TEK SERVICE MANUAL

Part No. 070-3783-01
Product Group 26

492/492P
SPECTRUM ANALYZER

PORTABLE/RACKMOUNT/BENCHTOP
(SN B030000 & UP)
VOLUME 1

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

Please Check for CHANGE INFORMATION at the Rear of This Manual

First Printing FEB 1981
Revised FEB 1984

Tektronix
COMMITTED TO EXCELLENCE

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SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

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.

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.

Use the Proper Fuse

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

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

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

SYMBOLS

In This Manual

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

As Marked on Equipment

ϟ DANGER—High voltage.

⏚ Protective ground (earth) terminal.

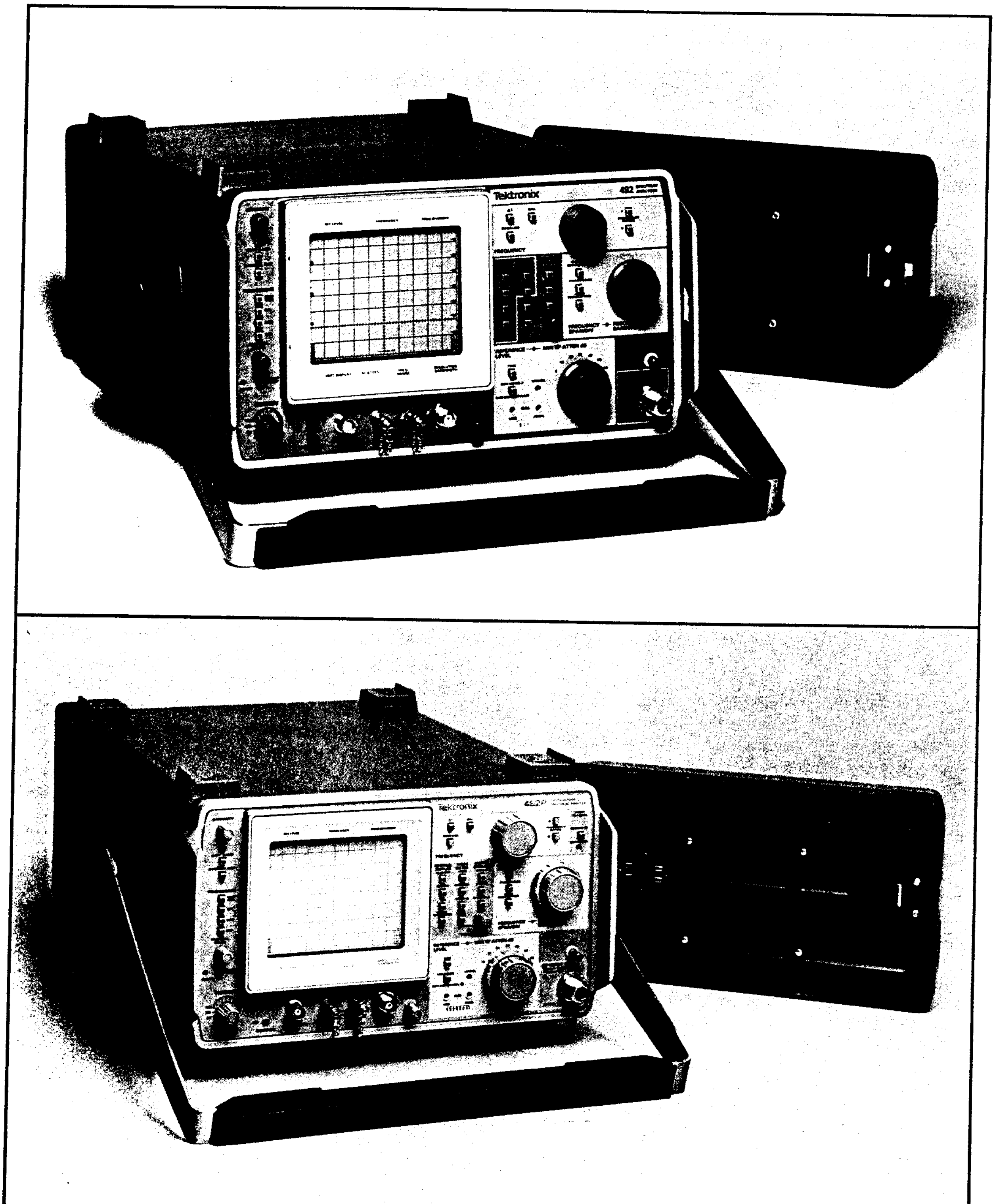
⚠ ATTENTION—refer to manual.

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



2726-30

The 492/492P Spectrum Analyzer.

GENERAL INFORMATION AND SPECIFICATION

GENERAL INFORMATION

Introduction

The Service manual consists of two volumes that contain information necessary to test, adjust, and service the Portable Rackmount/Benchtop 492/492P Spectrum Analyzer. The intent is to provide as complete information as possible as an aid in servicing this instrument. The Table of Contents at the beginning of Volume 1 lists contents of each section contained within Volume 1.

Change information that involves manual corrections and/or additions pending manual reprint and bind, is located at the back of the Service manual in the CHANGE INFORMATION section.

History information with the updated data is integrated into the text or diagrams when a page or diagram is updated. Revised pages have a revision date in the lower inside corner of the page. The manual may contain revisions that do not apply to your instrument; however, history information with updated data, is integrated into the text or diagram when the page or diagram is revised.

The person using these instructions should be knowledgeable in digital and analog circuit theory. Circuit analysis is primarily functional. The intent is to provide sufficient information for the technician to isolate the majority of malfunctions to a block of circuitry. Those users with an understanding of logic and analog circuitry should then be able to further isolate the malfunction to a specific component or components.

Most terminology is in accordance with those standards adapted by IEEE. A glossary of terms is provided as an appendix. Abbreviations in the documentation are in accordance with ANSI Y1.1-1972, with exceptions and additions explained in parentheses after the abbreviation. Graphic symbols comply with ANSI Y32.2-1975. Logic symbology is based on ANSI Y32.14-1973 and the manufacturer's data description. A copy of ANSI standards may be obtained from the Institute of Electrical and Electronic Engineers, 345 47th Street, New York, NY 10017.

Product Service

To assure adequate product service and maintenance for our instruments, Tektronix has established Field Offices and Service Centers at strategic points throughout the United States and in countries where our products are sold. Several types of maintenance or repair agreements are available. For example: for a fixed fee, a maintenance agreement program provides maintenance and re-calibration on a regular basis. Tektronix will remind you when a product is due for recalibration and perform the service within a specified time. 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 available through these centers.

Tektronix emergency repair service provides immediate attention to instrument malfunctions if you are in an emergency situation such as a field trip. Again, contact any Tektronix Service Center for assistance to get you on your way within a minimum of time.

Instrument Construction

The modular construction of the 492/492P instrument provides ready access to the major circuits. Circuit boards that contain sensitive circuits are either mounted on metal extrusions, each of which provides shielding between adjacent modules, or they are mounted within honeycomblike extrusions with a feedthrough connector through the wall of the compartment. Interconnection between boards and assemblies is provided by plugging these boards onto a main mother board. Most adjustments and test points are accessible while the instrument is operational and the modules or assemblies secured in their normal position. Extenders are provided with a Service Kit; see Maintenance section under Service Fixtures and Tools for Maintenance.

Any module can be removed without disturbing the structural or functional integrity of the other modules. The extenders allow most circuit board assemblies to function in an extended position for service or adjustment. The circuit boards mounted on the metal extrusion can be removed by removing the securing screws. All other circuit boards (which should require minimal service) are accessible by removing a cover plate.

NOTE

Disassembly of some modules may require special tools and procedures. These procedures will be found in the Maintenance section.

In instruments that have phase lock, the phase lock assembly contributes to the 492/492P stability. Circuits are completely rf isolated to ensure spurious free response, yet the close proximity minimizes losses or interactions with other functions. All compartments are enclosed on both sides by metal plates and all interconnections between compartments are made by feedthrough terminals rather than cables. If the compartments are opened, be sure that the shields and covers are properly reinstalled before operating.

Elapsed Time Meter

A 5000 hour elapsed time indicator, graduated in 500 hour increments, is installed on the Z Axis/RF Interface circuit board. This provides a convenient way to check operating time. The meter on new instruments may indicate from 200 to 300 hours elapsed time. Most instruments go through a factory burn-in time to improve reliability. This is similar to using aged components to improve reliability and operating stability.

Changing Power Input Range

The following procedures describe how to set the input power range.

a. Disconnect the power plug and remove the cover.

b. Remove the access plate at the upper left corner (viewed from the rear) of the power module.

c. Shift plug P1029 to the appropriate pins on J1029 as indicated by the silk screen nomenclature. Replace the access plate.

NOTE

The earlier version power supply module did not have this access plate. To access P1029 proceed as follows:

1) Set the instrument on its face and remove the four screws that hold the power supply module to the side rails. Lift the module off the instrument.

2) Remove the top and bottom screws then the side screw that holds the two sections of the power supply module together. Separate the two sections to expose the power supply circuit board.

3) Shift the plug P1029 (upper left corner) to the appropriate pins on J1029. Re-install the two sections and the power supply module.

d. Remove the input power specification plate over the input fuse on the back panel. Turn the plate over and reinstall so the exposed information on power specifications is correct.

e. Change the input fuse to the new value specified on the information plate.

f. Replace the cover and the power cord; then connect the instrument to the appropriate power source.

NOTE

The power cord supplied with the instrument and instrument power voltage requirements depend on the available power source (see the Specification part of this section for power cord options).

Replacing Fuses

Besides the input (back panel) fuse, the 492/492P power module has five fuses for the dc supplies (+300 V, F3014; +100 V, F1034; +17 V, F1014; +9 V, F1031; −7 V, F1011). Access to these fuses can be gained by removing the access plate at the upper right corner of the power module, or by separating the two sections as described for changing the input power range. Fuses are identified with stamped circuit numbers on the circuit board.

Selected Components

Some components, such as microcircuits, are selected to meet Tektronix specifications. These components are indicated in the parts list and carry a Tektronix Part Number under the Mfr. Part Number column.

Selected value components that compensate for parameter differences between active components are identified on the circuit diagram and in the parts list as a "SEL" value. The component description lists either the nominal value or a range of value. If the procedure for selection is not obvious, such as setting the gain or response of a stage, the criteria for selection is explained in the Calibration or Maintenance section of the manual. Where the selection procedure is obvious, such as establishing the frequency of an oscillator, no procedure is given.

Component Circuit Numbering Scheme

In this instrument, circuit numbers were assigned according to the components physical location on the board. For example, a component such as a resistor, located within row 2 column 08, is R2080. The fourth digit of the number is an expander used to designate two or more common components within a given grid, such as R2080, R2082, etc.

Chassis mounted components are assigned a three digit number to help identify their location.

The Replaceable Electrical Parts list prefixes these circuit numbers with an assembly number. R2080, on assembly A20, becomes A20R2080. Assembly and subassembly numbers are assigned in numerical order by location within the instrument.

Firmware Version and Error Message Readout

This feature of the 492/492P provides readout of the firmware version when the power on/off is cycled. During initial power-up cycle, the firmware version flashes on screen for approximately two seconds. The Replaceable Electrical Parts list section, under Memory Board (A54), lists the ROM's and their Tektronix part number for each firmware version.

An additional feature is error message readout. The following is a list of these messages and their meaning.

Error No.	Meaning
57	Tune routine failed in carry from lower DAC.
58	Failed to phase lock.
59	Lost lock.
60	Failed to recenter when phase lock cancelled or when going to an unlocked span.

Rackmount/Benchtop Versions

The rackmount version of the 492/492P Spectrum Analyzer is the 492/492P in a rackmount cabinet. Access to all front panel connectors is provided with Option 31 of this version. Additional cooling is provided and a front panel accessories drawer in the cabinet provides storage for most accessories. The benchtop version is the same as the rackmount with the exception of the side rails.

SPECIFICATION

The following list of instrument characteristics and features apply to the basic 492/492P Spectrum Analyzer after a 30-minute warmup, except as noted. Changes to the basic specifications due to the addition of options follow the basic listings.

Differences in the electrical and environmental characteristics for the rackmount/bench versions of the 492/492P are described in the Rackmount/Benchtop section of this manual. Refer to section 6 for this information.

The Performance Requirement column describes the limits of the characteristic, and the Supplemental column describes features and typical values or information that may be useful to the user. Procedures to verify performance requirements are provided in the Calibration section of the Service instructions. The Performance Check procedures require sophisticated equipment as well as technical expertise to perform.

The Operators Manual contains a procedure that checks all functions of the 492/492P. This check is recommended for incoming inspections to verify that the instrument is functioning properly.

Table 1-1
ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
	FREQUENCY RELATED	
Center Frequency Range (Internal Mixer)	50 kHz to 21 GHz	Frequency response degraded by 1 dB before 100 kHz.
Accuracy (after 2 hour warm up)	±(5 MHz + 20% of span/div) n or ±(0.2% of the center frequency + 20% of the span/div) whichever is greater.	
Readout Resolution		Within 1 MHz.
TUNE command accuracy (492P only under remote control) after a 2 hour warmup. 1st LO Tuning Band Freq Span/Div 1-3 > 50 kHz 4 >100 kHz 5-11 >200 kHz	±(7% of tune amount or ±150 kHz) n whichever is greater. (See listing of IF frequency, LO range, and harmonic number that follows, for value of n.)	
2nd LO Tuning 1-3 ≤ 50 kHz 4 ≤100 kHz 5-11 ≤200 kHz	±(7% of tune amount)	
Repeatability accuracy (return to a previous frequency setting) with an ambient temperature change ≤10°C (492P only under remote control).		±(2 MHz + 10% of Span/Div) or ±(0.1% of frequency + 10% of Span/Div) whichever is greater.
Residual FM (short term) after 2 hour warm up	≤(1 kHz peak-to-peak) n for a period of 20 ms, n is the 1st LO harmonic number used in the 1st mixer conversion, and related to the selected frequency range (band).	No video filter.

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Frequency Drift after 2 hour warm up at a fixed frequency and stable ambient temperature	≤200 kHz/hour, fundamental mixing.	A re-stabilization time of 10 minutes per GHz of frequency change must be allowed if the 1st LO frequency is retuned.
"Static" Resolution Bandwidth (6 dB down)	1 kHz to 1 MHz in decade steps, plus an automatic (AUTO position). Resolution bandwidth (6 dB down) is within 20% of the bandwidth selected.	In AUTO position the bandwidth is computed by an internal computer, based on the span/div, video filters, time/div, and vertical display selections. When both the TIME/DIV and RESOLUTION BANDWIDTH are in AUTO position, the resolution bandwidth is a function of the FREQUENCY SPAN/DIV selection.
Shape Factor (60 dB/6dB)	7.5:1 or less.	
Noise Sidebands	At least −75 dBc at 30 times the resolution offset for fundamental mixing.	
Pulse Stretcher Fall-Time		30 μs/division; ±50%.
Video Filter		
Narrow		Reduces video bandwidth to approximately 1/300th of the selected resolution bandwidth.
Wide		Reduces video bandwidth to approximately 1/30th of the selected resolution bandwidth.
Frequency Span/Div		
Range (in 1-2-5 sequence)		See span table below. Two additional positions provide full band (MAX span) display or 0 Hz (time domain) display.
Accuracy	Within 5% of the span/div selected over the center eight divisions of a ten-division display.	

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

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information	
IF Frequency, LO Range and Harmonic Number (n) Band and Freq Range		LO Range (MHz) and Harmonic (n)	1st IF (MHz)
1 (0 — 4.2 GHz)		2072 — 6272 (1−)	2072
2 (1.7 — 5.5 GHz)		2529 — 6329 (1−)	829
3 (3.0 — 7.1 GHz)		2171 — 6271 (1+)	829
4 (5.4 — 21.0 GHz)		2072 — 6276 (3−)	829
5 (15 — 21 GHz)		4309 — 6309 (3+)	2072
6 (18 — 26 GHz)		2655 — 3988 (6+)	2072
7 (26 — 40 GHz)		2443 — 3793 (10+)	2072
8 (40 — 60 GHz)		3792 — 5790 (10+)	2072
9 (60 — 90 GHz)		3861 — 5862 (15+)	2072
10 (90 — 140 GHz)		3823 — 5997 (23+)	2072
11 (140 — 220 GHz)		3728 — 5890 (37+)	2072

AMPLITUDE RELATED

Characteristic	Performance Requirement	Supplemental Information
Display Modes		10 dB/Div, 2 dB/Div, Linear, and Delta A.
Display Reference Level Range		−123 dBm to +40 dBm (+40 dBm includes 10 dB of IF gain reduction). +30 dBm or 1 W is the maximum safe input for 10 dB/DIV and 2 dB/DIV log modes. 20 nV/Div to 2 V/Div (1 W maximum safe input) in linear mode.
Steps		10 dB, 1 dB, and 0.25 dB for relative (Δ) measurements in log mode. 1-2-5 sequence and 1 dB equivalent increments in LIN mode.
Accuracy		Accuracy is a function of the RF attenuation, IF gain, resolution bandwidth, display mode, reference level, frequency band and response. Refer to accuracies of these characteristics The input RF attenuator steps 10 dB for reference level changes above −30 dBm or −20 dBm when MIN NOISE mode is active unless the MIN RF ATTEN setting is greater than normal. The IF gain increases 10 dB for each 10 dB reference level change below −30 dBm (−20 dBm for MIN NOISE mode).

Table 1-1 (cont)

<table>
<tr><th>Characteristic</th><th>Performance Requirement</th><th>Supplemental Information</th></tr>
<tr><td>Display Dynamic Range</td><td></td><td>80 dB at 10 dB/Div and 16 dB for 1-9 dB/Div and 8 divisions for linear mode.</td></tr>
<tr><td>Accuracy</td><td>±1.0 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window and ±0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window. LIN mode is ±5% of full screen.</td><td></td></tr>
<tr><td>RF Attenuator
Range</td><td></td><td>0 to 60 dB in 10 dB steps.</td></tr>
<tr><td>Accuracy[a]
Dc to 4 GHz</td><td>Within 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range.</td><td></td></tr>
<tr><td>4 GHz to 18 GHz</td><td>Within 0.5 dB/10 dB to a maximum of 1.4 dB over the 60 dB range.</td><td></td></tr>
<tr><td>IF Gain
Range</td><td></td><td>93 dB of gain increase, 10 dB of gain decrease (MIN NOISE activated) in 10 dB and 1 dB steps.</td></tr>
<tr><td>Accuracy</td><td>Gain steps are monotonic (same direction) with the following limits: Within 0.2 dB/dB to a maximum of 0.5 dB/9 dB except at the decade transitions of −19 to −20 dBm, −29 to −30 dBm, −39 to −40 dBm, −49 to −50 dBm, −59 to −60 dBm and −69 to −70 dBm, where an additional 0.5 dB can occur for a total of 1.0 dB per decade. Maximum deviation of the 90 dB range is within ±2 dB.</td><td></td></tr>
<tr><td>Differential Amplitude Measurement
Range</td><td></td><td>Delta A mode provides differential measurements in 0.25 dB increments
10 dB above to 40 dB below the reference level established when the delta A mode was activated.
DO NOT use the delta A mode outside the −123 dBm to +30 dBm reference level range.</td></tr>
<tr><td>Accuracy</td><td></td><td><table><tr><th>dB Difference</th><th>Steps</th><th>Error</th></tr><tr><td>0.25 dB</td><td>1</td><td>0.05 dB</td></tr><tr><td>2 db</td><td>8</td><td>0.4 dB</td></tr><tr><td>10 dB</td><td>40</td><td>1.0 dB</td></tr><tr><td>50 dB</td><td>200</td><td>2.0 dB</td></tr></table></td></tr>
<tr><td>Signal Amplitude Variation With Resolution Switching</td><td>Less than 0.5 dB</td><td></td></tr>
</table>

[a]Refer to "Verification of Tolerance Values" at the beginning of the Performance Check section.

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information

Sensitivity

The following tabulation shows the equivalent maximum input noise for each resolution bandwidth, with the internal mixer for frequency bands 1—5 (100 kHz—18 GHz), and TEKTRONIX High Performance Waveguide Mixers for bands 6—10 (18 GHz—140 GHz). The NARROW video filter is activated, for narrow resolutions (1 kHz or less); WIDE filter for wide resolution.

SENSITIVITY (VERSUS BANDWIDTH)

Frequency/Band	Equivalent Input Noise for Resolution Bandwidths			
	1 kHz	10 kHz	100 kHz	1 MHz
50 kHz—7.1 GHz (Bands 1—3)	−115 dBm	−105 dBm	−95 dBm	−85 dBm
5.4−18.0 GHz (Band 4)	−100 dBm	−90 dBm	−80 dBm	−70 dBm
15—21.0 GHz (Band 5)	−95 dBm	−85 dBm	−75 dBm	−65 dBm
18.0—26 GHz (Band 6)[a]	−100 dBm	−90 dBm	−80 dBm	−70 dBm
26—40.0 GHz (Band 7)[a]	−95 dBm	−85 dBm	−75 dBm	−65 dBm
40.0—60.0 GHz (Band 8)[a]	−95 dBm	−85 dBm	−75 dBm	−65 dBm
60.0—90.0 GHz (Band 9)	Typically −95 dBm for 1 kHz bandwidth at 60 GHz degrading to −85 dBm at 90 GHz			
90.0—150.0 GHz (Band 10)	Typically −85 dBm for 1 kHz bandwidth at 90 GHz degrading to −75 dBm at 140 GHz			
140.0—220 GHz (Band 11)	External Mixer Dependent			

Characteristic	Performance Requirement	Supplemental Information
Spurious Response		
Residual (no input signal, referenced to mixer input, and fundamental mixing for bands 1, 2, and 3)	−100 dBm or less	
Third order intermodulation products (MIN DISTORTION mode)	At least −70 dBc below any two on-screen signals within any frequency span	
Harmonic Distortion (cw signal, MIN DISTORTION mode)	At least −60 dBc for full screen signal	
LO Emissions (referenced to input mixer)	−10 dBm or less	

[a]TEKTRONIX High Performance Waveguide Mixers.

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
INPUT SIGNAL CHARACTERISTICS		
RF INPUT		Type N female connector, specified to 18 GHz, usable to 21 GHz
Input Impedance		50 ohm; vswr with ⩾10 dB of RF attenuation: 50 kHz-2.5 GHz; 1.3:1 (typically 1.2:1) 2.5-6.0 GHz; 1.7:1 (typically 1.5:1) 6.0-18.0 GHz; 2.3:1 (typically 1.9:1) 18.0-21 GHz; 3.5:1; (typically 2.7:1)
Input Level Optimum level for linear operation		−30 dBm referenced to input mixer This is achieved by being in MIN DISTORTION and not exceeding full screen
1 dB compression point	−18 dBm	No RF attenuation
Maximum input level RF Attenuation at 0 dB		+13 dBm (Input mixer limit)
With 20 dB or more RF Attenuation		+30 dBm (1 W) continuous, 75 W peak, pulse width 1 μs or less with a maximum duty factor of 0.001 (attenuator limit) **Do Not apply dc voltage to the RF INPUT**
External Mixer		Input for IF signal and the source of negative-going bias for external waveguide mixers. Bias range +1.0 to −2.0 V, 70 Ω source.
EXT IN HORIZ/TRIG		Dc coupled input for horizontal drive and ac coupled for trigger signal
Input Voltage Range Sweep		0 to +10 V (dc + peak ac) for full screen deflection
Trigger	1.0 V peak (minimum). Frequency 15 Hz to 1 MHz	Maximum input: 50 V (dc + peak ac) Maximum ac input: 30 V rms to 10 kHz then derate linearly to 3.5 V rms @ 100 kHz and above. Pulse width 0.1 μs minimum
ACCESSORY (J104)		This connector is for future applications
OUTPUT SIGNAL CHARACTERISTICS		
Calibrator (CAL OUT)	−20 dBm, ±0.3 dB at 100 MHz, ±1.7 kHz	100 MHz comb markers are provided for frequency and span calibration

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
1st LO and 2nd LO		Provides access to the output of the respective local oscillators (1st LO +7.5 dBm minimum to a maximum of +15 dBm. 2nd LO −22 dBm minimum to a maximum of +15 dBm). These ports must be terminated in 50 Ω at all times
VERTICAL		0.5 V, ±5% of signal per division of video above and below the centerline. Source impedance approximately 1 kΩ
HORIZ OUT		0.5 V/Div either side of center. Full range −2.5 V to +2.5 V, ±10% Source impedance approximately 1 kΩ
PEN LIFT		TTL compatible, nominal +5 volts to lift pen
IF OUT		Access to the 10 MHz IF. Output level is approximately −16 dBm for a full screen signal at −30 dBm reference level. Nominal impedance approximately 50 Ω
IEEE Std 488-1978 Port (GPIB) 492P		In accordance with IEEE 488 standard
PROBE POWER		Provides operating power for active probe systems. Output voltages and pin-out are shown in Fig. 1-1.
GENERAL CHARACTERISTICS		
Sweep		Triggered, auto, manual, and external
Sweep Time	20 µs/Div to 5 s/Div in 1-2-5 sequence (10s/Div in Auto)	
Accuracy	±5%	
Triggering	⩾2.0 division of signal for internal, and 1.0 V peak minimum for external	Internal, external, free run, and single sweep. Internal is ac coupled (15 Hz to 1 MHz)
Crt Readout		Displays: Reference level, frequency, vertical display mode, frequency span/div, frequency range, resolution bandwidth, and RF attenuation

POWER REQUIREMENTS

Characteristic	Description
Input Voltage	90 to 132 Vac or 180 to 250 Vac, 48 to 440 Hz
Power	
Power (Options 01, 02, 03)	At 115 V, 60 Hz; 210 watts maximum, 3.2 amperes
Leakage Current	5 mA peak

NOTE

If power to this instrument is interrupted, it may be necessary to re-initialize the microcomputer; when power is restored, turn the POWER switch Off for 5 seconds then back On.

PROBE POWER. The PROBE POWER connector on the rear panel of this instrument provides operating power for active probe systems. It is not recommended that these connectors be used as a power source for applications other than the compatible probes or other accessories which are specifically designed for use with this source.

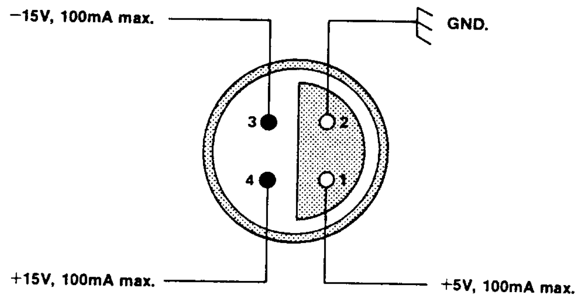


Fig. 1-1. Probe power connector pin out.

Table 1-2
ENVIRONMENTAL CHARACTERISTICS

Meets MIL T-28800B, type III, class 3, style C specifications, comprised of the following

Characteristic	Description
Temperature	
Operating and humidity	−15°C to +55°C/95% (+5%, −0%) relative humidity.
Non-operating	−62°C to +85°C.

NOTE

After storage at temperatures below the operating range, the microcomputer may not initialize on power-up. If so, allow the instrument to warm up for 15 minutes and re-initialize the microcomputer by turning the POWER Off for 5 seconds then back On.

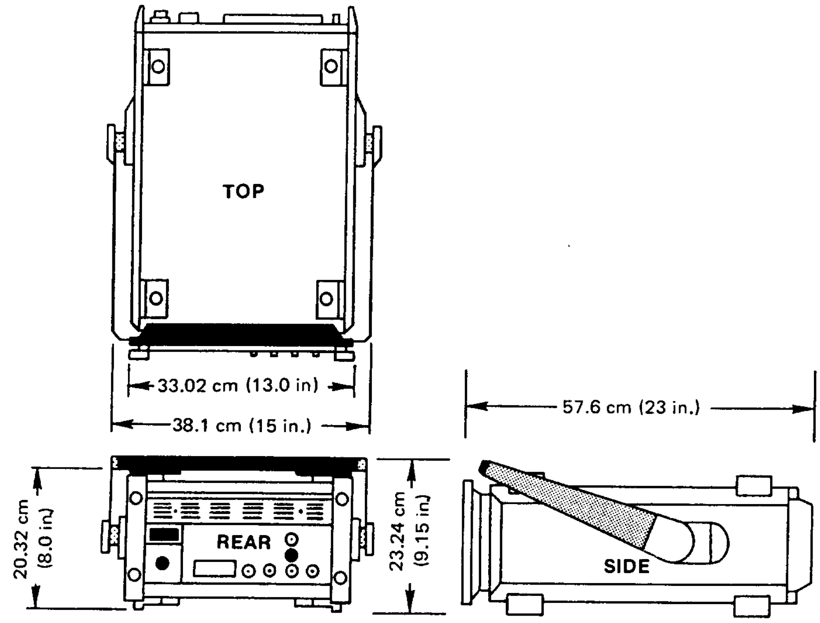
Altitude	
Operating	15,000 feet.
Non-operating	40,000 feet.
Humidity (Non-operating)	Five cycles (120 hours) of MIL-Std-810.
Vibration	Method 514 Procedure X (modified) MIL-Std-810C.
Operating	Resonant searches along all three axes at 0.025 inch, frequency varied from 10—55 Hz, 15 minutes. All major resonances must be minimum per axis plus dwell at reasonant frequency of 55 Hz for 10 minutes minimum per axis. Instrument secured to vibration platform during test. Total vibration time about 75 minutes.

Table 1-2 (cont)

Characteristic	Description	
Shock (Operating and Non-operating)	Three shocks of 30 g, one-half sine, 11 ms duration, each direction along each major axis. Guillotine-type shocks. Total of 18 shocks.	
Transit drop (free fall)	12 inch, one per each of six faces and eight corners.	
Electromagnetic Interference (EMI)	Within limits described in MIL-Std-461.	
	Test Method	**Remarks**
Conducted emissions	CE01	10 kHz to 20 kHz only.
	CE03 20 kHz to 50 MHz power leads.	Except 30 kHz to 35 kHz, relaxed by 15 dB.
Conducted susceptibility	CS01 30 Hz to 50 kHz power leads.	Full limits.
	CS02 50 kHz to 400 kHz power leads.	Full limits.
Radiated emissions	RE01 30 Hz to 30 kHz magnetic field.	Relaxed by 10 dB for fundamental. 2nd, 3rd harmonic of power line.
	RE02 14 to 10 GHz.	
Radiated susceptibility	RS01 30 Hz to 30 kHz magnetic field.	Full limit.
	RS03 up to 1 GHz.	Full limit.

Table 1-3
Physical Characteristics

Characteristics	Description
Weight (standard accessories and cover except manuals)	44 pounds (20.0 kg) maximum.
Dimensions (Fig. 1-2)	
Without front cover and handle or feet.	6.9 X 12.87 X 19.65 inches (17.5 X 32.69 X 49.91 centimenters).
With front cover, feet and handle	9.15 X 15.05 X 23.1 inches (handle folded back over instrument), 28.85 inches (handle fully extended).



2726-10B

Fig. 1-2. Dimensions.

ACCESSORIES

See Accessories page following Replaceable Mechanical Parts list, Volume 2.

OPTIONS

Options available for the 492/492P and their resultant changes to the specifications are listed below. Options are factory installed at the time of the initial order. Contact your local Tektronix Field Office for additional information.

OPTION 01

This option provides calibrated preselection to the first (1st) mixer for the 1.7 to 18 GHz frequency range and limiter protection below 1.8 GHz. Band 1 becomes 100 kHz to 1.8 GHz using an input low-pass filter; the preselector starts at Band 2 (1.7 GHz).

The following changes and additions in electrical characteristics apply:

Table 1-4
OPTION 01 ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement		Supplemental Information
Spurious Responses			
Intermodulation Products			
1.8—18 GHz	At least −70 dBc from any two on-screen signals within any frequency span.		⩾−100 dBc when signals are separated 100 MHz or more.
1.7—1.8 GHz	At least −70 dBc from any two −40 dBm signals within any frequency span.		
Harmonic Distortion (cw signal 1.7—18 GHz)	−100 dBc or more for full screen signal (MIN DISTORTION mode).		
LO emission, referenced to input mixer and with zero RF attenuation	Less than −70 dBm to 18 GHz.		
Input Level			
Maximum Safe Input			1 watt or +30 dBm.
1 dB Compression Point (minimum):			
1.7—2.0 GHz	−28 dBm		With no RF attenuation.
Otherwise	−18 dBm		With no RF attenuation.
Frequency Response and Display Flatness[a]			Frequency response is measured with RF attenuation ⩾10 dB and PEAKING optimized for each center frequency setting, when applicable. Response includes the effects of input vswr, mixing mode (n), gain variation, preselector, and mixer. Display flatness is typically 1 dB greater than the frequency response.
Coaxial (direct) Input	About mean average	Referenced to 100 MHz	
Band 1			
100 kHz—1.8 GHz	±1.5 dB		
50—1.8 GHz	±2.5 dB		
Band 2			
1.7—5.5 GHz	±2.5 dB	±3.5 dB	
Band 3			
3.0—7.1 GHz	±2.5 dB	±3.5 dB	
Band 4			
5.4—18.0 GHz	±3.5 dB	±4.5 dB	
Band 5			
15.0—21.0 GHz	±5.0 dB		

[a]Refer to "Verification of Tolerance Values" at the beginning of the Performance Check section.

Table 1-4 (cont)

Characteristic	Performance Requirement		Supplemental Information
External High Performance Waveguide Mixers			TEKTRONIX High Performance Waveguide Mixers.
Band 6 18.0—26 GHz	±3.0 dB	±6.0 dB	
Band 7 26—40.0 GHz	±3.0 dB	±6.0 dB	
Band 8 40—60 GHz	±3.0 dB	±6.0 dB	
Band 9 60—90 GHz			Typically ±3.0 dB
Band 10 90—140 GHz			Typically ±3.0 dB
Band 11 140—220 GHz			Dependent on external mixer.

SENSITIVITY

The following tabulation shows the equivalent maximum input noise for each resolution bandwidth, with the internal mixer for frequency bands 1—5 (100 kHz—18 GHz), and TEKTRONIX High Performance Waveguide Mixers for bands 6—10 (18 GHz—140 GHz). The NARROW video filter is activated, for narrow resolutions (1 kHz or less); WIDE filter for wide resolution.

Frequency/Band	Equivalent Input Noise for Resolutin Bandwidths			
	1 kHz	10 kHz	100 kHz	1 MHz
50 kHz—7.1 GHz (Bands 1—3)	−110 dBm	−100 dBm	−90 dBm	−80 dBm
5.4—12.0 GHz (Band 4)	−95 dBm	−85 dBm	−75 dBm	−65 dBm
12.0—18.0 GHz (Band 4)	−90 dBm	−80 dBm	−70 dBm	−60 dbm
15.0—21.0 GHz (Band 5)	−85 dBm	−75 dBm	−65 dBm	−55 dBm
18.0—26.5 GHz (Band 6)[a]	−100 dBm	−90 dBm	−80 dBm	−70 dBm
26.5—40.0 GHz (Band 7)[a]	−95 dBm	−85 dBm	−75 dBm	−65 dBm
40.0—60.0 GHz (Band 8)[a]	−95 dBm	−85 dBm	−75 dBm	−65 dBm
60.0—90.0 GHz (Band 9)[a]	Typically −95 dBm at 60 GHz degrading to −85 dBm at 90 GHz			
90.0—140 GHz (Band 10)	Typically −85 dBm at 90 GHz degrading to −75 dBm at 140 GHz			
140—220 GHz (Band 11)	External Mixer Dependent			

[a]**TEKTRONIX High Performance Waveguide Mixers.**

OPTION 02

This option provides digital storage. The following are the changes and additions to the instrument.

Multiple memory (A & B) display storge is provided with: Save A, Max Hold, B memory minus Save A memory, digital display averaging, and storage bypass for non-store display.

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

OPTION 03

This option adds a 100 Hz resolution filter and provides first (1st) local oscillator stabilization by phaselocking the oscillator to an internal reference. This reduces residual FM'ing to facilitate viewing narrow spans. The internal microcomputer automatically activates phaselock mode when the span/div is 50 kHz or less for bands 1—3, 100 kHz or less for band 4, and 200 kHz or less for band 5 and above. The following describes additions and changes to the specifications.

Table 1-5
OPTION 03 ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information		
Frequency Span/Div				
Range		**Band**	**Narrow Span**	**Wide Span**
		1—3 (0—7.1 GHz)	500 Hz/Div	200 MHz/Div
		4—5 (5.4—21 GHz)	500 Hz/Div	500 MHz/Div
		6 (18—26 GHz)	500 Hz/Div	1 GHz/Div
		7—8 (26—60 GHz)	500 Hz/Div	2 GHz/Div
		9 (60—90 GHz)	500 Hz/Div	2 GHz/Div
		10 (90—140 GHz)	500 Hz/Div	5 GHz/Div
		11 (140—220 GHz)	500 Hz/Div	10 GHz/Div
		Two additional positions provide full band display (Max span) or 0 Hz (time domain display.		
Accuracy	Within 5% of the span/div selected over the center eight divisions of a ten division display.			
Resolution	Additional resolution bandwidth of 100 Hz with 7.5:1 shape factor except instruments prior to B040000 that have the cavity 2nd LO A20, Tektronix Part No. 119-1022-00 and 119-1022-01. Shape factor for these instruments with 100 Hz resolution is 15:1.			

Table 1-5 (cont)

Characteristic	Performance Requirement	Supplemental Information
Noise Sidebands	At least −75 dBc at 30 times the resolution bandwidth offset (−70 dBc for 100 Hz resolution bandwidth) for fundamental mixing.	
Residual FM (short term) after 2 hour warm up	⩽(48 + 2n) Hz, peak-to-peak for a period of 20 ms. n is the 1st LO harmonic number used in the 1st mixer conversion, and related to the selected frequency range (band).	No video filter.
Frequency Drift, at a fixed frequency:		
B039999 and below and after a 2 hour warmup.	⩽25 kHz/hour, fundamental mixing.	
B040000 and up and after a 30 minute warmup;	⩽15 kHz/10 minutes, fundamental mixing.	⩽5 kHz/10 minutes, typical.
after a 1 hour warmup.	⩽3 kHz/10 minutes, fundamental mixing.	⩽1 kHz/10 minutes, typical.
Sensitivity (100 Hz)	8 dB better than 1 kHz sensitivity.	

OPTION 08

Deletes External Mixer capability. Standard accessories do not include the Diplexer. Frequency range of the instrument is 50 kHz to 21 GHz.

OPTION 20

Includes: General Purpose Waveguide Mixers; 12.5 to 40 GHz as listed below. Tektronix Part No. 016-0640-00.

Frequency Range	Part Number	Sensitivity: Equivalent Input Noise @ 1 kHz Bandwidth (Typical)
12.4—18 GHz	119-0097-00	−75 dBm
18.0—26.5 GHz	119-0098-00	−70 dBm
25.6—40 GHz	119-0099-00	−60 dBm

Cable: TNC-to-SMA male connectors, 012-0748-00

OPTION 21
(WM 490-2)

Includes: High Performance Waveguide Mixers; 18 to 40 GHz mixers and cable as listed.

Frequency Range	Nomenclature	Sensitivity: Equivalent Input Noise @ 1 kHz Bandwidth (Maximum)	Frequency Response	
			Mean Average	Referenced to 100 MHz
18.0—26.5 GHz	WM490K	−100 dBm	±3.0 dB	±6 dB
26.5—40 GHz	WM490A	−95 dBm	±3.0 dB	±6 dB

Cable: SMA-to-SMA connector, 012-0649-00

OPTION 22
(WM 490-3)

Includes: High Performance Waveguide Mixers: 18 to 60 GHz mixers and cable as listed.

Frequency Range	Nomenclature	Sensitivity: Equivalent Input Noise @ 1 kHz Bandwidth (Maximum)	Frequency Response	
			Mean Average	Referenced to 100 MHz
18.0—26.5 GHz	WM490K	−100 dBm	±3.0 dB	±6 dB
26.5—40 GHz	WM490A	−95 dBm	±3.0 dB	±6 dB
40—60 GHz	WM490U	−95 dBm	±3.0 dB	±6 dB

Cable: SMA-to-SMA male connector, 012-0649-00

NOTE

These characteristics assume that the waveguide mixer is connected to a cw signal source and that the PEAKING control is adjusted for maximum signal amplitude. The signal must be stable (not frequency modulated more than the resolution bandwidth); otherwise, frequency response specifications cannot be met.

OPTION 30

Rackmount version of 492/492P Spectrum Analyzer. (See Rackmount/Benchtop Versions, Section 6.)

OPTION 31

Rackmount version of 492/492P with cables from front panel to back of the cabinet. (See Section 6.)

OPTION 32

Benchtop version of 492/492P Spectrum Analyzer. (See Section 6.)

OPTIONS FOR POWER CORD CONFIGURATION

Tektronix has implemented options that provide internationally approved power cord and plug configurations. These are shown and illustrated in Fig. 1-3.

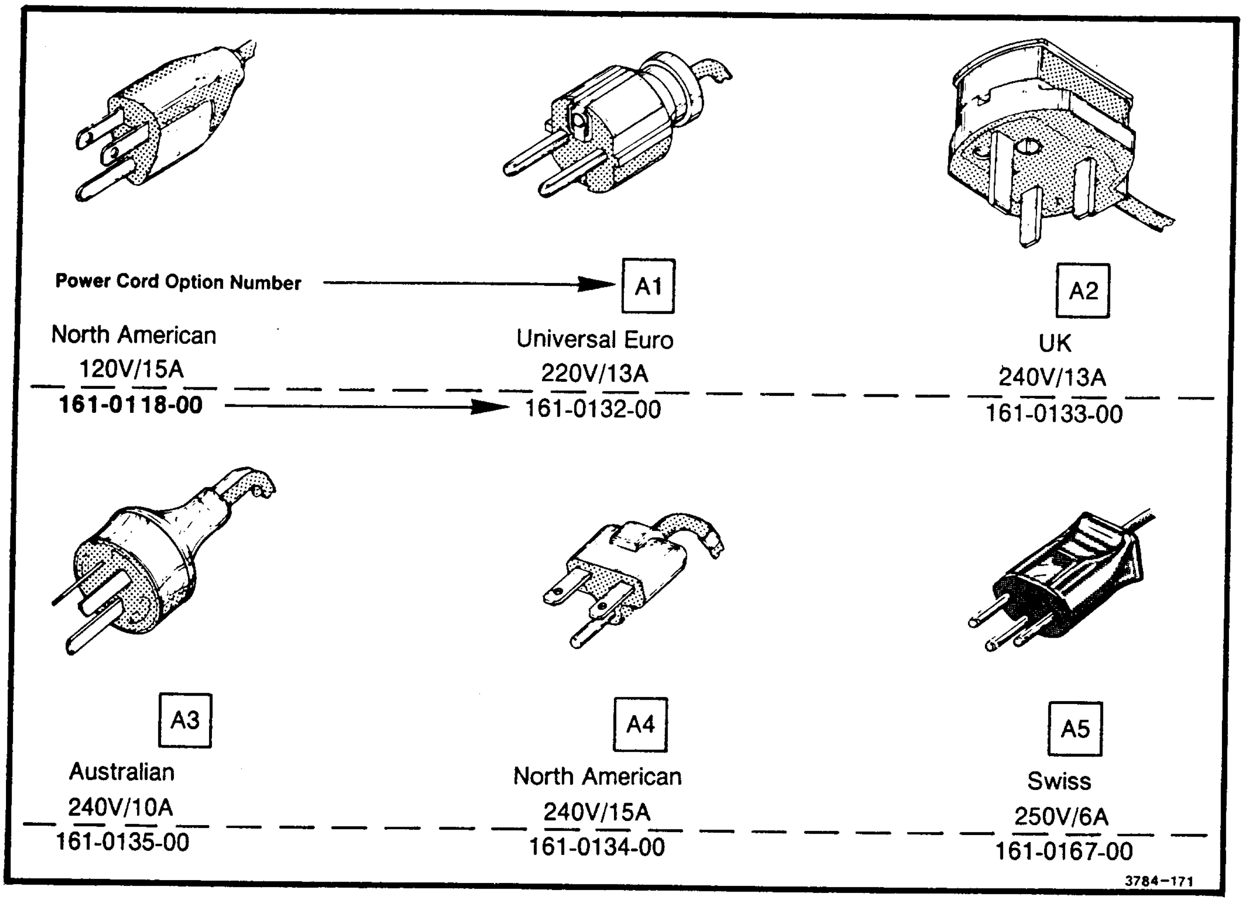


Fig. 1-3. International power cord and plug configuration for the 492/492P.

INSTALLATION AND REPACKAGING

Introduction

This section describes unpacking, installation, power requirements, and repackaging information for the 492/492P Spectrum Analyzer. Refer to Rackmount Benchtop section for information on these versions of the instrument.

Unpackaging and Initial Inspection

Before unpacking the 492/492P from its shipping container or carton, inspect for signs of external damage. If the carton is damaged, notify the carrier as well as Tektronix, Inc. The shipping carton contains the basic instrument and its standard accessories. Optional accessories are shipped in separate containers. Refer to the Accessories page following the Replacable Mechanical Parts list in the 492/492P Service Volume 2 manual for a complete listing.

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.

The instrument was inspected both mechanically and electrically before shipment. If should be free of mechanical damage and meet or exceed all electrical specifications. Procedures to check functional or operational performance are in the Calibration section. The functional check procedure verifies proper instrument operation and should satisfy the requirements for most receiving or incoming inspections. The electrical performance check follows the functional check.

Preparation for Use

The 492/492P 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 492/492P where paper, plastic, or like material might block the air intake.

The front panel cover for the 492/492P 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 accessories door is unlatched by pressing the latch to the side and lifting the cover.

The handle of the 492/492P 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 that 492/492P 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. See Removing the Cabinet at the beginning of the Calibration Procedure section.

Power Source and Power Requirements

The 492/492P 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 V 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 connectd 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 492/492P can be operated from either 115 Vac or 230 Vac nominal line voltage with a range of 90 to 132 on 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 to Changing Power Input Range in Section 1.

Repackaging for Shipment

When the 492/492P is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner and address, name of individual at your firm that can be contacted, complete serial number, and a description of the service required. If the original packaging is unfit for use or not available, repackage the equipment as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions that are at least six inches more than the equipment dimensions, to allow for cushioning. Table 2-1 lists instrument weights and carton strength requirements.

2. Install the front cover on the 492/492P and surround the equipment with polyethylene sheeting to protect the finish.

3. Cushion the equipment on all sides with packing material or urethane foam between the carton and the sides of the equipment.

4. Seal with shipping tape or industrial stapler.

Table 2-1
SHIPPING CARTON TEST STRENGTH

Gross Weight		Carton Test Strength	
Pounds	Kilograms	Pounds	Kilograms
0—10	0—3.73	200	74.6
10—30	3.73—11.19	275	102.5
30—120[a]	11.19—44.76	375	140.0
120—140	44.76—52.22	500	186.5
140—160	52.22—59.68	600	223.8

[a]Applicable to the 492/492P.

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

CALIBRATION

INTRODUCTION

Calibration consists of a Performance Check and an Adjustment Procedure. The descriptive detail for these procedures assume the user is knowledgeable in the use of sophisticated test equipment and test procedures. The Performance Check describes procedures to verify that the instrument is performing properly and meets specifications listed in Section 1. All tests can be performed without access to the interior of the instrument. The Adjustment Procedure provides instructional steps required to recalibrate the instrument circuits. After adjustment, the performance should be checked by the procedure described under the Performance Check part. We recommend adjusting only those circuits that do not meet performance criteria.

Since most instruments will have one or more options, procedures for these options are a sub-part of the step and integrated into this section.

The limits, tolerances, and waveform illustrations are aids to calibrate the instrument and are not intended as performance specifications.

HISTORY INFORMATION

The instrument and manual are periodically evaluated and updated. If modifications require changes in the calibration procedure, history information applicable to earlier instruments is included as a deviation within a step or as a sub-part to a step.

EQUIPMENT REQUIRED

Table 3-1 lists the test equipment and calibration fixtures recommended for the Performance Check and Adjustment Procedure. The characteristics specified are the minimum required for the checks. Substitute equipment must meet or exceed these characteristics. Special calibration fixtures that are listed facilitate the procedure. These are available from Tektronix, Inc., and may be ordered through your local Tektronix Field Office or representative.

Sophisticated test equipment and/or procedures are required to accurately measure some high tolerance characteristics. In these cases, a compromise may be made in the procedure. Any compromise is indicated by a footnote. Procedures to check these high tolerance specifications, when a compromise has been made, can be supplied by Tektronix Service Centers.

Table 3-1
EQUIPMENT REQUIRED

Equipment or Test Fixture	Characteristics	Recommendation and Use
	PERFORMANCE CHECK	
Test Oscilloscope	Vertical sensitivity, 50 mV/Div to 5 V/Div	Any TEKTRONIX 7000-Series oscilloscope with plug-in units for real-time display such as: 7A11/7B50A, and P6108 1X Probe (used to monitor signal and voltage levels)
Two Time Mark Generators	Marker output, 1 s to 1 μs; accuracy, 0.001%	TEKTRONIX TG 501 and TM 500-Series Power Module (used to check time/div and span accuracy)
Microwave Frequency Counter	10 Hz to 10 GHz, −20 dBm sensitivity	Hewlett Packard Microwave Frequency Counter 5342A (used to measure the Calibrator or 2nd LO frequency)

Table 3-1 (cont)

Equipment or Test Fixture	Characteristic	Recommendation and Use
Function or Sine-Wave Generator	1 Hz to 1 MHz; 0 to 20 V p-p	TEKTRONIX FG 503 Function Generator (used to check external trigger and horizontal input requirements)
Signal Generator(s)	10 Hz to 10 MHz constant output. 250 kHz—110 MHz, leveled output	Hewlett-Packard Model 654 (used to check frequency response)
	Two 500 kHz to 2.0 GHz generators calibrated and leveled. Output, +10 dBm to −100 dBm; spectral purity, ⩾60 dB below fundamental	TEKTRONIX SG 503 Signal Generator Hewlett-Packard Model 8640A/B Option 02 and two 8614A (used to check frequency response; also used as a signal source for IM and display accuracy checks)
Sweep Oscillator	100 kHz to 18 GHz; frequency response, ±1.0 dB	Hewlett-Packard Model 8620C with Model 86290A Option 8 and 86222B Sweep Oscillators (used to check frequency response and flatness)
Power Divider		Hewlett-Packard Model 11667A
Power Meter with Power Sensors	−60 dBm to −20 dBm full scale; 100 kHz to 18 GHz	Hewlett-Packard Model 435A with 8482A and Power Sensors
Vector Voltmeter or	Frequency to 100 MHz	Hewlett-Packard Model 8405A (used to check CALibrator OUTput)
Power Meter with Lowpass Filter	Measure −20 dBm within ±0.1 dB. The filter must have rolloff of 40 dB or more at 200 MHz	Hewlett-Packard Model 435A with 8481A Sensor (used to check CALibrator OUTput). Filter: Texscan or Lark
Comb Generator UHF	Provide comb line to 18 GHz; accuracy, 0.01%	TEKTRONIX Calibration Fixture 067-0885-00 with TM 500 Power Module (used to check frequency readout accuracy)
Spectrum Analyzer	Frequency range, 2.0—2.2 GHz	TEKTRONIX 7L18 or 492/492P (used to adjust 1st and 2nd LO frequency offset)
Attenuator (SMA connectors)	3 dB, 50 Ω; dc to 20 GHz	Weinchel Model 4M. Tektronix Part No. 015-1053-00
Attenuators (bnc connectors; two required)	20 dB, 50 Ω; dc to 2.0 GHz	Tektronix Part No. 011-0059-02
Coaxial Cable (50 Ω, 5 ns SMA connectors)		Tektronix Part No. 015-1006-00
Adapter (N male-to-SMA male)		Tektronix Part No. 015-0369-00
Adapter (N male-to-bnc female)		Tektronix Part No. 103-0045-00
T Connector (bnc)		Tektronix Part No. 103-0030-00

Table 3-1 (cont)

Equipment or Test Fixture	Characteristic	Recommendation and Use
Step Attenuators	Range, 0—110 dB in 10 dB and 1 dB steps; accuracy, ±0.1 dB; frequency range, dc to 18 GHz	Step attenuator such as Hewlett-Packard 849B and 8496B, calibrated by precision standard attenuators; such as Weinchel Model AS-6 attenuator
Coaxial Cables (50Ω; 2 required)		Tektronix Part No. 012-0482-00
ADJUSTMENTS		
All the items listed above plus the following are required for the Adjustment Procedure.		
Return Loss Bridge	10 MHz to 1 GHz, 50 Ω	Wiltron VSWR Bridge Model 62BF50
Attenuator (3 dB miniature)	Frequency, to 5 GHz; connectors, 5 mm	Weinchel Model 4M Tektronix Part No. 015-1053-00
Autotransformer	Capable of varying line voltage from 90 to 130 Vac	General Radio Variac Type W10MT3
Digital Multimeter	≤10μV to ≥350 Vdc	TEKTRONIX DM 501A or DM 502A.
Dc Block		Tektronix Part No. 015-0221-00
Adapter (Sealectro male-to-male)		Tektronix Part No. 103-0098-00; Sealectro Part No. 51-072-0000
Adapter (bnc female-to-Sealectro male)		Tektronix Part No. 103-0180-00
Three Extension Cables (Sealectro female-to-Sealectro male)[a]		Tektronix Part No. 175-2902-00
Adapter (bnc-to-Sealectro)		Tektronix Part No. 175-2412-00
Adapter (bnc female-to-SMA male)		Tektronix Part No. 015-1018-00
Cable (20"), Tip plugs to bnc		Tektronix Part No. 175-1178-00
Coaxial cable (8")		Tektronix Part No. 012-0208-00
Screwdriver, tuning		Tektronix Part No. 003-0675-00
Alignment tool	Square pin adjustment tool for VR calibration	Tektronix Part No. 003-0968-00
Screwdriver, flat, 6" with 1/8" tip.		
Screwdriver, Phillips type		No. 1
Allen wrenches (3), 3/32", 5/64", 7/64"		
Service Kit (Extender boards)[a]		Tektronix Part No. 672-0865-00

[a]These fixtures are part of the Service Kit 006-3286-00, listed in the Maintenance Section.

PERFORMANCE CHECK PROCEDURE

INTRODUCTION

As stated in the section introduction, the following procedure is a functional as well as performance check. All performance requirements listed under electrical characteristics in the Specification section are verified. The tests do not include any internal adjustments or checks. The checks should be performed in the sequence given because some tests rely on the satisfactory performance of related circuits. They are also arranged to minimize test equipment setup. If a performance measurement is marginal or below specification, an adjustment procedure to optimize the circuit performance will be found under a similar heading in the Adjustment Procedure of this section. If adjustment fails to return the circuit to specified performance, refer to the Maintenance section for troubleshooting and repair procedures. After adjustment, return to the Performance Check to continue with the calibration process.

INCOMING INSPECTION TEST

The Operators manual contains a functional check that checks all functions of the 492/492P. This check is recommended for incoming inspections because it provides a reliable indication that the instrument is performing properly. This Performance Check procedure checks all instrument specifications and requires sophisticated equipment as well as technical expertise to perform.

VERIFICATION OF TOLERANCE VALUES

Compliance tests of specified limits, listed in the Performance Requirement column of the instrument specifications, shall be performed after sufficient warm-up time and preliminary preparation (such as front-panel adjustments). Measurements shall be performed by instruments that do not affect the values measured.

Measurement tolerance of test equipment should be negligible in comparison to the specified tolerance; and, when not negligible, the error of the measuring apparatus shall be added to the tolerance specified.

PRELIMINARY PREPARATION

a. Perform the initial calibration described under Turn On Procedure in the Operator's manual. For rackmount/benchtop versions, refer to Rackmount/Benchtop section of this manual.

b. Set the front-panel controls as follows:

BASELINE CLIP	Off
TRIGGERING	FREE RUN
TIME/DIV	AUTO
FREQUENCY RANGE	Band 1 (0—4.2 GHz, 0—1.8 GHz Option 01)
FREQUENCY	100 MHz
Vertical Display	10 dB/DIV
FREQ SPAN/DIV	100 kHz
AUTO RESOLUTION	On
RF LEVEL	−20 dBm
MIN RF ATTEN dB	0
MIN NOISE (push button)	Off (MIN DISTORTION)
FINE (push button)	Coarse (not illuminated)
Digital Storage (Option 02)	
VIEW A	On
VIEW B	On
MAX HOLD	Off
SAVE A	Off
B−SAVE A	Off
PEAK/AVERAGE	Fully cw

c. Allow the instrument to warm up for at least two hours before proceeding with this check.

1. Check Operation of Front Panel Push Buttons and Controls

The following procedure checks functions activated by front-panel push buttons and that the buttons illuminate when the function is active. Operation of the front-panel controls is also checked.

With the CAL OUT signal applied to the RF INPUT, tune the 100 MHz, −20 dBm signal to center screen. Reduce the FREQ SPAN/DIV to 100 kHz keeping the signal centered on screen with the FREQUENCY control. Press or change the following push buttons and controls and note their effect.

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

READOUT. Inactive state, no crt readout. Active state, crt readout of REF LEVEL, FREQUENCY, FREQ SPAN/DIV, VERT DISPLAY, RF ATTEN, FREQ RANGE, and RESOLUTION BANDWIDTH. The INTENSITY control changes brightness.

GRAT ILLUM. Inactive state, no graticule lights. Active state, graticule lights.

BASELINE CLIP. Inactive, no clipping of the display baseline. Active, display intensity at the baseline is clipped (subdued).

TRIGGERING. Triggering mode is activated by pressing one of four push buttons. Pressing any one of the buttons cancels or deactivates the other mode.

FREE RUN. Active, trace free runs.

INT. Active, trace displayed when signal or noise level at left edge is ≥2.0 divisions and risetime is faster than 24 ms (15 Hz).

LINE. Active, trace triggered at power line frequency.

EXT. Active, trace runs when an external signal ≥1.0 V peak or less is applied to the back panel EXT IN connector.

SINGLE SWEEP. Pressing this button to activate single sweep aborts the recurrent sweep; pressing the button again arms the sweep generator and lights READY, which remains lighted until the sweep completes. The analyzer makes a single sweep of the selected spectrum when the conditions determined by TRIGGERING are met. Single sweep mode is cancelled when any TRIGGERING button is pressed. The effect of SINGLE SWEEP may be more apparent if VIEW A, VIEW B, and B−SAVE A are off.

TIME/DIV. Selects sweep rate and manual scan operation. In MNL position, MANUAL SCAN control should vary the crt beam across the full horizontal axis of the crt graticule.

VERTICAL DISPLAY. Display modes are activated by three push buttons. Pressing any of these buttons cancels the other mode.

10 dB/DIV. Active, display is a calibrated 10 dB/division, 80 dB dynamic range. Calibration is checked later in this procedure.

2 dB/DIV. Active, display is calibrated 2 dB/division, 16 dB dynamic range. Calibration is checked later in this procedure.

LIN. Active, display is linear between the reference level (top of graticule) and zero volt (bottom of graticule); the crt VERT DISPLAY reads out in volts/division.

PULSE STRETCHER. Active, increases the fall time of video signals to make narrow pulses on the display easier to see. With FREQ SPAN/DIV at MAX, TIME/DIV at 5 ms and Digital Storage off, the markers should increase in brightness when PULSE STRETCHER is active.

VIDEO FILTER. Two filters, independently selected to provide WIDE (1/30th) or NARROW (1/300th) of the resolution bandwidth for noise reduction.

DIGITAL STORAGE (Option 02). Either or both sections of memory can be selected to provide digital storage. When either or both are activated, signal amplitude should remain constant. Vary the PEAK/AVERAGE control and note that noise level below the PEAK/AVERAGE cursor is averaged.

VIEW A/VIEW B. When SAVE A is off, either VIEW A or VIEW B will display all data (1024 bits) in memory. Both sections of memory are updated each sweep. When SAVE A is activated, VIEW A displays data saved in the A section of memory (512 bits) and VIEW B displays data (512 bits) in the B section of memory. B section is updated each sweep.

SAVE A. Active, contents in A memory are saved and not updated. Verify operation by changing REF LEVEL and observe that the VIEW A display does not change when VIEW B is inactive.

MAX HOLD. Active, stores maximum signal amplitude at each memory location. Verify operation by changing FREQUENCY or REF LEVEL and note that the maximum level at each location is retained.

B−SAVE A. Active, the difference between updated data in B section of memory and that saved in A is displayed. Verify by saving data in A, then changing the refrence level and pressing B−SAVE A; only the difference can be observed by cancelling VIEW A and VIEW B. The reference (zero difference) level is normally set at graticule center, but can be internally adjusted. See Adjustment Procedure, step 15.

PEAK/AVERAGE. When digital storage is activated with VIEW A or VIEW B, this control positions a horizontal line or cursor on the display. Signals above the cursor are peak detected; signals below the cursor are averaged. The cursor should position anywhere within the graticule window.

IDENTIFY 500 kHz/ONLY. When active, the vertical position of the display alternately shifts about one division. Spurious signals shift horizontally on the alternate sweep, true signals do not shift. Reduce FREQ SPAN/DIV to 500 kHz with a signal tuned to center screen, reduce TIME/DIV to a slow sweep rate, and press the IDENTIFY button. Note the display of the calibrator signal.

PHASELOCK (Option 03). Activated to reduce residual FM when narrow spans are selected. The button lights when active; pressing the button turns phaselock off. When active, the microcomputer automatically selects phaselock for a span/division of 50 kHz or below in bands 1 through 3, 100 kHz or below in band 4, and 200 kHz or below in bands 5 and above.

AUTO RESOLUTION. When activated, RESOLUTION BANDWIDTH changes so bandwidth is compatible with FREQ SPAN/DIV selection. Check by changing FREQ SPAN/DIV and noting that RESOLUTION BANDWIDTH changes. UNCAL indicator should not light over the FREQ SPAN/DIV range if TIME/DIV selector is in AUTO position.

FREQUENCY SPAN/DIV. As this control is rotated clockwise, FREQ SPAN/DIV should change from 0 to MAX in 1-2-5 sequence. Display should indicate this change. Range of the Span/Div depends on Options (see Specification section).

RESOLUTION BANDWIDTH. As this control is rotated, resolution bandwidth should change in decade steps from 1 MHz to 1 kHz (100 Hz Option 03).

ΔF. When activated, center frequency readout initializes to 0 MHz. The frequency difference, to a desired signal or point on the display, can now be determined by tuning that point to center screen and noting the readout. Check by measuring the difference between calibrator markers. If the frequency is tuned below "0", the readout will indicate minus (−).

DEGAUSS. When pressed, residual magnetism build-up in the local oscillator system is reduced. Switch FREQ SPAN/DIV to 1 MHz and tune the calibrator marker to center screen. Note the signal position, then press the DEGAUSS button. The signal should shift horizontally and then return to a new location. Press again and the signal should return to the same new location. Return FREQ SPAN/DIV to 100 MHz.

FREQUENCY RANGE. Two push buttons that shift the 492/492P frequency bands. Press the Δ button and note the up shift of bands; then press the ∇ button and note that the bands shift down to the 0 to 4.2 GHz range (0 to 1.8 GHz Option 01).

CAL. Checked when performing Turn On Procedure.

REFERENCE LEVEL. Continuous control that requests the microcomputer to change the reference level one step for each detent. In the 10 dB/DIV Vertical Display mode, the steps are 10 dB. When FINE is activated, the steps are 1 dB. In the 2 dB/DIV mode, the steps are 1 dB or 0.25 dB for the FINE mode. When FINE is activated in the 2 dB/DIV mode, the ΔA mode is operational. The REFERENCE LEVEL goes to 0.00 dB then steps in 0.25 dB increments from an initial 0.00 dB reference level.

Set the MIN RF ATTEN to 0 dB. Set the vertical display to 10 dB/DIV, and rotate the REFERENCE LEVEL control counterclockwise to +30 dBm then clockwise to −120 dBm. Note the change in the display. Return the REF LEVEL to −20 dBm and note that 10 dB of RF ATTEN is switched in at −20 dBm.

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

FINE. When activated, REF LEVEL switches in 1 dB increments for 10 dB/DIV display mode, and 0.25 dB for 2 dB/DIV display mode. In the 2 dB/DIV display mode, FINE actuates ΔA mode.

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 decreasing 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.

UNCAL. This light comes on when the display is uncalibrated. Set the TIME/DIV to 50 ms, deactivate the AUTO RESOLUTION, and set the RESOLUTION BANDWIDTH to 10 kHz. UNCAL should light and remain lit until the FREQ SPAN/DIV is reduced to 200 kHz or the RESOLUTION BANDWIDTH is increased to 1 MHz. Return the TIME/DIV to AUTO and activate the AUTO RESOLUTION. Set the FREQ SPAN/DIV to 100 MHz.

EXTERNAL MIXER/PEAKING. In active mode, bias for external waveguide mixers is provided at the EXT MIXER connection. Activate the External Mixer mode by changing the FREQUENCY RANGE to 18—26 GHz and then measure the bias with a VOM between the center conductor and ground of the EXT MIXER port. Bias should range from about −2.0 to +1.0 V as the PEAKING control is varied. If your mixer requires positive-going bias, the 492 bias polarity can be reversed. Contact your local Tektronix Field Representative.

If the instrument has a preselector (Option 01), the control also varies the preselector tuning to augment tracking for the coaxial bands (0—21 GHz).

This completes the functional check of the front-panel controls and push buttons.

2. Check Frequency Readout Accuracy for 492/492P and Tune Accuracy of 492P Only

Readout accuracy ±(5 MHz 20% Span/Div) × n or ±(0.2% of center frequency +20% of the span/division) whichever is greater. Tune accuracy (492P only) is ±(7% of tune amount)n or ±(150 kHz)n whichever is greater. "n" is the harmonic number of the 1st LO that is used in the first conversion. Table 3-2 lists "n" and bands.

Table 3-2

HARMONIC NUMBER (n) vs FREQUENCY RANGE

Band	Frequency Range	n
1	0.0—4.2 GHz (0.0—1.8 GHz, Option 01)	1
2	1.7—5.5 GHz	1
3	3.0—7.1 GHz	1
4	5.4—18 GHz	3
5	15—21 GHz	3
6[a]	18.0—26.5 GHz	6
7[a]	26—40 GHz	10
8[a]	40—60 GHz	10
9[a]	60—90 GHz	15
10[a]	90—140 GHz	23
11[a]	140—220 GHz	37

[a]**External Mixer required.**

NOTE

Due to residual magnetism buildup in the 1st (YIG) oscillator tuning coils, accuracy of the frequency readout should be checked after the tuning coil has been degaussed by pressing the DEGAUSS button. Degauss when the FREQ SPAN/DIV is either 2 MHz or 1 MHz before reducing the FREQ SPAN/DIV to 500 kHz.

a. Test equipment setup is shown in Fig. 3-1. Set the front-panel controls as follows, then apply the comb generator output to the RF INPUT.

