Tektronix®
COMMITTED TO EXCELLENCE

492
OPERATORS HANDBOOK

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

070-2729-00

Serial Number ________________

First Printing MAR 1980

WARRANTY

Tektronix warrants that this product is free from defects in materials and workmanship. The warranty period is one (1) year from the date of shipment. Tektronix will, at its option, repair or replace the product if Tektronix determines it is defective within the warranty period and if it is returned, freight prepaid, to a service center designated by Tektronix.

Tektronix is not 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 from connecting the product to incompatible equipment;
c. if personnel other than Tektronix representatives modify the hardware or software.

There is no implied warranty of fitness for a particular purpose. Tektronix is not liable for consequential damages.

Printed in U.S.A. Specification and price change privileges are reserved.

TABLE OF CONTENTS

OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

TERMS

In This Manual

CAUTION 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.

As Marked 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.

SYMBOLS

In This Manual

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

As Marked on Equipment

⚡ DANGER — High voltage.

⏚ Protective ground (earth) terminal.

⚠ ATTENTION — refer to manual.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

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.

For detailed information on power cords and connectors, see 492 Service Vol. 1.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

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

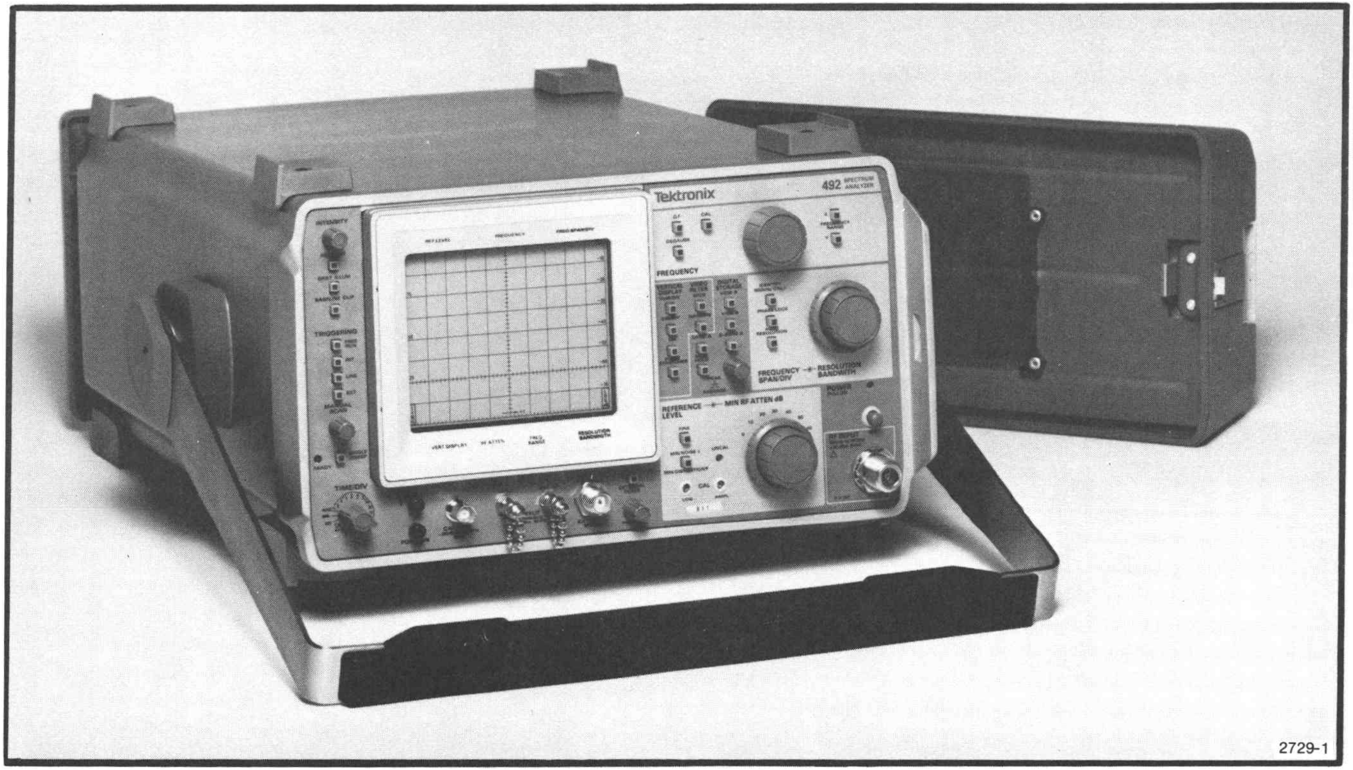
Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.



492 Spectrum Analyzer.

SECTION 1
DESCRIPTION AND SPECIFICATION

PRODUCT DESCRIPTION

The 492 Spectrum Analyzer is a high performance, compact, portable spectrum analyzer that displays absolute amplitude and frequency information of signals within the frequency spectrum of 50 kHz to 21 GHz with the internal coaxial mixer, and up to 60 GHz with optional external TEKTRONIX High Performance Waveguide Mixers. The 8.4 X 10.2 cm crt face reads out all major display parameters.

SPECIFICATION SUMMARY

Complete instrument specifications can be found in the 492 Operator's Manual.

These specifications apply at ambient temperature of 25°C after a 2 hour warm-up period.

Frequency Related Specifications

Center frequency range, RF INPUT	100 kHz—18 GHz (usable to 21 GHz)
Center frequency readout accuracy	Within (5 MHz + 20% of span/div) or within (0.2% of the center frequency + 20% of the span/div), whichever is greater.
Frequency drift	<= 200 kHz/hour

Amplitude Related Specifications

Frequency response and sensitivity:

Frequency Range	Frequency Response	Sensitivity 1 kHz Bandwidth
100 kHz—4.1 GHz without option 01	within 1.5 dB	−115 dBm
100 kHz—1.8 GHz with option 01	within 1.5 dB	−110 dBm
1.7—5.5 GHz	within 1.5 dB[a]	−115 dBm[b]
3.0—7.1 GHz	within 1.5 dB[a]	−115 dBm[b]
5.4—18.0 GHa	within 2.5 dB[a]	−100 dBm[b]
15.0—21.0 GHz	within 3.5 dB[a]	−95 dBm[b]

[a] **derate 1 dB for option 01.**

[b] **add −10 dB for option 01.**

Signal Level Accuracy:

Signal levels are measured after the instrument is calibrated to the 100 MHz calibrator signal. Sources of error in signal level measurement are shown below and are worst case for 25° Celsius operation. The sources of errors that are actually encountered will depend upon signal frequency, level, and measurement technique.

