. The signal will move back to center screen. SIGNAL TRACK will be indicated in the marker readout on the screen.
4. To exit the function, press **[Green-SHIFT] [SIGNAL TRACK]** again.

Gain Variation Between Resolution Bandwidths

Less *than < ±0.4 dB with respect to the 3 MHz filter, <0.8 dB between any two filters.*

1. Press **[Blue−SHIFT] [CAL]** and perform the steps prompted by the 495/R
2. Apply the **CAL OUT** signal to the **RF INPUT,** press **[Blue-SHIFT] [RESET],** and set the 495/P controls as follows:

CENTER/MARKER FREQUENCY	100MHZ
FREQUENCY SPAN/DIV	1MHZ
RESOLUTION BANDWIDTH	3MHZ
REFERENCE LEVEL	−18DBM
MIN RF ATTEN dB	0 (NORM)
VERTICAL DISPLAY	1DB/
WIDE VIDEO FILTER	ON
TIME/DIV	AUTO
PEAK/AVERAGE	Fully Clockwise

3. Adjust the **AMPL CAL** control to align the signal peak at the 6th graticule line and press **[SAVE A]**.
4. Change the **RESOLUTION BANDWIDTH to 1 MHz and SPAN/DIV** to **200 kHz.** Check that amplitude deviation from the 3MHZ reference (SAVE A trace) is no more than ±0.4 dB.
5. Change the **RESOLUTION BANDWIDTH** to **100 kHz** (300 kHz for Option 07) and the **SPAN/DIV to 50 kHz.**
6. **Set** the **RESOLUTION BANDWIDTH** to each of the remaining settings **(10 kHz to 10 Hz).** Check that amplitude deviation from the 3 MHz reference level is no more than ±0.4 dB.

Frequency Span/Div Accuracy

Frequency Span/Div Accuracy is ±5% of the selected Span/Div over the center 8 divisions of a 10 division display for values ≥50 Hz/Div, and ±10% of the selected span/div over the center 8 divisions of a 10 division display for values <50 Hz/Div.)

Span accuracy is the displacement error of CAL OUT markers from the center reference over the center 8 divisions of span. Linearity accuracy is determined by the displacement of CAL OUT signal markers from their specified positions over the center eight divisions of the display area, using the 1st graticule line as the reference.

1. Press **[Blue–SHIFT] [RESET]**; then set the 495/P controls as follows:

CENTER FREQUENCY	1GHZ
FREQUENCY SPAN/DIV	100MHZ
RESOLUTION BANDWIDTH	AUTO
REFERENCE LEVEL	-30DBM
TIME/DIV	AUTO
VERTICAL DISPLAY	10 DB/

2. Apply the CAL OUT signal to the RF INPUT.
3. **Set** the **CENTER/MARKER FREQUENCY** control to align the 100 MHz markers so that the 100 MHz/Div accuracy can be measured over the **center eight** divisions of the display. It may be necessary to change the **REFERENCE LEVEL to** obtain adequate marker amplitude.
4. Span is accurate when the 100 MHz lines are within 5% (2 minor divisions) of their reference graticule line over the center eight divisions. (It may be easier to observe the lines with DIGITAL STORAGE off.)
5. Linearity is accurate when the displacement of successive lines, over the center eight divisions, does not exceed 5% of 100 MHz (the FREQUENCY SPAN/DIV setting) or 0.2 division.

Resolution Bandwidth and Shape Factor

6 dB bandwidth within 20% of the selected bandwidth for all but the 10 Hz filter.

Shape factor is 7.5:1 or less for all bandwidths except the 10 Hz bandwidth.

The 10 Hz filter has a 60 dB bandwidth < 150 Hz.

1. Apply the **CAL OUT** signal to the **RF INPUT;** then press **[Blue-SHIFT] [RESET]** and set the 495/P controls as follows:

CENTER/MARKER FREQUENCY	100MHZ
SPAN/DIV	1MHZ
RESOLUTION BANDWIDTH	3MHZ
REFERENCE LEVEL	-20DBM
VERTICAL DISPLAY	2DB/
PEAK/AVERAGE	Fully Clockwise
TIME/DIV	AUTO

2. Press **[Green–SHIFT] [BANDWIDTH]** to turn on Bandwidth mode.
3. Press **[MARKER MENU] [7] [6] [dB]** to select a 6 dB bandwidth.

Table 5-1: Resolution Bandwidth and Shape Factor

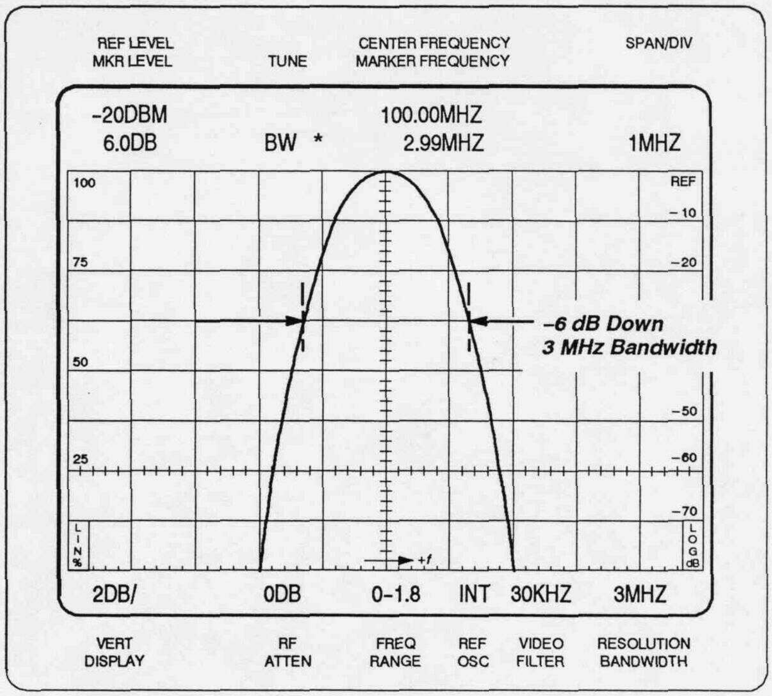
Filter	6 dB Bandwidth	60 dB Bandwidth	Shape Factor
3 MHz			
1 MHz			
300 kHz			
100 kHz			
10 kHz			
1 kHz			
100 Hz			

4. Record the measured 6 dB bandwidth for the 3 MHz filter in Table 5-1 (see Figure 5-5A). Bandwidth should equal 3 MHz ±600 kHz.
5. Reduce the **RESOLUTION BANDWIDTH to 1 MHz** and the **SPAN/DIV to 200 kHz**.

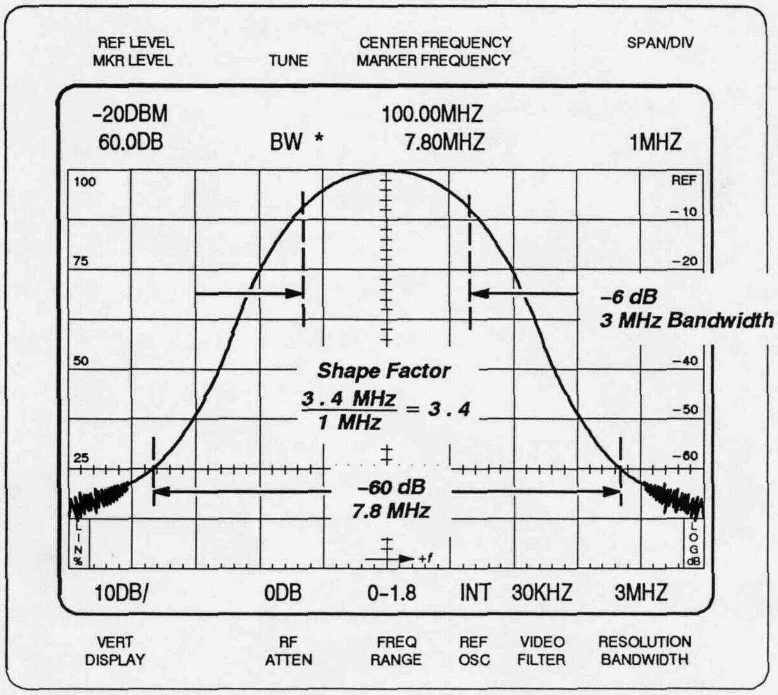
NOTE

*Press **[Green–SHIFT][PEAK FIND]** if the markers do not return to the signal after changing Resolution Bandwidth settings,*

6. Record the 6 dB bandwidth of the 1 MHz filter.
7. Reduce the **RESOLUTION BANDWIDTH to 100 kHz** and the **SPAN/DIV** to **20 kHz** (300 kHz and 50 kHz for Option 07).
8. Record the 6 dB bandwidth of the 100 kHz (300 kHz) filter.
9. Reduce the **RESOLUTION BANDWIDTH to 10 kHz** and the **SPAN/DIV to 5 kHz.**
10. Record the 6 dB bandwidth of the 10 kHz filter.
11. Reduce the **RESOLUTION BANDWIDTH to 1 kHz** and the **SPAN/DIV to 200 Hz.**
12. Record the 6 dB bandwidth of the 1 kHz filter.
13. Reduce the **RESOLUTION BANDWIDTH to 100 Hz** and the **SPAN/DIV to 20 Hz.**
14. Record the 6 dB bandwidth of the 100 Hz filter.
15. Press **[MARKER MENU] [7]** to select a new Bandwidth value, and enter **[6] [0] [dB]**.
16. Press **[10dB/DIV]**.



A. Measuring 6 dB down bandwidth



B. Measuring 60 dB down bandwidth and shape factor

Figure 5-5: Typical Display for Measuring Bandwidth and Shape Factor

17. Reduce the **RESOLUTION BANDWIDTH** to **10 Hz.** The 60 dB bandwidth should not exceed 150 Hz.
18. Increase the **RESOLUTION BANDWIDTH to 100 Hz** and the **SPAN/DIV to 200 Hz.**
19. Record the 60 dB bandwidth of the 100 Hz filter.
20. Increase the **RESOLUTION BANDWIDTH to 1 kHz** and the **SPAN/DIV to 2 kHz.**
21. Record the 60 dB bandwidth of the 1 kHz filter.
22. Increase the **RESOLUTION BANDWIDTH to 10 kHz** and the **SPAN/DIV to 10 kHz.**
23. Record the 60 dB bandwidth of the 10 kHz filter.
24. Increase the **RESOLUTION BANDWIDTH to 100 (300) kHz** and the **SPAN/DIV to 500 kHz.**
25. Record the 60 dB bandwidth of the 100 (300) kHz filter.
26. Increase the **RESOLUTION BANDWIDTH to 1 MHz** and the **SPAN/DIV to 1 MHz.**
27. Record the 60 dB bandwidth of the 1 MHz filter.
28. Increase the **RESOLUTION BANDWIDTH to 3 MHz** and the **SPAN/DIV to 2 MHz.**
29. Record the 60 dB bandwidth of the 3 MHz filter.
30. Using the 6 dB and 60 dB values recorded in Table 5-1, calculate the shape factor of all filters >10 Hz. Check that the shape factor is 7.5:1 or less. The shape factor is the ratio of −60 dB/−6 dB bandwidths (see Figure 5-5).

Check Reference Level Gain and RF Attenuator Steps

1. Apply the **CAL OUT** signal to the **RF INPUT;** then press **[Blue−SHIFT] [RESET]** and set the 495/P controls as follows:

CENTER/MARKER FREQUENCY	100MHZ
FREQUENCY SPAN/DIV	100KHZ
RESOLUTION BANDWIDTH	100KHZ
REFERENCE LEVEL	-20DBM
VERTICAL DISPLAY	10DB/
NARROW VIDEO FILTER	ON
TIME/DIV	AUTO

1. To check the RF Attenuator, increase **REFERENCE LEVEL** readout to **+40 dBm**. The signal peak will decrease 1 major division per 10 dB step of the RF ATTENUATION readout.

Table 5-2: 50 Ω Sensitivity Equivalent Input Noise Versus Resolution Bandwidth[a]

Frequency Range	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	300 kHz[b]	1 MHz	3 MHz
1 MHz to 1.8 GHz	-131 dBm	-125dBm	-115dBm	-105dBm	-95dBm	-90dBm	−85 dBm[c]	−80 dBm[d]

[a] Equivalent maximum input noise (average noise for each resolution bandwidth).

[b] Option 07 replaces the 100 kHz filter with a 300 kHz filter.

[c] Above 5 MHz.

[d] Above 10 MHz.