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz Option 01)
FREQUENCY	1.0 GHz
FREQ SPAN/DIV	200 MHz
AUTO RESOLUTION	On
MIN RF ATTEN	20 dB
Vertical Display	10 dB/DIV
Video Filter	WIDE
TIME/DIV	AUTO
Digital Storage (Option 02)	VIEW A/VIEW B

b. Tune the 1.0 GHz comb line to center screen. Decrease the FREQ SPAN/DIV to 2 MHz or 1 MHz, keeping the 1.0 GHz signal centered. Press the DEGAUSS button, decrease the FREQ SPAN/DIV to 500 kHz, and center the signal under the frequency dot.

c. Press the IDENTIFY 500 kHz/ONLY button to verify that the signal is a true response. Deactivate the identify feature. If the signal is true, activate the frequency CAL push button.

d. Calibrate the frequency readout by adjusting the frequency control for a readout of 1.000 GHz. Deactivate the CAL pushbutton.

e. Return the FREQ SPAN/DIV control to 200 MHz and tune the FREQUENCY to the next comb line (1.5 GHz). Decrease the FREQ SPAN/DIV to 2 MHz, degauss the tuning coils, then decrease the span to 500 kHz/div and center the comb line under the frequency dot. Then press the IDENTIFY 500 kHz/ONLY push button to verify that the signal is a true response. If true, check the frequency readout accuracy. If a spurious response, tune to the next marker and check. Readout must equal 1.500 GHz ±(5 MHz + 20% Span/Div) x n or; ±(0.2% of Center frequency + 20% Span/Div) whichever is greater.

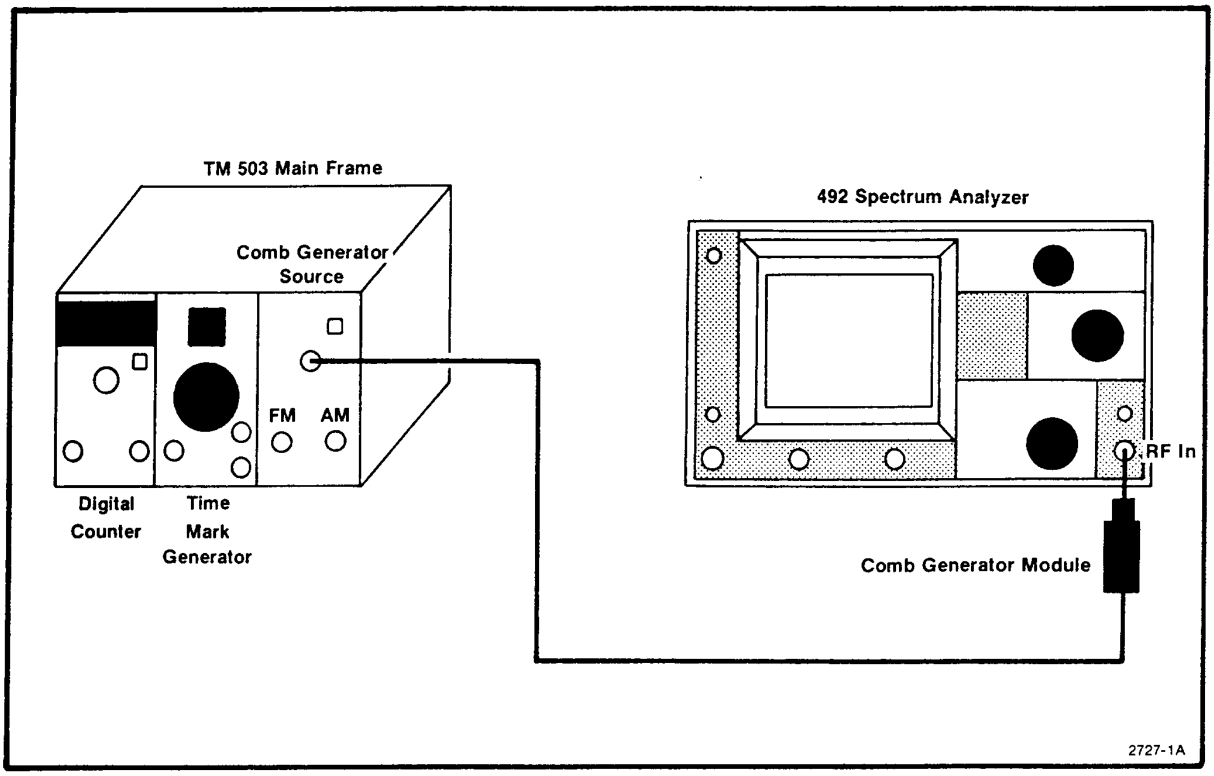


Fig. 3-1. Test equipment setup for checking frequency of the calibrator and the accuracy of the frequency readout.

f. Repeat this process checking frequency readout accuracy in 1 GHz or 2 GHz increments for bands 1 through 3 (0 to 7.1 GHz) applying the limit ±(0.2% of center frequency +20% of span/div) above 2.5 GHz.

Tune a comb line (marker frequency) to center screen with the FREQ SPAN/DIV at 1 MHz. Press DEGAUSS and recenter the marker if necessary with the FREQUENCY control. Activate the CAL pushbutton and adjust the FREQUENCY control so the frequency readout equals the required accuracy at that point. (i.e. If the marker is above the readout frequency then adjust the readout for a higher reading; for example, the readout for a 2.000 GHz marker would be moved to read 2.005 GHz with the marker centered.) Now recheck the frequency readout accuracy to ensure that the readout is within specifications over the range of the oscillator tuning.

Since the other bands operate on harmonics of the oscillator fundamental, accuracy or error will be the same as that measured for the fundamental bands multiplied by the harmonic number (n) of the band.

If you choose to check the higher bands, it may be necessary to increase the REF LEVEL to −10 dBm to locate true response of the 500 MHz comb. MIN RF ATTEN should not be decreased below 10 dB unless the instrument has the preselector (Option 01). When checking instruments with the preselector, adjust the PEAKING control for maximum signal response, when operating above band 1 (0 to 1.8 GHz), as each signal is tuned to center screen.

g. Leave the comb generator connected for 492P; disconnect the comb generator for the 492.

2A. 492P only—TUNE Accuracy Check ±(7% of frequency or 150 kHz)n, whichever is greater, after a 2-hour warm-up

a. Enter the following program on a 4050-Series controller:

```
100 REMARK TUNE CHECK
110 PRINT @1:"SAVEA OFF;TRIG FRERUN"
120 WBYTE @33,1:
130 INPUT T$
140 PRINT @1:"SIGSWP;SAVEA ON;TUNE";T$;";SIGSWP"
150 INPUT W$
160 GO TO 110
```

b. Connect the 4050-Series controller to the 492P with a GPIB cable (both should already be turned on). Set the 492P GPIB ADDRESS switches for address 1 (switch 1 up, all others in the switch bank down).

c. Change the front-panel controls for:

FREQUENCY RANGE	1.7—5.5 GHz
FREQ SPAN/DIV	200 MHz
FREQUENCY	2.0 GHz
VIDEO FILTER	Off
PEAK/AVERAGE	Fully cw

d. Type RUN and press RETURN on the controller. Line 110 of the program immediately sets the sweep and the digital storage so you can change FREQUENCY and other local controls as required for the TUNE check. Line 120 restores local control with the GTL message.

e. Center the marker while decreasing the FREQ SPAN/DIV to 10 MHz. Adjust PEAKING as necessary and set REFERENCE LEVEL to display the comb marker. For non-Option 01 instruments, set the SPAN/DIV to 500 kHz and use IDENTIFY to make sure the analyzer is centered on a real signal, then return to 10 MHz/div.

f. Enter 500M (type 500M and press RETURN). If you make an error in this procedure, press BREAK twice and run the program again. If the 492P asserts SRQ (evident by message on controller screen and S in 492P lower readout), enter WBYTE @20: to clear the SRQ.

g. The analyzer tunes 500 MHz, takes a single sweep, and sets up a display of the marker signal you centered and the signal acquired after the TUNE command executed. Note the error between the two signals.

h. Press RETURN to continue. Change FREQ SPAN/DIV to 200 MHz and FREQUENCY to 3.0 GHz. Repeat parts e through g, then repeat the procedure for a frequency of 4.5 GHz.

i. Tune error for the above checks should not exceed 3.5 divisions (7% of 500 MHz tune step is 35 MHz).

The foregoing procedure checks performance related to the upper DAC of the 1st LO center frequency control. The remaining procedure checks the lower DAC for the 1st LO.

j. Press RETURN and change the controls as follows:

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz, Option 01)
FREQ SPAN/DIV	200 MHz
FREQUENCY	1 MHz
REF LEVEL	+30 dBm

k. Disconnect the microwave comb generator and connect the output of the time mark generator to the RF INPUT. Set the time mark generator for 1 μs output.

l. Change the FREQUENCY (and REF LEVEL if necessary) while decreasing the FREQ SPAN/DIV to 100 kHz to maintain a centered marker above the 0 Hz spurious response.

m. Type 1M and press RETURN on the controller. Note the difference in the displayed signals, then press RETURN again.

n. Repeat part m seven times. Reset FREQUENCY after noting the error if the accumulated TUNE error is great enough to move the signal off screen. (The FREQUENCY control is active at the point where you note the TUNE error.) The largest error should not exceed 1.5 divisions (150 kHz).

This completes the check of TUNE command performance related to the 1st LO. The following steps check the upper DAC of the pair that control the 2nd LO center frequency.

o. Increase FREQ SPAN/DIV to 1 MHz and change FREQUENCY to center a marker at least three divisions away from the 0 Hz marker:

p. Decrease the span to 10 kHz/div keeping the marker centered and change the time marker output to 10 μs. Change the REFERENCE LEVEL as necessary to keep the marker above the noise.

q. Type 100K and press RETURN on the controller. Note the difference in the displayed signals, then press RETURN again.

r. Increase span to 50 kHz/div, change the time marker output to 1 μs, and tune FREQUENCY two markers to the left (−2 MHz). Repeat parts p and q.

s. Increase the span to 50 kHz/div, change the time marker output to 1 μs, and tune FREQUENCY four markers to the right (+4 MHz). Repeat parts p and q.

t. The largest error noted should not exceed 0.7 division (7% of 100 kHz tune or 7 kHz).

This completes a check of the 2nd LO upper DAC. A check of the 2nd LO lower DAC follows. Perform the rest of this step for Option 03 instruments only.

u. Apply 0.2 ms markers, then center one of the markers with the FREQUENCY while reducing FREQ SPAN/DIV to 1 kHz (change REFERENCE LEVEL as necessary).

v. Enter 5K at the controller and note the difference in the displayed signals. Since more than two time marks may be displayed, note the difference between the centered time-marker and the nearest time-marker. The difference should not exceed 0.35 division (7% of 5 kHz tune or 350 Hz).

3. Check Calibrator (frequency 100 MHz ±1.7 kHz, output level −20 dBm ±0.3 dB)

a. Check the calibrator frequency by connecting a frequency counter (e.g., TEKTRONIX DC 508 or Hewlett-Packard Model 5342A Digital Counter) to the 492/492P CAL OUT connector and measure the frequency. Fundamental frequency is 100 MHz ±1.7 kHz.

b. Three procedures for measuring output level are given; vector voltmeter, power meter, and comparison method using an accurate −20 dBm source.

1. Vector Voltmeter Method

   a. Terminate the voltmeter probe with a 50 Ω feedthrough termination and then connect the terminated probe to the 492/492P CAL OUT connector (Fig. 3-2).

   b. Set the vector voltmeter frequency to 100 MHz.

   c. Check—for an rms reading between 21.11 mV and 22.69 mV (−20 dBm is 22.36 mV rms across 50 Ω).

2. Power Meter Measurement

   a. Test equipment setup is shown in Fig. 3-2.

   b. Connect the power meter sensor through a lowpass filter (⩾40 dB at 200 MHz to remove harmonics of the fundamental) to the CAL OUT connector.

NOTE

Insertion loss of the filter with pads, measured at 100 MHz, must be determined to within ±0.05 dB. To ensure a 50 Ω match, use approximately 3 dB minimum-loss matching pads (attenuator) on both sides of the filter.

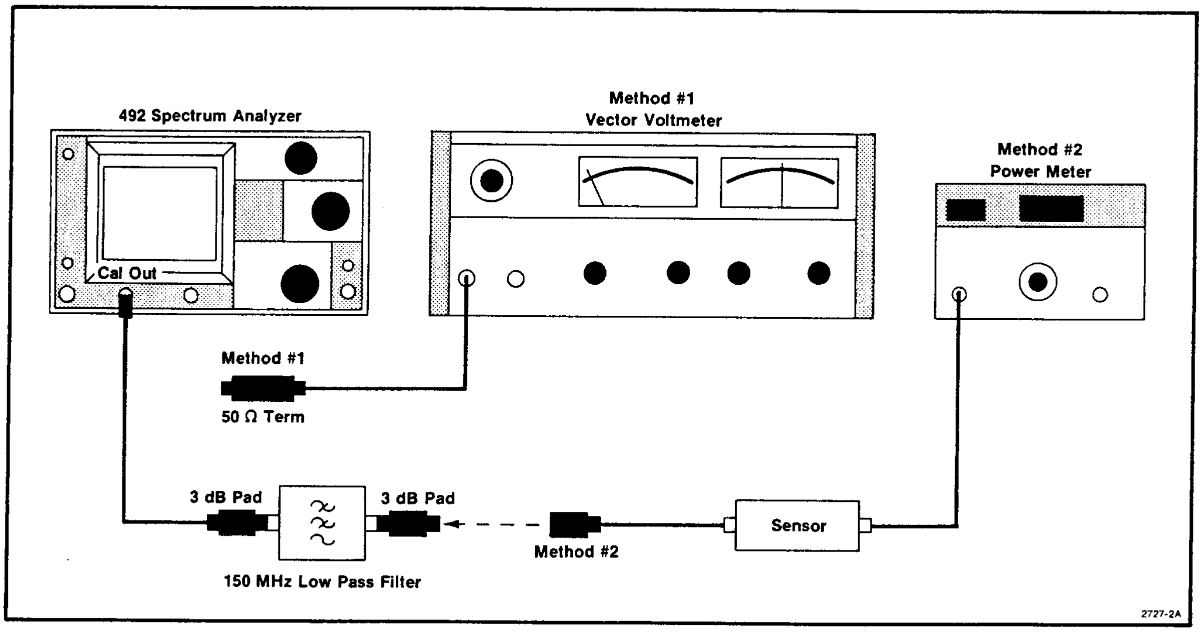


Fig. 3-2. Test equipment setup showing two methods that check calibrator output level.

c. Note the power reading. Reading, plus the loss through the filter and pads, must equal −20 dBm, ±0.3 dB.

3. Signal Substitution Method

NOTE

A power meter is used to verify the output level of the reference signal. Harmonics of the signal source must be greater than 40 dB down.

a. Apply a 100 MHz signal from a signal source (signal generator) through a 3 dB attenuator to the power meter. Adjust the output level for −20.0 dBm reading on the power meter.

b. Set the front-panel controls as follows:

FREQUENCY	100 MHz
FREQ SPAN/DIV	500 kHz
RESOLUTION	1 MHz
REF LEVEL	−10 dBm
TIME/DIV	AUTO
Video Filter	Off
Digital Storage (Option 02)	VIEW A/B
PEAK/AVERAGE	Fully cw

c. Disconnect the meter and (using the same instrument cable and attenuator) apply the calibrated reference signal to the 492/492P RF INPUT.

d. Switch to the 2 dB/DIV display mode and tune the reference signal to center screen. Select a REF LEVEL that positions the top of the signal to a graticule line (2nd or 3rd from the top of the screen). Select a span/div and resolution bandwidth to obtain a broad display for more accurate measurement. If the 492/492P has Option 02, store the reference display by activating SAVE A.

e. Remove the reference signal and apply the CAL OUT signal to the RF INPUT.

f. Note the displacement of the CAL signal from the reference. If the 492/492P has Option 02, activate B−SAVE A and note the displacement between the CAL signal and the reference. Displacement must not exceed 0.3 dB (0.75 minor division with a 2 dB/DIV display mode).

NOTE

If greater accuracy is desired, the vertical signal can be amplified through an external amplifier, such as the TEKTRONIX 7A15, to increase the vertical sensitivity. This is done by applying the veritical signal at the rear panel VERT connector of the 492/492P to the external amplifier input and selecting the vertical amplification and Time/Div values that provide the degree of accuracy desired.

4. Check RF Attenuator (within 0.3 dB/10 dB to a maximum of 0.7 dB over the 60 dB range to 4 GHz; within 0.5 dB/10 dB to a maximum of 1.4 dB over the 60 dB range to 18 GHz)

NOTE

The attenuator is factory checked to ensure accuracy. Any change in characteristics should be large enough to be readily noticed in operation. The Functional Check in the Operators manual provides a good indication of attenuator performance and would detect component failure. External 10 dB, 20 dB, or a 30 dB step attenuator (calibrated by the user or manufacturer to within 0.05 dB) must be used as a standard to check the RF attenuator in this procedure.

a. Test equipment is shown in Fig. 3-3. Apply a 0 dBm, 4 GHz signal, from a signal generator through 30 dB of calibrated attenuation to the RF INPUT of the 492/492P. Set the front panel controls as follows:

FREQUENCY RANGE	Band 3 (3.0—7.1 GHz)
FREQ SPAN/DIV	200 MHz
AUTO RESOLUTION	On
REF LEVEL	−30 dBm
Vertical Display	10 dB/DIV
TIME/DIV	AUTO
PEAKING	Max

b. Tune the signal to center screen as the FREQ SPAN/DIV is reduced to 20 kHz and change the RESOLUTION BANDWIDTH to 100 kHz. Activate the 2 dB/DIV Vertical Display mode and the NARROW Video Filter. Adjust the signal generator output so the signal peak is at some graticule reference level, such as seven divisions. If the instrument has Digital Storage, activate SAVE A.

c. Change the REFERENCE LEVEL 10 dB by switching to −20 dBm (this will add 10 dB of RF ATTENuation).

d. Remove 10 dB of external attenuation and compare the difference between the reference level and the new level.

Variation plus the calibrated 10 dB external attenuator correction factor must not exceed 0.3 dB. (If Digital Storage is provided, activate B−SAVE A to obtain the differential. Deactivate SAVE A and B−SAVE A.)

e. Readjust the signal generator output to establish a new reference level. Repeat the process to check the 20 dB attenuator by switching the REF LEVEL from −30 dBm to −10 dBm for 20 dB ATTEN, then remove 20 dB of external attenuation. Error must not exceed 0.6 dB.

f. Reinstall the 30 dB of external attenuation and set the REF LEVEL to −30 dBm. Re-establish a signal reference level as described above.

g. Check the 30 dB attenuator against the external standard, by switching the REF LEVEL to 0 dBm, for 30 dB RF ATTEN, then remove 30 dB of external attenuation. Error must not exceed 0.7 dB. (Include the calibrated attenuator correction factor.)

h. Since the remaining 60 dB range of the RF ATTENuator is obtained by the combination of these three attenuators, this completes the check of the RF attenuator. Error of any combination must not exceed 0.7 dB.

5. Check IF Gain Accuracy (±0.2 dB/dB and ±0.5 dB/10 dB to a maximum of ±2 dB over the full 90 dB range, 70 dB for a non-Option 03 instrument)

NOTE

This check requires calibrated attenuators as the standard to check the 10 dB and 1 dB steps. When making signal measurements within 10 dB of the noise floor, a correction factor should be used to correct for the logarithmic addition of noise in the system and analyzer, as shown in Table 3-3.

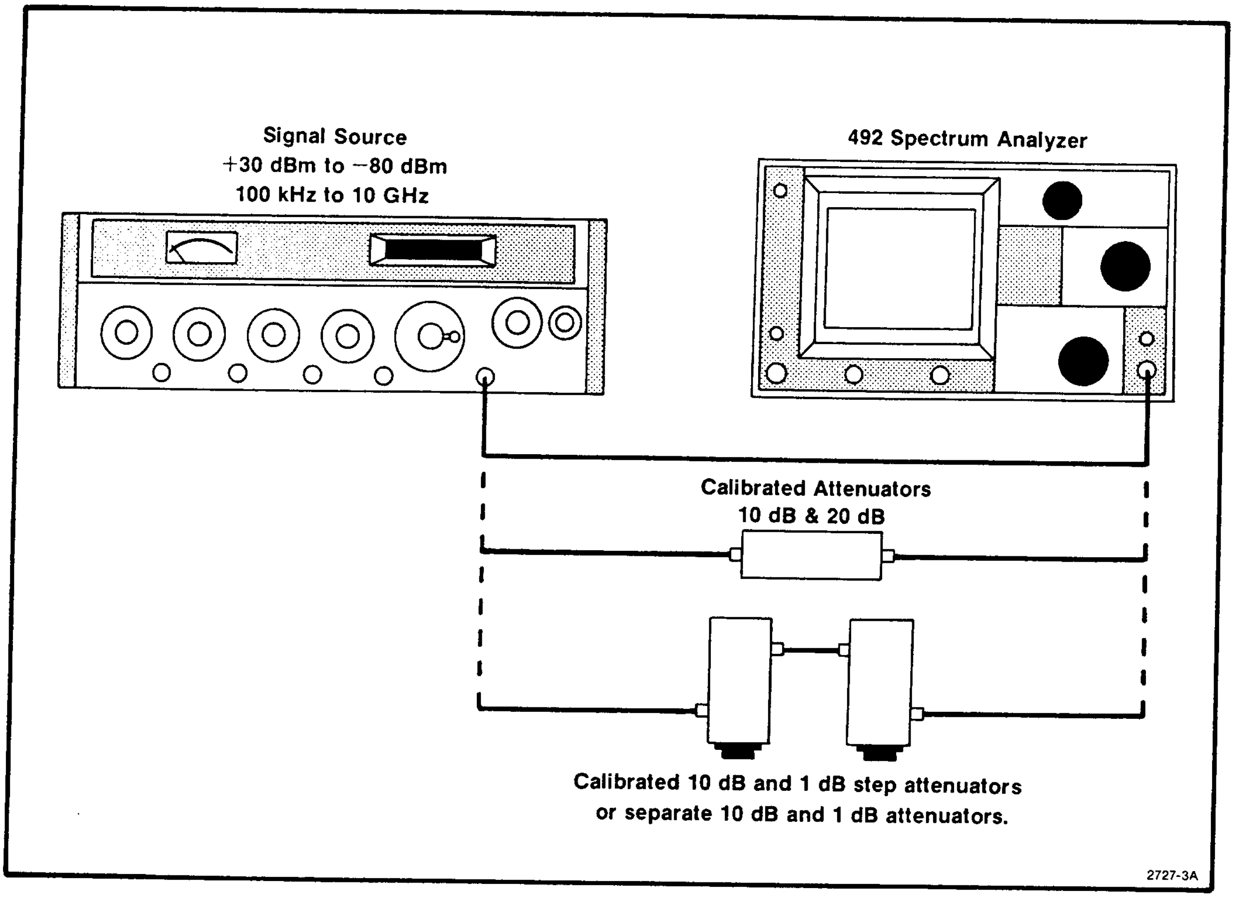


Fig. 3-3. Test equipment setup for verifying attenuator and gain accuracy.

a. Test equipment setup is shown in Fig. 3-3. Apply a −20 dBm, 100 MHz signal, from the signal generator through 10 dB and 1 dB step attenuators (set at 0 dB), to the RF INPUT; or directly to the RF INPUT of the 492/492P if individual fixed attenuators are to be used as the standard. Set the front-panel controls as follows:

FREQ SPAN/DIV	20 MHz
AUTO RESOLUTION	On
Vertical Display	10 dB/DIV
Video Filter	WIDE
REF LEVEL	−10 dBm
MIN RF ATTEN	0 dB

b. Tune the signal to center screen, then decrease the FREQ SPAN/DIV to 10 kHz. Now change the RESOLUTION BANDWIDTH to 10 kHz and again center the signal on screen.

c. Change the Vertical Display to 2 dB/DIV. Adjust the signal generator output so the signal amplitude is six divisions with the top of the signal positioned on the 6th graticule line.

d. Activate MIN NOISE and note signal level shift. Shift must not exceed ±0.8 dB, or 2 minor divisions (attenuator plus gain accuracies).

e. Re-position the signal level to the graticule reference line by adjusting the output of the signal generator.

f. Switch the REF LEVEL from −10 dBm to −20 dBm in 1 dB steps, adding 1 dB of external attenuation at each step and note incremental accuracy and the 10 dB gain accuracy. Incremental accuracy must be within 0.2 dB/dB (0.5 minor division). Maximum cumulative error must not exceed 0.5 dB (1.5 minor divisions) except when stepping from the 9 dB to 10 dB increment, where the error could be an additional 0.5 dB.

g. Deactivate MIN NOISE. Return the 1 dB step attenuator to 0 dB, decrease the signal generator output to 10 dB or add 10 dB of external attenuation with the 10 dB step attenuator. Readjust the generator output so the signal level is again at the reference line (6 division amplitude).

h. Change the REF LEVEL in 1 dB increments from −20 dBm to −30 dBm adding 1 dB increments of external attenuation with the 1 dB step attenuator and note incremental and 10 dB step accuracies.

i. Return the 1 dB step attenuator to 0 dB, decrease signal level 10 dB by adding 10 dB more of external attenuation or decreasing the signal generator output level then re-establish the signal reference amplitude.

j. Check the −30 dBm to −40 dBm gain accuracies as previously described.

k. Repeat the procedure checking gain accuracies to −70 dBm.

l. Establish a signal reference at −70 dBm, activate NARROW VIDEO FILTER, then check gain accuracy to −80 dBm.

m. Limitation to gain variation measurements over the remaining range is imposed by noise and residual FM'ing. Without Option 03 (phaselock stabilization) oscillator FM'ing limits practical gain variation measurements to the 10 kHz resolution bandwidth position which further compounds the measurement problem with a 10 dB higher noise floor than the 1 kHz resolution bandwidth. The gain variation accuracy of the −80 dBm to −100 dBm REF LEVEL positions are closely related to the accuracy of the previous checks; therefore, they are not validated in an instrument without Option 03.

Table 3-3
CORRECTION FACTOR TO DETERMINE TRUE SIGNAL LEVEL

Ratio in dB of signal plus noise—noise	3.01	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0
Subtract this correction factor for true signal level	3.01	2.20	1.65	1.26	0.97	0.75	0.58	0.46	0.28	0.18

If the instrument has Option 03 (phaselock) the 1 kHz resolution bandwidth is utilized. Proceed with the following:

1) decrease the RESOLUTION BANDWIDTH and FREQ SPAN/DIV to 1 kHz and re-establish a signal reference level as described previously;

2) check the −80 to −90 dBm gain accuracies by repeating the process previously described;

3) the remaining 10 dB of gain range cannot be checked accurately because of baseline noise. It is, however, directly related to the −70 dBm to −80 dBm check.

6. Check Display Accuracy and Range (80 dB in 10 dB/DIV mode with an accuracy of 1 dB/10 dB to a maximum cumulative error of ±2.0 dB over the 80 dB window; 16 dB in 2 dB/DIV mode with an accuracy of 0.4 dB/2 dB to a maximum cumulative error of ±1.0 dB over the 16 dB window; Lin mode is ±5%of full scale)

a. Test equipment setup is shown in Fig. 3-3. Apply +10 dBm signal through external attenuators set to 0 dB to the RF INPUT. Set the front-panel controls as follows:

REF LEVEL	+10 dBm
MIN RF ATTEN	0 dB
Video Filter	NARROW
Vertical Display	10 dB/DIV
FREQ SPAN/DIV	10 MHz
RESOLUTION BANDWIDTH	1 MHz

b. Tune the FREQUENCY to center the applied signal on screen. Reduce the FREQ SPAN/DIV and RESOLUTION BANDWIDTH to 10 kHz. Carefully adjust the generator output so the signal level is at the top graticule line.

c. Add external attenuation in 10 dB steps for a total of 80 dB and note that the signal steps down screen in 10 dB (±1.0 dB) steps. Maximum cumulative error should not exceed 2.0 dB over the display window.

d. Return the external attenuation to 0 dB and change the Vertical Display to 2 dB/DIV. Set the FREQ SPAN/DIV to 20 kHz and the RESOLUTION BANDWIDTH to 100 kHz. Adjust the signal amplitude to the top graticule line with the generator output control.

e. Repeat the procedure to check the accuracy of the 2 dB steps by adding external attenuation in 2 dB steps for a total of 16 dB. Deviation should not exceed ±0.4 dB/2 dB. Maximum cumulative deviation should not exceed ±1.0 dB over the 16 dB window.

f. Return the external attenuation to 0 dB. Change the Vertical Display to LIN. Adjust the signal generator output for a full screen display.

g. Add 6 dB of external attenuation. Note that the signal amplitude decreases half screen to 4, ±0.4 divisions.

h. Add an additional 6 dB of attenuation. Note signal amplitude decreases to 2, ±0.4 divisions or half amplitude.

i. Add another 6 dB of attenuation. Signal amplitude should decrease to 1.0, ±0.4 divisions.

j. Return the Vertical Display to 10 dB/DIV and disconnect the signal to the RF Input.

7. Amplitude Variation with Change in Resolution Bandwidth (≤0.5 dB)

a. Apply the calibrator signal to the RF INPUT and set the front-panel controls as follows:

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz Option 01)
FREQUENCY	200 MHz
FREQ SPAN/DIV	20 MHz
RESOLUTION BANDWIDTH	1 MHz
Vertical Display	2 dB/DIV
REF LEVEL	−20 dBm
MIN RF ATTEN	0 dB
PEAK/AVERAGE	AVERAGE

NOTE

If digital storage is used, the PEAK/AVERAGE control must be in the AVERAGE mode to measure amplitudes of the 1 MHz, 100 kHz, and 10 kHz resolution bandwidths and in the PEAK mode to measure the amplitude of the 1 kHz and 100 Hz bandwidths.

b. Tune the 200 MHz calibrator marker to center screen and reduce the FREQ SPAN/DIV to 500 kHz. Activate the FINE REFERENCE LEVEL function and adjust the REF LEVEL for a signal amplitude of six divisions.

c. Change the RESOLUTION BANDWIDTH to 100 kHz and the FREQ SPAN/DIV to 100 kHz. Check that the amplitude change is not more than 0.5 dB.

d. Repeat the procedure for 10 kHz resolution bandwidth with a FREQ SPAN/DIV of 10 kHz.

e. Change the PEAK/AVERAGE control to PEAK mode and repeat the procedure for the 1 kHz resolution bandwidth. (If the instrument has Option 03, reduce the SPAN/DIV to 1 kHz.)

f. If the 492/492P has Option 03, repeat the procedure to check amplitude variation for resolution bandwidths of 100 Hz with a FREQ SPAN/DIV of 500 Hz. (Video Filter must be off to maintain a calibrated display at 100 Hz resolution.)

8. Check Frequency Response (±1.5 dB to 7.1 GHz, Bands 1, 2, and 3; and ±2.5 dB to 18 GHz, Band 4)

Frequency response is the amplitude deviation, over a given frequency range, of a constant level input signal measured at the analyzer center frequency. It includes input attenuation, mixer and preselector (when installed) response, plus mixing mode gain variations (band-to-band). Measurement requires many small incremental checks across the spectrum analyzer frequency range. Response at each check point must be optimized and separated from spurious responses that are prevalent in instruments without the preselector. Those instruments that have the preselector require readjusting the PEAKING control at each check point for frequencies above the range of band 1 (e.g., above 1.7 GHz). Because the frequency range of the 492/492P is very wide, measuring the response in small increments is a slow process. A more expeditious method using a sweep oscillator is described in this procedure.

The procedure for checking frequency response depends on the 492/492P configuration (options installed). Procedures for each configuration are described in four parts. *Refer to the appropriate part of this step to check your instrument.* Test equipment (see Table 3-4) is the same for each procedure. If your instrument is the rackmount version with semi-rigid cables to the back panel (Option 31), frequency response may degrade at the higher frequency end (see Rackmount/Benchtop Version, Section 6 for details).

NOTE

Loss of signal through interconnecting cables becomes significant above 1 GHz; therefore, use short (25 inch or less) semi-rigid cable with precision fittings to interconnect the test equiment. Precision matching terminations and power dividers are used to minimize reflections.

Table 3-4
RECOMMENDED TEST EQUIPMENT

Equipment	Recommended
Signal Generator 10 kHz—10 MHz	HP654
Signal Generator 10 MHz—18.0 GHz	HP8620C Sweeper with 86222B and HP86290A RF Plug-in Units
Power Meter 0 to −10 dBm, 10 MHz—18GHz	HP435A with 8481A and 8482A Sensors
Power Divider	HP1167A
3 dB Attenuator, SMA Connectors	Weinschel Model 4M
High Performance 50 Ω Cable, SMA Connectors	See Equipment Required list
50 Ω Coaxial Cable, BNC Connectors	See Equipment Required list
Adapter N male-to-SMA male	See Equipment Required list

Part 1
Procedure for Instruments Without Options 01 or 02 (Preselector and Digital Storage)

a. Test equipment setup is shown in Fig. 3-4. Set the front-panel controls as follows:

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz Option 01)
FREQ SPAN/DIV	1 MHz
FREQUENCY	5 MHz
MIN RF ATTEN	30 dB
REF LEVEL	0 dBm
AUTO RESOLUTION	On
TIME/DIV	20 ms
Vertical Display	10 dB/DIV

b. Apply the output of a 100 kHz to 10 MHz signal generator, with an output monitor, to the RF INPUT of the 492/492P. Set the generator frequency to 5 MHz and its output for a −6 dBm to −10 dBm signal level.

c. Change the Vertical Display to 2 dB/Div and adjust the 492/492P REF LEVEL so the amplitude of the signal generator signal is about half screen.

d. Slowly tune the frequency of the signal generator across the 100 kHz to 10 MHz span, monitoring the output with the power meter to ensure a constant input signal level, and note amplitude variations. Response or variations must not deviate more than ±1.5 dB from the mean.

e. Remove the 10 kHz to 10 MHz signal source and connect the output of a 0.01 to 2.4 GHz generator to the RF INPUT (see Fig. 3-5). The output of the sweep generator is applied through a 3 dB attenuator and a semi-rigid high performance coaxial cable to a power divider. Connect one output of the power divider directly to the 492/492P RF INPUT and the other to the power sensor unit for the power meter. Ensure that all connections are snug.

f. With the FREQ SPAN/DIV at 200 MHz, tune the FREQUENCY to approximately 1.0 GHz. Adjust the generator cw frequency to 1.0 GHz and adjust the output for −6 dBm reading on the power meter.

g. With the Vertical Display at 2 dB/DIV, adjust the REF LEVEL so the amplitude of the signal is about half screen.

h. Set the sweep generator span so it sweeps from 0.01 to 2.2 GHz. Set the generator sweep mode for automatic internal sweep at its slowest sweep time (100 s). Monitor the power output as the generator sweeps across the span to ensure that the output remains constant. The frequency response (deviation from the mean) must not exceed ±1.5 dB. A typical response for the frequency range of 3.6 to 5.6 GHz is shown in Fig. 3-6.

NOTE

If any part of the span is not within specification, tune to the center of the respective section and decrease the FREQ SPAN/DIV to display that portion. Decrease the sweep of the sweep oscillator accordingly and check flatness for the narrower portion. It may be necessary to tune the center frequency across the respective span in small increments, measuring response at each point to verify response flatness.

i. Increase the FREQUENCY RANGE to band 2 (1.7—5.5 GHz). Tune the FREQUENCY to approximately

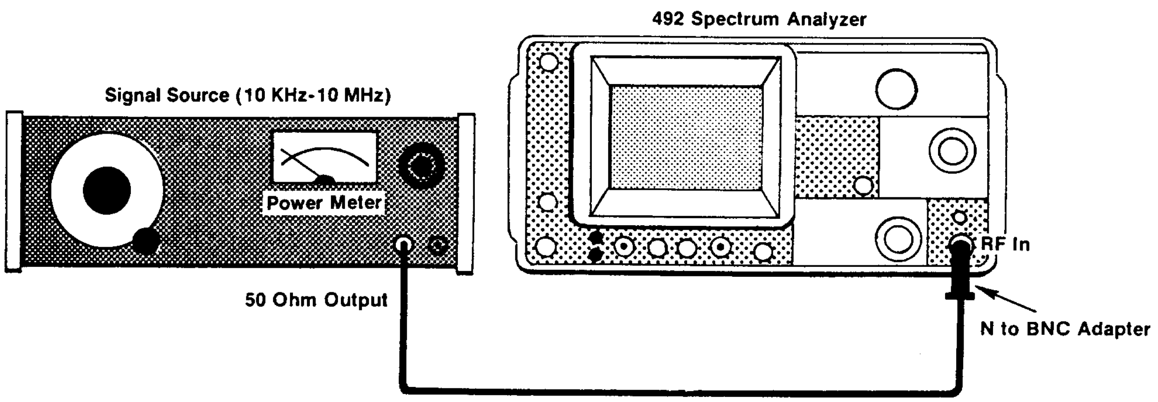


Fig. 3-4. Test equipment setup for checking the 10 kHz—10 MHz frequency response.

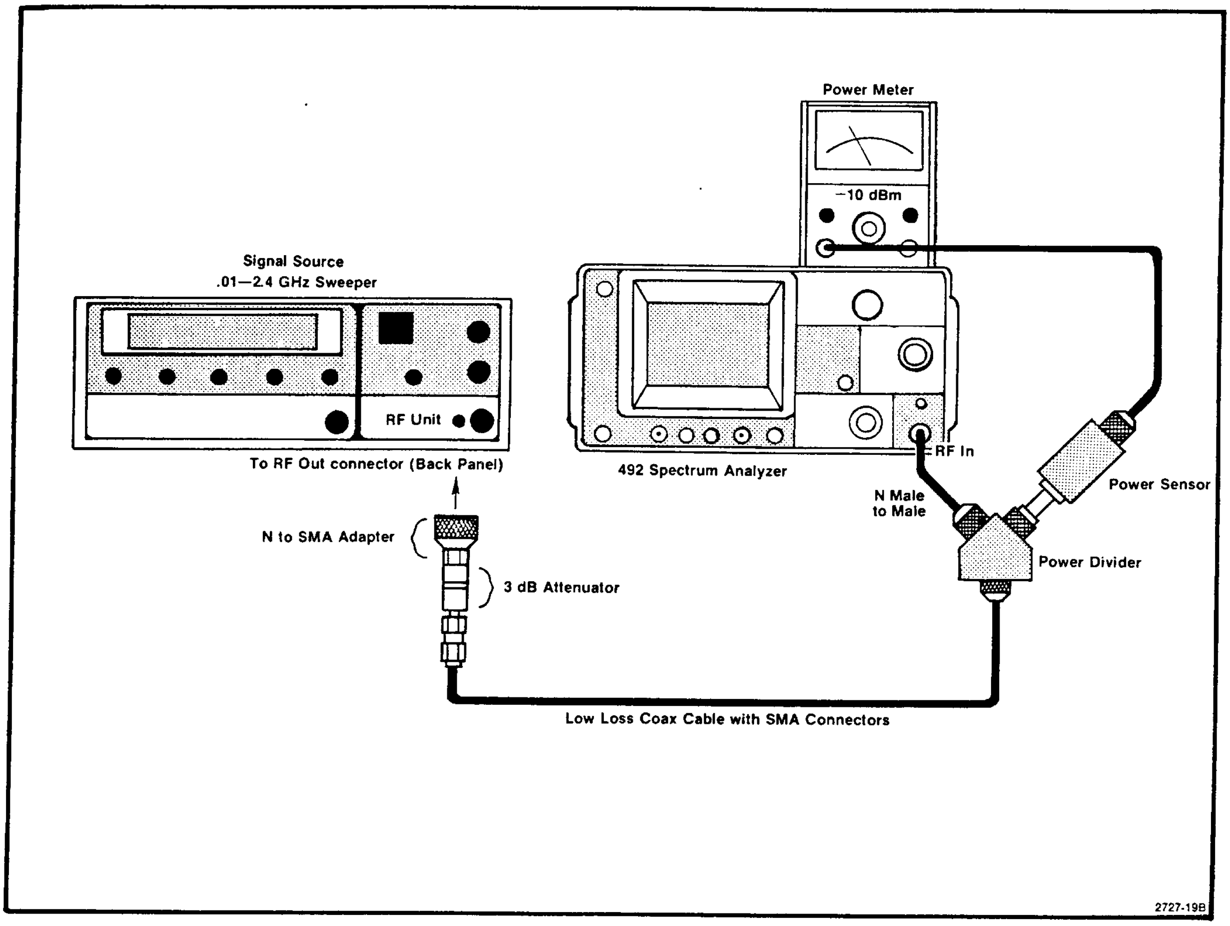


Fig. 3-5. Test equipment setup for measuring the 0.01—2.0 GHz frequency response.

2.0 GHz and set the FREQ SPAN/DIV to 100 MHz. For bands 2, 3, and 4, it is less confusing and easier to check frequency response in 1 GHz increments. The sweep generator start and stop range can be set for 1.6 to 2.4 GHz and the 492/492P FREQUENCY to 2.0 GHz for the first check.

j. Check the frequency response for the 1.7 to 2.4 GHz portion of band 2. Amplitude deviation, from a mean average, must not exceed ±1.5 dB.

k. Replace the 0.01 to 2.4 GHz sweep source with a 2.0 to 18 GHz sweep oscillator. Connect the test equipment as shown in Fig. 3-7. Switch the RF plug-in ALC to Mtr. Connect a coaxial cable between the Recorder Output of the power meter and the RF plug-in Ext ALC Input. Decrease the Power Level to approximately −6 dBm and adjust the Gain for stable operation (output stops oscillating).

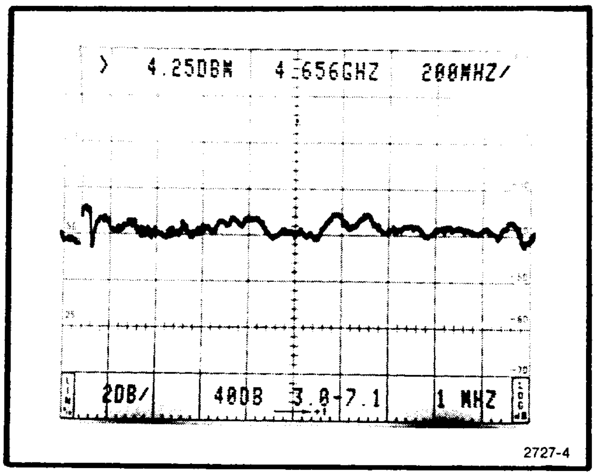


Fig. 3-6. Typical display showing frequency response from a sweeping signal source.

l. Tune the 492/492P FREQUENCY to 3.0 GHz. Apply a cw marker of 3.0 GHz to the 492/492P input. Re-establish a signal amplitude of approximately half screen. Switch the Marker Sweeper on, then sweep the 2.5 to 3.5 GHz portion of band 2.

m. Check and note the frequency response of this portion.

n. Increase the center FREQUENCY to 4.0 GHz and the sweep generator span range from 3.5 to 4.5 GHz. Check the next segment of the band 2 range.

o. Increase the sweep generator and 492/492P center FREQUENCY to the next 1 GHz segment and check frequency response for the upper portion of band 2.

p. Return the 492/492P FREQUENCY RANGE to band 1 and the FREQ SPAN/DIV to 200 MHz.

q. Using the above procedure, check the frequency response of the upper portion of band 1. (Image response for band 1 is 4 GHz from the true signal; therefore, a wider span can be used without interference from the image.)

r. Switch the 492/492P FREQUENCY RANGE to band 3 (3.0 to 7.1 GHz). Tune the center FREQUENCY to 3.5 GHz and reduce the FREQ SPAN/DIV to 100 MHz. Set the sweep generator for a sweep output from 3.0 to 4.0 GHz.

s. Repeat the procedure, in 1 GHz increments, to check the frequency response for band 3, then check the remaining bands to 21.0 GHz. Frequency response in band 4 (7.1—18 GHz) is ±2.5 dB and ±3.5 dB for band 5 (15—21.0 GHz).

t. Procedure for checking frequency response, when using external mixers, is provided in the respective mixer instruction sheet.

Part 2
Procedure for Instruments with Digital Storage (Option 02)

The frequency response check for instruments with Digital Storage is the same as the procedure for Part 1 with the additional feature of a stored display. Activate VIEW B, SAVE A, and MAX HOLD. This will provide a stored display of the frequency response as the frequency range is swept. Between steps, MAX HOLD must be deactivated and reactivated to clear storage for each sweep.

Part 3
Procedure for Instruments with Preselector (Option 01)

a. Test equipment setup is the same as the Part 1 procedure (Figs. 3-4 through 3-6). Set the front-panel controls as follows:

FREQUENCY RANGE	Band 1 (0—1.8 GHz)
FREQUENCY	5 MHz
FREQ SPAN/DIV	1 MHz
MIN RF ATTEN	30 dB
REF LEVEL	0 dBm
AUTO RESOLUTION	On
TIME/DIV	20 ms
Vertical Display	2 dB/DIV

b. Apply the output of a constant level and calibrated 100 kHz to 10 MHz signal generator to the RF INPUT of the 492/492P. Set the generator frequency to 100 kHz and its output for about −10 dBm.

c. Adjust the REF LEVEL so the amplitude of the 100 kHz signal is about half screen, in the 2 dB/DIV mode.

d. Slowly tune the frequency of the signal generator from 100 kHz to 10 MHz, monitoring the output to ensure it remains constant. Note the frequency response (amplitude deviation above and below the average). Frequency response or amplitude deviation must not exceed ±1.5 dB. (See Fig. 3-6 for the average level.)

e. Replace the 100 kHz to 10 MHz signal source with a 0.01 to 2.4 GHz sweep oscillator and connect the test equipment as shown in Fig. 3-5. The output of the sweep generator is applied through a 3 dB attenuator and high performance coaxial cable to a power divider. Connect one output of the power divider directly to the RF INPUT and the other output to the sensor for the power meter.

f. Change the FREQ SPAN/DIV to 200 MHz and tune the FREQUENCY to approximately 1.0 GHz. On the sweep generator, select a 1 GHz cw marker and adjust the output for about −6 dBm reading on the power meter. With the 492/492P Vertical Display in the 2 dB/DIV mode, adjust the REF LEVEL so the signal amplitude is about half screen.

g. Change the sweep generator sweep mode to automatic internal sweep and set the sweep time to 100 s for its slowest sweep time.

h. Check the frequency response as the sweep generator scans across the 10 MHz to 2 GHz span. Deviation must not exceed ±1.5 dB. (See Fig. 3-6.)

i. Change the FREQUENCY RANGE to band 2 (1.7 to 5.5 GHz) and tune the FREQUENCY to about 2.0 GHz. Set the FREQ SPAN/DIV to 100 MHz, switch the sweep generator cw marker on and set it to 2.0 GHz. Adjust the 492/492P PEAKING control for maximum signal amplitude.

j. Return the sweep generator to its sweep mode and set the Start/Stop markers for 1.5 and 2.5 GHz. Sweep the 1.7 to 2.5 GHz span for band 2 and note the frequency response. Frequency response or deviation must not exceed ±2.5 dB.

NOTE

If any segment or portion of the span fails to meet the ±2.5 dB specification, tune the 492/492P FREQUENCY to the center of this portion, apply a cw marker at the center frequency and readjust the PEAKING for maximum response. Decrease the FREQ SPAN/DIV to display that portion and then recheck frequency response.

k. Replace the 0.01 to 2.4 GHz sweep source with a 2 to 18 GHz sweep oscillator. Connect the test equipment as shown in Fig. 3-7. On the RF plug-in, switch the ALC to Mtr position and connect a coaxial cable between the Recorder Output of the power meter and the Ext ALC Input of the plug-in unit. Decrease the Power Level to approximately −6 dBm; then adjust the Gain for stable operation (output stops oscillating).

l. Set the FREQ SPAN/DIV to 200 MHz and tune the FREQUENCY to 4.0 GHz. Repeat the PEAKING procedure with a 4.0 GHz marker and then sweep the upper portion of band 2 checking frequency response. If necessary, recheck those portions that do not meet specification after the PEAKING control has been adjusted for that frequency portion.

m. Increase the FREQUENCY RANGE to band 3 (3.0 to 7.1 GHz). Tune the center FREQUENCY to approximately 5.0 GHz. Apply a cw marker of 5.0 GHz, so the PEAKING

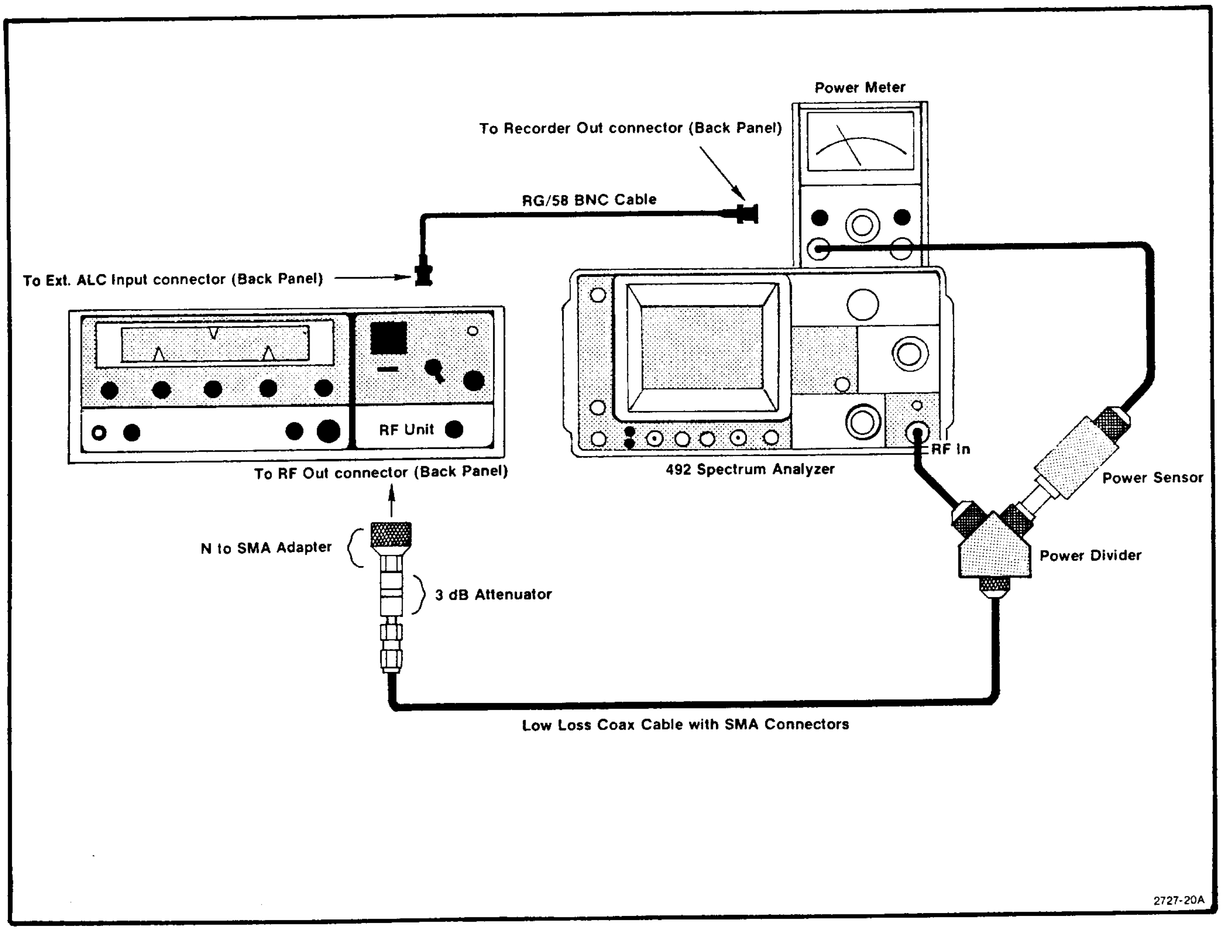


Fig. 3-7. Test equipment setup for measuring 2.0—18.0 GHz frequency response.

can be adjusted, and then return the FREQ SPAN/DIV to MAX. Sweep the 3.0 to 7.1 GHz frequency range of band 3, checking frequency response. It may be necessary to check frequency response in smaller segments, with PEAKING adjusted for the shorter spans, if the response does not meet the ±2.5 dB specification.

n. Repeat the foregoing procedure to check the response of the remaining bands to 21 GHz. Frequency response for band 4 (5.4—18 GHz) is ±3.5 dB and ±5.0 dB for band 5 (15.0—21.0 GHz).

Part 4
Procedure for Instruments with Preselector and Digital Storage (Options 01 and 02)

The procedure is the same as the procedure in Part 3 with the additional feature of storage. Activate VIEW B, SAVE A, MAX HOLD and deactivate VIEW A. MAX HOLD must be reactivated for each sweep to update data stored for each sweep.

9. Check Preselector Ultimate Rejection (Option 01)

a. Apply a 3.5 GHz, −30 dBm, signal from a signal generator to the RF INPUT. Set the front-panel controls as follows:

FREQUENCY RANGE	Band 2 (1.7—5.5 GHz)
FREQ SPAN/DIV	1 MHz
AUTO RESOLUTION	On
Vertical Display	10 dB/DIV
REF LEVEL	−30 dBm
MIN RF ATTEN	0 dB
TIME/DIV	AUTO
Digital Storage (Option 02)	VIEW A/VIEW B
Video Filter	WIDE

b. Tune the FREQUENCY to center the 3.5 GHz signal on screen and then reduce the FREQ SPAN/DIV to 10 kHz. Keep the signal centered on screen as the span is reduced. Adjust the signal generator output for a full screen display, adjusting PEAKING to maximize the signal amplitude.

c. Change the FREQUENCY to band 3 (3.0—7.1 GHz).

d. Check for any spurious response on the display. Any signal feedthrough must be down 70 dB or more from the level established in part b of this step. If this condition is not met, it is a good indication the YIG-tuned filter should be replaced.

10. Check Frequency Span/Div Accuracy (±5% of the selected span/div)

Span accuracy is checked by noting the displacement of calibrated markers from their respective graticule line over the center eight divisions of the screen. Range is in a 5-10-20 sequence and depends on the frequency band and option as shown in Table 3-5. The frequency span/div accuracy is checked for all FREQ SPAN/DIV settings on band 1 and at 500 MHz/Div on band 4.

Table 3-5
NARROW AND WIDE SPANS vs FREQUENCY BAND

Band	Narrow Span		Wide Span
	Standard	Option 03	All Instruments
1—3	10 kHz/Div	500 Hz/Div	200 MHz/Div
4—5	50 kHzDiv	500 Hz/Div	500 MHz/Div
6	50 kHz/Div	500 Hz/Div	1 GHz/Div
7—8	100 kHzDiv	500 Hz/Div	2 GHz/Div
9	200 kHz/Div	500 Hz/Div	2 GHz/Div
10	500 kHz/Div	500 Hz/Div	5 GHz/Div
11	500 kHz/Div	500 Hz/Div	10 GHz/Div

Accuracy: Within 5% of selected span/Div over center 8 divisions of display

a. Set the front-panel controls as follows:

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz Option 01)
RESOLUTION BANDWIDTH	1 MHz
FREQ SPAN/DIV	200 MHz
TIME/DIV	.1 s
Vertical Display	10 dB/DIV
REF LEVEL	−30 dBm
MIN RF ATTEN	0 dB
Digital Storage (Option 02)	VIEW A/VIEW B

b. Connect the CAL OUT to the RF INPUT and adjust the FREQUENCY to align the 100 MHz markers so the 200 MHz/div accuracy can be measured over the center eight divisions of the display (two markers per division). It may be necessary to change the REF LEVEL to obtain adequate markers. Maximum deviation must not exceed 10 MHz/div (0.25 minor divisions).

c. Change the FREQ SPAN/DIV to 100 MHz and check the span/div accuracy. Error must not exceed 5% of the span/div or 5 MHz/div.

RF ATTEN to 10 dB. Remove the RF INPUT and apply the microwave as shown in Fig. 3-8. Change to band 4 and switch the FREQ SPAN/DIV to /492P has Option 01, adjust the aximum marker amplitude. It may be just the FREQUENCY for best marker

ker to center screen then check the accu- ht divisions of the display. Deviation Hz/div.

z, and 10 GHz SPAN/DIV selections cannot be checked; however, their tly related to the 100 MHz and 200 MHz

FREQUENCY RANGE to band 1 GHz Option 01). Re-establish a REF and tune the FREQUENCY to the SPAN/DIV to 50 MHz and select a NDWIDTH of 1 MHz.

h. Remove the comb generator from the RF INPUT and connect the Marker Output of the time mark generator to the RF INPUT. Set the FREQ SPAN/DIV to 50 MHz, and apply 20 ns time markers to the 492/492P input.

i. Tune toward the lower frequency end of the band until 50 MHz markers are displayed over the center eight divisions (10 MHz markers will appear between each 50 MHz marker).

j. Check the accuracy of the 50 MHz/div span.

k. Reduce the FREQ SPAN/DIV to 20 MHz and apply 50 ns (20 MHz) markers. Check the span/div accuracy.

l. Change the RESOLUTION BANDWIDTH to 10 kHz, then repeat this procedure to check the FREQ SPAN/DIV accuracy from 10 MHz down to 1 MHz, using Table 3-6 as a guide to relate time markers to frequency span/div settings.

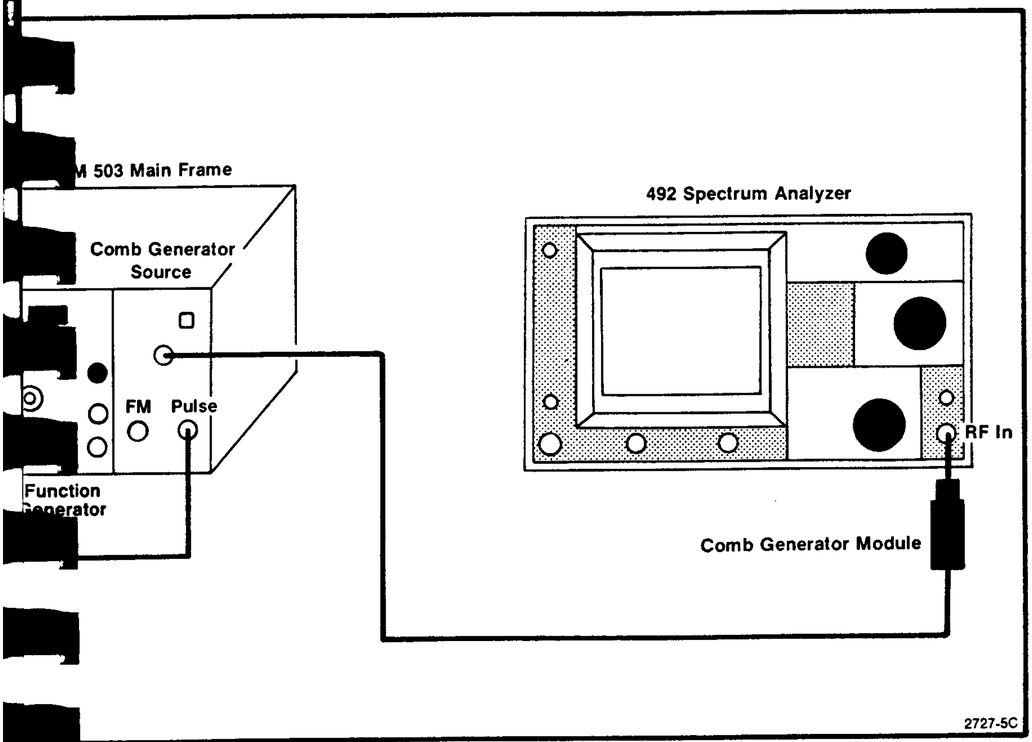


Fig. 3-8. Test equipment setup for checking span and timing accuracy.

Table 3-6
SPAN/DIV vs TIME MARKERS

FREQUENCY SPAN/DIV	Time Mark Generator Marker Output
20 MHz	50 ns
10 MHz	.1 μs
5 MHz	.2 μs
2 MHz	.5 μs
1 MHz	1 μs
500 kHz	2 μs
200 kHz	5 μs
100 kHz	10 μs
50 kHz	20 μs
20 kHz	50 μs
10 kHz	.1 ms
5 kHz	.2 ms (Option 03)
2 kHz	.5 ms (Option 03)
1 kHz	1 ms (Option 03)
500 Hz	2 ms (Option 03)

m. Remove the time mark generator signal and reconnect the comb generator to the RF INPUT. Modulate the 500 MHz comb generator with 2 μs (500 kHz) markers by applying the Marker Output to the Pulse Input of the comb generator. Change the REF LEVEL to −20 dBm and tune the FREQUENCY toward 500 MHz until 500 kHz markers are displayed over the center eight divisions of display.

n. Check the 500 kHz/div span accuracy.

o. Reduce the RESOLUTION BANDWIDTH to 1 kHz, then reduce the FREQ SPAN/DIV setting and time marks (see Table 3-6) to check the accuracy for the 50 kHz through 10 kHz FREQ SPAN/DIV selections.

p. For Option 03 instruments, reduce the RESOLUTION BANDWIDTH to 100 Hz and set the TIME/DIV to 50 ms. Check the 5 kHz through 500 Hz FREQ SPAN/DIV accuracy. (This procedure will not yield the best amplitude display but it will produce a readable frequency display.)

11. Check Time/Div Accuracy (accuracy within 5% of time selected)

a. Test equipment setup is the same as that required for step 10.

b. Apply the Marker Output from the time mark generator directly to the RF INPUT and the Trigger output to the 492/492P EXT TRIG connector on the back panel. Set the controls as follows:

FREQUENCY	≈1 MHz
FREQ SPAN/DIV	100 kHz
RESOLUTION BANDWIDTH	10 kHz
REF LEVEL	−20 dBm
TIME/DIV	50 ms
Triggering	EXT
Min RF ATTEN	20 dB

c. Apply 50 ms time markers. Tune the FREQUENCY toward 0 Hz as the FREQ SPAN/DIV is reduced to zero, so time markers are displayed on the time domain display (see Fig. 3-9). Adjust FREQUENCY if necessary.

d. Use the horizontal position control to align a marker on the 1st graticule line; then check the displacement of markers from their respective positions over the center eight divisions. Individual marker displacement must not exceed 5% or 2 minor divisions.

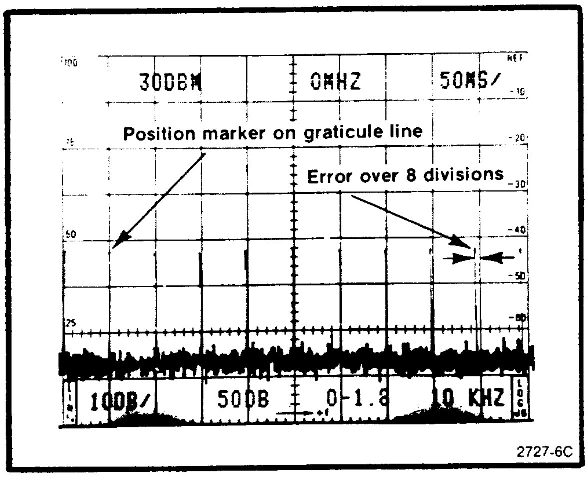


Fig. 3-9. Display to illustrate how timing accuracy is checked.

e. Check the accuracy of the 50 ms to 2 ms TIME/DIV settings by applying appropriate markers for each setting and note the displacement as described in part d of this step.

f. If the instrument has Digital Storage, deactivate the Digital Storage. Change the RESOLUTION BANDWIDTH to 1 MHz and adjust FREQUENCY for a satisfactory display of the time markers. Check the accuracy of the 1 ms and 20 μs TIME/DIV selections.

g. Remove the time mark generator output to the RF INPUT and EXT TRIG input of the 492/492P. Connect the comb generator 500 MHz signal to the RF INPUT and modulate the comb generator with .1 s markers by applying the marker output from the time mark generator to the Pulse input of the comb generator.

h. Set the TIME/DIV to .1 s and activate INT Triggering. Change the FREQ SPAN/DIV to 50 MHz and adjust the FREQUENCY to center the 500 MHz comb signal. If the instrument has Digital Storage, activate VIEW A, VIEW B.

i. Change the REF LEVEL to −30 dBm, then reduce the RESOLUTION BANDWIDTH to 1 kHz and the FREQ SPAN/DIV to 100 kHz while adjusting the FREQUENCY to optimize time markers on the display. Reduce the FREQ SPAN/DIV to zero.

j. Check the accuracy of the .1 s to 5 s sweep rates by applying appropriate markers to modulate the comb generator signal as the TIME/DIV selector is changed over this range.

12. Check Pulse Stretcher

a. Apply 1 ms time marks from the time mark generator to the RF INPUT of the 492/492P. Set the TIME/DIV to 500 μs, RESOLUTION BANDWIDTH to 1 MHz, Vertical Display to 2 dB/DIV, and REFERENCE LEVEL to −10 dBm.

b. Tune the FREQUENCY to approximately 0 MHz so the amplitude of the markers is near full screen. If necessary, change REF LEVEL. Set Digital Storage off, and SPAN/DIV to ZERO.

c. Activate PULSE STRETCHER and check that it extends the fall time of the markers.

13. Check Resolution Bandwidth and Shape Factor (bandwidth within 20% of that selected, shape factor 7.5:1 or less)

a. Apply the CAL OUT signal to the RF INPUT. Set the front-panel controls as follows:

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz, Option 01)
FREQUENCY	100 MHz
REF LEVEL	−20 dBm
Vertical Display	2 dB/DIV
FREQ SPAN/DIV	500 kHz
RESOLUTION BANDWIDTH	1 MHz
PEAK/AVERAGE	Fully cw
Digital Storage (Option 02)	VIEW A/VIEW B
TIME/DIV	AUTO
MIN NOISE	On

b. Adjust the FREQUENCY to center the calibrator signal on screen and measure the −6 dB bandwidth (see Fig. 3-10A). Bandwidth must equal 1 MHz ±200 kHz.

c. Change the Vertical Display mode to 10 dB/DIV.

d. Estimate the −60 dB bandwidth (see Fig. 3-10B). Calculate the shape factor (60/6 dB bandwidth ratio). Shape factor should equal 7.5:1 or less.

e. Switch the RESOLUTION BANDWIDTH to 100 kHz and the FREQ SPAN/DIV to 100 kHz. Check the bandwidth and shape factor of the 100 kHz filter by repeating the foregoing procedure.

f. Check the resolution bandwidth and shape factor for the remaining RESOLUTION BANDWIDTH selections. Decrease the FREQ SPAN/DIV as necessary to check each selection. Bandwidth must be within 20% of the bandwidth selected and the shape factor 7.5:1 or less.