Calibrator	within 0.3 dB maximum
RF Attenuator	within 1.4 dB maximum
Flatness	typically 1 dB greater than the frequency response
Band switching	within 1 dB with internal mixer
Resolution bandwidth switching	within 0.5 dB maximum
IF gain	within 2.0 dB maximum
Display and log	within 2.0 dB maximum

Spurious Response Specification

Residual (signals present with no RF input)	−100 dBm referred to mixer input for fundamental mixing
Harmonics of input signal	60 dB down for −30 dBm signal
Harmonic of input signal with option 01, 1.7—18 GHz	100 dB down for full screen signal (MIN DISTORTION mode)

Third order intermodulation distortion, 10 kHz—18 GHz	at least 70 dB down from any two on screen signals within any frequency span −30 dBm inputs
Third order intermodulation distortion with option 01, 1.7—18 GHz	100 dB down for two inputs of 100 MHz minimum separation

RF INPUT Specifications

Maximum input level	+30 dBm (>=20 dB RF attenuation) +13 dBm (no RF attenuation)
Input VSWR	better than 1.45:1 with >=10 dB RF attenuation
1 dB compression point	
without option 01	−10 dBm (no RF attenuation)
with option 01, 50 kHz—1.7 GHz	−10 dBm (no RF attenuation)
with option 01, 1.7—2.0 GHz	−28 dBm (no RF attenuation)
with option 01, 1.8—18 GHz	−10 dBm (no RF attenuation)
L.O. emmission	
without option 01	−10 dBm (no RF attenuation)
with option 01	−70 dBm (no RF attenuation)

Sweep and Display Specifications

Sweep time accuracy	within 5%
Trigger sensitivity	>=2.0 division of signal for internal, and 0.5 V peak minimum to 50 V peak maximum external
Trigger bandwidth	15 Hz to 1 MHz
VERT OUTPUT Levels	
bottom of screen	0 volt nominal
top of screen	+4 volt nominal
HORIZ OUTPUT levels	
left side of screen	−2.5 volt nominal
right side of screen	+2.5 volt nominal
PEN LIFT	TTL compatible. Goes high to lift pen.
External horizontal input	
left side of screen	0 volt nominal
right side of screen	+10 volt nominal

Other Specifications

Instrument power	90—132 VAC or 180—250 VAC internally selectable 210 Watts maximum (options 01, 02, 03)
Leakage current	5 mA peak (options 01, 02, 03)
Storage temperature	−62°C to +75°C
Operating temperature	−15°C to +55°C
Storage altitude	12,192 meters (40,000 feet) maximum
Operating altitude	4,752 meters (15,000 feet) maximum
Weight	21.78 kg (44 lb)

SECTION 2
OPERATION

PREPARATION FOR USE

The 492 can be installed in any position that allows air flow in 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. A fan draws air in through the bottom and expels air out the back. Avoid locating the 492 where paper, plastic, or like material might block the air intake.

The front panel cover for the 492 provides a dust-tight seal. Use the cover to protect the front panel when storing or transporting the instrument. The cover is also used to store accessories and external waveguide mixers. The cover is removed by first pulling up and in on the two release latches then pulling up on the cover. The door to the accessories compartment is unlatched by pressing the latch to the side and lifting the cover.

The handle of the 492 can be positioned at several angles to serve as a tilt stand, or it can be positioned at the top rear of the instrument between the feet and the rear panel so 492 instruments can be stacked. To position the handle, press in at both pivot points and rotate the handle to the desired position.

CAUTION

Removing or replacing the cabinet on the instrument can be hazardous. The cabinet should only be removed by qualified service personnel.

POWER SOURCE AND POWER REQUIREMENTS

The 492 is designed to operate from a single-phase power source that has one of its current-carrying conductors (neutral) at ground (earth) potential. Operating 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 volt single-phase, three-wire system) is not recommended, since 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, the unit frame must be connected to an earth ground.

Power and voltage requirements are printed on a back panel plate mounted below the power input jack. The 492 can be operated from either a 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. A multipin (harmonica) type connector on the power supply etched circuit board can be positioned to accommodate either voltage range. When the power supply circuitry is changed to accommodate a different power source, the information plate on the back panel must also be changed to reflect the new power requirements. Refer power input changes to qualified service personnel. Instructions are contained in the Service Information section.

WARNING

Only qualified service personnel should attempt to change the power input requirements. Unfamiliarity with safety procedures can result in personal injury. Refer to the Safety Summary at the front of this manual.

CONTROLS, INDICATORS, AND CONNECTORS

The following describes the function of the controls, indicators, and connectors on the front and rear panels of the 492. Figures 2-1 and 2-2 illustrate their locations. All options are covered in this description and some functions are described in greater depth under Operating Information.

Front Panel (Fig. 2-1)

(1) **INTENSITY.** Controls brightness of the crt trace and crt readout. (Focus is automatically adjusted electronically.)

(2) **READOUT.** Switches crt readout on or off. All spectrum analyzer parameters are read out except Time/Div. Brightness is proportional to the trace brightness and the ratio can be readjusted by service personnel.

(3) **GRAT ILLUM.** Switches graticule light on or off.

(4) **BASELINE CLIP.** When activated, the baseline of the display is clipped or subdued to increase the contrast between the display and the baseline.

(5) **TRIGGERING.** One of four triggering modes can be selected by pushbuttons that illuminate when activated. A SINGLE SWEEP pushbutton plus a READY indicator provide single sweep operation.

FREE RUN—When activated, the sweep is free running without regard to trigger signals. When selected, all other triggering modes are canceled.

INT—When activated, the sweep is triggered by any signal at the left edge of the display with an amplitude of 1.0 division or more. Other trigger modes are canceled.

LINE—When activated, a sample of the ac power line voltage is used to trigger the sweep. All other modes are canceled when selected.

EXT—When selected, the sweep is triggered by signals between 0.5 volt peak (minimum) to 50 volts peak (maximum) that are applied through the back panel EXT IN HORIZ/TRIG connector. When EXT is selected, the other modes are canceled.

(6) **SINGLE SWEEP.** When selected, one sweep is initiated after the sweep circuit has been triggered. Pushing this button does not cancel the trigger modes. The button must be pressed to rearm the sweep circuit after the sweep has run. When single sweep mode is first selected, the present sweep is aborted and the sweep circuit is not armed. To cancel single sweep, press one of the trigger mode pushbuttons.

