



**7L18
SPECTRUM
ANALYZER**

OPERATORS

INSTRUCTION MANUAL

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

Serial Number _____



WARRANTY

This Tektronix instrument is warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your Tektronix Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument type number or part number and serial number with all requests for parts or service.

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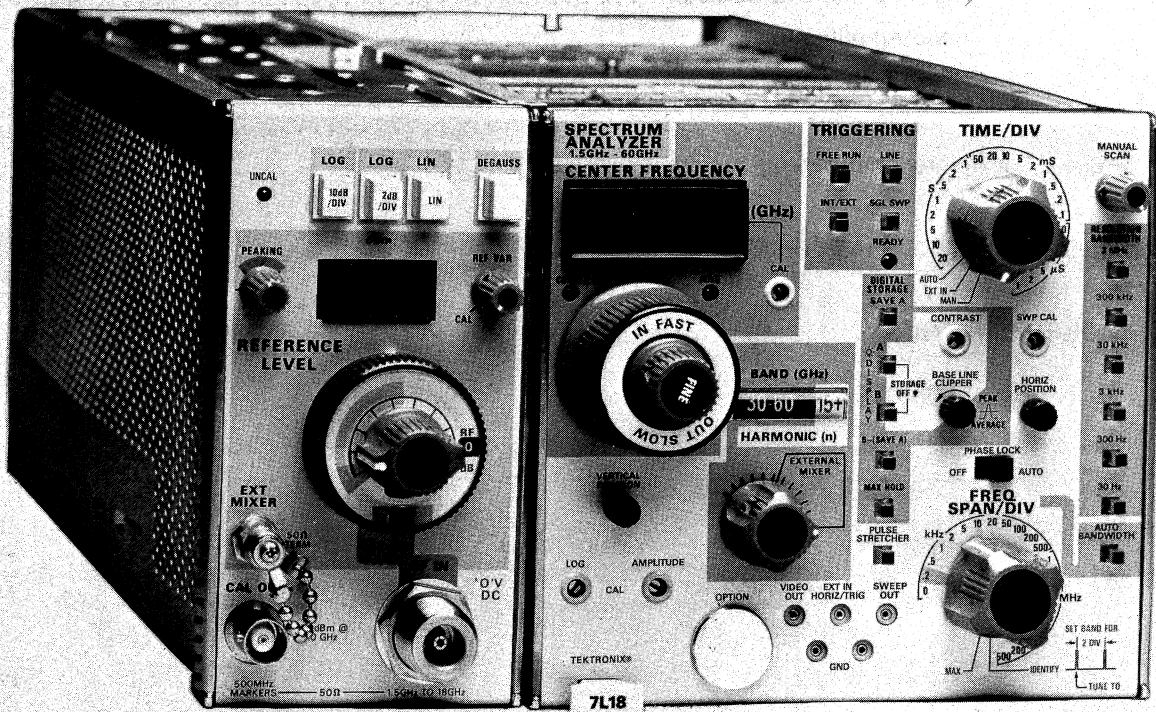
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2339-1A

SPECIFICATION

INTRODUCTION

The 7L18 Spectrum Analyzer is a three-unit-wide plug-in for Tektronix 7000-Series oscilloscope mainframes. The analyzer covers the spectrum range from 1.5 GHz to 18 GHz in five bands with direct input, and 12.5 GHz to 60.5 GHz in six bands with external waveguide mixers. The instrument features digital storage, internal preselector, dynamic range of 80 dB, less than 10 Hz of incidental oscillator frequency modulation, and a resolution bandwidth range of 30 Hz to 3 MHz.

The 7L18 digital storage feature permits stored waveform displays on conventional oscilloscope mainframes. In addition to flicker-free displays at slow sweep speeds, stored waveforms are available for subsequent viewing, comparison, or photographing. Conventional oscilloscopes generally have a smaller dot size than storage oscilloscopes; this enhances the resolution of low amplitude signals and other fine details. In the storage mode, the display can be divided with a positionable threshold cursor, above which the video signal is peak detected and below averaged. A maximum hold capability provides the means to measure the maximum signal amplitude over any time period. Two complete displays can be held in memory for comparison; the B—SAVE A feature displays the difference between the two stored waveforms.

The sweep generator provides 1 μ s/div to 20 s/div calibrated sweep speeds plus single sweep manual sweep, and external sweep modes. An automatic sweep rate mode selects the optimum sweep rate compatible with the selected frequency span and resolution settings.

ELECTRICAL CHARACTERISTICS

The following characteristics apply when the 7L18 Spectrum Analyzer is installed in a 7000-Series mainframe and after a warmup period of 30 minutes or more, except as noted.

Frequency-Related Characteristics

Center Frequency

Range: 1.5 GHz to 18 GHz in five bands (coaxial input). 12.5 GHz to 60.5 GHz in six bands (with external waveguide mixers). See Table 1-1.

Accuracy: $\pm(5 \text{ MHz} + 20\% \text{ of Frequency Span/Div})$ times the oscillator harmonic (n) of the band in use.

Resolution: Within 1 MHz with direct input and 10 MHz with waveguide mixers (after 2 hour warmup).

Table 1-1

Band	Frequency Range	Harmonic (n) ^a	FREQ SPAN/DIV Range	MAX SPAN Sweep
With Direct Input				
1	1.5 GHz to 3.5 GHz	—1	200 Hz to 500 MHz	200 MHz/Div
2	2.5 GHz to 4.5 GHz	+1	200 Hz to 500 MHz	200 MHz/Div
3	3.5 GHz to 7.5 GHz	—2	200 Hz to 500 MHz	500 MHz/Div
4	6.5 GHz to 12.5 GHz	+3	500 Hz to 500 MHz	1 GHz/Div
5	9.5 GHz to 18.0 GHz	—5	500 Hz to 500 MHz	1 GHz/Div
With External Waveguide Mixer				
6	12.5 GHz to 24.5 GHz	+6	500 Hz to 500 MHz	2 GHz/Div
7	14.5 GHz to 28.5 GHz	+7	500 Hz to 500 MHz	2 GHz/Div
8	16.5 GHz to 32.5 GHz	+8	500 Hz to 500 MHz	2 GHz/Div
9	18.5 GHz to 36.5 GHz	+9	500 Hz to 500 MHz	2 GHz/Div
10	20.5 GHz to 40.5 GHz	+10	500 Hz to 500 MHz	2 GHz/Div
11	30.5 GHz to 60.5 GHz	+15	500 Hz to 500 MHz	5 GHz/Div

^aA minus sign indicates the incoming signal is below the effective local oscillator harmonic frequency; a plus sign indicates the incoming signal is above the effective local oscillator harmonic frequency.

Frequency Span

Calibrated steps in a 1-2-5 sequence; range available for each band is shown in Table 1-1. Accuracy is within 5% of the span selected and linearity is within 5% over the center eight divisions of a 10-division display. Accuracy is degraded when operating in normally phase locked positions with the automatically selected phase lock defeated.

A MAX SPAN position provides for a full sweep of the first local oscillator; the span is set to the position shown in Table 1-1 (note that this causes the sweep to be shortened on some bands).

A 0 (zero) position provides fixed-frequency operation for time domain displays.

Frequency Response and Display Flatness

Frequency response, from 1.5 GHz to 60 GHz: ± 5 dB maximum.

Frequency response is measured with the PEAKING control optimized at each center frequency setting; display flatness is measured with the PEAKING control set within the dark "search" zone, and is typically ± 1 dB more than frequency response.

Typical and worst case maximum frequency response is graphically described in Fig. 1-2, and is specified in Table 1-2. Frequency response is measured with 10 dB of RF attenuation, and includes the effects of input swr, mixing mode (n), gain variation, preselector, and mixer.

Table 1-2

Frequency	Worst Case Maximum per Band
1.5 to 3.5 GHz	± 1.8 dB
2.5 to 4.5 GHz	± 1.8 dB
3.5 to 7.5 GHz	± 2.5 dB
6.5 to 12.5 GHz	± 4.0 dB
9.5 to 18.0 GHz	± 4.0 dB
18.0 to 26.5 GHz ^a	± 3.0 dB
26.5 to 40 GHz ^a	± 3.0 dB
40 to 60.5 GHz ^a	± 3.0 dB

^aUsing high performance type external waveguide mixers (optional accessories).

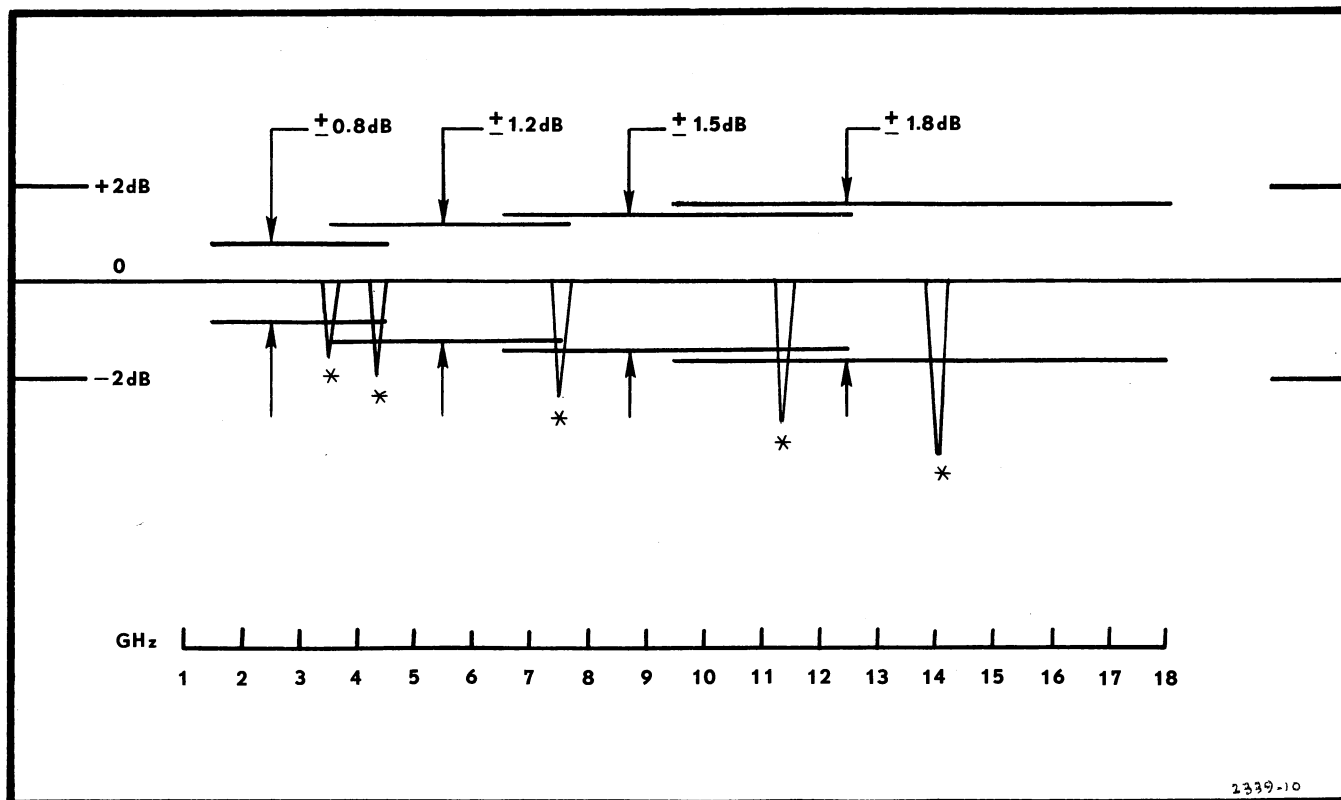


Fig. 1-2. Typical frequency response limits.