2. Set the 495/P controls as follows:

CENTER/MARKER FREQUENCY 200MHZ
REFERENCE LEVEL .... −20DBM

3. Increase the **MIN RF ATTEN dB** to **60 dB.** The noise level will increase 1 division for each 10 dB step. Keep the **MIN RF ATTEN dB** set to **60 dB.**
4. To check IF gain steps, switch the **REFERENCE LEVEL** control between **-20 dBm** and **+40 dBm.** The noise level will decrease 1 division per step.
5. Press **[FINE]**; then check that the trace rises 1 dB/step as the **REFERENCE LEVEL** is changed from **+40 dBm** to +30 **dBm.**
6. Press **[FINE]** again to turn the FINE mode off.
7. **Set** the **MIN RF ATTEN dB** setting to 0 dB.
8. Press **[MIN NOISE/MIN DISTORTION]** to select the MIN DISTORTION mode. The noise floor will rise about 1 division and the **RF ATTENUATION** increases **10 dB.** The REFERENCE LEVEL readout should not change.
9. Set the 495/P controls as follows:

REFERENCE LEVEL .... -60DBM
VERTICAL DISPLAY 2DB/

10. Adjust **REFERENCE LEVEL** so the signal level is near the top graticule line.
11. Change the **REFERENCE LEVEL** to **-54 dBm.** The REFERENCE LEVEL readout will change in 1 dB steps, and the display in 1 division steps.
12. Set **VERTICAL DISPLAY** readout to **1 dB/DIV** (press **[Blue−SHIFT] [dB/DIV] [1] [dB]**).
13. Change the **REFERENCE LEVEL** to **-60 dBm.** The signal amplitude will change in 1 dB increments (0.5 div).
14. Press **[FINE]** (Delta A mode). The REFERENCE LEVEL now reads 0.00 dB which denotes the Delta A mode.

15. Change the **REFERENCE LEVEL** control position. The **REFERENCE LEVEL** readout will change in **0.25 dB** increments.
16. Press **[FINE]** again to turn the FINE mode off.

Sensitivity, 1 MHz to 1.8 GHz

Refer to Table 5-2 for specifications. See *Section 2, Specification* for specifications relating to the 100 Hz to 1 MHz frequency range.

NOTE

Sensitivity is specified according to the input mixer average noise level. The calibrator signal is the reference used to calibrate the display.

1. Remove the **CAL OUT** signal from the **RF INPUT,** and terminate the Type N RF INPUT in its characteristic impedance of 50 Ω.
2. Press **[Blue–SHIFT] [RESET]**; then set the 495/P controls as follows:

SPAN/DIV	MAX
RESOLUTION BANDWIDTH	3MHZ
REFERENCE LEVEL	-85DBM
VERTICAL SCALE	2DB/
MIN RF ATTEN dB	0 (NORM)
WIDE VIDEO FILTER	ON
TIME/DIV	1 S
PEAK/AVERAGE	Fully Clockwise

3. Press **[TUNE]**. Use the **CENTER/MARKER FREQUENCY** control to place the marker on the highest noise floor location. This is usually near the right edge of the screen.
4. Press **[ZERO SPAN].**
5. Check that the marker amplitude readout indicates -80 dBm or less.
6. Press **[AUTO RESOLN]** to turn off AUTO RESOLUTION mode, and select the 1 MHz filter.
7. **Set** the **REFERENCE LEVEL** so that the trace is near mid-screen.
8. Check that the marker amplitude readout indicates −85 dBm or less.
9. Select the **100 kHz (300 kHz)** filter.
10. Set the **REFERENCE LEVEL** so that the trace is near mid-screen.
11. Check that the marker amplitude readout indicates -95 dBm (-90 dBm) or less.

12. Check that the noise level of the remaining filters (10 kHz to 10 Hz) is less than or equal to the value shown in Table 5-2. To measure the noise level of each filter, set the **REFERENCE LEVEL** so the trace is near mid-screen.

NOTE

Use a VERTICAL SCALE factor of 4 dB/div. to measure the 10 Hz filter noise level.

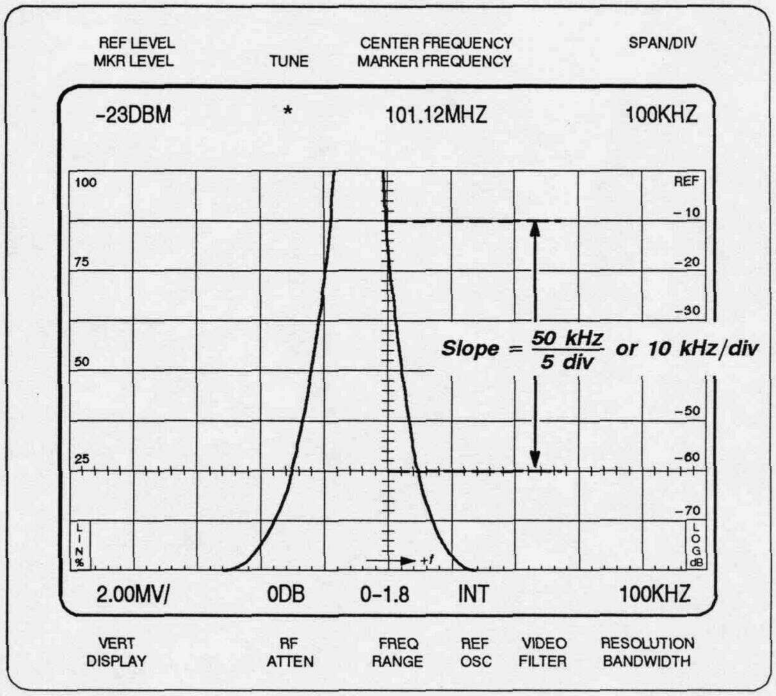
Residual FM

Residual FM is within 7 kHz over 20 ms with SPAN/DIV greater than 200 kHz, and 5 Hz over 20 ms with FREQ SPAN/DIV of 200 kHz or less.

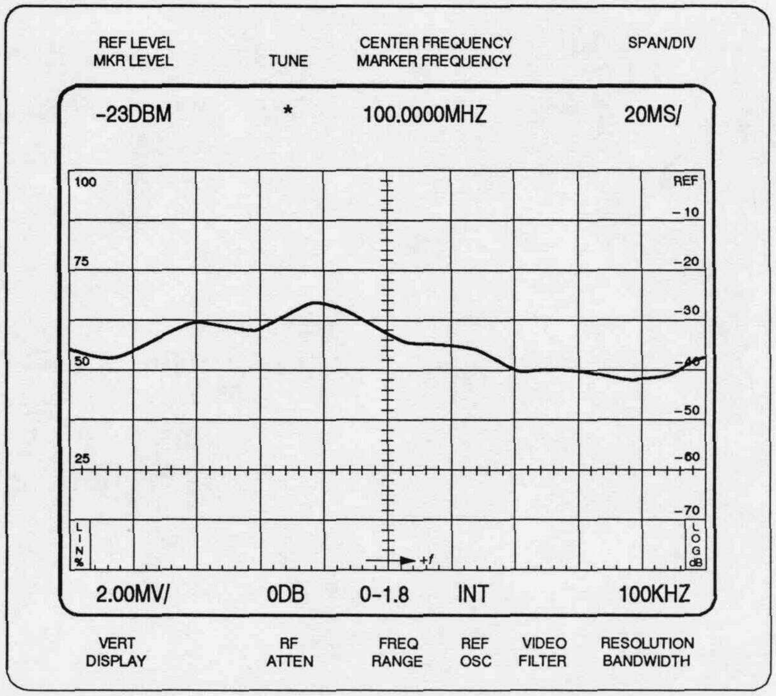
1. Apply the CAL OUT signal to the RF INPUT.
2. Press **[Blue−SHIFT] [RESET]**; then set the 495/P controls as follows:

REFERENCE LEVEL .... -23DBM
CENTER FREQUENCY 100MHZ
SPAN/DIV 1MHZ
VERT DISPLAY .... 10 DB/

3. Disable the 1st LO synthesis and phase lock by pressing **[Blue-SHIFT] [10 dB/DIV]**. **The** message FREQUENCY CORRECTIONS DISABLED: PRESS "HELP" will appear on the screen.
4. **Set** the **SPAN/DIV** to **100 kHz.** Use the **FREQUENCY/MARKER** control to center the 100 MHz CAL OUT signal on screen.
5. Press **[AUTO RESOLN]** and change the **RESOLUTION BANDWIDTH** to **100 kHz**.
6. Press **[LIN]**. Use the **FREQUENCY/MARKER** control to position the signal so the slope (horizontal versus vertical excursion) of the response can be determined as shown in Figure 5-6A. The slope is usually about 10 kHz/division.
7. Press **[ZERO SPAN]**, then set **TIME/DIV** to **20 ms.**
8. Adjust the **FREQUENCY/MARKER** control to position the trace near center screen as shown in Figure 5-6B. Press **[SAVE A]** to freeze the display for ease in measuring FM. The peak-to-peak amplitude of the display (number of vertical divisions) within any given horizontal division, scaled to the vertical deflections according to the slope estimated in part e, is the FM. Residual FM must not exceed 7 kHz for 20 ms or 7 kHz/division.
9. Press **[Blue-SHIFT] [10 dB/DIV]** to enable the phase lock. If SAVE A mode was used in part 8, press **[SAVE A]**.



A. Calculating slope of response



B. Measuring FM as the deviation/division of the response

Figure 5-6: Typical Display for Measuring Residual FM

10. Press [Blue–SHIFT] [FREQ] [1] [0] [0] [MHz], then press [ZERO SPAN].
11. Return the TIME/DIV to AUTO.
12. **Reduce the FREQ SPAN/DIV to 10 Hz and RESOLUTION BANDWIDTH to 10 Hz.**
13. Use the FREQUENCY/MARKER control to move the trace to a graticule line so its slope can be determined. See Figure 5-6A.
14. Switch the TIME/DIV to 20 ms and press [ZERO SPAN].
15. Adjust the FREQUENCY/MARKER control to position the trace near center screen as shown in Figure 5-6B. Press [SAVE A] to freeze the display for ease in measuring FM. The peak-to-peak amplitude of the display (number of vertical divisions) within any given horizontal division, scaled to the vertical deflections according to the slope estimated in part 13, is the FM. Residual FM must not exceed 5 Hz for 20 ms or 5 Hz/division.

Center Frequency Stability

Drift is 50 Hz/min or less with the 1st LO locked (SPAN/DIV<200 kHz) after 1 hour of warmup time in a stable ambient temperature.

1. Apply the CAL OUT signal to the RF INPUT.
2. Press [Blue-SHIFT] [RESET]; then set the 495/P controls as follows:

CENTER/MARKER FREQUENCY	100MHZ
REFERENCE LEVEL	-20DBM
SPAN/DIV	50HZ
RESOLUTION BANDWIDTH	100HZ
VERT DISPLAY	2DB/

3. Press [Blue-SHIFT] [PULSE STRETCHER] [6]. A message FREQUENCY CORRECTIONS DISABLED: "PRESS HELP" will appear on the screen. This disables the Frequency Corrections while maintaining the signal on the screen.
4. Press [SAVE A] to save the display.
5. Wait 60 seconds.
6. Note the frequency difference between the active and saved displays. Check that the frequency drift is no more than 50 Hz (1 major division).

Operation

This section describes the normal operating features of the 495/P Spectrum Analyzer. Many instrument features and operating modes are described, and examples are included to show some typical applications.

Instrument Operating Features

Firmware Version and Error Message Readout

Refer to *Section 5, Instrument Check Out* for information.

CRT Light Filters

Two light filters, amber and grey, are supplied as standard accessories to the instrument. Select the filter that best suits the surrounding light conditions, light reflections, and your viewing needs. To install the filter, pull the top of the plastic mask out and place the filter behind it. Remove the light filter when taking display photographs.

Intensity Level and Beam Alignment

Operate the instrument with the intensity level no higher than that required to clearly see the display. Trace alignment and beam focus are internal adjustments that must be performed by qualified service personnel. When the markers are turned on, set the intensity below the level where dot "blooming" or defocusing occurs.

The required intensity level for some displays may be high enough to produce a bright and flared baseline. This bright baseline can be eliminated (clipped) with the **[Blue-SHIFT] [BASELINE CLIP]** push button sequence. BASELINE CLIP mode is useful when photographing displays, and it also allows the lower readout characters to be more easily viewed.