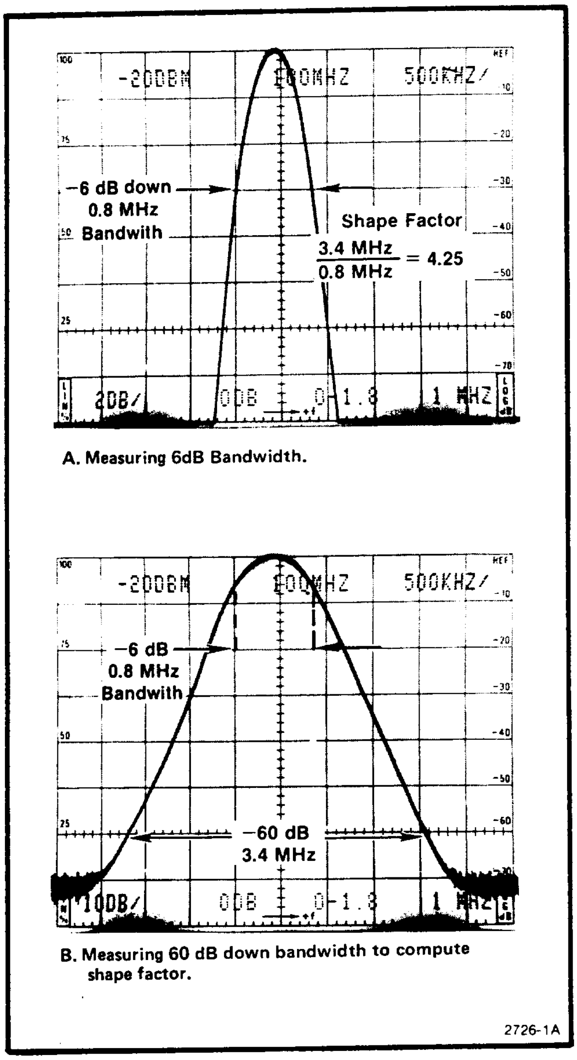
g. Deactivate MIN NOISE.

Alternate Procedure for Checking 100 Hz Bandwidth

The 2nd LO drift characteristics of some instruments may make the above procedure impractical for measuring bandwidth and shape factor at the 100 Hz Resolution Bandwidth selection. The following is an alternate procedure.

a. Turn POWER off. Set the instrument on its face and remove the power cord. Then, remove the cover to gain access to the interior of the instrument.

b. Disconnect P693 (input to VR#1 module, see Fig. 3-44). Apply a 10 MHz, −35 dBm signal, from a high resolution readout signal generator such as the HP 8640A/B, through the appropriate adapter cables to J693. (A TEKTRONIX DC 508 Digital Counter and a 10 MHz signal source may be used if the HP 8640A/B is not available.)



A. Measuring 6dB Bandwidth.

B. Measuring 60 dB down bandwidth to compute shape factor.

2726-1A

Fig. 3-10. Measuring resolution bandwidth and shape factor.

c. Reconnect the instrument to a power source and turn the POWER on. With a 10 MHz, −35 dBm signal applied to the VR input, a trace should be displayed near the reference line at the top of the graticule.

d. Vary the signal generator frequency above and below 10 MHz to find the frequency setting that causes maximum vertical deflection of the trace. This setting is referred to as reference-frequency. Adjust the generator output power to align the trace on the top graticule line.

e. Vary the generator frequency below the reference sufficiently to move the trace down screen 60 dB and note the generator frequency. Now, change the generator frequency to a setting above the reference that is sufficient to move the trace down 60 dB and note that generator frequency. The frequency change between 60 dB down points is the 60 dB bandwidth.

f. Adjust the generator frequency for full scale deflection; then activate 2 dB/DIV display mode. Insure that the trace is at the reference line.

g. Use the procedure described in part e to determine the 6 dB bandwidth.

h. Calculate the shape factor as described in the main procedure.

i. Turn POWER off and replace P693 on J693. Then, replace the instrument cover and turn POWER on to continue with the next step.

14. Check Sensitivity (Table 3-7 or Table 3-8)

NOTE

Sensitivity is specified according to the input or average noise level. The 492/492P calibrator is the reference used to calibrate the display.

a. Set the front-panel controls as follows:

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz, Option 01)
FREQUENCY	Within Band 1 (≈500 MHz)
Vertical Display	10 dB/DIV
MIN RF ATTEN	0 dB

REF LEVEL	−20 dBm
FREQ SPAN/DIV	10 kHz
RESOLUTION BANDWIDTH	1 MHz
Video Filter	WIDE
TIME/DIV	0.5 s
Digital Storage (Option 02)	VIEW A/VIEW B
PEAK/AVERAGE cursor	Top of screen (control fully cw)

b. Calibrate the reference level and display range as per Operating Instructions; then disconnect the calibrator signal from the RF INPUT. Change the REF LEVEL to −30 dBm.

c. Check the noise level below the −30 dBm reference level. Noise level must be −85 dBm or better (−80 dBm if your instrument has Option 01).

d. Check the noise level for 100 kHz and 10 kHz resolution bandwidths. Compare this level with characteristics listed in Table 3-7 or Table 3-8.

e. Change the REF LEVEL to −60 dBm and reduce TIME/DIV to 2 s.

f. Check the average noise level for 1 kHz resolution bandwidth against that listed in Table 3-7 or Table 3-8.

g. Repeat this procedure for the remaining coaxial input frequency range (100 kHz—21 GHz).

NOTE

On instruments without Digital Storage, it may be desirable with some RESOLUTION BANDWIDTH and REF LEVEL settings to activate the NARROW Video Filter. This procedure may be used to check sensitivity characteristics for optional external waveguide mixers if an accurate signal source has been used to establish the reference level.

Table 3-7
492/492P SENSITIVITY

Frequency Range	Resolution Bandwidth				Option 03
	1 MHz	100 kHz	10 kHz	1 kHz	100 Hz
50 kHz—7.1 GHz (Bands 1—3)	−85	−95	−105	−115	−123
5.4—18.0 GHz (Band 4)	−70	−80	−90	−100	−108
15.0—21.0 GHz (Band 5)	−65	−75	−85	−95	−103
18.0—26.5 GHz (Band 6)[a]	−70	−80	−90	−100	−108
26.5—40.0 GHz (Band 7)[a]	−65	−75	−85	−95	−103
40.0—60 GHz (Band 8)[a]	−65	−75	−85	−95	−103
60—90 GHz (Band 9)	Typically −95 dBm, 1 kHz resolution bandwidth degrading to −85 dBm at 90 GHz				
90—140 GHz (Band 10)	Typically −85 dBm, 1 kHz resolution bandwidth degrading to −75 dBm at 140 GHz				
140—220 GHz (Band 11)	Depends on mixer				

[a]High performance Tektronix Waveguide mixers.

Table 3-8
492/492P (Option 01) SENSITIVITY

Average Noise Level dBm (Max)

Frequency Range	Resolution Bandwidth 1 MHz	100 kHz	10 kHz	1 kHz	Option 03 100 Hz
50 kHz—7.1 GHz (Bands 1—3)	−80	−90	−100	−110	−118
5.4—18.0 GHz (Band 4)	−65	−75	−85	−95	−103
12.0—18 GHz (Band 4)	−60	−70	−80	−90	−108
15.0—21.0 GHz (Band 5)	−55	−65	−75	−85	−93
18.0—26.5 GHz (Band 6)[a]	−70	−80	−90	−100	−108
26.5—40.0 GHz (Band 7)[a]	−65	−75	−85	−95	−103
40.0—60 GHz (Band 8)[a]	−65	−75	−85	−95	−103
60—90 GHz (Band 9)	Typically −95 dBm, 1 kHz resolution bandwidth degrading to −85 dBm at 90 GHz				
90—140 GHz (Band 10)	Typically −95 dBm, 1 kHz resolution bandwidth degrading to −75 dBm at 140 GHz				
140—220 GHz (Band 11)	Depends on mixer				

[a]High performance Tektronix Waveguide mixers.

15. Frequency Drift (without phaselock—Option 03—and after a 2 hour warm up and stable ambient temperature, ≤200 kHz/hour; with phaselock and below serial # B040000, after a 2 hour warm up, ≤25 kHz/hour; with phaselock and serial # B040000 and up, ≤15 kHz/10 minutes after a 30 minute warm up; and ≤3 kHz/10 minutes after 1 hour warm up) and at a stable ambient temperature.

NOTE

This measurement and residual FM are dependent on oscillator stability. Therefore the instrument must have the specified warmup period and remain at a stable ambient temperature before checking. A restabilization time of 10 minutes per GHz of frequency change after the center frequency is retuned must be allowed for instruments that do not have phaselock—Option 03.

a. Select a Vertical Display of 10 dB/DIV, REF LEVEL −20 dBm, FREQUENCY RANGE 0—4.2 GHz (0—1.8 GHz Option 01), FREQ SPAN/DIV of 10 MHz, TIME/DIV at AUTO, and activate AUTO RESOLUTION.

b. Connect the CAL OUT signal to the RF INPUT. Tune one of the calibrator markers to center screen. Reduce span to 1 MHz/div and press the DEGAUSS button to remove any residual magnetism as the signal is centered and the FREQ SPAN/DIV is reduced. Allow 10 minutes or more of restabilization time for each GHz of frequency change before proceeding with this measurement for non-option instruments.

c. Adjust REF LEVEL for signal amplitude of seven divisions. Decrease the FREQ SPAN/DIV to 50 kHz keeping the signal centered as necessary with the FREQUENCY control.

d. If the instrument has Digital Storage (Option 02), activate VIEW A, VIEW B, and MAX HOLD.

e. Check the signal stability or drift over the specified time period. If the instrument has Digital Storage, drift will appear as the width of the response less the resolution bandwidth (see Fig. 3-11) after specified time period.

f. If the instrument has phaselock, activate PHASE LOCK and decrease the FREQ SPAN/DIV to 10 kHz (2 kHz for instruments with the phaselocked 2nd LO, B040000 and up).

g. Repeat parts d and e of this step to check stability.

16. Check Residual FM (within 1 kHz for 20 ms without phaselock, and within 50 Hz for 20 ms with Option 03 phaselock)

a. Set the FREQUENCY RANGE to band 1 (0—4.2 GHz or 0—1.8 GHz Option 01). If the 492/492P has phaselock, cancel PHASE LOCK and center the calibrator signal with the FREQUENCY control. (Increase FREQ SPAN/DIV to locate signal if off screen, then return to 10 kHz/div.)

b. Set RESOLUTION BANDWIDTH to 10 kHz and the Vertical Display to LIN. Activate FINE and adjust REF LEVEL for a full screen display.

c. Position the marker signal with the FREQUENCY control so the slope (horizontal versus vertical excursion) of the response can be measured as illustrated in Fig. 3-12A. SINGLE SWEEP may be advantageous to freeze the display if the instrument has Digital Storage.

d. Switch FREQ SPAN/DIV to zero (time domain), TIME/DIV to 20 ms, and adjust FREQUENCY to position the display near center screen as shown in Fig. 3-12B. Note the peak-to-peak amplitude of the display within any horizontal division, scaling the vertical deflections according to the slope estimated in part c. Residual FM must not exceed 1 kHz for 20 ms.

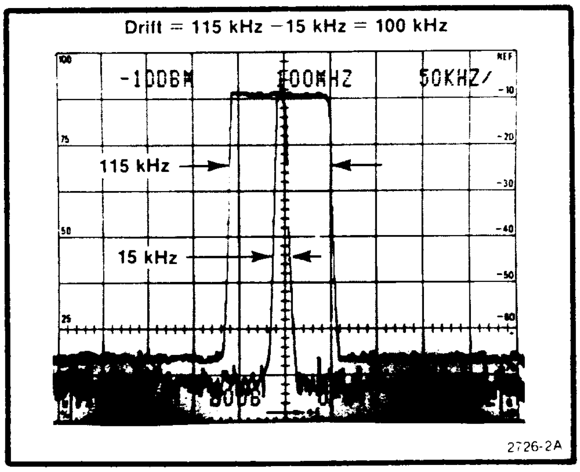


Fig. 3-11. Typical display of drift measurement without phaselock showing width of marker stored with MAX HOLD and beginning display of marker saved in A.

e. If the instrument has phaselock, proceed as follows:

1) switch TIME/DIV to AUTO and activate PHASE LOCK. Increase FREQ SPAN/DIV to bring the signal on screen, then reduce the span to 500 Hz/div and the RESOLUTION BANDWIDTH to 1 kHz. Keep the signal centered with the FREQUENCY control;

2) calculate the slope as described in part c;

3) switch to zero span and TIME/DIV to 10 ms/div; then measure residual FM using the same technique described above. Residual FM, for Option 03 instruments, must not exceed 50 Hz for a 20 ms period or two divisions.

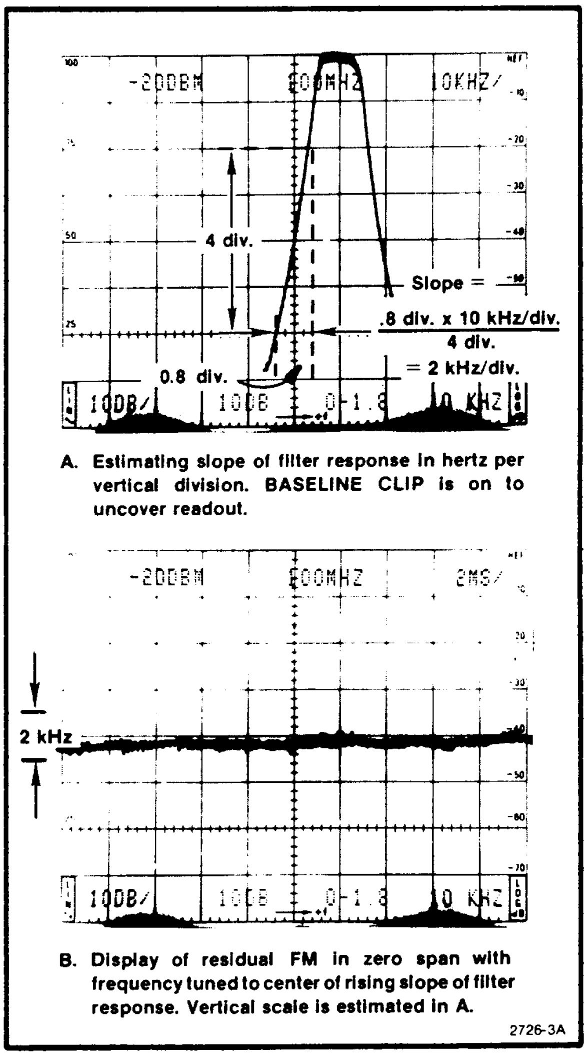


Fig. 3-12. Displays that illustrate how to measure residual FM with PHASELOCK off. The same technique is used with PHASELOCK on (Option 03).

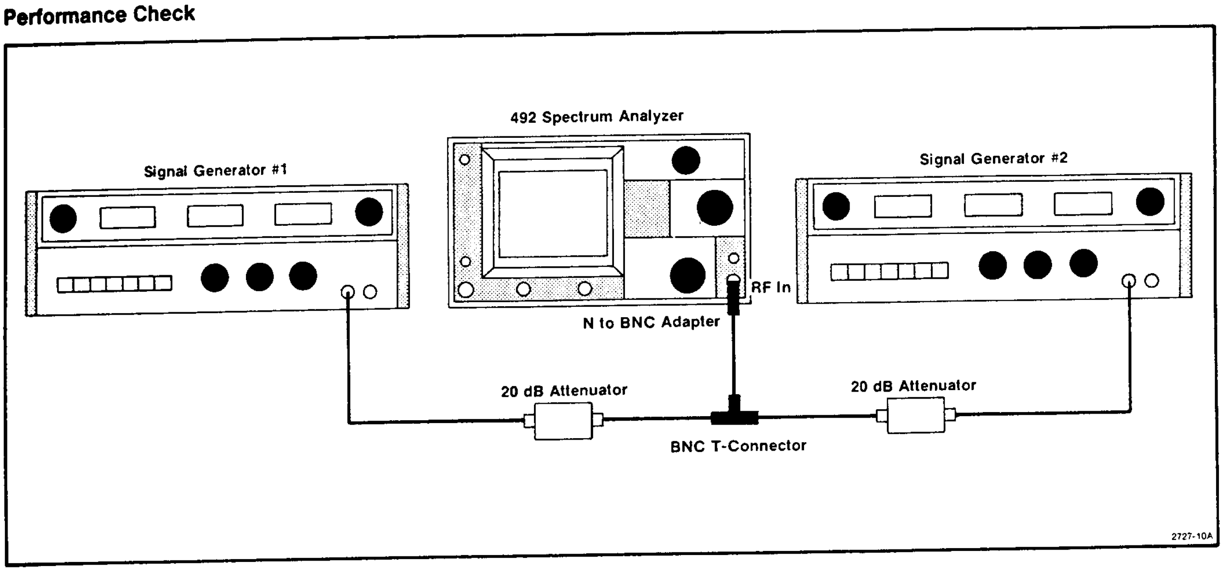


Fig. 3-13. Test equipment setup for measuring intermodulation distortion.

17. Check Intermodulation Distortion (third order is ⩾−70 dBc from any two on-screen signals within any frequency span. Option 01 from 1.8 to 18 GHz, IM is ⩾−70 dBc within any frequency span; and from 1.7 to 1.8 GHz, IM is ⩾−70 dBc down from any two −40 dBm signals within any frequency span)

a. Set the front-panel controls as follows:

Vertical Display	10 dB/DIV
FREQUENCY RANGE	Band 1
FREQ SPAN/DIV	5 MHz
RESOLUTION BANDWIDTH	100 kHz
TIME/DIV	AUTO
REF LEVEL	−30 dBm
MIN RF ATTEN	0 dBm
MIN NOISE	Off
Digital Storage (Option 02)	VIEW A/VIEW B

b. Apply two signals from two 50 Ω sources, separated about 2 MHz and within the frequency range of band 1. Apply the signals through 20 dB attenuators (for isolation), a bnc "T" connector, and bnc-to-n adapter, to the 492/492P RF INPUT (test equipment setup is shown in Fig. 3-13).

c. Adjust the output of the signal generators for two −30 dBm, or full screen signals, on the 492/492P display. Decrease the signal frequency separation to 1 MHz and the FREQ SPAN/DIV to 500 kHz. Set the RESOLUTION BANDWIDTH to 10 kHz.

d. Check third order intermodulation products (see Fig. 3-14). Ensure that third order products are −70 dB or more down from the input signal level.

NOTE

Intermodulation products may not appear unless the input signal level is off screen. Use the VIDEO FILTER and very slow sweep rates to help resolve these sidebands.

e. Decrease signal separation and FREQ SPAN/DIV settings and check again for sidebands. Check IM distortion at other portions of the frequency range. IM distortion should be down at least 70 dBc.

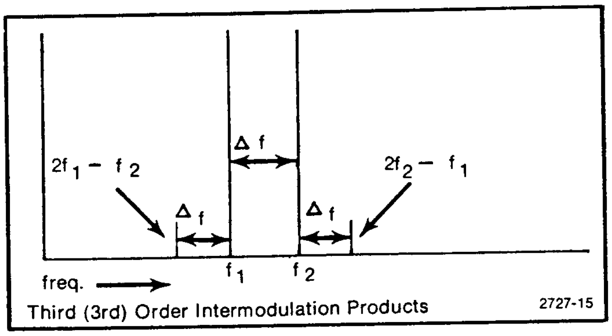


Fig. 3-14. Intermodulation products.

f. If the instrument has Option 01, check IM distortion as follows:

1) change the FREQUENCY RANGE to band 2 (1.8 GHz or higher), FREQ SPAN/DIV to 50 MHz, and RESOLUTION BANDWIDTH to 100 kHz. Apply two signals above 1.8 GHz. Establish a full screen reference level by adjusting the output of the signal generator;

2) reduce the FREQ SPAN/DIV and RESOLUTION BANDWIDTH so the noise floor is more than 70 dB down from the reference level. Check for IM products. Sidebands must be 70 dB or more below the signal level;

3) change the frequencies of the signal generators to frequencies within the 1.6—1.8 GHz range and the level to −40 dBm;

4) using the above procedure, measure IM distortion. IM products must be 70 dB or more down from the −40 dBm signal level.

18. Check Harmonic Distortion (−60 dBc or −100 dBc for Option 01, below the level of a full screen signal in MIN DISTORTION mode)

a. Set the front-panel controls as follows:

FREQUENCY RANGE	Band 1
FREQ SPAN/DIV	5 MHz
AUTO RESOLUTION	On
Vertical Display	10 dB/DIV
REF LEVEL	−30 dBm
MIN RF ATTEN	0 dB
Video Filter	WIDE
Digital Storage (Option 02)	VIEW A/VIEW B

b. Apply the output of the signal generator, through a lowpass or bandpass filter (with a minimum of 40 dB rolloff to attenuate multiples of the generator frequency), to the 492/492P RF INPUT (see Fig. 3-15). Frequency of the signal generator depends on the frequency characteristics of the filter. Ensure that the REF LEVEL is in the MIN DISTORTION mode.

c. Tune the 492/492P FREQUENCY to the applied signal frequency. Adjust the generator output for a full screen (−30 dBm) signal.

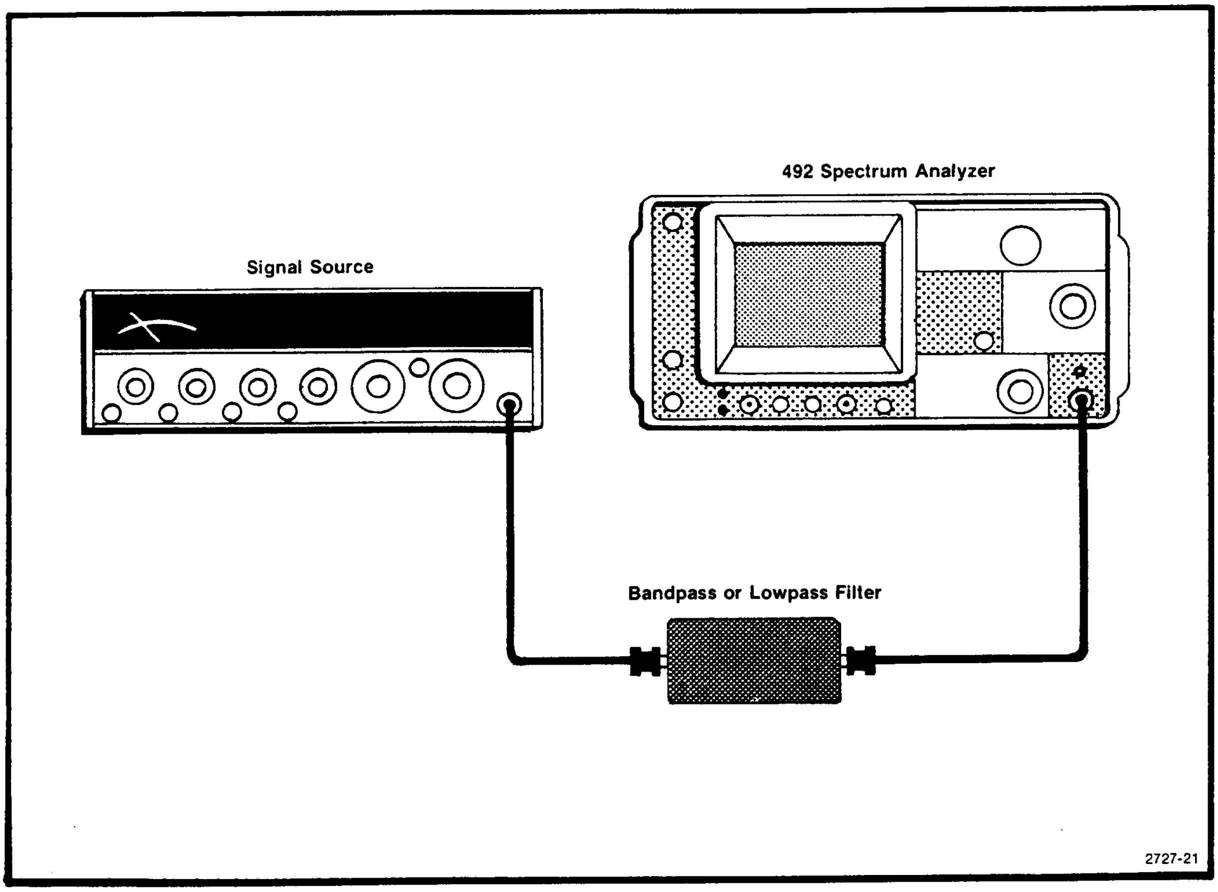


Fig. 3-15. Test equipment setup to check harmonic distortion.

d. Activate ΔF. Adjust the FREQUENCY so the 2nd multiple of the input frequency is centered. Increase the REF LEVEL to −50 dBm, decrease the FREQ SPAN/DIV to 500 kHz and the RESOLUTION BANDWIDTH to 10 kHz.

e. Check the display for harmonic spurii (spurious responses) of the input signal. Harmonic spurii must be down 60 dB or more from the −30 dBm carrier (−40 dB below top of screen).

f. Increase the FREQUENCY to the 3rd harmonic. Check for harmonic spurii. Again responses must be down 40 dB from the top of the screen (60 dBc).

g. If the instrument has Option 01 and Option 03, increase the REF LEVEL to −70 dBm, decrease the FREQ SPAN/DIV to 2 kHz and the RESOLUTION BANDWIDTH to 100 Hz. Deactivate the Video WIDE Filter. Check that harmonic spurii are 100 dB or more down from the −30 dBm carrier level.

19. Check Noise Sidebands (−75 dBc or more at 30 times the resolution bandwidth offset, fundamental mixing, Option 03 is −70 dBc for 100 Hz resolution bandwidth)

a. Set the front-panel controls as follows:

FREQUENCY RANGE	Band 1
FREQ SPAN/DIV	20 MHz
Vertical Display	10 dB/DIV
TIME/DIV	AUTO
REF LEVEL	−20 dBm
AUTO RESOLUTION	On
VIDEO FILTER	WIDE
Digital Storage (Option 02)	VIEW A/VIEW B

b. Apply the CAL OUT signal to the RF INPUT. Center one of the markers on screen with the FREQUENCY control and adjust the REF LEVEL for a full screen display.

c. Keep the calibrator marker centered on screen as the FREQ SPAN/DIV is reduced to 10 kHz and the RESOLUTION BANDWIDTH is decreased to 1 kHz. If Option 03 is installed, note that phaselock is operative.

d. Increase the REF LEVEL 20 dB to −40 dBm to position the signal peak 20 dB above the reference line. Check the amplitude of the noise sidebands 30 times the resolution bandwidth away from the signal (see Fig. 3-16). Noise sidebands should be 75 dB or more below the peak signal level or 55 dB below the top of the screen.

e. If your instrument has Option 03, decrease the FREQ SPAN/DIV to 1 kHz and the RESOLUTION BANDWIDTH to 100 Hz. Check the amplitude of the noise sidebands 3 kHz away from the signal. Noise sidebands should be 70 dB below the signal level or 50 dB below the top of the screen.

20. Check Residual Response (≤ −100 dBm)

a. Remove all signals to the RF INPUT and set the front-panel controls as follows:

FREQUENCY	Bands 1—3 (100 kHz—7.1 GHz)
FREQ SPAN/DIV	10 MHz
REF LEVEL	−50 dBm
MIN RF ATTEN	0 dB
RESOLUTION BANDWIDTH	10 kHz
TIME/DIV	AUTO
Vertical Display	10 dB/DIV
Digital Storage (Option 02)	VIEW A/VIEW B

b. Scan the frequency range of bands 1, 2, or 3 in 100 MHz increments. Note the amplitude of any spurious response. Spurii amplitude must not exceed −100 dBm. (By activating ΔF after each increment, it is easier to determine 100 MHz increments.)

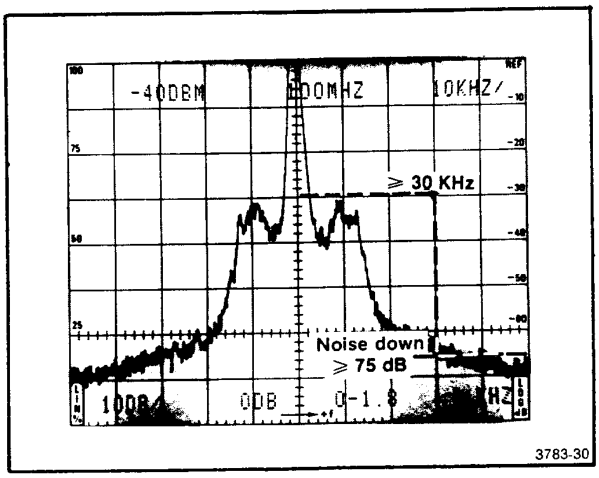


Fig. 3-16. Typical display of phaselock noise.

21. Check LO Emission Out the RF INPUT (no more than −10 dBm and less than −70 dBm for Option 01 instruments)

Two methods or procedures can be used to check EMI:

1) connect a sensitive power meter (see equipment list) to the RF INPUT and directly measure the emitted signal level; or

2) use a high frequency spectrum analyzer and connect the RF INPUT to the RF INPUT of the analyzer under test. Change the TIME/DIV of the analyzer under test to MML.

22. Check Digital Storage (Option 02)

a. Set the front-panel controls as follows:

FREQUENCY	100 MHz
FREQ SPAN/DIV	10 MHz
RESOLUTION BANDWIDTH	1 MHz
Vertical Display	2 dB/DIV
REF LEVEL	−12 dBm
RF ATTEN	20 dB
Digital Storage (Option 02)	VIEW A

b. With the calibrator signal applied to the RF INPUT, tune the signal to center screen while reducing the FREQ SPAN/DIV to 200 kHz. Change the Vertical Display to 2 dB/DIV, then activate SAVE A.

c. Change the REF LEVEL to −10 dBm. Activate VIEW B. Display B should be 2 dB below display A.

d. Activate B−SAVE A. Check that B−SAVE A display is the algebraic difference between display B and display A (see Fig. 3-17).

e. Deactivate SAVE A and B−SAVE A.

23. Check Triggering Operation and Sensitivity internal trigger sensitivity ⩾2 divisions, external trigger ⩾1.0 V, 15 Hz to 1 MHz)

a. Apply the output of a signal generator, modulated by a sine-wave generator, to the RF INPUT of the 492/492P. Monitor the output of the sine-wave generator with a test oscilloscope (see Fig. 3-18).

b. Set the front-panel controls as follows:

Vertical Display	LIN
FREQ SPAN/DIV	10 kHz
TIME/DIV	20 ms
RESOLUTION BANDWIDTH	1 MHz
REF LEVEL	−30 dBm
Digital Storage (Option 02)	VIEW A/VIEW B

c. Set the signal generator for a −30 dBm, 100 MHz signal and tune the 492/492P FREQUENCY to center the signal on screen.

d. Decrease the output of the signal generator so the display is half screen, then modulate the signal with a 1 kHz sine wave.

e. Decrease the FREQ SPAN/DIV to 0. Adjust the FREQUENCY control if necessary to keep the signal centered.

f. Adjust the sine-wave generator output for a modulation amplitude of two divisions, then switch TRIGGERING to INT.

g. Check the internal trigger operation through the 15 Hz to 1 MHz frequency range.

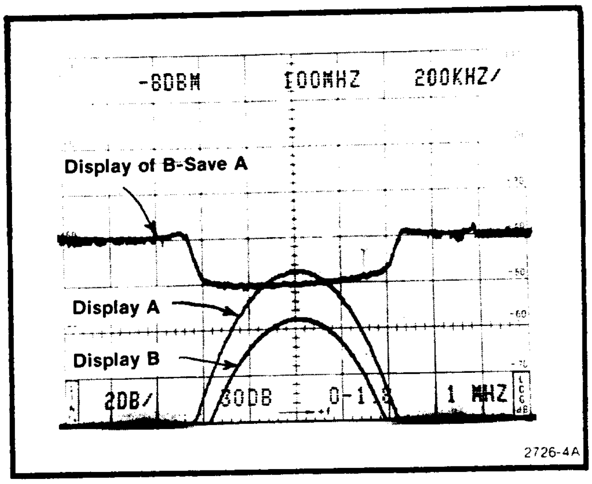


Fig. 3-17. Multiple exposure to illustrate how the differential between two signals can be measured.

NOTE

Because of deflection amplifier response, the display amplitude will decrease at the high frequency end.

The triggering signal can also be applied through a bnc-to-jack cable, to pins 1, 2 and 3 (see Fig. 3-25) of the rear-panel ACCESSORIES connector (pin 2 is Video in; pin 1 Ext Video select and pin 3 is ground). Connect a jumper between pins 1 and 3.

h. Disconnect the test equipment. Apply, through a bnc "T" connector and coaxial cable, the sine-wave generator output to the EXT IN HORIZ/TRIG connector on the back panel of the 492/492P (see Fig. 3-19). Monitor the input signal amplitude with a test oscilloscope.

i. Set the sine-wave generator frequency to 1 kHz. Adjust its output level for 2 V peak-to-peak (1.0 V peak) as indicated on the test oscilloscope (see Fig. 3-20).

j. Change the 492/492P TIME/DIV to .2 s. Activate the EXT Triggering.

k. Check that sweep runs as the generator frequency is varied from 15 Hz to 1 MHz.

l. Return the TRIGGERING to FREE RUN and the input signal level to 0 V.

24. Check External Sweep Operation (0 to 10 V ±1 V should provide a full sweep across the 10 division graticule span)

a. With the test equipment connected as directed for the previous step, change the TIME/DIV to EXT and deactivate VIEW A/VIEW B.

b. Change the Vertical Display to 2 dB/DIV and position the crt beam on the left graticule edge with the POSITION control. This establishes the 0 V reference.

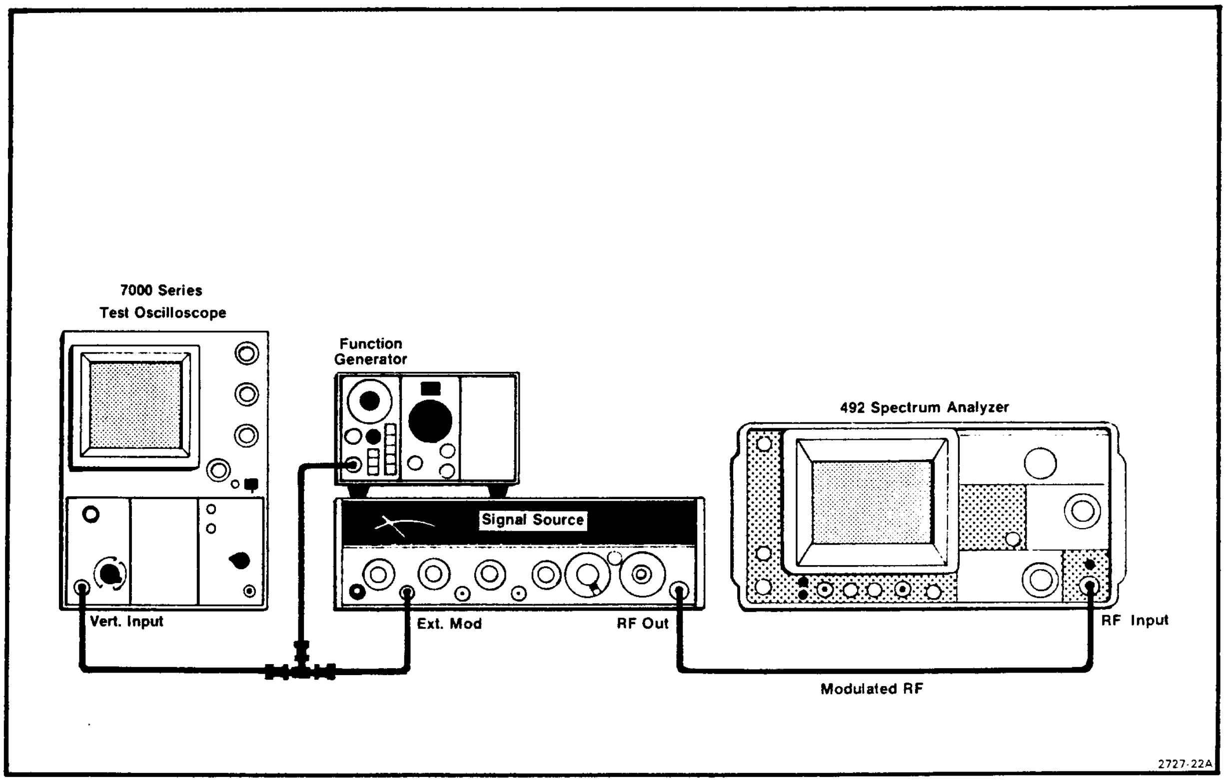


Fig. 3-18. Test equipment setup for checking triggering requirements.

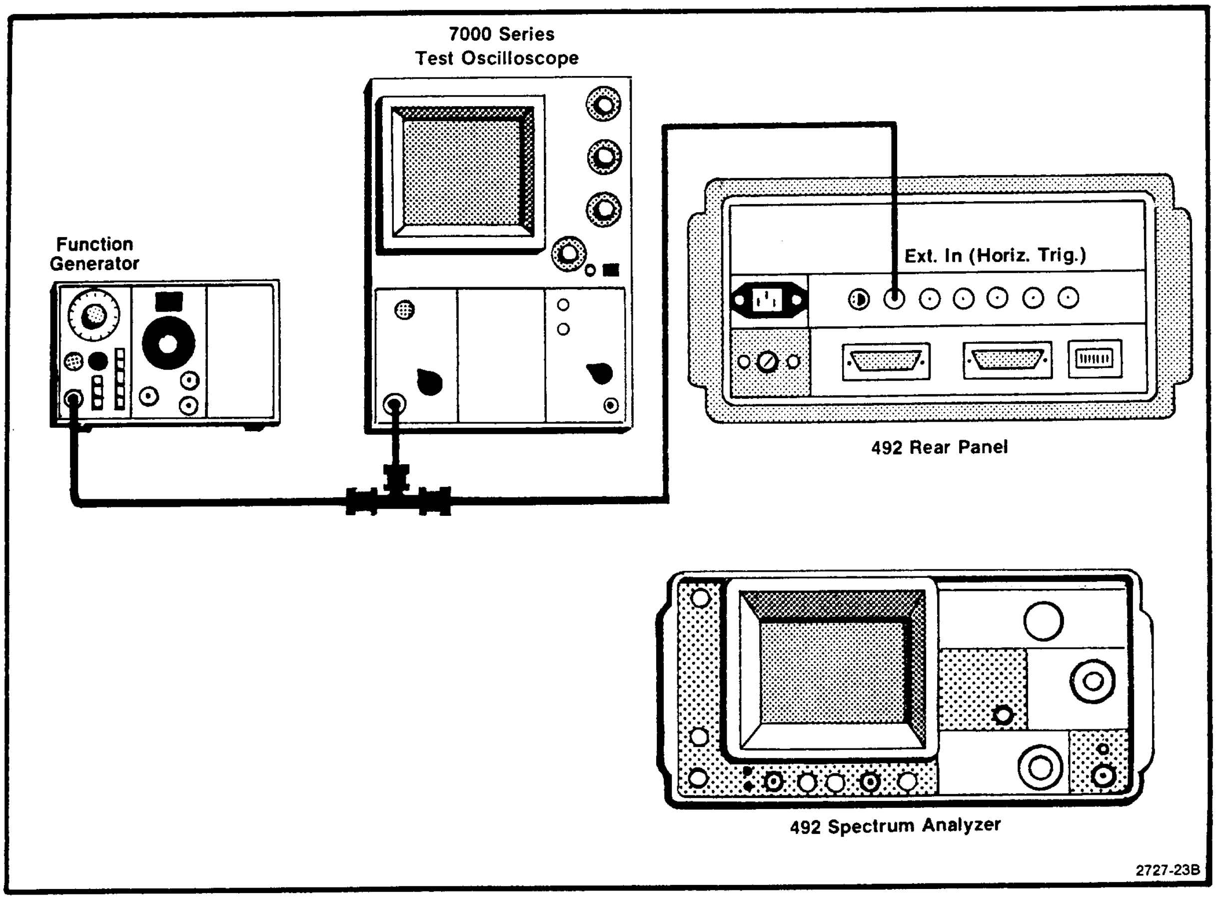


Fig. 3-19. Test equipment setup to check external triggering and horizontal input characteristics.

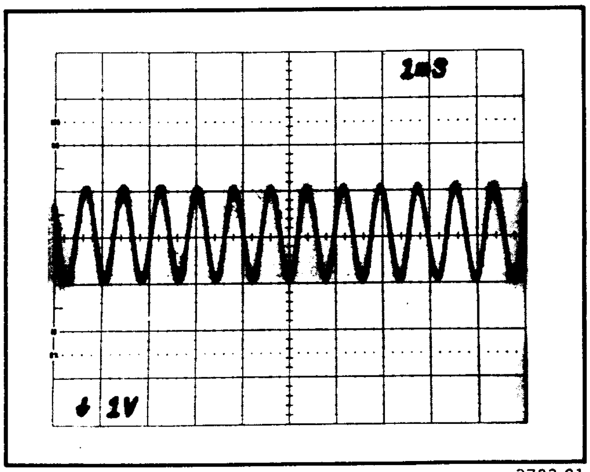


Fig. 3-20. Test oscilloscope display of a sinewave input signal to EXT TRIG connector (input 1.0 V peak at 2.0 V peak-to-peak).

c. Connect the output of the sine-wave generator, with a frequency of 1 kHz, to the back panel EXT IN connector. Increase the output for a full 10-division sweep.

d. Check the output peak-to-peak voltage level of the generator. Output should equal 20 V, ±2 V peak-to-peak (10 V ±1 V peak).

NOTE

A variable voltage source can be used in lieu of the sine-wave generator to check external sweep operation.

e. Disconnect and remove the test equipment. Return TIME/DIV to AUTO.

25. Check Vertical Output (provides 0.5 V ±5% of signal per division of display from the centerline)

a. Connect the VERT OUTPUT to the input of a dc-coupled test oscilloscope with a sensitivity of 1 V/DIV and sweep rate of 10 ms.

b. Set the 492/492P controls as follows:

FREQUENCY	100 MHz
Triggering	FREE RUN
TIME/DIV	AUTO
Vertical Display	2 dB/DIV
RESOLUTION BANDWIDTH	100 kHz
FREQ SPAN/DIV	100 kHz
REF LEVEL	−20 dBm
Digital Storage (Option 02)	Off

c. Apply the CAL OUT signal to the RF INPUT and tune the 100 MHz signal to center screen.

d. Activate the FINE step REF LEVEL function and adjust the REF LEVEL for an eight division display.

e. Check the vertical signal output level on the test oscilloscope. Output level should equal plus and minus 2 V for a total of 4 V ±0.2 V (see Fig. 3-21).

26. Check Horizontal Signal Output (0.5 V ±5% either side of center screen with a full range of −2.5 V to +2.5 V ±10%)

a. Connect a dc-coupled test oscilloscope to the HORIZ OUTPUT connector. Set the 492/492P TIME/DIV to MNL position.

b. Adjust the crt beam five divisions either side of center screen with the MANUAL SCAN control. The output range should equal −2.5 V to +2.5 V, ±10%.

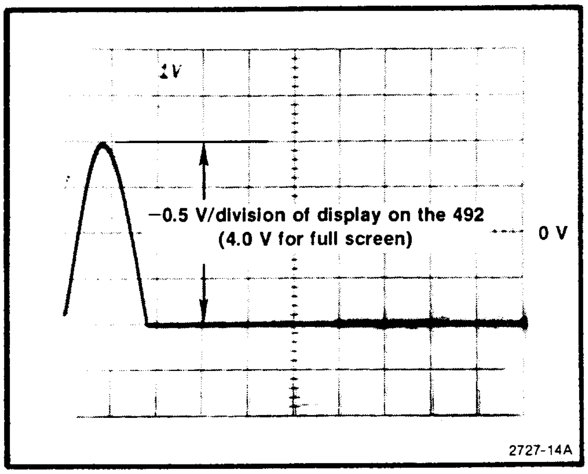


Fig. 3-21. Display of a full screen signal at the Vertical Output connector.

c. Return the TIME/DIV to AUTO; disconnect and remove the test equipment.

27. 492P GPIB Verification Program

This verification program for TEKTRONIX 4050-Series Computer Terminal checks functional operation of the GPIB interface in a 492P Spectrum Analyzer. All interface lines are verified as well as all interface messages, except those for parallel poll. In addition, the instruments' interface is checked for operation on other primary addresses, as well as the talk-only and listen-only modes.

The program is written in TEKTRONIX 4050 BASIC, and is divided into individual tests, each for a specific interface line, message, or function. The tests start on even 1000 line numbers to allow easy modification of the program.

The following describes the function of each test in the program.

Lines 1—5000:	Interfaces to user definable keys for recovery from a failed test.
Lines 5000—6000:	Inputs the primary address of the 492P under test (1 should be used).
Lines 6000—7000:	ID query response test. The instrument must be able to talk and listen, to send out its ID? response and manipulate all eight of the DIO lines for the test to be successful.
Lines 7000—8000:	Local lock-out test. Tests correct operation of the interface message that should disable all programmable front panel controls.
Lines 8000—9000:	Go to LOCAL test. Tests correct operation of the interface message that should enable all front panel controls.
Lines 9000—10000:	Group Execute Trigger test. Checks that a GET message does cause the 492P to abort the present sweep and re-arm the trigger, causing a sweep to start and end, sending out an End-of-Sweep SRQ. Thus, the SRQ line, as well as the GET message, is verified.
Lines 10000—11000:	Selected Device Clear Test. This test verifies that an SDC message does indeed reset the 492P's GPIB output buffer clearing out it's ID? response.
Lines 11000—12000:	Device clear test. This test is identical to the selected device clear test, except the universal command DCL is used instead.
Lines 12000—13000:	Addressed as listener, talker test. This test checks to see that the 492P microprocessor correctly recognized that the GPIA chip has been addressed to listen or talk, and sends the appropriate character to the crt readout (L or T).
Lines 13000—14000:	Serial Poll test. This checks correct operation of the serial poll enable (SPE) and serial poll disable (SPD) interface messages. The status byte is read, and if anything other than ordinary operation is indicated, the instrument fails the test.
Lines 14000—15000:	GPIB rear panel switch test. All five primary address switches are checked for correct operation. Three subroutines are called in the process of testing one address switch. The first two send a formatted messge to the 4050 display, and the third performs the address switch test.
Lines 15000—16000:	Line feed or EOI switch test. Checks for correct selection of line feed as a termination when selected by this switch by sending an ID? terminated only by a line feed.
Lines 16000—17000:	Talk-only mode test. When selected, this mode should cause the instrument to send a SET? response and (optionally) a CURVE? response whenever the RESET-TO-LOCAL button is pressed. The string received from the instrument is thus examined for existence of a portion of the correct SET? response after the RESET-TO-LOCAL button is pressed.
Lines 17000—18000:	Listen-only mode test. When selected, this mode will cause the instrument to respond to any message on the bus, since it is always addressed to listen. The command "REF 0" is sent to the bus without addressing the instrument, then the listen-only mode is deselected and the instrument interrogated to see if it did respond to the REF command while in the listen-only mode.
Lines 18000—19000:	Interface clean (and Remote Enable) test. This IFC line on the GPIB will unaddress the instrument's interface. This fact is verified by noting that the "L" is not present in the crt readout, indicating that the IFC line worked; also the REN line will be unasserted when the end statement is executed (except for some early 4052 and 4054's). Thus, a front panel in the local mode is evidence that the REN line was successfully unasserted. (Evidence it was asserted is that the instrument was able to execute commands sent to it by previous tests.)

Lines 19000—end: Utility routines. "Rear panel interface switch test text routine" puts headers on the interface switch test display. The "rear panel test text routine" tells the operator what to do after changing the address switches. "Test address switch" acquires an ID? response from the instrument on its new address during the address switch test. The "SRQ handler" will handle any 49X SRQ's that occur, although none, except the power-up SRQ, would be expected. (The end of sweep SRQ during the GET test is handled by another SRQ handler.) "Delay Generator" generates delays for other tests. The "Failure Decision Handler" allows the program to be restarted with the user definable keys if any test fails.

```
1 GO TO 5000
4 B2=1
5 RETURN
20 B2=5
21 RETURN
5000 REM *** 49XP GPIB VERIFICATION PROGRAM ***
5030 INIT
5040 ON SRQ THEN 19280
5050 DIM V$(400),W$(400)
5060 I7=0
5070 PAGE
5080 PRINT "JJJENTER 49XP'S PRIMARY ADDRESS (DEFAULT = 1) ";
5090 INPUT T$
5100 IF T$<>"" THEN 5130
5110 A1=1
5120 GO TO 5180
5130 A1=VAL(T$)
5140 IF A1>0 AND A1<31 THEN 5180
5150 PRINT "JJGERROR!! ";A1;" IS NOT A VALID ADDRESS";
5160 PRINT " ONLY 0 THRU 30 ARE VALID ADDRESSESKK"
5170 GO TO 5080
5180 PAGE
5190 REM
5200 REM
5210 REM
5220 REM
5230 REM
6000 REM ***"ID" QUERY RESPONSE ***
6010 PRINT "*** "ID" QUERY RESPONSE ***"
6020 PRINT @A1:"INI;ID?;SIG"
6030 INPUT @A1:T$
6040 V$=SEG(T$,1,9)
6050 IF V$="ID TEK/49" THEN 6080
6060 PRINT "JJJ*** "ID" QUERY RESPONSE *** FAIL ***G"
6070 GO TO 19530
6080 WBYTE @32+A1:64,128,-127
6090 PRINT @A1:"WFM ENC:BIN;CUR?"
6100 PRINT @37,0:37,255,255
6110 INPUT %A1:T$
6120 WBYTE @64+A1:
6130 RBYTE R,R,R,T6
6140 WBYTE @95:
6150 IF R=>128 AND T6<128 THEN 7000
6160 PRINT "JJJ*** DIO8 TEST *** FAIL ***G"
6170 GO TO 19530
6180 REM
6190 REM
6200 REM
6210 REM
6220 REM
7000 REM *** LOCAL LOCK-OUT..............LLO ***
7010 PRINT "*** LOCAL LOCK-OUT..........LLO ***"
```

```
7020 WBYTE @32+A1,17:
7030 PRINT @A1:"SET?"
7040 INPUT @A1:V$
7050 PRINT "II49XP IN LOCAL LOCK-OUT MODE (LLO)"
7060 PRINT "IIATTEMPT TO USE 49XP CONTROLS"
7070 PRINT " IIPRESS RETURN <CR> WHEN DONE ";
7080 INPUT T$
7090 PRINT @A1:"SET?"
7100 INPUT @A1:W$
7110 IF W$<>V$ THEN 7130
7120 GO TO 8000
7130 PRINT "J*** LOCAL LOCK-OUT.............LLO *** FAIL ***G"
7140 GO TO 19530
7150 REM
7160 REM
7170 REM
7180 REM
7190 REM
8000 REM *** GO TO LOCAL.............GTL ***
8010 PRINT @A1:"INI;TIM?"
8020 INPUT @A1:R
8030 PRINT @A1:"TIM INC"
8040 PRINT "*** GO TO LOCAL.............GTL ***"
8050 WBYTE @32+A1,1:
8060 PRINT @A1:"TIM?"
8070 INPUT @A1:T6
8080 IF R<>T6 THEN 8100
8090 GO TO 9000
8100 PRINT "J**** GO TO LOCAL...........GTL *** FAIL ***G"
8110 GO TO 19530
8120 REM
8130 REM
8140 REM
8150 REM
8160 REM
9000 REM *** GROUP EXECUTE TRIGGER........GET ***
9010 PRINT "*** GROUP EXECUTE TRIGGER...GET ***"
9020 ON SRQ THEN 9120
9030 I7=0
9040 PRINT @A1:"INIT;TIM 100M;SIG;EOS ON"
9050 WBYTE @32+A1,8:
9060 T6=3
9070 GOSUB 19390
9080 PRINT @A1:"EOS OFF"
9090 IF I7<>1 THEN 9150
9100 ON SRQ THEN 19280
9110 GO TO 10000
9120 WBYTE @20:
9130 I7=1
9140 RETURN
9150 PRINT "GROUP EXECUTE TRIGGER...GET *** FAIL ***G"
9160 GO TO 19530
9170 REM
9180 REM
9190 REM
9200 REM
9210 REM
10000 REM *** SELECTED DEVICE CLEAR...SDC ***
10010 PRINT "*** SELECTED DEVICE CLEAR...SDC ***"
10020 PRINT @A1:"ID?"
10030 WBYTE @32+A1,4:
10040 WBYTE @64+A1:
10050 RBYTE R
10060 IF ABS(R)<>255 THEN 10080
```

```
10070 GO TO 11000
10080 PRINT "*** SELECTED DEVICE CLEAR........SDC *** FAIL ***G"
10090 GO TO 19530
10100 REM
10110 REM
10120 REM
10130 REM
10140 REM
11000 REM *** DEVICE CLEAR...........DCL ***
11010 PRINT "*** DEVICE CLEAR............DCL ***"
11020 PRINT @A1:"ID?"
11030 WBYTE @20:
11040 WBYTE @64+A1:
11050 RBYTE R
11060 IF ABS(R)<>255 THEN 11080
11070 GO TO 12000
11080 PRINT "*** DEVICE CLEAR...........DCL *** FAIL ***G"
11090 GO TO 19530
11100 REM
11110 REM
11120 REM
11130 REM
11140 REM
12000 REM ** ADDRESSED AS LISTENER, TALKER ***
12010 PRINT "*** 49XP ADDRESSED AS LISTENER..***"
12020 WBYTE @32+A1:76,79,82,68,79,-63
12030 T6=1
12040 GOSUB 19390
12050 INPUT @A1:V$
12060 T$=SEG(V$,16,1)
12070 IF T$="L" THEN 12100
12080 PRINT "J*** 49XP ADDRESSED AS LISTENER *** FAIL ***G"
12090 GO TO 19530
12100 PRINT "*** 49XP ADDRESSED AS TALKER....***"
12110 PRINT @A1:"INI;TIM 50M;SIG;SIG;WAI;LORDO?"
12120 INPUT @A1:V$
12130 T$=SEG(V$,16,1)
12140 IF T$="T" THEN 13000
12150 PRINT "*** 49XP ADDRESSED AS TALKER *** FAIL ***"
12160 GO TO 19530
12170 REM
12180 REM
12190 REM
12200 REM
12210 REM
13000 REM *** SERIAL POLL ***
13010 PRINT "*** SERIAL POLL.........SPD/SPE ***"
13020 WBYTE @95,63,24,64+A1:
13030 RBYTE R
13040 WBYTE @95,25:
13050 IF R=0 OR R=16 THEN 13080
13060 PRINT "J*** SERIAL POLL *** FAIL ***G"
13070 GO TO 19530
13080 T6=3
13090 GOSUB 19390
13100 REM
13110 REM
13120 REM
13130 REM
13140 REM
14000 REM *** GPIB INTERFACE REAR PANEL SWITCH TEST ***
14010 PAGE
14020 A1=2
14030 GOSUB 19000
```

```
14040 PRINT " 0 1 0 1 0 1 0 0 0 1 0"
14050 GOSUB 19070
14060 GOSUB 19190
14070 PAGE
14080 A1=4
14090 GOSUB 19000
14100 PRINT " 0 1 0 1 0 1 0 0 1 0 0"
14110 GOSUB 19070
14120 GOSUB 19190
14130 PAGE
14140 A1=8
14150 GOSUB 19000
14160 PRINT " 0 1 0 1 0 1 0 1 0 0 0"
14170 GOSUB 19070
14180 GOSUB 19190
14190 PAGE
14200 A1=16
14210 GOSUB 19000
14220 PRINT " 0 1 0 1 0 1 1 0 0 0 0"
14230 GOSUB 19070
14240 GOSUB 19190
14250 REM
14260 REM
14270 REM
14280 REM
14290 REM
15000 REM *** "LF" OR "EOI" SWITCH ***
15010 PAGE
15020 A1=1
15030 GOSUB 19000
15040 PRINT " 0 1 0 1 1 1 0 0 0 0 1"
15050 GOSUB 19070
15060 PRINT "JJTESTING "LF" OR "EOI" SWITCH"
15070 GOSUB 19190
15080 WBYTE @32+A1:73,68,63,10
15090 INPUT @A1:T$
15100 T$=SEG(T$,1,9)
15110 IF T$="ID TEK/49" THEN 15140
15120 PRINT "J"LF" OR "EOI" SWITCH *** FAIL ***G"
15130 GO TO 19530
15140 T6=2
15150 GOSUB 19390
15160 REM
15170 REM
15180 REM
15190 REM
15200 REM
16000 REM *** TALK ONLY MODE ***
16010 PAGE
16020 GOSUB 19000
16030 PRINT " 0 1 1 1 0 1 0 0 0 0 1"
16040 GOSUB 19070
16050 PRINT "JJJTESTING TALK ONLY"
16060 INPUT @A1:V$
16070 I7=POS(V$,"FINE OFF",1)
16080 IF I7<>0 THEN 17000
16090 PRINT "JJJTALK ONLY MODE *** FAIL ***G"
16100 GO TO 19530
16110 REM
16120 REM
16130 REM
16140 REM
16150 REM
17000 REM *** LISTEN ONLY MODE ***
```

```
17010 PAGE
17020 GOSUB 19000
17030 PRINT " 1I0I0I0 0 0 0 1"
17040 GOSUB 19070
17050 PRINT "JJJTESTING LISTEN ONLY"
17060 PRINT @A1:"INI"
17070 T6=0.5
17080 GOSUB 19390
17090 WBYTE 82,69,70,32,-48
17100 PAGE
17110 GOSUB 19000
17120 PRINT " 0I0I0I0 0 0 0 1"
17130 GOSUB 19070
17140 PRINT @A1:"REF?"
17150 INPUT @A1:V$
17160 IF V$<>"REFLVL +0.0" THEN 17180
17170 GO TO 18000
17180 PRINT "JJJLISTEN ONLY MODE *** FAIL ***G"
17190 GO TO 19530
17200 REM
17210 REM
17220 REM
17230 REM
17240 REM
18000 REM *** INTERFACE CLEAR AND REMOTE ENABLE TEST......IFC & REN ***
18010 PAGE
18020 PRINT "JJJTESTING IFC(INTERFACE CLEAR), AND REN(REMOTE ENABLE)"
18030 WBYTE @32+A1:
18040 T6=3
18050 GOSUB 19390
18060 PRINT "JJCHECK THE 49XP CRT, FOR AN "L" BETWEEN THE VERTICAL"
18070 PRINT "DISPLAY AND THE MIN RF ATTEN READOUTS."
18080 PRINT "JPRESS RETURN TO CONTINUE.";
18090 INPUT P$
18100 INIT
18110 PRINT "JIF AN "L" IS STILL PRESENT, THE IFC LINE IS FAULTY,"
18120 PRINT "IF THE "L" VANISHED, IFC TESTED OK."
18130 PRINT "JJCHECK ALSO THE 49XP FRONT PANEL FOR PROPER LOCAL CONTROL"
18140 PRI "IF THE FRONT PANEL IS LOCKED OUT, THE REN LINE IS FAULTY, IF"
18150 PRINT "NOT, REN TESTED OK"
18160 PRINT "JJJGPIB VERIFICATION COMPLETEG"
18170 END
18180 REM
18190 REM
18200 REM
19000 REM *** REAR PANEL INTERFACE SWITCH TEST TEXT ROUTINE ***
19010 PRINT "SET GPIB ADDRESS SWITCHES TO:"
19020 PRINT "JJLISTENITALKILF ORI ADDRESS"
19030 PRINT " ONLYIONLYIEOII16 8 4 2 1"
19040 PRINT "------I----I-----I---------"
19050 RETURN
19060 REM
19070 REM *** REAR PANEL TEST TEXT ROUTINE ***
19080 PRINT "JJAFTER CHANGING THE SWITCHES, ";
19090 PRINT "PRESS THE REMOTE/LOCAL BUTTON ONCEJJ"
19100 PRINT "I(NOTE: IF YOU GET A GPIB INTERFACE ERROR MESSAGE,"
19110 PRINT "I           IT MEANS THAT THE SWITCH(ES) WERE'NT "
19120 PRINT "I           READ CORRECTLY. TO RE-TEST, TYPE"
19130 PRINT "I           "RUN" FOLLOWED BY THE LINE NUMBER IN THE"
19140 PRINT "I           ERROR MESSAGE) "
19150 PRINT "JJIPRESS RETURN <CR> WHEN DONE ";
19160 INPUT T$
19170 RETURN
19180 REM
```

```
19190 REM *** TEST ADDRESS SWITCH ***
19200 PRINT @A1:"ID?"
19210 INPUT @A1:T$
19220 T$=SEG(T$,1,9)
19230 IF T$="ID TEK/49" THEN 19260
19240 PRINT "ADDRESS SWITCH TEST FAIL"
19250 GO TO 19530
19260 RETURN
19270 REM
19280 REM *** SRQ HANDLER ***
19290 T6=3
19300 GOSUB 19390
19310 POLL Z1,Z1;A1
19320 PRINT @A1:"ERR?"
19330 INPUT @A1:S$
19340 PRINT "GGAN INTERRUPT OCCURED ON THE BUS, THE 49XP RETURNS ";S$
19350 PRINT "JPRESS RETURN <CR> TO CONTINUE ";
19360 INPUT T$
19370 RETURN
19380 REM
19390 REM *** DELAY GENERATOR ***
19410 REM *** T6 GIVEN IN SEC (GLOBAL) *** I9 SCRATCH ***
19420 IF T6<0 THEN 19510
19430 IF RND(0)>0.5 THEN 19490
19440 REM *** 4051 ***
19450 T6=T6*220
19460 FOR I9=1 TO T6
19470 NEXT I9
19480 GO TO 19510
19490 REM *** 4052
19500 CALL "WAIT",T6
19510 T6=0
19520 RETURN
19530 REM **** FAILURE DECISION HANDLER ****
19540 PRINT "JJISELECT A UDK:"
19550 PRINT "I (1) RE-START"
19560 PRINT "I (5) END"
19570 SET KEY
19580 B2=0
19590 IF B2<>1 AND B2<>5 THEN 19590
19600 IF B2=5 THEN 19630
19610 PAGE
19620 GO TO 6000
19630 END
```

This concludes the Performance Check part of the Calibration Procedure.

ADJUSTMENT PROCEDURE

If the 492/492P operation is out of tolerance for a particular specification, determine the cause, repair if necessary, then use the appropriate adjustment procedure to return the instrument operation to specification. After any adjustment, repeat that part of the Performance Check to verify operation.

Allow instrument to warm up for at least two hours in ambient air of +20°C to +30°C before performing an adjustment.

Waveform illustrations used in these instructions may be idealized. They are not intended to be representative of specification tolerances.

Adjustment steps that interact are noted, and reference is made within the procedure to the affected circuit or steps.

CAUTION

STATIC DISCHARGE CAN DAMAGE MANY SEMICONDUCTOR COMPONENTS USED IN THIS INSTRUMENT.

Many semiconductor components, especially MOS types, can be damaged by static discharge. Damage may not be catastrophic, therefore, not immediately apparent. It usually appears as a 'weakening' of the semiconductor characteristics. Devices that are particularly susceptible are: MOS, CMOS, JFETs, and high impedance operational amplifiers. Damage can be significantly reduced by observing the following precautions.

1. Handle static-sensitive components or circuit assemblies at or on a static-free surface. Work station areas should contain a static-free bench cover or work plane such as conductive polyethylene sheeting and a grounding wrist strap. The work plane should be connected to earth ground.

2. All test equipment, accessories, and soldering tools should be connected to earth ground.

3. Minimize handling by keeping the components in their original containers until ready for use. Minimize the removal and installation of semiconductors from their circuit boards.

4. Hold the IC devices by their body rather than the terminals.

5. Use containers made of conductive material or filled with conductive material for storage and transportation. Avoid using ordinary plastic containers. Any static sensitive part or assembly (circuit board) that is to be returned to Tektronix, Inc., should be packaged in its original container or one with anti-static packaging material.

Table 3-9
ADJUSTMENT STEPS FOR CALIBRATING THE 492/492P

Adjustment Step	Page
1. Check and adjust low voltage power supply	3-43
2. Crt display	3-44
3. Deflection amplifier, gain and frequency response	3-45
4. Adjust sweep timing	3-47
5. Calibrate the 1st LO system and center frequency control	3-50
6. Check 2nd LO frequency and adjust tuning range	3-53
7. Adjust 1st converter bias	3-57
8. Baseline leveling (Video Processor)	3-58
9. Log amplifier calibration	3-61
10. Calibrating the resolution bandwidth and shape factor	3-63
11. Presetting the variable resolution gain and band leveling	3-66
12. Calibrator output level	3-68
13. IF gain calibration	3-68
14. Digital storage calibration	3-69
15. Setting B−SAVE A reference level	3-71
16. Band leveling for coaxial bands (1—5)	3-71
17. Band leveling for waveguide bands (6—11)	3-72
18. Preselector driver (Option 01) calibration	3-73
19. Phaselock calibration	3-76

Preparation

To prepare the rackmount or benchtop version for adjustment, refer to the Rackmount/Benchtop Versions section of this manual (Section 6).

Remove the cabinet of the 492/492P as follows:

1) set the 492/492P on its face or front panel;

2) loosen the four screws through the back rubber feet;

3) pull the cover up and off of the 492/492P;

4) place the instrument on the bench and reconnect the power cord.

1. Check and Adjust Low Voltage Power Supply

This high efficiency power supply uses an internal oscillator. The frequency of the oscillator is adjusted for 66 kHz. This adjustment is normally required only after replacing oscillator components; therefore, Part 1 of this step should only be performed after repair. Part 2 is the normal adjustment and check procedure.

WARNING

The 492/492P uses a high efficiency power supply. The potential of the primary ground for this supply is different than chassis or earth ground. An isolation transformer, with a turns ratio of 1:1 and a 500 VA minimum rating, should be used between the power source and the 492/492P power input receptacle. The transformer must have a three-wire input and output connector with ground through the input and output. Stancor GIS21000 is a suitable transformer. A jumper should also be connected between the primary ground side to chassis ground (emitter of Q2061 and the ground terminal of the input filter FL301).

If the power supply is separated from the instrument and operated on the bench, hazardous potentials will exist within the supply for several seconds after power is disconnected. This is due to the slow discharge of capacitors C6101 and C6111. A relaxation oscillator lights DS5112 (next to C6111) when the potential exceeds 80 volts.