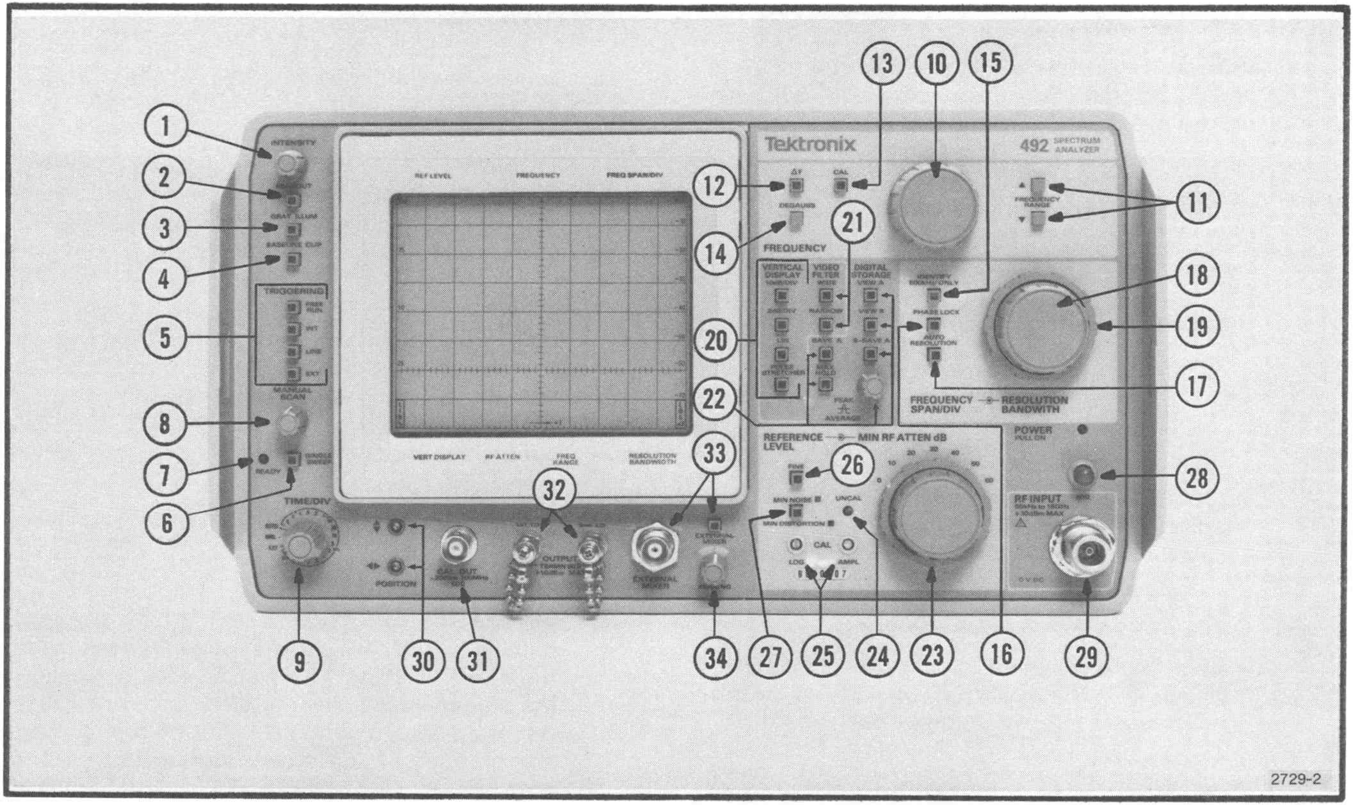


Fig. 2-1. Front panel selectors, controls, and connectors.

(7) **READY.** When SINGLE SWEEP is selected, this indicator lights while the sweep circuit is armed and ready for a trigger signal. The indicator stays lit until the sweep ends.

(8) **MANUAL SCAN.** When the TIME/DIV selector is in the MNL position, this control will manually scan the spectrum.

(9) **TIME/DIV.** Selects sweep rates from 5 s/div to 20 μs/div in 5-2-1 sequence. This switch also selects AUTO, EXT, and MNL modes.

AUTO (automatic)—In this position the sweep rate is selected by the microcomputer to maintain a calibrated display for any FREQ SPAN/DIV, RESOLUTION, and VIDEO FILTER combination.

EXT (external input)—This position connects the rear panel EXT IN HORIZ/TRIG connector to the horizontal sweep circuit. A voltage ramp of 0 to +10 volts will sweep 10 divisions of the horizontal (x) axis.

MNL (manual)—In this position the horizontal axis can be swept with the MANUAL SCAN control.

(10) **FREQUENCY.** Tunes the center frequency. Tune rate is proportional to the selected FREQ SPAN/DIV. Any given signal moves across the display at a constant rate for all spans. In MAX span, the tuning range depends on the band; for example, in Band 2 (1.7—5.5 GHz) the frequency dot will not tune to the extreme left edge of the graticule, or in Band 6 (15—21 GHz) the dot will tune only to the right of center.

(11) **FREQUENCY RANGE** (band). These two pushbuttons shift the center frequency range up or down. Frequency range of the band is displayed on the crt readout.

(12) **ΔF.** A convenience for measuring frequency difference between signals (see Operational Procedure). When selected, the frequency readout goes to zero. It will then read out the deviation from this reference as the FREQUENCY is tuned.

(13) **CAL.** When activated, the frequency readout can be calibrated to center frequency by adjusting the FREQUENCY control for the correct reading. When calibrated, deactivate the CAL mode.

(14) **DEGAUSS.** When the DEGAUSS button is pressed, current through the tuning coils of the YIG oscillator (1st LO) and YIG preselector (when installed) is reduced to zero to minimize hysteresis effects. This enhances center frequency and display amplitude accuracy. DEGAUSS does not function when the FREQ SPAN/DIV is less than 1 MHz/Div. Degauss the tuning coils after a significant frequency change and before calibrating the center frequency readout.

(15) **IDENTIFY 500 kHz ONLY.** Signal identify feature is functional only when the FREQ SPAN/DIV is 500 kHz. When activated (button lit) true signals will change amplitude each sweep; images and spurious response signals will shift horizontally or off screen. To ensure that the signal is changing amplitude every sweep, decrease the sweep rate so each sweep can be analyzed; or, if the instrument has digital storage, activate SAVE A, VIEW B.

When the true signal is centered under the dot marker after degauss, the FREQUENCY readout is the signal frequency (within specification). Degauss by pressing DEGAUSS at FREQ SPAN/DIV setting of 1 MHz or 2 MHz.

(16) **PHASE LOCK (Option 3).** The 1st LO is locked to a stable internal reference and the 2nd LO swept to reduce residual FM in narrow spans; the button lights when phase lock is active. In narrow spans phase lock can be turned off or back on by pressing the button. Spans for which the microcomputer automatically selects phase lock are:

Band	Span/Div
1, 2, 3	50 kHz and below
4	100 kHz and below
5 and above	200 kHz and below

(17) **AUTO RESOLUTION.** This is a pushbutton that activates automatic bandwidth selection for the selected FREQ SPAN/DIV and TIME/DIV and VIDEO FILTER. An internal microcomputer selects bandwidth to maintain a calibrated display. When the TIME/DIV is in AUTO mode, resolution bandwidth becomes a function of the FREQ SPAN/DIV selection.

(18) **FREQUENCY SPAN/DIV.** This is a continuous detented control that selects frequency span/div. Span/div is indicated by the crt readout. Range of the span/div selection depends on the frequency band and options. Table 3-1 lists the range for the various bands and options. Selection is a 5-10-20 sequence plus MAX span and 0 Hz span positions.

When MAX span is selected, the span displays the full band. Sweep beyond the band is clamped to the baseline. A dot marker near the top of the screen indicates the position on the span of the crt frequency readout. This dot and frequency point will be center screen when the FREQ SPAN/DIV is reduced below MAX span position. When zero span is selected Time/Div is read out instead of Span/Div.

Table 2-1

SPAN/DIV RANGES VERSUS BAND AND OPTION

Band	Narrow Span/Div		Wide Span/Div
	Standard	Option 3	All Instruments
1—3 (0—7.1 GHz)	5 kHz	500 Hz	200 MHz
4—5 (5.4—21 GHz)	10 kHz	500 Hz	500 MHz
6 (18—26 GHz)	20 kHz	500 Hz	1 GHz
7—8 (26—60 GHz)	50 kHz	500 Hz	2 GHz
9 (60—90 GHz)	100 kHz	500 Hz	2 GHz
10 (90—140 GHz)	100 kHz	500 Hz	5 GHz
11 (140—220 GHz)	100 kHz	500 Hz	10 GHz

(19) **RESOLUTION BANDWIDTH.** This is also a continuous detented control that selects resolution bandwidth. Bandwidth is indicated by crt readout. Range of selection is 1 kHz to 1 MHz in decade steps. An additional resolution bandwidth of 100 Hz, when Option 3 is installed, is provided. Changing the resolution bandwidth with this control deactivates AUTO RESOLUTION.

(20) **VERTICAL DISPLAY.** These four pushbuttons select the display mode. The crt readout indicates scale factor.

10 dB/DIV—When activated, the dynamic range of the display is a calibrated 80 dB with each major graticule representing 10 dB.

dB/DIV—Increases resolution so that each major graticule division represents 2 dB.

LIN—Selects a linear display between zero volts (bottom graticule line) and the reference level (top graticule line) scaled in volts/division. See REFERENCE LEVEL.