Signal Application

Signal frequencies to 1.8 GHz can be applied through a short, high-quality, 50 Ω coaxial cable to the RF INPUT connector. These signals pass through an internal RF attenuator before application to the 1st mixer.

RF INPUT Connector

The nominal input impedance of the coaxial RF INPUT is 50 Ω, and 75 Ω on the optional 75 Q INPUT (Option 07). Because cable losses can be significant at microwave frequencies, it is important to keep the cables as short as possible. Impedance mismatch between the signal source and the RF

INPUT will produce reflections that degrade flatness, frequency response, and sensitivity, and may increase spurious responses. Impedance mismatch can be caused by poor connections, incorrect signal source impedance, and long or low-quality coaxial cable. When optimum flatness or frequency response is desired and signal strength is adequate, set the **MIN RF ATTEN dB** control **to 10 dB** or more. The addition of the attenuator helps minimize reflections to improve the input characteristics.

CAUTION

The front end of the spectrum analyzer is specified at +30 dBm maximum. It is possible to set the reference level to +40 dBm with MIN NOISE activated. If the signal level is increased for a full-screen display, the input level will exceed the power rating of the attenuator. Do not apply any DC potential to the RF INPUT. Use a DC block if a signal is riding on any DC potential. For DC block ordering information, see the Optional Accessories in the ***495/495P Service Manual, Volume 2,*** *or contact your local Tektronix Field Office or representative.*

Spurious responses can be minimized if the signal amplitude is kept within the graticule window. A recommended procedure is to select a reference level setting that limits stronger signals to the graticule window.

High-level signals can cause compression. If excessive signals are applied (above +30 dBm or +20 dBm when MIN NOISE mode is on), the 1st mixer attenuator may be destroyed. Signals above +30 dBm must be reduced by external attenuators. Ensure that the frequency range of any external attenuator is adequate.

Line impedance stabilizing networks, used for conducting EMI/RF measurements, will often have several volts of 60 Hz signal at the output. To protect the input mixer, use a DC block (refer to the ***495/495P Service Manual, Volume 2,*** or contact your local Tektronix Field Office or representative for ordering information). It is important to be sure that all equipment being tested has power applied through the line stabilizing networks before any RF signal is connected to the spectrum analyzer input.

Connecting to a 75 Ω Source — Signals from a 75 Q source, at the lower frequencies (1 MHz to 1 GHz), can be applied directly to the 75 Q INPUT if Option 07 is installed. 75 Q signals may be applied to the 50 Q RF INPUT by using a 75 Ω-to-50 Q minimum loss attenuator (refer to the Tektronix catalog or contact your local field office or representative for ordering information). A circuit diagram of a suitable matching pad for this purpose is shown in Figure 6-1.

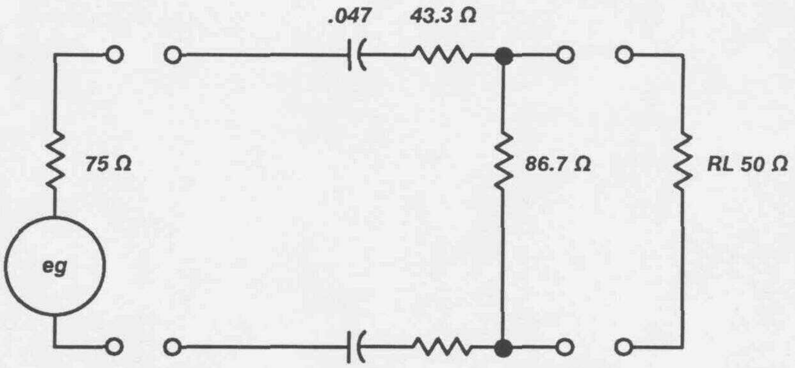


Figure 6-1: Circuit of a 75 to 50 Ω Matching Pad (AC Coupled)

Sensitivity and power levels are often rated in dBm (dB with reference to 1 mW regardless of impedance). Sensitivity and power levels for 75 Q systems are usually rated in dBmV (dB with reference to 1 mV across 75 Ω). Figure 6-2 shows the relationship between 50 Q and 75 Q units with matching attenuators included. The conversion to alternate reference level units is listed below for 75 Q and is shown in Table 6-1 for 50 Q

dBmV (75 Q) = dBm (50 Q) +54.47 dB:

e.g. *-60 dBm (50 Ω) + 54.47 dB = -5.5 dBmV (75 Ω)*

dBm (75 Q) = dBm (50 Q) +5.72 dB:

e.g. *-60 dBm (50 Ω) + 5.72 dB = -54.3 dBm (75 Ω)*

NOTE

When the alternate 75 Ω input is used, the reference level readout is correct for any units without additional conversions.

Amplitude Conversion — A conversion chart is shown in Figure 6-3. It can be used to convert input signal levels of voltage or power to dBm, dBV, dBmV, and dBuV.

Table 6-1: 50 O System Reference Level Conversion

To **From**	**dBm**	**dBmV**	**dBuV**
dBm	0	+47	+107
dBmV	**-47**	**0**	**-60**
dBuV	-107	**+60**	**0**

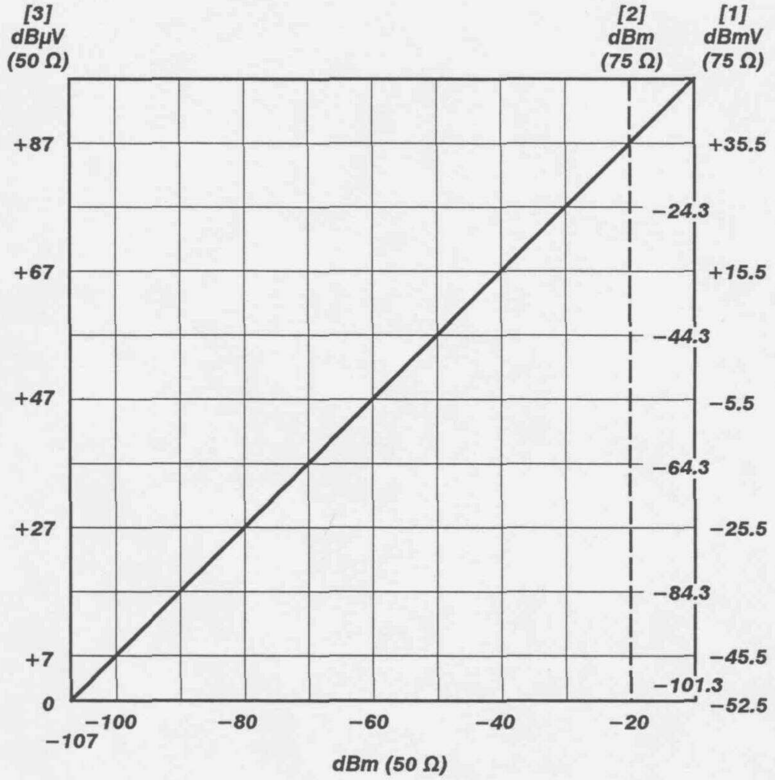
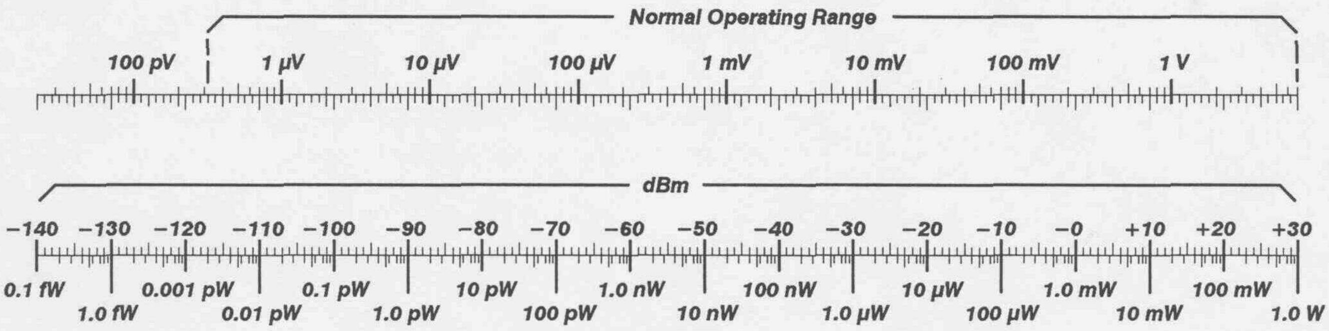


Figure 6-2: Graph Illustrating the Relationship Between dBm, dBmV, and dBµV (Matching Attenuator Included Where Necessary)



Note: Volts RMS....multiply by 2.8 for peak-to-peak.
0 dBm = 1 milliwatt

Figure 6-3: Volts-dBm-Watts Conversion Chart for 50 Ω Impedance

Resolution Bandwidth, Frequency Span, and Sweep Time

Resolution is the ability of the instrument to display discrete frequency components within a frequency span. This ability is a function of the instrument bandwidth, sweep time, frequency span, and incidental FM. Bandwidth also has an effect on the noise level. As the bandwidth decreases, the signal-to-noise ratio, or sensitivity, increases so that maximum sensitivity is attained with the narrow resolution bandwidths.

As the spectrum analyzer sweep rate is increased, a critical rate is reached where both sensitivity and resolution are degraded. Therefore, sweep time for a calibrated display is dependent on the resolution bandwidth and frequency span.

In MAX SPAN mode, the display represents the full frequency range. The frequency readout on the screen is indicated on the display by a frequency dot if markers are off or by the primary marker if markers are turned on. This frequency point will shift to center screen when the **FREQUENCY SPAN/DIV** is reduced to some setting other than **MAX.** The **FREQUENCY SPAN/DIV** setting depends on the particular measurement application. Wide spans are usually used to monitor a frequency spectrum for spurious signals, or check harmonic content. When wide spans are used for non-digital store displays, the sweep rate is usually set for minimum flicker. This requires wider resolution bandwidths to maintain a calibrated display. Narrow spans are used to analyze the characteristics about or near a particular signal, such as modulation side bands, bandwidth, or power line related distortion. Slow sweep rates are required when using narrow spans and high resolution to observe signal phenomena.

The 495/P will select the sweep rate and resolution bandwidth so the display remains calibrated for the selected frequency span/division if **TIME/DIV** is in the AUTO mode and AUTO RESOLN mode is on. AUTO RESOLN mode optimizes bandwidth for the selected **FREQUENCY SPAN/DIV** and **TIME/DIV** settings unless either is outside the range of calibration. When this occurs, **UNCAL** lights and a > symbol prefixes the **REFERENCE LEVEL** readout on the screen.

To analyze pulsed signals, a wider bandwidth than that provided by the automatic feature is usually required. Set **RESOLUTION BANDWIDTH** to approximately one-tenth the side lobe frequency width or the reciprocal of the pulse width, if known, in order to ensure adequate bandwidth. The resolution bandwidth is usually set for optimum main lobe detail after the sweep rate has been selected.

Using the HELP Feature

When there is a question about the function of any front-panel push button or control, press the **[HELP]** key; then press the push button or turn the control in question. A message displayed on the screen describes the function. The functions of all blue-labeled and green-labeled push buttons can be called up without pushing the entire push button sequence each time. Just push the appropriate **[SHIFT]** push button, push [HELP], and push any of the push buttons as desired. For example, press **[Blue–SHIFT]**

[HELP] [PLOT] to receive information about the PLOT feature. Because the [Blue−SHIFT] push button was pressed when entering HELP mode, information about the CAL mode will be displayed when [FINE] is pressed. CAL is the blue-shifted function of the [FINE] push button.

HELP mode will also provide explanations for the functions available from the marker menu. For detailed instructions, see *Using the Markers Feature* later in this section.

HELP mode is also useful in error detection (see *Error Detection* later in this section).

Using the Signal Identifier

The 495/P features a SIGNAL IDENTIFY mode to help identify true signals from false signals. When in this mode, the frequency of the local oscillators are shifted on alternate sweeps. At the same time, the sweeps are vertically displaced about two divisions. True signals shift only a small amount on alternate sweeps, while false signals or spurious responses will shift at least 1 division.