*Aberrations at approximately 3.5 GHz, 4.5 GHz, 7.5 GHz, 11.5 GHz, and 14 GHz are within worst case maximum frequency response.

Resolution Bandwidth

Six resolution bandwidth selections from 30 Hz to 3 MHz, in decade steps, are provided. Bandwidth accuracy, at the 6 dB down level is within 20% of the resolution selected. Shape factor over the 60 dB to 6 dB level is 12:1 or better for 30 Hz resolution bandwidth, and 4:1 or better for 300 Hz to 3 MHz resolution bandwidths. Amplitude change over the six bandwidths is less than 0.5 dB.

Incidental FM

When phase locked, ≤ 10 Hz (p-p) $\times n$ when not phase locked ≤ 10 kHz (p-p) $\times n$, for three seconds. (n is the harmonic number for the band in use.)

Stability (after a two-hour warmup period at a fixed temperature)

Within (2 kHz/hr $\times n$) when phase locked; within (50 kHz/10 min $\times n$) when not phase locked.

Amplitude-Related Characteristics

Sensitivity

Sensitivity (average noise level) is shown in Table 1-3, and specified with internal mixer for bands 1-5, and external mixers for bands 6-11. Figure 1-3 shows typical close-in signal measurement capability versus offset from carrier.

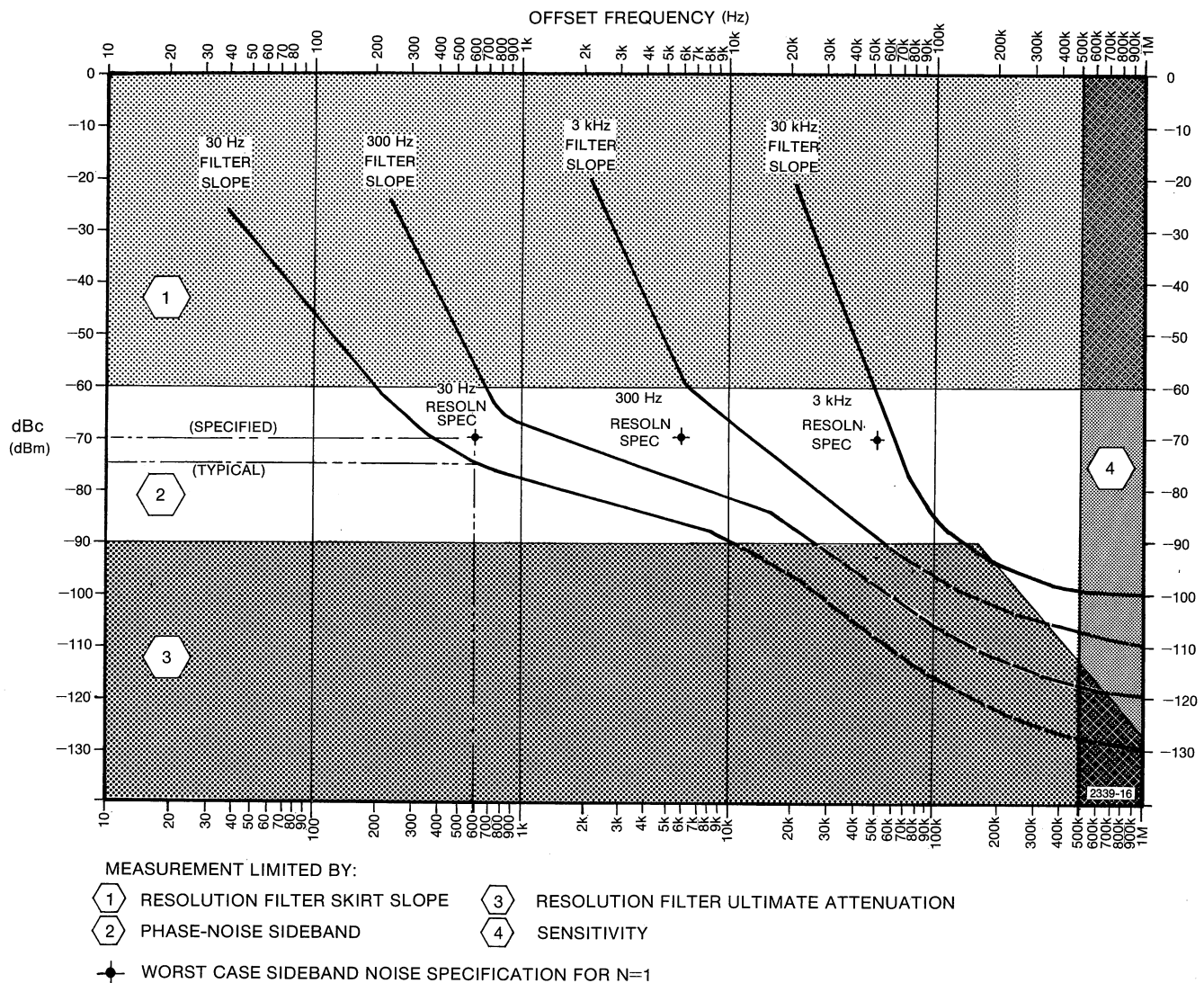


Fig. 1-3. Graph illustrates typical close-in signal measurement limitations for the 7L18 Spectrum Analyzer. Measurement limitations are due to; resolution filter shape factor (skirt slope), phase noise sideband level, ultimate filter attenuation, average noise level (sensitivity) characteristics. Graph is for oscillator fundamental conversion with phase lock operative. Average noise level increases with harmonic (n) number as per Table 1-3 (e.g. Signals offset 600 Hz and specified to -70 dBc can usually be measured down to -74 dBc with 30 Hz resolution—see examples).

Specification—7L18 Operators

Maximum Input Power Level

−30 dBm with the RF Attenuator at 0 dB; +30 dBm with the RF Attenuator at 60 dB, for linear operation. (+30 dBm is also the power rating of the RF Attenuator.)

NOTE

The maximum input power level to the RF Attenuator is 1 watt average and 200 watts peak. Burnout, 1 W or more at the input.

Input Characteristics

Input Impedance: 50 ohms nominal (1.5 to 18 GHz).

Connector: Type "N" female.

VSWR: ≤ 1.35 for RF Attenuator settings ≥ 10 dB.

Maximum Input Level: 1 watt (+30 dBm).

Optimum Input Level: ≤ -30 dBm with zero RF Attenuation.

Input Compression Point: ≥ -28 dBm from 1.5 to 1.8 GHz. -18 dBm or more from 1.8 to 18 GHz.

Local Oscillator Emission: -80 dBm, 1.5 to 18 GHz (10 dB RF Attenuator setting).

Dynamic Ranges and Accuracies

LOG 10 dB/DIV: Provides a calibrated 80 dB dynamic range. Accuracy is within ± 1 dB/10 dB with a maximum error of 2 dB over the 80 dB range.

LOG 2 dB/DIV: Provides a calibrated 16 dB dynamic range. Accuracy is within ± 0.4 dB/2 dB with a maximum error of 1.0 dB over any 10 dB range.

LIN: Provides linear display within 10%, of full screen, over the 8-division graticule height, with calibrated reference levels.

Reference Level

The Reference level is determined by the combination of the RF Attenuator and IF Gain settings, and is calibrated in 10-dB steps from +40 dBm to -110 dBm (+30 dBm is the maximum safe input level).

Reference level variation between any two bands is ± 1 dB maximum with internal mixer and typically within ± 3 dB with waveguide mixers.

Table 1-3

Average Noise Level (dBm max)

Frequency Range (GHz)	Resolution Bandwidth					
	3 MHz	0.3 MHz	30 kHz	3 kHz	300 Hz	30 Hz
1.5 to 3.5	−79	−89	−99	−109	−119	−127
2.5 to 4.5	−79	−89	−99	−109	−119	−127
3.5 to 7.5	−69	−79	−89	−99	−109	−117
6.5 to 12.5	−67	−77	−87	−97	−107	−115
9.5 to 18.0	−52	−62	−72	−82	−92	
12.5 to 18.0	−55	−65	−75	−85	−95	
18.0 to 26.5 ^a	−60	−70	−80	−90	−100	
26.5 to 40 ^a	−55	−65	−75	−85	−95	
40 to 60.5 ^a	−45	−55	−65	−75	−85	

^aHigh performance type mixers.

RF Attenuator

60 dB of attenuation range, calibrated in 10-dB steps. Incremental accuracy is ± 0.3 dB or 1% of dB setting (whichever is greater) to 4 GHz; ± 0.5 dB or 2% of dB setting (whichever is greater) from 4 GHz to 18 GHz.

IF Gain

Range: 90 dB. The selector is a ten-position switch that changes the IF gain in 10-dB steps. In the 10 dB/DIV display mode, there is one position of gain reduction (indicated by the red sector behind the knob) and four positions of gain (blue sector) for a total of 40 dB gain change. In the 2 dB/DIV and LIN display modes, there are five additional positions of gain change (white sector) for a total of 90 dB of gain change.

At any set frequency and attenuator position, the maximum variation from indicated reference levels with changes in gain will be within 1 dB per 10 dB step, and within 2 dB overall. This also applies to changes between 2 dB/DIV, 10 dB/DIV, and LIN.

IF gain variation with different resolution bandwidths (at 25°C): ± 0.5 dB.

Spurious Responses

Residual Response: (Referred to band 1, no attenuation and no signal present at the input): -110 dBm, or less except the Calibrator harmonics which are -100 dBm or less.

Intermodulation Distortion: Third order products are down 70 dB or more from any two -40 dBm signals for 1.5 to 1.8 GHz, and 70 dB or more from any -30 dBm signals for 1.8 to 18 GHz, referenced to the input mixer, when the IF Gain is not in the gain-reduced position (red sector).

Mixed: All harmonic mixing, image, and multiple responses down 70 dB or more to 18 GHz.

Phase noise sidebands are at least -70 dB for a frequency offset of 20 x resolution bandwidth or more.

General

Calibrator

2.000 GHz $\pm 0.01\%$ with an absolute amplitude level of -30 dBm ± 0.5 dB at 25°C ambient temperature. 500 MHz harmonics are generated to provide a comb of markers for frequency span calibration.

Sweep Modes and Rates

Calibrated sweep rates from 1 μ s/DIV to 20 s/DIV in a 1-2-5 sequence, plus auto, manual or external sweep source can be selected. Sweep rate accuracy is within 5% of that selected.

Triggering

Sources and Modes: Internal, external, line, free run, single sweep.

Sensitivity: Internal, 1 division; external, $+0.5$ V minimum to $+50$ V maximum.

Frequency Range ac-coupled: 15 Hz to 1 MHz.

External Input Impedance: Approximately 10 k Ω for signals less than 10 V; approximately 8 k Ω for signals over 10 V.

Video Output Connector

Provides 500 mV $\pm 5\%$ of signal per division of display. Baseline of the display is 0 volt. (An additional excursion of about 0.4 volt below 0 volt baseline reference will be part of the output.) Source impedance is about 5 k Ω .

External Horizontal/Trigger Input Connector

Requires 0 V to 10 V ± 1 V to sweep the full frequency span.

Requires 0.5 volt peak-to-peak to trigger the sweep circuits. Maximum safe input; 50 volts (dc + peak ac).