PULSE STRETCHER—Increases the fall time of pulse signals so very narrow pulses in a line spectrum display can be seen. The effect is most apparent for discrete signals analyzed at resolution bandwidths that are narrow compared to the span; PULSE STRETCHER may be necessary for digital storage of such signals, especially if they are averaged.

(21) **VIDEO FILTER.** One of two (NARROW and WIDE) filters can be activated to reduce the video bandwidth and reduce high frequency components for display noise averaging. The NARROW filter is approximately 1/300th of the selected resolution bandwidth; the WIDE filter is about 1/30th the bandwidth. Activating either filter cancels or deactivates the other filter. Press the pushbutton to switch the filters off.

(22) **DIGITAL STORAGE (Option 2).** Five pushbuttons and one control operate the digital storage functions. With none of the pushbuttons activated, the 492 display is not stored.

VIEW A, VIEW B—When either or both of these pushbuttons are selected, the pushbutton illuminates and the contents of memory A and/or memory B are displayed. With Save A mode off, all memory locations are displayed and updated continuously. Data in A memory is interlaced with data from B memory.

SAVE A—When activated, this mode holds data in A memory and inhibits further updating. With SAVE A and VIEW A active, data in A memory is displayed but not updated, serving as a reference to compare contents of B memory.

B—SAVE A—When activated, the differential (arithmetic difference) of data in B memory and the saved data in memory A is displayed. SAVE A mode is activated and SAVE A button illuminated. The zero difference point is nominally set at the middle graticule line with positive differences displayed above this line and negative differences below. (The zero difference position on screen is internally switch selectable.)

MAX HOLD—When activated the digital storage memory retains the maximum signal amplitude at each memory location. This permits visual monitoring of signal frequency and amplitude at each memory location over an indefinite period of time. This feature is used to measure drift, stability, and record peak amplitudes.

PEAK/AVERAGE—This control selects the amplitude at which the vertical display is either peak detected or averaged. Video signals above the level set by the control (shown by a horizontal line or cursor), are peak detected and stored; video signals below the cursor are digitally averaged and stored. See Peak/ Average Control (Digital Storage) under General Information.

(23) **MIN RF ATTEN dB and REFERENCE LEVEL.** These two concentric controls select the minimum RF attenuation (in dB) between the RF INPUT and the first mixer and the display reference level respectively.

MIN RF ATTEN dB. Sets the minimum amount of RF attenuation. Changing REF LEVEL will not decrease RF attenuation below that set by the MIN RF ATTEN selector.

Both reference level and actual RF attenuation (which may exceed the MIN RF ATTEN dB setting) are displayed by the crt readout.

REFERENCE LEVEL—a continuous control that requests the microcomputer to change the reference level one step each time the control is moved one detent. The normal steps are 10 dB in the 10 dB/DIV vertical display mode and 1 dB in the 2 dB/DIV mode. When the vertical display is changed to LIN, the reference level remains the same, but can be changed in dB steps equivalent to a full-scale display (8 divisions X volts/division); in LIN, the normal volts/division steps are a 1-2-5 sequence. See FINE below for the fine reference level steps.

(24) **UNCAL.** This indicator lights when the display amplitude is no longer calibrated (e.g., selecting a sweep rate that is not compatible with the frequency span/div and resolution bandwidth).

(25) **LOG and AMPL CAL.** These adjustments calibrate the dynamic range of the display. The LOG calibrates the logarithmic gain in dB/Div, the AMPL calibrates the reference level of the top graticule line at the top of the screen.

(26) **FINE.** A pushbutton used to select fine incremental steps for the REFERENCE LEVEL. The reference level does not change when FINE is switched off even if it is not at a normal step for the display mode.

Vertical Display Mode	FINE Increment
10 dB/DIV	1 dB
2 dB/DIV	0.25 dB (ΔA mode)[a]
LIN	Voltage equivalent to 1 dB

(27) **MIN NOISE/MIN DISTORTION.** One of two algorithms is selected to control attenuator and IF gain. MIN NOISE (button illuminated) reduces the noise level by reducing attenuation 10 dB and reducing IF gain 10 dB. MIN DISTORTION reduces IM distortion due to input mixer overload. To observe any change, the RF ATTEN, displayed by the crt readout, must be 10 dB higher than that set by the MIN RF ATTEN selector.

In MIN DISTORTION mode (button not illuminated) distortion is minimum.

[a] **For ΔA mode description see Delta A Mode under General Operating Information.**

(28) **POWER.** Pull type switch that switches the main power supply on.

(29) ⚠ **RF INPUT.** A 50 Ω coaxial input connector for signals 21 GHz or below. The maximum, non-destructive input signal level to the input mixer is +13 dBm or 30 mW. Signals above −10 dBm may cause signal compression.

CAUTION

The maximum rating of the RF attenuator is +30 dBm (1 watt average, 75 watts peak, pulse width ≤1 μs, with a duty cycle that does not exceed 0.001). Burn-out occurs above 1 watt.

If MIN NOISE is activated and RF ATTEN is 60 dB, the +30 dBm rating could be exceeded. If the input signal level is increased for a full screen display the input level will be +40 dBm. Reduce high level signals with external attenuators if the RF attenuator rating may be exceeded. Use external attenuators and the MIN RF ATTEN to reduce the level into the 1st mixer to −10 dBm or less. Input voltage to the input mixer must not contain any dc component. Refer to Signal Application (under General Operating Instructions) discussed later in this section.

(30) **POSITION ◀▶ ▲▼**. These controls position the display on the horizontal and vertical axes.

(31) **CAL OUT** (Calibrator output). The source of a calibrated −20 dBm (±0.3 dB) 100 MHz (±0.01%) signal, and a comb of frequency markers 100 MHz apart. The calibrated 100 MHz marker is used as a reference for calibrating reference level and log scale. The comb of 100 MHz markers is used to check span and frequency readout accuracy.

(32) **OUTPUT 1st and 2nd LO.** These connectors provide access to the output of the respective local oscillators. The connectors must be terminated into 50 Ω when they are not connected to some external device.

(33) **EXT MIXER.** When the EXT MIXER button is activated, bias is provided out the EXT MIXER port for external waveguide mixers. The IF output from the external mixer is then applied through the EXT MIXER port to the 2nd converter. External mixer connection and operation is described under General Operating Information.

CAUTION

Do not exceed mixer input limits. Refer to the external mixer operating instructions at the end of the General Operating Information part of this section.

(34) **PEAKING.** This control varies mixer bias for external mixers in the EXT MIXER mode. If the 492 has a preselector (Option 1), the control also adjusts the preselector filter tracking for the 1.7 to 21 GHz frequency range (Bands 2—5). In both cases it is adjusted for maximum signal amplitude. Refer to External Mixer Operation for more detailed instructions.

Rear Panel (Fig. 2-2)

(1) **EXT IN HORIZ/TRIG.** Dc coupled input for horizontal drive voltages and ac coupled for trigger signal. A 0 to +10 volt ramp produces full sweep. 0.5 to 50 volt peak signals are required for trigger (0.1 μs minimum pulse width), 15 Hz to 1 MHz. Selection as to HORIZ or TRIG mode depends on front panel TRIGGERING and TIME/DIV selections.

(2) **PROBE POWER.** Provides operating voltage (±15 V and +5 V) for active probes, such as TEKTRONIX P6056 or P6021. Refer to probe instruction manuals for operating procedures.

(3) **HORIZ** (output). Source of a signal that is 0.5 V for each division of display.

(4) **VERT** (output). Source of a signal that is 0.5 V for each division of display.