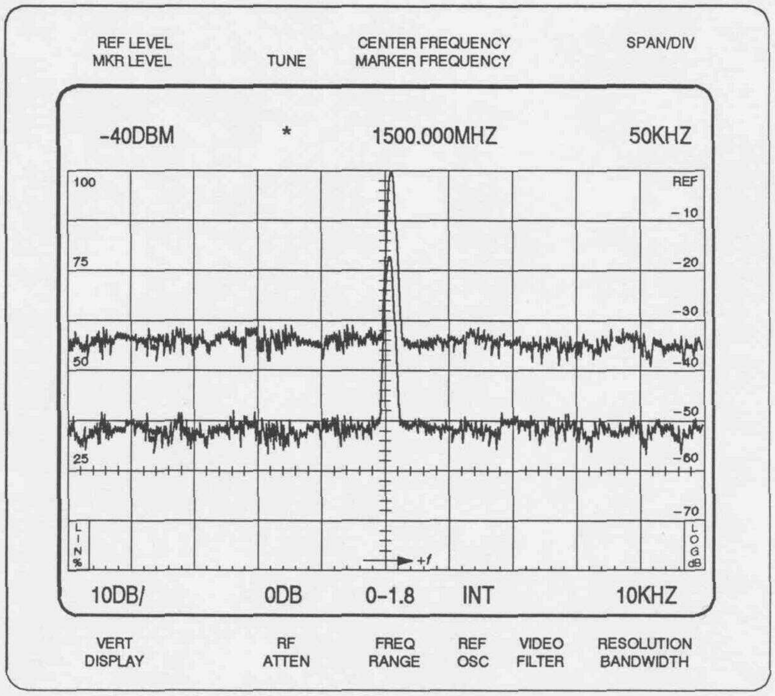
This mode can only be activated when the FREQUENCY SPAN/DIV is 50 kHz or less.

Figure 6-4 illustrates two typical examples of signal identification. In Figure 6-4A, the signal remains at the same horizontal screen location for alternate sweeps. This is a true response. A false signal may shift horizontal screen location on alternate sweeps, or disappear from the screen as shown in Figure 6-4B.

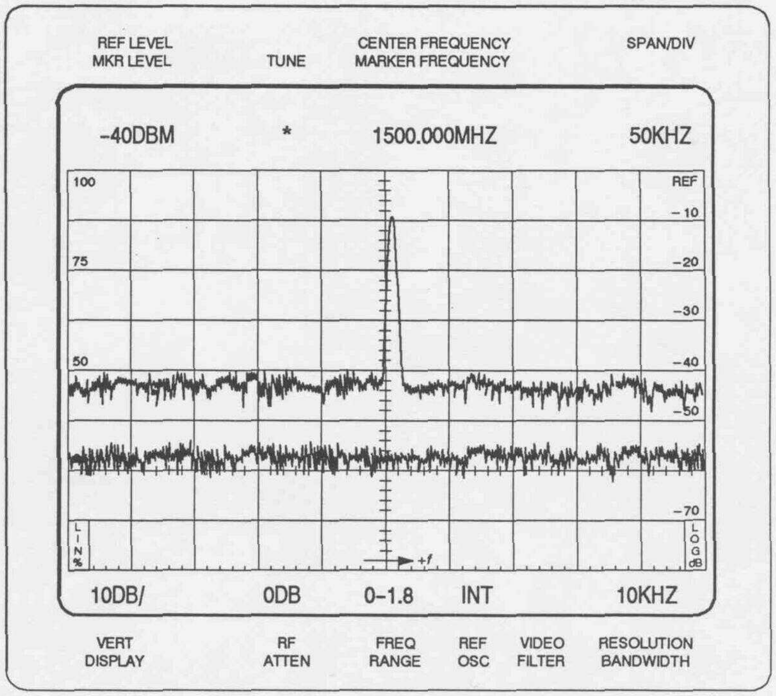
Using the Video Filters

The video filters restrict the video bandwidth so noise is reduced (see Figure 6-5). When signals are closely spaced, the filter can reduce the modulation between two signals to make it easier to analyze the display. The filters can also be used to average the envelope of pulsed RF spectra that have a relatively high pulse repetition frequency (prf). However, because the filter is basically an integrating circuit, the video filter will not be very effective when measuring low prf spectra.

The WIDE filter reduces the bandwidth to approximately 1/30th the selected resolution bandwidth; the NARROW filter to approximately 1/300th. Using the filter may require a reduction in the sweep rate to maintain a calibrated display. UNCAL lights if the sweep rate is not compatible with the other parameters to maintain a calibrated display. When either the WIDE or NARROW filter is selected, the filter bandwidth is displayed on the CRT lower readout line.

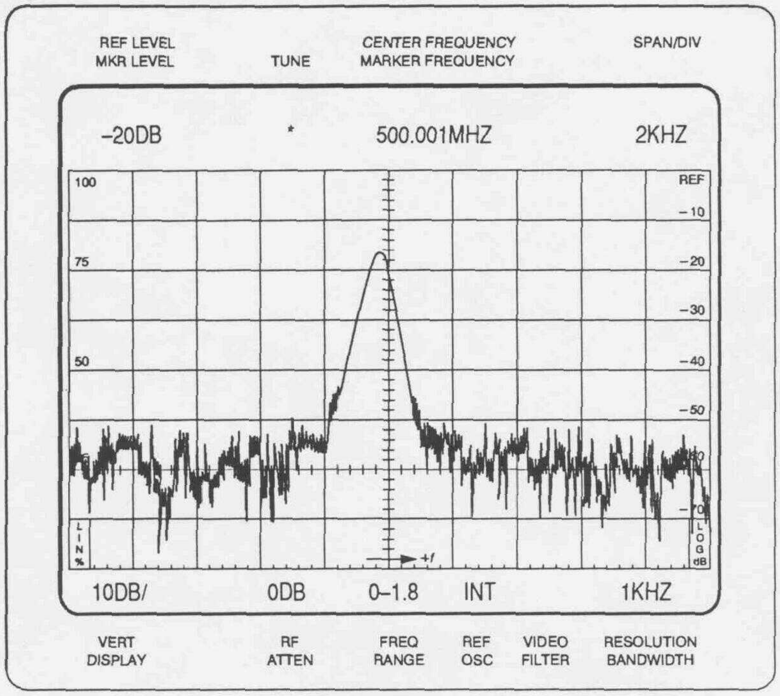


A. Typical response of a true or real signal

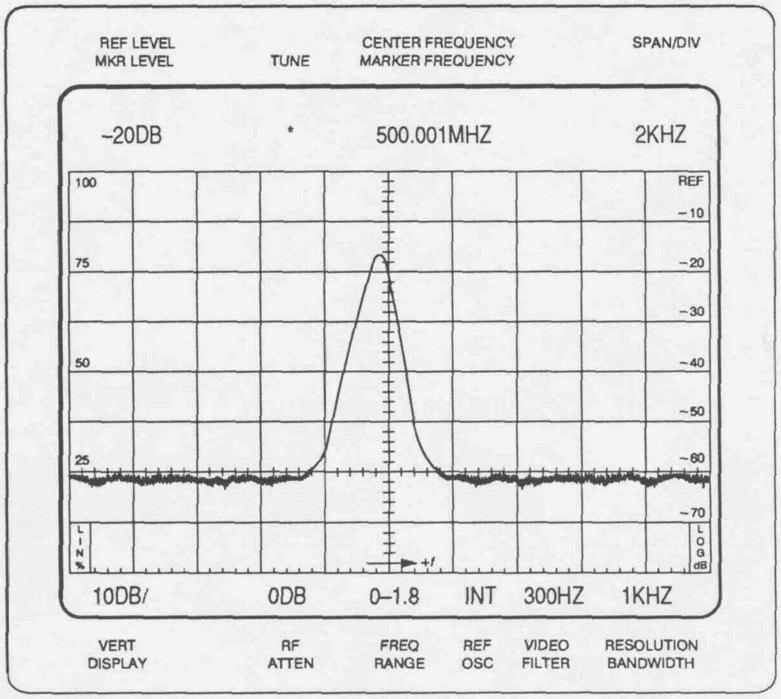


B. Typical response from a false signal. Signal for bottom sweep is off screen

Figure 6-4: Typical Example of Identifier Mode Displays



A. Spurii and IM obscured in the noise



B. Same display with Video Filter activated

Figure 6-5: Typical Display With and Without the VIDEO FILTER

Using Time Domain Operation

When the **FREQUENCY SPAN/DIV** is **zero**, the 495/P functions as a tunable receiver to display time domain characteristics within the selected resolution bandwidth. Characteristics such as modulation pattern and pulse repetition rates can now be analyzed with **TIME/DIV** selections. Resolution bandwidth is usually maximum (3 MHz) for time domain analysis of the signal.

Triggering the Display

The TRIGGERING mode is usually **FREE RUN** for spectrum displays. However, it may be desirable or necessary to trigger the display when the event is time related to some source, or when the frequency span has been reduced to zero for time domain analysis. In FREE RUN mode, the sweep will not synchronize with any input signal.

In addition to FREE RUN mode, the sweep can be triggered internally (**INT**) by the video signal, at the line frequency rate of the power supply (LINE), or by an external signal (EXT) applied to the **HORIZ|TRIG EXT IN** connector on the rear panel. The required amplitude for triggering is 2.0 divisions or more for internal triggering and from 1.0 to 50 V maximum (DC + peak AC) for external triggering.

In addition to the TRIGGERING source selections, SINGLE SWEEP mode is provided. This mode is useful for viewing single events. In SINGLE SWEEP mode, the sweep will run once after the circuit has been armed and a trigger signal arrives. The READY indicator lights when the circuit is armed and waiting to be triggered and remains lit during sweep time. Push **[SINGLE SWEEP]** once to activate the SINGLE SWEEP mode and cancel the current sweep. Push **[SINGLE SWEEP]** again to arm the trigger circuit so it is ready for a trigger signal.

Sweeping the Display

Horizontal sweep voltage for the display can be internal or from an external source. Sweep rate and source are selected with the **TIME/DIV** control. When the **TIME/DIV** control is in the **AUTO** position, the sweep rate is automatically set to maintain a calibrated display.

When **TIME/DIV** is in the **EXT** position, a signal source of 0 to +10 V applied to the **HORIZ|TRIG EXT IN** connector will sweep the CRT beam across the 10 division span. The input is DC coupled and sensitivity is 1 V/div. External input impedance is approximately 10 kΩ.

The beam can be manually positioned by the **MANUAL SCAN** control when **TIME/DIV** is in the **MNL** position (see *Manual Scan of the Spectrum* that follows).

Manual Scan of the Spectrum

The MANUAL SCAN control is usually used to examine a particular point or sector of a display. One example is looking at one of the null points of a frequency modulation spectrum. Another example is when it takes unnecessarily long to look at a small segment of the full span because of the slow sweep rate. With a wide **FREQUENCY SPAN/DIV** and/or a narrow **RESOLUTION BANDWIDTH,** it is very possible to manually scan too fast to achieve an accurate display. Best results are obtained without digital storage. Digital storage can produce unpredictable results due to the sweep rate, and the digital storage display is only updated when scanning from left to right.

Reference Level, RF Attenuation, and Vertical Display

When a change is made to **REFERENCE LEVEL,** the gain distribution is automatically selected (IF gain and input RF Attenuation) for the new reference level. The selection is made according to the settings **of VERTICAL DISPLAY, FINE, MIN RF ATTEN dB, and MIN NOISE/MINDISTORTION.**

The amount of input RF Attenuation set is based on the reference level requested and the settings of **MIN RF ATTEN dB** and **MIN NOISE/MIN DISTORTION.** The 495/P assumes the **MIN RF ATTEN dB** selection is the minimum attenuation required for the expected signal levels, and will not reduce RF Attenuation below this value. As **MIN RF ATTEN dB** is increased, the lowest reference level is raised an equal amount. At 0 dB minimum attenuation, the lowest reference level is −117 dBm; at 10 dB minimum attenuation, the lowest reference level is -107 dBm, and so on. The best ratio of RF Attenuation to IF gain is selected according to the MINIMUM NOISE/MINIMUM DISTORTION mode (see the description later in this section).

The REFERENCE LEVEL control steps depend on the VERTICAL DISPLAY mode and FINE mode settings. With LOG mode selected, the **REFERENCE LEVEL** control steps in 1 dB to 15 dB increments if FINE mode is off. With FINE mode on, the **REFERENCE LEVEL** control steps in 1 dB increments for display factors of 5 dB/div or more, and 0.25 dB for display factors of 4 dB/DIV or less. The 0.25 dB increments apply to the Delta A mode (see the description later in this section).

With LIN mode selected and FINE mode off, the bottom of the CRT graticule is zero volts, and the top of the CRT graticule is eight times the vertical display factor. The display factor changes in a 1 -2-5 volts/division sequence from 500 mV to 50 nV with FINE mode off. With FINE mode on, the reference level changes in 1 dB steps and the scale factor/division is one-eighth the voltage equivalent of the REFERENCE LEVEL setting.