Sweep Output Connector

Provides -5 V to $+5$ V $\pm 5\%$ for full-screen display. Source impedance is approximately 1 k Ω .

ENVIRONMENTAL CHARACTERISTICS

The 7L18 will meet the foregoing electrical characteristics within the environmental limits of a standard 7000-series oscilloscope mainframe. Complete details on environmental test procedures, including failure criteria, etc., can be obtained from a local Tektronix Field Office or representative.

ACCESSORIES

Standard

Spectrum Analyzer Graticule	337-1439-01
Spectrum Analyzer Graticule	337-1159-02
50-ohm coaxial cable, 10 in.	012-0208-00
Adapter, BNC female to N male	103-0045-00
Instruction Manual (Operators)	070-2339-02
Instruction Manual (Service)	070-2295-00
Spectrum Analyzer Securing Kit	016-0637-00

Optional

Waveguide Mixers—Please refer to Section 3, External Waveguide Mixers, for descriptions and part numbers.

Carrying Case—Protective aluminum case with hinged latchable front cover and carrying handle: Tektronix Part No. 016-0626-00.

Service Kit—Tektronix Part No. 006-2487-00. The service kit includes the following:

Phase Lock Extender	067-0868-00
Standard Extender	067-0869-00
Narrow Extender	067-0870-00

PACKAGING AND INSTALLATION

UNPACKING AND INSPECTION

The carton assembly for the 7L18 consists of an inner protective carton containing the instrument, supported within the outer shipping carton by four cushioning pads. The standard accessories are packed in the space between the inner and outer cartons; optional accessories, if ordered, are packaged separately.

When the instrument is first received, inspect the outer carton for signs of shipping damage. If there is damage, it should be noted on the shipping receipt. It is difficult for shippers to damage a properly-packaged instrument without outward evidence, but should this occur, contact the shipper as soon as possible, and save all packing materials.

When unpacking the instrument, save all materials; at least until all accessories have been accounted for.

This instrument was inspected both mechanically and electrically before shipment. It should be free of mars or scratches and electrically meet or exceed all specifications. Inspect the instrument for physical damage and check the electrical performance by the Operational Check procedure provided within these instructions. This procedure will verify that the instrument is operating correctly and it will satisfy most receiving or incoming inspection requirements. If instrument specifications are to be verified, refer to the Service Instructions for the 7L18.

If there is physical damage or performance deficiency, contact your local Tektronix Field Office or representative.

INSTALLATION AND REMOVAL

Install the 7L18 in a 7000-Series mainframe and perform the first-time operation and/or performance check as described in section 3.

NOTE

The bottom panel mounting screws on some 7000-Series mainframes may protrude enough to catch the 7L18 as it is inserted into the oscilloscope. These screws can either be replaced by shorter screws or they can be cut flush with the tapped nut.

Safety Latch

The 7L18 is latched into place in the mainframe. To remove the plug-in, pull out on the release handle, located in the lower left corner of the wider front panel, until the unit comes out of the mainframe an inch or two. There is a safety latch to prevent the plug-in from coming out farther if the plug-in latch should fail. The release for this latch is located on the bottom of the right lower rail and is released by pressing upwards, then pulling the plug-in the rest of the way out.

Securing (Bolt Down) Provisions

Under normal laboratory conditions, or where the oscilloscope plug-ins are frequently changed, the plug-in latches described in the previous paragraph are adequate to secure the 7L18. However, under more rugged conditions, where the plug-in is not likely to be changed routinely, a securing kit (016-0637-00). It is used to bolt and secure the 7L18 into the mainframe.

REPACKAGING AND SHIPPING

CAUTION

DO NOT SHIP THE 7L18 PLUG-IN INSTALLED IN A MAINFRAME. It should be shipped in a separate carton.

The safest, easiest, and least expensive means of packing is to reuse the carton assembly in which the instrument was received. If the original carton is not available or has been damaged, repackage the instrument as follows:

Surround the instrument with a polyethylene bag or sheeting to protect its finish. Select a corrugated cardboard carton with a test strength of 275 pounds and inside dimensions at least six inches greater than the instrument. Pack at least three inches of dunnage or urethane foam on all sides between the instrument and carton. Seal the carton with shipping tape or an industrial stapler.

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing the name and address of the owner, the name of an individual to contact at your firm, the complete instrument serial number, and a description of the service required.

7000-SERIES MAINFRAME COMPATIBILITY AND MAINFRAME SELECTION

The 7L18 Spectrum Analyzer Plug-In Unit is compatible with all 7000-Series oscilloscope mainframes, with or without readout or storage. It is also compatible with the militarized AN/USM-281C (7603N11S).

For optimum portability, we recommend mainframe 7603 with Option 8. This option provides a high impact strength protective front cover.



The 7L18 should never be shipped installed in a mainframe.

If the spectrum analyzer-mainframe combination is to be used in portable mode, we strongly recommend that the 7L18 be secured in the mainframe with the provided securing kit (standard accessory).

Option 6 for some 7000-Series oscilloscopes (i.e. 7603, 7613) provides a special crt internal graticule. (Contact your local Tektronix Field Office or representative.

OPERATION

Introduction:

This section describes: 1) Function of the front panel controls, selectors, indicators, and connectors. 2) Initial operation that describes adjustments required to calibrate the 7L18 to a 700-Series mainframe. 3) Functional or operational check of the instrument to verify that the instrument is operating properly and help familiarize you (the user) with the instrument. 4) General operating information followed by; 5) some typical applications.

CAUTION

A safety latch must be released before the 7L18 can be pulled from the oscilloscope compartment. The unit will pull out part way, when the front panel release is pulled, then the spring safety latch must be pushed up to free the unit so it can be pulled the rest of the way out. This safety latch is located underneath the right rail near the front corner (see Fig. 3-1).

Front Panel Indicators and Connectors:

The following is a general description of the 7L18 controls, indicators and connectors. This description will familiarize you with their function and Fig 3-1 illustrates their location.

① **REFERENCE LEVEL** (also indicates RF Attenuation and maximum power level)—These concentric controls select and indicate input attenuation and instrument (IF) gain. Normally, the attenuation and gain controls should not be set to offset each other. The readout windows indicate maximum power input level (MAX dBm) and RF Attenuation (RF dB). Only the red and blue sector positions are valid when in the 10 dB/DIV mode; all positions are valid when in the 2 dB/DIV and LIN modes.

NOTE

To avoid signal compression, do not use the red sector position below 2 GHz.

② **dBm**—This LED display indicates the input power required to cause a deflection of the beam to the top graticule line. The same reading also appears on the crt when using oscilloscopes with the readout feature. The display is correct only for coaxial inputs.

③ **REF VAR** (reference variable)—This variable control adjusts the reference level between steps of the REFERENCE LEVEL controls. When the REF VAR is in the CAL position, the level is the same as that selected by the switches and indicated by the readout. The REF VAR does not change the readout; when not in the CAL position, a "<" appears in the crt readout display.

④ **LOG 10 dB/DIV**—This button selects a display mode with a calibrated dynamic range of 80 dB from the top graticule line to the bottom. Each division represents a 10 dB change.

⑤ **LOG 2 dB/DIV**—This button selects a display mode with a calibrated dynamic range of 16 dB from the top graticule line to the bottom. Each division represents a 2 dB change.

⑥ **LIN**—This button selects a linear display that corresponds to the linear calibration on the left side of the graticule overlay.

⑦ **UNCAL**—This indicator lights to show that an uncalibrated condition exists, such as the sweep speed being too fast for the selected span and bandwidth.

⑧ **DEGAUSS**—This button removes residual magnetism in the tuning coils of the YIG oscillator and YIG preselector which causes a slight frequency shift. Using it enhances the frequency and amplitude accuracy of the display.

This frequency shift affects center frequency and amplitude accuracies. Therefore, it should be pushed after a change in center frequency to ensure optimum accuracy.

NOTE

Do not push DEGAUSS button when phase locked (fine tune indicator lighted).

⑨ **PEAKING**—In the coaxial input bands (1.5—18.0 GHz) this control varies the tracking of the input preselector so it aligns with the input signal frequency. For the waveguide bands (18—60 GHz), the control varies the external mixer bias. It is adjusted for optimum signal amplitude. All amplitude characteristics (i.e. flatness, sensitivity, etc.) are dependent with this adjustment.

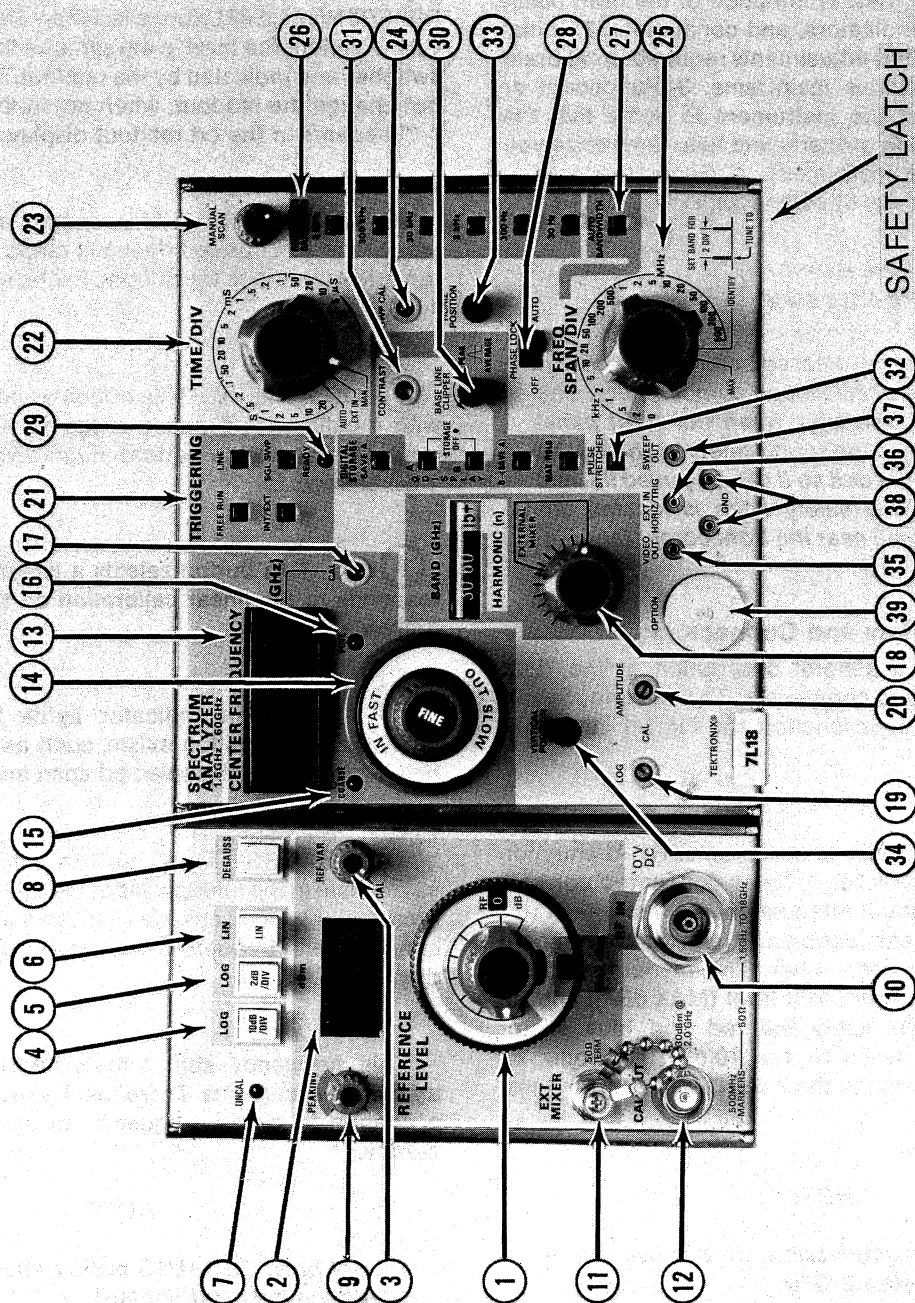


Fig. 3-1. 7L18 Front panel controls, indicators, and connectors.