(5) **PEN LIFT.** TTL compatible, nominal +5 V provided to lift the pen of a chart recorder.

(6) **10 MHz IF** (+20 dBm max). Access to the 10 MHz IF signal. Output level is about −10 dBm with a full screen signal at −30 dBm reference level, maximum output is +20 dBm.

(7) **J104 ACCESSORY.** Possible future applications for the 492 may use this connector.

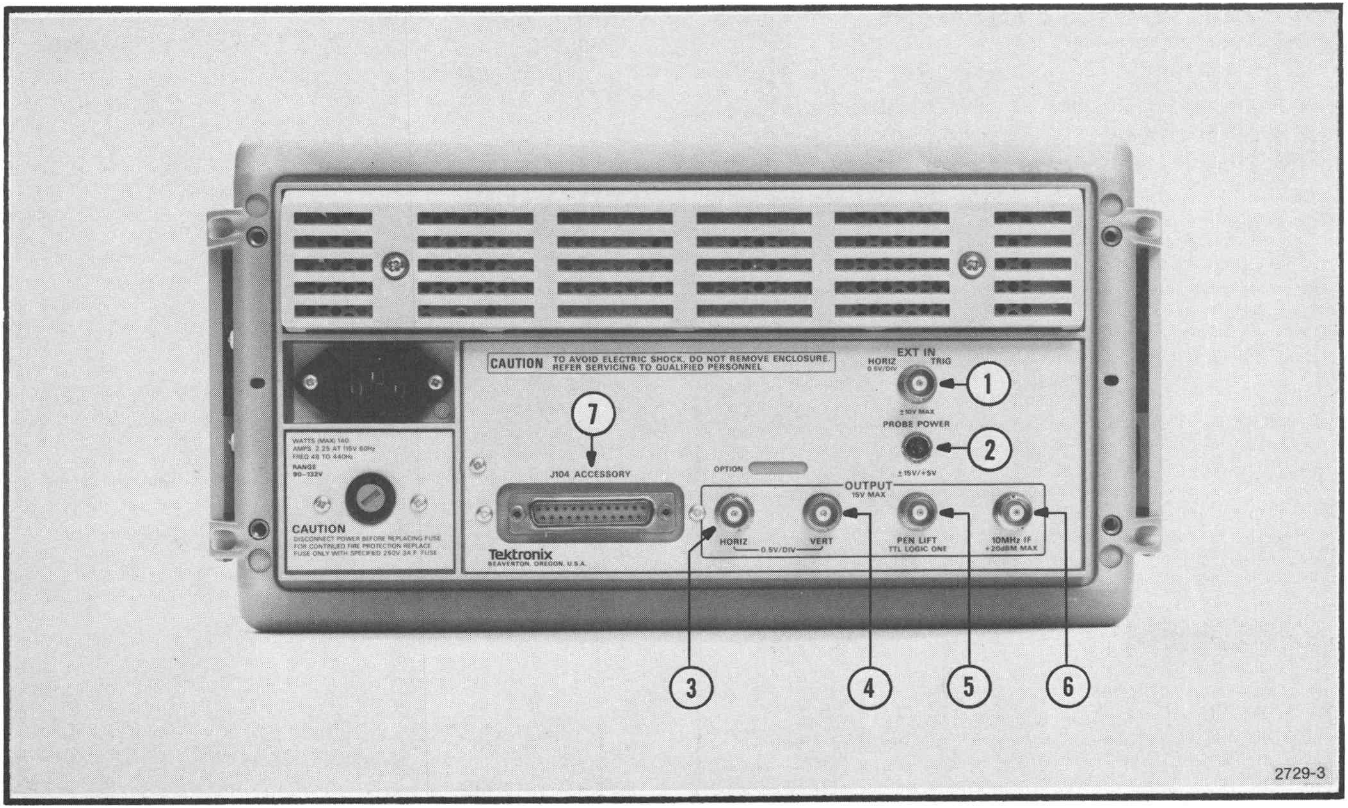


Fig. 2-2. Rear panel connectors.

INITIAL TURN ON

a. Connect the 492 power cord to an appropriate power source (see Power Requirements under Installation instructions) and switch POWER on. Allow three to four minutes for the instrument to warm up and stabilize before proceeding. Note that the crt readout is functioning (see Fig. 2-3).

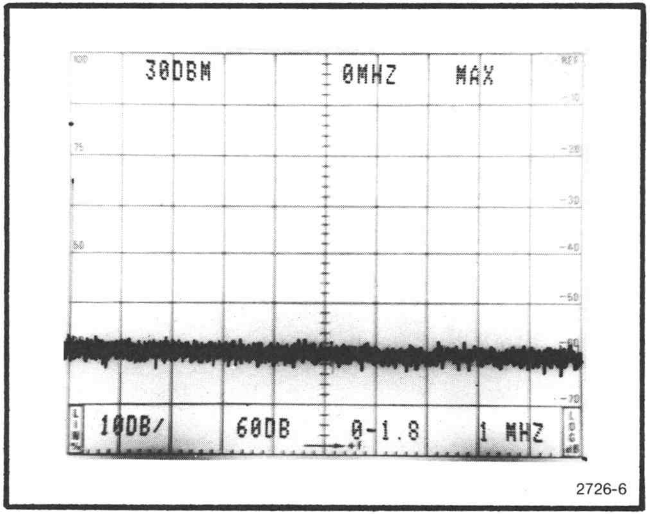


Fig. 2-3. CRT readout for power-up state.

When POWER is switched on (power up), the operating functions and modes of the 492 initialize to the following "power up" state.

Vertical Display	10 dB/DIV
FREQUENCY	0.00 MHz
REF LEVEL	+30 dBm
RF ATTENuation	60 dB
FREQUENCY RANGE	0.0—4.2 GHz (0.0—1.8 GHz with Option 1)
AUTO RESOLUTION	On
RESOLUTION BAND-WIDTH	1 MHz
FREQ SPAN/DIV	MAX
TRIGGERING	FREE RUN
READOUT	On
Digital Storage (Option 2)	VIEW A/VIEW B on
All other pushbuttons	Inactive or off

b. Set MIN RF ATTEN to 0 dB and PEAK/AVERAGE control fully ccw. Set the TIME/DIV to AUTO, the REFERENCE LEVEL to −20 dBm, and adjust the INTENSITY for a display with the desired brightness. Note, the RF ATTEN readout is now 10 dB.

c. Apply the CAL OUT to the RF INPUT by connecting a 50 Ω coaxial cable between the CAL OUT connector and the RF INPUT.

d. In the MAX frequency span mode, a dot marker in the upper portion of the screen indicates the location on the display to which the 492 center frequency is tuned. With a frequency readout of 0 MHz, it will be in the upper left portion of the screen. Adjust the center FREQUENCY control and note the dot marker move across the display.

e. Note the comb of 100 MHz markers at the left side of the display (see Fig. 2-4). Tune the dot marker to a position above the first 100 MHz marker.

f. Change the FREQ SPAN/DIV to 100 MHz. Note that the dot marker is now centered horizontally and the 100 MHz signal is at or near center screen.

g. Position the dot marker to the graticule centerline with the horizontal (◀▶) position control. Adjust the center frequency control to tune the signal over the dot marker.

h. Press the 2 dB/DIV Vertical Display button, then position the baseline of the display to the bottom graticule line with the vertical (▲▼) POSITION control.