Alternate Reference Level Units Selection

To select an alternate to dBm reference level units, press [Blue−SHIFT] **[REF LEVEL UNITS].** This sequence enters the reference level units menu. Now select one of the four available selections:

- [0] selects dBm
- [1] selects dBv
- [2] selects dBmV
- [3] selects dBuV

The 495/P automatically converts the REFERENCE LEVEL readout for the new units. For example, a readout of 0 dBm changes to −13 dBV when dBV units are selected from the menu.

Using the Delta A Mode

To select the Delta A mode, push **[FINE]** while the **VERTICAL DISPLAY** factor is **4 dB/Div** or less. The **REFERENCE LEVEL** readout goes to **0.00 dB** and the **REFERENCE LEVEL** control steps in 0.25 dB increments from this reference.

The Delta A mode accurately measures signal-relative amplitude difference. This is possible because the gain distribution (IF gain and RF Attenuation) does not change in the Delta A mode. The **REFERENCE LEVEL** setting is changed by shifting the log amplifier offset. The total range of the Delta A mode is 57.75 dB. The measurement range depends on the **REFERENCE LEVEL** setting that is current at the time the Delta A mode is activated. It is typically at least 0 to 48 dB below the **REFERENCE LEVEL** setting that was current at the time the Delta A mode was activated. The overall instrument reference level range of −117 dBm to +50 dBm cannot be exceeded.

The Delta A mode is turned off when the **VERTICAL DISPLAY** factor is increased above **4 dB/Div,** when FINE mode is turned off, or when the gain distribution is changed with the MIN **RF ATTEN dB** or MIN **NOISE** selections.

Signals with large amplitude differences that are within the Delta A range can be compared without the distortion usually introduced when signals are driven off-screen. Signals shifted off-screen by changes in the Delta A reference level are not over-driving the input. This is because the RF Attenuator and IF gain do not change. Thus, the mixers do not see any change in signal levels even though the Delta A reference level changes.

Follow these steps to measure the amplitude level difference between two signals using the Delta A mode:

1. Press **[FINE]** to select the Delta A mode.
2. Select a **VERTICAL DISPLAY** factor of **4 dB/Div or less** with the dB/DIV DATA ENTRY push buttons, or press the **[2 dB/DIV]** push button.
3. **Set** the **REFERENCE LEVEL** control to position the peak of the larger signal to a graticule line.
4. Press the **[FINE]** push button twice to reset the readout to **0.00 dB.**
5. **Use** the **REFERENCE LEVEL** control to set the peak of the lower amplitude signal to the same graticule line established in step 3.
6. The REFERENCE LEVEL readout will now indicate the amplitude difference between the two signals in dB.

NOTE

Do not confuse the Delta A mode with the delta marker mode.

Using MIN NOISE, MIN DISTORTION, or REDUCED GAIN Mode

One of three methods can be selected to control RF Attenuator and IF gain settings. MIN NOISE mode minimizes noise level by decreasing input attenuation and IF gain by 10 dB. MIN DISTORTION mode minimizes input mixer overload by increasing input attenuation and IF gain by 10 dB.

The REDUCED GAIN mode uses the identify offset to reduce the effective gain of the 495/P, which lowers the displayed noise level. Because identify offset is one division, and because the RF Attenuator is controllable in 10 dB steps, the REDUCED GAIN mode can only be selected when the VERTICAL SCALE factor is 10 dB/Div.

The REDUCED GAIN mode reduces the IF gain and RF Attenuation by 10 dB for any REFERENCE LEVEL setting for which the RF Attenuation (in non-REDUCED GAIN mode) is at least 10 dB greater than the MIN RF ATTEN dB control setting.

With MIN NOISE mode on and MIN RF ATTEN dB set to 60 dB, the REFERENCE LEVEL can be set to +40 dBm. Do not increase input signal level to full screen with a REFERENCE LEVEL of +40 dBm because this will exceed the RF Attenuator rating.

In the REDUCED GAIN mode, the REFERENCE LEVEL may be set to +40 dBm (with MIN DISTORTION mode on) or +50 dBm (with MIN NOISE mode on). However, the maximum input level of the 495/P is still +30 dBm. NEVER apply more than +30 dBm to the input of the 495/P at any time, regardless of the indicated level.

REDUCED GAIN mode is selected from the SPECIAL MODES Menu (press [Blue–SHIFT] [VIDEO FILTER WIDE] [2]. Menu item [2] toggles the REDUCED GAIN mode from off to on, or on to off, each time it is selected. The REDUCED GAIN mode is indicated by an R located at the top right corner of the screen. (If an error message is displayed, the R will not appear on the screen.)

The REDUCED GAIN mode can be used with either MIN DISTORTION or MIN NOISE modes. When MIN DISTORTION mode is 13turned on, the REDUCED GAIN mode effects the display in a manner that is similar to activating the MIN NOISE mode (noise decreases by 10 dB). When MIN NOISE mode is active, the REDUCED GAIN mode will further increase the distortion. Also, on-screen compression may occur. For this reason, any digital storage data that appears above the top of the viewing area (that is, data values of 225 to 250, above the top graticule line) is likely to be inaccurate.

If the IDENTIFY mode is used when REDUCED GAIN mode is active, the identify (alternate) sweep is moved up one division on the screen. It is normally moved down one division.

Using Digital Storage

Digital storage provides a smooth, flicker-free display. Two complete displays can be digitized and stored. In addition, the STORE DISPLAY and RECALL functions will store up to nine displays in memory (see *Using the Store and Recall Features* later in this section). One of the two digitized waveforms can be saved and then compared to later waveforms. The MAX HOLD feature updates digital storage data only when the input signal amplitude is greater than previous data. This allows monitoring and graphic plotting of display changes (amplitude and frequency) with time.

The display is divided by a horizontal line that is positioned with the **PEAK/ AVERAGE** control. Above the line, video information is peak detected; below the line, signal averaging occurs. This feature subdues noise in the portion below the line and allows full peak detection above the line. An intensified spot on the line indicates the horizontal position where memory is being updated. The average (number of samples) is a function of the sweep rate; the slower the rate the more samples.

The digital storage display is divided into an A and B section. Data can be stored in either A or B or in both. There are 500 horizontal locations in A and 500 horizontal locations in B. When both are displayed, the origin of the B waveform is shifted so the A and B coordinates are interlaced to provide 1000 display increments. Data in memory is continually updated with each sweep so the display is always current.

SAVE A Mode — When SAVE A mode is turned on, data in the A section is saved and only the B section of storage is updated. This takes place whether the A waveform is displayed or not. This mode captures an event or waveform, with its readout, for comparison with a subsequent event displayed by the B display. If VIEW B is on, the readout applies to the current B waveform. If SAVE A and VIEW A are on and VIEW B and B−SAVE A are off, the readout applies to the saved A waveform.

B-SAVE A Mode — When B-SAVE A mode is turned on, the arithmetic difference between the B waveform and the saved A waveform is displayed (see Figure 6-6). This convenient mode can be used to align filters or other devices. The reference waveform is stored in A and the unknown is displayed by B. The reference level is usually set mid-screen so positive and negative quantities can be observed. The position of the zero reference can be changed by an internal switch. Contact qualified service personnel to have the reference level repositioned.

MAX HOLD Mode — MAX HOLD mode causes the memory to be updated only if the new input is of higher magnitude than the former (B memory only if SAVE A is active). This allows monitoring of signals that may change with time and provides a graphic record of amplitude/frequency excursions.

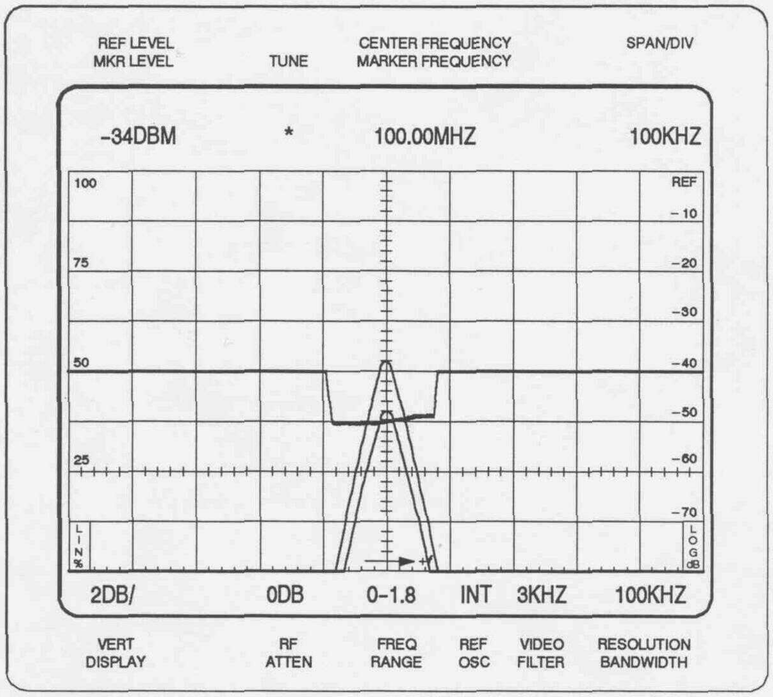


Figure 6-6: Typical Display Using B−SAVE A to Observe the Difference Between SAVE A and B Displays

Signal averaging is useful for suppressing noise. The number of samples averaged per horizontal digitized slot is a function of the 495/P sweep rate. The slower the sweep speed, the more samples averaged per horizontal slot. RESOLUTION BANDWIDTH affects the amplitude difference between peak detected and average levels of CW signals. When the RESOLUTION BANDWIDTH is less than 1/30th the FREQUENCY SPAN/DIV (e.g., 100 kHz or less with 5 MHz FREQUENCY SPAN/DIV) there will be significant error in the average amplitude levels of CW signals, especially if only A or B is displayed. The peak value will be the true value. When using narrow RESOLUTION BANDWIDTH with wide frequency spans, it is best to run digital storage with both the A and B waveforms interlaced and the cursor (horizontal line) at the bottom of the display.

To measure signal amplitude level, set the cursor to the bottom of the screen. To average noise, set the horizontal line at least one division above the noise level.

Using the Store and Recall Features

The 495/P features two functions to store up to nine waveforms, with marker(s) and readout, in memory to be recalled later for review or analyses. To save the display currently on the screen, press **[Blue−SHIFT] [STORE DISP]**, the register number (**[0] - [8]**) where you want to store the display, and if SAVE A mode is on, the identity of the display you want stored (A or B). To later recall this same display, press **[Blue-SHIFT] [RECALL],** and the register menu showing the center frequency of each stored display will appear on the screen. Select the correct register number with a DATA ENTRY push button, and then select the part of the digital storage (A or B) where you want to place the recalled display.

SAVE A mode is automatically turned on to prevent an overwrite. If location A is selected, VIEW A must be on to see the recalled display, and VIEW B must be off to see the readout that applies to the recalled display.

If VIEW B and VIEW A are on, both the display recalled in A and the current display in B will be visible on the screen. The readout shown applies to the current B display. Turn VIEW B off to see the readout that applies to the recalled A display.

If location B is selected, the next sweep will overwrite the display unless SINGLE SWEEP mode was activated before selecting B. A message will appear on the screen as a reminder of this. VIEW B must be on to observe the recalled display. Remember to turn SINGLE SWEEP mode off when leaving this recalled mode.

Plotting the Display

Press [PLOT] (495) or [Blue–SHIFT] [PLOT] (495P) to drive many external plotters such as those listed below:

- Tektronix HC 100
- Tektronix 4662 Option 01
- Tektronix 4662 Option 31
- Tektronix 4663 (emulating the 4662)
- Hewlett-Packard HP7470A
- Hewlett-Packard HP7475A
- Hewlett-Packard HP7580B
- Hewlett-Packard HP7585B
- Hewlett-Packard HP7486B
- Gould 6310
- Gould 6320

To use the plot feature, connect the plotter to the 495/P with an IEEE STD 488 (GPIB) cable, and complete the following steps:

1. Set the corners of the plot for a 3:2 aspect ratio for the Tektronix plotters, or 6:5 for the Hewlett Packard and Gould plotters. The plotter must be in the Listen Only mode. On the 495P, the TALK ONLY switch on the rear-panel GPIB ADDRESS switch bank must be closed or in the 1 position.
2. Set the plotter interface switches as follows:

   Tektronix HC 100:

   Address = 31

Tektronix 4662 Option 01 or 4662 Option 31 (rear panel):

A = 0, 1, 8, or 9
B = C or D
C = X (does not matter)
D = X (does not matter)

Tektronix 4663:

Interface Select = 1 if Option 04 or 2 if Option 01
Initial Command/Response Format = 5
Interface Mode = Listen Only

Hewlett-Packard or Gould Plotters:

Address = 31

3. Press [Blue–SHIFT] [SAVE A] on the 495/R and select the desired plotter type from the displayed menu. The selection is stored in memory and does not need to be selected again unless the plotter type is changed.
4. Select the display and the information that you wish to plot. The PLOT feature is similar to using a camera. The plot includes everything that is turned on for the CRT display. The information plotted depends on the setting of several front-panel push buttons and controls:
   - If READOUT is on, the CRT readout will be plotted with the display.
   - If GRAT ILLUM is on, the bezel and graticule information will be included with the plot.
   - If VIEW A, VIEW B, or B-SAVE A are on, these waveforms will be part of the plot (if any of these functions are off, they will not be plotted).