Part 1
Adjusting the Power Supply Oscillator Frequency

a. Remove the Power Supply module as described in the Maintenance section. Remove the Power Supply module cover and disconnect P3045.

b. Apply power to the module by plugging the power cord into the power input plug and connect it to a suitable power source (115 V ac or 230 V ac, depending on the position of P1091 on J1091).

c. Use a plastic or insulated tuning tool or equivalent, to insert between the two power switches to engage these switches.

d. Connect a test oscilloscope probe with a deflection sensitivity of 5 V/div and sweep rate of 10 μs/div to TP6053 (Fig. 3-22). Note the output waveform of the oscillator U6059. Amplitude should be approximately 10 V.

e. Adjust R6061 (Oscillator Freq Adj) for a waveform period of 15 μs (66 kHz).

f. Reinstall the power supply module cover, then install the module on the 492/492P.

Part 2
Check and Adjust Low Voltages

a. Connect a Variac (line voltage regulator) in line with the 492/492P power input and set the Variac for 117 Vac.

b. Connect a digital voltmeter (DVM) to +15 V test point (Fig. 3-22B) on the Z-Axis board to monitor the +15 V supply.

c. Remove the power supply cover screw located below the 10 MHz IF OUTPUT jack on the rear panel (see Fig. 3-22A). This will provide access to the +15 V adjustment, R6028.

d. Insert a narrow bit screwdriver through the screw hole and engage adjustment R6028. Adjust for +15 V on the DVM.

e. Vary the input voltage range from 90 to 132 Vac and note that the +15 V supply remains regulated.

f. Check the other supply voltages at test points indicated in Fig. 3-22B against tolerances listed in Table 3-10.

Table 3-10
POWER SUPPLY VOLTAGE TOLERANCES

Supply	Tolerance
+9 V	+8.92 V to +10.1 V
−5 V	−4.95 V to −5.05 V
−15 V	−14.84 V to −15.13 V
+5 V	+4.73 V to +5.23 V
+17 V	+16.8 V to +18.6 V
+100 V	+95 V to +105 V
+300 V	+280 V to +310 V

g. Remove the line voltage regulator (Variac) and reconnect the 492/492P directly to the power source.

2. CRT Display (Z-Axis board)

NOTE

Instruments prior to serial number B042200 do not have Crt Bias adjustment R2040. If your instrument does not have R2040, proceed to part b of this step. Auto Focus Tracking R1067 and Auto Focus Gain R1063 no longer affect the display. They are set mid range and not described in this procedure.

a. Switch POWER off and preset the INTENSITY control fully counterclockwise, MANUAL SCAN to midrange, and TIME/DIV to MNL. Set the Intensity Limit R1027 on the Z-Axis board (Fig. 3-23) fully counterclockwise and Crt Bias R2040 on the High Voltage board (Fig. 3-24) fully clockwise.

b. Switch POWER on and after the power-up state has stabilized change the Vertical Display mode to 2 dB/DIV, deactivate READOUT, and if the instrument has Option 02 turn Digital Storage off.

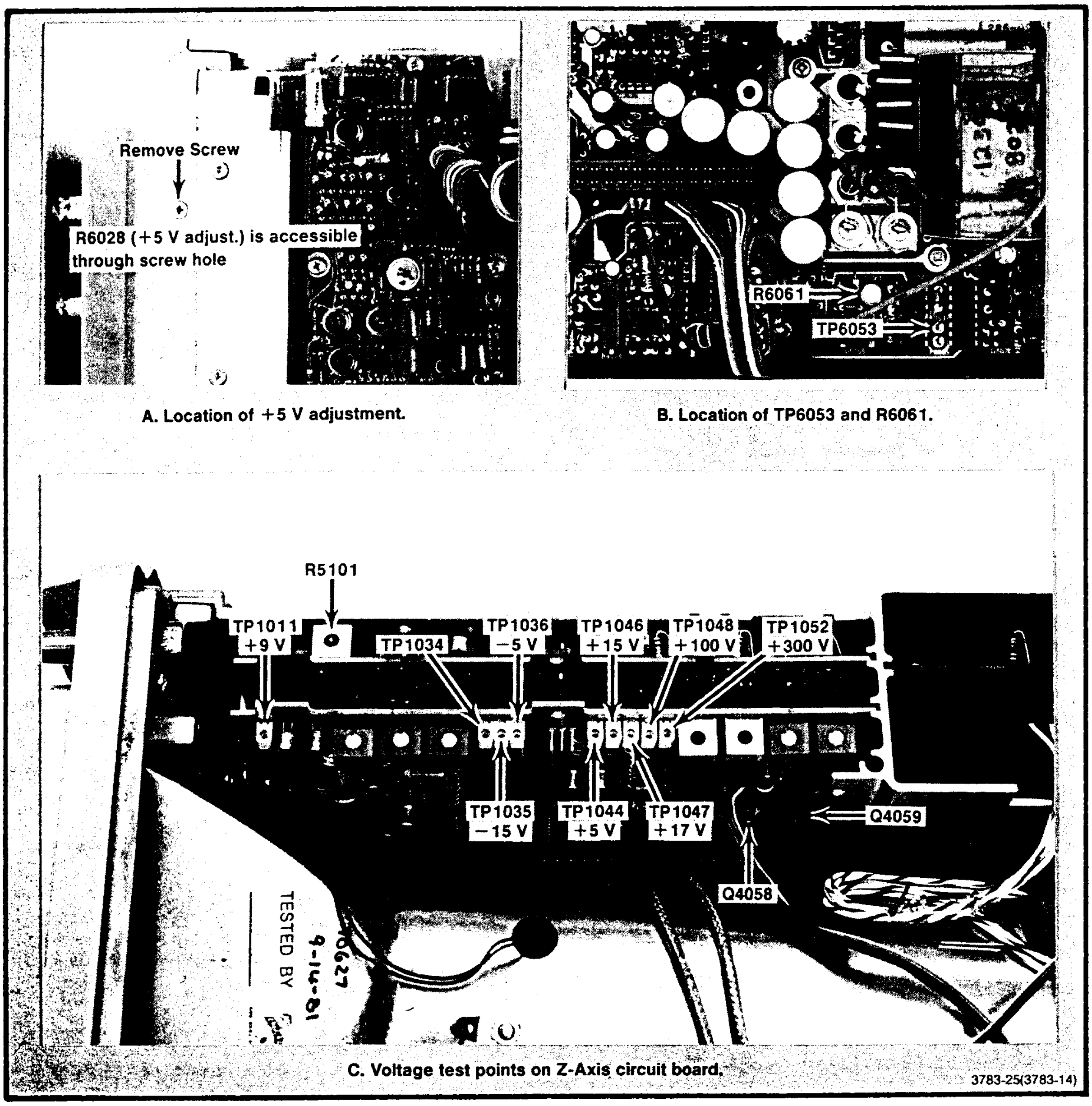


Fig. 3-22. Low voltage power supply adjustments and test point locations.

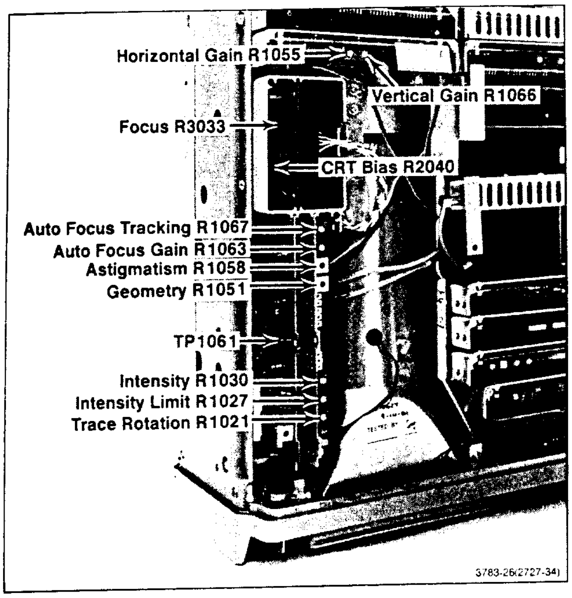


Fig. 3-23. Adjustments and test points on the deflection amplifier, High Voltage module, and Z Axis/RF Interface board.

c. Adjust Crt Bias as follows:

1) Using a voltmeter on the 20 volt range, measure and record the collector voltage of Q4058 or Q4059 (Fig. 3-22) on the Z-Axis board.

2) Turn INTENSITY clockwise until a crt beam dot appears on the screen.

3) Focus the dot by adjusting R3033 on the High Voltage board (Fig. 3-23).

4) Set the INTENSITY control for a collector voltage which is about 5.5 volts higher than the voltage noted in part 1.

5) Use the non-metallic screwdriver to adjust Crt Bias R2040 counterclockwise until the crt beam is visible, then turn the adjustment clockwise until the dot just extinguishes, with the screen shaded. (If no dot appears with the adjustment fully counterclockwise, this will be the bias setting.)

6) Turn the INTENSITY control clockwise until a dot is visible. Defocus the dot with the focus adjustment, then adjust Astigmatism R1058 (Fig. 3-23) for a round dot. Re-focus the crt beam dot.

7) Turn the INTENSITY control counterclockwise until the dot just disappears and again measure the collector voltage of Q4058 or Q4059. Voltage should equal or exceed the voltage measured in part 4. If the voltage is less, repeat the procedure for setting Crt Bias.

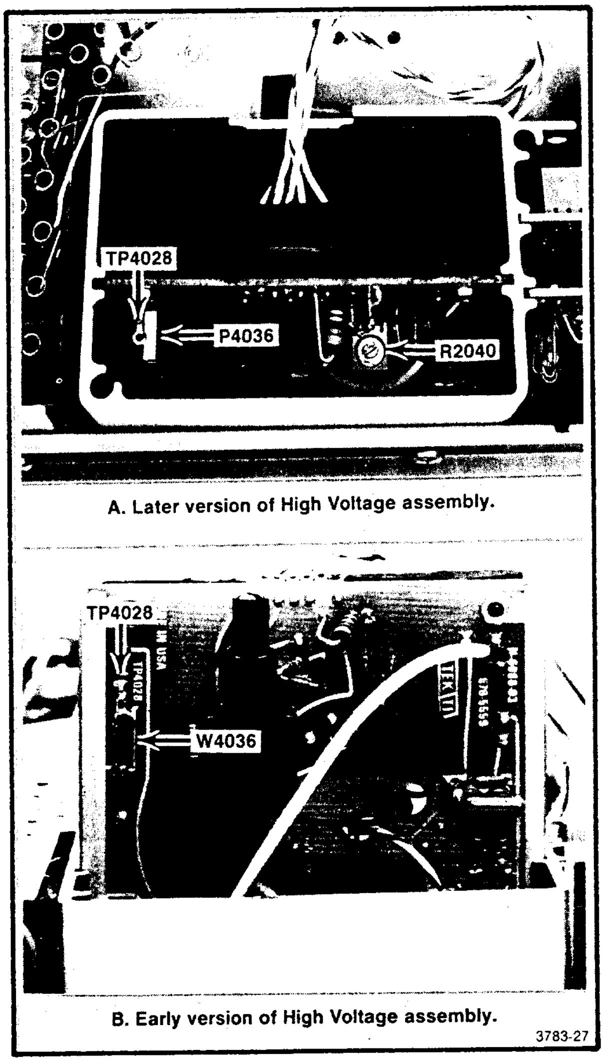


Fig. 3-24. Location of wire strap (W4036) on high voltage circuit board.

d. Adjust the Crt cathode current as follows:

1) Switch POWER off then remove P4036 (Fig. 3-24) on the High Voltage board. Turn the INTENSITY control fully clockwise, the MANUAL SCAN fully counterclockwise and ensure that the TIME/DIV is in MNL position. Set the Intensity Limit R1027 on the Z-Axis board (Fig. 3-23) fully clockwise.

2) Connect the voltmeter between TP4028 (Fig. 3-24) and the ground lug on the crt shield.

3) Turn POWER on. After the instrument initializes, activate the 2 dB/DIV display mode and switch READOUT and Digital Storage off.

4) Adjust Intensity Limit R1027 (Fig. 3-23) for a voltage reading of 0.9 volt at TP4028.

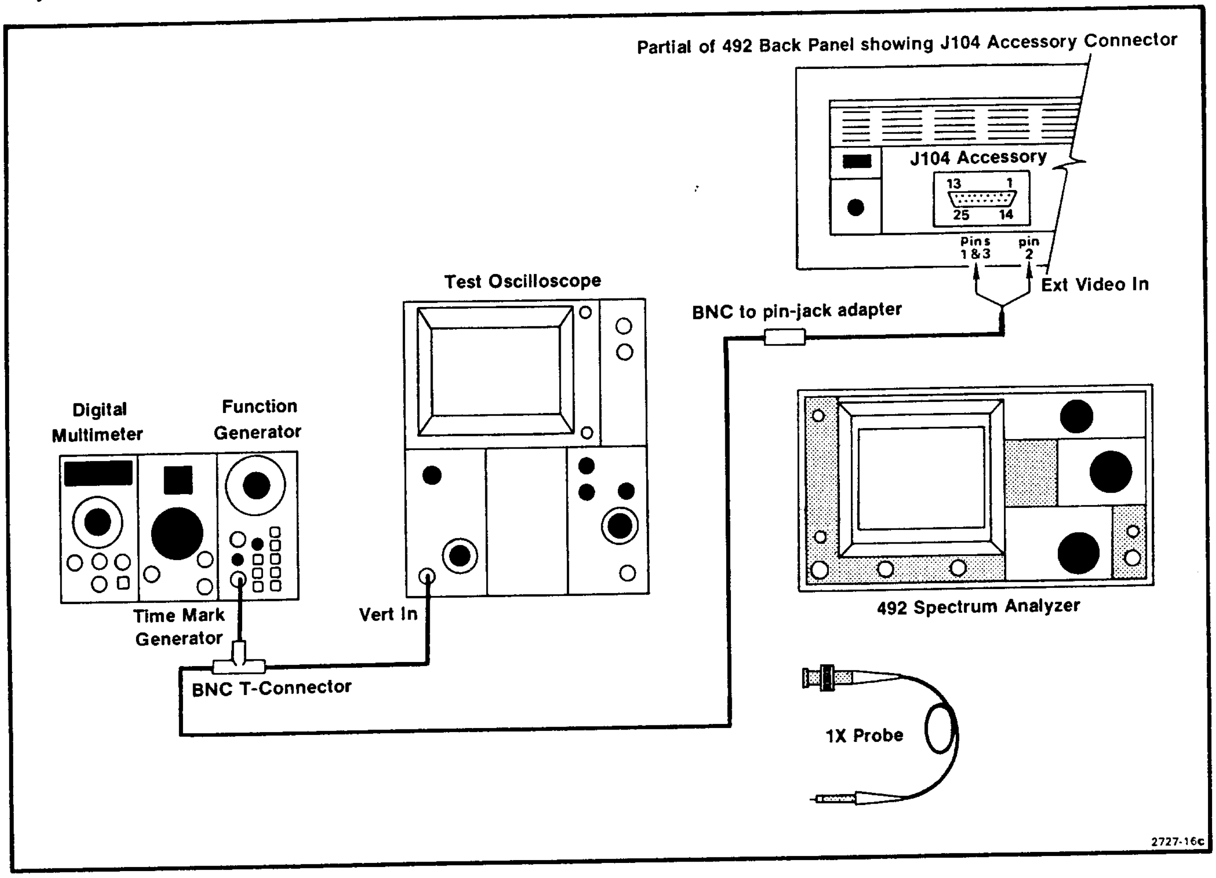


Fig. 3-25. Test equipment setup for calibrating the Deflection Amplifier.

5) Switch POWER off and re-install the jumper P4036, on the High Voltage board. Turn POWER on.

e. Apply the CAL OUT signal to the RF INPUT and set the front panel controls as follows:

FREQUENCY	100 MHz
FREQ SPAN/DIV	10 MHz
RESOLUTION BANDWIDTH	MAX
TIME/DIV	AUTO
REF LEVEL	−20 dBm
VIDEO FILTER	NARROW
MIN RF ATTEN dB	0
Vertical Display	10 dB
Digital Storage	off

f. Reduce the FREQ SPAN/DIV toward 0 Hz while keeping the calibrator signal centered on screen with the FREQUENCY control. Adjust the REF LEVEL so the trace is approximately mid-screen; then adjust the Trace Rotation R1021 (Fig. 3-23) so the trace is aligned with the graticule lines.

g. Change the REF LEVEL so the trace is approximately 15 to 20 dB below the top of the screen. Now, while alternately switching between 2 dB/DIV and 10 dB/DIV, adjust Geometry R1051 (Fig. 3-23) for the straightest trace at the top and bottom of the screen.

If the instrument has Digital Storage, turn the storage on and use the PEAK/AVERAGE cursor, positioned at the top and bottom of the screen, as a reference line to set geometry.

h. Change the REF LEVEL to position the trace within the graticule area with the Vertical Display mode in 2 dB/DIV. Activate Digital Storage if the instrument has Option 02.

i. Adjust INTENSITY so the trace is just visible.

j. Adjust Δ Intensity R1030 (Fig. 3-23) so the brightness of the readout characters is the same (just discernible) as the trace.

k. Rotate the INTENSITY control and note that the brightness of the trace and readout characters track.

3. Deflection Amplifier (gain and frequency response)

a. Test equipment setup is shown in Fig. 3-25. Set the TIME/DIV to 5 ms, Vertical Display to 2 dB/DIV, and switch Digital Storage off. Position the trace on the bottom graticule line.

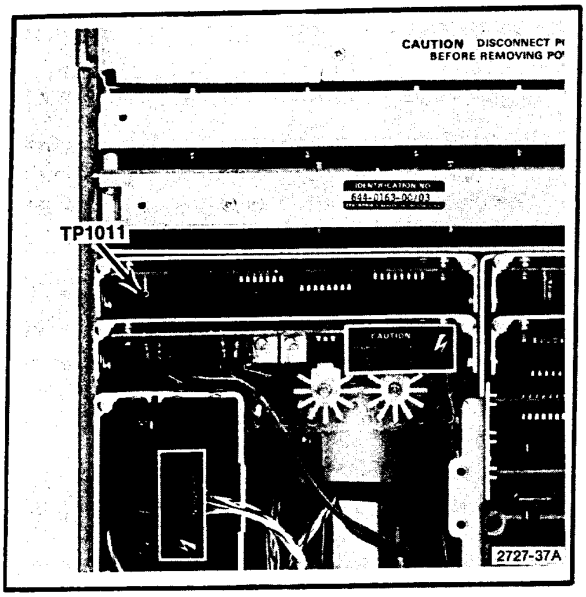


Fig. 3-26. Location of TP1101 on Crt Readout.

b. Apply a 5 kHz, 0 to +4 V signal, from the sine-wave generator, through a bnc-to-pin-jack adapter, to the Ext Video input (pin 2) and Video Select (pin 1) of the ACCESSORIES jack (see Fig. 3-25).

c. Adjust Vert Gain, R1066 (Fig. 3-23), for a full screen display (0 to +4 V). Remove the 5 kHz signal from pin 2 of the ACCESSORIES jack.

d. Set TIME/DIV to MNL, and Vertical Display to 2 dB/DIV.

e. Connect a digital voltmeter (DVM) to TP1061 (Fig. 3-23) and adjust MANUAL SCAN for 0.0 V at TP1061. Adjust horizontal Position control to center MANUAL SCAN dot,

f. Adjust MANUAL SCAN for a reading of +5 V at TP1061. Now adjust Horiz Gain, R1055 (Fig. 3-23), to position the crt beam to the right graticule edge (10th graticule line).

g. Adjust MANUAL SCAN so crt beam moves to the left edge of the graticule and check that the voltage at TP1061 is now approximately −5.0 V.

h. Turn the POWER off and disconnect the DVM. Remove and install the Deflection Amplifier board on an extender.

i. Change the test oscilloscope to Ext Trigger. Apply the Readout Off signal at TP1011 (Fig. 3-26), in the upper left corner of the crt readout board, to the test oscilloscope Ext Trigger input. Adjust the controls for a triggered sweep. Turn the 492/492P sweep off by activating SINGLE SWEEP, deactivate Digital Storage and ensure READOUT is on.

j. Connect the test oscilloscope probe to the collectors of Q1031 and Q1024. Adjust C5021 (Fig. 3-27) for the best frequency response (no overshoot or rolloff).

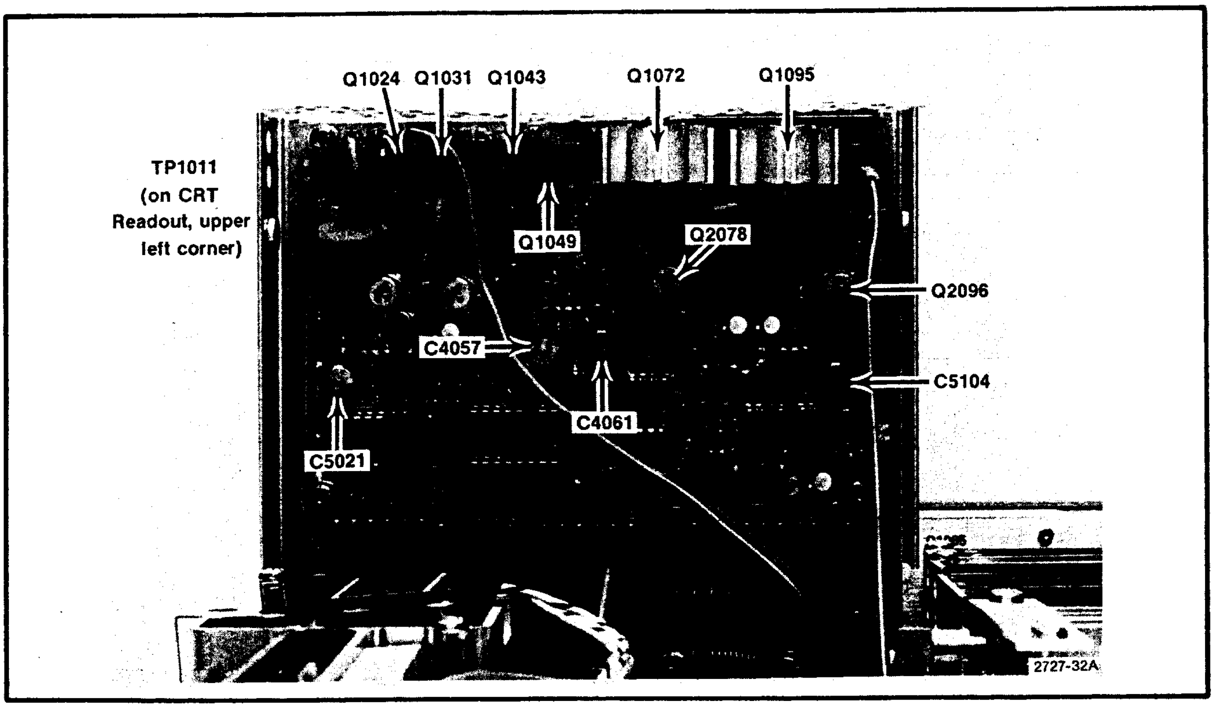


Fig. 3-27. Test points and adjustments on the Deflection Amplifier board for gain and frequency response calibration.

k. Connect the probe to the collectors of Q1043 and Q1049. Adjust C4057 (Fig. 3-27) for the best response.

l. Connect the probe to the collectors of Q1072, Q2078 (Fig. 3-27), and adjust C4061 for the best response.

m. Connect the probe to the collectors of Q1095, Q2096 (Fig. 3-27), and adjust C5104 for best response.

n. Remove the probe and Ext Trigger connection to TP1011.

o. Check the appearance of "Z" in GHz of the frequency readout. If necessary, adjust C5104 and C4061 (vertical output) for the straightest top on the Z.

p. Set the Vertical Display to LIN and adjust REF LEVEL for 100 μV/. Set TIME/DIV to MNL and adjust MANUAL SCAN fully clockwise.

q. Adjust C5021 and C4057 for best REF LEVEL readout (straightest letters and numerals).

4. Adjust Sweep Timing

a. Test equipment setup is shown in Fig. 3-28. Select EXT Triggering, TIME/DIV of 10 ms, and a FREQ SPAN/DIV of 10 MHz or less.

b. Apply 10 ms time marks from the time-mark generator to the EXT Video In (pins 2 and 1 of the ACCESSORIES jack, see Fig. 3-28) and the Trigger Output of the time-mark generator to the EXT TRIG input on the back panel of the 492/492P. This should provide a display of 10 ms markers.

c. Adjust Sweep Timing, R5105 (see Fig. 3-29), for 1 marker/division. (Use POSITION adjustments to align markers.)

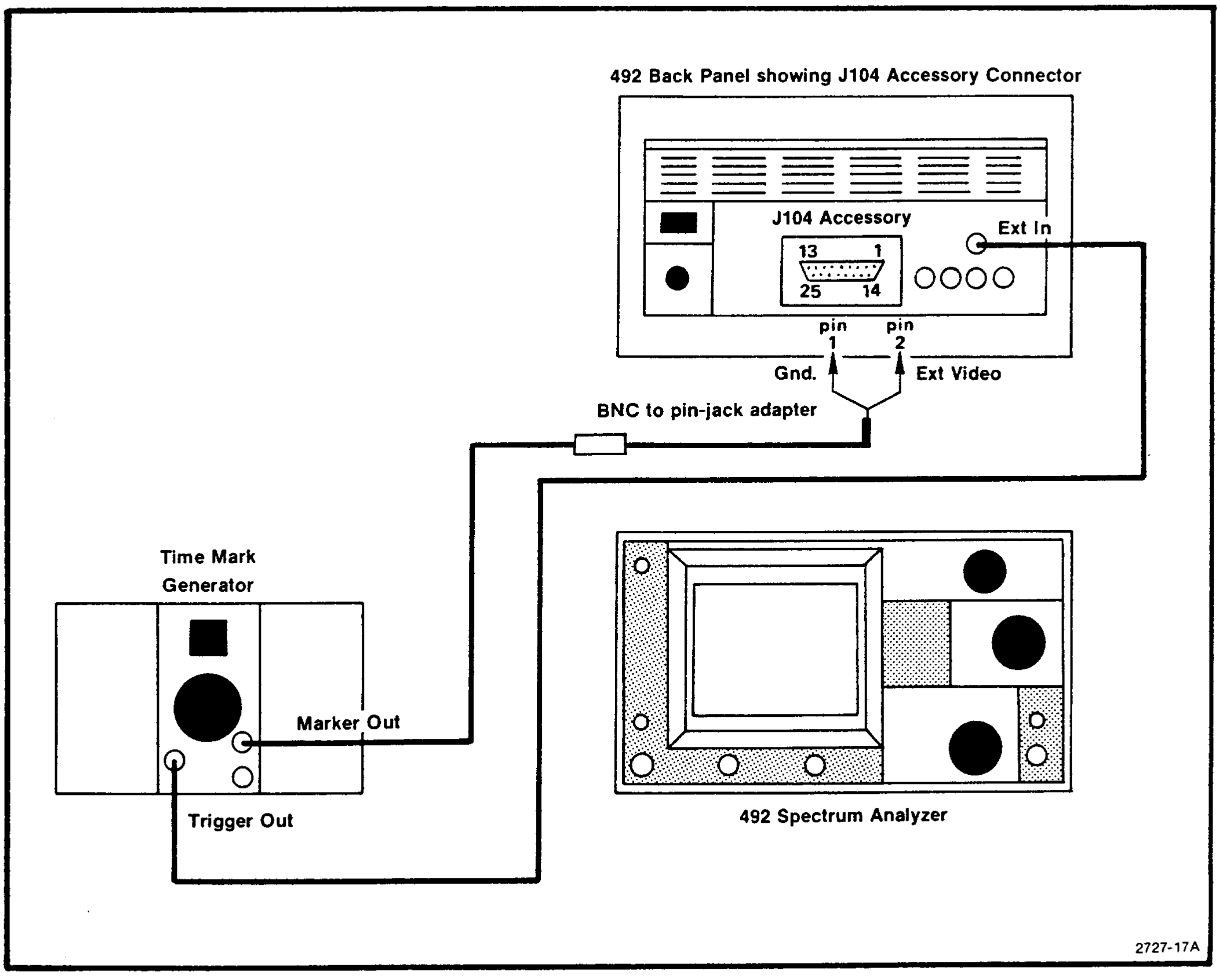


Fig. 3-28. Test equipment setup for calibrating sweep timing.

d. Check the remaining TIME/DIV selections for ±5% or less error over the center eight divisions.

e. Set the TIME/DIV to AUTO, FREQ SPAN/DIV to MAX, and activate AUTO RESOLUTION.

f. Check the Time/Div versus Resolution Bandwidth as per Table 3-11 for the different FREQ SPAN/DIV settings.

g. Return Triggering to FREE RUN and remove the time-mark generator markers to the 492/492P. Reposition the trace if moved in part c.

Table 3-11
RESOLUTION AND SWEEP RATE
AS A FUNCTION OF SPAN IN THE AUTO MODE

FREQ SPAN/DIV	RESOLUTION	TIME/DIV
MAX	1 MHz	50 ms
200 MHz	1 MHz	20 ms
100 MHz	1 MHz	10 ms
50 MHz	1 MHz	10 ms
20 MHz	1 MHz	10 ms
10 MHz	1 MHz	10 ms
5 MHz	1 MHz	10 ms
2 MHz	100 kHz	10 ms
1 MHz	100 kHz	10 ms
500 kHz	100 kHz	10 ms

Table 3-11 (cont)

FREQ SPAN/DIV	RESOLUTION	TIME/DIV
200 kHz	10 kHz	50 ms
100 kHz	10 kHz	20 ms
50 kHz	10 kHz	10 ms
20 kHz	10 kHz	10 ms
10 kHz	1 kHz	50 ms
OPTION 03 ONLY		
5 kHz	1 kHz	20 ms
2 kHz	1 kHz	10 ms
1 kHz	100 Hz	.5 s
500 Hz	100 Hz	1 s

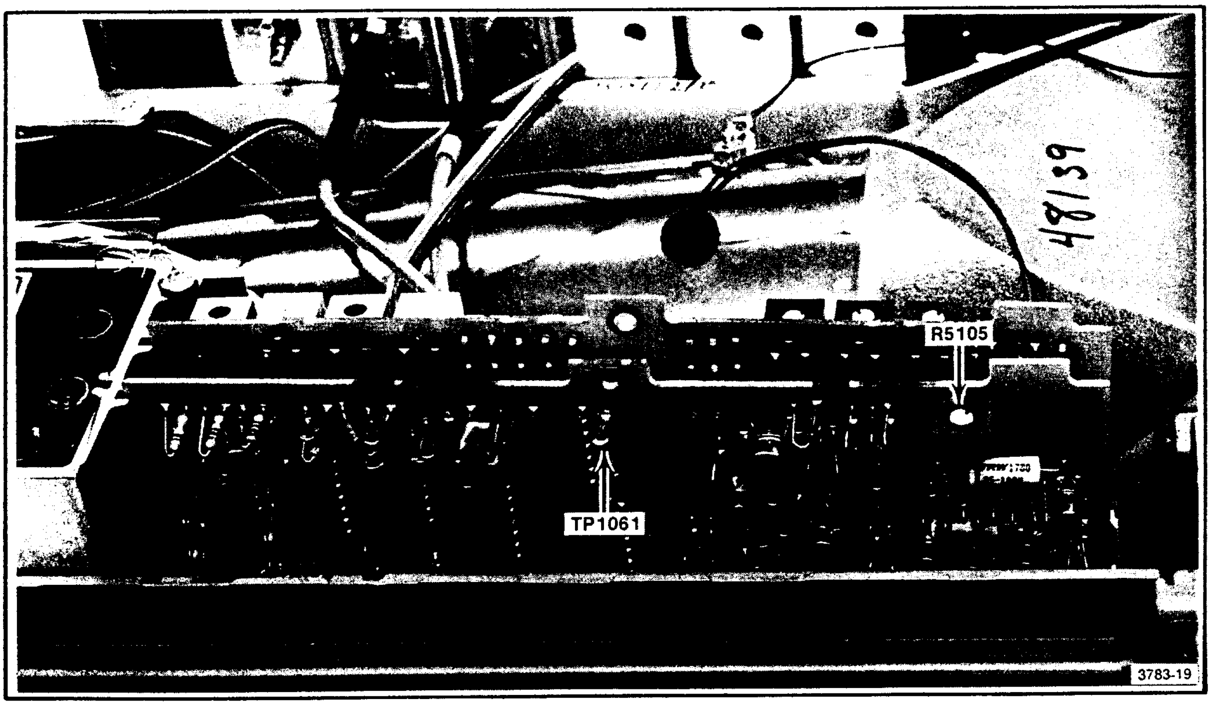


Fig. 3-29. Location of timing adjustment R5105 and TP1061 on Sweep board.

5. Calibrate the 1st LO System and Center Frequency Control

An alternate procedure for the 492P is provided using program control. Before proceeding with this step, check sweep timing and amplitude accuracy.

a. Adjust Coarse Tuning Range

1) Test equipment setup is shown in Fig. 3-30. Set the front-panel controls as follows:

FREQUENCY RANGE	0—4.2 GHz (0—1.8 GHz Option 01 and activate EXTERNAL MIXER). If the 492/492P has Option 01 and Option 08 (External Mixer deleted), switch POWER off, remove Preselector Driver board, switch POWER on and select band 1.
FREQ SPAN/DIV	200 MHz
TIME/DIV	MNL
Triggering	FREE RUN
MANUAL SCAN	Midrange

2) Connect the digital voltmeter (DVM), set to the 20 V range, between TP1058 of the 1st LO Driver and chassis ground (Fig. 3-31), so the voltage at the test point can be monitored. Adjust FREQUENCY for a readout of 0 MHz as the FREQ SPAN/DIV is reduced to 5 MHz. Note the DVM reading.

3) Tune the FREQUENCY for a readout of 4.278 GHz (switch FREQ SPAN/DIV to 200 MHz to facilitate tuning, then reduce to 5 MHz).

4) Note the DVM setting.

5) If the differential between 0 MHz and 4.278 GHz is not 20.00 V, adjust Coarse Tuning Range R1032 on the Center Frequency Control board (Fig. 3-31) until the voltage difference between the two frequency points is 20.00 V.

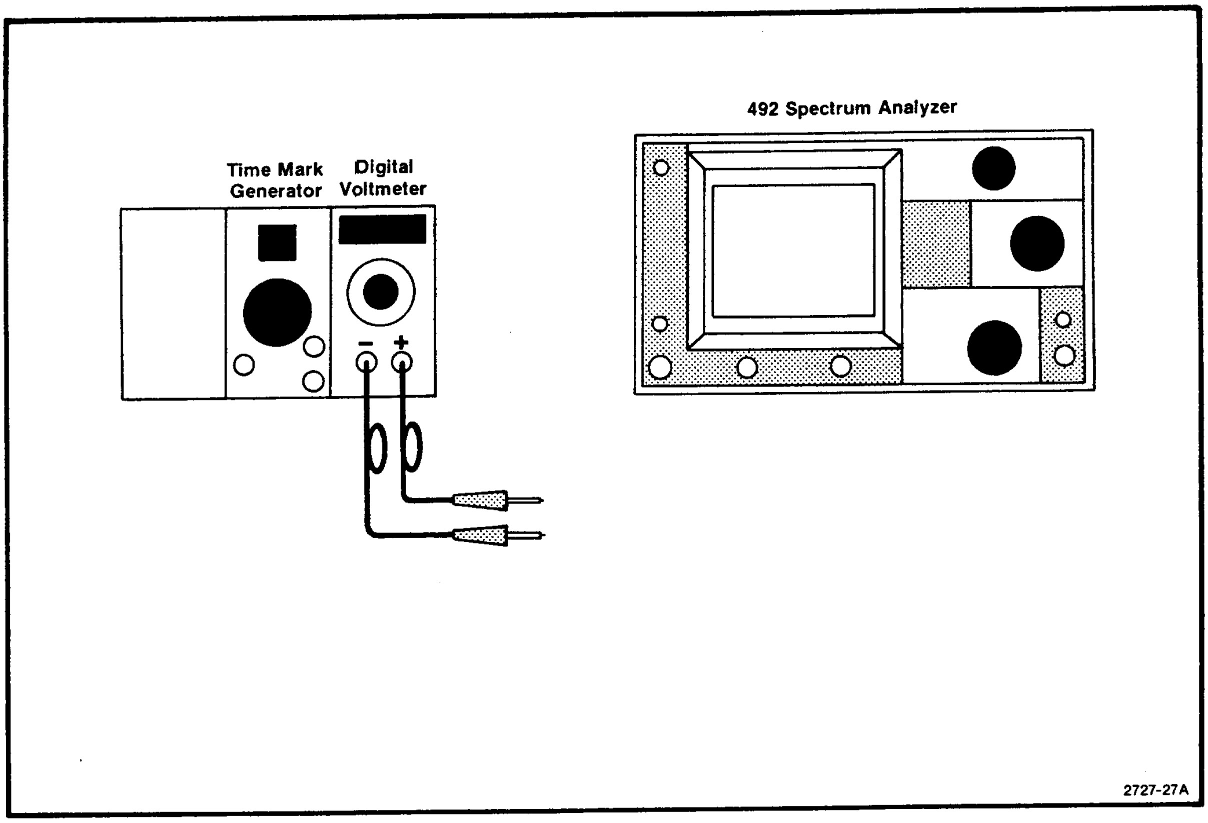


Fig. 3-30. Test equipment setup for calibrating sweep ramp for the 1st LO Driver.

b. Calibrate 10 V Supply

1) Connect the DVM to TP1059, on the 1st LO Driver (Fig. 3-31A).

2) Adjust R1034 (Fig. 3-31A) for −10.00 V).

c. Adjust Sweep Offset

1) Connect a shorting strap from TP1035, on the Span Attenuator board, to chassis ground (Fig. 3-31). Monitor the voltage on TP1073 (Fig. 3-31) with the DVM.

2) Adjust Sweep Offset R1063 for 0.00 V.

3) Remove shorting strap and switch EXTERNAL MIXER off. If the Preselector Driver board was removed turn POWER off and replace the board. Turn POWER on.

d. Calibrate Frequency Span to Center Frequency Readout. (This is followed by an alternate procedure for 492P only instruments.)

1) Apply the Calibrator output to the RF INPUT. Set the FREQ SPAN/DIV to 100 MHz, activate FREQUENCY CAL, then set the readout calibration at the center of the CAL range (range is about ±15 MHz). Deactivate the FREQUENCY CAL function.

2) Initialize the front panel control settings by switching POWER off, then on. Set the FREQ SPAN/DIV to 200 MHz, TIME/DIV to AUTO, and REFERENCE LEVEL to −30 dBm (MIN RF ATTEN at 0 dB).

3) Adjust the FREQUENCY to tune the 18th marker of the Calibrator signal to the center of the screen, then reduce the FREQ SPAN/DIV to 2 MHz, activate DEGAUSS, and set the FREQUENCY readout to 1.800 GHz.

4) Adjust the 1st LO Offset R1032 (Fig. 3-31) on the 1st LO Driver board to center the 1.8 GHz marker.

5) Tune the FREQUENCY for a readout of 100 MHz (switch the SPAN/DIV to a higher setting to facilitate tuning, then back to 2 MHz). Degauss by pressing DEGAUSS.

6) Adjust 1st LO Sensitivity R1031 (Fig. 3-31) on the 1st LO Driver board to center the 100 MHz marker.

7) Repeat these steps to correct for any interaction.

8) Tune the FREQUENCY for readout of 4.200 GHz (for Option 01 instruments, select band 2 and tune for a readout of 5.500 GHz). Switch the SPAN/DIV to a higher setting to facilitate tuning then back to 2 MHz. Press the DEGAUSS button.

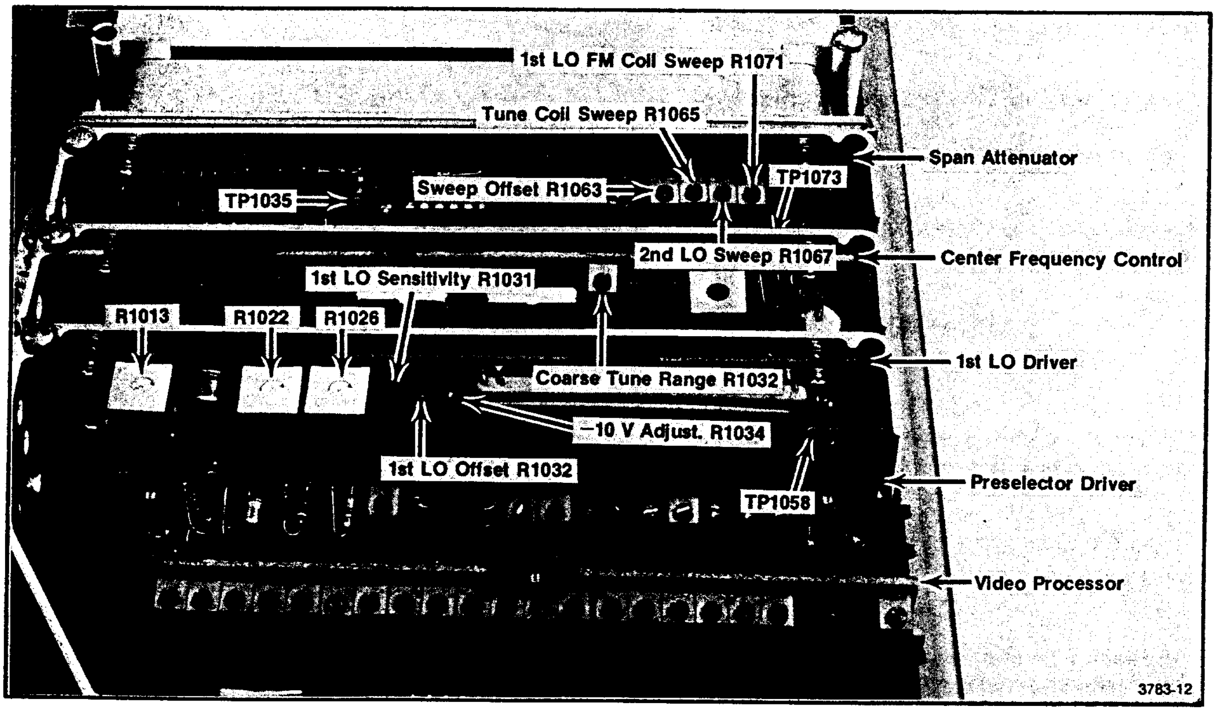


Fig. 3-31. 1st LO balance and span adjustments and test points.

9) Check that the 4.2 GHz (5.5 GHz, Option 01) marker is within 8.4 MHz (11.0 MHz, Option 01) of screen center. (If the error is large it may be necessary to change the SPAN/DIV to 5 MHz.) If the error is greater than 8.4 MHz (11.0 MHz, Option 01) proceed with the next step, if not proceed to paragraph 11.

10) Center the 4.2 GHz (5.5 GHz, Option 01) marker on screen with the FREQUENCY control.

a) If the readout is equal to or greater than 4.216 GHz (5.522 GHz Option 01) adjust the 1st LO Offset R1032, on the 1st LO Driver board, (Fig. 3-31) to move the marker 4 MHz (5.5 MHz, Option 01) lower.

b) If the readout is between 4.208 and 4.216 (5.511 and 5.522, Option 01) adjust R1032 to move the marker one half the difference between the error and 4.208 GHz (5.511 GHz, Option 01); for example, a readout of 4.212 would require a 4.210 (4.212 − 4.208) correction.

11) Tune the FREQUENCY readout to 4.207 GHz (5.510 GHz, Option 01) and adjust the 1st LO Sensitivity R1031, on the 1st LO Driver board, (Fig. 3-31) so the marker is at center screen.

12) Recheck readout accuracy as described in the Performance Check part (step 2) of this section, across band 1 (band 1 and 2 of Option 01 instruments) to ensure that the accuracy is within performance requirement.

ALTERNATE PROCEDURE TO CALIBRATE FREQUENCY SPAN TO CENTER FREQUENCY READOUT, FOR 492P INSTRUMENTS.

Instructions for the 4050 program are given in parentheses.

1. Send

"INIT;REF −20;SPAN 2M;SIG"
"FREQ 100M;DEG;SIG;WAIT;FREQ 1.8G;DEG;-SIG;WAIT; REP 1200"

This will give an adjustment sequence for about two minutes. If necessary, re-send the command to complete the adjustment.

(Press USER key 3 to start the sequence and press the BREAK key to stop.)

2. If the adjustments are fairly close, two signals will appear on screen on alternate sweeps; a large and a small signal. The small signal is 1.8 GHz, the large at 100 MHz. Proceed with the following adjustments:

a) Adjust the 1st LO Offset R1032 on the 1st LO Driver board, to bring the two signals to the same horizontal position. If one or no signals appear on screen, adjust R1031 until a signal comes on screen. Then adjust R1032 (1st LO Offset) until the second signal appears while alternately adjusting the 1st LO Sense R1031 to keep the first signal on screen.

b) Adjust 1st LO Sense R1031, on the 1st LO Driver board, to align the two signals with the vertical centerline of the graticule.

c) Send "FREQ 4.2 G;DEG"
(For Option 01, send; "FREQ 5.5 G; Deg")

d) If the marker is greater than 8.6 MHz (11.0 MHz, Option 01) perform steps d(10) and d(11)

e) Recheck across band 1 by re-sending the 4050 program of paragraph 1 above and repeat paragraph 2 procedure.

e. Adjust 1st LO Sweep (Applicable to both 492 and 492P instruments)

1) With the Calibrator output applied to the RF INPUT, set the FREQ SPAN/DIV to 100 MHz and tune the FREQUENCY to about 500 MHz.

2) Adjust Tune Coil Swp R1065 (Fig. 3-31) on the Span Attenuator board so the 100 MHz harmonics of the Calibrator are spaced at one division intervals over the center eight divisions of the graticule. Adjust the FREQUENCY as necessary to align the markers.

3) Remove the Calibrator signal.

4) Set the FREQ SPAN/DIV to 2 MHz, REF LEVEL to +10 dBm, FREQUENCY about 15 MHz, then apply 0.5 μs markers from a time-mark generator to the RF INPUT.

5) Adjust the 1st LO FM Coil Swp R1071 (Fig. 3-31) for 1 marker/division over the center eight divisions of the display.

f. Max Span Dot (Offset to align dot with display).

a) Remove 50 Ω cable from 492 RF INPUT.

b) Set 492 CENTER FREQUENCY to exactly 0 MHz, AUTO RESOLUTION pushbutton on, FREQ SPAN/DIV to MAX, and VIEW A and VIEW B both OFF.

c) Select R1028 on the YIG Driver board to set the MAX SPAN DOT directly on the Start Spur. See Fig. 53B.

NOTE

A larger resistor will move the Dot to the right and a smaller resistor will move it to the left. A 1K change in resistance will move the dot approximately one minor division.

g. Adjust 2nd LO Sweep

1) Set the front panel controls as follows:

FREQUENCY RANGE	5.4—18 GHz (Band 4)
FREQUENCY	6.0 GHz
FREQ SPAN/DIV	20 MHz
AUTO RESOLUTION	Activated
Vertical Display	10 dB/DIV
REF LEVEL	−10 dBm
MIN RF ATTEN	20 dB

2) Connect the comb generator to the RF INPUT and apply 10 μs markers from the time-mark generator to the FM Input of the comb generator. Adjust PEAKING (Option 1 instruments) to maximize the amplitude of the comb markers.

NOTE

If a signal cannot be located at 6.0 GHz with Option 1 instruments, check preselector tracking, step 18.

3) Adjust REF LEVEL and FREQUENCY to display and center the 6.0 GHz comb line, then reduce FREQ SPAN/DIV progressively to 100 kHz while keeping the 6.0 GHz signal centered on the display.

4) Adjust the 2nd LO Swp, R1067, (Fig. 3-31) on the Span Attenuator circuit board, so the two comb lines near the graticule edges are 8 divisions (800 kHz) apart.

5) Disconnect and remove the comb generator and time-mark generator from the RF INPUT. Return the FREQUENCY RANGE to band 1.

6. Check 2nd LO Frequency and Adjust Tune Range

The procedure applies to both versions of the 2nd LO. An alternate procedure is also described for use with the programmable 492P over the GPIB bus.

a. Check the 2nd LO frequency as follows:

1) Set the FREQUENCY RANGE to band 1 and FREQ SPAN/DIV to MAX.

2) Connect a microwave frequency counter, such as Hewlett Packard 5342A, with a sensitivity of −20 dBm or better, to the 2nd LO Output connector.

3) Measure the 2nd LO frequency. Frequency should be 2182 MHz ±1.0 MHz. If the frequency is not within this limit, proceed as follows: Instruments that have the 2182 MHz Phaselocked 2nd LO (B040000 and up) refer to the Maintenance section for repair. If your instrument has the Cavity 2nd LO (B039999 and below) proceed with the following adjustment.

a) Using a 5/16 inch open-end wrench and a 5/64 inch Allen wrench, loosen the lock nut and adjust the Fine Tune slug in the cavity (Fig. 3-32B) for a counter reading of 2182.0 MHz.

CAUTION

Do not adjust the two slotted slugs. These are Varactor diode mounts.

b) Tighten the lock nut and recheck the oscillator frequency. If correct, disconnect the counter and proceed with part b.

b. Adjust tuning range of the 2nd LO as follows:

1) On the Center Frequency Control circuit board, center the Fine Tune Range, R4040, and the Fine Tune Sensitivity, R3040, adjustments (see Fig. 3-33).

2) Set the FREQUENCY TO 5 MHz, FREQ SPAN/DIV to 100 kHz, REF LEVEL to +10 dBm and MIN RF ATTEN to 10 dB. Apply 2 μs markers from a time-mark generator to the RF INPUT.

3) Adjust the FREQUENCY to position a frequency marker 2.5 major divisions right of center then reduce the FREQ SPAN/DIV to 50 kHz. Markers should now appear at the graticule edge.

4) Turn the FREQUENCY control counterclockwise until the 2nd LO reaches the end of its tuning range (markers stop moving).

5) Note the position of the marker signal. If the instrument has digital storage, activate SAVE A to save the marker reference position.

6) Turn the FREQUENCY control clockwise and count the markers as they cross the reference signal location until the end of the tuning range is reached. The 9th marker should now be on screen close to the reference point. Note its position with respect to the reference established in part 5.

7) If the 9th marker is more than one major division from the reference, adjust Fine Tune Range R4040 so as to reduce this distance by one half.

Adjustment Procedure

8) The 492P, if used with an external controller, requires adjustment of the Fine Tune Sensitivity R3040. A controller is required to make this adjustment. See Alternate Procedure for 492P; otherwise, R3040 should remain centered.

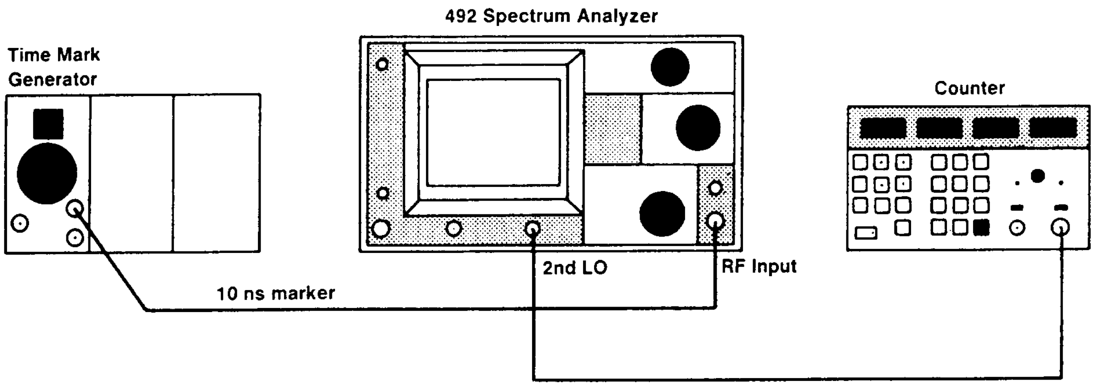
c. Adjust Identify Offset as follows:

1) Apply 1 μs markers to the RF INPUT and set the FREQ SPAN/DIV to 500 kHz;

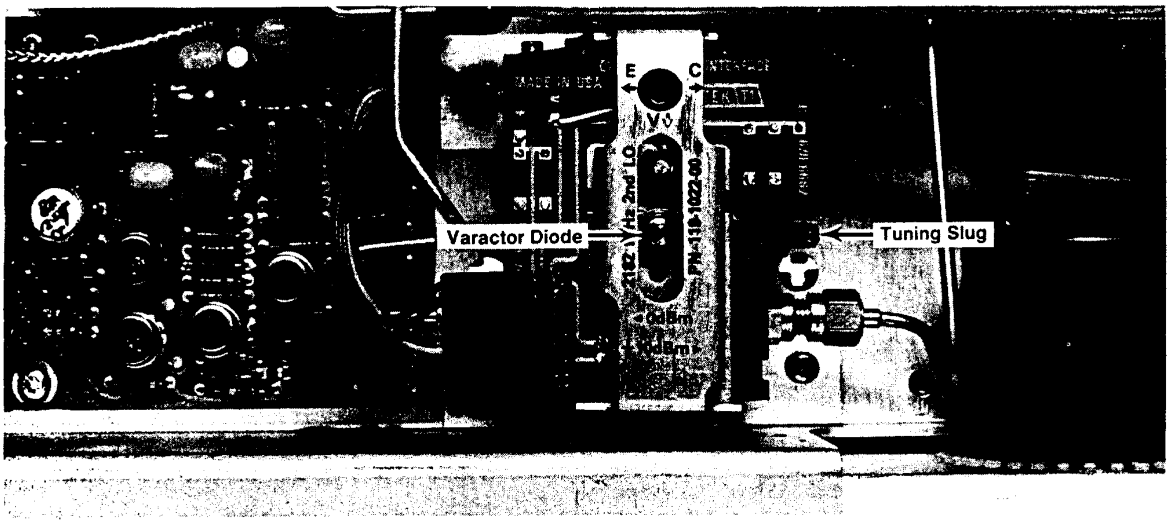
2) Tune the FREQUENCY to 5 MHz then center one of the 1 μs markers on screen.

3) Activate the IDENTIFY 500 kHz/ONLY mode;

4) Adjust Coarse Tune Sensitivity R1028 (Fig. 3-33) on the Center Frequency Control board so that, on alternate sweeps, the signals align horizontally with each other.



A. Test equipment setup for check and adjustment of 1st and 2nd LO frequency.



B. Tuning adjustment on the 2nd LO.

3783-15

Fig. 3-32. Test equipment setup for check and adjustment of 1st and 2nd LO frequencies.

ALTERNATE PROCEDURE FOR 492P

NOTE

Instructions in parentheses refer to the 4040-Series program as listed at the end of step 7 (Adjust 1st Converter Bias). At the end of any programmed procedure press the RETURN TO LOCAL button.

a. Adjust the 1st LO Tune Sensitivity as follows:

1) Set the MIN RF ATTEN to 30 dB and apply 1 μs markers to the RF INPUT from the time mark generator. Set the FREQ SPAN/DIV to 500 kHz and adjust FREQUENCY to center one of the markers on screen.

2) Send: "INIT;FREQ 10M;SPAN 100k" to the 492P over the GP!B bus.

3) Adjust the FREQUENCY control to center the marker on screen, then send: "TUNE 5M; SIG; WAIT;TUNE −5M;SIG;WAIT;RPT 1200". This will repeat the adjustment sequence for about two minutes. Send the instruction again if necessary to complete the adjustment.

(Press USER DEFINABLE KEY #4 to start the sequence and press BREAK to stop the sequence.)

b. Adjust the Coarse Tune Sensitivity R1028 until the harmonics of alternate sweep are at the same horizontal position in the display as the regular sweep. It is not important where they are in the display, just so they are at the same horizontal location.

c. Adjust the 2nd LO range as follows:

1) Tune the FREQUENCY to about 10 MHz and center one of the 1 μs markers on screen.

2) Decrease the FREQ SPAN/DIV to 50 kHz keeping the marker centered on screen with the FREQUENCY control.

3) Send: "TUNE 2M;SIG;WAIT;TUNE −2M;SIG;WAIT; REP 1200". This will repeat the adjustment sequence for about two minutes. Repeat the command if necessary.

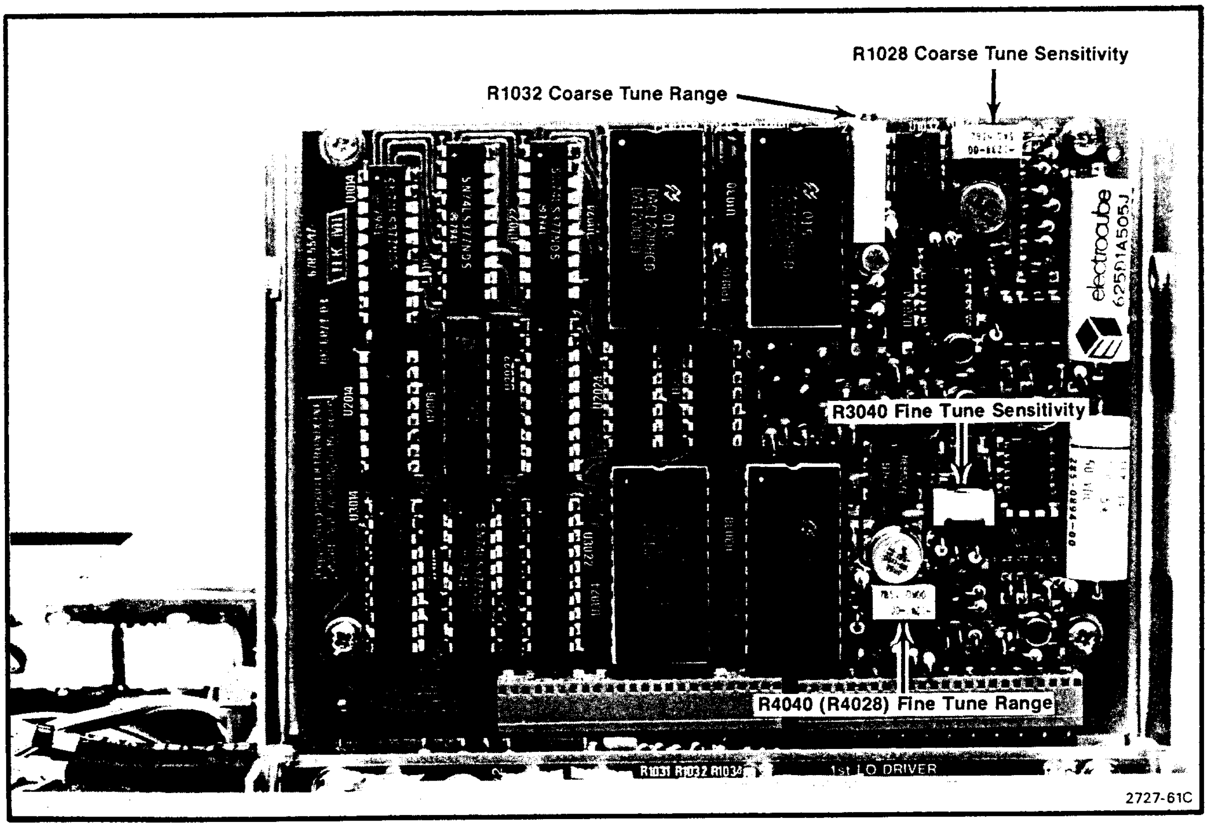


Fig. 3-33. Center Frequency Control adjustment locations.

(Press USER DEFINABLE KEY #5 to start the sequence and BREAK to stop the sequence.)

d. Adjust Fine Tune Range, R4040, until the displayed signals for alternate sweeps align horizontally with those on the initial sweep.

e. Adjust the 2nd LO Tune Sensitivity as follows:

1) Apply 0.5 ms markers to the RF INPUT, change the FREQ SPAN/DIV to 1 MHz, and tune FREQUENCY to about 0 MHz. Decrease the FREQ SPAN/DIV to 5 kHz and tune the zero spur to the left side of the display. Decrease the FREQ SPAN/DIV to 500 Hz.

2) Send: "TUNE 2K;SIG;WAIT;TUNE −2K;SIG; WAIT; REP 150". This will repeat the adjustment sequence for five minutes. Repeat the command if necessary.

(Press USER DEFINABLE KEY #6 to start the sequence and press BREAK to stop the sequence.)

3) Adjust Fine Tune Sensitivity R3040 until the harmonics displayed in alternate sweep have the same horizontal location as the even sweep. Note: This may take some time because of the long sweep time and drift.

PROGRAM TO FACILITATE CALIBRATING THE 1st LO DRIVER AND THE CENTER FREQUENCY CONTROL BOARDS OF THE 492P, USING TEKTRONIX 4050-SERIES COMPUTER TERMINAL

```
1     ON SRQ THEN 700
2     GO TO 700
4     ON SRQ THEN 100
5     GO TO 210
8     ON SRQ THEN 100
9     GO TO 230
12    ON SRQ THEN 100
13    GO TO 300
16    ON SRQ THEN 100
17    GO TO 400
20    ON SRQ THEN 100
21    GO TO 500
24    ON SRQ THEN 100
25    GO TO 600
100   REM *** ERROR HANDLING ROUTINE ***
110   POLL Z8,Z9;A9
120   PRINT @A9:"ERR?"
130   INPUT @A9:Z$
140   PRINT @Z$
150   RETURN
200   REM *** ADJUST COARSE TUNE RANGE R1032 CEN FRE CONTROL BRD ***
210   PRINT @A9:"FRE 0"
220   RETURN
230   PRINT @A9:"FRE 4278M"
240   RETURN
300   REM *** ADJUST 1ST LO SENSE (GAIN) AND OFFSET ***
310   PRINT @A9:"FRE 100M;DEG;SIG;WAI"
320   PRINT @A9:"FRE 1.8G;DEG;SIG;WAI"
330   GO TO 310
400   REM *** ADJUST COARSE TUNE SENSITIVITY R1028 CEN FRE CON BRD ***
```

```
410 PRINT @A9:"TUN 5M;SIG;WAI"
420 PRINT @A9:"TUN -5M;SIG;WAI"
430 GO TO 410
500 REM *** ADJUST FINE TUNE RANGE R4040 CEN FRE CON BRD ***
510 PRINT @A9:"TUN 2M;SIG;WAI"
520 PRINT @A9:"TUN -2M;SIG;WAI"
530 GO TO 510
600 REM *** ADJUST FINE TUNE SENSITIVITY R3040 CEN FRE CON BRD ***
610 PRINT @A9:"TUN 2K;SIG;WAI"
620 PRINT @A9:"TUN -2K;SIG;WAI"
630 GO TO 610
700 REM *** START UP PROCEDURE ***
710 PAGE
720 PRINT "ENTER THE 492P'S GPIB PRIMARY ADDRESS";
730 INPUT A9
740 POLL Z8,Z9;A9
750 RETURN
```

7. Adjust 1st Converter Bias

NOTE

This adjustment should only be necessary if frequency response problems are encountered.

a. Switch the FREQUENCY RANGE control to the 3.0—7.1 GHz band. Adjust Bias 1 (R1043) on the 1st LO Driver (Fig. 3-34) for 0.25 V at TP1011.

b. Switch the FREQUENCY RANGE to the 5.4—18 GHz band. Adjust Bias 2 (R1022) for 0.25 V at TP1011.

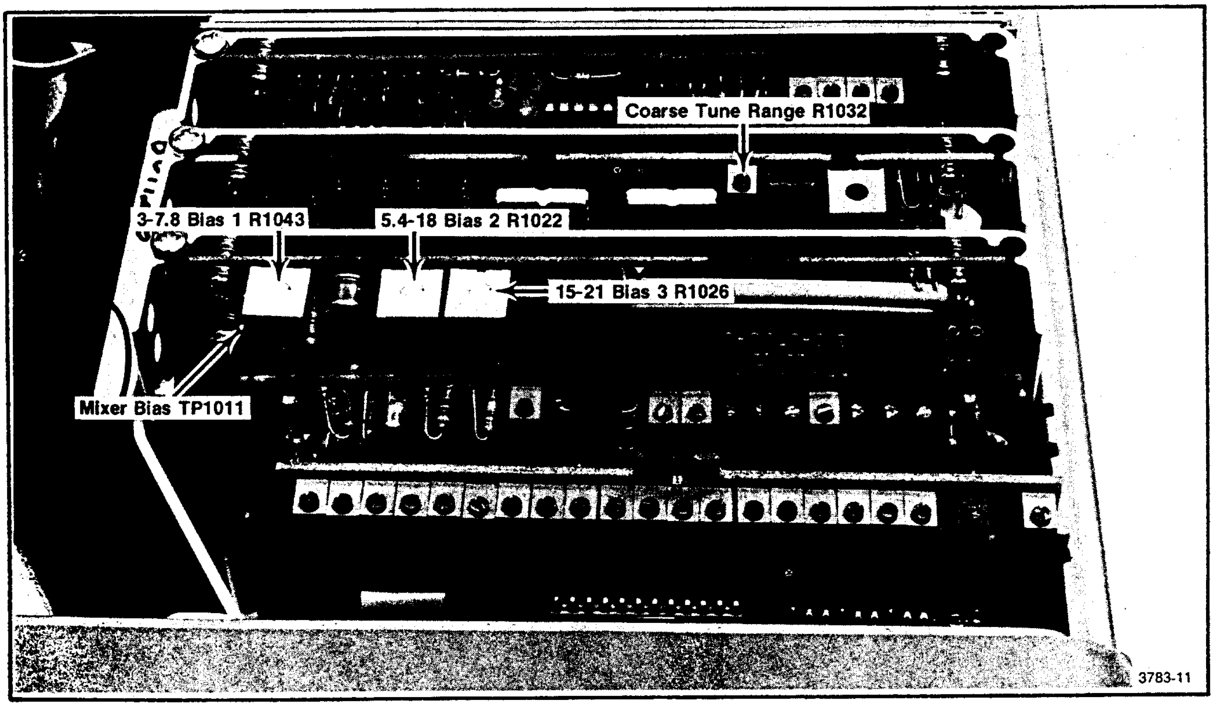


Fig. 3-34. 1st LO Driver adjustments and test point locations.

c. Change the FREQUENCY RANGE control to the 15—21 GHz band. Adjust Bias 3 (R1026) for −0.25 V at TP1011.