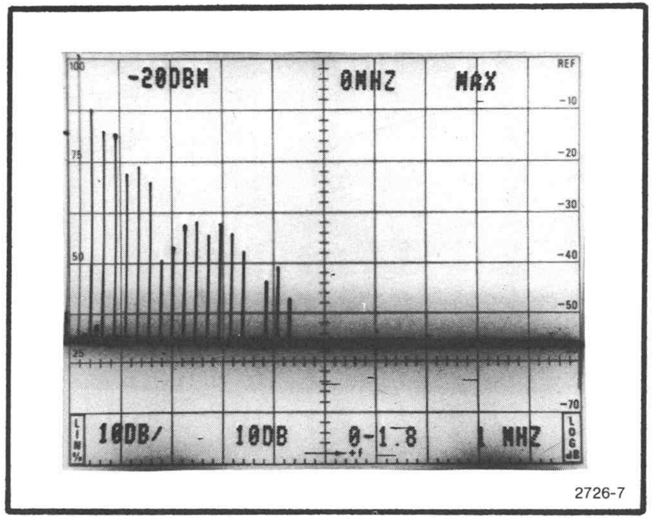


Fig. 2-4. Typical display of calibrator markers in MAX SPAN position.

CALIBRATE CENTER FREQUENCY READOUT

a. Change the Vertical Display to 10 dB/DIV. If the instrument has phase lock, ensure that the PHASE LOCK is de-activated or the FREQ SPAN/DIV is above 50 kHz (recommend setting of 10 MHz).

b. Tune the FREQUENCY to place the 100 MHz calibrator signal over the center-span dot marker. Reduce FREQ SPAN/DIV to 1 MHz, press the DEGAUSS button, and fine tune center frequency.

NOTE

Degauss function is inoperative when the FREQ SPAN/DIV is less than 1 MHz.

c. Press the CAL button to activate the calibration function (button illuminated); then adjust the FREQUENCY tuning control for a readout of 100 MHz. Press the CAL button to deactivate the CAL mode and increase FREQ SPAN/DIV to 20 MHz.

d. Check—center frequency accuracy at other multiples of the 100 MHz calibrator signal. Approach each check point from the low frequency side and degauss the tuning coils of the oscillator as each check point is approached. Readout should be within ±(5 MHz + 20% span/div) or ±(0.2% of center frequency + 20% of span/div) whichever is greater.

e. Return the frequency to 100 MHz.

CALIBRATE REFERENCE LEVEL AND DYNAMIC RANGE

a. With the 100 MHz calibrator signal tuned to center screen and the REF LEVEL at −20 dBm, set the FREQ SPAN/DIV to 20 kHz, as indicated by the crt readout.

b. Alternately switch Vertical Display from 10 dB/DIV to 2 dB/DIV and adjust AMPL CAL so the peak amplitude of the signal is the same for each logarithmic display mode.

c. With the Vertical Display mode at 10 dB/DIV, set the top of the calibrator signal to the top graticule line with the LOG CAL adjustment so the signal level indicates −20 dBm.

d. Check—the display log scale over 50 dB of dynamic range by switching REF LEVEL in 10 dB steps from −20 dBm to +30 dBm and noting that the display amplitude decreases 10 dB or one division per step.

e. Set the REF LEVEL at −20 dBm and the Vertical Display to 2 dB/DIV.

f. With the REF LEVEL selection in coarse mode, change the REF LEVEL to −10 dBm in 1 dB steps. Check that the amplitude and REF LEVEL readout reduces 1 dB/step for a total of 10 dB ±1.3 dB.

g. Return the REF LEVEL to −20 dBm and activate FINE for the ΔA mode.

h. Change the REF LEVEL 2.00 dB. Check that the REF LEVEL readout changes in 0.25 dB steps and the display amplitude decreases 2 dB ±0.5 dB (1 division ±0.25 division) to match the 2 dB change in readout. Return the REF LEVEL to 0.00 dB.

i. Change the display mode to 10 dB/DIV, switch the REF LEVEL from −20 dBm to −10 dBm. Check that the REF LEVEL changes in 1 dB increments and the total change in display amplitude is 10 dB ±1.3 dB (1 division ±0.13 division).

j. Return the REF LEVEL to −20 dBm and cancel FINE for coarse steps.

CHECK SPAN ACCURACY AND LINEARITY

Span accuracy is the displacement error of calibrator markers from the center reference over ±4 divisions of span. Linearity is the displacement error of markers from their specified points over the display area, with the 1st graticule line as the reference.

a. Set the FREQ SPAN/DIV to 50 MHz and the frequency to about 500 MHz. Tune the 500 MHz calibrator marker to center screen so it is below the center frequency dot marker.

b. Check span accuracy by noting that the 100 MHz markers are within 5% of their reference graticule line over the center eight divisions.

c. Tune one of the markers to the 1st graticule line. Check linearity by noting that the displacement between successive markers, with respect to the FREQ SPAN/DIV setting over the display area, does not exceed 5%.

SECTION 3
GENERAL OPERATING INFORMATION

SIGNAL APPLICATION

Signal frequencies up to 21 GHz are applied through a short, high quality, 50 Ω coaxial cable, to the RF INPUT connector. These signal pass through an internal RF attenuator to the first (1st) mixer. Option 1 version of the 492 has a filter selector that automatically selects either a low-pass filter or tuned preselector (depending on frequency band) between RF attenuator and the 1st mixer.

Signals above 21 GHz are applied to an external waveguide mixer. The output of the waveguide mixer is then applied through the EXT MIXER port to the second converter of the 492. Waveguide mixers and their application are described later.

RF INPUT CONNECTOR

The nominal input impedance of the coaxial RF INPUT is 50 Ω. 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 and degrade flatness, frequency response, sensitivity, and increase spurious responses. Impedance mismatch can be caused by poor connections, incorrect signal source impedance, long or low quality coaxial cable, etc. When optimum flatness or frequency response is desired and signal strength is adequate, set the MIN RF ATTENuation for 10 dB or more. The addition of the attenuator helps minimize reflections to improve the input characteristics.

CAUTION

With MIN NOISE activated and 60 dB of MIN RF ATTEN, the REF LEVEL can be set to +40 dBm. The front end of the 492 is specified at +30 dBm maximum. Do not increase input signal level to full screen with a REF LEVEL of +40 dBm because this will exceed the attenuator rating. DC input is limited to zero (0) volt.

As stated in the preceding CAUTION, too much power can cause signal compression or if excessive, it can destroy the 1st mixer. Signals greater than −30 dBm or −20 dBm in MIN NOISE mode, should be attenuated by the RF ATTENuator. Signals above the safe input level (+30 dBm) must be attenuated by external attenuators. Ensure that the frequency range of external attenuators is adequate.

Signal levels of −10 dBm or more (−28 dBm Option 1, for 1.7 to 1.8 GHz range, see Specifications) may be compressed. This may degrade signal reference level measurements and generate spurious responses.

RESOLUTION BANDWIDTH, FREQUENCY SPAN, AND SWEEP TIME

Resolution is the ability of a spectrum analyzer to display discrete frequency components within a frequency span. This ability is a function of the analyzer bandwidth, sweep time, frequency span, and incidental FM. Frequency span and sweep time are normally selected to provide the minimum resolution bandwidth setting for a particular cw signal. Bandwidth also has an effect on noise level. As the bandwidth decreases, signal-to-noise ratio or sensitivity increases. Maximum sensitivity is therefore attained at the narrow resolution bandwidth settings.

As the 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 resolution bandwidth and the frequency span.