10 RF IN—This connector is used for input of direct signals on the lower five bands (1.5 to 18 GHz).



Any dc applied to this connector can damage the input circuits.

11 EXT MIXER—When external waveguide mixers are used, this connector serves both as a local oscillator output to the mixer, and as an IF input from the mixer to the spectrum analyzer.

When external mixers are not being used, this connector must be terminated in 50 Ω .



Bias polarity is negative-going. This is the correct polarity for TEKTRONIX Waveguide Mixers. Some commercial mixers require positive bias. Check bias requirements of non-Tektronix mixers before connecting them to the 7L18.

12 CAL OUT (calibrator output)—This connector provides comb-type frequency markers with 500 MHz spacing. The level of the 2000 MHz marker is -30 dBm ± 0.5 dB. (Early instruments used 1.5 GHz as the calibrated -30 dBm signal.)

13 CENTER FREQUENCY—This LED display shows the center frequency to the nearest 1 MHz for bands 1 through 5, (1.5–18.0 GHz) or the nearest 10 MHz for bands 6 through 11 (12.5–60.5 GHz). When the BAND switch is in the OPTIONS position, the display shows the first local oscillator frequency.

14 **15** **16** TUNING, COARSE, FINE—The TUNING controls tune the center frequency. Whether the Coarse or FINE TUNING control is to be used depends upon the settings of the BAND, FREQ SPAN/DIV, and PHASE LOCK controls.

The Coarse TUNING control has a two-speed knob. Pushed in, it drives the tuning potentiometer directly; pulled out, it drives the potentiometer through a 40:1 vernier. The FINE TUNING is a single-speed control concentric with the Coarse TUNING.

The COARSE and FINE indicators show which control should be used. Both indicators will light if the next finer position of the FREQ SPAN/DIV control will change the TUNING from Coarse to Fine. Before moving the FREQ SPAN/DIV selector to a narrower position, carefully center the display with the Coarse control, and make sure that the FINE control is near the center of its range.

17 CAL—This control permits adjustment of the CENTER FREQUENCY readout to agree with a known frequency, which is tuned to the center of the display.

18 BAND (GHz) and HARMONIC—This switch selects the band to be used, by setting up the preselector range and the CENTER FREQUENCY range. The HARMONIC (n) window shows the local oscillator harmonic in use. A + (plus) sign indicates that the incoming signal is above the local oscillator harmonic selected; a – (minus) sign indicates that the incoming signal is below the local oscillator incoming selection. Note that with waveguide mixers the preselector is not used, and the correct switch setting must be determined by means of the IDENTIFY position of the FREQ SPAN/DIV control (see 25).

The OPTIONS position is intended for future applications.

19 **20** LOG and AMPLITUDE CAL—The LOG CAL adjustment calibrates the display for dB/DIV; the AMPLITUDE CAL adjustment sets an input signal of the correct amplitude to the reference level (top graticule line) see Adjustment procedure page 3-6.

21 TRIGGERING—Trigger operation is controlled by four pushbuttons and one indicator, which function as follows:

FREE RUN—When this button is illuminated (by pushing), the sweep will run without regard to triggering signals. Pushing this button will cancel any of the other modes. This mode is selected by the instrument when it is initially turned on.

LINE—When illuminated (by pushing), the trigger signal source is a sample of the ac power line voltage. Pushing this button will cancel any of the other modes.

INT/EXT (internal/external)—When this button is illuminated (by pushing), the sweep is triggered by either the oscilloscope mainframe trigger source or a signal applied to the EXT HORIZ IN/TRIG connector. If both triggers are supplied, the sweep will be triggered by the signal that arrives first. Pushing this button will cancel any of the other modes.

Operation—7L18 Operators

SGL SWP (single sweep)—Pushing this button arms (sets) the sweep trigger circuit. A trigger signal will initiate one sweep. Pushing this button does NOT cancel any of the other modes. The button lights to show when the single sweep mode is selected. Push to reset trigger circuits.

READY—When SGL SWP is selected, this indicator shows that the sweep circuit is capable of being triggered. The indicator will stay on until the end of a sweep.

(22) TIME/DIV—This switch selects sweep speeds from 20 s/DIV to 1 μ s/DIV, plus AUTO, EXT IN (external horizontal input), and MAN (manual sweep).

AUTO (automatic)—In this mode, one of the normal sweep speeds is automatically selected by internal circuitry, based upon the settings of the FREQ SPAN/DIV, RESOLUTION BANDWIDTH, and PHASE LOCK.

EXT IN (external input)—This position allows a signal applied to the EXT IN HORIZ/TRIG connector to sweep the horizontal axis (0 V to +10 V; see 36).

MAN (manual)—In this position, the horizontal axis can be swept by the MANUAL SCAN control.

(23) MANUAL SCAN—When the TIME/DIV control is in the MAN position, this control is used to scan the display manually.

(24) SWP CAL (sweep calibration)—This control adjusts the amplitude of the sweep output voltage. It compensates for slight differences in oscilloscope mainframe deflection sensitivities. (See Initial Adjustment procedure page.)

(25) FREQ SPAN/DIV—This switch selects frequency spans from 0.2 kHz/DIV (bands 1 through 3) or 0.5 kHz/DIV (bands 4 through 11) to 500 MHz/DIV. The shaded area around the 0.2 kHz position is intended to remind the user that this position is available in bands 1 through 3 only; if it is selected on other bands, the actual span (and crt readout) will remain at 0.5 kHz/DIV.

0—The zero (0) span converts the analyzer to a tuned receiver for a time domain display. This permits time analysis of signal characteristics within the RESOLUTION BANDWIDTH selection.

IDENTIFY—This position selects the correct conversion when using waveguide mixers. It provides a frequency span of 510 MHz/DIV such that, when the correct harmonic is chosen with the BAND selector and CENTER FREQ control, the "real" signal will appear two divisions to the left of the image. When this "real" signal is centered, the CENTER FREQUENCY will read the correct signal frequency.

MAX (maximum)—This position provides a span that is the full width of the band selected. Maximum frequency span depends upon the band in use (refer to Table 3-1). Sweep beyond the band limits is clamped to the baseline. When in the MAX position, without digital storage, the center frequency tuning position is indicated by an intensity marker on the display.

(26) RESOLUTION BANDWIDTH—These buttons select resolution bandwidths of 3 MHz, 300 kHz, 30 kHz, 300 Hz, or 30 Hz. The buttons light to show which bandwidth is selected.

(27) AUTO BANDWIDTH—In this position, the resolution bandwidth is a function of the FREQ SPAN/DIV and TIME/DIV settings. When the TIME/DIV is AUTO, the AUTO BANDWIDTH resolution is a function of the FREQ SPAN/DIV setting only.

(28) PHASE LOCK—This switch selects either 1st LO phase lock operation (AUTO) or no phase lock. In the AUTO position, phase lock occurs when the frequency span becomes narrow enough to notice display instability due to oscillator drift and incidental FM. The transition to phase lock mode occurs at different FREQ SPAN/DIV settings depending on the frequency band in use. When the 1st LO is locked, only the FINE tuning control affects tuning. In the OFF position, phase noise is eliminated and close-in signals that may be obscured by phase noise may be observed.

(29) DIGITAL STORAGE

SAVE A—When activated, this button illuminates and inhibits A memory from further updating. SAVE A is switched off by again pushing the button.

DISPLAY A, DISPLAY B—When either or both of these modes are selected, the pushbutton is illuminated and the contents of memory A and/or memory B are displayed. With the SAVE A control off, all memory locations are displayed and updated continuously (this is the instrument turn-on mode).

B— (SAVE A)—When activated, this button illuminates and displays the contents of memory B minus the contents saved in memory A. This permits a comparison between two displays. The SAVE A button is also illuminated and its function is in effect.

MAX HOLD—When activated, this button illuminates and the digital storage memory retains the maximum signal amplitude at each memory location. This permits visual monitoring of signal frequency and amplitude at each memory location over an indefinite time period.

30 BASE LINE CLIPPER-PEAK/AVERAGE—This is a dual-function control. When the digital storage is off, it operates as a baseline clipper (i.e., as the control is rotated counterclockwise, more of the vertical display is progressively clipped, or blanked). When the digital storage is on, the control sets the level at which the vertical display is either peak detected or averaged. Video signals above the level set by the control (shown by the horizontal cursor) are peak-detected and stored; video signals below the cursor are averaged and stored. See Peak/Average Control under Digital Storage (page 3-18).

31 CONTRAST—When the digital storage is off, this control adjusts the brightness ratio between the blanked and unblanked portion of the display. Overall display intensity is set by the oscilloscope INTENSITY control.

32 PULSE STRETCHER—This button enhances the visibility of pulsed RF signals within wide resolution bandwidths, by lengthening the fall time of the vertical signal. The pushbutton lights to show when it is enabled.

33 HORIZ POSITION—This control positions the display horizontally. (See limited Operation for adjustment procedure.)

34 VERTICAL POSITION—This control positions the display vertically (see Initial Operation for adjustment procedure).

35 VIDEO OUT—This connector provides a buffered video output to drive an external device such as a chart recorder. Output level is about 500 mV per displayed division. The source impedance is about 5 k Ω .

36 EXT IN HORIZ/TRIG—The function of the dual-purpose input depends on the setting of the TIME/DIV control. When the TIME/DIV control is set to any sweep position (or AUTO), a positive applied signal will initiate the sweep. When the TIME/DIV control is set to EXT IN, an applied voltage will position the beam horizontally. To

sweep the full span, a voltage of 0 V to +10 V \pm 1 V is required (sensitivity is about 1 V/div). 0 V corresponds to the left edge of the graticule; +10 V corresponds to the right edge.

37 SWEEP OUTPUT—This connector supplies a positive-going ramp of about -5 V to $+5$ V and a source impedance of about 1 k Ω .

38 GND—These two pin connectors are connected to signal ground in the instrument. DO NOT use these pins for safety earth connections.

39 OPTION—Access for a connector which may be installed in future or custom instruments.

INITIAL OPERATION

Control Settings

a. Install the 7L18 in an oscilloscope mainframe, turn on the power, and adjust the oscilloscope controls to display the proper channel(s) and brightness. If a storage mainframe is used, switch the storage feature off.

b. Set the 7L18 controls as follows:

REFERENCE LEVEL	Switch the RF Attenuator to 0 dB and the IF Gain selector (inner control) for a REFERENCE LEVEL readout of -30 dBm.
LOG 10 dB/DIV	Pushed in
REF VAR	Fully counterclockwise (CAL position)
BAND (GHz)	1.5-3.5 (band 1—)
TUNING	Adjust CENTER FREQUENCY to about 2.0 GHz.
TRIGGERING	FREE RUN
TIME/DIV	AUTO
RESOLUTION BANDWIDTH	AUTO BANDWIDTH
PHASE LOCK	AUTO
FREQ SPAN/DIV	10 MHz
DIGITAL STORAGE	Off (all lights extinguished)
PULSE STRETCHER	Off
BASELINE CLIPPER	Fully cw.