8. Baseline Leveling (Video Processor)

This procedure adjusts the baseline so band 4 response perturbations are offset to level the display.

a. Test equipment setup is shown in Fig. 3-35.The output of the sweep generator is applied through a 3 dB attenuator and high performance coaxial cable to a power divider. Connect one output of the power divider directly to the RF INPUT of the 492/492P and the other to the sensor for the power meter. Set the RF plug-in ALC switch to MTR position and connect a coaxial cable between Recorder Output of the power meter and the Ext ALC Input of the 2—15 GHz plug-in unit on the sweeper. Set the Power Level to approximately −10 dBm then adjust the Gain on the unit for stable operation (output stops oscillating).

b. Switch POWER off, pull the Video Processor board and install it on an extender board.

c. On the Video Processor board pull the Leveler Disable plug P3035 (see Fig. 3-36).

d. Switch POWER on and set the controls as follows:

FREQUENCY RANGE	5.4—18.0 GHz (band 4)
FREQ SPAN/DIV	MAX
MIN RF ATTEN	10 dB
REF LEVEL	−10 dBm
FREQUENCY	10 GHz
Vertical Display	10 dB/DIV
RESOLUTION	AUTO
TIME/DIV	10 ms

e. On the sweep generator, select a 5.5 GHz cw marker and adjust the output for −10 dBm reading on the power meter.

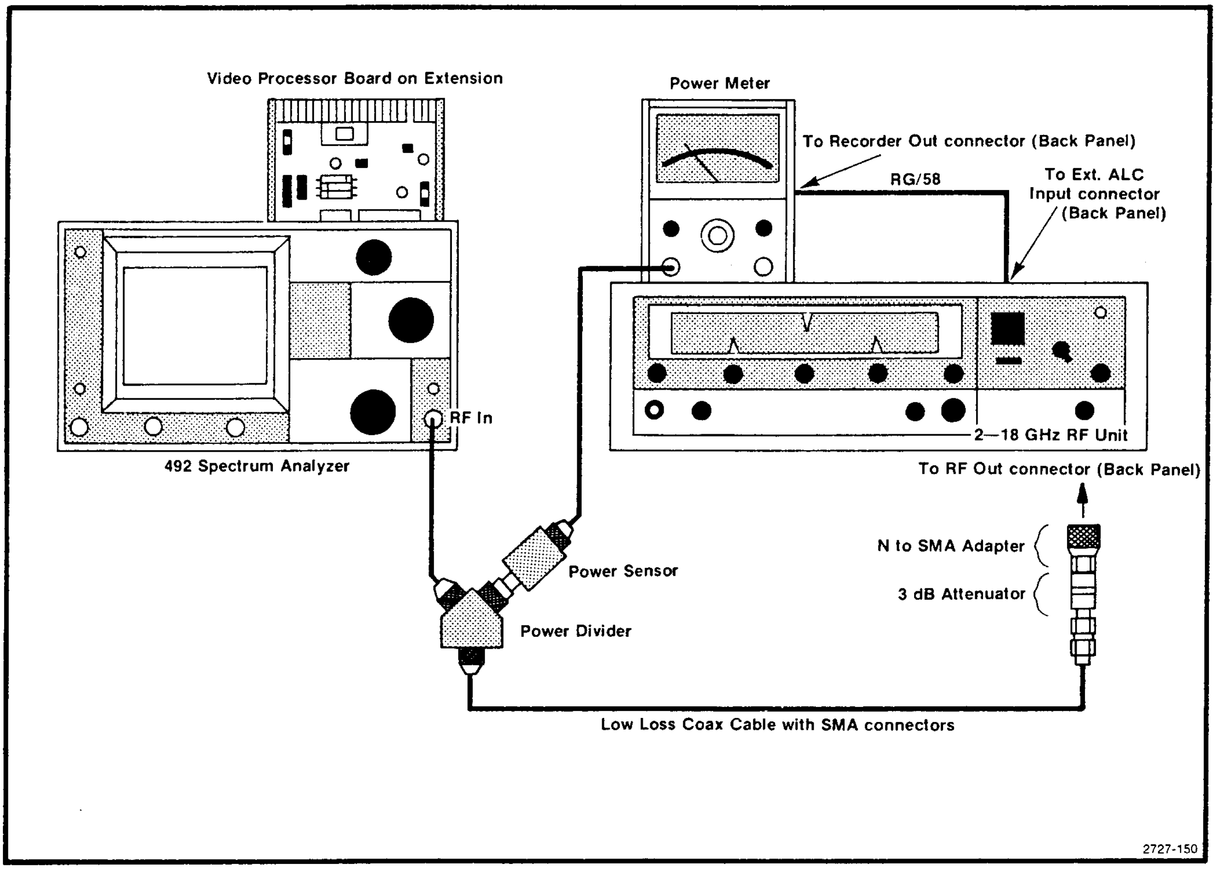


Fig. 3-35. Test equipment setup for adjusting baseline leveling.

f. Switch the Vertical Display to 2 dB/DIV and adjust the REF LEVEL so the signal amplitude is half screen. If the 492/492P has Option 01, adjust PEAKING for maximum response.

g. On the sweep generator, change to the automatic internal sweep (Marker Sweep) and set the sweep time for 100 s/sweep (its slowest sweep).

h. Activate VIEW A and VIEW B then select a sweep time on the 492/492P so the stored display is solid (no breaks in the digitized display, see Fig. 3-37A).

i. Activate MAX HOLD and SAVE A. Trace and record the response of band 4.

j. Deactivate VIEW A and MAX HOLD (SAVE A and VIEW B still active).

k. Switch the Vertical Display mode to 10 dB/DIV and note the baseline. Activate NARROW Video Filter and adjust the REF LEVEL so the baseline moves to the top of the screen.

l. Switch the Vertical Display mode to 2 dB/DIV. Activate VIEW A and adjust the REF LEVEL so SAVE A display and the baseline are at center screen.

m. Unplug P2060 (Fig. 3-36) and move it from Normal to Invert mode (one pin to the left). Replace Leveler Disable plug P3035.

n. Start with R1061 and adjust the leveling potentiometers sequentially, from R1061 through R1013, so the contour of the baseline is an average of the SAVE A display. In the process use Horiz adjust R1069 (Fig. 3-36) to shift the baseline to the right or left so the baseline aligns with the average contour of SAVE A display.

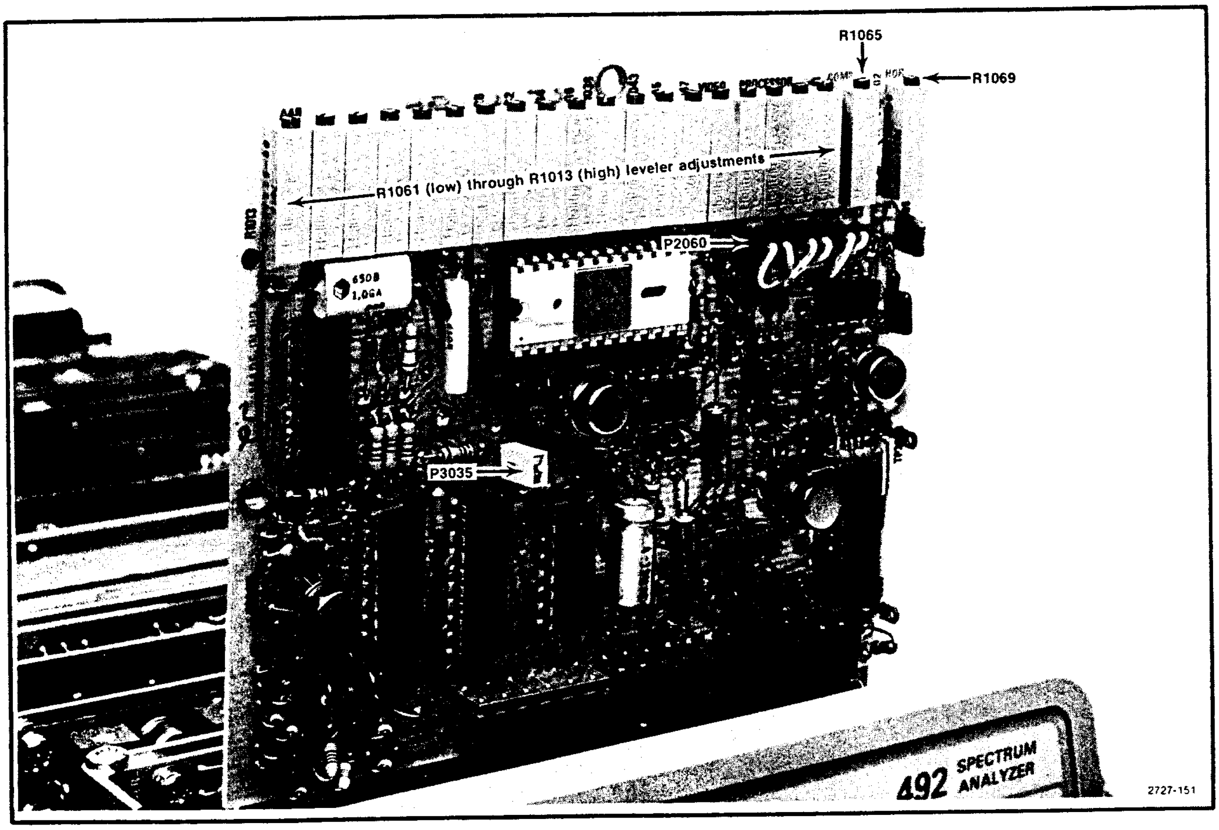


Fig. 3-36. Adjustments and test points on the Video Processor board.

o. Replace P2060 to the Normal mode position (one pin to the right). The baseline will now be 180° or the inverse of its previous position.

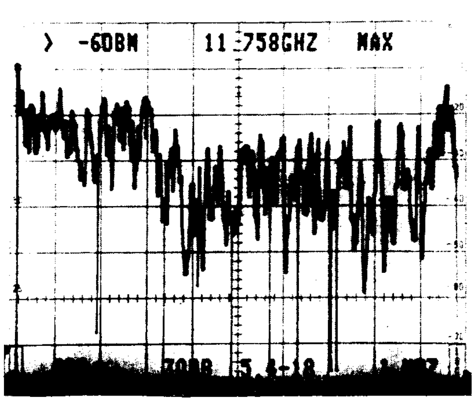
p. Deactivate and then activate VIEW A, VIEW B, SAVE A, and MAX HOLD. Retrace and check new response. Response should appear flat (see Fig. 3-37B).

q. Switch POWER off, and reinstall the Video Processor board. Disconnect and remove the signal to the RF INPUT from the test equipment.

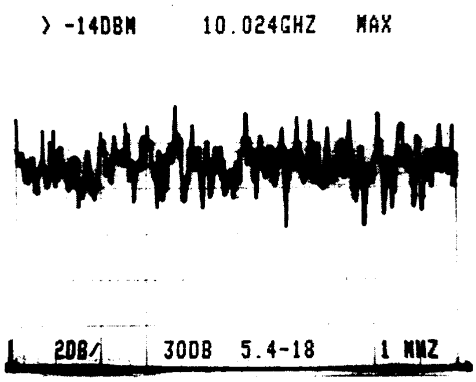
r. Compensation adjustment R1065 is set at the factory and usually does not require adjustment. Pull Leveler Disable plug P3035 then replace it. If the baseline remains straight or breaks up after the plug is replaced, compensation is required. Adjustment procedure is as follows:

1) with the front-panel controls set as directed in part d, activate NARROW Video Filter and change TIME/DIV to 50 ms. Alternately turn the 19 level adjustments clockwise and counterclockwise so every other potentiometer is fully clockwise and the adjacent potentiometer is fully counterclockwise. Display should now appear as a periodic triangular waveform;

2) adjust the REF LEVEL so the baseline is near full screen then switch to the 2 dB/DIV mode and adjust so the display is mid-screen (see Fig. 3-38A);



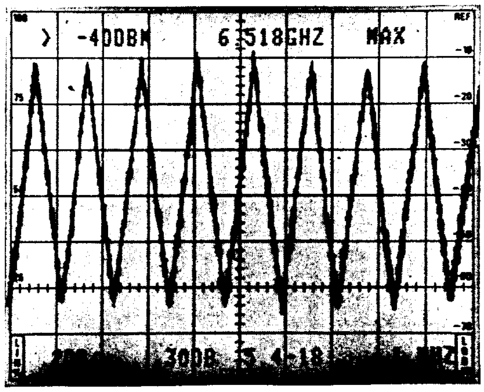
A. Typical response before baseline leveling.



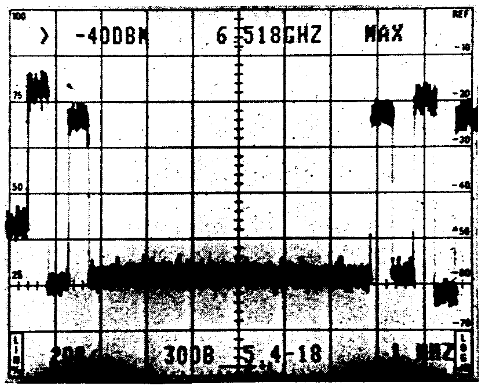
B. Typical response after baseline leveling.

2727-152

Fig. 3-37. Typical response displays when adjusting baseline leveling.



A. Series of waveforms. Amplitude approximately ±5 dB above and below baseline reference.



B. Typical display when display breaks up.

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Fig. 3-38. Typical response displays when adjusting compensation of baseline leveling circuits.

3) turn Compensation adjustment R1065 counterclockwise until the display breaks up (see Fig. 3-38B);

4) now turn R1065 clockwise 1.5—2 turns past the point the display again becomes a periodic triangular waveform;

5) turn Horiz adjust R1069 to center the display;

6) return the baseline leveler adjustments to their midrange position for a straight line display and proceed with the baseline leveling alignment as previously described (parts a through q).

9. Log Amplifier Calibration

CAUTION

Use only an insulated screwdriver or tuning tool, such as Tektronix Part No. 003-0675-00, to make these adjustments.

a. Test equipment setup is shown in Fig. 3-39. Set the front-panel controls as follows:

REF LEVEL	−70 dBm
MIN RF ATTEN	0 dB
FREQ SPAN/DIV	200 MHz
FREQUENCY	200 MHz
TIME/DIV	AUTO
Vertical Display	10 dB/DIV
CAL (LOG and AMPL)	Centered

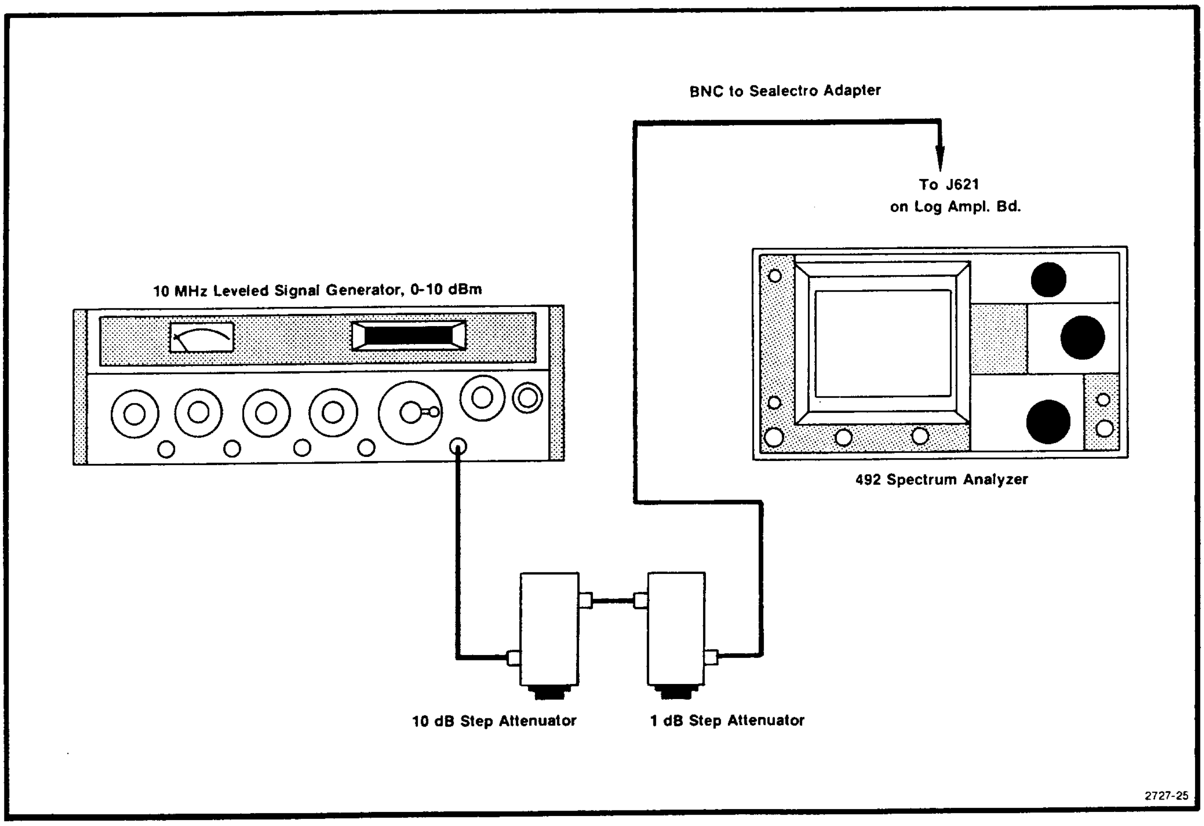


Fig. 3-39. Equipment setup for calibrating log amplifier.

b. Remove P621 and apply a 10 MHz signal of 0 dBm from the signal generator, through 10 dB and 1 dB step attenuators, to the input of the Log Amplifier at J621 (Fig. 3-40). Set the step attenuators for 50 dB of attenuation.

c. Position the display at a graticule reference line with the variable output of the signal generator; then switch the REF LEVEL from −70 dBm to −120 dBm, and adjust the front panel LOG CAL so each 10 dB step equals one division.

d. Set the REF LEVEL to −20 dBm and the attenuators for 0 dB.

e. Increase the step attenuators in 10 dB steps. Adjust Log Gain, R4020 (Fig. 3-40), so each 10 dB of change produces a division of change on the display.

f. Return the step attenuator to 0 dB. Display should be full screen (0 dBm); if not, readjust the signal generator output for 0 dBm.

g. Alternately switch the Vertical Display between 10 dB/DIV and 2 dB/DIV while adjusting Input Ref Lvl, R4071 (Fig. 3-40), for minimum amplitude change between the two displays.

h. Switch Vert Display to 2 dB/DIV. Switch in 10 dB of attenuation and note how close the 10 dB step is to five divisions of display change. If the 10 dB step is short (trace falls short of the correct line), adjust gain with R4020 slightly in the same direction; then switch out the 10 dB of attenuation and adjust R1071 for a full screen display. Repeat this check until the 10 dB step is within 0.2 dB. Switch to 10 dB/DIV display mode and recheck 10 dB logging.

i. Switch to the 2 dB/DIV mode; then momentarily remove the input signal to the Log Amplifier and position the display on the bottom graticule line. Re-apply the signal to the Log Amplifier.

j. Adjust Output Ref Lvl, R4081 (Fig. 3-40), for a full screen (eight divisions) display.

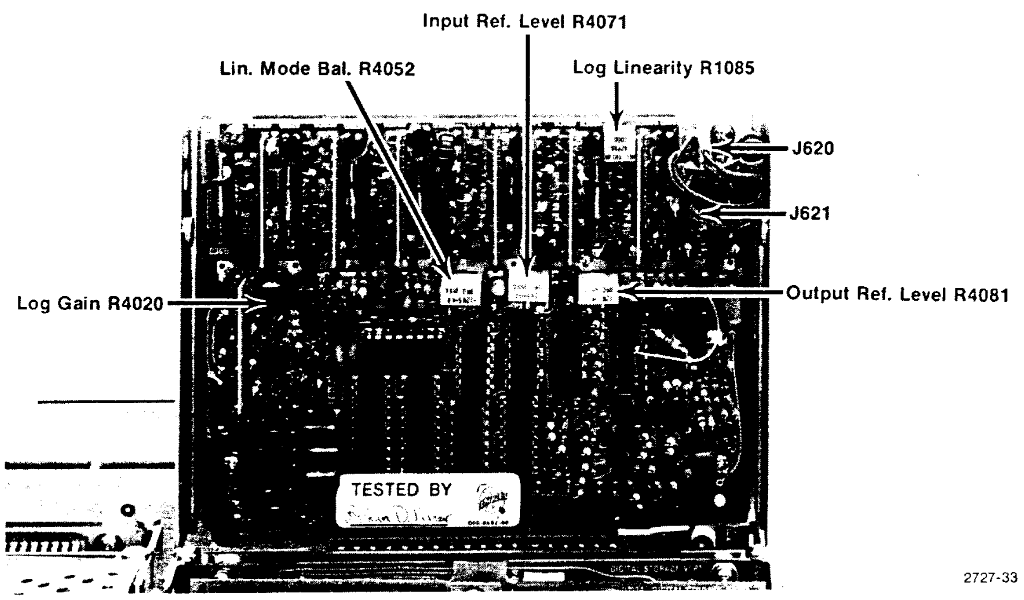


Fig. 3-40. Location of connectors and adjustments on the Log and Video Amplifier.

k. Switch to the 10 dB/DIV mode and set the step attenuators for 40 dB. Adjust Log Linearity, R1085 (Fig. 3-40), so the display is mid-screen.

l. If a large change in the setting of R1085 was required in part k of this step, repeat the adjustments of R4071 and R4081 because of interaction.

m. Check the accuracy of 10 dB/DIV and 2 dB/DIV display modes by switching the attenuation in 10 dB steps for 10 dB/DIV mode and 1 dB steps for the 2 dB/DIV mode. Note that the display steps one division ±0.25 minor division for each 10 dB step, and ±1.0 minor division for the 2 dB mode. Once the individual steps have been verified, reset the signal level for full screen; then switch in the appropriate step attenuation to step the display down screen to measure the worst case error over the dynamic range. Maximum error must not exceed ±1.5 dB over the first 80 dB of range, or ±1.0 dB over the 16 dB range.

n. If the 10 dB log step in the 2 dB/DIV mode is long, adjust gain with R4020 for less gain and rebalance R4071.

o. Set the step attenuators for 10 dB of attenuation; then adjust the signal output level for a full screen display (+10 dBm) in the 2 dB/DIV mode.

p. Activate MIN NOISE and switch out the 10 dB of attenuation.

q. Check that the display level returns to within ±1.0 dB of reference.

r. Set the Ref Level to −15 dBm and adjust the signal generator output for a full screen display in the 2 dB/DIV mode.

s. Switch the Vertical Display to LIN and adjust Lin Bal, R4052 (Fig. 3-40), for a full screen display. Display amplitude of LIN, 2 dB/DIV, and 10 dB/DIV display should now be the same.

t. Check LIN mode linearity by adding 6 dB, 12 dB, and 18 dB of attenuation and noting that the display level is down from top of screen four (±0.4), six (±0.4), and seven (±0.4) divisions.

u. Remove the signal generator signal connection to the Log Amplifier input jack and replace P621.

10. Calibrating the Resolution Bandwidth and Shape Factor

NOTE

The filters are aligned separately and then combined with a signal applied through both the VR#1 and VR#2 modules. The final touch-up adjustments can be made for filter shape and bandwidth. Because of interaction, it is easy to offset one filter with misadjustment of the other; therefore, only slight adjustments should be made.

Adjust the bandwidth of each filter section at the 3 dB down level. This point should be as wide or slightly wider than the 6 dB down point of the combined two filter sections.

For gain levels and alignment theory, refer to the *VR part in the Theory of Operation section.*

a. Equipment setup is shown in Fig. 3-41.

1) place the VR module on an extender and connect the output 10 MHz signal, from the 3rd Converter, to the input of the VR#2 section. Use a Sealectro male-to-male adapter and coaxial cable to connect between P693 and J683;

2) connect the output of VR#2 to the input of the Log Amplifier assembly by connecting a cable from J682 to J621 (see Fig. 3-40);

3) connect the CAL OUT signal through a coaxial cable to the RF INPUT;

4) set the front-panel controls as follows:

FREQUENCY	100 MHz
FREQ SPAN/DIV	50 kHz
RESOLUTION BANDWIDTH	100 kHz
REF LEVEL	−20 dBm

b. Tune the signal to center screen and change the Vertical Display to 2 dB/DIV. Adjust the REF LEVEL for a seven division signal. Tune the display to center screen.

NOTE

The 10 kHz filter is used as the reference for centering the response of all filters.

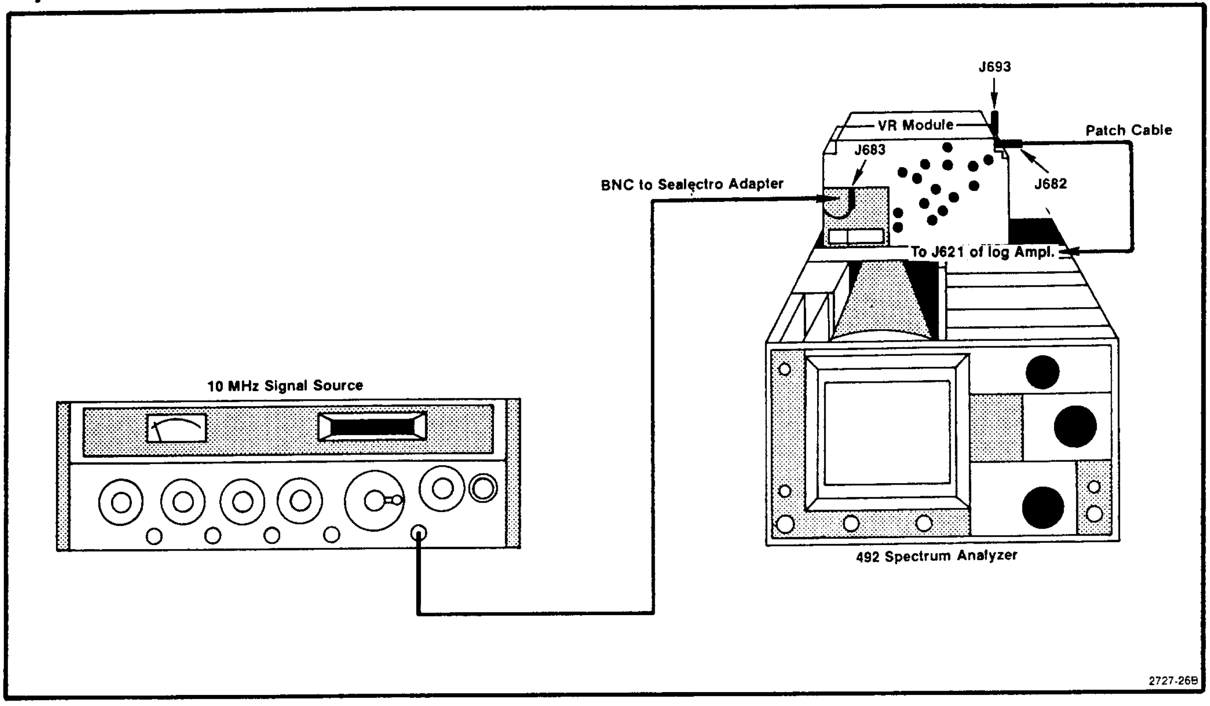


Fig. 3-41. Test equipment setup for calibrating the VR section.

c. Increase the FREQ SPAN/DIV to 50 kHz and the RESOLUTION BANDWIDTH to 100 kHz.

d. Adjust C2050 and C5055 (Fig. 3-42) for the best 100 kHz filter shape and waveform centering (100 kHz, 3 dB down, and centered with respect to the 10 kHz reference). Refer to Fig. 3-43.

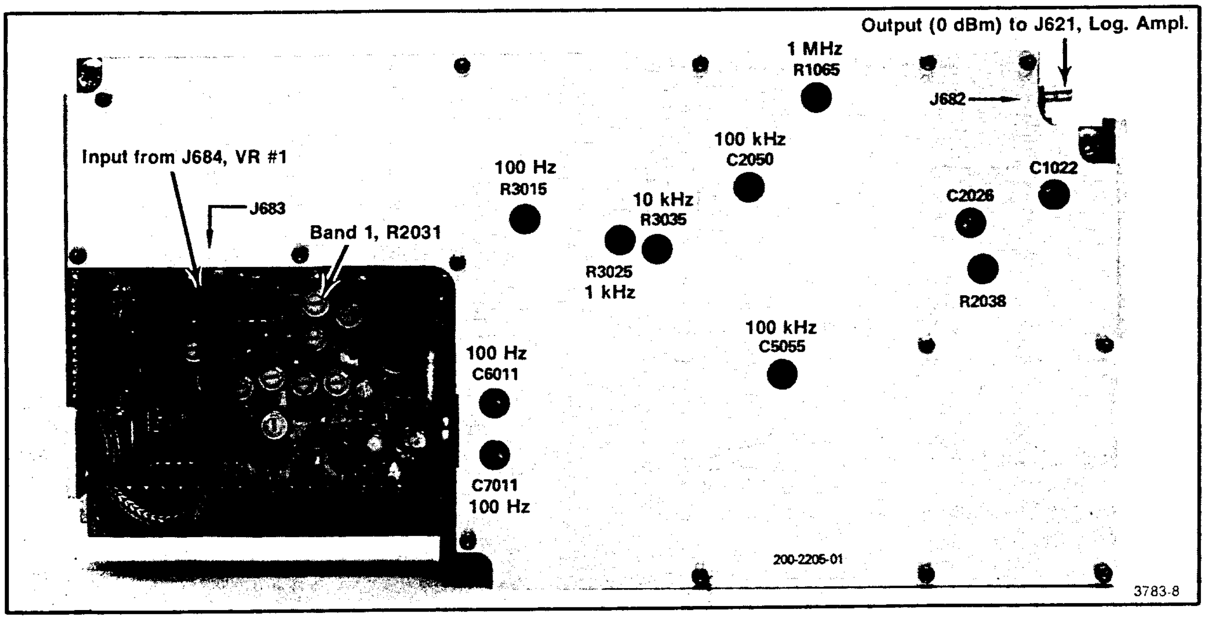


Fig. 3-42. Calibration adjustments on the VR #2 module.

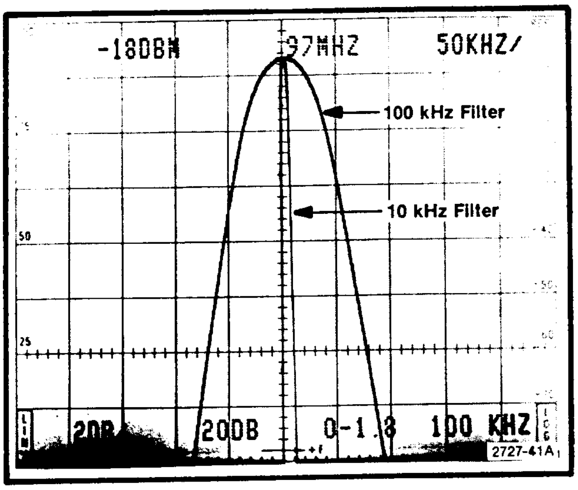


Fig. 3-43. Response of the 100 kHz filter.

e. Return the RESOLUTION BANDWIDTH to 10 kHz and recheck for centering. Switch the FREQ SPAN/DIV to 500 kHz and the RESOLUTION BANDWIDTH to 1 MHz.

f. Adjust C2026 and C1022 (Fig. 3-42) for the best 1 MHz filter shape and waveform centering.

g. If the instrument has Option 03 (100 Hz filter) switch the RESOLUTION BANDWIDTH to 100 Hz and FREQ SPAN/DIV to 500 Hz.

h. Adjust the 100 Hz filter shape and response amplitude with C6011 and C7011. Adjust for maximum amplitude and a bandwidth, at the 3 dB down point, of 100 Hz.

i. Now disconnect the 10 MHz third converter signal (P693) from the VR#2 input and connect it to the input of VR#1 (J693), through the Sealectro male-to-male adapter and coaxial cable. Connect the output of VR#1 (P683) through another Sealectro male-to-male adapter and coaxial cable to the input of the Log Amplifier at J621 (Fig. 3-40).

j. Change the FREQ SPAN/DIV to 500 kHz and RESOLUTION BANDWIDTH to 100 kHz. Readjust the REFERENCE LEVEL for a seven division signal in the 2 dB/DIV display mode.

k. Switch the FREQ SPAN/DIV to 10 kHz and the RESOLUTION BANDWIDTH to 10 kHz. Center the response on screen.

l. Now, switch the FREQ SPAN/DIV to 50 kHz, the RESOLUTION BANDWIDTH to 100 kHz, and adjust the 100 kHz filter with C3023 and C3035 (Fig. 3-44) for filter shape and frequency centering.

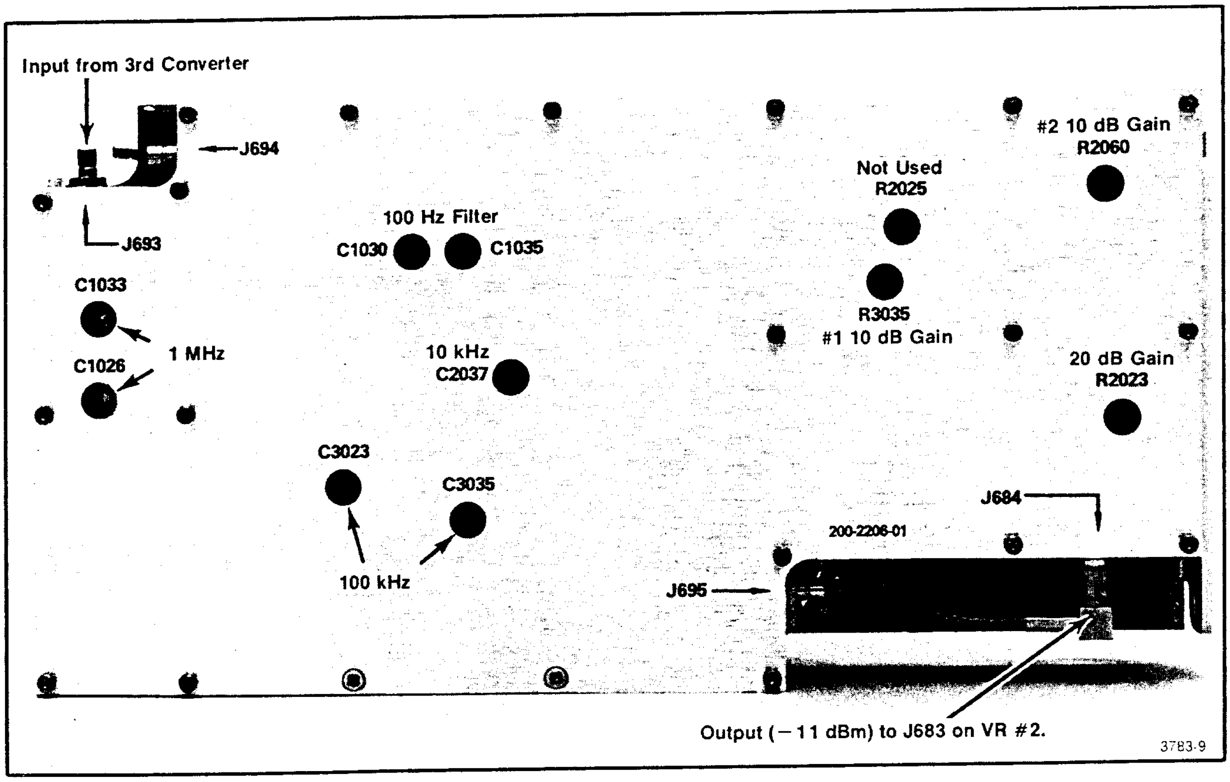


Fig. 3-44. Calibration adjustments on the VR #1 module.

m. Switch back to 10 kHz RESOLUTION BANDWIDTH and recheck centering.

n. Switch the RESOLUTION BANDWIDTH to 1 MHz and FREQ SPAN/DIV to 500 kHz; then adjust the 1 MHz filter response and centering with C1033 and C1026 (Fig. 3-44).

o. Return the FREQ SPAN/DIV to 5 kHz and RESOLUTION BANDWIDTH to 10 kHz and center the signal on screen.

p. Adjust the 10 kHz filter with C2037 (Fig. 3-44) for best filter shape.

q. If the instrument has Option 03, switch the RESOLUTION BANDWIDTH to 100 Hz and the FREQ SPAN/DIV to 500 Hz. Adjust the 100 Hz filter with C1030 and C1035 (Fig. 3-44) for amplitude and waveshape.

r. Disconnect the cable between P683 and the Log Amplifier input (J621). Reconnect P683 to J683 and connect the output from the VR#2 to the Log Amplifier input (J621). The signal should now pass through both VR#1 and VR#2 to the input of the Log Amplifier.

s. Check the waveshape, bandwidth, and centering of all filters. Center the 100 kHz and 1 MHz filter response around the 10 kHz filter. If necessary, make only fine or minor adjustments. Figure 3-45 shows typical response shapes.

t. Check filter leveling using the 100 kHz filter as the reference amplitude. Adjust all filters to the 100 kHz level as follows:

Filter	Adjust	Location
1 MHz	R1065	VR#2
10 kHz	R3035	VR#2
1 kHz	R3025	VR#2
100 Hz (Option 03)	R3015	VR#2

Locations of the adjustments are shown in Figs. 3-42 and 3-44.

11. Presetting the Variable Resolution Gain and Band Leveling

NOTE

The Log Amplifier must be calibrated before adjusting any VR gain settings. Log Amplifier calibration can be verified by applying a 0 dBm, 10 MHz signal to the input (J621) of the Log Amplifier and checking for full screen display with a −20 dBm REF LEVEL.

The Post VR Gain, R2038 (Fig. 3-42), is normally preset by removing the VR#2 module cover and applying a −21 dBm, 10 MHz signal to pin JJ. Adjust for a full screen display with a REF LEVEL of −30 dBm. Replace the cover before proceeding with the other gain adjustments. Band gain adjustments, other than band 1, must be done after tracking has been calibrated and flatness checked. If the range of any band gain adjustments is insufficient, add a diode between the output from U3023 and the base of Q2049, as shown on the schematic diagram for Variable Resolution No. 2.

a. Test equipment is shown in Fig. 3-41. Install VR#2 module on an extender board as shown in Fig. 3-42. Set the front panel-controls as follows:

REF LEVEL	−30 dBm
MIN RF ATTEN	0 dB
FREQ SPAN/DIV	1 MHz
RESOLUTION BANDWIDTH	100 kHz
VERT DISPLAY	2 dB/DIV

b. As described in the preceding note, the gain of the Post VR Amplifier should be 21 dB for best signal-to-noise ratio through the VR stages. If any maintenance has been performed on this stage, perform the following steps.

1. Remove the cover for the VR#2 module. Disconnect the jumper connector to the input of the Post VR Amplifier (pin JJ).

2. Apply a 10 MHz, −21 dBm signal from a 50 Ω signal generator source to pin JJ of the amplifier.

3. Adjust Gain R2038 for a full screen display.

4. Remove the signal from the input to the Post VR Amplifier and replace the jumper between pins JJ of the 2nd Filter Select output and the input to the Post VR Amplifier. Replace the cover for the VR#2 module.

c. Adjust the front panel AMPL CAL to its fully ccw position and set the Band 1 Gain R2031 (Fig. 3-42) on VR#2 fully ccw.

d. Disconnect P693 from the input to VR#1 module (Fig. 3-44) and apply a 10 MHz, −35 dBm signal from the signal generator through a bnc-to-Sealectro adapter to J693. Adjust the generator frequency to peak the signal.

e. Signal amplitude should be between 3.5 and 6.5 divisions. (If signal amplitude is not within these limits it indicates a gain problem in the VR.)

f. If the signal is above 5 divisions, adjust the Post VR Gain R2038 (Fig. 3-42) for a 5 division signal amplitude (if the signal amplitude is less than 5 divisions proceed to part g).

g. Adjust the front panel AMPL CAL for a 7 division signal.

h. Decrease the generator output to −45 dBm and change the REF LEVEL to −40 dBm.

i. Adjust the 10 dB Gain R3035 (Fig. 3-44) of VR#1 so the signal amplitude is 7 divisions.

j. Change the generator output to −55 dBm and the REF LEVEL to −50 dBm.

k. Adjust the 20 dB Gain R2023 (Fig. 3-44) for a 7 division signal amplitude.

l. Change the generator output to −75 dBm and the REF LEVEL to −70 dBm.

m. Adjust the 10 dB Gain R2060 (Fig. 3-44) for a 7 division signal amplitude.

n. Increase the REF LEVEL to −30 dBm and the generator output to −35 dBm. Check for a 7 division signal amplitude. Repeat this check for −45, −55, −65, and −75 dBm input levels and note that each maintains the 7 division signal to verify that the gain of the VR gain stages are correct. Readjust gain if necessary.

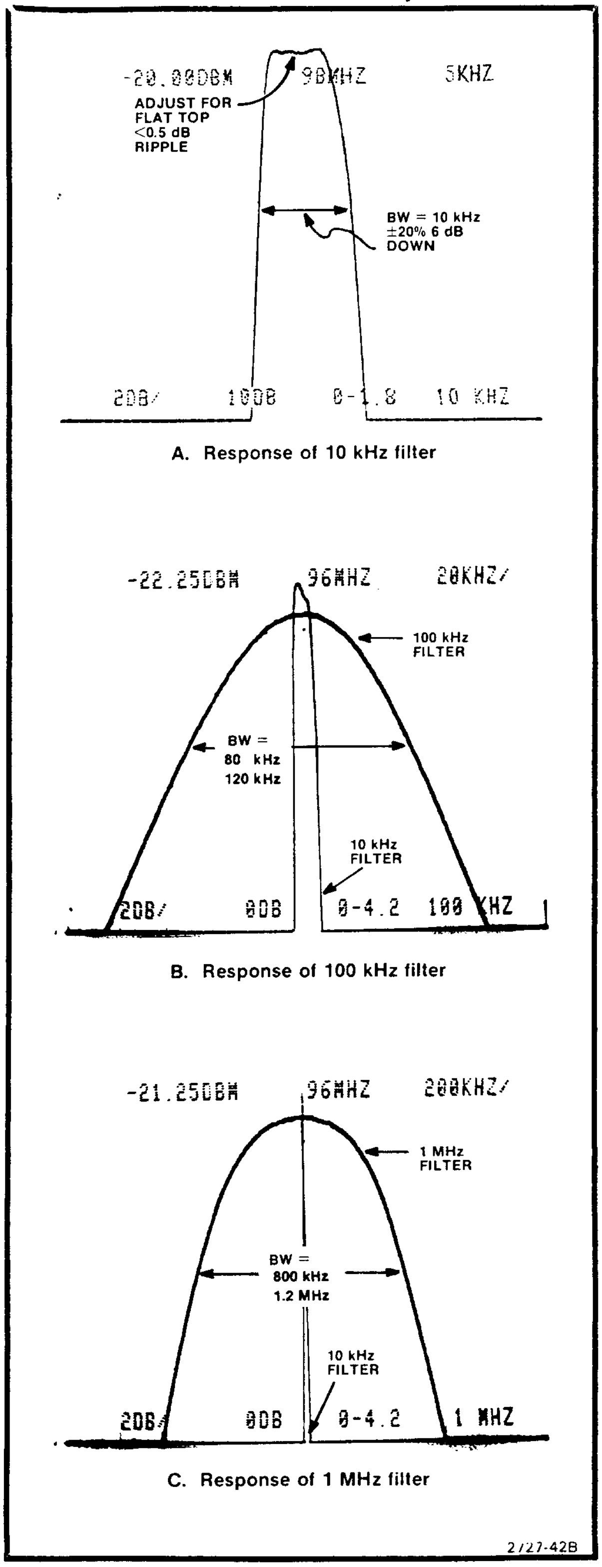


Fig. 3-45. Typical response of 10 kHz, 100 kHz and 1 MHz bandwidth filters.

o. Remove the 10 MHz signal to J680 and reconnect P680. The final band gain level adjustments are described after calibrating the Preselector Tracking and checking flatness. The mean level for each band is set to the level of band 1.

12. Calibrator Output Level

The calibrator output level is calibrated to a known reference. The procedure for checking the level is described in step 3 of the Performance Check part. Output level is adjusted with Cal Level, R1045 (Fig. 3-46). An adjustable capacitor, C3031 within the cover, is only adjusted if the oscillator fails to start. It is adjusted for maximum output. If the Cal Level adjustment (R1045) should run out of range, change the value of select resistor A34A1R1018.

13. IF Gain Calibration

a. Set the RESOLUTION BANDWIDTH to 100 kHz, REF LEVEL to −20 dBm, and apply a −21.5 dBm, 110 MHz signal, through step attenuators, to the input (J365) of the 110 MHz filter (Fig. 3-46).

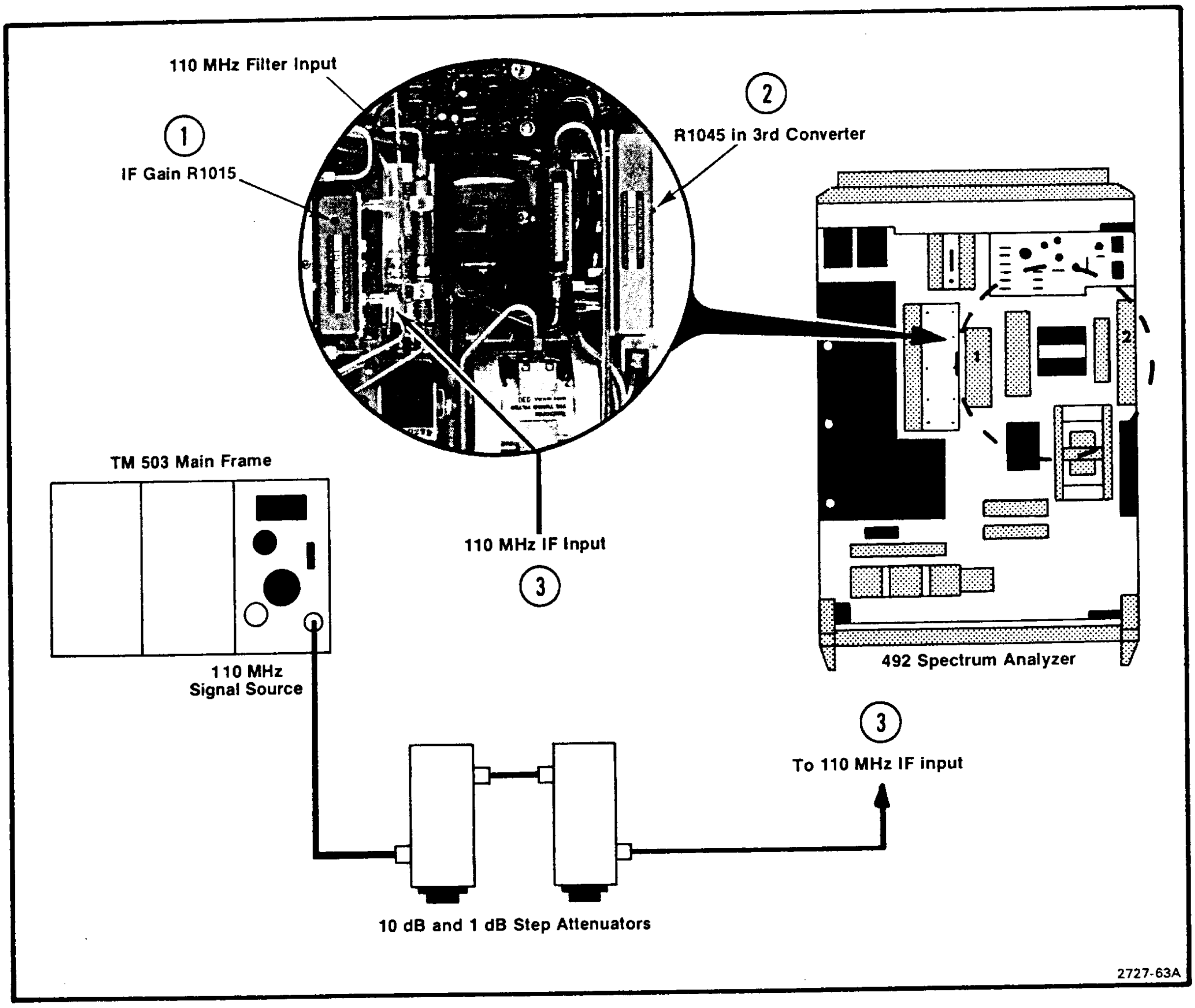


Fig. 3-46. Test equipment setup for adjusting IF gain and the location of the calibrator level adjustment.

b. Set the step attenuators for 0 dB (with −21.5 dBm input the signal level should be 7 divisions or more). Adjust the generator output for a 7 division signal reference level.

c. Remove the 110 MHz signal to the 110 MHz filter and reconnect P365.

d. Set the step attenuators for 21 dB; then apply the 110 MHz signal to the input (J321) of the 110 MHz IF amplifier (Fig. 3-46).

e. Adjust the gain of the IF amplifier with R1015 for a display amplitude that equals the seven division reference set in part b.

f. Remove the 110 MHz signal and reconnect P321.

g. Apply the CAL OUT signal to the RF INPUT. Set the REF LEVEL to −20 dBm. Center the 100 MHz calibrator signal on screen then decrease the FREQ SPAN/DIV to 100 kHz with a RESOLUTION BANDWIDTH of 100 kHz. Keep the calibrator signal centered on screen with the FREQUENCY control.

h. Verify that band 1 Gain, R2031, is fully ccw. Set the front panel AMPL CAL fully ccw.

i. Adjust the 110 MHz IF Gain, R1015, (Fig. 3-46) for a signal amplitude of 5 divisions. (If this cannot be achieved, it indicates excessive loss through the front end.)

j. Adjust AMPL CAL for a full screen signal. AMPL CAL should now have 6 dB down range and at least 6 dB of up range.

NOTE

Two variable capacitors, C325 and C2047, do not require adjustment during calibration. Procedure requires return loss measurement which is a maintenance and repair function.

14. Digital Storage Calibration

NOTE

This is a two-part procedure; the first can be used to calibrate the 492/492P, the second is a program to be used with TEKTRONIX 4050-Series Computer terminal with the programmable 492P only.

a. Apply the CAL OUT signal to the RF INPUT and set the front-panel controls as follows:

FREQUENCY	200 MHz
FREQ SPAN/DIV	20 MHz
REF LEVEL	−10 dBm
Vertical Display	10 dB/DIV
AUTO RESOLUTION	On
TIME/DIV	AUTO
Digital Storage (Option 02)	VIEW A

b. Adjust the PEAK/AVERAGE cursor so it is about one division above the bottom of the screen.

c. On the Horizontal Digital Storage board for SN B043115 and above:

1) adjust Output Offset, R1039 (Fig. 3-47A), so the left edge of the cursor is at the left edge of the crt (about 0.25 division over-span from the left graticule line);

2) adjust Output Gain, R1041 (Fig. 3-47A) so the right edge of the cursor is at the right edge of the crt;

3) alternately switch VIEW A on and off while adjusting Input Offset, R1046 (Fig. 3-47A), so the storage signal at the left edge of the screen tracks with the non-stored signal;

4) alternately switch VIEW A on and off while adjusting Input Gain, R1048 (Fig. 3-47A), so the storage signal at the right edge tracks with the non-store signal.

5) Repeat steps 3 and 4 until the storage signal matches the non-stored signal on both edges of the screen.

On the Horizontal Digital Storage board for SN B043114 and below:

1) adjust Horizontal Offset, R3041 (Fig. 3-47), so the left edge of the cursor is at the left edge of the crt (about 0.25 division over-span from the left graticule line);

2) adjust Output Gain, R1040 (Fig. 3-47), so the right edge of the cursor is at the right edge of the crt;

3) alternately switch the VIEW A (Digital Storage) on and off while adjusting Input Gain, R1045 (Fig. 3-47), so the storage signal at the right edge tracks with the non-store signal.

d. On the Vertical Digital Storage board:

1) output Gain R1024 and Output Offset R1036 (Fig. 3-47) are adjusted at the factory in the 492P only (the alternate procedure follows). These adjustments should not be changed; however, if they are disturbed, center these adjustments and center Input Gain R1034 before proceeding;

2) switch to 2 dB/DIV display mode;

3) using a signal near the bottom of the display, adjust Vertical Offset R1030 (Fig. 3-47), so the stored display is the same amplitude as the non-store signal;

4) change the REF LEVEL to raise the amplitude of the signal to full screen;

5) adjust Input Gain R1034 (Fig. 3-47), so the stored display of the high amplitude signal is the same as the non-store display;

6) repeat the low level and high level adjustments to compensate for interaction.

ALTERNATE PROCEDURE FOR 492P INSTRUMENTS

a. Set the front-panel controls as follows:

FREQUENCY	100 MHz
FREQ SPAN/DIV	10 MHz
REF LEVEL	−10 dBm
AUTO RSOLUTION	Off
RESOLUTION BANDWIDTH	1 MHz
Vertical Display	2 dB/DIV
Video Filter	NARROW
TIME/DIV	AUTO
Digital Storage (Option 02)	VIEW A and VIEW B
PEAK/AVERAGE	Fully ccw

b. Connect CAL OUT to the RF INPUT.

c. Connect the 492P and 4050-Series Controller with a GPIB cable (both should already be turned on). Set the 492P GPIB ADDRESS switches on the rear panel for address 1 (switch 1 up, all others down).

d. Enter and run the following program:

```
100 DIM C(1000)
110 K=125
120 I1=0
130 FOR I=1 TO 10
140 FOR J=1 TO 100
150 C(II+J)=K
160 NEXT J
170 K=K-25
180 I1=I1+100
190 IF K>=25 THEN 210
200 K=225
210 NEXT I
220 PRINT @1:"SIGSWP"
230 WBYTE @33:64,C,-255
```

e. Adjust the POSITION controls to center the FREQUENCY dot and place the baseline on the bottom graticule line.

f. Adjust the following (Fig. 3-47A) for SN B043115 and above to match the step waveform to the graticule:

Assembly	Adjustment
Horizontal Digital Storage	Output Offset, R1039
Horizontal Digital Storage	Output Gain, R1041
Vertical Digital Storage	Output Offset, R1036
Vertical Digital Storage	Output Gain, R1024

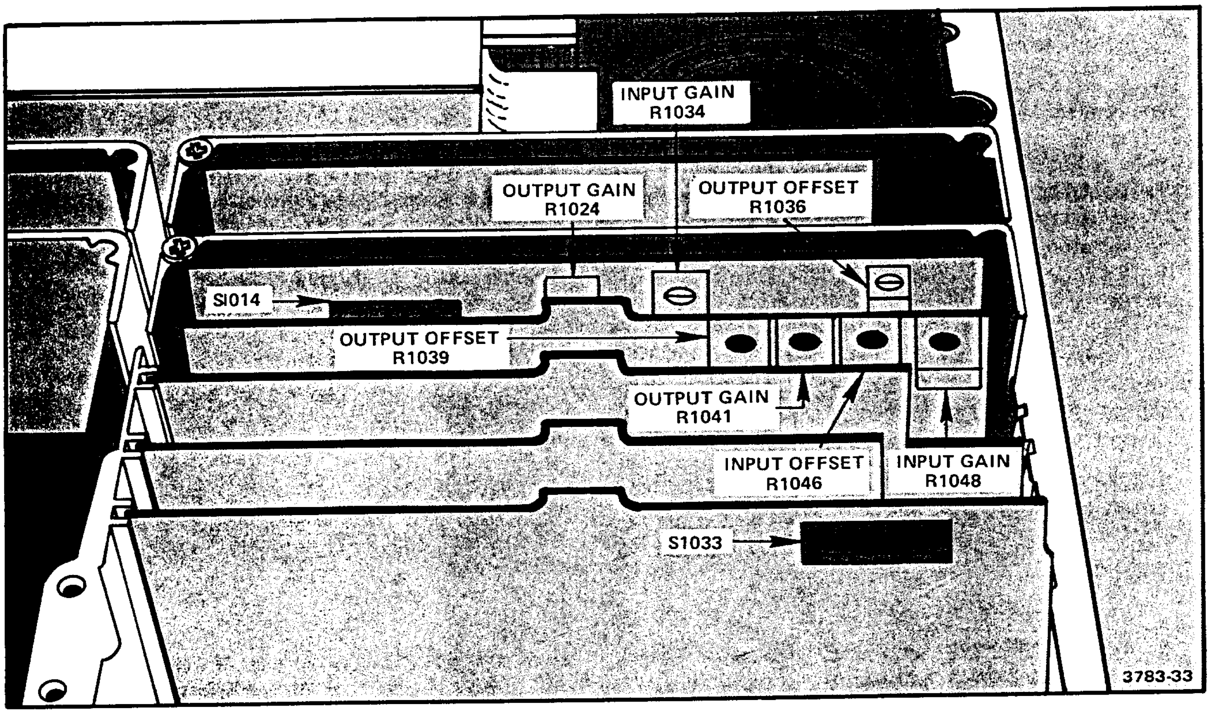


Fig. 3-47A. Digital Storage adjustment locations (SN B043115 & above).

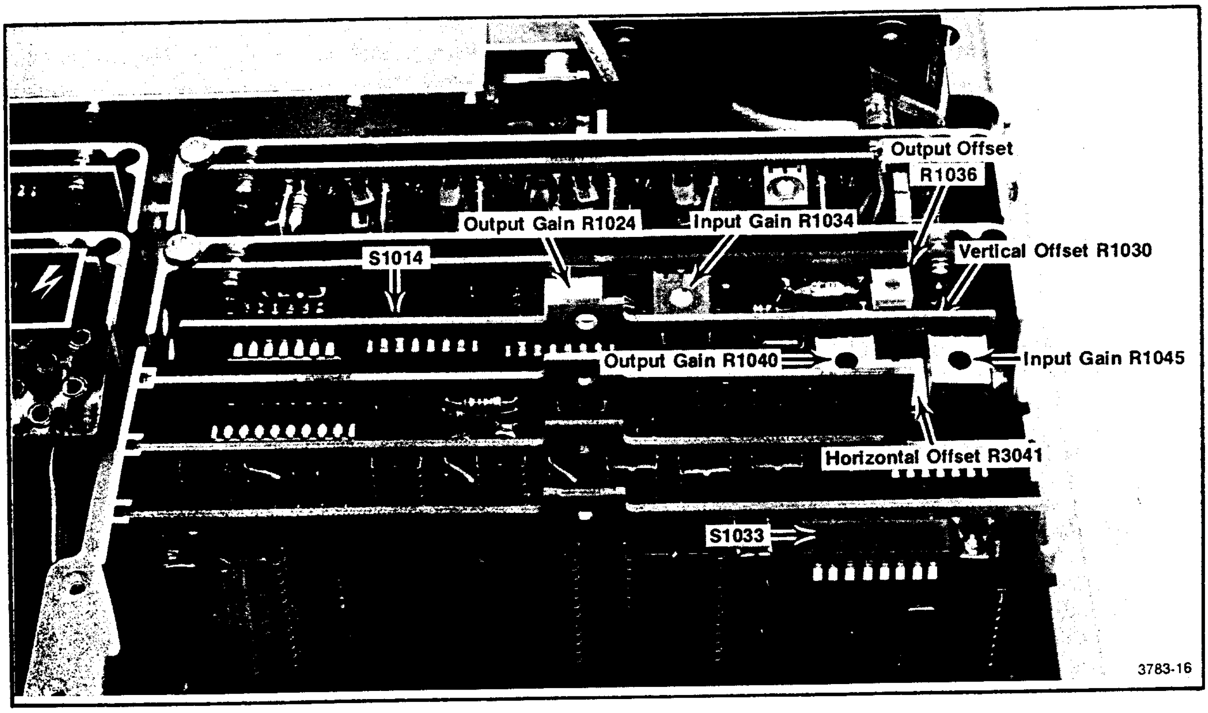


Fig. 3-47. Digital Storage adjustment locations (SN B043114 & below).

Adjust the following (Fig. 3-47) for SN B043114 and below to match the step waveform to the graticule:

Assembly	Adjustment
Horizontal Digital Storage	Horizontal Offset, R3041
Horizontal Digital Storage	Output Gain, R1040
Vertical Digital Storage	Output Offset, R1036
Vertical Digital Storage	Output Gain, R1024

Be sure that the left and right edges of the step waveform coincide with the left and right edges of the graticule. (This matches the horizontal display width of a 1000-point waveform to the graticule.)

g. Press FREE RUN and reduce the span to 200 kHz/div. Keep the signal centered with the FREQUENCY control.

h. Increase REF LEVEL for a signal peak about one division above the bottom of the graticule.

i. Cancel VIEW A, while pressing VIEW B repeatedly, and adjust Vertical Offset R1030, on the Vertical Digital Storage board to minimize the amplitude difference between the stored and real-time waveforms.

j. Reduce REF LEVEL to bring the signal peak close to the top of the graticule.

k. Again, while pressing VIEW B repeatedly, adjust Input Gain R1034 on the Vertical Digital Storge board to minimize the amplitude difference between the stored and real-time waveforms.

l. Because the offset and gain adjustments interact, repeat parts h through k as necessary.

m. Cancel the NARROW Video Filter.

n. Increase FREQ SPAN/DIV to 10 MHz and tune the signal to within one division of the right edge of the graticule.

o. While pressing VIEW B repeatedly, adjust Input Gain R1048 SN B043115 and above (R1045 SN B043114 and below) on the Horizontal Digital Storage board, so the horizontal position of the stored signal matches that of the nonstored signal.

15. Setting B−SAVE A Reference Level

When B−SAVE A is selected, the expression implemented is (B−SAVE A)−k where k is a constant set by the input data for an 8-to-4 line encoder, U1015. Each bit will move the reference level about 0.2 minor division. Normally, the reference level is set at the center graticule line; however, it can be set anywhere within the graticule area by the setting of an 8-bit binary switch, S1014 (Fig. 3-48). The MSB (switch #8) shifts the display about five divisions, switch #7 half this amount, etc. The following procedure sets the reference level.

a. Estimate the amount and direction the reference level is to be shifted.

b. Switch the POWER on and close or open the switches on S1014 (Fig. 3-48) to obtain the desired B−SAVE A reference level.

16. Band Leveling for Coaxial Bands (Bands 1—5)

NOTE

The mean value of the flatness response for each band is set to a −20 dBm reference at 100 MHz.

a. Perform band 1 gain adjustment as described under Baseline Leveling (step 8).

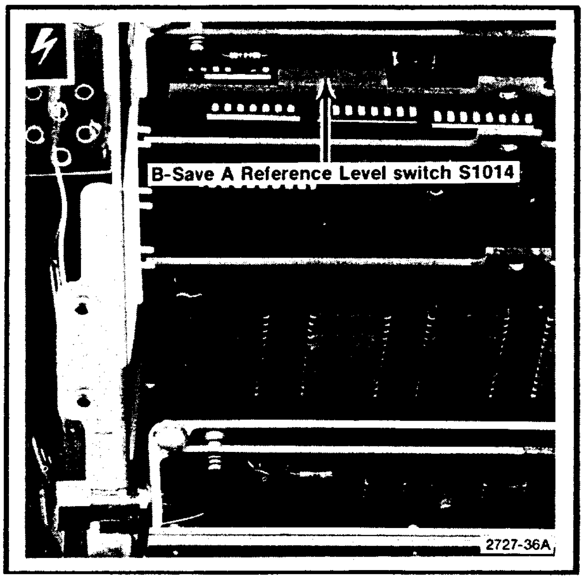


Fig. 3-48. Location of binary switch (S1014) for setting B−SAVE A reference level.

b. Perform flatness check of bands 1 through 5 as described under Frequency Response Check of the Performance Check and note the frequency at the mean level for each band.

c. Set the front-panel controls as follows:

Vertical Display	2 dB/DIV
REF LEVEL	−20 dBm
FREQ SPAN/DIV	10 MHz
RESOLUTION BANDWIDTH	1 MHz
TIME/DIV	AUTO
Digital Storage (Option 02)	VIEW A/VIEW B

d. Switch the frequency range to band 2 (1.7—5.5 GHz) and apply a calibrated −20 dBm signal whose frequency is the same as that noted for the mean level in part b.

NOTE

If a power meter is used to monitor signal level, connect the power meter sensor at the RF INPUT.

e. Tune the signal to center screen and reduce the FREQ SPAN/DIV to either 1 MHz or 500 kHz.

f. Adjust band 2 Gain R3034 (Fig. 3-49), for a full screen (−20 dBm) display.

g. Increase the FREQ SPAN/DIV to about 200 MHz and change the FREQUENCY RANGE to band 3 (3.0—7.1 GHz). Apply a calibrated −20 dBm signal at the frequency noted for the mean level in part b.

h. Tune the signal to center screen and again decrease the span to about 500 kHz/Div with a RESOLUTION BANDWIDTH of 1 MHz.

i. Adjust band 3 Gain R3030 (Fig. 3-49), for a full screen display.

j. Repeat the above procedure for each coaxial band (1—5) and set the gain of each with the appropriate adjustment (see Fig. 3-49). If the range of any adjustment is insufficient, add or remove the appropriate diode (see schematics and Fig. 3-49) to obtain the required range. Adding the diode increases gain.

17. Band Leveling for Waveguide Bands (Bands 6—11)

a. Test equipment setup is shown in Fig. 3-50. Apply 2072 MHz at −58 dBm, through a dc-blocking capacitor to the EXT MIXER input. Monitor the input with a power meter to set the input level. Set the front-panel controls as follows:

FREQUENCY RANGE	18—26 GHz (band 6)
FREQ SPAN/DIV	200 MHz
AUTO RESOLUTION	On
REF LEVEL	−30 dBm

NOTE

The baseline of the display will rise when 2072 MHz signal is applied to the EXT MIXER input port connector.

b. With −60 dBm input level applied, adjust band 6 Gain Leveling R3032 (Fig. 3-49), for full screen display.

c. Change the FREQUENCY RANGE and input signal level as listed in Table 3-12. Adjust the appropriate Band Gain adjustments (Fig. 3-49) for full screen display. Input levels and gain adjustment for the waveguide bands need to be adjusted only if these bands will be used.

d. Turn power off; replace VR module.

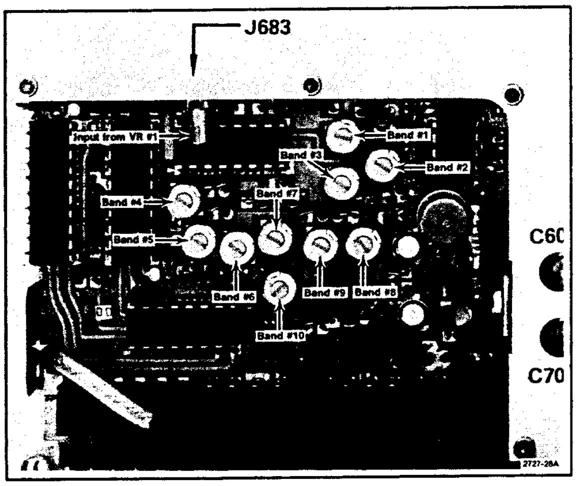


Fig. 3-49. Band leveling adjustments and gain diodes (when installed) on VR #2 module.