In spans other than MAX SPAN, frequency span is symmetrical about the center frequency. In MAX SPAN the display represents the full frequency range of the selected band. A frequency dot above the display indicates the location on the spectrum of the FREQUENCY readout. The frequency span used depends on the application. Wide spans are normally used to monitor a frequency spectrum for spurious signals, check harmonic content, etc. Narrow spans are used to identify the characteristics around a particular signal, such as modulation side bands, bandwidth, power line related distortion, etc. When wide spans are used, sweep rate on non-store displays is usually increased to eliminate flicker. This requires wider resolution bandwidths. Narrow spans, used to observe signal phenomenons, usually call for narrow resolution bandwidths and therefore slow sweep speeds.

The 492 features microcomputer circuitry that selects sweep rate and resolution bandwidth to correlate with the selected frequency span. When both TIME/DIV and RESOLUTION are in the AUTO mode, the display is calibrated for each FREQ SPAN/DIV selection. The AUTO position of the TIME/DIV selector ties the sweep speed to the analyzer span/div and resolution bandwidth. The AUTO mode of the RESOLUTION BANDWIDTH optimizes bandwidth for the selected FREQ SPAN/DIV and TIME/DIV settings unless either is outside the range of correction. When this occurs, the UNCAL indicator lights and a ">" symbol prefixes the REF Level readout on the crt display.

When analyzing pulse signals, a wider bandwidth than that provided by AUTO is usually desired. The resolution bandwidth should be on the order of 1/10 the side lobe frequency width, or the reciprocal of the pulse width, in order to ensure adequate resolution. The RESOLUTION BANDWIDTH is usually set for optimum main lobe detail after the sweep rate has been selected.

USING THE PEAKING CONTROL

The PEAKING control adjusts bias for the EXT MIXER port and the preselector tracking for the instruments with Option 1. It is adjusted for maximum conversion or maximum signal amplitude. This control has a marked effect on performance when operating in the higher frequency ranges. Mixer peaking when Option 1 is installed, must be adjusted before relative amplitude and sensitivity measurements are made when operating above Band 1 (1.8 GHz). Frequency response and flatness are also affected; therefore, after any significant frequency change, it is good practice to degauss, then adjust PEAKING for maximum signal amplitude. Degauss with FREQ SPAN/DIV of 2 MHz or 1 MHz.

USING THE SIGNAL IDENTIFIER

Conversion in the 1st mixer generates many spurious responses. This is due to the multiple harmonics of the local oscillator converting input signals to an intermediate frequency within the bandpass of the IF. This is especially true for the basic 492 (without the Option 1 preselector) and when the waveguide mixers are used.

To help identify true signals, the 492 features an 'identify' mode. With the FREQ SPAN/DIV at 500 kHz, press the IDENTIFY 500 kHz/ONLY button. True signals will alternately shift vertically while spurious signals shift horizontally or off screen. Identify mode will operate only when the frequency span is 500 kHz/div.

USING THE VIDEO FILTERS

The video filter restricts the video bandwidth so that noise or beat signals are reduced (see Fig. 3-1). When signals are closely spaced, the filter may be useful to reduce modulation between two signals so they can be more easily analyzed. The filters can also be used to average the envelope of pulsed RF spectra that has a relatively high prf (pulse repetition frequency); however, because the filter is basically an integrating circuit, selecting a Video Filter when measuring low prf spectra produces poor results.

The WIDE filter reduces the bandwidth to approximately 1/30th the selected resolution bandwidth; the NARROW filter about 1/300th. Using the filter may require a reduction in the sweep rate to maintain a calibrated display. Again the UNCAL indicator will light if the sweep speed is too fast for video filtering.

TIME DOMAIN OPERATION

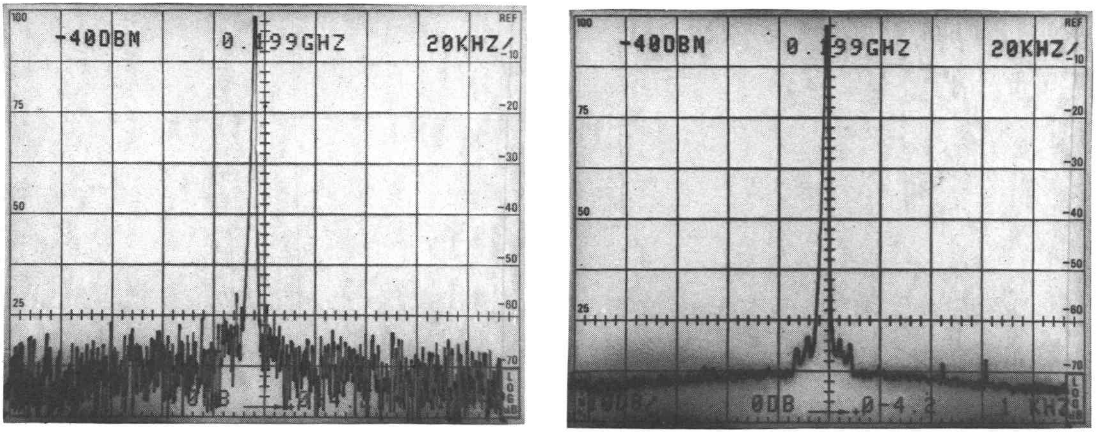
When the FREQ SPAN/DIV is reduced to zero, the analyzer functions as a tunable receiver to display time domain characteristics within the capabilities of the resolution bandwidth. The TIME/DIV selector can now be used to analyze such characteristics as modulation pattern, pulse repetition rates, etc.

TRIGGERING THE DISPLAY

Triggering 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 the FREE RUN mode the sweep will not synchronize with any input signal.

The sweep can be triggered internally from the vertical or video signal, at the line frequency rate of the power supply, or from an external signal applied to the EXT IN HORIZ/TRIG jack on the back panel. The amplitude of trigger signal required to trigger the sweep is one (1.0) division or more, for internal triggering, and 0.5 volt to a maximum of 50 volts (dc + peak ac) for external triggering.

Trigger source is selected by activating one of the triggering pushbuttons. In addition to the four trigger source selections, SINGLE SWEEP mode can be selected. The sweep will run once after the circuit has been armed and trigger signal arrives. The READY indicator lights when the circuit is armed and waiting for a trigger signal and remains lit until the sweep has run. Pushing the SINGLE SWEEP button once activates single sweep mode; pushing it again arms the trigger circuit so it is ready for a trigger signal.



A. Spurii and IM obscured in the noise floor.

B. Same display with Video Filter activated.

2729-4

Fig. 3-1. Integrating the display with the Video Filter.

SWEEPING THE DISPLAY

Horizontal sweep for the display is either internal or from an external sweep source. Sweep rate and source are selected by the TIME/DIV switch. When the TIME/DIV switch is in the AUTO position, the sweep rate is controlled by an internal microcomputer.

When the TIME/DIV is in the EXT position, a signal source of 0 to +10 volts, applied to the EXT IN HORIZ/TRIG connector, will sweep the crt beam the full 10 division graticule span. The input is dc coupled, sensitivity is 1 V/div. External input impedance is about 10 kΩ.

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

MANUAL SCAN OF THE SPECTRUM

Manual scan is used to examine a particular point or portion of a display such as one of the null points of a frequency modulation spectrum or where a slow sweep of the full span would take unnecessarily long. When the TIME/DIV control is set in the MNL position, the display may be swept with the MANUAL SCAN control. The sweep scan is usually first calibrated in one of the timed sweep positions. Note that with a wide span/div and/or a narrow resolution bandwidth setting, it is possible to scan too rapidly to achieve an accurate display. Also, digital storage can give unpredictable results when used with the MNL SCAN mode. Digital storage is updated only when scanning toward the right.