The zero level for a B-SAVE A waveform is usually the graticule center line. (Switches within the instrument can set the level. Contact your service personnel for this change.) If you desire to shift the zero level for the plotting function only, press [Blue-SHIFT] [B-SAVE A], and enter the desired level in display units (25 is the bottom graticule line, 25 units/div). This zero level is retained in memory. It is not related to the display zero level, since the processor has no way of determining the internally-set zero level for the screen and no way to change it.

Using the Markers Feature

The marker modes provide direct readout of frequency and amplitude information of any point along any displayed trace. Relative (delta) frequency and amplitude information between any two points along any displayed trace or between traces is also available. Two independent marker frequencies and amplitudes cannot be displayed at the same time.

Marker Terms — The following definitions of marker terms are used throughout this section.

Live Trace — Any combination of the A trace when SAVE A is off and/or the B trace. A trace recalled into B is not an active trace.

Active Trace — Any combination of the A trace when SAVE A is off and/or the B trace; or, the B-SAVE A trace. A trace recalled into B is not an active trace.

Inactive Trace — Either a SAVE A trace or a trace recalled into the B display before the sweep is started.

Primary Marker — The marker displayed in the Single Marker mode whose frequency and/or position is changed when tuning with the **CENTER/MARKER FREQUENCY** control. When two markers are displayed, the brightest marker is the Primary marker.

Secondary Marker — The "second" marker; displayed only in the Delta Marker mode.

Marker Turn On — The Single Marker mode places one marker (Primary marker) on the spectrum to display marker frequency and amplitude. The Delta Marker mode places two markers (Primary marker and Secondary marker) that display the difference in frequency and amplitude between the two markers. When two markers are displayed, the Primary marker is brighter. The Primary marker position and frequency can be changed with the **CENTER/MARKER FREQUENCY** control or from the GPIB.

The marker(s) can be turned on by pushing many of the push buttons related to marker action. Here are some examples:

- **[TUNE CF/MKR]** (push button lit) turns on the Primary marker
- **[Blue–SHIFT] [MKR → CENTER]** turns on the Primary marker
- **[Green–SHIFT] [PEAK FIND]** turns on the Primary marker
- **[Green-SHIFT] [SIGNAL TRACK]** turns on the Primary marker
- **[Green-SHIFT] [MKR → REF LVL]** turns on the Primary marker

  [Green-SHIFT] [1←MKR→2] turns on both the Primary and Secondary markers

- **[Green-SHIFT]** [A **MKR]** turns on both the Primary and Secondary markers

There are three push button sequences that turn the marker(s) off:

- **[Blue-SHIFT] [MKR OFF]** turns off all marker functions
- **[Blue-SHIFT] [INIT]** turns off all marker functions (the instrument is returned to the initial turn-on condition)
- **[Green-SHIFT]** [A **MKR]** (when both markers are on) turns off the Secondary marker and returns the instrument to the Single Marker mode

The markers are visible only when DIGITAL STORAGE functions are on; there can be no markers on a real-time trace. When a trace with a marker or markers is stored, the marker positions and frequencies are also stored. When the trace is recalled and the marker system is on, the marker(s) first appears at the stored locations(s). Therefore, there is greater accuracy than is normally possible on an inactive trace. This is especially true if the stored marker frequency was the result of a signal count. The increased accuracy is lost as soon as the marker is tuned.

In either the Single or Delta marker mode, a second line of readout appears at the top of the screen. In the Single Marker mode, the marker frequency readout is displayed directly below the center frequency readout, and the marker amplitude is displayed directly below the reference level readout. In the Delta Marker mode, the frequency of the Primary marker with respect to that of the Secondary marker is displayed directly below the frequency readout, and the amplitude of the Primary marker with respect to that of the Secondary marker is displayed directly below the reference level readout. When in the Delta Marker mode, the relative amplitude and frequency readouts are enclosed on the screen in parentheses. If the marker amplitude is outside the digital storage range, OVER or UNDER is displayed in the amplitude readout field.

Marker Menu and Assign Menu — Most of the marker functions are available directly from front-panel push button sequences. There are additional marker functions that are available either by direct selection from the Marker Menu, or after they have been assigned from the Assign Menu to either the **[ASSIGN 1] or [ASSIGN 2]** push button. Press **[MARKER MENU]** to show a list of additional marker functions. These functions are all available simply by selecting them with the correct DATA ENTRY number push button (see *Marker Functions* in Section 4 for the description of these functions).

Follow these steps to assign a function to the **[ASSIGN 1]** or **[ASSIGN 2]** push button. (Once a function has been assigned, it will remain until the push button is assigned a different function.)

1. Press **[MARKER MENU]** to show a list of additional marker functions.
2. Select **[6]** ASSIGN FUNCTION TO KEY This will bring up the Assign Menu that contains the functions that can be assigned.
3. Push the correct DATA ENTRY number push button.
4. For menu items 0, 1, 2, 3, or 6:
    a. **The** two **[ASSIGN]** push buttons will light.
    b. A message will appear that asks you which push button you want to use for that function.
    c. Push the desired push button.
    d. The assignment has been made.

5. For functions 4 or 5
   - a. A message prompts you to enter the amount you want the marker to move.
   - b. Enter the amount and units selection.
   - c. The two **[ASSIGN]** push buttons will light.
   - d. A message will appear that asks you which push button you want to use for that function.
   - e. Push the desired push button.
   - f. The assignment has been made.

Once a function has been assigned, you can get a description of the function by pressing **[Green–SHIFT]** **[HELP]** and the correct **[ASSIGN]** push button.

Assigning Markers — When the marker mode is first turned on from the front panel, the trace(s) on which the marker(s) appears is determined by the traces that are currently displayed, as indicated in Table 6-2. When a trace is turned off, any marker(s) on it is re-located according to Table 6-2. When a trace is turned on, the previous marker locations do not change; except, the marker always jumps to the active trace in maximum span or when in the SIGNAL TRACK mode.

Table 6-2: Marker Trace Organization

VIEW A	VIEW B	SAVE A	B–SAVE A	Primary Marker On	Secondary Marker On
Off	Off	Off	Off	Full[a]	Full[a]
Off	Off	On	Off	A[a]	A[a]
Off	Off	On	On	B–SAVE A	B–SAVE A
Off	On	Off	Off	Full	Full
Off	On	On	Off	B	B
Off	On	On	On	B	B
On	Off	Off	Off	Full	Full
On	Off	On	Off	A	A
On	Off	On	On	B–SAVE A	B–SAVE A
On	On	Off	Off	Full	Full
On	On	On	Off	B	A
On	On	On	On	B	A

[a] Not applicable. Since no digital storage traces are being viewed, there is no visible marker. The listed trace is that for which marker readouts are given.

Tuning Markers — Move the Primary marker with the front-panel **CENTER/MARKER FREQUENCY** control (when the **[TUNE CF/MKR]** push button is lit). To make it possible to change the position of the Secondary marker, you must make the Secondary marker be the Primary marker. Push **[Green−SHIFT] [1←MKR→2]** to swap the Primary and Secondary marker positions. Move the Primary marker (which used to be the Secondary marker), and then push **[Green−SHIFT] [1←MKR→2]** again to swap the Primary marker back to its previous location.

The marker normally moves over the fixed display. Marker tuning (both frequency and position) stops when the screen edge is reached while using the **CENTER/MARKER FREQUENCY** control.

The marker tuning rate depends on the speed with which the **CENTER/MARKER FREQUENCY** control is turned. If the control is turned rapidly, the marker moves 1/10 of a division per increment. If the knob is turned quite slowly, the marker moves 1/100 of a division per increment. At intermediate turning speeds, the marker moves approximately 1/30 of a division per increment.

When two markers are displayed (delta-marker mode), and the marker frequency, center frequency, and span are changed, the Secondary marker remains fixed at its original frequency and is allowed to move off the screen. If the Primary and Secondary markers are swapped (with the **[Green-SHIFT] [1←MKR→2]** push button) while the Secondary marker is off the screen, the display is centered on the frequency of the old Secondary marker (now the new Primary marker). The old Primary marker (now the new Secondary marker) is placed off the screen.

Error Detection

When an internal error is found in the 495/P, the words ERROR USE HELP will flash one after the other at the top, right corner of the screen (a steady ERROR message will appear when under remote control). This message appears when the markers are on or the instrument is in MAX SPAN mode. Press **[HELP]** to read the definition of the problem and the probable effects of the problem. If the markers are off and the measurement is not in MAX SPAN mode, the error message will be steady and will specify the problem area. Additional information and servicing instructions are in the diagnostics information in *Section 6, Maintenance* in the ***Service Manual, Volume 1***. If you cannot solve the problem with the HELP information, report all problems or error information to qualified service personnel.

Using the Automatic Performance Testing Feature

The push button sequence **[Blue−SHIFT] [CAL]** activates a routine that tests frequency and relative amplitude of the IF filters. This routine should be done any time the temperature changes. Settings are held in memory after the test routine has run. Refer to *Display Parameter Controls* in Section 4 for more details.

Using the Tracking Generator Mode

In order to obtain higher frequency accuracy when using the tracking generator, the TRACKING GENERATOR mode disables use of the frequency correction factors for all resolution bandwidth filters wider than 10 kHz. These wide filters may be centered too far from 10 MHz for the difference to be corrected with the Tracking Adjust control on the tracking generator.

All amplitude correction factors are always used.

For maximum frequency and amplitude accuracy, always adjust the Tracking Adjust control to peak the response in the resolution bandwidth filter you are using. Remaining amplitude errors can be corrected by using the B–SAVE A mode of digital storage.

Use the **[Blue–SHIFT] [VIDEO FILTER WIDE]** push button sequence to enter the SPECIAL MODES Menu. Press [0] to select TRACKING GENERATOR mode (select it again to turn it off). When the TRACKING GENERATOR mode is on, a T appears at the top right corner of the screen unless an error message is being displayed.

Using the Sideband Analyzer Mode

Since the 1405 Sideband Analyzer only uses the first local oscillator of the 495/P, it is only useful when the first local oscillator is sweeping (not phase locked). The SIDEBAND ANALYZER mode extends the usefulness of the 1405 by causing the 495/P to phase lock in 50 kHz/Div instead of the normal 200 kHz/Div.

Use the [Blue-SHIFT] [VIDEO FILTER WIDE] push button sequence to enter the SPECIAL MODES Menu. Press [1] to select SIDEBAND ANALYZER mode (select it again to turn it off). When the SIDEBAND ANALYZER mode is on, an S appears at the top right corner of the screen unless an error message is being displayed.

Using the EOS Correction Mode

The instrument normally measures the drift rate of its oscillators and corrects them when needed to maintain specified accuracy. When the EOS CORRECTION mode is on, the oscillators are corrected at the end of every sweep.

Use the **[Blue-SHIFT] [VIDEO FILTER WIDE]** push button sequence to enter the SPECIAL MODES Menu. Press [3] to select EOS CORRECTION mode (select it again to turn it off). When the EOS CORRECTION mode is on, an E appears at the top right corner of the screen unless an error message is being displayed.

Using the Time Measurement Feature

The 495/P employs a special time measurement feature that is available when the instrument is in the ZERO SPAN mode, with either one or two markers on.

Use the **[Blue–SHIFT] [VIDEO FILTER WIDE]** push button sequence to enter the SPECIAL MODES Menu. Press **[4]** to select ZERO-SPAN TIME mode (select it again to turn it off). When the ZERO-SPAN TIME mode is on, a Z appears at the top, right corner of the screen unless an error message is being displayed.