Table 3-12
EXT MIXER BAND LEVELING ADJUSTMENTS

Band	Input Level	Gain Adjustment
6 (18—26 GHz)	−60 dBm	R3024
7 (26—40 GHz)	−60 dBm	R3026
8 (40—60 GHz)	−60 dBm	R3032
9 (60—90 GHz)	−60 dBm	R3029
10 (90—140 GHz)	−60 dBm	R3028
11 (140—220 GHz)	−60 dBm	R3028

18. Preselector Driver (Option 01) Calibration

a. Turn POWER off, pull Preselector Driver and install on extender board (Fig. 3-51), then switch POWER on.

b. Set the offset for driver U2054 as follows: (Offset should only require adjusting if U2054 is changed.)

1) set the FREQUENCY RANGE to band 1 (0—1.8 GHz);

2) pull P3055 and connect a voltmeter between TP4054 and analog ground (Fig. 3-52). Set the voltmeter range to 30 μV or less;

3) adjust Driver Offset R2066 (Fig. 3-52) for 0 V;

4) disconnect meter and replace P3055;

5) turn POWER off, reinstall Preselector Driver board and switch POWER on.

c. Connect digital multimeter between center tap of PEAKING potentiometer and ground. Adjust the control for 0 V indication. If index on the knob is not aligned with the mark on the front panel, loosen knob and position the mark so it is aligned.

d. Apply the CAL OUT signal to the RF INPUT. Set the REF LEVEL to −30 dBm, FREQ SPAN/DIV to 20 MHz and activate AUTO RESOLUTION. Select the 1.7—5.5 GHz FREQUENCY RANGE and adjust the FREQUENCY to center the 2.1 GHz marker. Center Input Offset adjustment R1031 (Fig. 3-52), press DEGAUSS button, and then center the 2.1 GHz marker on screen with the FREQUENCY control.

e. Ground TP1069 (Fig. 3-52), with a jumper strap and adjust the Preselector Offset (R1064) for maximum response of the 2.1 GHz signal. Remove the grounding strap and press DEGAUSS button.

f. Peak the 2.1 GHz signal with the −829 MHz IF Offset, R1049 (Fig. 3-52).

g. Remove the Calibrator signal to the RF INPUT and connect the output of the microwave comb generator to the RF INPUT (see Fig. 3-51). Change the REF LEVEL to 0 dBm. Now tune the CENTER FREQUENCY to 5.5 GHz and center the 5.5 GHz comb marker on screen. Press DEGAUSS, then recenter the 5.5 GHz signal.

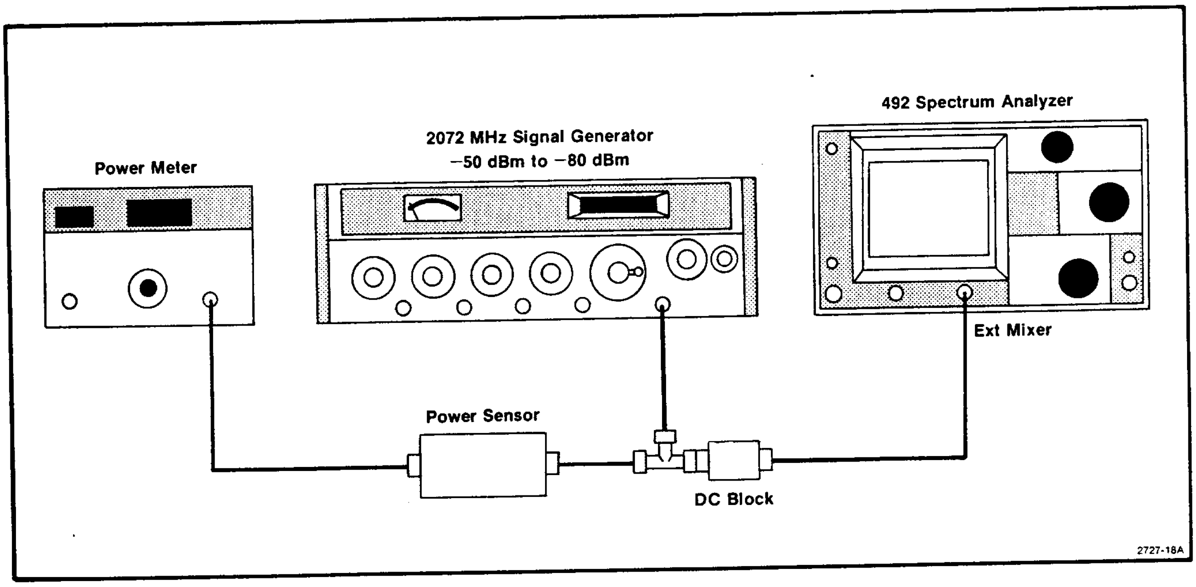


Fig. 3-50. Test equipment setup for calibrating band leveling of the external mixer bands.

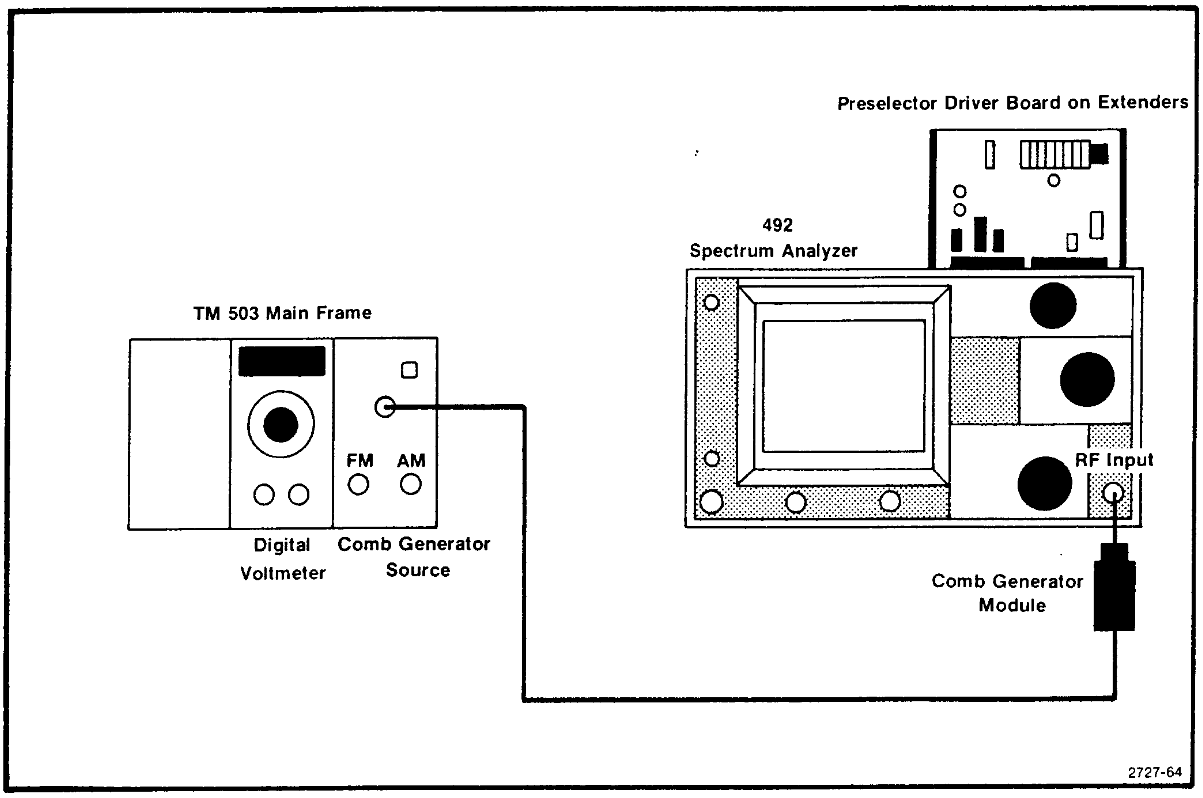


Fig. 3-51. Test equipment setup for calibrating Preselector Driver.

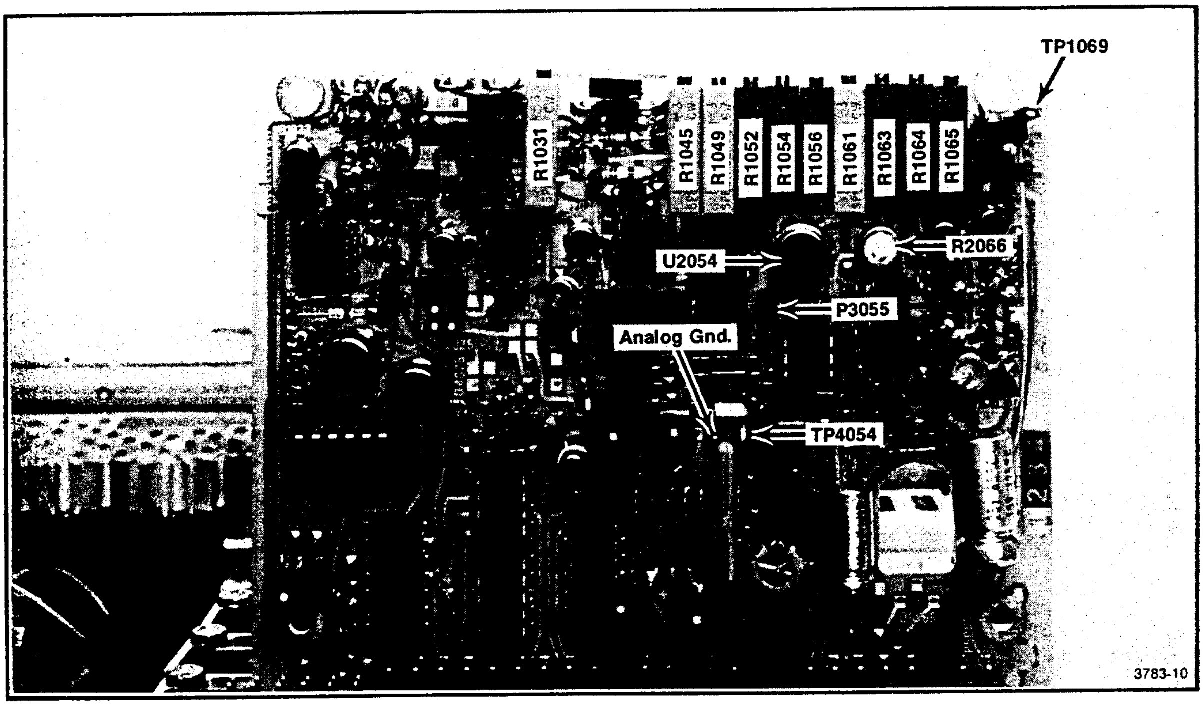


Fig. 3-52. Preselector Driver adjustments and test points.

h. Peak the 5.5 GHz signal with the Preselector Sense, R1065 adjustment.

i. Repeat parts f through h to ensure that the 2.1 and 5.5 GHz frequency points track the input tuning.

j. Change the FREQUENCY RANGE to band 4 (5.4—18.0 GHz). Center the 6 GHz marker on screen with the FREQUENCY control, then press the DEGAUSS button. Peak the 6 GHz signal with the front-panel PEAKING control.

k. Adjust FREQUENCY to center the 9 GHz marker on screen. Peak this response with the X3 Gain, R1052 adjustment.

l. Repeat parts j and k to ensure tracking over this range.

m. Increase FREQUENCY to the 12 GHz marker, press DEGAUSS, then peak the 12 GHz point with Shaper #1, R1054 adjustment (Fig. 3-52).

n. Adjust FREQUENCY to center the 17 GHz marker, press DEGAUSS, then peak the signal with Shaper #2, R1056 adjustment.

o. Recheck the 6, 9, 12, and 17 GHz points to verify that they all peak at the same position of the front-panel PEAKING control. If they do not, repeat parts g through n.

p. Change the FREQUENCY RANGE to the 1.7—5.5 GHz band. Center a comb marker between 5.4 and 5.5 GHz, press DEGAUSS, then peak the signal with the front-panel PEAKING control.

q. Change FREQUENCY RANGE to the 5.4—18.0 GHz band and center the same signal used in part p with the FREQUENCY control. Press DEGAUSS, then adjust Input Offset R1031, to peak the signal.

r. Repeat parts p through q until the signal amplitude peaks, on both bands, occur at the same position of the PEAKING control.

s. Set PEAKING control so the index mark aligns with the front-panel mark. Change FREQUENCY RANGE to 1.7—5.5 GHz, adjust FREQUENCY to center the 3.5 GHz comb marker, then press DEGAUSS.

t. Adjust −829 MHz IF Offset R1049 (Fig. 3-52) to peak the 3.5 GHz response.

u. Change FREQUENCY RANGE to 3.0—7.1 GHz and center 5.0 GHz marker signal on screen with the FREQUENCY control after the DEGAUSS button has been pressed.

v. Peak the 5.0 GHz signal with the +829 MHz IF Offset R1045 adjustment.

w. Change FREQUENCY RANGE to 15—21 GHz and adjust FREQUENCY to center the 15 GHz marker on screen. Press the DEGAUSS button as signal is tuned to center screen.

x. Peak the 15 GHz signal with the front-panel PEAKING control.

y. Tune the 19 GHz marker to center screen and press DEGAUSS.

z. Peak the 19 GHz signal with Shaper #3, R1061, adjustment (Fig. 3-48).

aa. Tune to the 21 GHz marker, degauss, then peak the signal with Shaper #4, R1063, adjustment.

ab. Recheck the 15, 19, and 21 GHz points to verify that they all peak at the same position of the PEAKING control.

ac. Change the FREQUENCY RANGE to 5.4—18 GHz, then center the 15 GHz marker on screen. Degauss as the signal is centered.

ad. Peak the signal with the PEAKING control, then switch FREQUENCY RANGE to 15—21 GHz and center the same 15 GHz marker on screen. Press the DEGAUSS button.

ae. Peak the 15 GHz signal with Preselector Offset, R1064, if necessary.

af. Change FREQUENCY RANGE to 3.0—7.1 GHz and center a 5.0 GHz signal on screen. Press DEGAUSS as the signal is centered.

ag. Peak the signal with the +829 MHz IF, R1045 adjustment.

ah. Change to the 1.7—5.5 GHz band and center a 3.5 GHz marker on screen after degaussing.

ai. Peak the 3.5 GHz signal with the −829 MHz IF, R1049, adjustment.

aj. All bands should now track. The signal peak with the front-panel PEAKING control should occur with the knob index marker near the front-panel mark.

19. Phaselock Calibration

The phaselock assembly normally requires calibration only after some part of the assembly has been repaired or replaced. Phase noise, produced by the phaselock loop, is specified for −70 dBc or better 3 kHz out from the response. This should be checked before calibrating the assembly.

a. Test equipment setup is shown in Fig. 3-53. Remove the Phaselock module and the two cover plates so all circuit test points and adjustments are accessible. Plug the assembly on extender boards and into the instrument. Use extender cables and adapters to reconnect signal cables to their respective connector (cable with yellow band to J501, cable with black band to J502, and cable between J500 and J511 on Phaselock Control board).

b. Switch the 492/492P POWER on, set the TIME/DIV to MNL, FREQ SPAN/DIV to 50 kHz, and Phaselock on.

c. Check Offset Mixer—This part of the procedure is only required after repair or replacement of the Mixer board.

1. Connect the Direct Input of a frequency counter to pin N (Fig. 3-54A) and adjust the counter controls for a count. Note the frequency.

2. Connect the counter to pin K and note the frequency.

3. Connect the counter to the collector of Q1040 and note the frequency. Frequency should equal the difference between pins N and R (e.g., 25.080 −25.00 = 80 kHz). Disconnect the counter probe from the collector of Q1040.

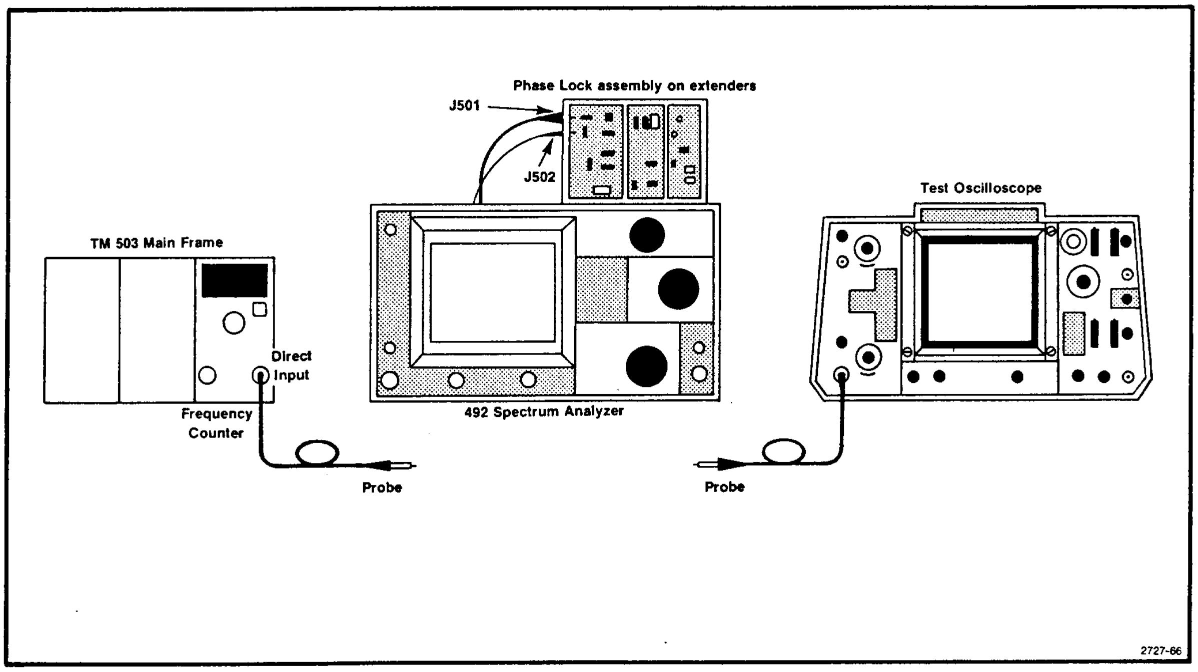


Fig. 3-53. Test equipment setup for calibrating Phaselock assembly.

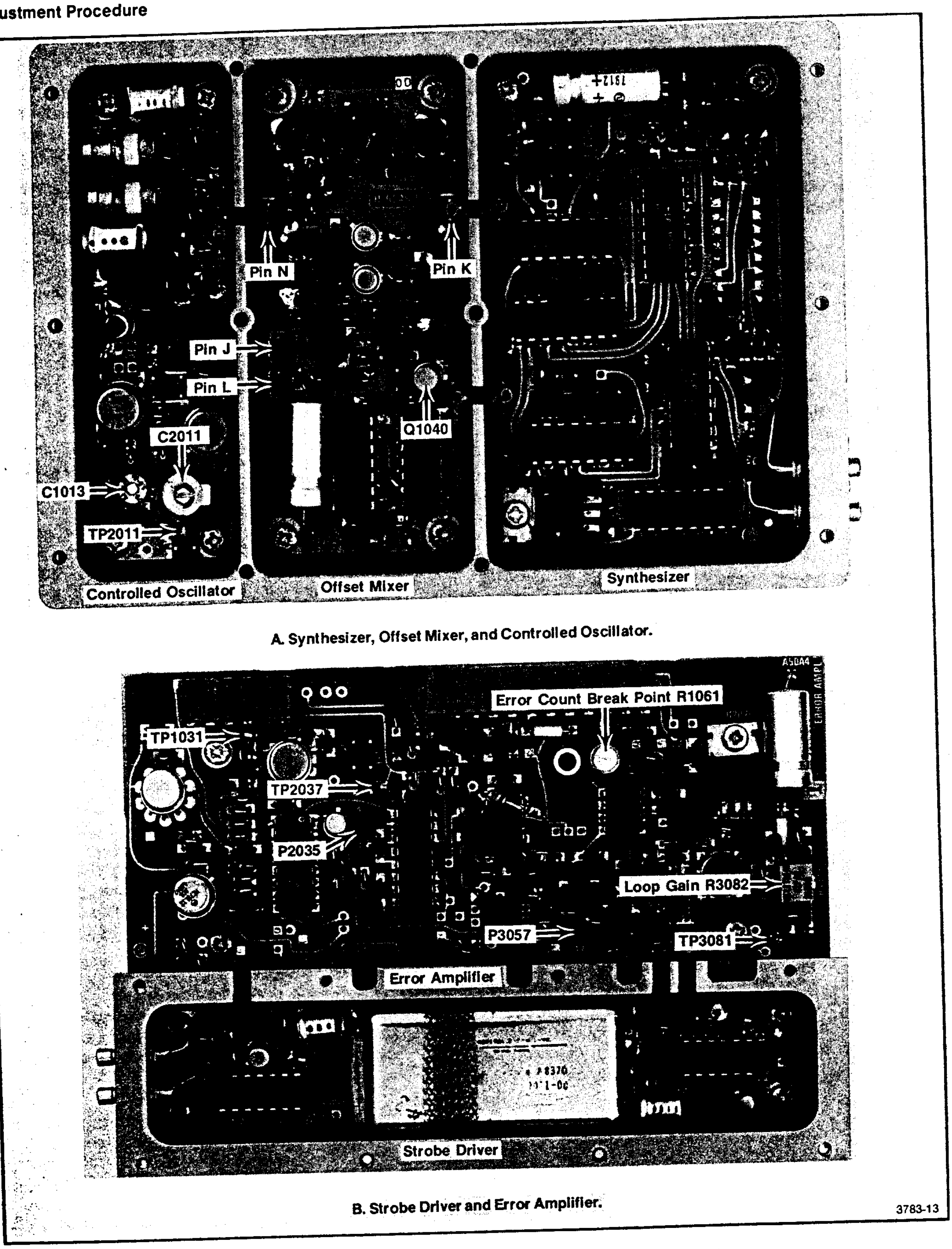


Fig. 3-54. Adjustments and test point locations in the Phaselock module.

4. Connect the probe of a test oscilloscope to the collector of Q1040 and check for a 50% duty cycle.

d. Check Controlled Oscillator frequency—This part of the check is only required after repair or replacement of the Controlled Oscillator board.

1. Connect the Direct Input of the frequency counter to TP2011 (Fig. 3-54A). Ground pin L on the Offset Mixer board.

2. Connect an 80 k resistor in series with a 2 k variable potentiometer from pin H to ground; then adjust the variable resistor for a voltage reading of 12.0 ±0.1 V at pin B.

3. Adjust C1013 (Fig. 3-54A) for a frequency of 25.10 MHz.

4. Now replace the 80 k resistor with a 4 k resistor and adjust the variable resistor for a reading of 5.75 ±0.1 V at pin B.

5. Adjust C2011 (Fig. 3-54A) for a frequency of 25.032 MHz.

6. Repeat sub-parts 3 through 5 until the oscillator range is 25.100 to 25.032 MHz.

e. Check Strobe Driver—Excessive noise on the display and intermittent lock are indications that the strobe pulse out of the Strobe Driver is noisy or low in amplitude. This can be caused by a mismatch in input or output impedance to the band-pass filter FL2064. The following procedure is required if the filter or any component that affects the input or output impedance match is replaced.

1. With the instrument in phase lock mode, connect a test oscilloscope probe to TP2087. Note the amplitude of the 5 MHz strobe signal. Amplitude of the sinusodial strobe signal is normally 5 to 6 volt peak-to-peak.

2. If the strobe signal amplitude is low and noisy, change the value of select capacitors C1032 and C2105 to obtain the maximum strobe pulse amplitude at TP2087. Value of these capacitors range from 3.3 to 27 pF.

3. If the signal amplitude is still low, connect a frequency counter probe to TP2015. Frequency must range from 5.0067 to 5.0188 MHz. Frequency is a function of the Controlled Oscillator assembly and counter U1022.

f. Error Amplifier Adjustment—This part of the procedure sets loop gain and error count break point. This part is required when either the Phaselock assembly, 1st LO, Phase Detector, or Error Amplifier is replaced.

1. Set the TIME/DIV to 1 s, FREQUENCY RANGE to band 2 (1.7—5.5 GHz), PHASELOCK on, FREQUENCY SPAN/DIV to 50 kHz, and AUTO RESOLUTION on.

2. Pull P3057 (Fig. 3-54B); this turns the strobe to the Phase Gate on. Turn Loop Gain R3082 fully counterclockwise. Pull and install P2035 between pins 2 and 3.

3. Connect the test oscilloscope probe to TP3081 (Fig. 3-50B) and trigger the test oscilloscope on the signal at TP2037 (U2048-6) shown in Fig. 3-54B. Set the Time/Div to 5 ms and Volts/Div to 0.5 V. Note the beat notes. Beat notes are produced by the difference between strobes from the phaselock (one every 5 MHz) and the particular frequency the 1st LO is tuned to.

4. Turn Loop Gain R3082 clockwise slowly and note the amplitude of the beat notes prior to lock. This usually occurs between 0.5 V and 1.5 V peak to peak. The beat notes will disappear when lock occurs.

5. Turn Loop Gain R3082 fully clockwise, increase FREQ SPAN/DIV to MAX, set RESOLUTION BANDWIDTH to 100 Hz, and TIME/DIV to AUTO.

6. As the sweep scans across the span note the position of the smallest beat note. Tune the center FREQUENCY to position the frequency dot at this location.

7. Reduce the FREQ SPAN/DIV to 100 MHz. Set TIME/DIV to 1 s and activate VIEW A if the instrument has Digital Storage.

8. Adjust Loop Gain until the beat note amplitude is 1.5 times the amplitude noted in part 4 of this step. If this does not occur, it is an indication the Phase Gate is defective.

9. Change the TIME/DIV to MNL, deactivate VIEW A/VIEW B, reduce the FREQUENCY SPAN/DIV to 50 kHz, then increase to 100 kHz and center the crt beam on screen with the MANUAL SCAN control. Now adjust FREQUENCY for a null (zero frequency) of the display on the test oscilloscope.

10. Adjust MANUAL SCAN to position the crt beam four divisions from the center screen reference (four divisions represents 400 kHz).

11. Monitor and trigger the test oscilloscope on TP1031 at the top of R1038 (Fig. 3-54B) and adjust the Error Count Breakpoint potentiometer R1061, from its mid-range position, clockwise until the display just starts to break up.

12. Move the crt beam four divisions to the other side of center with the MANUAL SCAN control and note that the square wave response again starts to break up 400 kHz from center. As the beam crosses center, the display on the test oscilloscope should go through a null. If a null is not found, readjust center frequency. Adjust R1061, if necessary, so break points are 400 kHz either side of the null at center screen.

13. Reconnect P2035 between pins 1 and 2 and install P3057. Disconnect the test oscilloscope trigger and probe connections. Insure that P2035 and P3057 are installed correctly; their absence will produce spurious responses on the display.

14. Reduce FREQ SPAN/DIV to 50 kHz and ensure phaselock occurs.

15. Replace the covers on the assembly and reinstall the module in the 492/492P.

16. Perform the phaselock noise check as described in the Performance Check part.

This concludes the Adjustment Procedure. Repeat the appropriate Performance Check to verify specification.

MAINTENANCE

Introduction

This section describes the procedure for reducing or preventing instrument malfunction, plus troubleshooting, and corrective maintenance. Preventive maintenance improves instrument reliability. Should the instrument fail to function properly, corrective measures should be taken immediately; otherwise, additional problems may develop within the instrument.

Static-Sensitive Components

CAUTION

Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 4-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

1) minimize handling of static-sensitive components;

2) transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components;

3) discharge the static voltage from your body by wearing a grounded wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel;

4) nothing capable of generating or holding a static charge should be allowed on the work station surface;

5) keep the component leads shorted together whenever possible;

6) pick up components by the body, never by the leads;

7) do not slide the components over any surface;

8) avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge;

9) use a soldering iron that is connected to earth ground;

10) use only special anti-static suction type or wick type desoldering tools.

Table 4-1
RELATIVE SUSCEPTIBILITY TO STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels[a]
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

[a]**Voltage equivalent for levels:**

1 = 100 to 500 V 4 = 500 V 7 = 400 to 1000 V (ext)
2 = 200 to 500 V 5 = 400 to 600 V 8 = 900 V
3 = 250 V 6 = 600 to 800 V 9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 Ω.)

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, performance check, and if needed, a recalibration. The preventive maintenance schedule that is established for the instrument should be based on the environment in which the instrument is operated and the amount of use. Under average conditons (laboratory situation) a preventive maintenance check should be performed every 1000 hours of instrument operation.

CAUTION

Do not allow water to get inside any enclosed assembly or components such as the hybrid assemblies, RF Attenuator assembly, potentiometers, etc. Instructions for removing these assemblies are provided in the Corrective Maintenance section. Do not clean any plastic materials with organic cleaning solvents such as benzene, toluene, xylene, acetone or similar compounds because they may damage the plastic.

Elapsed Time Meter

A 5000 hour elapsed time indicator, graduated in 500 hour increments is installed on the Z-Axis/RF Interface circuit board. This provides a convenient way to check operating time. The meter on new instruments may indicate from 200 to 300 hours elapsed time. Most instruments go through a factory burn-in time to improve reliability. This is similar to using aged components to improve reliability and operating stability.

Cleaning

Clean the instrument often enough to prevent dust or dirt from accumulating in or on it. Dirt acts as a thermal insulating blanket and prevents efficient heat dissipation. It also provides high resistance electrical leakage paths between conductors or components in a humid environment.

Exterior. Clean the dust from the outside of the instrument by wiping or brushing the surface with a soft cloth or small brush. The brush will remove dust from around the front-panel selector buttons. Hardened dirt may be removed with a cloth dampened in water that contains a mild detergent. Abrasive cleaners should not be used.

Interior. Clean the interior by loosening accumulated dust with a dry soft brush, then remove the loosened dirt with low pressure air to blow the dust clear. (High velocity air can damage some components.) Hardened dirt or grease may be removed with a cotton tipped applicator dampened with a solution of mild detergent in water. Do not leave detergent on critical memory components. Abrasive cleaners should not be used. If the circuit board assemblies need cleaning, remove the circuit board by referring to the instructions under Corrective Maintenance in this section.

After cleaning, allow the interior to thoroughly dry before applying power to the instrument.

Lubrication

Components in this instrument do not require lubrication.

Service Fixtures and Tools for Maintenance

The following kits and fixtures are available to aid in servicing the 492/492P:

Nomenclature	Tektronix Part No.
Service Kit; consisting of:	006-3286-00
1 Front panel extender	067-0973-00
1 Power module extender	067-0971-00
1 Accessories Interface extender	067-0972-00
1 Ribbon cable	175-2901-00
3 Coaxial cables, Sealectro male-to-Sealectro female	175-2902-00
1 VR module handle	367-0285-00
1 Circuit board extender assembly kit:	672-0865-00
consisting of:	
1 Left extender board	670-5562-00
2 Right extender boards	670-5563-00
1 Frame (extrusion for circuit board extender)	426-1527-00
6 Screws, panhead with flat and lockwashers	211-0116-00

In addition to the above, the following tools are recommended:

Screwdriver, flat, with 1/4 to 3/8-inch bit.
Screwdriver, Posidrive® 440-2.
Wrench, 5/16-inch open end (used to remove or replace semi-rigid coaxial cable connectors).
Hex drive wrenches, 3/32, 5/64, 7/64-inch (used to remove hex screws that hold module assemblies and their covers in place).

Visual Inspection

After cleaning, carefully check the instrument for such defects as defective connections, damaged parts, and improperly seated transistors and integrated circuits. The remedy for most visible defects is obvious. If heat-damaged parts are discovered, try to determine the cause of overheating before the damaged part is replaced; otherwise, the damage may be repeated.

Transistor and Integrated Circuit Checks

Periodic checks of the transistors and integrated circuits are not recommended. The best measure of performance is the actual operation of the component in the circuit. Performance of these components is thoroughly checked during the performance check or recalibration; any sub-standard transistors or integrated circuits will usually be detected at that time.

When handling MOS FET's, keep the shorting strap in place until the transistor is in its socket.

Performance Checks and Recalibration

The instrument performance should be checked after each 1000 hours of operation or every six months if the instrument is used intermittently to ensure maximum performance and assist in locating defects that may not be apparent during regular operation. Instructions for conducting a performance check are provided in the Performance Check part of the Calibration section.

TROUBLESHOOTING

The following are a few aids and suggestions that may assist in locating a problem. After the defective assembly or component has been located, refer to the Corrective Maintenance part of this section for removal and replacement instructions.

Troubleshooting Aids

Diagrams. Block and circuit diagrams, on foldout pages in the Diagrams section, contain any significant waveform, voltage, and logic data information. Any necessary information as to how the data was acquired, such as operational state of the instrument, is provided on the diagram or adjacent to it. Refer to the Replaceable Electrical Parts list section for a description of all assemblies and components.

NOTE

Corrections and modifications to the manual and instrument are described on inserts bound into the rear of the manual. Check this section for changes and corrections to the manual or the instrument.

Circuit Board Illustrations. Electrical components, connectors, and test points are identified on circuit board illustrations located on the inside fold of the corresponding circuit diagram or the back of the preceding diagram. A grid on the circuit board illustrations and the circuit schematic plus a look-up table, provides the means to quickly locate components on either diagram.

Wiring Color Code. Color coded wires are used to aid circuit tracing. Power supply dc voltage leads have either a red background for positive voltage or a violet background for negative voltage. Signal wires and coaxial cables use an identifying one-band or two-band color code.

Multiple Terminal (Harmonica) Connectors. Some intercircuit connections are made through pin connectors that may be mounted in a harmonica type holder. The terminals in the holder are identified by numbers that appear on the holder and the circuit diagrams. Connector orientation to the circuit board is keyed by triangles on the holder and the circuit board (see Fig. 4-1). In some cases, the triangle or arrow is screened on the chassis adjacent to the connector. Some connectors contain more than one section. Connectors are identified on the schematic and board with a "P" or "J".

Resistor Values. Many types of resistors (such as composition, metal film, tapped, thick film resistor network package, plate, etc.) are used in the 492/492P. The value is either color coded in accordance with the EIA color code, or printed on the body of the component.

Capacitor Marking. The capacitance value of ceramic disc plate and slug capacitors or small electrolytics are marked in microfarads on the side of the component body. The ceramic tubular capacitors and feedthrough capacitors are color coded in picofarads. Tantalum capacitors are color coded as shown in Fig. 4-2.

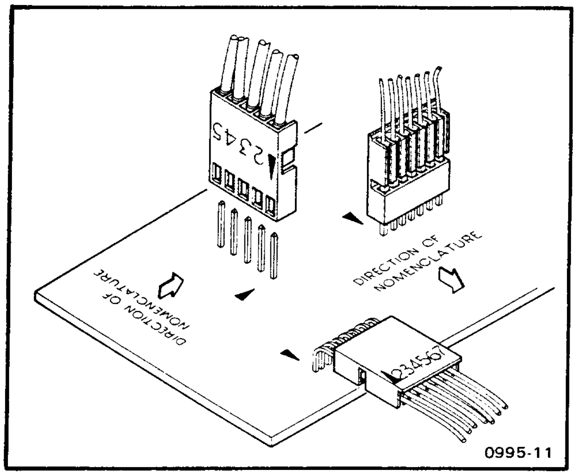


Fig. 4-1. Multipin (harmonica) connector configuration.

Diode Color Code. The cathode of each glass encased diode is indicated by a stripe, a series of stripes, or a dot. Some diodes have a diode symbol printed on one side. Figure 4-3 illustrates diode types and polarity markings that are used in this instrument.

Transistor and Integrated Circuit Electrode Configuration. Lead identification for the transistors and MOS FET's is shown in Fig. 4-4. IC pin outs are shown either by table or box on the schematic diagram.

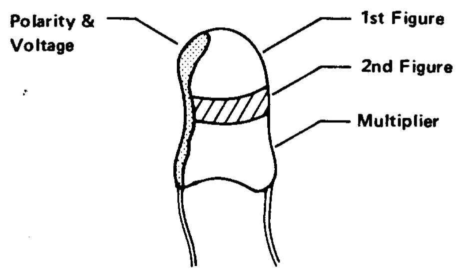
Semiconductor failures account for the majority of electronic equipment failures. Most semiconductors are soldered to the boards. The following guidelines should be observed when substituting these components.

NOTE

Before using any test equipment to make measurements on static-sensitive components or assemblies, be certain that any voltage or current supplied by the test equipment does not exceed the limits of the components to be tested.

a. Try to isolate the problem to a component through signal analysis. Determine that circuit voltages will not damage the replacement.

b. Turn the power off before removing a component.



DIPPED TANTALUM CAPACITOR MARKING

A AND B CASE

CAPACITANCE AND VOLTAGE COLOR CODE

Rated Voltage VDC 25°C	Color	CODE FOR CAPACITANCE IN PICOFARADS		
		1st Figure	2nd Figure	Multiplier
3-4	Black	0	0	None
3-6	Brown	1	1	X10
3-10	Red	2	2	$X10^2$
3-15	Orange	3	3	$X10^3$
3-20	Yellow	4	4	$X10^4$
3-25	Green	5	5	$X10^5$
3-35	Blue	6	6	$X10^6$
3-50	Violet	7	7	$X10^7$
	Gray	8	8	
3	White	9	9	

(1733) 1735-9

Fig. 4-2. Color code for some tantalum capacitors.

c. Use a de-soldering tool and 25 watt or less soldering iron to remove the components.

d. Use only good components for substitution and be sure the new component is inserted into the socket properly before soldering. Refer to the manufacturer's data sheet or Fig. 4-3 for lead configuration.

e. Turn power on and check performance.

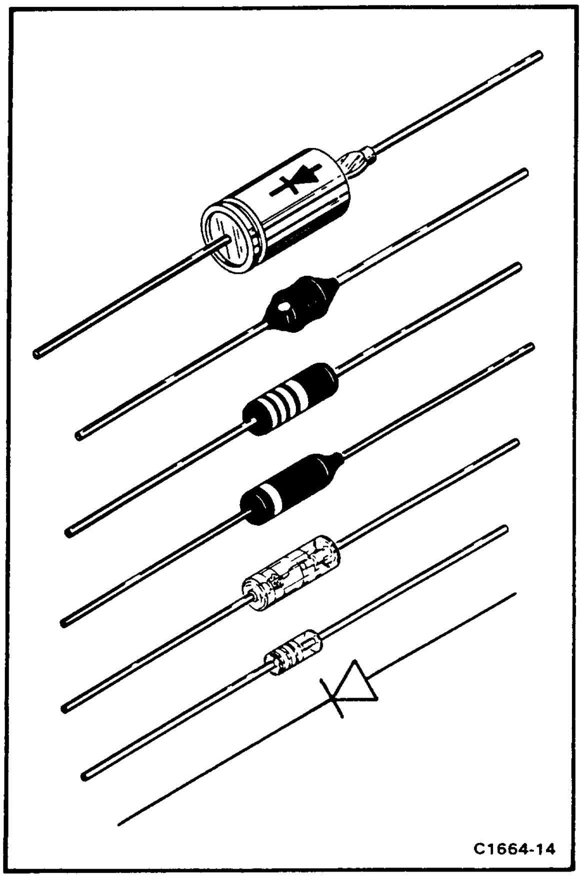


Fig. 4-3. Diode polarity markings.

NOTE

If a substitute is not available, check the transistor or MOS FET with a dynamic tester such as the TEKTRONIX Type 576 Curve Tracer. Static type testers, such as an ohmmeter, can be used to check the resistance ratio across some semiconductor junctions if no other method is available. (Do not measure resistance across MOS FET's because they are very susceptible to static charges.) Use the high resistance ranges (R X 1k or higher) so the external test current is limited to less than 6 mA. If uncertain, measure the external test current with an ammeter. Resistance ratios across base-to-emitter or base-to-collector junctions usually run 100:1 or higher. The ratio is measured by connecting the meter leads across the terminals, noting the reading, then reversing the leads and noting the second reading.

Diode Checks. Most diodes can be checked in the circuit by taking measurements across the diode and comparing these with voltages listed on the diagram. Forward-to-back resistance ratios can usually be taken by referring to the schematic and pulling appropriate transistors and pin connectors to remove low resistance loops around the diode.

CAUTION

Do not use an ohmmeter scale with a high external current to check the diode junction. Do not check the forward-to-back resistance ratios of mixer diodes. See Replacing the Dual Diode Assembly instructions under Replacing Assemblies.

Troubleshooting and Checking the Power Supply

WARNING

The 492/492P uses a high efficiency power supply. The potential of the primary ground for this supply is different than chassis or earth ground. An isolation transformer, with a turns ratio of 1:1 and a 500 VA minimum rating, should be used between the power source and the 492/492P power input receptacle. The transformer must have a three-wire input and output connector with ground through the input and output. Stancor GIS1000 is a suitable transformer. A jumper should also be connected between the primary ground side to chassis ground (emitter of Q2061 and the ground terminal of the input filter FL301).

If the power supply is separated from the instrument and operated on the bench, hazardous potentials will exist within the supply for several seconds after power is disconnected. This is due to the slow discharge of capacitors C6101 and C6111. A relaxation oscillator lights DS5112 (next to C6111) when the potential exceeds 80 volts.

General Troubleshooting Techniques

The following procedure is recommended to isolate a problem and expedite repairs.

1. Ensure that the malfunction exists in the instrument. Check the operation of associated equipment and the operating procedure of the 492/492P (see Operating Instructions).

2. Determine and evaluate all trouble symptoms. Try to isolate the problem to a circuit or assembly. For example: Absence of the frequency marker dot could indicate a malfunction in the video summing stage, the marker generator, or the switching circuitry. A test oscilloscope will check the

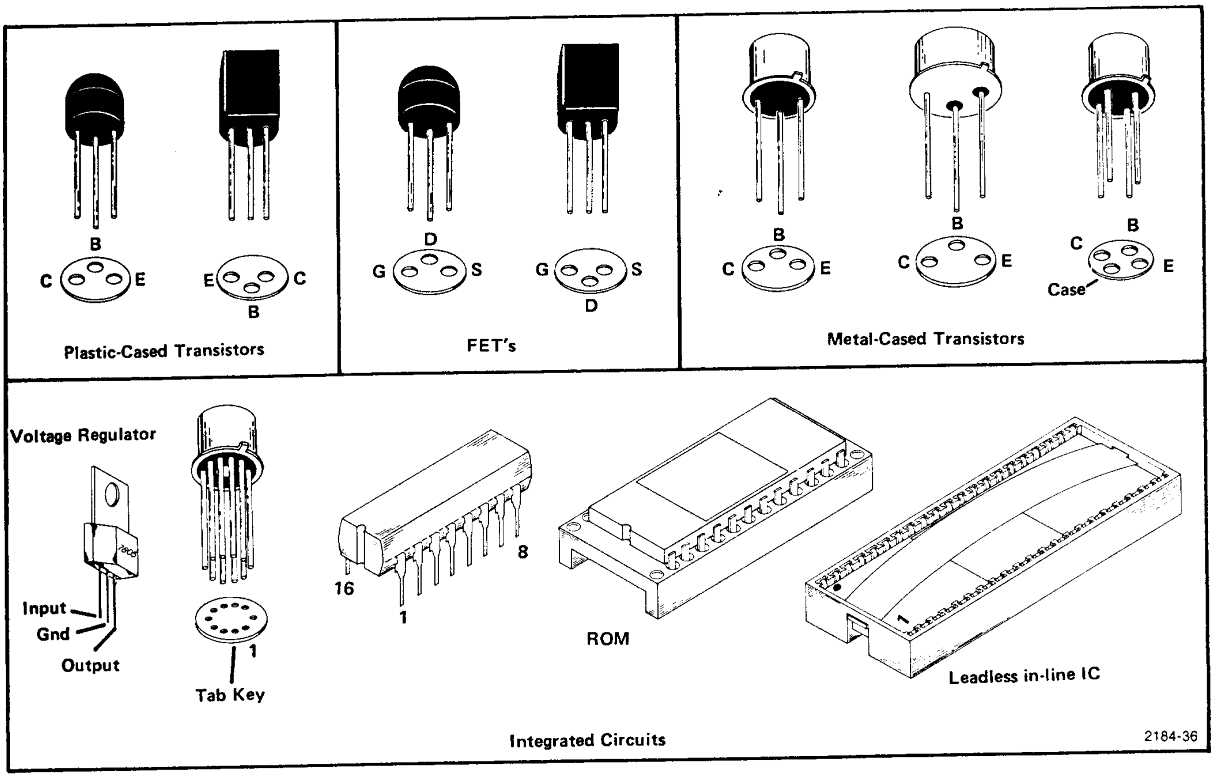


Fig. 4-4. Electrode configuration for semiconductor components.

input to the video summing stage and isolate the problem to one or the other of the two circuits. The block diagrams in the Diagrams section can aid in signal tracing and circuit isolation. It also shows the required signal level at different points to produce full screen deflection.

Block diagrams are provided in three levels. The first level shows all major circuit systems for the 492/492P, the second level shows detail block diagrams of each system, such as the phaselock system, and the third level shows a block diagram of a given circuit or circuit board within the system. Levels two and three block diagrams usually contain signal and voltage levels for each stage.

CAUTION

When measuring voltages and waveforms, use extreme care in placing meter leads or probes. Because of high component density and limited access within the instrument, an inadvertent movement of the leads or probe could cause a short circuit. This may produce transient voltages which can destroy many components.

3. Make an educated guess as to the nature of the problem such as component failure or calibration, and the functional area most likely at fault.

4. Visually inspect the area or assembly for such defects as broken or loose connections, improperly seated components, overheated or burned components, chafed insulation, etc. Repair or replace all obvious defects. In the case of overheated components, try to determine the cause of the overheated condition and correct before applying power.

5. By successive electrical checks, locate the problem. At this time an oscilloscope or signature analyzer is a valuable test item for evaluating circuit performance. If applicable, check the calibration adjustments. Before changing an adjustment, note its position so it can be returned to its original setting. This will facilitate recalibration after the trouble has been located and repaired.

6. Determine the extent of the repair needed; if complex, we recommend contacting your local Tektronix Field Office or representative. If minor, such as a component replacement, see the Replaceable Parts list for replacement information. Removal and replacement procedure of the assemblies and sub-assemblies is described under Corrective Maintenance.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques and procedures required to replace components in this instrument are described here.

Obtaining Replacement Parts

All electrical and mechanical parts are available through your local Tektronix Field Office or representative. The Replaceable Parts list section contains information on how to order these replacement parts.

NOTE

Some components that are heat sinked to the circuit board extrusion or module wall are soldered to the board after the board is mounted in place. This is necessary to avoid cracking the IC case when the mounting screw is tightened. These components are identified by a note on the schematic drawing. Their part number appears with chassis mounted components in the Replaceable Electrical Parts list.

Parts orientation and lead dress should be duplicated because some components are oriented to reduce interaction or control circuit characteristics.

If a part you have ordered has been replaced with a new or improved part, your local Field Office or representative will contact you concerning any change in the part number. After repair, the circuits may need recalibration.

Parts Repair and Return Program

Assemblies containing hybrid circuits or substrates in a semi-sealed module, complex assemblies such as the YIG oscillator, 829 MHz converter assembly, or phase gate detector can be returned to Tektronix for repair under the repair and return program. Contact your local Field Office for exchange rates.

Tektronix repair centers provide replacement or repair service on major assemblies as well as the unit. Return the instrument or assembly to your local Field Office for this service.

Soldering Techniques

CAUTION

Disconnect the instrument from its power source before replacing or soldering components.

Some of the circuit boards in this instrument are multilayer; therefore, extreme caution must be used when a soldered component is removed or replaced. Excess heat from the soldering iron and bent component leads may pull the plating out of the hole. We suggest clipping the old component free. Leave enough lead length so the new component leads can be soldered in place. If you desire to remove the component leads, use a 15 watt or less pencil type iron. Straighten the leads on the back side of the board; then when the solder melts, gently pull the soldered lead through the hole. A desoldering tool should be used to remove the old solder.

Replacing the Square Pin for the Multi-pin Connectors

It is important not to damage or disturb the ferrule when removing the old stub of a broken pin. The ferrule is pressed into the circuit board and provides a base for soldering the pin connector.

If the broken stub is long enough, grasp it with a pair of needle nose pliers, apply heat with a small soldering iron to the pin base of the ferrule, and pull the old pin out. (The pin is pressed into the ferrule so a firm pull is required to pull it out.)

If the broken stub is too short to grasp with pliers, use a small dowel (0.028 inch in diameter) clamped in a vise to push the pin out of the ferrule after the solder has been heated.

The old ferrule can be cleaned by reheating the solder and placing a sharp object such as a toothpick or small dowel into the hole. A 0.031 inch drill mounted in a pin vise may also be used to ream the solder out of the old ferrule.

Use a pair of diagonal cutters to remove the ferrule from the new pin; then insert the pin into the old ferrule and solder the pin to both sides of the ferrule.

If it is necessary to bend the new pin, grasp the base of the pin with needle nose pliers and bend against the pressure of the pliers to avoid breaking the board around the ferrule.

Selected Components

Some components, such as microcircuits, are selected to meet Tektronix specifications. These components carry only Tektronix part numbers under the Mfr Part number column, in the Replaceable Parts list.

Some circuits require a selected component value to compensate for parameter differences between active components. These are identified on the circuit diagram and the Replaceable Parts list. The Replaceble Parts list description for the component gives either a nominal value or range of value. If the procedure for selection is not obvious or complex, such as setting the gain or response of a stage, the criteria for selection is explained in the Calibration or this section of the manual. Where the selection procedure is obvious, such as establishing the frequency of an oscillator, no procedure is given.

Installing Matched Crystals for the VR 100 Hz Filters

The crystals for the 100 Hz filter circuit of the VR assembly are matched. The four crystals come with rubber tie-down straps. Plug the matched crystals into the two boards, insert the rubber tie-down into the two holes provided on either side of the crystal on the board and pull through until the crystal is held in place by the tension of the rubber tie-down.

Replacing EPROM's or ROM's

Firmware for the microcomputer is contained in ROM's on the Memory and GPIB boards. Refer to the Replaceable Electrical Parts list (Vol. 2) under these assemblies (A54 Memory, and A56 GPIB) for the versions and IC part numbers.

Firmware Version and Error Message Readout

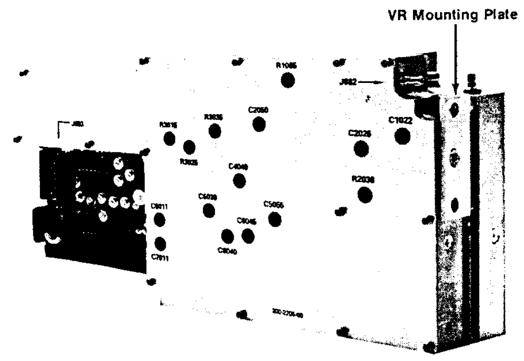
This feature of the 492/492P provides readout of the firmware version when the power on/off is cycled. During the initial power-up cycle, the firmware version flashes on screen for approximately two seconds. The Replaceable Electrical Parts list section, under Memory board (A54), lists the ROM's and their Tektronix part number for each firmware version.

An additional feature is error message readout. The following is a list of these messages and their meaning.

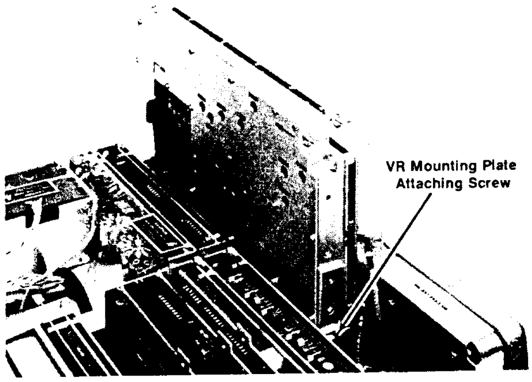
Error #	Meaning
57	Tune routine failed to carry from lower DAC.
58	Failed to phaselock.
59	Lost lock.
60	Failed to recenter when phaselock cancelled or when going to an unlocked span.

Servicing the VR Module

The VR module requires mechanical support when it is installed on board extenders. Mechanical support is provided by moving the mounting plate at the upper side of the module (Fig. 4-5A) to the bottom side. This allows installation of a mounting screw through a support bracket into the mounting plate screw hole as shown in Fig. 4-5B.



A. Location and position of mounting plate.



B. VR module on extender boards and secured for servicing.

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Fig. 4-5. Preparing the VR module for service showing how it is supported when on an extender.

REPLACING ASSEMBLIES AND SUBASSEMBLIES

Most assemblies or sub-assemblies in this instrument are easily removed and replaced. The following describes procedures for replacing those assemblies that require special attention. Top and bottom views of the 492/492P with Options 01, 02, and 03, are shown in Figs. 4-6 and 4-7. These figures identify most assemblies by name and assembly number.

Removing or Replacing Semi-rigid Coaxial Cables

Performance of the instrument is easily degraded if these connectors are loose, dirty, or damaged. The following procedure will help ensure good performance.

1. Use a 5/16 inch open-end wrench to loosen or tighten the connectors. It is good practice to use a second wrench to hold the rigid (receptacle) portion of the connector to prevent bending or twisting the cable.

2. Ensure that the plug and receptacle are clean and free of any foreign matter.

3. Insert the plug connector fully into the receptacle before screwing the nut on. Tighten the connection to 8 to 10 inch pounds. Do not overtighten (15 to 20 inch pounds) because this can damage the connector.

Replacing the Dual Diode Assembly

The diode sub-assembly housing the Schottky mixer diodes permits easy field replacement of the diodes.

CAUTION

The diodes are beam-lead devices mounted on a quartz suspended substrate; these diodes are extremely static sensitive. Refer to the Caution note on static that precedes this section. Do not expose the diode assembly to any RF field.

The diode sub-assembly is secured in place with four 0-80 screws. An 8-32 threaded hole is provided to facilitate insertion and removal of the sub-assembly. There are three contact points located on the substrate side of the sub-assembly. Use care when mounting and orienting these contacts with the mating contacts in the mixer assembly to ensure proper fit and function. Insertion and removal of the sub-assembly more than twice is not recommended due to the gold ribbon attach technique used in fabrication.

A tuning screw, mounted through the top of the diode assembly, adjacent to the 8-32 screw hole is adjusted to null a start spur on band 1 to −13 dBm. Although precalibrated, care should be taken to not force the tuning screw after it bottoms out on the surface of the quartz suspended substrate. (The null usually occurs about one full turn from the bottom.)

The diode assembly is packaged in a static-free package. Keep the diode sub-assembly in this package until ready to install. The following procedure should be used when replacing this sub-assembly.

1. Remove the two mounting screws and remove the assembly from the 492/492P; then loosen and disconnect the three coaxial cable connections to the mixer assembly.

2. Remove the four 0-80 screws and insert a 8-32 screw into the threaded hole provided in the center of the diode assembly.

3. Lift the diode assembly out of the mixer assembly by means of the 8-32 screw; then remove the screw.

4. Open the diode package, grasp the diode assembly by its side with tweezers and place it on a static-free surface. Grasp the side of the assembly with the fingers to avoid contact with the diodes and insert the 8-32 screw.

5. Orient the diode assembly so the three contact tips are aligned with their respective contacts in the mixer; then using the index fingers of both hands so equal pressure is applied, press the sub-assembly into place.

6. Insert the four mounting screws, tighten, then replace and tighten the three coaxial connectors so they are just snug. Install the two mounting screws that hold the assembly in the 492/492P.

Replacing the Crt

Removal

1. Remove the snap-in printed bezel and crt light filter.

2. Use a 8/64 inch Allen wrench to remove the four bezel screws, unplug and remove the inner bezel.

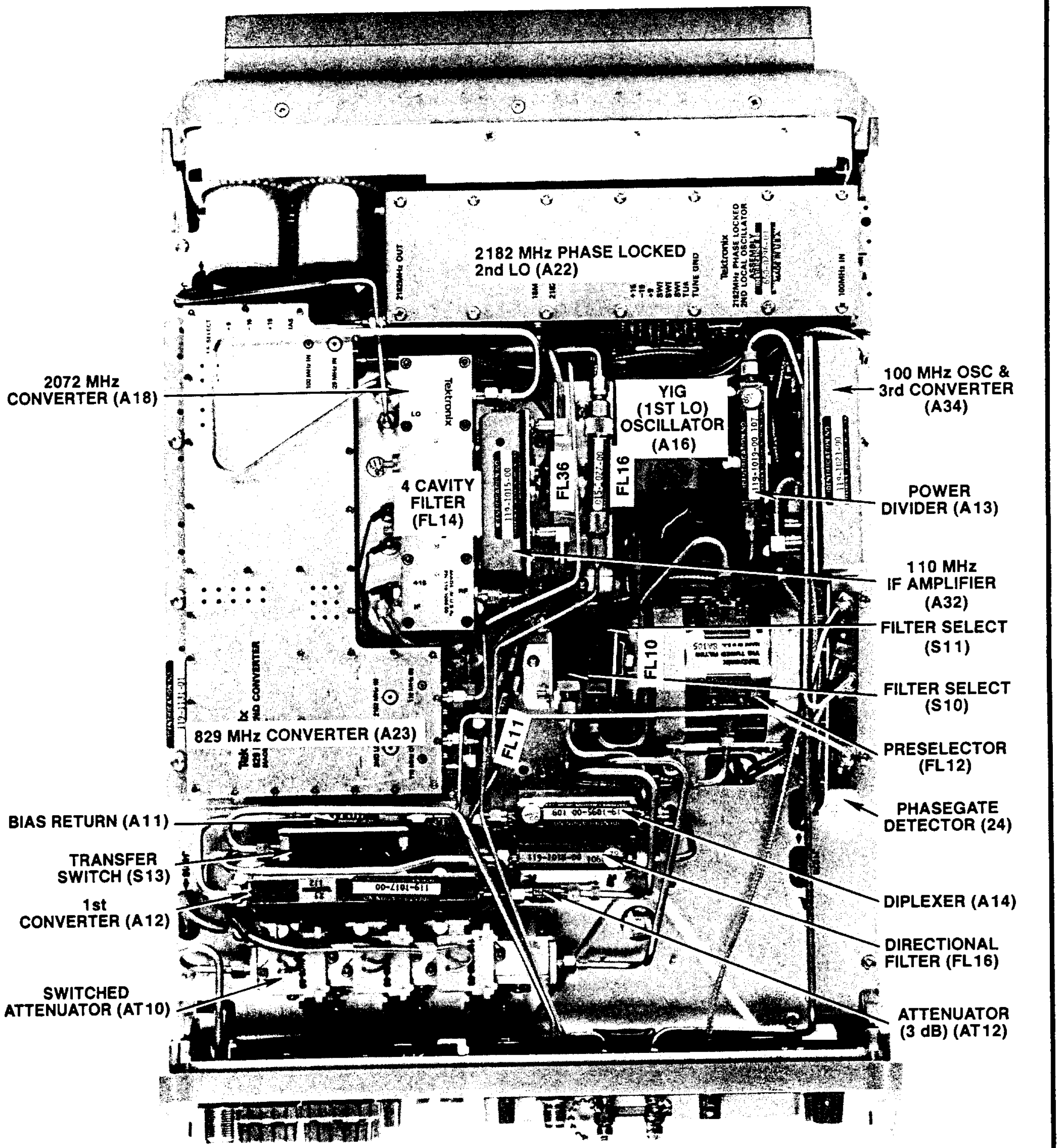


Fig. 4-6. RF deck of the B040000 and up version showing the major assemblies.

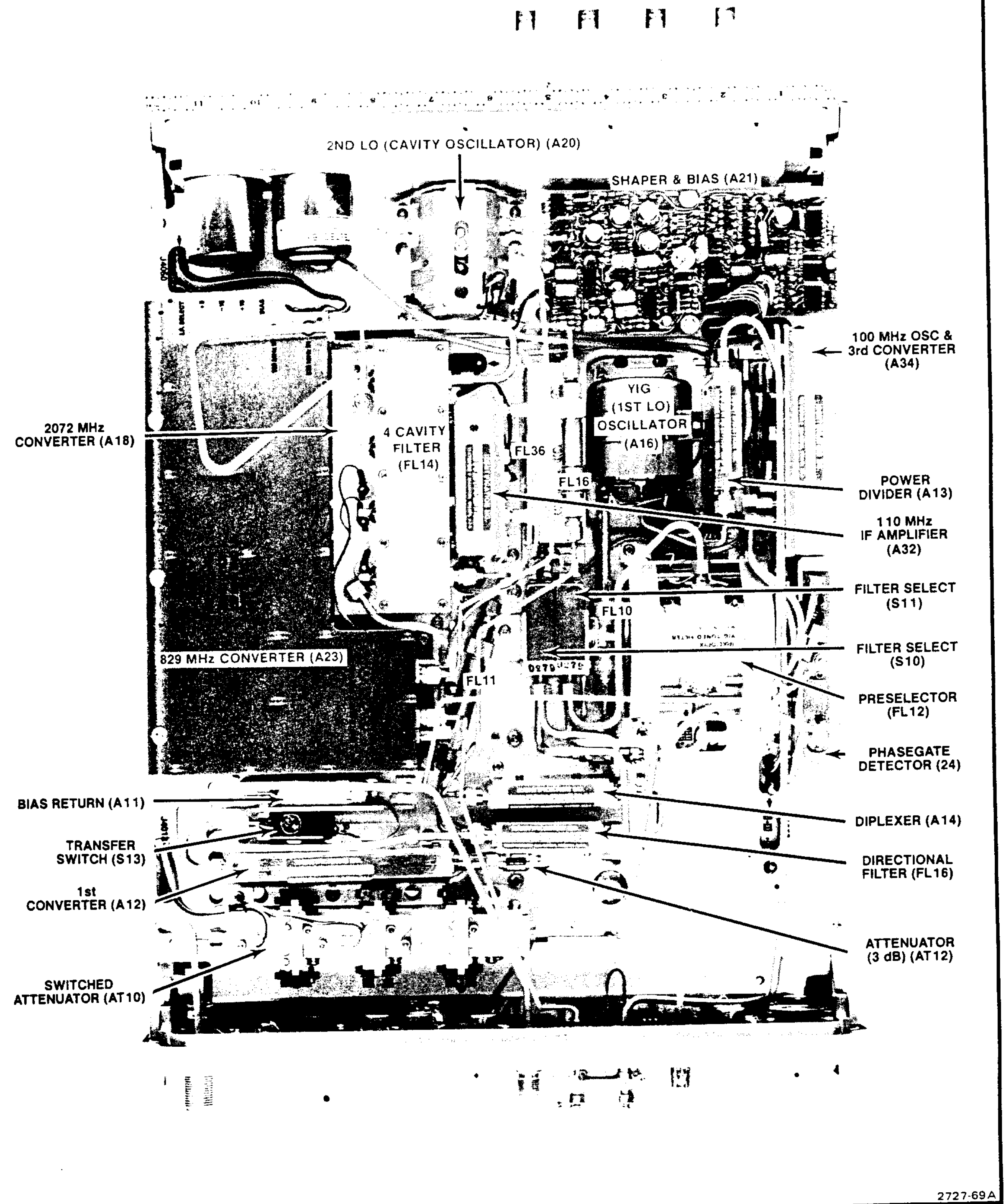


Fig. 4-6A. View of the 492/492P RF deck for B039999 and below versions showing major assemblies and circuit boards.

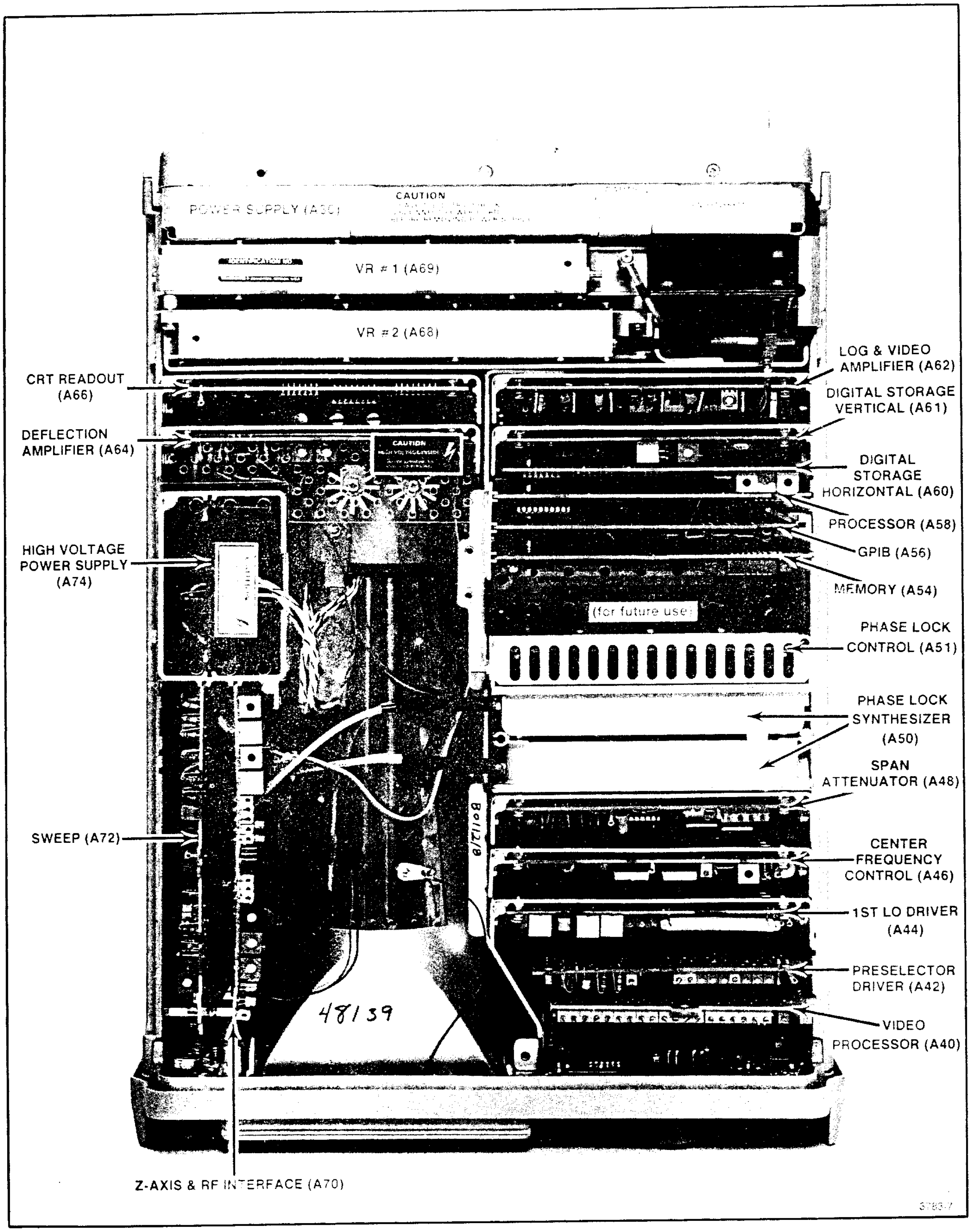


Fig. 4-7. View of the 492/492P top deck showing major assemblies.