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c. Connect the CAL OUT to the RF IN, using the coaxial cable and adapter supplied with the instrument. This should produce a display similar to Fig. 3-2; it may be necessary to adjust the TUNING slightly to center the display on screen (the display is the calibrator signal at 2.0 GHz).

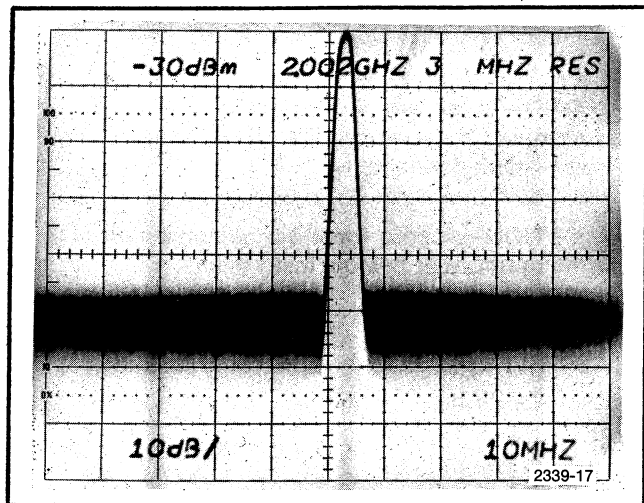


Fig. 3-2. Initial display of calibrator signal.

d. Adjust PEAKING control to maximize the calibrator signal amplitude.

e. For maximum accuracy, allow the system to warm up for at least 30 minutes before making the following adjustments.

Horizontal Position and Center Frequency Calibration

a. Push the DEGAUSS button then adjust the CENTER FREQUENCY TUNING for minimum calibrator signal shift as the FREQ SPAN/DIV is switched between 10 MHz and 100 kHz positions.

b. Return the SPAN/DIV to 10 MHz then position the signal to center screen with the HORIZ POSITION control.

c. Adjust the CENTER FREQUENCY CAL for a center frequency readout of 2.0 GHz.

SWP CAL Adjustment

a. Set FREQ SPAN/DIV to 100 MHz and tune the CENTER FREQUENCY to center a 2.0 GHz marker signal.

b. Adjust the SWP CAL for three frequency markers in ten divisions (marker centered on the left edge, center, and right edge of the display).

Log Display Calibration (AMPLITUDE and LOG CAL Adjustment)

NOTE

1.500 GHz was the -30 dBm Calibrator signal on early 7L18. This was changed to 2.0 GHz.

a. Set the FREQ SPAN/DIV to 1 MHz and tune the CENTER FREQUENCY to 2.000 GHz. Select 2 dB/DIV display mode.

b. Set the display baseline at the bottom graticule line with the VERTICAL POSITION control. Adjust PEAKING for maximum signal amplitude. It may be necessary to adjust LOG CAL for an on screen signal.

c. Adjust AMPLITUDE CAL while alternately switching between 2 dB/Div and 10 dB/DIV so the signal amplitude is the same for both modes. Now adjust LOG CAL, in the 10 dB/DIV mode, for a full screen signal (top graticule line).

d. Re-check the display level for both Log modes and adjust AMPLITUDE CAL if necessary.

e. Select 2 dB/DIV display mode and switch the RF Attenuator to 10 dB.

f. Check—display level should decrease 10 dB or 5 divisions.

NOTE

Changing the VERTICAL POSITION will uncalibrate the dynamic display range.

Contrast Adjustment

When operating without digital storage, contrast between the clipped and unclipped portion of the display is set by the CONTRAST adjustment.

a. With digital storage off (Display A/ Display B push buttons not lighted), turn the BASELINE CLIPPER fully clockwise and set the oscilloscope Intensity and Focus for the desired display brightness.

b. Turn the BASELINE CLIPPER about midrange and adjust the CONTRAST for the desired contrast between the clipped and unclipped portions of the display. Contrast is usually set so the baseline is just visible.

FUNCTIONAL OR OPERATIONAL CHECK

The following procedure should meet most incoming and receiving inspection requirements and help familiarize the user with instrument operation. This procedure requires minimal test fixtures and no external test equipment. A detailed performance check procedure is part of the service instruction manual. We recommend using this Functional Check as part of the user routine maintenance program and as a preliminary step before the Performance and Calibration portion of the service instruction.

The 7L18 Calibrator is an accurate signal source and the RF Attenuator an accurate step attenuator, they are therefore used as the reference for this check.

NOTE

The Calibrator reference frequency on earlier instruments was 1.5 GHz. This is shown in parenthesis in this procedure.

Equipment Required

The following fixtures and equipment are required. These are available through your local Tektronix Field Office or representative.

1. "20 dB" or equivalent attenuator: Tektronix Part No. 011-0086-00.
2. Adapter: N male to BNC female (part of accessories).
3. 50 ohm coaxial cable: 18 inch, BNC to BNC connectors (part of accessories).

1. Preliminary Preparation

a. Perform the initial front panel setup procedure described under Initial Operation.

b. Set the front panel controls as follows:

RF Attenuator	0 dB
REFERENCE LEVEL	−30 dBm
Display Mode	10 dB/DIV
REF VAR	CAL detent
BAND (GHz)	1— (1.5—3.5 GHz)

CENTER FREQUENCY	2.0 (1.5) GHz
TRIGGERING	FREE RUN
TIME/DIV	AUTO
RESOLUTION	
BANDWIDTH	AUTO
PHASE LOCK	AUTO
FREQ SPAN/DIV	1 MHz
Digital Storage	Display A/ Display B
PEAK/AVERAGE	Fully clockwise (cursor top of screen)

c. Allow the instrument to warmup at least 30 minutes before proceeding with this check.

2. Check Frequency Readout Accuracy: $\pm(5 \text{ MHz} + 20\% \text{ of Span/Div}) \times n$

NOTE

Due to hysteresis in the tuning system and residual magnetism buildup in the 1st (YIG) oscillator tuning coils, accuracy of the frequency readout should be checked by approaching each check point from the same direction (low to high). Degauss the tuning coil by pressing the DEGAUSS button within a few megahertz of the check point.

a. With the Center Frequency readout calibrated at 2.000 GHz as described under Initial Operation and the SPAN/DIV at 1 MHz, tune the CENTER FREQUENCY to center the 2 GHz calibrator marker on screen. Press the DEGAUSS button and adjust PEAKING as the signal is tuned to center screen.

b. Check—the indicated frequency readout. Readout should be within 1.995 and 2.005 GHz or within $\pm 5.2 \text{ MHz}$ of 2.000 GHz.

c. Repeat this procedure to check accuracy of the readout at the 3.0 GHz and 3.5 GHz markers. Accuracy must be within $\pm(5 \text{ MHz} + 20\% \text{ of } 1 \text{ MHz}) \times n$.

d. Switch to Band 2 (2.5—4.5 GHz) and repeat the procedure to check readout accuracy at 3.0 GHz, 3.5 GHz, and 4.0 GHz.

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e. 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 1 & 2) multiplied by the harmonic number (n) of the band.

NOTE

In some cases the calibrator harmonic may be very small or missing. Either ignore the check point or try reducing the resolution bandwidth (e.g. 30 kHz) to increase the signal to noise ratio or sensitivity. Adjust PEAKING at each check point.

3. Check Resolution Bandwidth and Shape Factor: (Bandwidth 3 MHz to 30 Hz $\pm 20\%$. Shape factor 12:1 or less for 30 Hz resolution and 4:1 or less for the other bandwidths)

a. With the 7L18 tuned to the 2.000 GHz Calibrator signal and the Reference Level at -30 dBm, set the FREQ SPAN/DIV at 1 MHz and push the 3 MHz RESOLUTION BANDWIDTH button.

b. Switch the display mode to 2 dB/Div and adjust the REF VAR control so the signal amplitude level is full screen.

c. Measure the 6 dB bandwidth (see Fig. 3-3). Bandwidth must equal 3 MHz ± 600 kHz.

d. Switch the display mode to 10 dB/DIV, FREQ SPAN/DIV to 2 MHz and the TIME/DIV to 0.5 s.

e. Estimate the -60 dB bandwidth by extending the slope of the response down through the noise level to the -60 dB graticule line. Calculate the shape factor (see Fig. 3-4). Shape factor must equal 4:1 or less.

f. Switch to 300 kHz RESOLUTION BANDWIDTH and 200 kHz Span/Div, then check the bandwidth and shape factor of the 300 kHz filter by repeating the foregoing procedure.

g. Switch to each remaining RESOLUTION BANDWIDTH selections, decrease the FREQ SPAN/DIV selection as necessary to check the bandwidth and shape factor of each selection. Bandwidth must be within 20% of that selected, shape factor is 4:1 or less except the 30 Hz filter which is 12:1 or less.

4. Check RF Attenuator and 10 dB/Div Display Accuracy: (RF Attenuator, ± 0.3 dB; display, 10 dB/Div ± 1 dB to a maximum of 2 dB overall)

NOTE

The accuracy of the 2 dB/Div and LIN display modes are not checked using the calibrator signal. The check procedure for these two display modes will be part of the service instructions. The RF Attenuator check is a confidence check to assure that it is functioning properly. Accuracy can be checked by using a very accurate external 10 dB step attenuator and high quality coaxial cables.

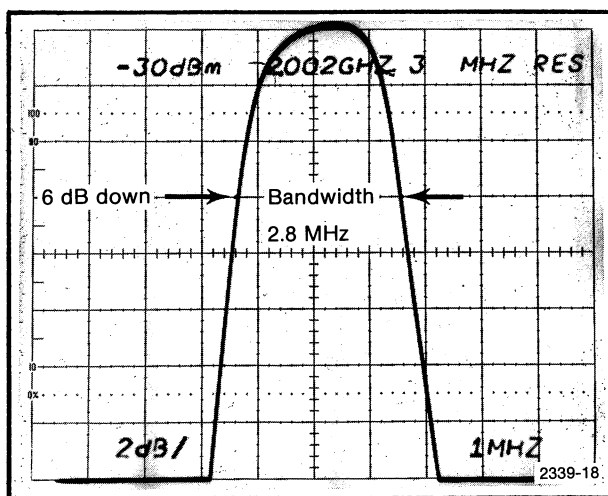


Fig. 3-3. Display mode Log. Bandwidth measured 6 dB down.

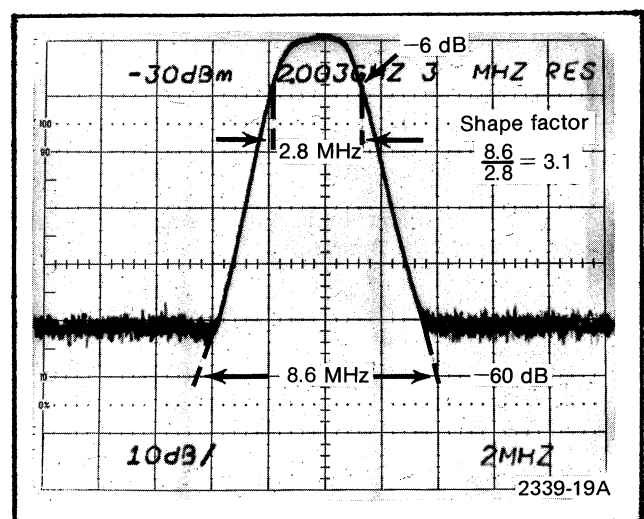


Fig. 3-4. Display mode 10 dB/DIV. Shape factor is ratio of 60:6 dB levels.