In the ZERO-SPAN MODE, the marker frequency readout or delta-marker frequency readout is replaced by a time or delta time readout, respectively. The time readout in the single-marker mode is the time to the marker position from the trigger point. This point is 1/2 division to the left of the screen. In the Delta Marker Mode, the delta time readout gives the time difference between the two markers. In both cases, the time value is scaled from the marker position(s) and the time/division. No actual time measurement is done.

The time measurement feature is available only during certain timing conditions. If the **TIME/DIV** setting is **MNL EXT,** or is faster than **1 ms/Div,** the message TIME UNAVAILABLE is displayed in the location of the normal readout.

When in the DELTA TIME READOUT mode, both markers must be on the same trace for time measurement. If the markers are on different traces when ZERO SPAN mode is entered, the secondary marker will move to the trace of the primary marker. (This marker will not move back when leaving zero span.) When either marker is assigned to a new trace, both markers (assuming delta markers are on) will move together.

In frequency-mode marker operation, the secondary marker remains at a constant frequency, while the primary marker remains at a constant horizontal location. However, in the TIME mode, both markers remain at constant horizontal positions as the sweep speed is changed.

Most of the frequency-related marker functions remain frequency-related in ZERO SPAN mode. The **[Green–SHIFT] [STEP SIZE]** push button still defines the frequency step size for the marker or delta marker.

In the tune marker mode, **[Blue-SHIFT] [FREQ]** and the DATA ENTRY push buttons will enter marker time. If the TIME UNAVAILABLE message is displayed, the entry functions will be disabled.

The **[Blue-SHIFT] [MKR → CENTER]** push button function is not available in ZERO SPAN mode.

BANDWIDTH and SIGNAL TRACK modes will go to idle in ZERO SPAN mode. Since the idle message appears in the frequency/time readout location, these functions are turned off so the time display can appear on the screen.

Programming Features (495P GPIB Operation)

Setting GPIB Address Switches

The general purpose interface bus (GPIB) ADDRESS switches on the rear panel set the value of the instrument's GPIB address. The *495P Programmer* manual contains details of how the switches are used in remote control operations.

The switches can be set as desired, except when using Tektronix 4050-Series controllers. They reserve address 0 for their own use. Selecting a primary address of 31 logically removes the instrument from the bus. With address 31 selected, the 495P does not respond to any GPIB address, but remains both unlistened and untalked. If the switches are changed after power-up, the [RESET TO LOCAL] or [Blue–SHIFT] [PLOT] push button must be activated so the 495P will update the primary address.

TALK ONLY, LISTEN ONLY Switches

The switches for talk-only and listen-only operation are part of the GPIB ADDRESS switch bank on the 495P rear panel. Set either or both switches as needed (you can have talk only, listen only, or both talk only and listen only features). If the 495P power is on, press [RESET TO LOCAL] or [Blue-SHIFT] [PLOT] to implement changes to the switch settings. Both the TALK ONLY and LISTEN ONLY switches must be off (down) when the 495P is used with any controller.

Set the LF OR EOI switch to EOI (down) for use with Tektronix equipment. The switches marked 1, 2, 4, 8, and 16 may be set to any combination except all ones (decimal 31), which logically disconnects the 495P from the bus, or all zeroes when using the instrument with a 4050-Series controller.

Connecting to a System

Connect the 495P to a GPIB system through the GPIB cable supplied with the instrument. Connect the cable after the power to the 495P has been turned on, or the controller is turned off, to avoid generating interference on the bus.

Personalized Macros

The 495P allows you to personalize your instrument to fill your specific needs. Eight programs compiled by you to your specifications can be stored in memory to be called up and run at any time. This feature makes it possible for you to perform complete tests with only the 495P; without the need of a controller. These unique programs made up of existing, prepared commands are macroinstructions (macros).

The dictionary definition of a macro is "a single computer instruction that stands for a sequence of operations." Most of the commands available with the 495P can be used in macros.

There is 8K of memory reserved for personalized macros (the MEMORY query in the *Macros* section of the ***495P Programmer*** manual describes how to find out how much memory is available). When you create the macro, you have 22 characters available to you for the definitive names. Refer to the ***495P Programmer*** manual for the available commands and their use, the amount of memory needed for each usable command, examples, and sample macros.

Operational Considerations and Precautions

Following are some operational precautions to observe and traps that can occur when analyzing displays.

RF INPUT Power Limit

CAUTION — DO NOT EXCEED THE RF INPUT POWER LIMIT OF +30 DBM. DO NOT APPLY DC VOLTAGE TO THE RF INPUT.

Instrument Warm-up After Storage

After storage below -15° C, allow 15 minutes instrument warm-up time, then turn the power off and back on.

Auto Resolution

Use AUTO RESOLN mode with care when measuring absolute amplitude level. Always use a bandwidth wider than the incidental FM of the signal source.

Level of Pulsed Signals

The spectrum for a pulsed signal is spread out. Consequently, the height of the displayed response is less for a pulsed signal than for a CW signal of the same peak amplitude. This loss in display height means, in effect, a loss in sensitivity. The amount of loss can be computed from the following formula:

Voltage loss = $(t_oB)(1.5)$
where t_o = pulse duty cycle
B = resolution bandwidth

The power of the self-generated noise increase is proportional to bandwidth. Pulsed RF voltage level is also proportional. Since power is proportional to voltage squared, a wider bandwidth gives better sensitivity and greater dynamic range for pulsed RF inputs.

When in doubt about signal level overdrive problems, reduce the signal level by inserting RF attenuation; then, repeat the measurement. If the two agree, the measurement is correct. If not, the input mixer stage is probably overdriven.

An important consideration for pulsed RF measurements is the peak signal level at the mixer. The signal level is greater by $(t_oB)(1.5)$ than the peak level displayed on the screen. Taking the sensitivity loss into account is the only way of being sure that the mixer peak power input for linear operation is not exceeded.

Level of Continuous Wave Signals

Problems similar to those described in *Level of Pulsed Signals* can occur when analyzing CW signals at relatively narrow span widths. The large CW signal may not appear on screen because its frequency is outside the set span width. The mixer, nevertheless, is saturated and will compress signals.

Excessive Input Signal Level

Too much input power will destroy the front-end mixer or RF Attenuator. Replacement mixers and attenuators are costly. When working with high power signals, use couplers or other devices to reduce the signal down to acceptable levels. Once the signal is below the rating of the RF Attenuator, prevent possible mixer damage by setting the **MIN RF ATTEN dB** control fully clockwise; then reduce attenuation if needed.

No CRT Trace

The push button sequence **[Blue–SHIFT] [BASELINE CLIP]** is used to reduce the brightness of the baseline on the screen for easier viewing of the readout. If **TRIGGERING, INTENSITY,** and **Vertical POSITION** seem to be set properly and there is no CRT trace, check the status of the **[Blue-SHIFT] [BASELINE CLIP]** mode. The trace may be turned off.

PEAK/AVERAGE

The PEAK/AVERAGE control is normally set fully counterclockwise so narrow signals in wide spans are not reduced in amplitude.

Digital Storage Effects on Signal Analyses

When using digital storage, the frequency base is divided into storage slots. For peak displays above the cursor (horizontal line) the display point in each slot corresponds to the maximum sampled value of the signal. Samples are taken at about 9 us intervals. When sweeping at one second per division, this is about 1000 samples per slot. For average displays below the cursor, the values of all samples per slot are added and divided by the number of samples to compute the display point for each slot. Each display point is connected to create a smooth display. When A or B memory are displayed independently, only half of the slots are connected. The following situation may affect measurements made when using the digital storage display.

If the cursor set by PEAK/AVERAGE is above the signal level, the average value for each digital slot will be displayed. With narrow resolution bandwidths compared to the slot width, the average value of the resolution response shape will be displayed. The resulting display will not represent the true signal amplitude.

To avoid this situation, run digital storage with A and B interlaced. Do not set the **PEAK/AVERAGE** cursor to average a CW signal. It is best if the cursor is about 1/4 division above the signal to be averaged, and about 1/2 division below the signal to be analyzed.

These restrictions do not apply when the resolution bandwidth is wide compared to a digital storage slot (e.g., 5 MHz FREQUENCY SPAN/DIV with 1 MHz RESOLUTION BANDWIDTH).

Stored Display Averaged in Wide Spans

When operating in wide spans with digital storage, low-level signals will be averaged with the noise and lost if the **PEAK/AVERAGE** cursor is above the display. Turn the control fully counterclockwise for peak detection when operating with wide spans.

Automatic Calibration of Relative Amplitudes of Resolution Bandwidth Filters

If a MEASUREMENT FAILED message appears when the automatic calibration completes, refer to the correction factors for an explanation. Press **[Blue–SHIFT] [LIN]** to display the correction factors held in memory. Refer to *Display Calibration* in Section 5 for further information.

Triggering

The TRIGGERING mode is set to **FREE RUN** for most applications. In pulsed RF applications, a triggered display is required to measure between pulse repetition lines to determine the pulse repetition rate.

Internal triggering requires two or more divisions of signal amplitude. Tune the **CENTER/MARKER FREQUENCY** control to position a signal of two divisions or more at the sweep start (left edge of the screen) before changing the trigger source from **FREE RUN** to **INT.**

Service Information

Service Manual

The 495/P service manuals are separate publications. The ***495/495P Service Manual, Volume 1*** includes circuit descriptions, troubleshooting information, calibration procedures, and maintenance procedures. The **495/495P *Service Manual, Volume 2*** includes the electrical and mechanical parts lists, standard and optional accessories, and schematic diagrams.

WARNING

Service manuals are intended for use by QUALIFIED SERVICE PERSONNEL ONLY. To avoid electrical shock, DO NOT perform any servicing unless qualified to do so. Service personnel should read the Safety information at the beginning of the service manuals before performing any servicing.

Product Service

To assure adequate product service and maintenance for our instruments, Tektronix, Inc. has established Field Offices and Service Centers at strategic points throughout the United States and in all other countries where our products are sold. Contact your local Service Center, representative, or sales engineer for details regarding warranty, calibration, emergency repair, repair parts, scheduled maintenance, maintenance agreements, pickup and delivery. On-Site Service for fixed installations and other services are available through these centers.

Emergency Repair

This service provides immediate attention to instrument malfunction if you are in an emergency situation. Contact any Tektronix Service center for assistance to get you on your way within a minimum amount of time.

Maintenance Agreements

Several types of maintenance or repair agreements are available. For example, for a fixed fee, a maintenance agreement program provides maintenance and calibration on a regular basis. Tektronix, Inc. will remind you when a product is due for calibration and perform the service within a specified time-frame. Refer to Options M1 through M9 in *Section 7, Options,* for extended service and warranty options available. Any Service Center can furnish complete information on costs and types of maintenance programs.

Options

This section describes the options available at this time for the spectrum analyzer. Changes in specifications, if any, are described in this section. Contact your local Tektronix Field Office or representative for additional information and ordering instructions (unless otherwise indicated).

Options are usually factory installed; however, field kits are available for some options. Contact your local Tektronix Field Office or representative for information on field kits and their installation.

Options M1, M2, M7, M8, and M9 (Extended Service and Warranty Options)

There are six extended service and warranty options offered for the 495P (see Table 7-1) that go beyond the basic one-year coverage. Contact our local Tektronix Field Office or representative for additional information to satisfy your specific requirements.

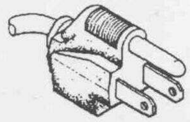
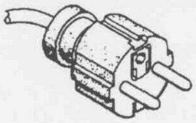
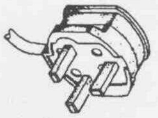
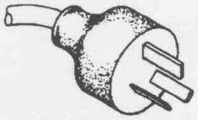
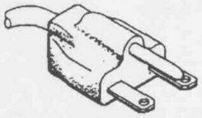
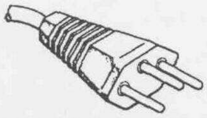
Table 7-1: Extended Service and Warranty Options

Option	Description
M1	2 years service and 2 calibrations
M2	4 years service
M3	4 years service and 4 calibrations
M7	2 calibrations
M8	4 calibrations
M9	2 years service

Options A1, A2, A3, A4, and A5 (Power Cord Options)

There are five international power cord options offered for the spectrum analyzer (see Table 7-2). For ordering purposes, refer to the *Replaceable Mechanical Parts* list in the ***495/495P Service Volume*** **2,** for the Tektronix Part Number.