REFERENCE LEVEL, RF ATTENUATION, AND VERTICAL DISPLAY

A change in the REFERENCE LEVEL control requests the microcomputer to change the display reference level—the absolute amplitude represented by the top of the crt graticule. The microcomputer selects the gain distribution (IF gain and input RF attenuation) for the new reference level according to the setting of the FINE, VERTICAL DISPLAY mode, MIN RF ATTEN dB, and MIN NOISE/MIN DISTORTION selectors.

The amount of attenuation between the RF INPUT and the first mixer, set by the microcomputer, is based on the reference level requested and the mode of the MIN RF

ATTEN dB and MIN NOISE/MIN DISTORTION selectors. The microcomputer assumes the MIN RF ATTEN dB selection is the minimum attenuation required for the expected signal levels. It does not reduce RF attenuation below this value. It also selects the best ratio of RF attenuation and IF gain according to the MIN NOISE/MIN DISTORTION mode (see description that follows). MIN RF ATTEN selects the lower limit reference level range. As MIN RF ATTEN dB is increased, the lower limit reference level is raised an equal amount. At 0 dB minimum attenuation, the lower limit reference level is −123 dBm. At 10 dBm minimum attenuation, the reference level goes to −113 dBm, etc.

The reference level increments depend on the Vertical Display mode and FINE selector mode. Reference level steps for the log displays are 10 dB and 1 dB with FINE off, and 1 dB and 0.25 dB with FINE activated (0.25 dB steps apply to the ΔA mode). For LIN displays with FINE off, the microcomputer selects the reference level, which is the equivalent of an 8-division signal, where 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. For LIN displays with FINE on, the reference level changes in 1 dB steps and the scale factor is 1/8 the voltage equivalent of the reference level.

DELTA A MODE

To select this mode, activate 2 dB/DIV and FINE; the REF LEVEL readout becomes *0.00 dB and the REFERENCE LEVEL steps in 0.25 dB increments.

The ΔA mode is useful for measuring relative amplitude differences of signals more accurately. This is because the gain distribution (IF gain and RF attenuation) is not changed when ΔA mode is activated. The REF LEVEL is changed by shifting the log amplifier offset. The measurement range of the ΔA mode is at least from 10 dB above to 40 dB below the reference level established when the mode was activated; however, the overall instrument display characteristic of −123 dBm to +30 dBm cannot be exceeded. The asterisk in the REF LEVEL readout remains until the ΔA mode gain distribution is changed.

The ΔA mode is canceled when either FINE or 2 dB/DIV are deactivated, or a selector that could change gain distribution (MIN RF ATTEN or MIN NOISE) is changed. The analyzer also deactivates ΔA mode when EXT MIXER or an external mixer frequency range is selected.

Signals with large differences in amplitude that are within the ΔA range can be compared without the distortion usually introduced when signals are driven off-screen. Signals shifted off-screen by changes in the ΔA reference level are not overdriving the input because the attenuator and IF gain are not changed; thus the mixers do not see any change in signal levels due to the ΔA reference level changes.

To measure amplitude level differences of two signals: 1) Select ΔA mode by activating 2 dB/DIV and FINE. 2) Using the REF LEVEL control, set the larger amplitude signal to a graticule line. 3) Press the FINE pushbutton twice to deactivate and re-activate the ΔA mode. 4) Using the REF LEVEL control, set the lower amplitude signal to the same graticule line established in step 2. 5) The REF LEVEL readout displays the dB difference in amplitude level.

MIN NOISE/MIN DISTORTION

This pushbutton selects one of two algorithms that control attenuator and IF gain settings. MIN NOISE minimizes noise level while MIN DISTORTION minimizes input mixer overload. To observe any change when MIN NOISE is activated, the RF ATTEN crt readout must be 10 dB higher than that set by the MIN RF ATTEN selector.

CAUTION

With MIN NOISE activated and 60 dB of MIN RF ATTEN, the REF LEVEL can be set to +40 dBm. The front end of the 492 is specified at +30 dBm maximum. Do not increase input signal level to full screen with a REF LEVEL of +40 dBm because this will exceed the attenuator rating. DC input is limited to zero (0) volt.

DIGITAL STORAGE (OPTION 02)

Digital storage provides a smooth (flicker free) display. Two complete events can be stored. One of these can be saved and then compared to subsequent updated information. A MAX HOLD feature updates the stored data in memory when the new input is of higher amplitude thus allowing monitoring and graphic plotting of display changes with time. Vertical information can be divided by a cursor, or horizontal line, that is positioned with the PEAK/AVERAGE control. Above the cursor, video information is peak detected and displayed; below the cursor, signal averaging occurs. The average (number of samples) is a function of sweep speed. The slower the sweep, the greater the number of samples averaged. This feature suppresses noise in that portion below the cursor and allows full peak detection of vertical data above the cursor. An intensified spot on the cursor indicates the horizontal position at which memory is being updated.

When digital storage is used, an additional quantization error of 0.5% of full screen must be added to the amplitude performance characteristics (i.e., frequency response, sensitivity, etc.).

Digital storage memory is functionally divided into two sections—A and B. Data can be stored in A or B or in both. There are 512 horizontal locations in A and 512 horizontal locations in B. When both are displayed, the origin of B is shifted such that the A and B coordinates are interlaced to provide 1024 display increments. Data in memory is continually updated with each sweep so the display, when viewing A or B, is always current.

When SAVE A function is activated, data in A memory is held in storage and only B memory is updated. This inhibition takes place whether A is displayed or not. This mode captures an event or waveform for comparison with a subsequent event displayed by VIEW B mode. In this mode all of A memory is displayed, then all of B, each by a separate sweep.

When B−SAVE A is activated, the contents of data in B memory minus the contents saved in A are displayed. This provides the comparison of the two events by presenting the algebraic difference of the two displays. This convenient mode can be used to align filters or other devices when tuning for a null. The reference waveform is stored in A and the unknown in B. If the device under test is active, the B waveform may be larger than the reference which results in a shift in the zero reference line. The position of the zero reference can be selected with an 8-bit digital switch. The reference level is normally set mid-screen so positive and negative quantities can be observed. Qualified service personnel can position the reference anywhere within the graticule window.

MAX HOLD causes the digital 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.

Signal averaging is useful for suppressing noise. The number of samples averaged per digitized slot (increment) is a function of the spectrum analyzer sweep rate. The slower the sweep speed, the more samples averaged per resolution bandwidth. Resolution bandwidth also affects the amplitude difference between peak detected and average levels of cw signals. When the resolution bandwidth is less than 1/30th the span/division (e.g., 100 kHz or less with 5 MHz span/div) there will be significant difference between peak and average amplitude levels of cw signals. The peak value will be the true value, the average value will be in error, especially if only A or B is displayed. It is best to run digital storage with both A and B interlaced when using narrow resolution bandwidth with wide frequency spans.

Tektronix
COMMITTED TO EXCELLENCE

MANUAL CHANGE INFORMATION

Date: 8-12-80

Change Reference: C1/880

Product: 492 OPERATORS HANDBOOK

Manual Part No.: 070-2729-00

492P Programmable Spectrum Analyzer

This handbook also applies to local operation of the TEKTRONIX 492P Programmable Spectrum Analyzer. For information on controls available on the 492P, but not the 492, see Section 1 of the 492P Programmer's Manual, which covers topics such as the 492P RESET TO LOCAL button, GPIB ADDRESS switches, and talk/listen-only modes.