- a. Set the 7L18 controls as follows:

Display Mode	10 dB/DIV
RF Attenuator	0 dB
REFERENCE LEVEL	−30 dBm
FREQ SPAN/DIV	1 MHz
RESOLUTION BANDWIDTH	AUTO
TIME/DIV	AUTO
PHASE LOCK	AUTO
Digital Storage	Display A/ Display B
CENTER FREQUENCY	2.000 (1.500) GHz

b. Apply the Calibrator signal through a coaxial cable to the RF Input and tune the signal to center screen. Reduce the FREQ SPAN/DIV to 2 kHz keeping the signal centered with the tuning controls and activate 3 kHz RESOLUTION BANDWIDTH.

c. Maximize the signal amplitude with the PEAKING control. If the signal is not full screen perform the Amplitude and Log Cal adjustment procedure described under Initial Operation.

d. Increase the RF Attenuator setting to 20 dB. Note the signal reference level.

e. Return the RF Attenuator to 0 dB then insert or add an accurate 20 dB attenuator between the RF Input and the CAL OUT connector.

f. Check—Signal amplitude should be within 0.3 dB of the amplitude noted in step d.

g. Remove the external attenuator and set the RF Attenuator at 30 dB. Establish a reference level.

h. Return the RF Attenuator to 10 dB and again insert the external 20 dB attenuator to verify the next 20 dB step of the RF attenuator.

i. Repeat this procedure to check the remaining steps of the RF Attenuator.

j. Return the RF Attenuator to 0 dB and remove the external attenuator.

k. With the signal at the −30 dBm reference level, increase the RF Attenuator in 10 dB steps to 60 dB.

l. Check—The signal amplitude should decrease 1 ± 0.1 division for each 10 dB step and the overall error should not exceed 0.2 division or 2 dB for the 60 dB range.

m. Return the RF Attenuator to 40 dB.

5. Check the REF VARIABLE and Gain Selector Range: (Variable range is at least 10 dB, IF Gain selector range is 90 dB in 10 dB steps)

a. With the controls set as described in step 4 and the SPAN/DIV at 2 kHz, increase the RF Attenuator setting to 50 dB (Reference Level of +20 dBm).

b. Rotate the REF VAR control through its range and note signal amplitude change.

c. Check—REF VAR control range should increase the signal level 10 dB or more. Return the control to its CAL detent.

d. Check—that the IF Gain selector increases the signal amplitude 10 dB ± 1 dB for each increment in the blue (10 dB/Div) sector and decreases the gain 10 dB ± 1 dB in the amber (gain reduction) sector. Overall deviation should not exceed 2 dB.

e. Change the display mode to 2 dB/DIV. Insert or add a 20 dB attenuator between the CAL OUT and RF Input connector. Set the RF Attenuator at 20 dB and the Gain selector for −50 dBm reference level readout (last position in the blue sector). Adjust the signal level to a graticule reference line (one or two division below center screen) with the REF VAR control.

f. Increase the RF Attenuator and IF Gain selector in 10 dB steps and check that each step of the IF Gain selector, in the 2 dB/Div portion (white sector), increases the calibrator signal amplitude 10 dB ± 1 dB.

NOTE

Resolution bandwidth and frequency span must be reduced to check the last two Gain selector steps.

g. Return the RF Attenuator to 20 dB, the IF Gain selector for a Reference Level readout of −50 dBm, SPAN/DIV to 2 kHz, and RESOLUTION BANDWIDTH to 3 kHz. Adjust the Calibrator signal amplitude to a graticule reference line with the REF VAR control.

Operation—7L18 Operators

h. Check—gain variation as different resolution bandwidths are selected. Variation must not exceed 0.5 dB (1/4 div.).

NOTE

When checking the 30 Hz resolution bandwidth, reduce the SPAN/DIV to 0.2 kHz.

i. Return the RF Attenuator to 0 dB, IF Gain selector for a Reference Level readout of -30 dBm, SPAN/DIV to 2 kHz, RESOLUTION BANDWIDTH to 3 kHz and REF VAR control to CAL detent.

6. Check Sensitivity: (-127 to -52 dBm, depending on resolution bandwidth and frequency band)

NOTE

Sensitivity for the 7L18 is specified according to the input or average noise level. The 7L18 calibrator is the reference used to calibrate the display. Accuracy of this reference can be verified using a 2.0 GHz bandpass filter with known loss and an accurate power meter.

a. Set the front panel controls as follows:

CENTER FREQUENCY	Within Band 1 (1.5 to 3.5 GHz)
Display Mode	10 dB/DIV
RF Attenuator	0 dB
REFERENCE LEVEL	-30 dBm
FREQ SPAN/DIV	2 kHz
RESOLUTION BANDWIDTH	3 MHz
TIME/DIV	0.5 s
PEAK/AVERAGE	
Cursor	Top of screen
Digital Storage	Display A/ Display B

b. Disconnect the calibrator signal from the RF INPUT.

c. Check—noise level below the -30 dBm reference level (see Fig. 3-5). Must not exceed -79 dBm (see Table 3-1).

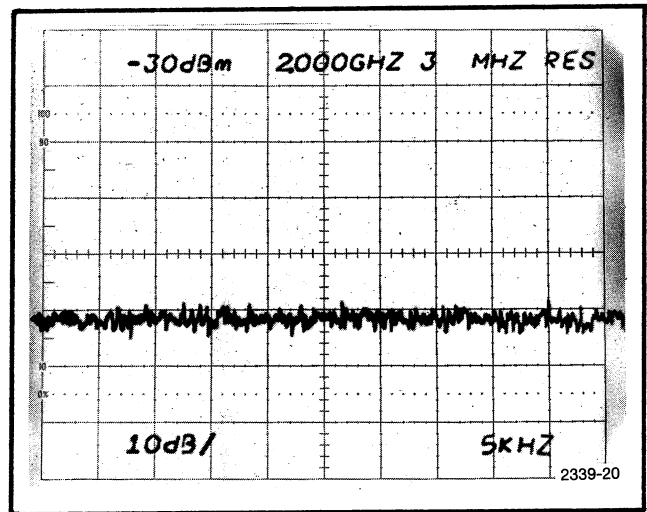


Fig. 3-5. Measuring average noise level as an indication of sensitivity.

d. Check—noise level for 300 kHz and 30 kHz resolution bandwidths. Compare this level with characteristics listed in Table 3-1.

e. Increase the IF Gain for a REFERENCE LEVEL of -60 dBm and reduce TIME/DIV to 10 s.

f. Check—average noise level for 3 kHz, 300 Hz, and 30 Hz resolution bandwidths. Compare these levels with characteristics listed in Table 3-1.

g. Repeat this procedure for each coaxial (internal) mixer band (1-5).

NOTE

This procedure may be used to check sensitivity characteristics for optional external waveguide mixers when an accurate signal source is used to establish a reference.

Table 3-1
7L18 SENSITIVITY

Frequency Range (GHz)	Average Noise Level dBm (max) Resolution Bandwidth					
	3 MHz	0.3 MHz	30 kHz	3 kHz	300 Hz	30 Hz
1.5 to 3.5	-79	-89	-99	-109	-119	-127
2.5 to 4.5	-79	-89	-99	-109	-119	-127
3.5 to 7.5	-69	-79	-89	-99	-109	-117
6.5 to 12.5	-67	-77	-87	-97	-107	-115
9.5 to 18.0	-52	-62	-72	-82	-92	
12.5 to 18.0	-50	-60	-70	-80	-90	
18.0 to 26.5 ^a	-60	-70	-80	-90	-100	
26.5 to 40 ^a	-55	-65	-75	-85	-95	
40 to 60.5 ^a	-45	-55	-65	-75	-85	

^aHigh performance type mixers.

7. Check Stability: (Within 2 kHz/hr x n, when phase locked; and within 50 kHz/10 min x n when phase lock is inoperative)

NOTE

Stability is checked only after a 2 hour warmup period at a fixed frequency.

a. Set the Display Mode to 10 dB/DIV, SPAN/DIV to 1 MHz, RESOLUTION BANDWIDTH and TIME/DIV at AUTO. Tune the Calibrator signal to center screen, and push DEGAUSS button.

b. Switch PHASE LOCK to AUTO then decrease the SPAN/DIV to 500 Hz keeping the signal centered on screen with the tuning controls.

c. Activate MAX HOLD. Do NOT disturb the instrument for one hour.

d. CHECK—stability or drift as the width of the response (see Fig. 3-6) over the specified time period. Drift must not exceed 2 kHz.

e. Deactivate MAX HOLD, switch PHASE LOCK to OFF, SPAN/DIV to 20 kHz, re-center the calibrator signal then reactivate MAX HOLD.

f. Check—stability over 10 min period with phase lock inoperative. Drift must not exceed 50 kHz.

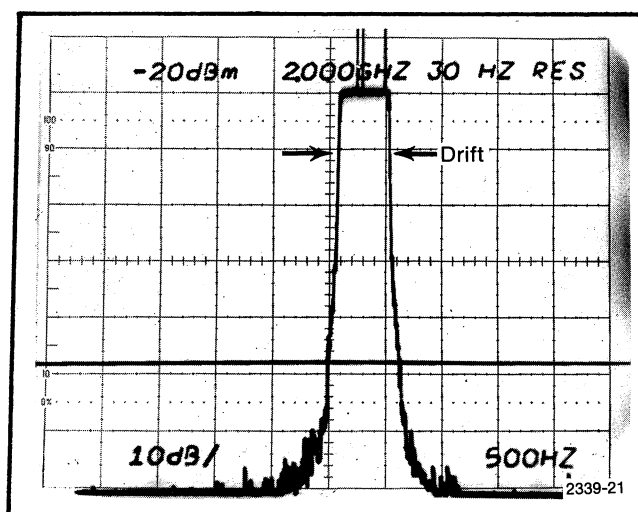


Fig. 3-6. Measuring stability using MAX HOLD feature of 7L18.

8. Check Incidental FM: (≤ 10 Hz x n when phase locked; ≤ 10 kHz x n when not phased locked)

NOTE

This measurement is dependent on oscillator stability, therefore, the instrument must have at least a 2 hour warmup period. Recommend performing this check after stability has been checked.

Operation—7L18 Operators

- a. Set the 7L18 controls as follows:

CENTER FREQUENCY 1.00
 FREQ SPAN/DIV 100 kHz
 RESOLUTION
 BANDWIDTH 30 kHz
 TIME/DIV AUTO
 Display Mode LIN
 REFERENCE LEVEL -30 dBm
 Digital Storage ON
 PHASE LOCK AUTO

- b. With the calibrator signal tuned to center screen, decrease SPAN/DIV to 10 kHz then position the signal with the FINE tune control, so the slope (horizontal span versus vertical excursion) or the filter response can be measured over four divisions of amplitude (see Fig. 3-7a).

- c. Calculate the frequency excursion per division of amplitude. (e.g. If the horizontal excursion is 5 kHz over the four divisions the slope equals 1.25 kHz/Div).

- d. Switch PHASE LOCK to "OFF", decrease SPAN/DIV to 0 Hz, in steps, keeping the signal centered with the tuning control. At 0 Hz span carefully tune so the display is near mid screen (see Fig. 3-7b). Set TIME/DIV to 0.5 s.

- e. CHECK—the peak-to-peak amplitude deviation over a 3 second (6 division) span. Deviation must not exceed 10 kHz (8 division at 1.25 kHz/div).