3. Unsolder the ground wire from the front-panel casting and unplug the crt cables at their respective board connections (high voltage module, deflection amplifier, and Z-Axis board).

4. Slide the crt, with its shield, out through the front panel.

5. Remove the crt shield as follows:

a) remove the tube base cap and unplug the socket;

b) remove the two side screws that hold the upper shield in place; then remove the shield;

c) loosen the screws that clamp the plastic bracket around the crt; then remove the bracket.

Replacement

1. Install the plastic bracket so the back on the clamp is 5.07 inches from the back of the crt socket guide.

2. Replace the crt shield plus the socket and base shield by reversing the removal procedure. The finished crt assembly length, with cap installed, must equal 11.05 inches. If it is longer, the assembly may short circuit the Log Amplifier circuit board when it is installed.

3. Install crt with shield assembly into the front panel. Install bezel and tighten the four mounting screws.

CAUTION

Do not reposition the front-panel blue plastic crt holders. They have been factory aligned so the crt assembly seats properly. Visually inspect to ensure that the crt assembly clears the circuit board components.

4. Reconnect cables to their respective board connectors and resolder the ground lead to its terminal. Replace crt light filter and snap-in bezel.

Repairing the Crt Trace Rotation Coil

The trace rotation coil is part of the crt assembly. If the coil is damaged beyond repair, the crt with the coil must be replaced.

If the "finish" (red) lead is broken, remove the tape and unwind one or two turns so it can be respliced and soldered to the lead wire. Rewind and retape.

If the "start" (black) lead is broken and the lead is too short to resplice, attempt to fish out the broken end so one or two turns can be unwound. Resplice and solder to the lead; then rewind and retape.

Front-Panel Assembly

The front-panel assembly does not have to be removed to replace any of the push buttons. Refer to Replacing Front-Panel Push Buttons procedure that follows. The crt is removed with the front-panel assembly.

Removal

1. Unscrew and remove the mounting nuts and washers for the RF INPUT, EXT MIXER, plus the two 1st and 2nd LO OUTPUT connectors.

2. Remove the two screws that hold the front panel to the RF deck (center and left side).

3. Unplug the CAL OUT coaxial cable from the 3rd Converter; then disconnect the five crt cables from the Z-Axis/RF Interface, High Voltage module, and Deflection Amplifier.

4. Looking at the top of the instrument, remove the one screw that holds the front panel to the side extrusion, between the crt and the right side of the instrument.

5. Now set the instrument on its side and remove the four screws that hold the front panel to the side rails.

6. Pull the front panel up and off the Mother board.

Replacement

Replace the front panel by reversing the removal procedure.

Front-Panel Board

NOTE

A replacement Front-Panel board comes with switches and controls for all Options (01, 02, 03, etc.). Before replacing an existing board, remove the switches and controls on the new board that are not used on the existing instrument.

Removal

1. Remove the front-panel assembly as described previously.

2. Use an Allen wrench to loosen the knob locking screw and remove all knobs.

3. Lay the front-panel on its face; then remove the eleven circuit board screws and the screw that heat sinks and holds IC U6090 on the board. Note that the screw next to the connector plug has a fiber washer.

4. To prevent losing the grounding rings or bushings between the front-panel controls and the front-panel casting, hold the circuit board against the front-panel casting while turning the complete assembly so it rests on the base of the crt assembly.

5. Gently lift the casting from the circuit board. Ensure that the grounding rings remain on the shaft of all controls as the casting is removed.

Replacement

Reverse the removal procedure, ensuring that the fiber washer is on the board screw next to the connector plug. This washer prevents the screw from shorting a circuit board run to the front-panel casting.

Replacing Front-Panel Push Button Switches

The front-panel assembly does not have to be removed to replace any push button switch. The procedure follows:

1. Remove front-panel knobs. Loosen and remove nuts and washers for the RF INPUT, EXTERNAL MIXER, plus the 1st and 2nd LO connectors.

2. Remove the screw that was under the FREQUENCY tuning knob which holds the panel to the front-panel casting.

3. Loosen the black screws through the crt bezel so the panel can be moved enough to lift it off the casting.

4. Unplug and replace the desired switches.

Main Power Supply Module

CAUTION

To avoid damage to the Mother board connector J5041 and Interface connector J1034 during removal or installation of the Power Supply Module, use the following procedure.

Removal

1. Disconnect the power cord, set the 492/492P on its face or front panel and remove the instrument cover.

2. Unplug the coaxial cable connector P620 from the Log Amplifier assembly and pull the cable through so it is clear.

3. Remove the three screws that hold the power module to the RF deck flange (bottom right side).

4. Remove the four screws that hold the power supply module to the side-rails.

5. With the instrument on its face and the RF deck on the near side, pull the left side of the power module from its side-rail (no more than one and one-half inch). Now grasp both sides of the module and lift to separate the module from the Mother board.

WARNING

Because C6011 and C6101 discharge very slowly, hazardous potentials exist within the power supply for several minutes after the power switch is turned off. A relaxation oscillator, formed by C5113, R5111, and DS5112, indicate the presence of voltages in the circuit until the potential across the filter capacitors is below 80 V.

Replacement

1. Set the instrument face down with the RF deck on the near side.

2. Hold the power supply module over the instrument so the right side is touching the side-rail and the left side is about one and one-half inch above its side-rail.

3. Align connectors P5041 and P1034 with their respective Mother board and Interface board connectors and press the module into place between the side-rails.

4. Replace the four module holding screws and the three flange screws.

5. Thread the coaxial cable under the semi-rigid cables on the RF deck and through the deck opening to the Log Amplifier assembly connector J620 so the cable will not catch when the instrument cover is replaced.

6. Replace the instrument cover.

High Voltage Power Supply

Before the High Voltage Power Supply circuit board can be unplugged and removed, a screw through the side-rail into a nylon standoff bushing, at the bottom corner of the board, must be removed.

Replacing the 1st (YIG) Local Oscillator Interface Board

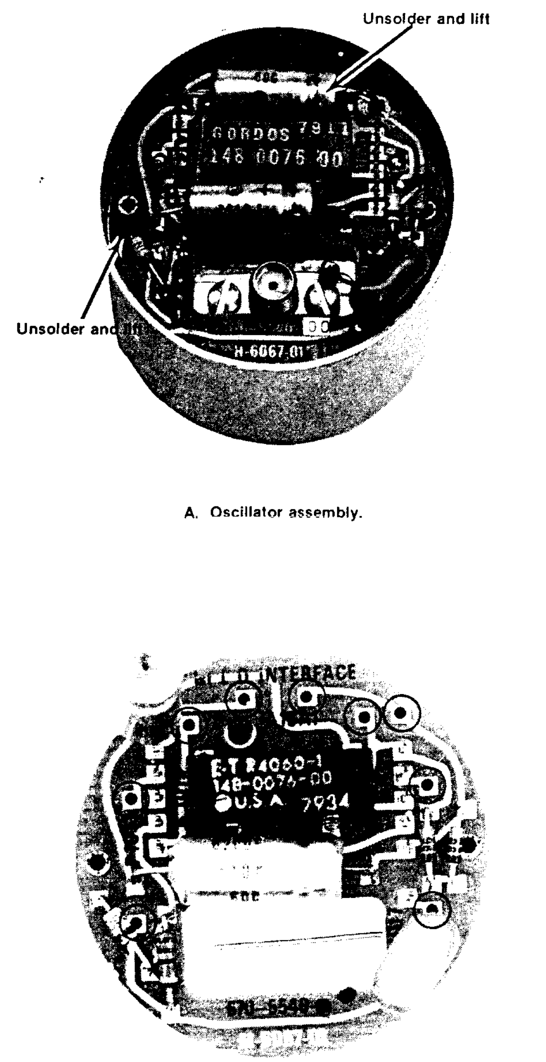
The YIG oscillator assembly includes an interface circuit board that can be ordered separately. To replace the board refer to Fig. 4-8 and the following procedure. Use a desoldering tool to remove the solder as these leads are unsoldered.

1. Unsolder and lift one end of C1014 (820 μF) capacitor at the top of the board.

2. Unsolder and lift one end of VR1010.

3. Unsolder and lift the wire to the ground lug on P166.

4. Unsolder the eight leads to the YIG and lift the board off the assembly.



A. Oscillator assembly.

Unsolder circled connections.

B. Interface board showing terminals to unsolder for removal.

2727-68

Fig. 4-8. Removing YIG Oscillator Interface circuit board.

Compliant Mounted Fan (SN B042720 and up)

Instruments SN B042720 and up have a compliant mounted fan (see Fig. 4-9A).

Removal

1. Remove the power supply as described in this section.

2. Remove six screws that hold the power supply cover in place. Take the coaxial cable out of the plastic retainer clip and lift the power supply cover with the fan up. Unplug the fan from the Fan Drive Board.

3. Remove the nuts and lockwashers which hold the fan brackets from the back side of the power supply housing. The fan will fall free from the brackets.

4. The resilient mounts from the corners of the fan frame should be removed if a new fan is to be installed.

Replacement

1. Insert 4 resilient mounts in the corners of the fan flush with the fan frame.

2. Install one of the fan brackets to the power supply housing by attaching its lock washers and nuts to the back of the housing.

NOTE

Fan brackets should be installed as in Fig. 4-9A.

3. Insert the posts of the bracket into the holes provided in the resilient mount, and install the remaining bracket with the lockwashers and nuts to the back side of the power supply housing.

4. Reconnect the fan to the Fan Drive Board, then replace the cover with the fan onto the power supply module.

5. After installing the six screws that hold the cover in place, ensure that the fan assembly moves freely. Replace the coaxial cable in the plastic retaining clip.

6. Reinstall the power supply assembly as directed under Power Supply Replacement. Apply power and check for normal fan operation.

Compliant Mounted Fan (SN B030000 to B042719)

Instruments SN B030000 to B042719 may have a compliant mounted fan (see Fig. 4-9B). It is important that the mounting screws for these fans are not over-tightened.

Removal

1. Remove power supply as described in this section.

2. Remove six screws that hold the power supply cover in place. Take the coaxial cable out of the plastic retainer clip and lift the power supply cover with fan up, so harmonica connector P3045 can be disconnected and the cover removed.

3. Unsolder the leads to the fan.

4. Using a 1/4 inch open-end wrench or needle-nose pliers, retain the nylon nut while unscrewing the fan mounting screws with a Phillips screwdriver.

NOTE

After the fan is removed, be sure to retain the rubber and steel washers on the screws. These are essential for proper operation of the compliant mount. Do not remove the self-locking nylon nuts.

5. Remove the lead gasket from the old fan and install it on the replacement fan assembly. Do not over-tighten the screws retaining the gasket. The lead is soft enough to be deformed by over-tightening.

Replacement

1. Refer to Fig. 4-9B and replace as follows:

a) place the foam gasket between the fan housing and the power supply module cover;

b) insert the two 5/8 inch machine screws, with washers mounted as shown in Fig. 4-9B, through the two eyelets. Place the fan in position; then, while holding the nylon nut with needle-nose pliers, screw the mounting screws into the nut until the end of the screws is just flush with the nut. Do not re-use these nuts because they can loosen with vibration. The nylon nuts are self-locking.

2. Re-solder the fan power leads, brown to pin 1, red to pin 2, orange to pin 3, and yellow to pin 0.

3. Reconnect the plug P3045, making sure the index markers are aligned, then replace the cover with the fan onto the power supply module.

4. After installing the six screws that hold the cover in place, ensure that the fan assembly moves freely. Replace the coaxial cable in the plastic retaining clip.

5. Reinstall the power supply assembly as directed under Power Supply Replacement. Apply power and check for normal fan operation. If fan does not run, check the connection of harmonica connector plug P3045.

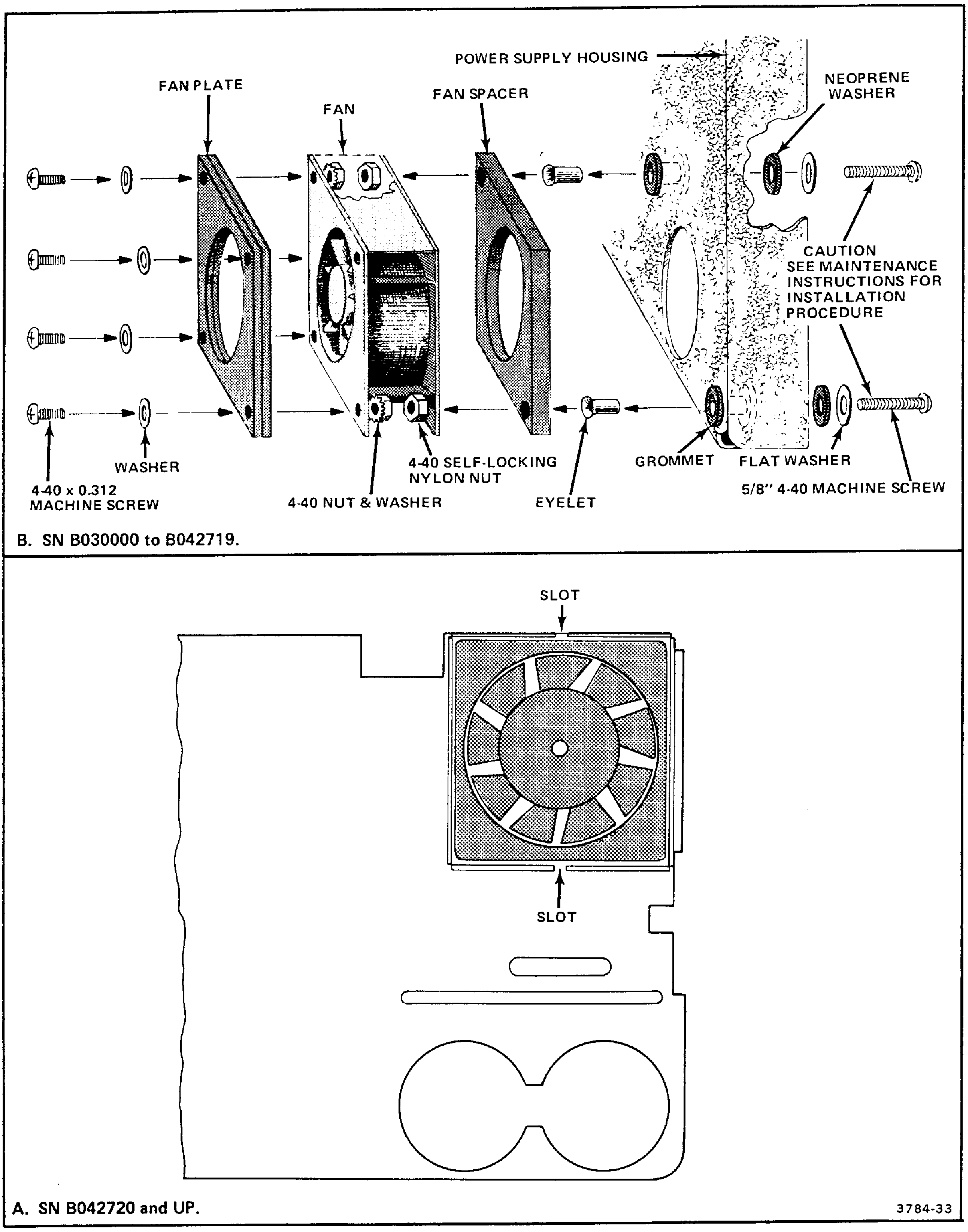


Fig. 4-9. Fan Assembly.

MAINTENANCE ADJUSTMENTS

The following procedures are not part of the regular calibration. They are applicable when an assembly is replaced or after major repair.

110 MHz IF Assembly Return Loss Calibration

NOTE

The IF assembly must be removed to gain access to the adjustments.

Table 4-2
EQUIPMENT REQUIRED

Test Equipment	Characteristics	Recommended Type
Spectrum Analyzer	Frequency range ⩾110 MHz	TEKTRONIX 492/492P or 7L18 Spectrum Analyzer
Signal Generator	Frequency 110 MHz at +10 dBm	TEKTRONIX SG 503 for the TM 500 Series
VSWR Bridge		Wiltron VSWR Bridge, Model 62BF50
10 dB and 1 dB Step Attenuators	50 Ω, 0 dB to 40 dB	TEKTRONIX 2701 Attenuator
Termination	50 Ω	Tektronix Part No. 011-0049-01
Adapter	Bnc-to-Sealectro	Tektronix Part No. 175-0419-00

1. Test equipment setup is shown in Fig. 4-10. Apply 110 MHz at 2 V peak to peak (+10 dBm) through 35 dB attenuation to the RF Input of the VSWR bridge. Connect the RF Out of the VSWR bridge to the RF Input of the spectrum analyzer. (Do not connect the 110 MHz IF to the VSWR bridge.)

2. Set the spectrum analyzer center frequency to 110 MHz, SPAN/DIV to 5 MHz, RESOLUTION BANDWIDTH to 3 MHz, VERTICAL DISPLAY to 10 dB/DIV, and REFERENCE LEVEL to −20 dBm.

3. Adjust the step attenuator for full screen (−20 dBm) display.

4. Connect the 110 MHz IF input to the VSWR bridge and connect a 50 Ω termination to the output of the IF amplifier. Now plug the power cable P3045 into the + and −15 V source and ground the case of the assembly.

5. Adjust C2047 and C325 (Fig. 4-11) simultaneously for minimum signal amplitude on the spectrum analyzer display. Minimum amplitude must be at least 35 dB down from the full screen reference of −20 dBm.

6. Disconnect test equipment setup and replace the 110 MHz IF assembly.

CAUTION

Do not open the assembly. Adjust the tuning slug only after checking the filter characteristics.

2072 MHz 2ND CONVERTER

The 2nd Converter assembly consists of a four cavity 2072 MHz bandpass filter, mixer, and a 110 MHz lowpass filter. The assembly is calibrated at the factory, prior to installation, and requires no calibration after it is installed. We recommend replacing the assembly if it should malfunction. The following procedure describes adjustments that can be made if the biasing should malfunction or the seal on any of the filter tuning slugs is broken. The mixer diodes are not to be replaced in the field. Return the assembly to Tektronix, Inc., for repair.

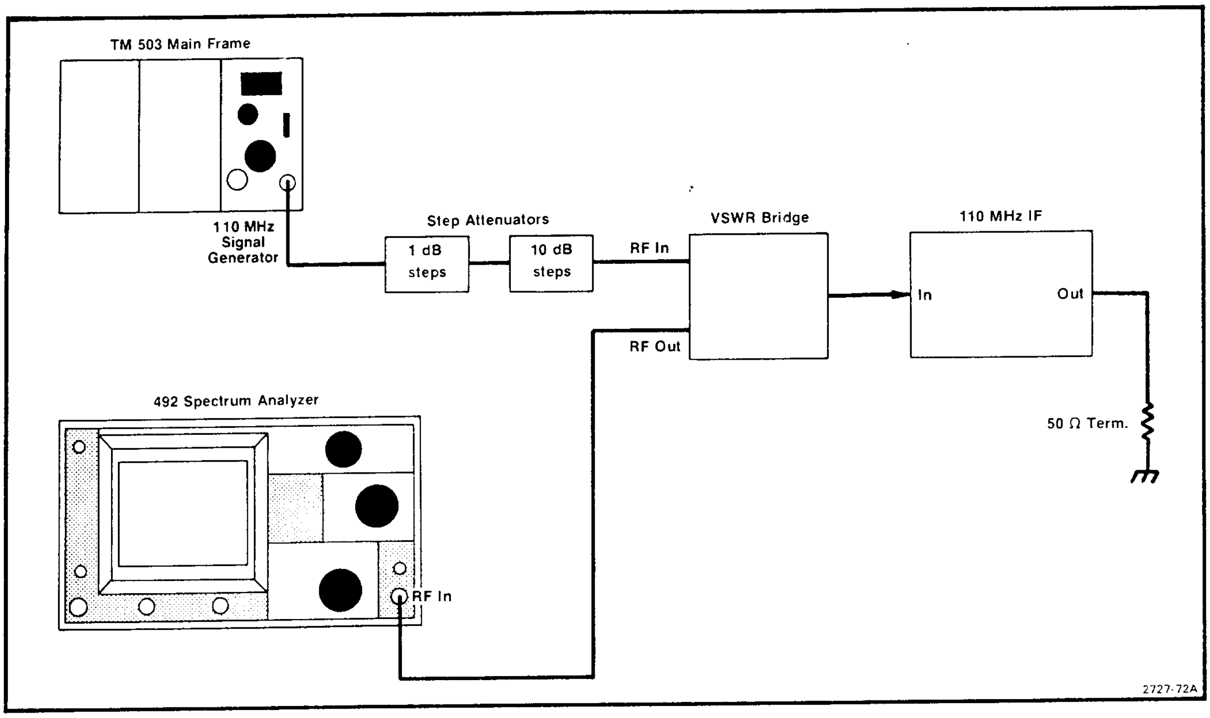


Fig. 4-10. Test equipment setup for adjusting return loss for the 110 MHz IF assembly.

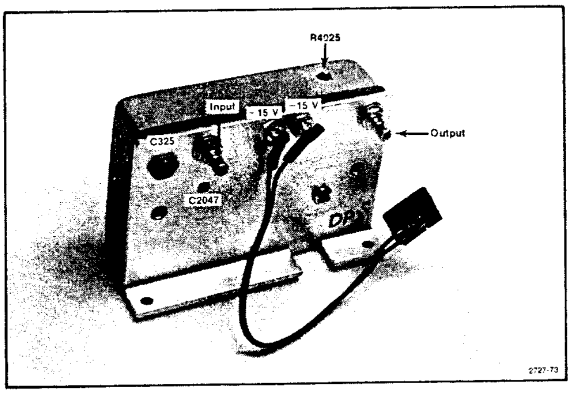


Fig. 4-11. Location of the 110 MHz IF return loss adjustments and IF Gain adjustment.

FOUR CAVITY FILTER

The characteristics of the filter are checked with a network analyzer. Frequency of the filter is 2072 MHz, bandpass is 15 MHz down 1 dB, return loss is 20 dB or greater, and insertion loss is 1 dB.

If the seal is broken on any tuning slug, adjust for maximum return loss.

MIXER

To gain access to the Bias adjustments, remove the assembly from its mounting; then remove the mounting plate on the bottom of the assembly. Reconnect the Mixer to the input/output lines, using the same cables (cable length of semi-rigid cables is critical). Apply the CAL OUT signal to the RF INPUT and tune a marker to center screen. Simultaneously adjust both bias potentiometers for maximum signal amplitude.

110 MHz THREE CAVITY FILTER

Alignment is not a normal calibration adjustment. The tuning slugs are adjusted for center frequency and response shape so the resolution bandwidth is within specifications. The adjustment procedure follows.

1. With the CAL OUT signal applied to the RF INPUT, tune the signal to center screen and reduce the RESOLUTION BANDWIDTH to 1 kHz.

2. Tune the signal to center screen to establish center frequency reference; then increase the RESOLUTION BANDWIDTH to 1 MHz.

3. Adjust the tuning slugs for best response shape, centered around the reference. Ensure bandwidth (6 dB down) is 1 MHz.

4. Check resolution bandwidth accuracy over the range of the RESOLUTION BANDWIDTH selector to ensure that bandwidth is within specification.

829 MHz Converter Maintenance

Some circuit boards in this assembly contain critical length printed elements. When damaged, these elements are usually not repairable; therefore, the circuit board must be replaced. Even though replacement boards are precalibrated and repair can be accomplished by replacing the board, we recommend sending the instrument or assembly to your Tektronix Service Center for repair.

The 829 MHz bandpass filter in the IF section, and the 719 MHz LO in the LO section, require adjustment only if the board has been damaged or active components (transistor or varactor) have been replaced. The following describes preparation for service and replacement procedures. The first two steps describe how to gain access to either the LO or the IF section; the remaining steps describe adjustment procedure for each section.

1. To gain access to the LO section

a. Switch POWER off; use a 5/64 Allen wrench to loosen and remove the cover screws.

b. Remove the cover.

c. Refer to step 3 for adjustment procedure.

2. To gain access to the IF section

a. Switch POWER off; use a 5/16 inch wrench to disconnect and remove all coaxial connectors to the 829 MHz converter.

b. Unscrew and remove the six mounting screws, unplug the input power connector P4050, then remove the 829 MHz converter assembly.

c. Turn the assembly over and remove the cover for the IF section.

d. To troubleshoot or calibrate the circuits, set the assembly at a location so the input power plug P4050 can be reconnected to the Mother board. Be sure to observe plug orientation (pin 1 to pin 1).

e. Refer to step 4 for adjustment procedure.

3. 719 MHz Oscillator Range Adjustment

a. Adjustment requires the following test equipment:

A frequency counter with a frequency range to 1 GHz (nine digit readout), sensitivity of 20 mV rms prescale, 15 mV rms direct (such as TEKTRONIX DC 508A); a digital voltmeter with a 3.5 digit readout (such as TEKTRONIX DM 502A); test leads for the DVM, a 50 Ω coaxial cable with bnc connectors (Tektronix part number 012-0482-00) and a sma male-to-bnc female adapter (Tektronix part number 015-1018-00).

b. The 2nd LO range is from 714.5 MHz to 723.5 MHz (with the cover off). 719 MHz is the optimum center frequency. Frequency of the oscillator is controlled by the Tune Volts from the 25 MHz Phaselock circuit (located at TP1011) which varies from +5 V (low end) to +11.9 V (high end) with +6.75 to +7.5 V as the limits for operation at 719 MHz. Set the digital voltmeter to measure 12 V then connect it between TP1011 (Fig. 4-12) and ground.

c. Disconnect the 100 MHz reference from the 3rd Converter by unplugging P235 (Fig. 4-12). The oscillator should go to its upper limit and the voltmeter indicate about 11.9 V.

d. Connect the 75 MHz—1000 MHz input of the frequency counter through a 50 Ω coaxial cable to the front-panel 2nd LO OUTPUT connector.

e. The 719 MHz oscillator frequency is a function of the length of the printed 1/4 wavelength transmission line. Minor adjustments to the oscillator frequency are made by shortening the U-shaped transmission line stub, off the main line. Graduation marks (see Fig. 4-12) along the side of the stub provide a guide to calculate frequency correction. Each minor mark from the end or cut across the stub, represents an approximate change of 2 MHz.

Check the frequency by noting the reading on the frequency counter. If above 723.900 MHz, the stub must be lengthened. Solder a bridge across the cut and recheck frequency. Nominal frequency for an uncut stub is 710 MHz.

f. Shorten the line so the frequency is near 723.500 MHz. For example: The frequency difference be-

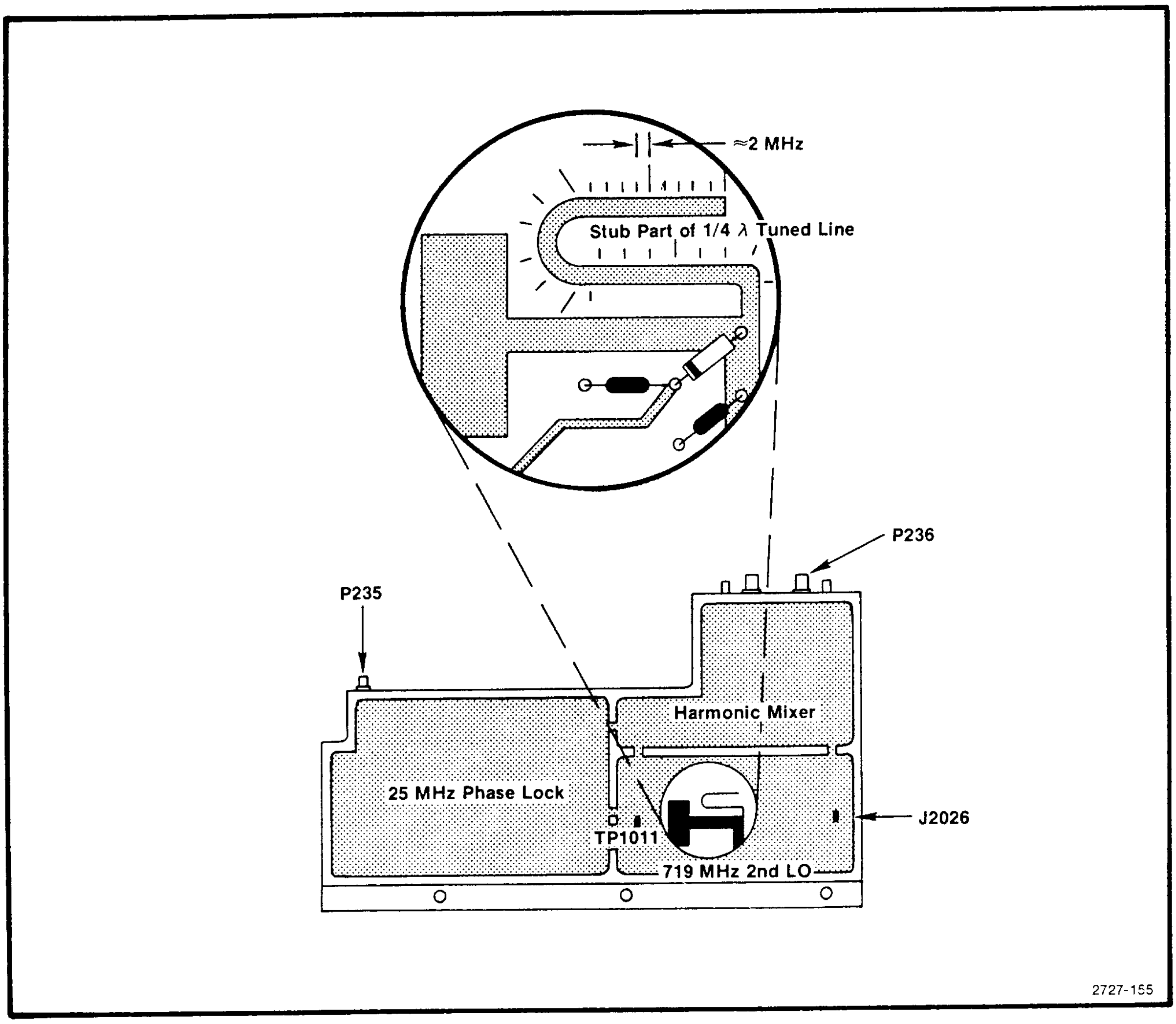


Fig. 4-12. LO section of 829 MHz converter showing test points and connectors.

tween desired and actual, divided by 2 MHz, equals the number of minor divisions from the line end for the new cut. Make a cut across the line and check that the new frequency is between 723.100 and 723.900 MHz. Repeat as necessary.

g. Cover the 719 MHz oscillator cavity with the 829 MHz Converter cover, press down to ensure good shielding, and note the frequency readout of the counter. Frequency should fall within 723.600 and 724.400 MHz.

h. Reconnect P234 (100 MHz) and P237 (2182 MHz) and confirm that phaselock is operating by noting that the voltage on TP1011 is between 6.75 and 7.5 V. This completes the adjustment of the 719 MHz LO. Replace the cover and reinstall the 829 MHz converter assembly.

4. 829 MHz Coaxial Bandpass Filter Adjustment

NOTE

This procedure is necessary if the position of one of the variable capacitor loops (tabs) has been altered, changing the bandpass characteristics of the filter.

a. Test equipment required:

Spectrum analyzer with tracking generator.	492/492P Spectrum Analyzer with TR 503 tracking Generator; or 7L13 with a TR 502 Tracking Generator.
Frequency Counter	TEKTRONIX DC 508
Return Loss Bridge	Wiltron Model 62BF50

b. Unsolder and reconnect the jumper, on the 829 MHz Amplifier board, to the test Peltola jack J1029 (see Fig. 4-13).

c. Connect the spectrum analyzer, tracking generator, and frequency counter together as a system, with the frequency counter connected to the Auxiliary RF Output of the tracking generator (see Fig. 4-14).

d. Connect the spectrum analyzer/tracking generator system through the return loss bridge to the Peltola jack (J1029) on the 829 MHz amplifier board (see Fig. 4-14). Reconnect P235 (100 MHz reference signal) and P237 (2182 MHz input) to the LO section of the converter.

Terminate the 110 MHz Output (J232) connector with 50 Ω, using a bnc-to-Sealectro adapter and 20 dB bnc attenuator. Pull the IF SELECT line high by switching to band 2 (1.7—5.5 GHz).

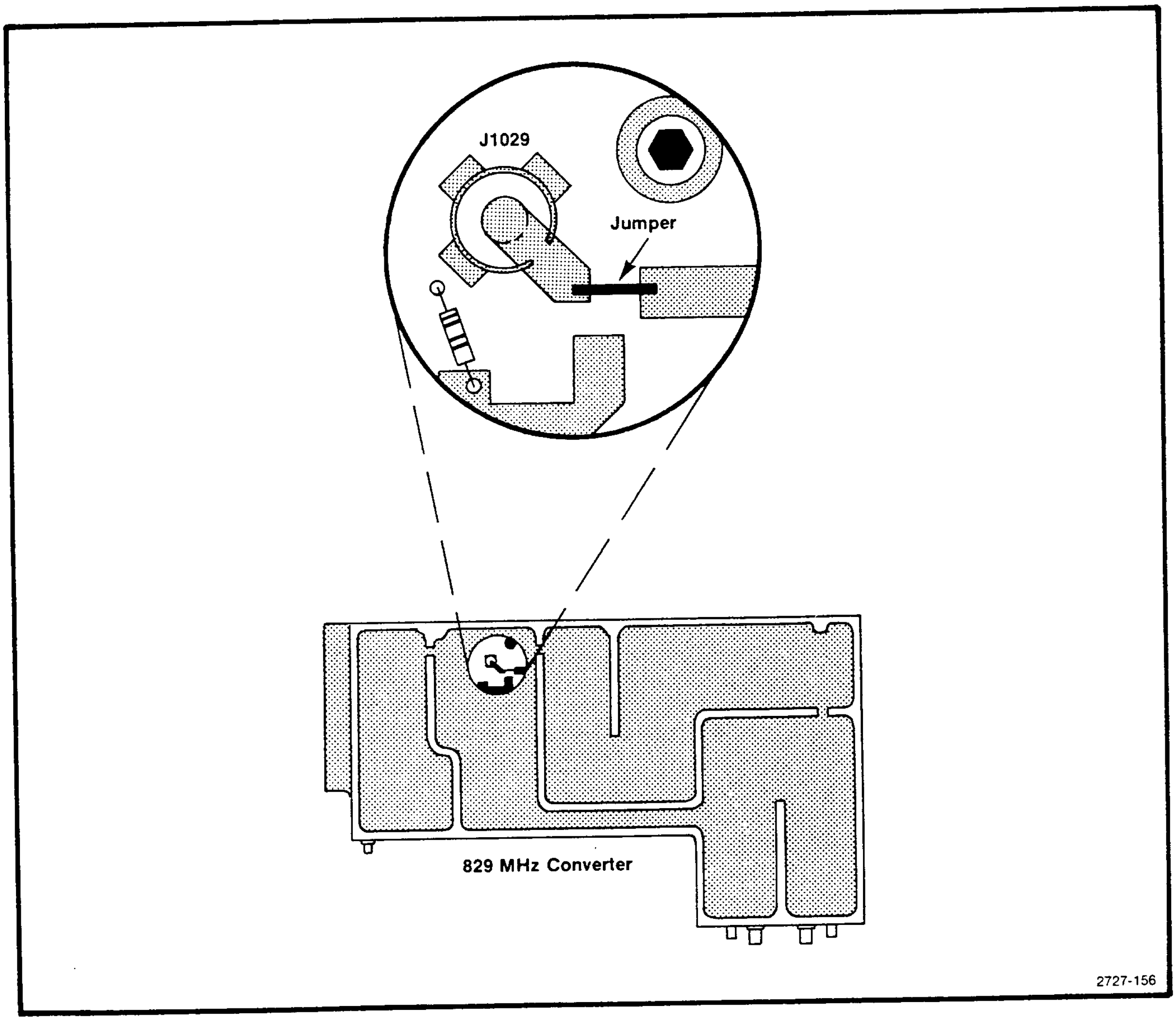


Fig. 4-13. Location of test jack and jumper on the 829 MHz Amplifier board.

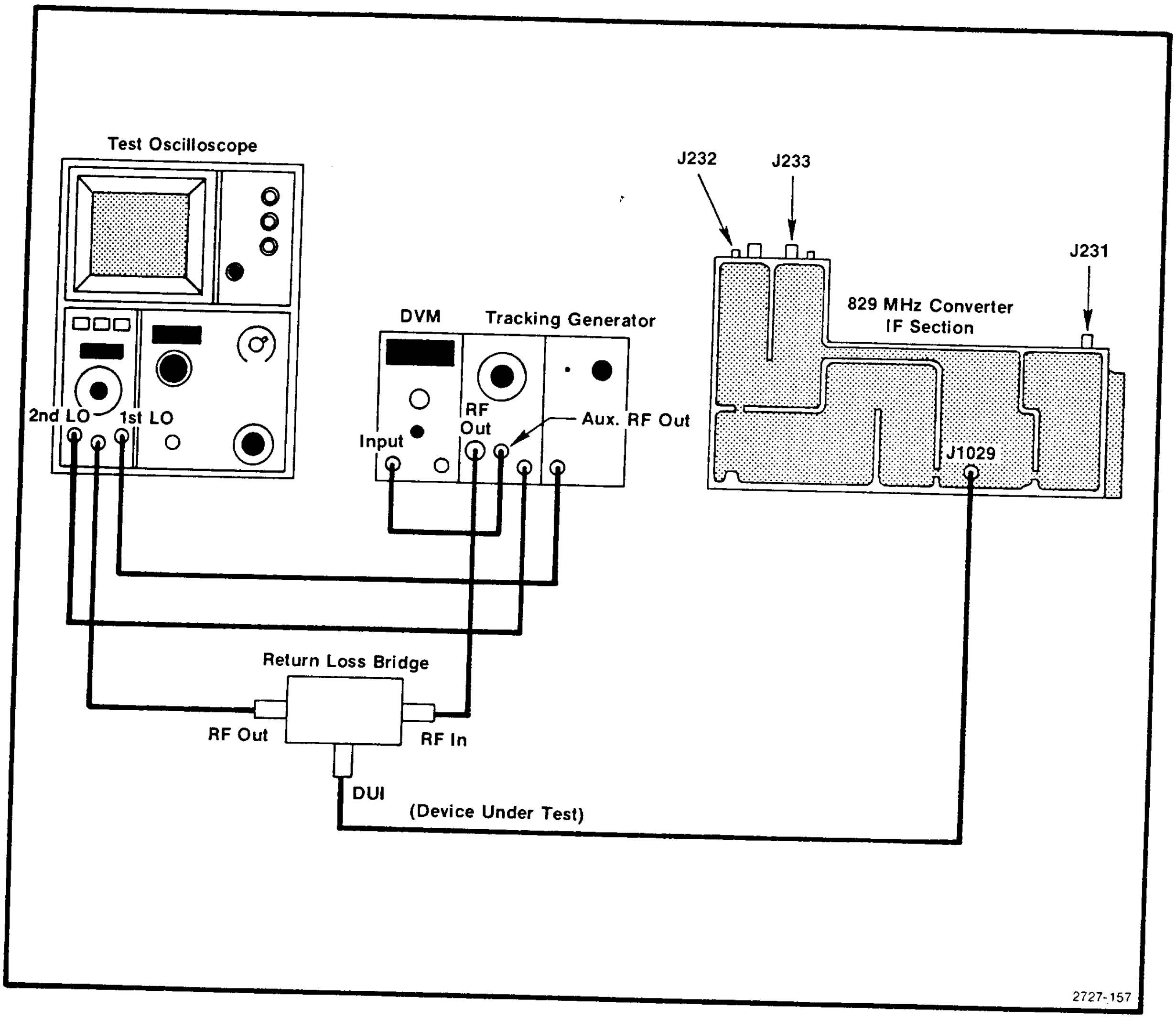


Fig. 4-14. Test equipment setup for aligning the 829 MHz filter.

e. Set the test spectrum analyzer Reference Level to −20 dBm, Vertical Display mode to 2 dB/div, Resolution Bandwidth to 300 kHz, and Freq Span/Div to 20 MHz. Tune the Center Frequency for a readout of 829.00 MHz on the frequency counter.

f. Adjust the 1/4 wavelength lines in the filter in sequence, starting with the resonator at the 829 1MHz input (see Fig. 4-15). Adjustment is made by shorting the adjacent resonator to ground with a low inductance conductor, such as a broad blade screwdriver, then bend the loop or tab of the respective stub with a non-metallic tuning tool to change the series capacitance of the resonator.

g. With the adjacent resonator (second) shorted to ground, adjust the series capacitance by bending the tab so the response on the spectrum analyzer display is centered at 829 MHz (see Fig. 4-16A).

h. Now move the shorting strap (screwdriver) to the next resonator and adjust the tab of the second resonator for a response as indicated in Fig. 4-16B.

i. Remove the short from the third resonator and short the fourth resonator. Adjust the third resonator for a response similar to that shown in Fig. 4-17A.

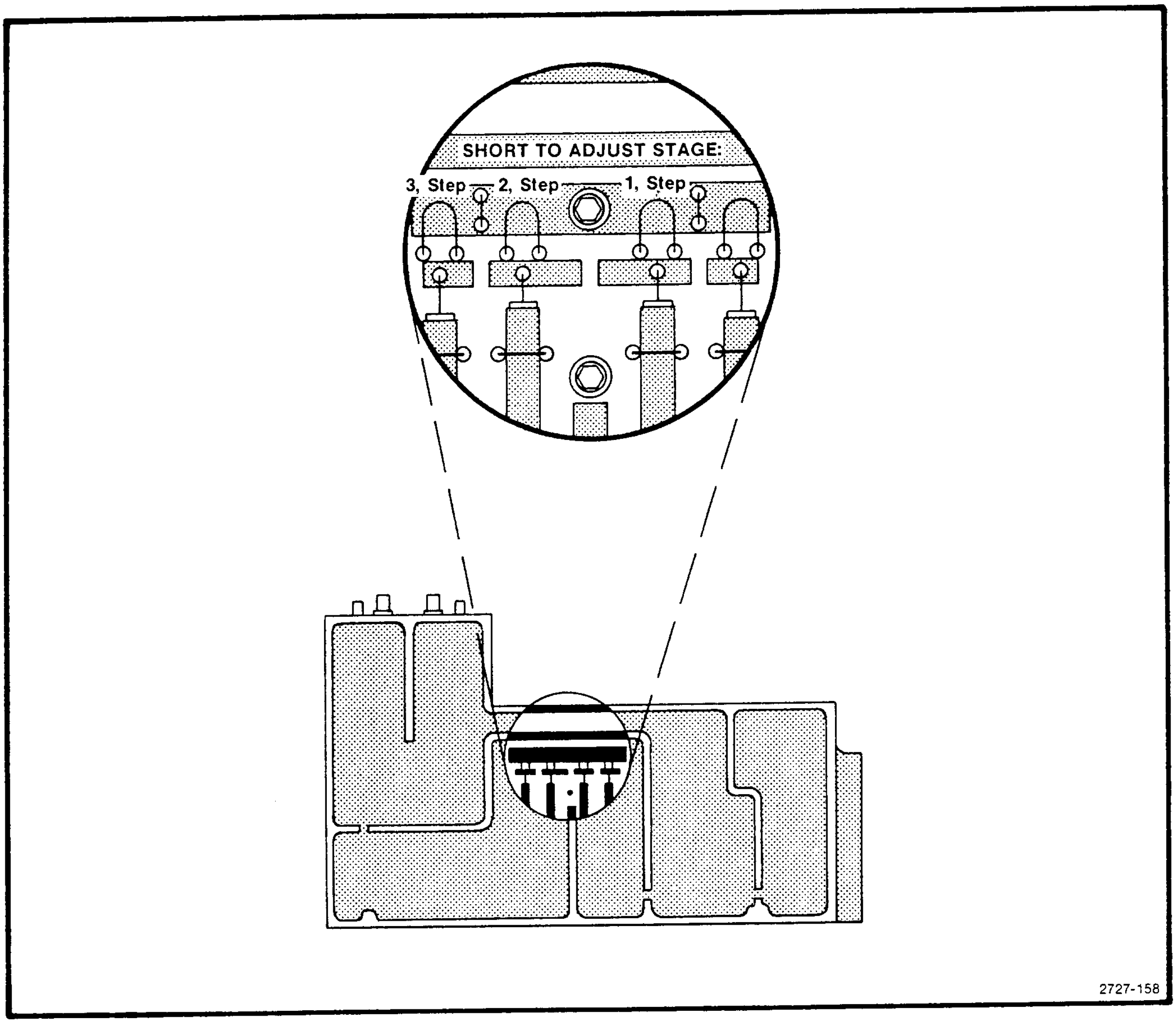


Fig. 4-15. Filter tune tabs in the 829 MHz converter.

j. Repeat the procedure for the final (fourth) resonator for a response similar to that shown in Fig. 4-17B.

k. Check that the return loss is equal to or greater than 12 dB.

l. Disconnect the return loss Device Under Test lead to the Peltola jack J1029 on the 829 MHz Amplifier board, then unsolder and reconnect the jumper to the amplifier output.

m. Replace the 829 MHz Converter cover and reinstall the assembly in the 492/492P.

Troubleshooting and Calibrating the 2182 MHz Phaselocked 2nd LO

The assembly contains a microstrip phaselocked 2182 MHz oscillator and its phaselocking circuits. The 14-22 MHz Phaselock board is contained in the mu-metal housing; the 2182 MHz Oscillator, 2200 MHz Reference, and 2200 MHz Reference Mixer are contained in the machined aluminum housing.

The 2182 MHz Microstrip Oscillator and the 2200 MHz Reference Mixer contain critical length printed elements. When damaged, these elements are difficult to repair; therefore, the board should be replaced. If either the varactor

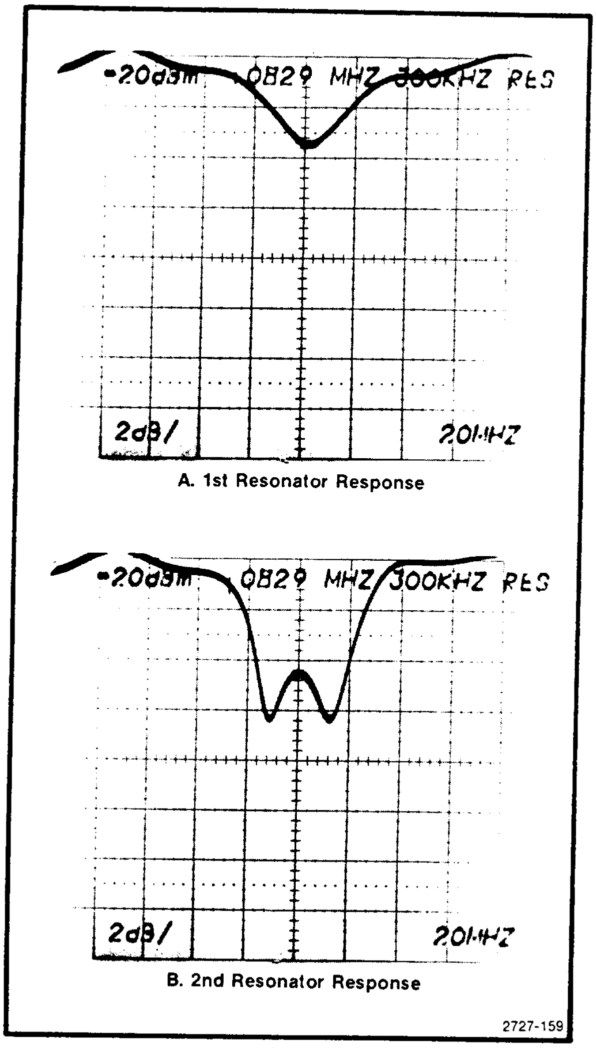


Fig. 4-16. Typical response when the first and second resonators of the 829 MHz filter are adjusted correctly.

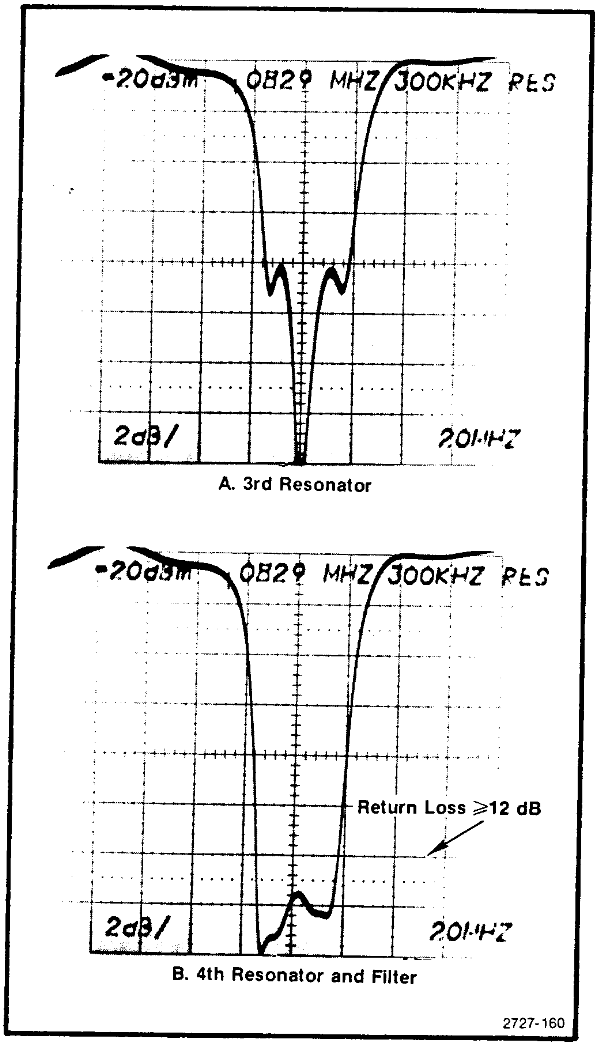


Fig. 4-17. Typical response when the third and fourth resonators are tuned correctly.

diode or the oscillator transistor for the 2182 MHz Oscillator is replaced and the oscillator frequency is beyond adjustment with the frequency adjust tab, described in this procedure, the circuit board must be replaced.

Even though replacement boards are precalibrated at the factory and repair can be accomplished by replacing the board, we recommend sending the instrument or assembly to your Tektronix Service Center for repair.

The 2182 MHz Phaselocked 2nd LO should only require calibration when a component within the assembly has been replaced. This procedure is in two parts, the LO section and the phaselock section. Equipment required to calibrate the LO section is listed in Table 4-3 and the equipment required to calibrate the phaselock section is listed in Table 4-4.

Oscillator Section

Table 4-3
EQUIPMENT REQUIRED FOR 2nd LO CALIBRATION

Test Equipment	Characteristics	Recommended Type
Spectrum Analyzer	Frequency range to 2.5 GHz	TEKTRONIX 492, 492P
Signal Generator	Calibrated 100 MHz with frequency accuracy within ±20 kHz and an amplitude settable to 0 dBm.	Hewlett-Packard Model 8640 A/B.
Digital Voltmeter	Measures to within 0.01 V, impedance ⩾1 MΩ.	TEKTRONIX TM 500-Series DM 501A, DM 502A, DM 505
Variable Power Supply	0 to −12.5 V, accurate to 0.1 V	TEKTRONIX TM 500-Series PS 501-1
Terminations (2)	50 Ω, 3 mm connectors	Tektronix Part No. 011-0049-01

1. Preparation

a. Test equipment setup is shown in Fig. 4-18. Turn the POWER off. Place the 492/492P Spectrum Analyzer upside down so the RF deck is exposed. Use a 5/16 inch wrench to loosen and remove the two semi-rigid cable connections to the assembly. Remove the flexible coaxial cable connection to the 100 MHz input.

b. Remove the 14 screws that hold the cover on the mu-metal section and remove the cover. Unsolder the leads to feedthrough capacitors C2203 and C2204. (These are the center two feedthroughs that feed through the circuit board, as shown in Fig. 4-22.)

c. Replace the cover using two or three screws to hold the cover in place. Remove the 2nd LO assembly mounting screws and carefully remove the 2nd LO assembly so the power input connections remain intact. Turn the assembly over so the machined aluminum housing is up and place the assembly on a flat surface. Use a 5/64 Allen wrench to remove the screws holding the lid on the machined aluminum housing. Place the screws in a safe place; then remove the lid for the aluminum housing, exposing the three RF circuit boards within the oscillator section.

d. Install a 50 Ω terminator on the 2182 MHz buffered output port, P222, (see Fig. 4-19). Set the variable power supply to 0 V. Connect the plus (+) terminal to the 2nd LO housing and the negative (−) terminal to the exposed end of C2203 and L2031, through a 1 kΩ resistor.

e. Apply a 100 MHz, 0 dBm signal from the signal generator to the 100 MHz Reference input port, P221. (Frequency must be within 20 kHz of 100 MHz.)

f. Connect a test spectrum analyzer to the 2182 MHz unbuffered output port, P210. Set the test analyzer CENTER FREQUENCY to 2182 MHz, FREQ SPAN/DIV to 20 MHz, DISPLAY MODE to 10 dB/Div, and the REFERENCE LEVEL to +10 dBm. Do not position any of the cables over the 2nd LO assembly oscillator section because they can affect the frequency of the oscillator.

g. Bend the feedback and frequency adjusting tabs, C1021 and C1022 (see Fig. 4-1), with your finger so they are approximately 30° above the board surface.

2. Adjust and Check Oscillator Frequency (Refer to Fig. 4-19)

a. Switch the 492/492P POWER and the variable power supply on. Adjust the voltage output from the variable power supply to 5.0 V. Voltage on C2203 should now equal −5 V and a signal should appear on the test spectrum analyzer.

b. Check for a collector voltage across C2023 of +10.0, ±0.7 V.

c. Check V_{be} at TP1015. If V_{be} is greater than +0.5 V, push the feedback adjustment tab down slightly and if less than −0.3 V, lift the tab. If V_{be} is greater than +0.8 V, replace the microstrip oscillator board. If V_{be} is more negative than −1 V, check the bias circuitry. Adjust V_{be} for +0.15 V, ±0.05 V at TP1015. Do not touch the feedback tab while measuring voltages.

d. Check for an oscillator frequency of 2182 MHz, ±5 MHz. Bend the frequency adjustment tab C1022 to

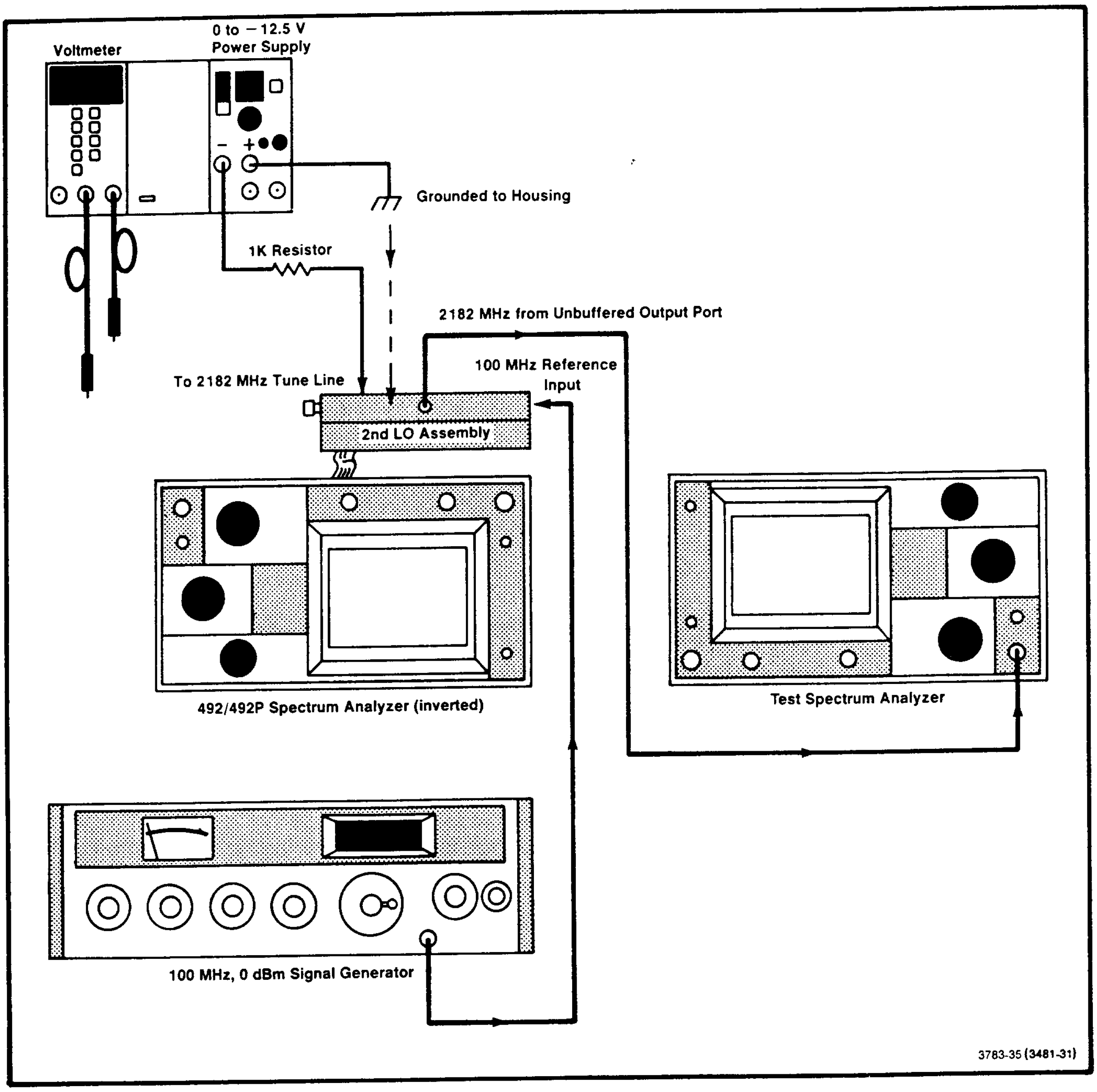


Fig. 4-18. Test equipment setup for calibrating the oscillator section of the 2182 MHz Phaselocked 2nd Lo.

bring the oscillator within tolerance. (Bend the tab up to increase frequency and down to lower frequency.) If unable to bring the oscillator frequency within range, replace the 2182 MHz microstrip oscillator board.

3. Measure Output Power

NOTE

Before making power measurements, ensure that the unused port is terminated into 50 Ω. Unterminated ports will degrade both frequency and power measurements.

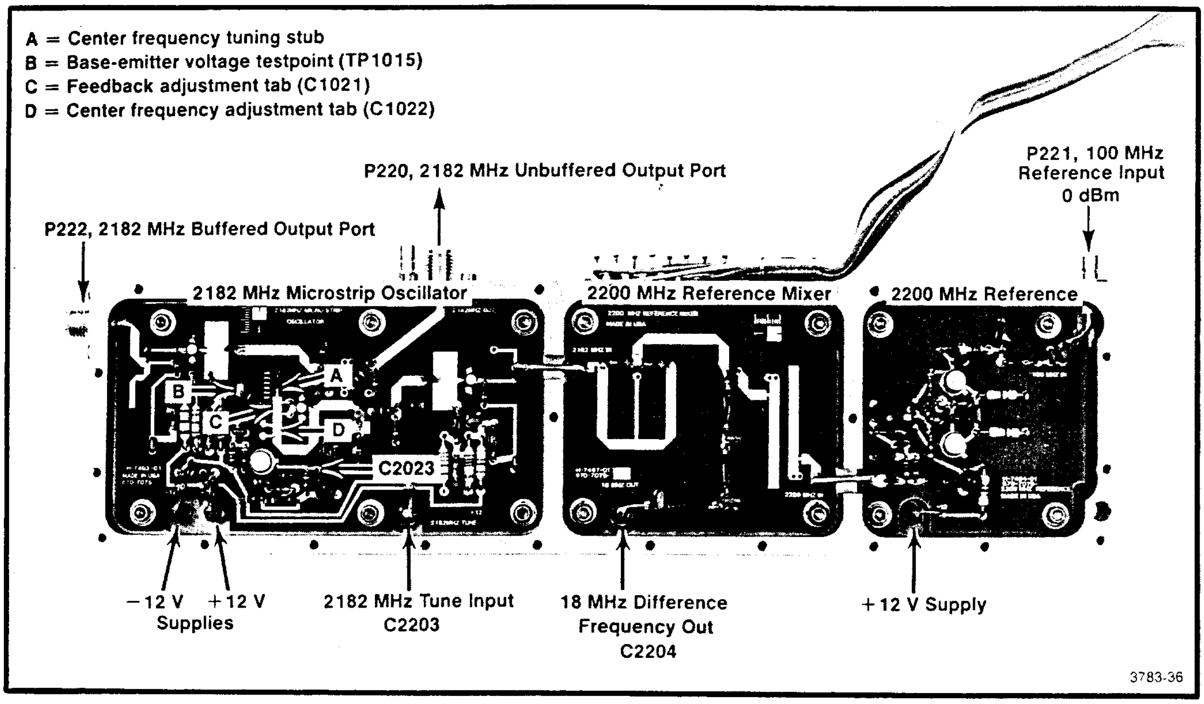


Fig. 4-19. Adjustments and test point locations within the oscillator section.

a. Check for 0 dBm ±3 dB output power at the unbuffered port, P220.

b. Connect the test spectrum analyzer to P222, terminate P220, then check for an output level of +10 dBm ±3 dB from the buffered port.

4. Check the 2200 MHz Reference Mixer

a. Use a probe, consisting of a short length of semi-rigid coaxial cable with a dc block (see Fig. 4-20), to connect the output of the reference mixer (C204) to the input of the test spectrum analyzer. Ground the outershield of the coaxial cable against the 2nd LO housing.

b. Confirm that the output signal frequency is 18 MHz, ±1 MHz. Adjust the tab (C1022) for the 2182 MHz Microstrip Oscillator, to bring the 18 MHz within the 1 MHz tolerance.

c. Confirm that the output level of the 18 MHz signal is approximately −36 dBm. If the level is below −46 dBm, check the signal levels from the 2200 MHz Reference Mixer and the 2182 MHz Microstrip Oscillator (−28 dBm, ±8 dB from the 2200 MHz Reference Mixer and +8 dBm, ±3 dB from the oscillator).

5. Check the Tune Range

a. Adjust the variable supply to vary the voltage to the 2182 MHz tune line from 0 to −12.5 V and note the frequency change at C2204 (output of the 2200 MHz Reference Mixer).

b. Frequency change or tune range should equal 20 to 35 MHz for a voltage change of 0 to −12.5 V on the tune line.

6. Reassembly

a. Disconnect and remove the connections from the variable power supply and the test spectrum analyzer.

b. Replace the lid for the oscillator housing and install the 26 screws. Install the screws loosely, then tighten them starting from the center of the lid and progress along the edges toward the corners to insure that no gaps exist between the lid and the housing. Any gaps will allow RF leakage that can produce spurious responses.

c. Reinstall the assembly on the RF deck. Remove the 50 Ω terminations and reconnect the cables. Use a 5/16 inch open-end wrench to tighten the semi-rigid coaxial connectors to 8 to 10 inch-pounds.

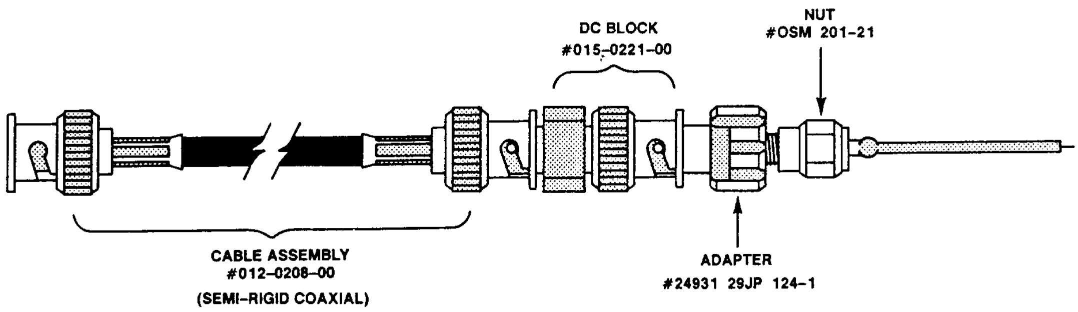


Fig. 4-20. Construction of a coaxial test probe for the 2182 MHz Phaselocked 2nd LO.

d. Remove the mu-metal lid and reconnect the leads to feedthrough capacitors C2203 and C2204, on the Phaselock board. Replace the lid and install the 14 screws. Tighten the screws from the center toward the corners of the lid to prevent gaps between the lid and the housing. Do not overtighten because the screws are easily stripped.

Troubleshooting and Calibrating the 14-22 MHz Phaselock Section of the 2nd LO Assembly

This side of the assembly contains the 14-22 MHz Phaselock circuit board. Replacing oscillator components in this section may alter sweep linearity and frequency of the 14-22 MHz oscillator. The following checks and calibration should aid in repairing and returning the assembly to satisfactory operation.

Table 4-4
EQUIPMENT REQUIRED FOR CALIBRATING THE
14-22 MHz PHASELOCK CIRCUIT

Test Equipment	Characteristics	Recommended Type
Digital Voltmeter	Accuracy within 0.01 V	TEKTRONIX TM 500-Series DM 501A, DM 502A, or DM 505
Frequency Counter	Frequency to 40 MHz	TEKTRONIX TM 500-Series DC 503A, DC 508A, or DC 509
Service Kit Extender board		Tektronix Part No. 672-0865-00

1. Preliminary

a. Test equipment setup is shown in Fig. 4-21. Remove and install the Center Frequency Control board on an extender board.

b. Switch POWER on and set the FREQ SPAN/DIV to 1 MHz.

2. Check Voltages

a. Check all input voltages at the feedthrough capacitors in the housing wall. Refer to Fig. 4-22 or the voltages printed on the lid. Voltage at the sweep and tune input lines should equal 0 V ±0.05 V with the FREQ SPAN/DIV ⩾100 kHz.

b. Turn the POWER off. Remove the lid for the mu-metal housing assembly to gain access to internal circuitry.

c. Switch POWER on, then check the internal regulated voltages (+12 V, ±0.4 V, at C2201; −12 V, ±0.4 V, at C2202; and +5.2 V, ±0.25 V, at TP1018).