Table 7-2: Power-Cord and Plug Identification

Plug Configuration	Nominal Usage	Option #
	North America 125 V	Standard
	Europe 230 V	A1
	United Kingdom 230 V	A2
	Australia 230 V	A3
	North America 230 V	A4
	Switzerland 230 V	A5

Option 07 (75 Input)

Option 07 provides a 75 Q input in addition to the standard 50 Ω input. Table 7-3 lists the changes and additions to the standard electrical characteristics. These characteristics apply to the 75 Q Input,

Table 7-3: Option 07 Alternate Specifications

Characteristic	Performance Requirement	Supplemental Information
Input		
Input Impedance		75 Q.
Return Loss 5 MHz to 800 MHz		17 dB (1.35:1 VSWR).
Return Loss 800 MHz to 1000 MHz		13 dB (1.6:1 VSWR) with ≥10 dB attenuation.
Maximum Input Level		
With 0 dB Attenuation		+78 dBmV.
With 20 dB or More Attenuation		+78 dBmV, 100 VDC maximum (DC + Peak AC).
Frequency		
Center Frequency Operating Range		0 to 1000 MHz.
Static Resolution Bandwidth	Within 20% of 300 kHz bandwidth (6 dB down)	300 kHz filter replaces the standard 100 kHz filter.
Frequency Response		
5 MHz to 1000 MHz	±2.0 dB about the midpoint between two extremes	Frequency response is measured with > 10 dB RF Attenuation. The response figure includes the effects of: • Input VSWR • Mixer • Gain variations Variations in display flatness contribute about 1 dB to the response figure.
1 MHz to 5 MHz		Typically <3 dB down from the 5 MHz response.

Table 7-3: Option 07 Alternate Specifications (Cont.)

Characteristic	Performance Requirement	Supplemental Information
Amplitude		
Reference Level Range (with 0 Reference Level Offset)		−68 dBmV to +99 dBmV. +89 dBmV is achievable in MIN NOISE or REDUCED GAIN mode. +99 dBmV is achievable with MIN NOISE on and with REDUCED GAIN mode activated.
Sensitivity		
Equivalent Input Noise Sensitivity		Measured at 25° C with: • 0 dB RF Attenuation (Min Atten 0 dB • Narrow Video Filter On • Vertical Display 2 dB/div (5 dB/div in 10 Hz Filter) • Digital Storage On • Max Hold Off • Peak/Average in Average • 1 s Time/Div • Zero Span • Input Terminated in Characteristic Impedance
5 MHz to 1000 MHz, 75 Q RF INPUT		
10 Hz Filter	-82 dBmV	
100 Hz Filter	-76 dBmV	
1 kHz Filter	-66 dBmV	
10 kHz Filter	-56 dBmV	
300 kHz Filter	-41 dBmV	
1 MHz Filter	-36 dBmV	
3 MHz Filter	-31 dBmV	
50 Ω RF INPUT		
300 kHz Filter	-90 dBmV	
Output		
Calibrator Output		
CAL OUT Level	+20 dBmV ±0.5 dB	100 MHz comb of markers provide amplitude calibration at 100 MHz.
Impedance		75 Q nominal.
Physical		
Weight		Option 07 adds 7 ounces (0.2 kg) to the standard instrument. Weight with only Option 07 added is 43 lbs. 4 oz. (19.7 kg) (including cover and standard accessories, except manuals).

Option 39 (Silver Batteries)

Option 39 provides silver batteries for the instrument's battery-powered memory. The battery life at +55° C is 1 -2 years, and 2-5 years at +25° C. We recommend removing the silver batteries during long-term storage.

Option 42 (110 MHz IF Output)

This option provides a 110 MHz IF output with bandwidth greater than 4.5 MHz for broad-band, swept receiver applications. Table 7-4 lists the changes from the standard instrument.

Table 7-4: Option 42 Alternate Specifications

Characteristic	Performance Requirement	Supplemental Information
Frequency		
Center Frequency	108.5 MHz to 111.5 MHz	
3 dB Bandwidth	≥4.5 MHz	
Bandpass Ripple	≤0.5 dB	
Symmetry About 110 MHz	±1.0 MHz	
Power		
Power Out with -30 dBm Input and Signal at Full Screen	≤0 dB	Nominal output impedance is 50 Ω. 1 dB compression of output ≥0 dBm in MIN DISTORTION and non-reduced gain modes only.

Option 52 (North American 220 V)

Option 52 provides a North American 220 V configuration with the standard power cord. The fuses are replaced with 2A slow blow.

Glossary

The following glossary is presented as an aid to better understand the terms as they are used in this document and with reference to spectrum analyzers.

General Terms

Center Frequency
That frequency which corresponds to the center of a frequency span, expressed in hertz.

Baseline Clipper (Intensifier)
A means of increasing the brightness of the signal relative to the baseline portion of the display.

dBc
Decibels referenced to carrier level.

dBm
A unit to express power level in decibels referenced to 1 milliwatt.

dBmV
A unit to express voltage levels in decibels referenced to 1 millivolt.

dBuV
A unit to express voltage levels in decibels referenced to 1 microvolt.

Effective Frequency Range
That range of frequency over which the instrument performance is specified. The lower and upper limits are expressed in hertz.

Envelope Display
The display produced on a spectrum analyzer when the resolution bandwidth is greater than the spacing of the individual frequency components.

Frequency Band
A continuous range of frequencies extending between two limiting frequencies, expressed in hertz.

Full Span (Maximum Span)
A mode of operation in which the spectrum analyzer scans an entire frequency band.

Intermodulation Spurious Response (Intermodulation Distortion — IMD)
An unwanted spectrum analyzer response resulting from the mixing of the nth order frequencies, due to non-linear elements of the spectrum analyzer. The resultant unwanted response are displayed.

Line Display

The display produced on a spectrum analyzer when the resolution bandwidth is less than the spacing of the signal amplitudes of the individual frequency components.

Line Spectrum

A spectrum composed of signal amplitudes of the discrete frequency components.

Markers

The instrument uses three types of markers:

Update Marker

Marks the current sweep position in a digital storage display as the display is being updated.

Video Markers

Marker signals applied to the external VID | MARKER input from a Tektronix 1405 Television Sideband Analyzer. The Video Markers mark frequencies of interest on the television signal.

Waveform Markers

When the Marker function is enabled, it provides a movable cursor with readout of frequency and amplitude at the marker position. When the delta marker mode is enabled, a second marker allows operations and readout between the two marker positions. (Also see Waveform Marker Terms.)

Maximum Safe Input Power

WITHOUT DAMAGE

The maximum power applied at the input which will not cause degradation of the instrument characteristics.

WITH DAMAGE

The minimum power applied at the input which will damage the instrument.

Pulse Stretcher

A pulse shaper that produces an output pulse, whose duration is greater than that of the input pulse, and whose amplitude is proportional to that of the peak amplitude of the input pulse.

Scanning Velocity

Frequency span divided by sweep time and expressed in hertz per second.

Signal Identifier

A means to identify the spectrum of the input signal when spurious responses are possible.

Video

The term is used here generally to mean a signal after the detector stage. It can also be used more specifically to mean a base-band (zero carrier frequency) television signal.

Video Filter

A post detection low-pass filter.

Zero Span

An operating mode in which the frequency span is reduced to zero.

Frequency Terms

Display Frequency

The input frequency as indicated by the spectrum analyzer and expressed in hertz.

Frequency Drift

Gradual shift or change in displayed frequency over the specified time due to internal changes in the spectrum analyzer, where other conditions remain constant. Expressed in hertz per second.

Frequency Linearity Error

The error of the relationship between the frequency of the input signal and the frequency displayed (expressed as a ratio).

Frequency Span (Dispersion)

The magnitude of the frequency band displayed; expressed in hertz or hertz per division.

Impulse Bandwidth

The displayed spectral level of an applied pulse divided by its spectral voltage density level assumed to be flat within the pass-band.

Residual FM (Incidental FM)

Short term displayed frequency instability or jitter due to instability in the spectrum analyzer local oscillators. Given in terms of peak-to-peak frequency deviation and expressed in hertz or percent of the displayed frequency.

Shape Factor (Skirt Selectivity)

The ratio of the frequency separation of the two (60 dB/6 dB) down points on the response curve to the static resolution bandwidth.

Static (Amplifier) Resolution Bandwidth

The specified bandwidth of the spectrum analyzer's response to a CW signal, if sweep time is kept substantially long. This bandwidth is the frequency separation of two points on the response curve, usually 6 dB down, if it is measured either by manual scan (true static method) or by using a very low speed sweep (quasi-static method).

Zero Pip (Response)

An output indication which corresponds to zero input frequency.

Amplitude Terms

Deflection Coefficient

The ratio of the input signal magnitude to the resultant output indication. The ratio may be expressed in terms of volts (rms) per division, decibels per division, watts per division, or any other specified factor.

Display Dynamic Range

The maximum ratio of the levels of two non-harmonically related sinusoidal signals each of which can be simultaneously measured on the screen to a specified accuracy.

Display Flatness

The unwanted variation of the displayed amplitude over a specified frequency span, expressed in decibels.

NOTE

Display flatness is closely related to frequency response. The main difference is that the spectrum display is not moved to center screen.

Display Law

The mathematical law that defines the input-output function of the instrument. The following cases apply:

Linear

A display in which the scale divisions are a linear function of the input signal voltage.

Square law (power)

A display in which the scale divisions are a linear function of the input signal power.

Logarithmic

A display in which the scale divisions are a logarithmic function of the input signal voltage.

Display Reference Level

A designated vertical position representing a specified input level. The level may be expressed in dBm, volts, or any other units.

Dynamic Range

The maximum ratio of the levels of two signals simultaneously present at the input which can be measured to a specified accuracy.

Frequency Response

The unwanted variation of the displayed amplitude over a specified center frequency range, measured at the center frequency, expressed in decibels.

Gain Compression
Effect seen at an input level where the analyzer circuits have less gain than their small signal values. This is usually specified at the 1 dB compression point in terms of the input level required to reduce the gain by 1 dB.

Hum Sidebands
Undesired responses created within the spectrum analyzer, appearing on the display, that are separated from the desired response by the fundamental or harmonic of the power line frequency.

Input Impedance
The impedance at the desired input terminal. Usually expressed in terms of VSWR, return loss, or other related terms for low impedance devices and resistance-capacitance parameters for high impedance devices.

Noise Sidebands
Undesired response caused by noise internal to the spectrum analyzer appearing on the display around a desired response.

Relative Display Flatness
The display flatness measured relative to the display amplitude at a fixed frequency within the frequency span, expressed in decibels.

Residual Response
A spurious response in the absence of an input signal. (Noise and zero pip are excluded.)

Sensitivity
Measure of a spectrum analyzer's ability to display minimum level signals, expressed in volts or decibels. Intermediate frequency (IF) bandwidth, display mode, and any other influencing factors must be given.

Spurious Response
A response of a spectrum analyzer wherein the displayed frequency is not related to the input frequency.

Digital Storage Terms

Clear (Erase)
Presets memory to a prescribed state, usually that denoting zero.

Digitally Averaged Display
A display of the average value of digitized data computed by combining serial samples.

Digitally Stored Display
A display method whereby the displayed function is held in a digital memory. The display is generated by reading the data out of memory.

Max Hold (Peak Mode)

Digitally stored display mode which, at each frequency address, compares the incoming signal level to the stored level and retains the greater. In this mode, the display indicates the peak level at each frequency after several successive sweeps.

Multiple Display Memory

A digitally stored display having multiple memory sections which can be displayed separately or simultaneously.

Save

A function which inhibits storage update, saving existing data in a section of a multiple memory (e.g., Save A).

Scan Address

A number representing each horizontal data position increment on a directed beam type display. An address in a memory is associated with each scan address.

View (Display)

Enables viewing of contents of the chosen memory section (e.g., "View A" displays the contents of memory A; "View B" displays the contents of memory B).

Volatile/Non-volatile Storage

A volatile storage system is one where any total loss of power to the system will result in a loss of stored information. Non-volatile memory is not subject to the instrument power supply for its storage.

Waveform Marker Terms

Active Trace

Live Trace or the B-SAVE A trace (a trace recalled into B is not an active trace).

Inactive Trace

SAVE A trace or a trace recalled into the B display before the sweep is started.

Live Trace

Any combination of the A trace and/or the B trace when SAVE A is off.

Primary Marker

The marker displayed in the Single Marker mode whose frequency and/or position is changed when tuning with the CENTER/MARKER FREQUENCY control. When two markers are displayed, the brightest marker is the Primary marker.

Secondary Marker

The "second" marker; displayed only in the Delta Marker mode.

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.