NOTE

Disregard radical excursions caused by frequency drift of the oscillator. Since FM is a multiple of "n" or the oscillator harmonic, there is not need to check bands above 4.5 GHz.

- f. Switch PHASE LOCK to AUTO, SPAN/DIV to 10 kHz, TIME/DIV to AUTO, and RESOLUTION BANDWIDTH to 3 kHz.

- g. Keep the calibrator signal centered with the FINE tuning control as the SPAN/DIV is reduced to 0.2 kHz and the RESOLUTION BANDWIDTH to 300 Hz.

- h. Again calculate the frequency excursion per division of display (e.g. $60 \text{ Hz} \div 4 = 15 \text{ Hz/div}$).

- i. Decrease the FREQ SPAN/DIV to 0 Hz and carefully adjust the FINE tuning to center the response. Set TIME/DIV to 0.5 s.

- j. CHECK—the peak-to-peak deviation over six divisions (3 seconds) of span. Must not exceed 10 Hz (3/4 of a division as per the example in step h.)

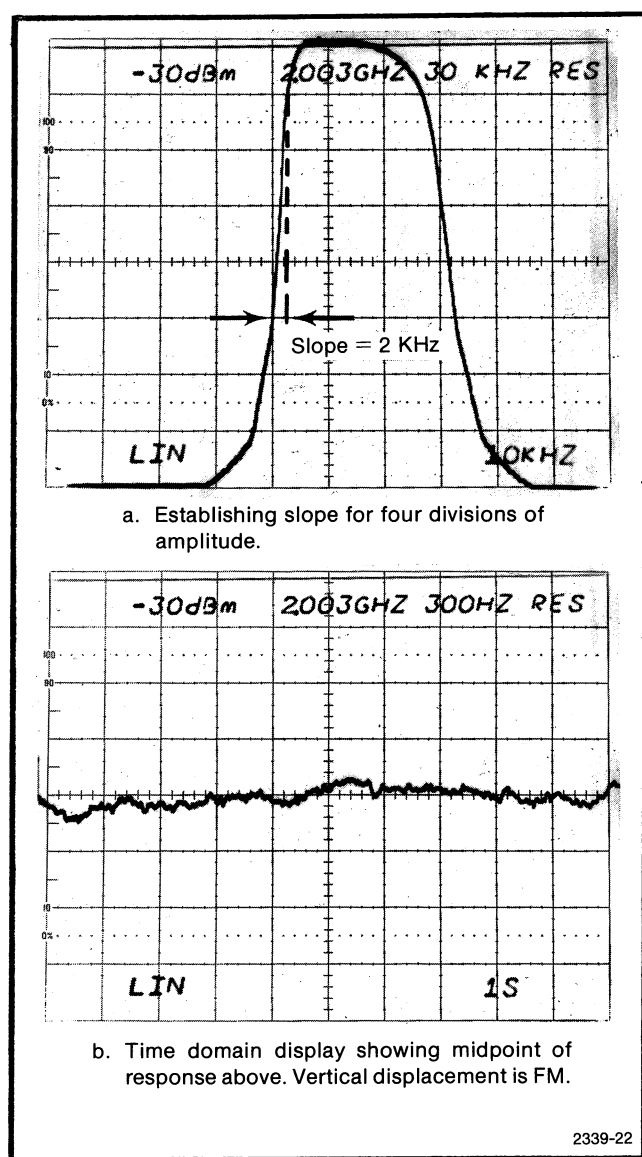


Fig. 3-7. Measuring incidental FM.

9. Digital Storage

- a. Set the 7L18 controls as follows:

CENTER FREQUENCY 2.000 (1.500) GHz

Display Mode 10 dB/DIV

RF Attenuator 30 dB

REFERENCE LEVEL +0 dBm

TIME/DIV 0.2 s

FREQ SPAN/DIV 1 MHz

RESOLUTION

BANDWIDTH 3 MHz

Digital Storage Display A

- b. With the calibrator signal applied to the RF Input tune the signal to center screen and activate SAVE A.

- c. Change the RF Attenuator to 40 dB and activate DISPLAY B digital storage. Display B of the Calibrator signal should be 10 dB less than display A.

- d. Activate B—(SAVE A).

- e. Check-B—(SAVE A) display should be the difference between display B and display A (approximately 10 dB), see Fig. 3-8.

- f. Deactivate SAVE A and B—(SAVE A) functions and activate MAX HOLD.

- g. Change the RF attenuator and CENTER FREQUENCY settings then note that the MAX HOLD function retains and holds the maximum signal amplitude and frequency excursion.

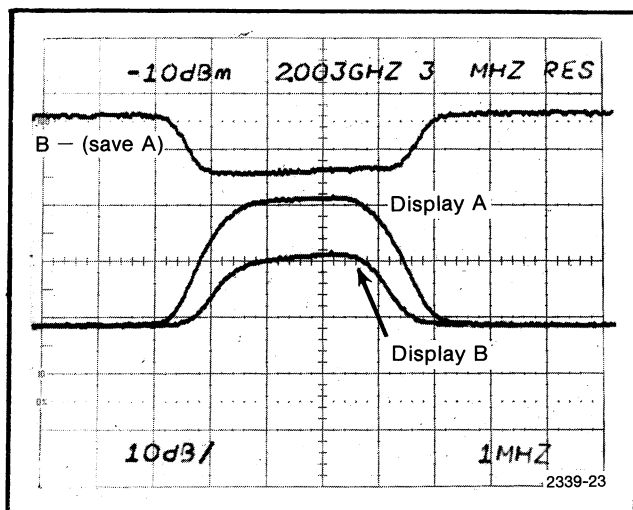


Fig. 3-8. Using digital storage feature to measure differential between two displays.

- h. Deactivate MAX HOLD and select DISPLAY A. Select AUTO BANDWIDTH resolution and reduce the SPAN/DIV to 100 kHz keeping the signal centered on screen with the tuning controls.

- i. Vary the PEAK/AVERAGE control to shift the cursor over the screen and note that signal and noise are averaged below the cursor.

This completes the operational check of the 7L18.

GENERAL OPERATING INFORMATION

Signal Application

The nominal RF input impedance to the 7L18 is 50 Ω . At microwave frequencies, cable losses can become significant. Impedance mismatches between RF input and the signal source cause reflections, degrading measurement of flatness, sensitivity, etc. To reduce mismatch and minimize cable losses, use quality 50 Ω coaxial cable to connect the signal source to the RF IN connector. Keep the cable as short as possible.

CAUTION

The maximum input power level to the RF Attenuator is 1 watt average and 200 watts peak. Burnout occurs above 1 watt.

Avoid applying signals above -30 dBm (except as described below) to the first mixer of the 7L18 (input signal level minus RF Attenuator setting). Such signals can overload the mixer and produce spurious signals. A conversion chart shown in Fig. 3-9 will aid in determining input signal level from a voltage or power source. For some applications you may wish to know the relationship between dBm and dB μ V. For 50 Ω systems, dB μ V = dBm + 107 dB.

As indicated on the chart, operation from -30 dBm to -20 dBm (red sector of IF Gain switch) is permissible only if the signals are widely separated (at least 30 to 50 MHz) and the input frequency is above 2 GHz.

Spurious response, caused by signal overload into the 1st mixer, can be minimized if the signal amplitude is kept within the graticule limits. A recommended procedure is to adjust the Gain selector for some baseline noise on the display, then increase the RF Attenuator setting until the strongest signals are within the graticule limits. If this does not bring these signals within limits, add external attenuators.

CAUTION

It is possible to exceed the power input specifications of the input attenuator if the IF Gain is reduced and the signal is brought to full screen with maximum attenuation.

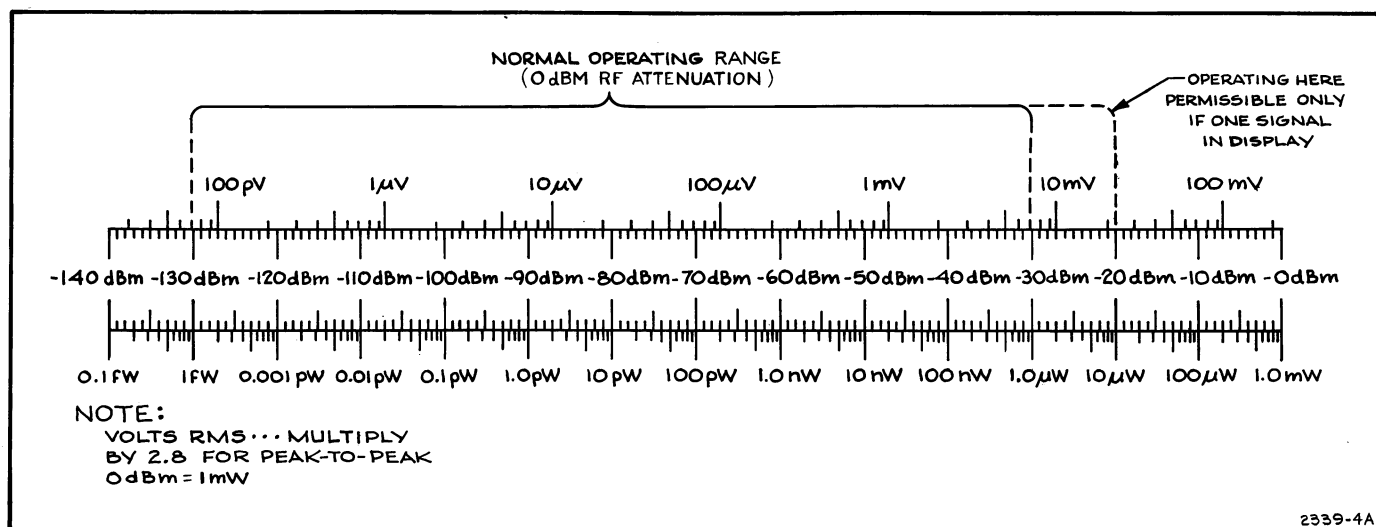


Fig. 3-9. Volts-dBm-watts conversion chart for 50 Ω impedance.

Frequency Span, Resolution Bandwidth, and Sweep Time.

Frequency span, resolution, and sweep rate must correlate to maintain a calibrated and meaningful display. The 7L18 features microprocessor circuitry that selects sweep rate and resolution bandwidth. When both the TIME/DIV and RESOLUTION are in AUTO mode, the display is calibrated for each FREQ SPAN/DIV SELECTION: Fig. 3-10 shows the sweep rate and resolution bandwidth that is automatically selected as a function of the FREQ SPAN/DIV selections. For example; when FREQ SPAN/DIV is 500 kHz, the sweep rate and resolution bandwidths that are automatically selected are 0.1 s/div and 30 kHz.

The AUTO position of the TIME/DIV selector ties the sweep speed to the analyzer frequency span and resolution bandwidth. Fig. 3-10 also shows the sweep rate for each manually selected RESOLUTION BANDWIDTH as a function of the SPAN/DIV setting. For example; 30 kHz RESOLUTION with a SPAN/DIV of 20 MHz, sets the sweep rate to 5 s. If the RESOLUTION BANDWIDTH is changed to 300 kHz the sweep rate changes to 20 ms, etc.