3. Check Tune Linearity

NOTE

This check should only be used to verify linearity of previously calibrated assemblies. If varactor CR1075 has been replaced, go to Step 4, Coarse Linearity Adjustment.

a. Set the front panel controls as follows:

CENTER FREQUENCY	10 MHz
FREQ SPAN/DIV	100 kHz
AUTO RESOLUTION	On
Vertical Display	10 dB/DIV
REF LEVEL	−20 dBm
TIME/DIV	AUTO

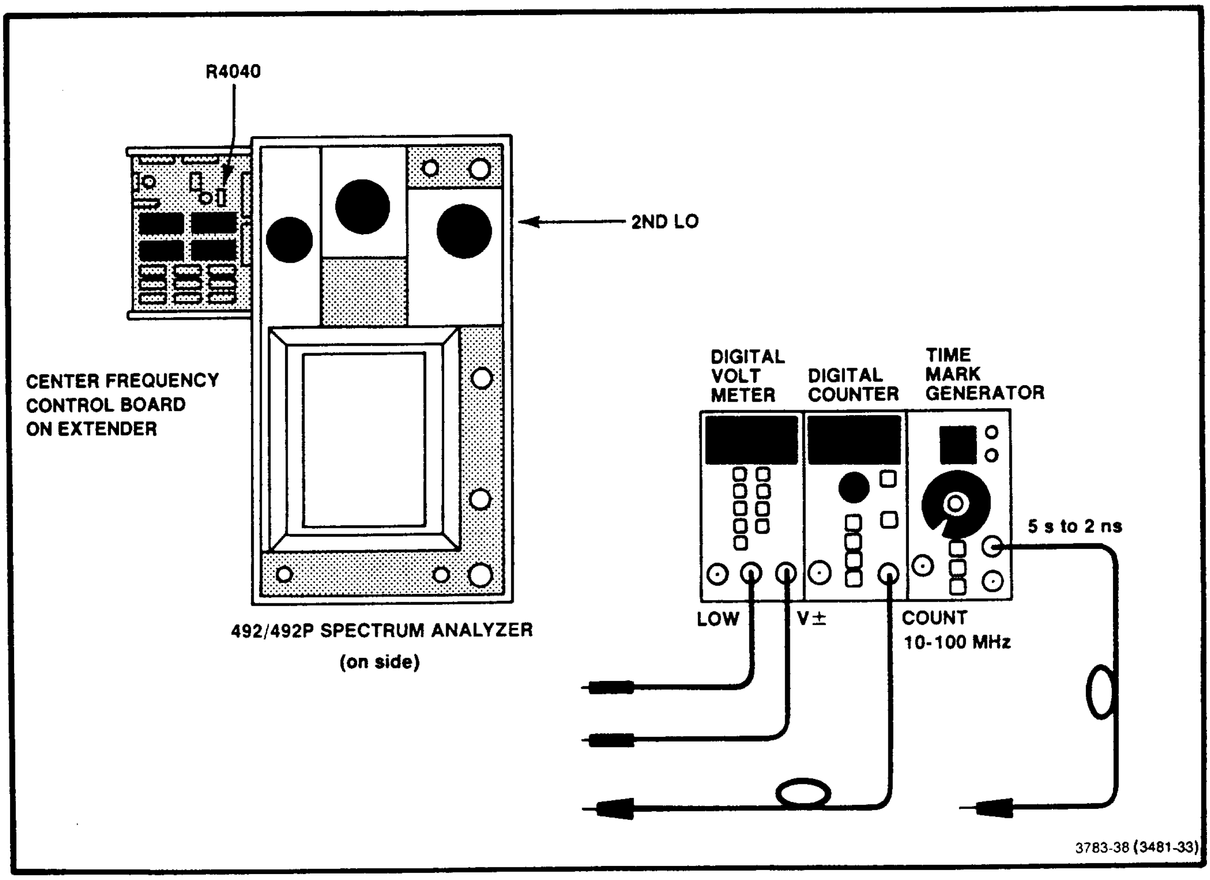


Fig. 4-21. Test equipment setup for calibrating the phaselock section of the 2182 MHz Phaselocked 2nd LO.

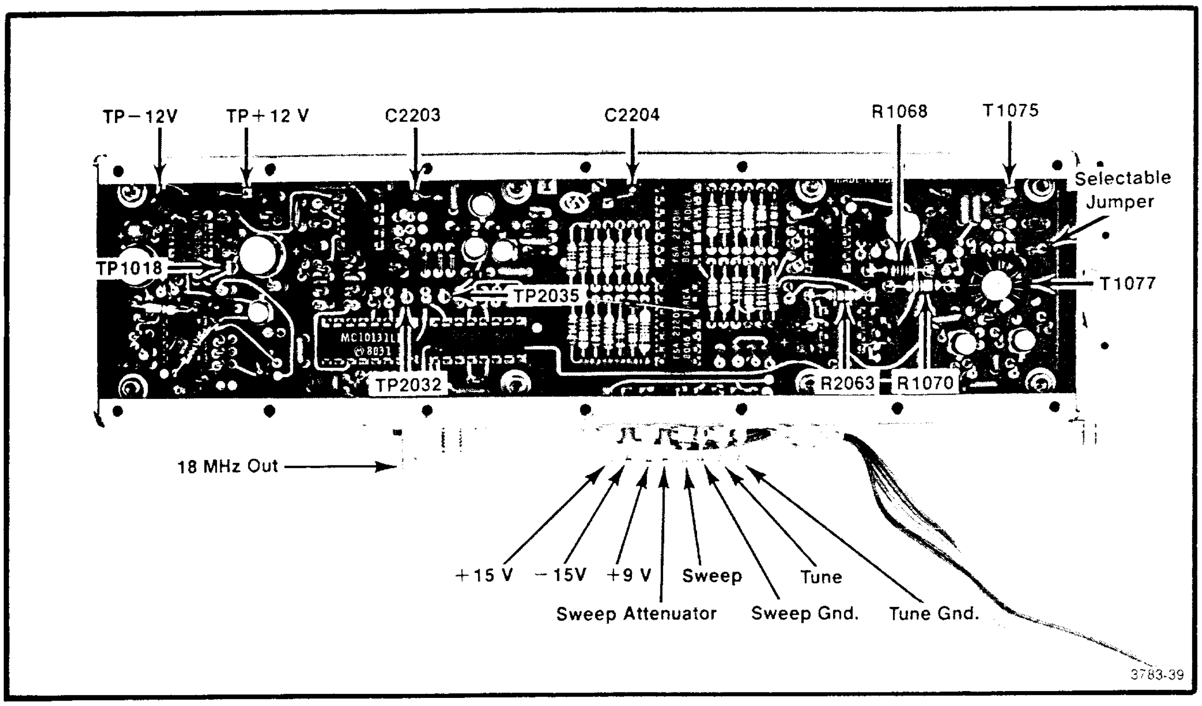


Fig. 4-22. Location of test points and components associated with calibrating the 14-22 MHz Phaselock circuit.

b. Apply 5 μs markers from a time mark generator to the RF INPUT and tune one of the markers to center screen. Reduce the FREQ SPAN/DIV to 50 kHz. Adjust the REF LEVEL for a signal level of 2 to 3 divisions.

c. Turn the FREQUENCY control counterclockwise until the center frequency stops tuning; then turn clockwise until a marker signal is one major division from the left edge of the graticule. Another signal, one major division from the right edge, should also be displayed. Spacing between the left and right markers should be approximately eight divisions.

d. Note the spacing between the left and right marker signals to the nearest 0.5 minor division.

e. Turn the FREQUENCY control clockwise, to increase center frequency, until the next marker signal is one division in from the left edge and again note the spacing between this marker and the marker near the right edge.

f. Continue this process of tuning up in frequency until the center frequency stops tuning, noting the signal spacing at each check point.

g. If the total spacing variation is two minor divisions or less, the linearity is satisfactory and you can proceed to part 6 (Check Center frequency of the 14-22 MHz Oscillator). If the error was more than two minor divisions, continue with part 4 (Coarse Linearity Adjustment).

4. Coarse Linearity Adjustment

The shaping circuit has a wide range of adjustment to compensate for variations in the tuning varactor characteristics. This range of adjustability, however, makes the circuit calibration tedious. This coarse adjustment procedure presets the component values to make it easier to perform the fine adjustments.

a. Replace select resistors, R2063 (Gain) with a 10 kΩ potentiometer, R1070 (2nd Order Shape) with a 5 kΩ potentiometer, and R1068 (3rd Order Shaper) with 2 kΩ potentiometer (see Fig. 4-22). Center all potentiometers. Install a wire jumper between T1077 and T1075 in the normal position as illustrated in Fig. 4-23. Increase the sweep sensitivity by connecting a 750 Ω resistor from the 2nd LO Sweep input (at C222) to the standoff at the junction of R2063 and pin 2 of U2063.

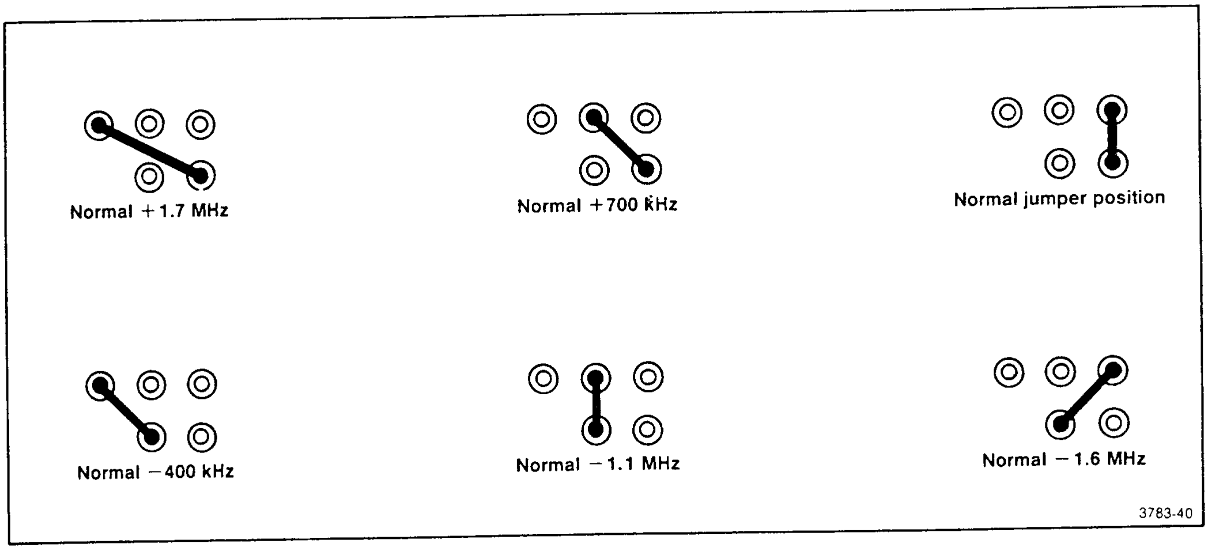


Fig. 4-23. Jumper positions between T1077 and T1075 versus frequency compensation for the 14-22 MHz Oscillator.

b. Apply 1 μs markers from the time mark generator to the RF INPUT. Set the Center Frequency to 10 MHz and adjust the REF LEVEL to display the comb of markers. Set the FREQ SPAN/DIV to 100 kHz and center a marker on the display with the center FREQUENCY control. Reduce the FREQ SPAN/DIV to 50 kHz.

c. Adjust the Gain potentiometer R2063 so there is approximately one marker signal per division near the display center. The 2nd LO is now being swept beyond its normal tuning range; the actual span is approximately 1 MHz/division. If the sweep linearity of the 2nd LO is satisfactory, each marker over the center eight divisions will align with a graticule line.

d. Observe the center eight divisions of the display and adjust linearity as follows:

1. Adjust R1070 so the spacings between marker signals are equal at the right and left sides of the display. Decrease the resistance if the marker spacing on the right side is less than the left and increase the resistance if the spacing is greater on the right than the left side. Adjusting R1070 will change the 2nd LO center frequency causing the center marker to shift position. Increase the FREQ SPAN/DIV to 100 kHz, recenter the marker, then return the SPAN/DIV to 50 kHz.

2. Decrease R1068 if the spacing between markers at the center of the display is closer than the markers at the right or left edge. Increase the value if the spacing at center screen is wider.

3. Adjustment of either R1070 or R1068 will affect span/div. Readjust R2063 for one marker/division near the center part of the display.

4. Repeat parts 1—3 until the best uniform signal spacing over the center eight divisions of the display, is obtained.

e. Remove the 750 Ω resistor between the 2nd LO Sweep Input and the junction of R2063 and pin 2 of U2063 (part b of this procedure). This completes the coarse linearity adjustment.

5. Fine Linearity Adjustment

a. Apply 5 μs markers from the time mark generator to the RF INPUT. Center the frequency of the 2nd LO by switching the FREQ SPAN/DIV to 100 kHz then down to 20 kHz.

b. Center a pair of markers on the display with the FREQUENCY control.

c. Change the Vertical Display to 2 dB/DIV, FREQ SPAN/DIV to 20 kHz, and adjust the REF LEVEL for a signal amplitude of two to three divisions.

d. Adjust R2063 (Gain) so the signals are separated exactly six major divisions.

e. Rotate the CENTER FREQUENCY control counter-clockwise until the analyzer stops tuning, then rotate the control clockwise to center a pair of markers on the display. Adjust the REF LEVEL as needed.

f. Note the spacing of the markers to the nearest 0.5 minor divison. Enter this data on a graph of spacing versus marker pair number.

g. Tune the frequency up to the next pair of markers and center on the display. Note the spacing and again plot on the graph.

h. Repeat this measurement process for each successive marker pair until the end of the tuning range is reached. (This requires approximately 38 measurements.) The finished plot depicts the tuning sensitivity variation over the tuning range of the 2nd LO. Aberrations or ripple in the plot with a period of two to four points and amplitude of about one minor division peak-to-peak are due to discrete gain breakpoints in the shaping circuit. A single large discontinuity (approximately 2.0 minor divisions peak-to-peak) indicates a defective shaper resistor or diode.

i. Note the mean slope of the plot. Disconnect one end of R1070 and carefully measure its resistance with the digital meter. Record this value on the tuning plot.

j. Increase the value of R1070 approximately 10% if the plot has positive slope. Decrease the value if the slope is negative. Record the new value and reconnect the potentiometer.

k. Make a new plot as outlined in parts b through g and compare the slope of the new plot against the previous plot. Interpolate or extrapolate from the two slopes and the resistance values to determine the resistance necessary to obtain zero average slope.

l. If the plot is convex (upward curvature toward the ends), decrease the resistance of R1068. Increase the value if the curvature is downward. The procedure for this adjustment is similar to that described for R1070 in parts h and i. Change the resistance of R1068 approximately 10%; then rerun the plot and interpolate the resistance value until you have minimized curvature. This adjustment may affect the slope because of interaction; therefore, it may be necessary to repeat the adjustment of R1070. When R1068 and R1070 are properly adjusted, the tuning plot should approach a straight line with zero slope. Peak-to-peak variation across the plot should not exceed two minor divisions, including breakpoint ripple. Shape of the plot is not important if the total excursions do not exceed two minor divisions (p-p). An S-shaped plot is not uncommon.

m. Measure the resistance of the potentiometers for R1068 and R1070 and replace with standard value 1%, 1/8 W resistors. Do not replace R2063 at this time.

6. Set the Center Frequency of the 14-22 MHz Oscillator

a. Switch the FREQ SPAN/DIV to 100 kHz or more; then connect a frequency counter to the 18 MHz output port P224.

b. Select the jumper tap combination as shown in Fig. 4-23, so the center frequency is within 500 kHz of 18 MHz.

7. Check and Calibrate Tune Sensitivity

a. Set the FREQ SPAN/DIV to 100 kHz then to 0. Verify that the tune voltage at TP4044 on the Center Frequency Control board is 0 V, ±50 mV.

b. Measure the 14-22 MHz Oscillator frequency at the 18 MHz output port (P224) to the nearest 10 kHz and record the frequency.

c. Monitor the voltage at TP4044 on the Center Frequency Control board and turn the FREQUENCY control clockwise until the voltage stops changing.

d. Adjust the Fine Tune Range, R4040, on the Center Frequency Control board for a voltage of −9.38 V at TP4044.

e. Adjust the Gain resistor, R2063, on the 14-22 MHz Phaselock board so the counter frequency is 2.25 MHz greater than the number recorded in part b.

f. Remove the potentiometer for R2063 and measure its resistance; then replace it with the nearest standard 1%, 1/8 W resistor.

8. Conclusion

a. Replace the housing lid with its 14 screws.

b. Tighten the screws sequentially, starting from the center of the lid and progressing toward the corners to prevent gaps between the lid and the housing. Use care to not strip the screws as you tighten them.

c. Remove the extender for the Center Frequency Control board and reinstall the board in the instrument.

d. Refer to the Calibration section to recalibrate the 2nd LO spans and identify functions.

Troubleshooting Aids for the 2182 MHz Phaselocked 2nd LO

NOTE

If the Phaselocked 2nd LO assembly is in the instrument, it may be desirable to set the FREQ SPAN/DIV to 100 kHz or greater so the 2nd LO is not swept or tuned.

The difference frequency from the 2200 MHz Reference Mixer is amplified and fed to output port P224. Nominally, the signal at P224 is 18 MHz with an approximate output level of −5 dBm into 50 Ω. This port is convenient for monitoring the operation of the 14-22 MHz voltage controlled oscillator. When the phaselock is operating, the difference frequency exactly equals the frequency of the 14-22 MHz VCO. If the lock loop is not functioning properly, the difference frequency signal will either disappear completely or tune to its range limits at approximately 4 MHz or 32 MHz. Note that when the loop is unlocked, RF leakage from the 14-22 MHz oscillator buffer can be seen at P224, with a level of approximately −35 dBm. Output from the oscillator can be monitored more directly, if desired, at TP2032 by using a high impedance probe with a dc block. Similarly, the amplified difference frequency can be monitored at TP2035.

Another check of phaselock operation can be made by measuring the dc voltage on the 2182 MHz tune line, at feedthrough capacitor C2203. Nominally, this voltage is approximately −5 V when phaselocked. Use a FREQ SPAN/DIV of 100 kHz or greater before making the measurement. If there is no difference frequency signal, the voltage at C2203 will be approximately 0 V. A voltage of approximately −13 V at C2203 may indicate loss of signal from the 14-22 MHz oscillator.

Narrow-band noise on the 2nd LO signal may be due to noise modulation of the 14-22 MHz VCO. Monitor the signal at P224 to see if the 14-22 MHz oscillator is noisy. Noise on this oscillator is often caused by noise on the + or − 12 volt supplies. Use a differential oscilloscope, with 1 Hz to 300 Hz bandwidth limits to check supply noise. Measure the ac differential between the supply and the 2nd LO housing. Less than 5 μV p-p noise is typical, while 50 μV p-p of noise will cause noticeable performance degradation. Output noise from the shaper, at the junction of R1067 and R1068, is typically less than 5 μV p-p..

Tuning problems may be caused by defective operational amplifiers in the shaper. When the voltages on the sweep and tune lines are 0 V (i.e., span/div of 100 kHz or greater), there should be 0 V at pin 6 of U2063 and pins 1 and 7 of U1062.

When making power measurements of microwave circuits at circuit board interfaces, use a coaxial probe with very little stray inductance (see Fig. 4-20). Ground the outer conductor of the probe to the circuit housing within a few tenths of an inch of the measurement point. Disconnect other circuit loads from the measurement point.

MICROCOMPUTER SYSTEM MAINTENANCE

Several maintenance aids are built into the microcomputer system. These are microcomputer operating modes that demonstrate correct performance or indicate the location of a problem, if any.

Switches that set up two of these test modes are described first, followed by instructions for the three test modes. In the first mode, the microcomputer executes a self-test that verifies, in so far as possible, correct operation. RAM, ROM, and interface adapters are checked; any failure found is indicated.

The second mode hardwires the microcprocessor to execute an instruction that toggles the address bus; this mode requires less of the system to run, so may be used to troubleshoot problems that disable the first mode.

The third mode gets at communication between the microcomputer and the rest of the instrument. The microcomputer exercises the instrument bus to help isolate problems that do not show up in the first mode, but prevent normal instrument operation because of a breakdown in communication.

Some notes on operation of several versions of instrument firmware conclude the discussion of microcomputer system maintenance.

Memory Board Option Switch

S1033 on the Memory board informs the microcomputer whether to configure itself at power-up for several test modes, for instrument modifications, and for Option 08. Figure 4-24 shows the correct setting of the individual switches in S1033.

The microcomputer reads these switches only at power-up. For a change in a switch position to take effect, the instrument must be powered-up after the switch is changed.

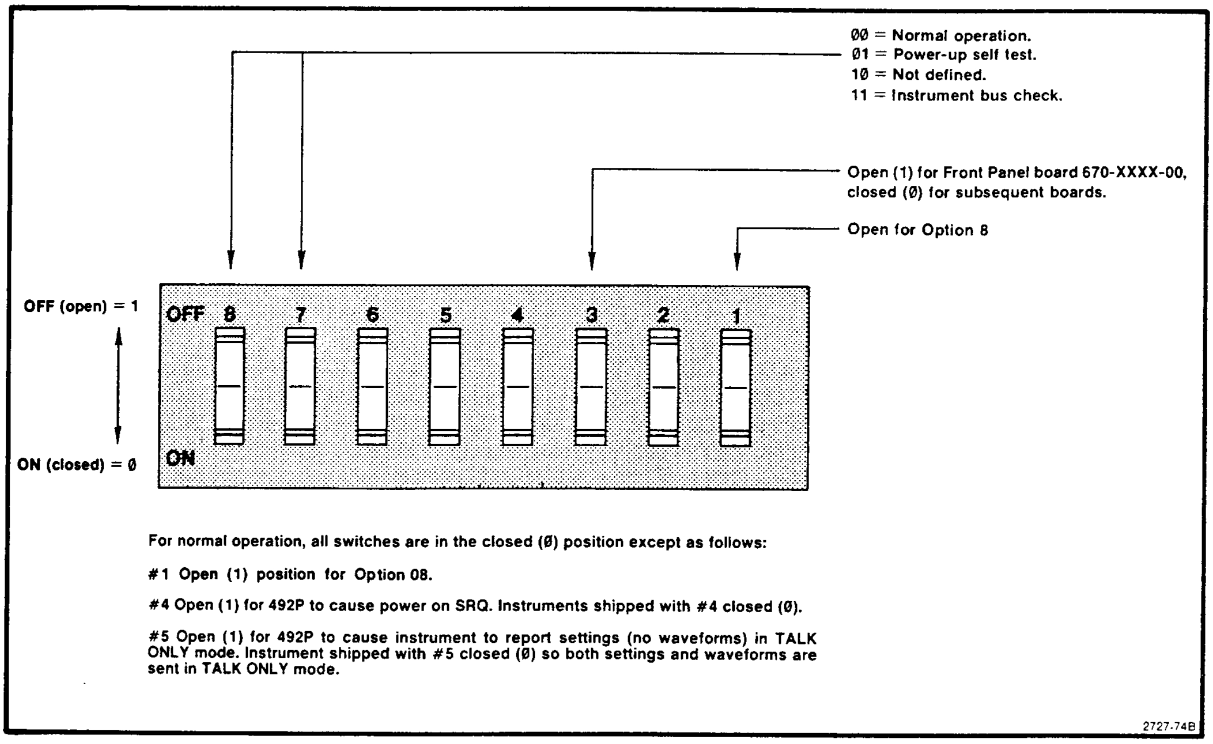


Fig. 4-24. The Memory board option switch band S1033.

Power-Up Self-Test Mode

The microcomputer enters a self-test mode when the instrument is turned on if this mode is selected (Fig. 4-24). In this mode the instrument does not operate normally. The microcomputer performs the following steps, stopping the test to indicate the source of any problem found by blinking an LED on the Processor board.

Addresses are specified as hexadecimal numbers in this description.

Step 1. At power-up, the microcomputer vectors to the self-test in the ROM at the top of address space U2028 on the Memory board. The microcomputer first verifies the checksum of U2028. If the routine for this step runs, but does not obtain the correct checksum for the ROM, the routine halts and blinks the ROM 17 LED, DS1044.

This step uses only U2028 and no other memory; so if the test does not blink the LED and does not proceed to step 2, U2028 is probably the culprit. Consider first, however, that the correct ROM must be installed, both phases of the clock on the Processor board must be present, and the microcomputer system (exclusive of the instrument bus or GPIB) must be operating correctly. If in doubt about the 6800 microprocessor, its bus, or the microcomputer bus, skip to the instructions under Microcomputer Test Mode, to exercise the microcomputer in a more simple manner.

Step 2. The microcomputer next checks the condition of RAM. This step does not rely on the RAM being ok to execute. The procedure is: the microcomputer loads the bit pattern 01010101 into a RAM location, reads the location, and compares what is returned to what was stored. The microcomputer then repeats this test with the pattern 10101010.

The microcomputer attempts to test all RAM addresses. If it finds an error on the Memory board, it stops the test and pulses the RAM LED, DS1042—once for an error in U2035, twice for an error in U2032, and three times for an error in both RAM IC's; these IC's are on the Memory board. If the microcomputer finds an error on the GPIB board, it pulses the LED 7, 8, or 9 times in a similar manner for low RAM—U1046 and U1037—or 9, 10, or 11 times for high RAM—U1042 and U1032. The microcomputer continues to repeat the number of pulses after an error is found.

Step 3. The microcomputer proceeds to checksum all the ROMs. A checksum is stored in the header of each ROM. This is compared to a checksum formed by the successive 8-bit sum of each byte in the ROM starting at the fourth location in the ROM. The upper eight bits of the ROM's address (stored at the first location) are also added to the checksum. Thus, if a ROM is installed in the wrong socket, it's checksum does not verify.

The ROM sockets, including those on the GPIB board, are checked starting at the lowest address (U1012 on the Memory board). The check starts by looking at the MSB in the first and fourth locations in the ROM's address range. If both bits are one, it is assumed that no ROM is installed.

When a defective ROM is found, the routine discontinues the test and pulses repeatedly the ROM LED, DS1038, to indicate the ROM socket where an error was found:

ROM Socket	Board	Pulses
U1012	Memory	1
U1017	Memory	2
U1023	Memory	3
U1028	Memory	4
U2012	GPIB	6
U2019	GPIB	7
U2025	GPIB	8
U2031	GPIB	9
U3012	GPIB	10
U3019	GPIB	11
U3025	GPIB	12
U3019	GPIB	13
U2012	Memory	14
U2017	Memory	15
U2023	Memory	16
U2028	Memory	17

If this step fails, it can be forced to continue checking ROMs; just turn power off and unplug the defective ROM, then turn power on to restart the self-test.

Step 4. The microcomputer checks part of the instrument bus PIA, U3016 on the Processor board. First the microcomputer writes to the A control register and then reads back from the register. Next it repeats these operations with the A data direction register. If either of these attempts fail, the routine stops and pulses the bus LED, DS1036.

Step 5. This step checks part of the GPIA, U2047 on the GPIB board (if installed). The microcomputer resets the GPIA and checks to see that the GPIA is not addressed to talk or listen. The GPIA is then set to listen-only mode and checked to see that it is addressed to listen. Then the GPIA is set to talk-only mode and checked to see that it is addressed to talk. If any part of this step fails, the test stops and pulses repeatedly the GPIB LED, DS1034.

If the test completes successfully, the microcomputer pulses repeatedly the OK LED, DS1032, to indicate the number of empty memory blocks found. The LED blinks N+1 times, where N is the number of empty ROM sockets (the memory block 1600—1800 is not used). If the GPIB board is not installed, its eight ROM sockets are counted as empty. If the LED blinks more than N+1 times, a ROM (or ROMs) failed to respond in Step 3; look for a possible problem on the chip-select line or on the MSB (bit 7) data line.

If the microcomputer seems to test ok, but does not control the instrument, skip to the Instrument Bus Check, where microcomputer communication with the rest of the instrument is exercised.

Microcomputer Test Mode

A microcomputer test mode is selected by moving jumper P1020 on the Processor board to the TEST position. This hardwires the 6800 data lines to hex 5F. As a result, the 6800 continuously executes a CLRB instruction, repetitively cycling through all of its address space. The instrument does not function in this mode. Rather it sets up a known pattern on the microcomputer address, data, and control lines and at the output of address decoders. This mode allows an attack on problems that prevent the microcomputer from running its self-test check.

NOTE

If CR2025 on the Processor board is missing, it may be added as shown on the Processor diagram to make the correct instruction on the data lines.

Microcomputer Bus. As the microcomputer cycles through its address space, it toggles the address lines. The MSB, A15, has a period of about 1540 ms; the period of A14 through A0 is divided by two from the line above down to the LSB, A0, with a period of about 4.7 μs. The four high-order lines, A15 through A12, are shown in Fig. 4-25. Ignore the narrow pulses that may be evident during the low portion of each cycle.

The data lines on the microprocessor side of U1013 on the Processor board are static; D7 and D5 are low, the others are high. In the TEST position, P1020 disables U1013. On the other side of this buffer, the data lines are being driven by the various memory devices on the bus as they are addressed.

Examining the data lines can locate shorted or open lines—lines inactive at high, low, or in-between states or changing in unison, usually to indeterminate logic levels of +1 to +2 V. A problem related to a particular device may

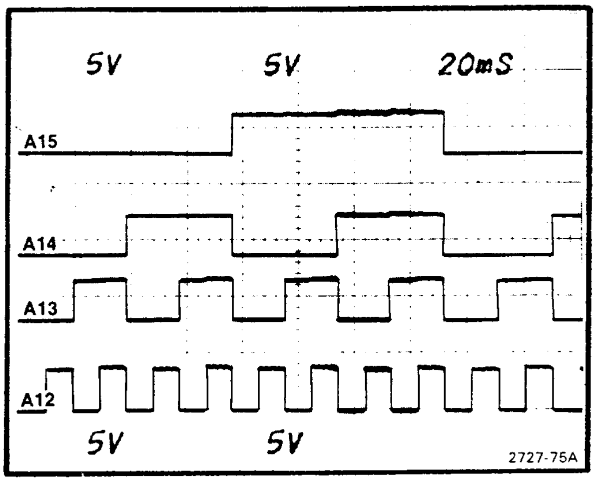


Fig. 4-25. A15 through A12 in microcomputer test mode.

be evident only while that device is addressed; compare a problem that occurs only during a portion of the A15 cycle to the address decoder outputs pictured below.

Processor Address Decoders. Address decoder U2044 on the Processor board sets its outputs low in turn to access block of memory space. See Fig. 4-26, where the Y0 through Y2 outputs are compared to A15. The other outputs follow in sequence with similar pulse widths. The self-test indicators connected to the decoder outputs blink in sequence as the microcomputer cycles through its address space.

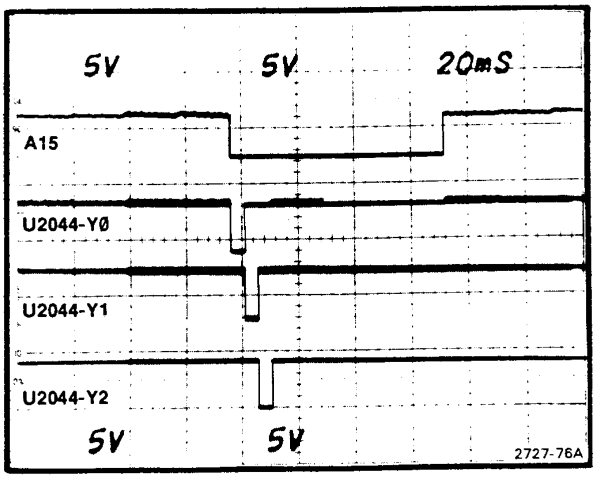


Fig. 4-26. A15 and Y0 through Y2 of address decoder U2044.

A portion of one address block, decoded by U2044, is further decoded by U1037B. Figure 4-27 shows the U1037B enable line on top and below it in order, Y0 through Y2. Y3 is similar in width and follows in sequence.

The narrow pulses evident during the time each output of U2044 and U1037B is asserted result from address lines toggling between microcomputer cycles.

Clocks and Control Lines. The 6800 clock lines are complementary, nonoverlapping square waves with periods of about 1.17 μs. VMA, RESET, NMI, and R/W should be high (logic one). IRQ may be either high or low, depending on how assemblies on the insrument bus powered up.

Memory Address Decoders. Address decoders U1036 and U1038 on the Memory board set their outputs low to access blocks of ROM addresses. These outputs are shown in relation to A15 in Fig. 4-25. The RAM (U2035 and U2032) chip-select lines and option switch register (U1033) enable line are also decoded on the Memory board as shown in part d of Fig. 4-28. The narrow pulses which may be evident during the time each output is asserted can be ignored for the reason noted above under Processor Address Decoders.

GPIB Board Address Decoders. Address decoder U1021 on the GPIB board sets its outputs low in sequence while the 492P is operating in the microcomputer test mode. Y0 through Y2 are shown in relation to A15 in Fig. 4-29. Although not shown, Y3 through Y7 are asserted in order with the same pulse width.

U1028 further decodes two address decoder signals from the Processor board. One enable and two output signals are shown in Fig. 4-30. The other output, $\overline{ASR}$, is not shown, but looks the same as $\overline{GPS}$: they appear to be asserted at the same time. These two signals can be compared for correct operation by speeding up the sweep and noting that they toggle in a complementary fashion during the time they appear to be low in the figure.

Instrument Bus Check Mode

If the microcomputer performs the power-up self-test, but fails to control the instrument properly, the instrument bus check may uncover the problem. The instrument bus check mode may be selected by setting the option switch as shown in Fig. 4-24. In this mode, the microcomputer continuously writes to the instrument bus to exercise it in a repetitive manner. Consequently, the instrument does not operate normally.

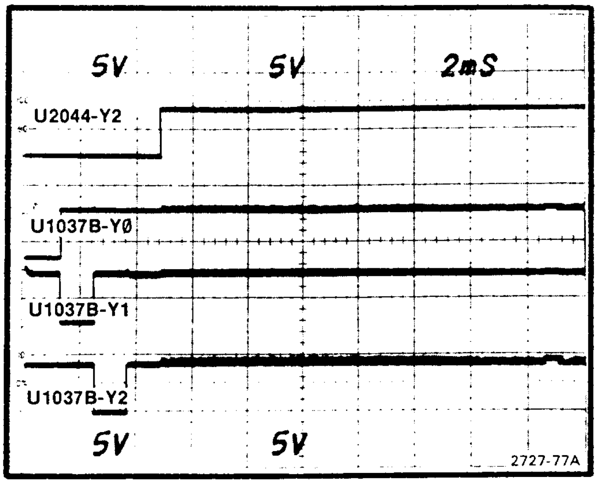


Fig. 4-27. Enable and Y0 through Y2 of address decoder U1037B.

The pattern on the instrument bus toggles DATA VALID and POLL and exercises the address and data lines at separate times. The address lines change when DATA VALID is low and the data lines change when DATA VALID is high. There may be an exception on DB4 through DB0; these lines may continue to change after DATA VALID goes low if an assembly on the bus is requesting service because of the way it powered up. In this case, an assembly or assemblies may respond to the high state of POLL and the changing state of AB7 and attempt to report status.

The pattern for the upper address and data lines is shown in Fig. 4-31. Each lower order line changes at a rate that is twice the next higher line, resulting in 128 cycles on the LSB lines. The initial pulse on the upper four data lines is not part of the divide-by-two pattern and is not repeated on the lower four data lines. By comparing the lines to those in Fig. 4-31, checking that they divide-by-two, it is possible to discover open or shorted lines. Look for lines that stay high or low, change together or at wrong times in the pattern, or go to indeterminate logic levels (−1 to −2 V).

Firmware Operating Notes

The following are exceptions to normal instrument operation that relate to the different firmware versions. The instrument displays its version number during power-up for about two seconds. To see the message, turn power off then on; the version message will appear at the upper center of the screen.

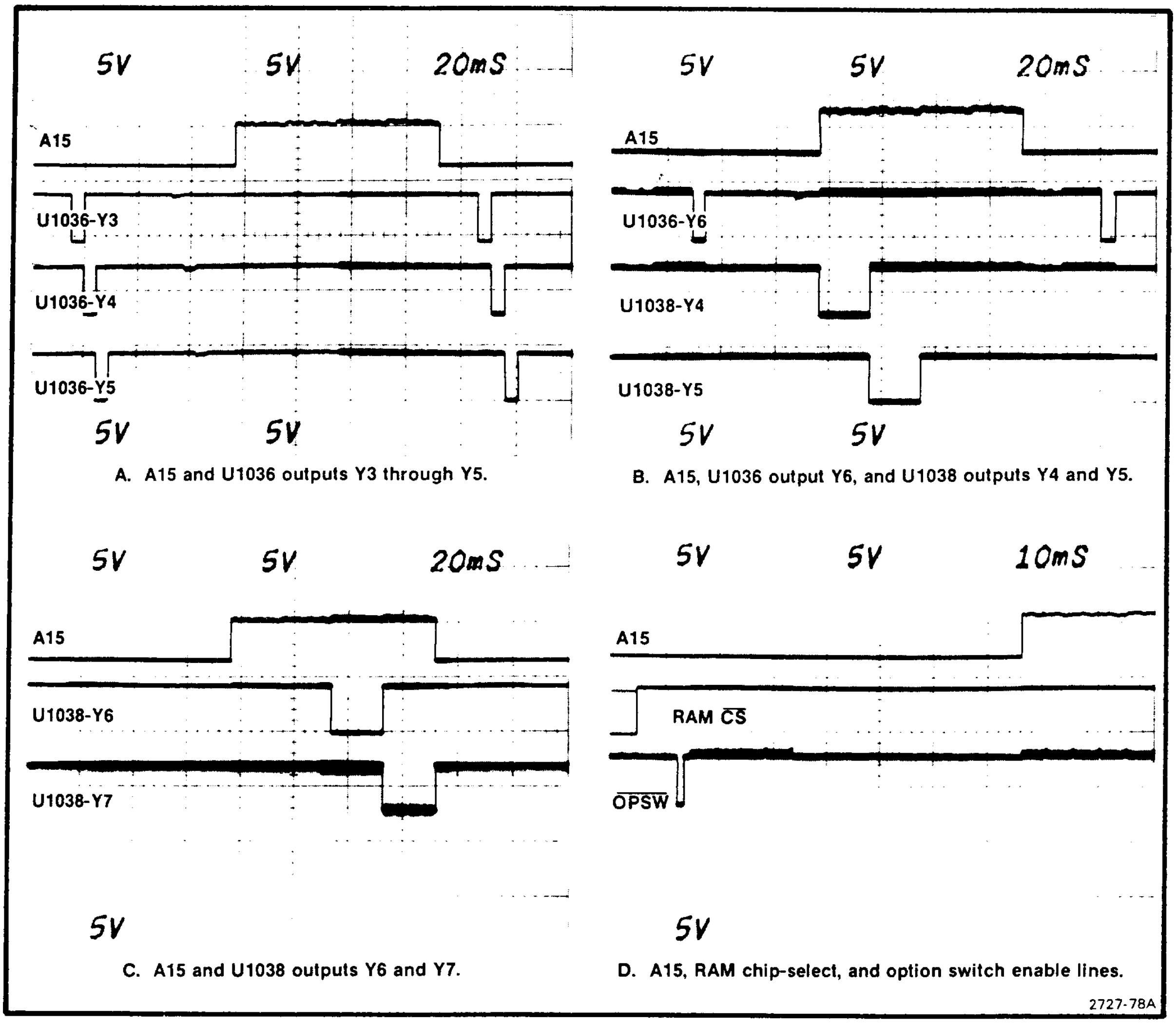


Fig. 4-28. A15 and Memory board address decoder outputs.

Exceptions for Firmware Version 8.2

1. The external Mixer bias is turned off for bands 1 through 5 whenever frequency span or band is changed; however, the indicator remains lit. If an external mixer is used for these bands, EXTERNAL MIXER must be cancelled and then reactivated after every FREQUENCY SPAN/DIV or band change.

2. The microcomputer may not maintain a calibrated display when AUTO RESOLUTION and AUTO TIME/DIV are selected if a WIDE or NARROW VIDEO FILTER is also selected. This is evident when the UNCAL indicator lights. Change the RESOLUTION BANDWIDTH or increase TIME/DIV (if not set to AUTO) for a calibrated display.

3. The REFERENCE LEVEL may hang up above +30 dBm in the ΔA mode. For example: with a REFERENCE LEVEL of +30 dBm in MIN DISTORTION mode, select ΔA mode and increase the REF LEVEL for a readout of +1.00 dBm, then switch out of ΔA mode by cancelling FINE. The analyzer will not respond now to changes of REF LEVEL. Normal operation can be restored by selecting either 10 dB/DIV, LIN, MIN NOISE or EXTERNAL MIXER.

4. The input attenuator may not set to 60 dB on power-up, even though the RF ATTEN readout shows 60 dB. The attenuator is correctly set, however, when the REFERENCE LEVEL is changed and it now matches the readout.

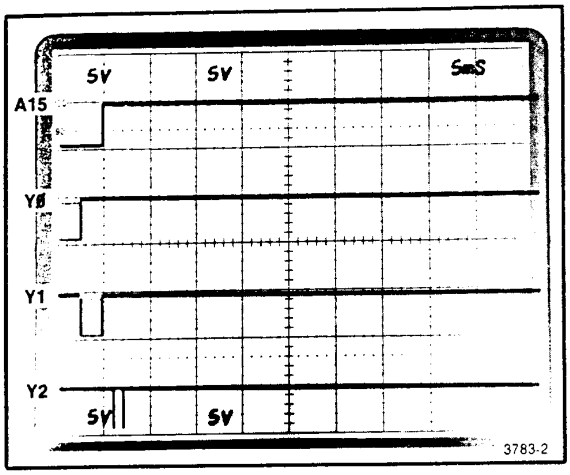


Fig. 4-29. A15 and Y0 through Y2 of address decoder U1021 on the GPIB board.

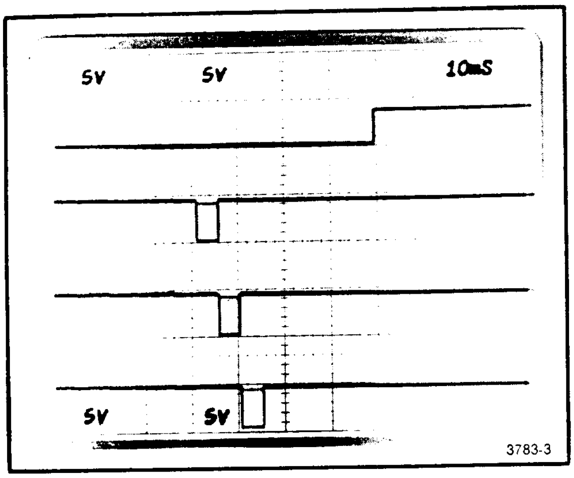
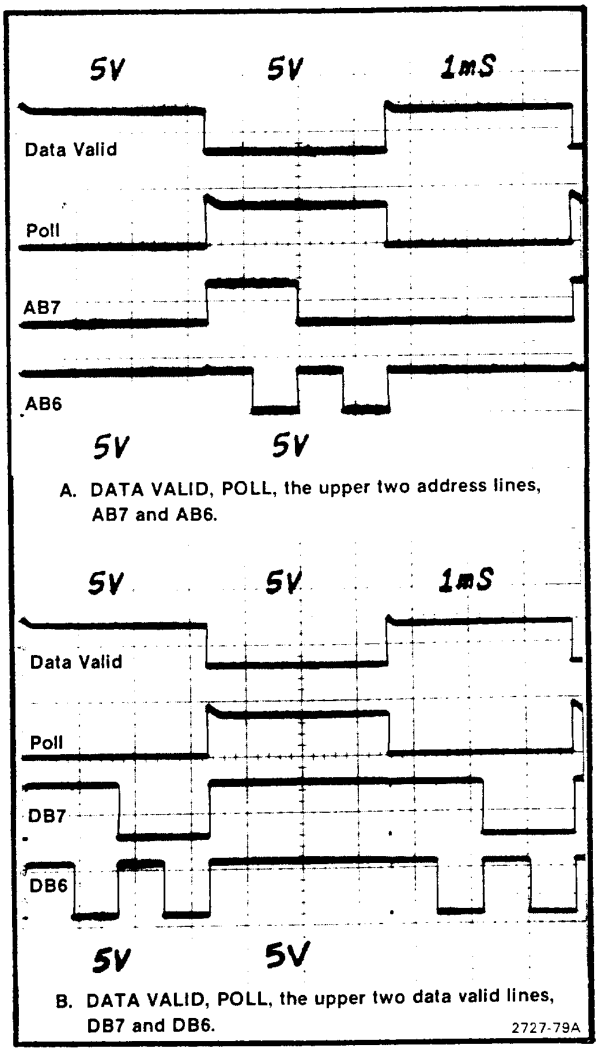


Fig. 4-30. One enable and outputs LORAM, HIRAM, and GPS of address decoder U1028 on the GPIB board.



A. DATA VALID, POLL, the upper two address lines, AB7 and AB6.

B. DATA VALID, POLL, the upper two data valid lines, DB7 and DB6.

Fig. 4-31. Instrument bus check.

Exceptions for Firmware Versions 8.2, 8.7, and 8.8

1. EXTERNAL MIXER changes (on or off) cause the microcomputer to restore the video filter that was in at the last frequency range change. The front-panel VIDEO FILTER indicators will not indicate this change if one is made. To ensure that the desired filter is activated, after changing EXTERNAL MIXER selection, reselect the desired filter.

2. An error 57 message may be displayed when the FREQ SPAN/DIV is 2 kHz or less and the FREQUENCY is tuned to the end of the 2nd LO range (the 2nd LO frequency is tuned for narrow spans). To validate an error 57 message in narrow spans, tune the FREQUENCY in the opposite direction at least five turns. If the message remains, it indicates a hardware failure.

Exceptions for Version 1.1 in the 492P only

1. The sense of the parallel poll is reversed when the 492P responds to parallel poll.

2. The EXTMXR response is not omitted in the SET query response for Option 08 instruments. As a result, the instrument reports an error and does not execute the SET query response. Recommend removing the EXTMXR message unit before transmitting the SET query response to an Option 08 instrument.

Exceptions for Versions 1.1 and 1.2 in the 492P only

The INC and DEC arguments for the TIME command do not operate if the display is uncalibrated (UNCAL indicator lit). Also, if 0 or a negative number is used as an argument for the TIME command, no error will be reported and the command is not executed.

Changes incorporated in Version 1.2 firmware:

1. INIT resets the display data pointer to its power-up value: 500,225.

2. Pressing RESET TO LOCAL while a message, including a REPEAT command, is executing, limits message execution to 256 times, if the message contains WAIT. A SIGSWP command preceding WAIT in the message is ignored after RESET TO LOCAL button is pressed. The REPEAT loop, therefore, completes faster.

3. The command DELFR OFF is inserted after FINE OFF at the beginning of SET query response. The DELFR response is also sent after the FREQ response.

These changes remove the uncertainty in how the SET query is executed with various combinations of instrument settings.

TROUBLESHOOTING ON THE INSTRUMENT BUS

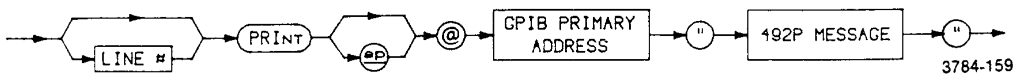
Instrument Bus Data Transfers

The 492P can execute two commands and queries to aid troubleshooting of circuit functions that are interfaced to the instrument bus. These functions are configured by data sent from the microcomputer or respond with data for the microcomputer; in either case, the data is transferred over the instrument bus. The commands and queries provided for this purpose are:

Command	Query	Action
ADDR	ADDR?	Sets, returns address for DATA command
DATA	DATA?	Sets, returns data on 492P instrument bus

Because the DATA command can change the status of internal functions, its use may prevent normal operation of the 492P.

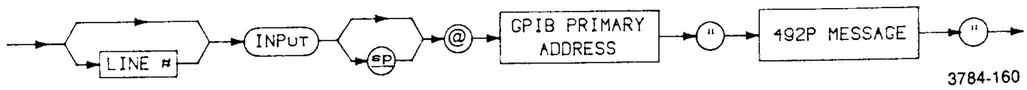
Using a 4050-Series controller, these commands and queries are transmitted to the 492P with the PRINT statement:



3784-159

For the GPIB PRIMARY ADDRESS, enter the decimal equivalent of the GPIB ADDRESS switch settings on the 492P rear panel.

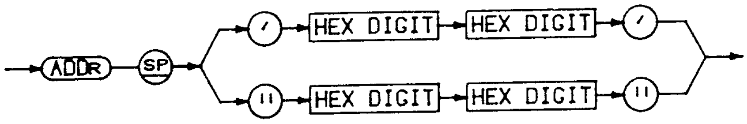
The 492P response to a query is input with the INPUT statement:



3784-160

A string variable is formed by adding a dollar sign ($) to a variable name such as A or X1, making: A$ or X1$.

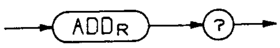
ADDR (instrument bus address) command:



3784-165

HEX. DIGIT: A character in the sequence 0 through 9 and A through F representing a hexadecimal digit. The two digits (in order) form a number to represent a location on the instrument bus. If a character is not a hexadecimal digit or part of a pair of digits, it is not used in executing the ADDR command and an error is reported.

ADDR (instrument bus address) query:



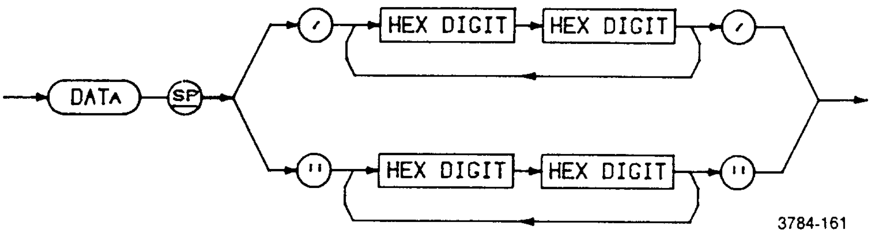
3784-166

Response to ADDR query:

3784-167

The two digits form the hex. address that applies to succeeding DATA commands or queries.

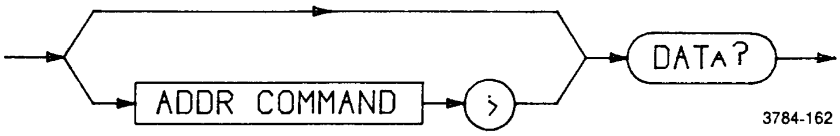
DATA (instrument bus data) command:



3784-161

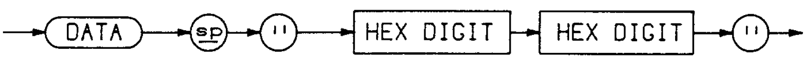
HEX. DIGITS: As with ADDR, a pair of digits forms a hex. number. The number is a data value to be stored at the instrument bus location specified by the last ADDR command. This allows internal 492P parameters to be set for servicing; these parameters control functions by setting the status or mode of 492P circuit assemblies. Up to 16 pairs of characters are accepted to set a function to a new value repeatedly. If a character is not a hex. digit or part of a pair of digits, the data byte formed by the pair is not executed and an error is reported. Also, an error is reported when data is sent to an invalid address.

DATA (instrument bus data) query:



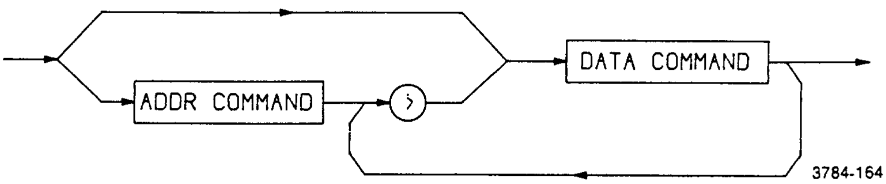
3784-162

Response to DATA query:



3784-163

Combined ADDR command and DATA command:



3784-164

The address command may precede a data command or query to identify the instrument bus location as part of the same message.

Errors related to ADDR and DATA commands:

Error	ADDR and DATA COMMAND
41	ADDR/DATA argument invalid
42	ADDR not compatible for DATA command

Instrument Bus Registers

Registers provide the link between the instrument bus and microcomputer-controlled functions. The registers are defined here in order according to the number of the diagram where the register appears. The definitions are provided to help in constructing DATA commands (see above) and interpreting responses to DATA queries.

The data is presented here as binary. In some cases the data occupies the entire register width, as does a value in digital storage, for instance. In other cases, a single bit or group of bits in the register conveys a code. The upper five bits in the sweep rate and mode register indicate the sweep time/division, for instance. The meaning of the data is not fully defined here; refer to the description of the circuit module in Section 5 for details.

To use the binary data and codes presented here with the DATA command and query presented above, you must convert binary to hexadecimal. This takes three steps:

1) group the lower four bits and the upper four bits (break the data byte in half);

2) convert each group of four bits to a hex. digit. Hex. digits range from 0 to F in this sequence: 0123456789ABCDEF;

3) group the two hex. digits together, keeping their respective places—upper and lower.

For example, binary code 01001011 would be transformed by:

1) 01001011 = 0100 1011

2) 0100 = 4 and 1011 = B (8+0+2+1=B)

3) 4 and B make the two-digit hex. number 4B.

Variable Resolution Mother Board #2 (refer to diagram 19). There are two variable resolution registers that the microcomputer writes to, although both are addressed at 3F (see Table 4-5). The data MSB steers the other bits that are defined into the desired register. When DB7 equals 1, it steers DB0 through DB2 to select the resolution bandwidth. When DB7 equals 0, it steers DB6 through DB0 to select the amount of gain added in the VR section and the band-leveling gain (gain adjustment related to front-end response in each band). These two functions are addressed and set together by the same data byte, although they are broken into two portions of the table below to show the portions of the data byte that form the codes for the two functions.

Table 4-5
VARIABLE RESOLUTION DATA REGISTER (3F)

Resolution Bandwidth DB7=1

DB7	DB2	DB1	DB0	Selects
1	0	0	1	1 MHz
1	0	1	0	100 kHz
1	0	1	1	10 kHz
1	0	0	1	1 kHz
1	1	0	1	100 Hz
1	1	1	0	For future use

Gain, Leveling DB7=0

DB7	DB6	DB5	DB4	DB3	Leveling
0	0	0	0	0	Band 1
0	0	1	0	0	Band 2
0	0	0	1	0	Band 3
0	0	1	1	0	Band 4
0	0	0	0	1	Band 5
0	0	1	0	1	Band 6
0	0	0	1	1	Band 7
0	0	1	1	1	Band 8
0	1	0	0	0	Band 9
0	1	1	0	0	Band 10

DB7	DB2	DB1	DB0	Gain
0	0	0	0	0 dB
0	0	0	1	10 dB
0	1	0	0	20 dB
0	1	0	1	30 dB
0	1	1	1	40 dB

Log and Video Amplifier (refer to diagram 22). Two registers receive data from the microcomputer (see Table 4-6); one controls video offset (78) and the other controls display modes and vertical scale factor (79).

Table 4-6
LOG & VIDEO AMP REGISTERS (78 AND 79)

Bit		Function/Mode
Video Offset (78)		
DB7—DB0		Video offset, LSB = 1/4 dB, total range = 63.75 dB
Modes and Scale Factor (79)		
DB7		Pulse stretcher on/off (1/0)
DB6		Identify offset on/off (1/0)
DB5	DB4	
0	1	Lin
1	0	Log
0	0	Full-screen deflection
DB3—DB0		Log vertical scale factor in dB/div

Video Processor (refer to diagram 23). A register (7C) controls out-of-band clamping, video filtering, and leveling (see Table 4-7).

Table 4-7
VIDEO PROCESSOR CONTROL (7C)

Bit				Function
DB5	DB6	DB7		Out-of-Band Clamp
1	1	0		No clamp
1	0	0		Clamp upper 5 div
1	1	1		Clamp lower div
0	1	0		Clamp lower 5 div
DB4	DB3	DB2	DB1	Video Filter
0	0	0	0	Off
0	0	0	1	30 kHz
1	0	0	1	3 kHz
1	1	0	1	300 Hz
0	0	1	1	30 Hz
1	0	1	1	3 Hz
1	1	1	1	0.3 Hz
	DB0			Base-line Leveling on/off (1/0)

Digital Storage (refer to diagram 24). Two registers (at 7A and FA) on the Vertical Digital Storage board transfer display data to and from the microcomputer for 492P GPIB operations. Another register (at 7B) controls digital storage functions (see Table 4-8).

Table 4-8
DIGITAL STORAGE REGISTERS (7A, FA, AND 7B)

Bit		Function
Digital Storage Input (7A)		
DB7—DB0		Data values for digital storage. A write to 7B clears the address counter so values are stored for points on display starting at left and proceeding to right in order.
Digital Storage Output (FA)		
DB7—DB0		Data values from digital storage. A write to 7B initializes output to begin at left of trace and proceed to right.
Digital Storage Control (7B)		
DB7		Halt/run (0/1) storage acquisition
DB6	DB5	PEAK/AVERAGE cursor
1	1	Knob position
1	0	PEAK
0	1	AVERAGE
DB4		MAX HOLD on/off (1/0)
DB3		VIEW B−A on/off (1/0)
DB2		VIEW B on/off (1/0)
DB1		VIEW A on/off (1/0)
DB0		SAVE A on/off (1/0)

Z-Axis/RF Interface (refer to diagram 27). A register on the Z-Axis/RF Interface board enables Z-axis and RF attenuator control (see Table 4-9).

Table 4-9
Z-AXIS AND RF DECK CONTROL (4F)

Bit			Function
DB7			Baseline clipper on/off (1/0)
DB6	DB2	DB0	RF attenuation
1	1	1	0 dB
1	1	0	10 dB
0	1	1	20 dB
1	0	1	30 dB
1	0	0	40 dB
0	0	1	50 dB
1	1	1	60 dB
DB5			1 = 829 MHz 2nd Converter 0 = 2 GHz 2nd Converter
DB4			1 = EXT MIXER 0 = RF INPUT
DB3			Set to 0 for 100 ms to switch attenuator

Crt Readout (refer to diagram 29). One register (5F) controls crt readout and data steering. Another register (2F) accepts data from the microcomputer (see Table 4-10).

Table 4-10
CRT READOUT REGISTERS (5F AND 2F)

Bit	Function
	Crt Control (5F)
DB3	1 = max span dot 0 = center frequency dot
DB2	1 = error or GPIB RDOUT message (page 2) 0 = normal readout (page 1)
DB1	1 = data sent to 2F is character address 0 = data sent to 2F is character code
DB0	1 = readout on 0 = readout off—required to load characters
	Address/Data (2F)
DB1	in 5F = 1
DB6—DB0	Address in readout RAM. Upper line is 0—31. Lower line is 32—63 (page of RAM selected by DB2 at address 5F)
DB1	in 5F = 0
DB7	1 blanks character (used for space)
DB6	1 shifts character down 1/2 screen (used for upper readout only)
DB5—DB0	Lower 6 bits of ASCII code for character

Front Panel (refer to diagram 30). Writing to register 74 loads data into shift registers that drive all the lights on the front panel, including the one for the crt graticule (see Table 4-11). Four 8-bit shift registers store the data, requiring eight writes of four bits each time (one bit for each register) to update the front-panel lights. The table below shows the order that data is entered to control the lights. A 0 turns on the light (except in the case of the crt graticule); a 1 turns off the light.

Reading from F4 accesses the keyboard encoder and the FREQUENCY knob encoder.

Table 4-11
FRONT-PANEL REGISTERS

Write Number	DB4	DB2	DB1	DB0
Writing data to shift registers for lights (74)				
1	MAX HOLD	ZERO SPAN	GRAT ILLUM	CAL
2	CLIP	REMOTE	FINE	LIN
3	AD-DRESSED	10 dB	READY	NARROW
4	READOUT	20 dB	LINE TRIG	WIDE
5	ΔF	IDENTIFY	SINGLE SWEEP	B−SAVE A
6	EXTR MIXER	MIN NOISE	FREE RUN	VIEW B
7	AUTO RESOLU-TION	PHASE LOCK	INT RUN	VIEW A
8	PULSE STRETCH-ER	UNCAL	EXT TRIG	SAVE A

A 1 on DB3 initializes encoder (power-up)

Bit	Functions
Reading data from switch encoders (F4)	
DB7	FREQUENCY down/up (1/0)
DB6—DB0	Switch codes (see Fig. 5-39)

Sweep (refer to diagram 33). The microcomputer writes to two registers (0F and 1F) to control sweep rate, mode, holdoff, interrupts and triggering (see Table 4-12).

Table 4-12
SWEEP REGISTERS

DB7	DB6	DB5	DB4	DB3	Time/Div
Sweep Rate and Mode (0F)					
1	1	0	1	1	20 μs
1	0	1	1	1	50 μs
1	0	0	1	1	100 μs
0	1	0	1	1	200 μs
0	0	1	1	1	500 μs
0	0	0	1	1	1 ms
1	1	0	0	1	2 ms
1	0	1	0	1	5 ms
1	0	0	0	1	10 ms
0	1	0	0	1	20 ms
0	0	1	0	1	50 ms
0	0	0	0	1	100 ms
1	1	0	0	0	200 ms
1	0	1	0	0	500 ms
1	0	0	0	0	1 s
0	1	0	0	0	2 s
0	0	1	0	0	5 s
0	0	0	0	0	10 s
1	1	1	1	1	Manual
0	1	1	1	1	External

A 1 on DB2 sets single-sweep mode

A 1 on DB0 sets trigger in single-sweep mode

Bit		Function
Holdoff, Interrupt, Trigger (1F)		
DB7		1 enables end-of-sweep interrupt
DB6	DB5	Sweep Holdoff
0	0	Short
0	1	Medium
1	0	Long
DB4	DB3	Trigger Mode
0	0	Free run
0	1	Internal
1	0	External
1	1	Line
DB0		Aborts sweep

Span Attenuator (refer to diagram 35). Two registers (75 and 76) control the span attenuator (see Table 4-13).

Table 4-13
SPAN ATTENUATOR REGISTERS (75 AND 76)

Bit		Function
Span Magnitude (75)		
DB7—DB0		Lower 8 bits of 10-bit attenuation code (000 is max attenuation)
Span Magnitude and Attenuator (76)		
DB7		Sweep ± (1/0) to match ± mixing
DB6	DB5	Sweep decade attenuator
0	0	X 1.0
0	1	X 0.1
1	0	X 0.01
DB4	DB3	Output select and calibration
0	0	1st LO main coil
0	1	1st LO FM coil
1	0	2nd LO
DB2		For future use
DB1—DB0		Upper two bits of attenuation code

1st LO Driver (refer to diagram 36). One register (72) controls functions on the 1st LO Driver board. Another register (7E) is added for the 492P to make the PEAKING control programmable (see Table 4-14).

Table 4-14
1st LO DRIVER REGISTERS (72 AND 7E)

Bit			Function
1st LO Driver Functions (72)			
DB7			Normal/max span mode (1/0)
DB6			Connect/disconnect sweep voltage to driver (1/0)
DB5			Driver off/on (1/0)—off for degauss
DB4			Filter on/off at driver output (1/0)—on for unphase-locked narrow spans
DB3			External mixer disconnect/connect (1/0); connected in bands 1—5 if external mixer selected; always connected in higher bands
DB2	DB1	DB0	Internal Mixer Bias for
1	1	0	Band 1
1	1	0	Band 2
1	1	0	Band 3
1	0	1	Band 4
0	1	1	Band 5
1	1	1	Selects no internal mixer bias
PEAKING Control (7E)			
DB7			0 steers DB4—DB0 to upper latch
DB6			0 steers DB5—DB0 to lower latch
DB5—DB0			1 sent to DB4 of upper latch disables front-panel PEAKING control; DB3—DB0 of upper latch and DB5—DB0 of lower latch form 10-bit input to DAC for programmable PEAKING voltage

Preselector Driver (refer to diagram 37). A register (77) controls functions on the Preselector Driver (see Table 4-15). A single bit, DB3, responds on the data bus to indicate the board is installed when the microcomputer performs a read at F7.

Table 4-15
PRESELECTOR DRIVER CONTROL (77)

Bit		Function
DB7	DB6	829 MHz offset
0	1	− conversion
1	0	+ conversion
0	0	829 MHz IF not used
DB5		Driver output filter on/off (1/0); on for narrow spans
DB4		LPF/preselector switch (0/1)
DB3		1st LO FM coil not-swept/swept (1/0)
DB2		Driver on/off (1/0)—off for degauss
DB0		3rd/1st harmonic 1st LO conversion (1/0)

Center Frequency Control (refer to diagram 39). Registers are provided for control functions (70) and data values for center frequency DAC(s) (71). A read (F0) returns the results of a comparison of the DAC output voltage and a memory voltage (see Table 4-16).

Table 4-16
CENTER FREQUENCY CONTROL REGISTERS (70, 71, AND F0)

Bit	Function/Meaning
Control (70)	
DB7	1st LO storage gate open/close (1/0)
DB6	0 steers DAC data to 1st LO high byte
DB5	0 steers DAC data to 1st LO mid byte
DB4	0 steers DAC data to 1st LO low byte
DB3	2nd LO storage gate open/close (1/0)
DB2	0 steers DAC data to 2nd LO high byte
DB1	0 steers DAC data to 2nd LO mid byte
DB0	0 steers DAC data to 2nd LO low byte
DAC Data (71)	
DB7—DB0	Data for center frequency DAC(s) steered by control register
Center Frequency Control Read (F0)	
DB7	1st LO DAC stored voltage comparator
DB0	2nd LO DAC stored voltage comparator

Phase Lock Control (refer to diagram 40). A register (73) accepts data to preload the ÷n counter and control the synthesizer. Successive reads from another register (F3) obtain status and counter outputs (see Table 4-17). After resetting the counter output register selector, three read cycles return status bits and counter bits in the most significant byte and remaining counter bits in following bytes.

Table 4-17
PHASELOCK CONTROL REGISTERS (73 AND F3)

Bit	Function/Meaning
Write (73)	
DB7	1 clocks data on DB0 into a latch
DB6	0 (unused)
DB5	1 clears the counters
DB4	1 transfers DB0 serial data to control latch outputs
DB3	1 resets the counter output register selector
DB2	For future use
DB1	1 transfers DB0 serial data to synthesizer N latch outputs
DB0	Serial data for control of synthesizer N latches
Read (F3)—Most Significant Byte	
DB7	1 = error voltage below a preset amount
DB6	1 = error voltage above a preset amount
DB5	Always 1
DB4	1 when phaselocked
DB3	1 when valid count is in counters
DB2—DB0	Upper three bits of counter output; the remaining 16 bits are in the following two bytes