MAX SPAN FOR BAND	FREQUENCY SPAN/DIV	RESOLUTION BANDWIDTH									
		3 MHz	300 KHz	30 KHz	3 KHz	300 Hz	30 Hz				
11	5 GHz	0.5 s	5 s	">" DISPLAYED TO INDICATE UNCALIBRATED CONDITION. SWEEP LIMITED TO 20 s/DIV.							
6-10	2 GHz	0.2 s	2 s								
4-5	1 GHz	0.1 s	1 s								
3	IDENT, 500 MHz	50 ms	0.5 s								
1-2	200 MHz	20 ms	0.2 s								
	100 MHz	10 ms	0.1 s	20 s	SWEEP RATE FOR CALIBRATED DISPLAY LIMITED TO 2 ms/DIV WHEN PHASE LOCK INOPERATIVE OR 5 ms/DIV WHEN PHASE LOCK IS OPERATIVE						
	50 MHz	5 ms	50 ms	10 s							
	20 MHz		20 ms	5 s							
	10 MHz		10 ms	2 s							
	5 MHz		5 ms	1 s							
	2 MHz			0.5 s	20 s						
	1 MHz			0.2 s	10 s						
	500 KHz			0.1 s	5 s						
	200 KHz			50 ms	2 s						
	100 KHz			20 ms	1 s				20 s		
	50 KHz			10 ms	0.5 s	10 s					
	20 KHz			5 ms	0.2 s	5 s					
	10 KHz				0.1 s	2 s					
	5 KHz				50 ms	1 s				20 s	
	2 KHz				20 ms	0.5 s				10 s	
	1 KHz				10 ms	0.2 s	5 s				
	500 Hz				5 ms	0.1 s	2 s				
	200 Hz					50 ms	1 s				
	0		2 ms; 5 ms IF DIGITAL STORAGE IS ON								
			2339-14A								

Fig. 3-10. Sweep rate (Time/Div) as a function of FREQ SPAN/DIV and RESOLUTION BANDWIDTH for a calibrated display. Shaded area denotes the AUTO mode for sweep rate and resolution bandwidth as a function of FREQ SPAN/DIV selections.

Fig. 3-11 shows the AUTO RESOLUTION bandwidth as a function of the FREQ SPAN/DIV and TIME/DIV selections. For example: a FREQ SPAN/DIV selection of 2 MHz provides a resolution bandwidth of 300 kHz for the TIME/DIV range from 0.2 s to 1 ms.

Resolution bandwidth is one determinate of an analyzer's ability to discretely display adjacent signals. This ability is also a function of the analyzer's sweep rate, frequency span, and incidental FM. The AUTO mode of the RESOLUTION BANDWIDTH selectors optimizes bandwidth for the selected FREQ SPAN/DIV and TIME/DIV settings unless either is outside the range of correction. When this occurs the UNCAL indicator lights and a > symbol appears on the crt display. (A < symbol prefixing the REFERENCE LEVEL reading indicates the REF VAR control is not in its CAL detent.)

When analyzing pulse signals a wider bandwidth than that provided by AUTO is usually desired. Pulsed technique is described under Typical Applications.

Frequency span is symmetrical about the center frequency. The frequency span used depends on the application. Wide frequency spans are used to monitor a frequency spectrum for spurious signals, check harmonic distortion, etc. Narrow frequency spans are used to identify particular signals and check characteristics such as

modulation, bandwidth, etc. When wide frequency spans are displayed, sweep rate is usually increased to eliminate flicker. This requires wide resolution bandwidths. When narrow frequency spans are used, high resolution capability is usually desired, so slow sweep speeds are required.

When the FREQ SPAN/DIV is reduced to 0, the analyzer functions as a tunable receiver, to display time domain characteristics within the capabilities of the resolution bandwidth selected. The TIME/DIV control can now be used to examine or analyze such characteristics as modulation pattern, pulse repetition rates, etc.

The 0.2 kHz position of the FREQ SPAN/DIV switch is shaded to remind the user that this position is valid on bands 1 through 3 (1.5—7.5 GHz) only. If this position is inadvertently selected on bands 4 through 11 (6.5—60.5 GHz), the span (and the crt readout) will remain at 0.5 kHz/div.

IF Gain

The REFERENCE LEVEL is adjusted and determined by the combination settings of the RF Attenuator switch and the IF Gain switch. The IF gain selector has three sections, which function as follows:

Red sector—reduces the IF Gain by 10 dB thereby effectively reducing the noise floor and increasing the signal-to-noise ratio for wider resolution bandwidth.

FREQUENCY SPAN/DIV	TIME/DIV																							
	s									ms									μ s					
	20	10	5	2	1	0.5	0.2	0.1		50	20	10	5	2	1	0.5	0.2	0.1	50	20	10	5	2	1
MAX (BAND 11)																								
MAX (BAND 6-10)																								
MAX (BAND 4-5)																								
MAX (BAND 3)																								
MAX (BAND 1-2)																								
IDENTIFY																								
500MHz																								
200MHz																								
100MHz																								
50MHz																								
20MHz																								
10MHz																								
5MHz																								
2MHz																								
1MHz																								
500KHz																								
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100KHz																								
50KHz																								
20KHz																								
10KHz																								
5KHz																								
2KHz																								
1KHz																								
.5KHz																								
.2KHz																								
0																								

Fig. 3-11. Resolution bandwidth for AUTO BANDWIDTH mode, as a function of FREQ SPAN/DIV and manually selected TIME/DIV settings.

When a source and its harmonics, or several sources, are separated more than 50 MHz, the preselector will prevent intermodulation in the mixer. The mixer can be overloaded up to 10 dB without causing spurious responses. The preselector will limit below 2 GHz, in the reduced IF Gain (red sector) position and cause compression of the display. Do not use the red sector position for signals below 2 GHz.

Blue sector positions—increases gain in 10-dB steps. This sector is used in all display modes.

White sector positions—increase gain in 10-dB steps only in 2 dB/DIV and LIN modes. This sector has no effect on the 10 dB/DIV display.

Phase Lock

The 1st LO can be phase locked for narrower spans. When phase locked, the oscillator stability and incidental FM specifications are greatly improved. However, phase noise sidebands, increase close-in to the signal source, and may obscure low-level sideband signals. The user can switch phase lock off to reduce this noise. This is useful down to about 3 kHz resolution bandwidth.

Normally the PHASE LOCK switch is in AUTO position. With wide frequency spans, phase lock is inoperative and the coarse (large) TUNING control tunes the CENTER FREQUENCY. As the SPAN/DIV is decreased, phase lock becomes operative at a selected FREQ SPAN/DIV that is dependent on the frequency band (Fig. 3-12). When phase locked, CENTER FREQUENCY tuning shifts to the FINE (small) TUNING control. Two indicators, COARSE and FINE, light to denote which control is operative. When both indicators are lit, phase lock will become operative at the next position down.

FREQ. SPAN/DIV	BAND			
	1-2	3-4	5-9	10-11
MAX	COARSE TUNING INDICATOR LIGHTED			
IDENTIFY				
500 MHz				
200 MHz				
100 MHz				
50 MHz				
20 MHz				
10 MHz				
5 MHz				
2 MHz				
1 MHz	FINE and COARSE ON			
500 KHz				
200 KHz	FINE TUNING INDICATOR LIGHTED			
100 KHz				
50 KHz				
20 KHz				
10 KHz				
5 KHz				
2 KHz				
1 KHz				
500 Hz				
200 Hz				
0				

Fig. 3-12. Auto phase lock operation as a function of the FREQ SPAN/DIV. Clear area denotes transition state where both the COARSE and FINE indicators are illuminated.

Before reducing the frequency span into phase lock state, center the FINE TUNING control and keep the signal of interest centered on screen. This insures that the signal will not jump off screen when phase lock becomes operative and provides ample FINE tuning range.

When phase locked, if the DEGAUSS button is pushed or the Coarse TUNING control is moved, the displayed signal may be lost. If this happens, simply increase the FREQ SPAN/DIV to a non-phase locked position, retune the signal if necessary, then reduce the span again.

DEGAUSS Button

Pushing the DEGAUSS button reduces the current through the tuning coils of the YIG preselector and oscillator to zero. This removes any residual magnetism that might contribute to a frequency shift. The button should be pushed after a significant change in center frequency to ensure the accuracy of the CENTER FREQUENCY readout.

NOTE

DO NOT push the DEGAUSS button while phase locked (FINE tuning indicator on). To do so will result in loss of phase lock and probable loss of the display. If this should occur, try rocking the Coarse tune control to regain the display. If this fails, momentarily increase the frequency span until the COARSE indicator lights, recenter the display with the TUNING control, then again reduce the frequency span.

Triggering the Display

TRIGGERING is usually switched to the FREE RUN mode for spectrum analyzer displays; however, it may be desirable or necessary to trigger the sweep when the event is time-related to some source, or when the FREQ SPAN/DIV is reduced to zero for a time-domain analysis. The sweep can be triggered from the vertical or video signal from either vertical plug-in compartment, from the power line voltage, and from an internal or external source.

In the INT/EXT triggering mode, the display is triggered when the triggering signal source is within specifications. If the triggering signal is below the requirement or is absent, the sweep recurs automatically to provide a display baseline (except in single sweep). Note that, if both an internal and external triggering signal is supplied, the sweep will be triggered by the signal that arrives first. If only external triggering is desired, set the mainframe trigger source to an input such as the center interface connector of the 7L18, that will ensure the absence of an internal signal.

NOTE

When internally triggering on pulsed spectra, it may be necessary to tune the sweep start away from a null point to trigger the display.

External triggering is used when it is necessary to synchronize the display with an external trigger source, such as a pulse generator or modulator, as when measuring the prf of a radar signal. The trigger signal is applied to the EXT IN HORIZ/TRIG jack on the front panel, and the TIME/DIV selector is set to the desired sweep rate. If time domain information is desired, set the FREQ SPAN/DIV to 0 and the RESOLUTION BANDWIDTH higher than the highest modulating frequency.

In the LINE triggering mode, the triggering signal is a sample of the power line voltage.

Single sweep operation provides one sweep each time the SGL SWP button is activated and a trigger is present. If the trigger source is FREE RUN the sweep will run once each time the SGL SWP button is pushed. When in the LINE mode, the sweep is triggered by the line voltage after the SGL SWP button is pressed. When in the INT/EXT mode, the sweep will not run when SGL SWP is pressed until the arrival of a triggering signal. The READY indicator lights to show that the trigger circuit is armed and waiting for a trigger signal, or it is sweeping it. Push to reset after each sweep.

Digital Storage

The digital storage feature allows any 7000-Series mainframe to display one to three waveforms for subsequent viewing, comparison, or photographing. Digital storage also enhances the resolution of low-amplitude signals and other fine details that might otherwise be lost.

The SAVE A button inhibits one half of the storage locations from further updating. (Note that this inhibition takes place, whether A is displayed or not.) This "captures" a waveform for comparison, for instance, with a subsequent waveform which can be displayed via DISPLAY B.

If B—SAVE A is activated, the algebraic difference between A and B memories is displayed (SAVE A is activated, if it was not previously). This display is available at the same time as DISPLAY A and DISPLAY B, if desired.

MAX HOLD causes the digital memory to be updated only if the new input is of a higher magnitude than the former one (B memory only, if SAVE A is activated). This feature allows monitoring of signals that may change with time to provide a graphic record of amplitude/frequency excursions.

With the RESOLUTION BANDWIDTH $\leq 1/30$ th the Span/Div, it is possible to lose signal information when only A or B is displayed. With narrow resolution bandwidth it is best to display both A and B.

Peak/Average Control—With digital storage, the vertical display can be divided by a cursor (displayed as a horizontal line) which is positioned with the BASELINE CLIPPER (Peak/Average) control. Video is peak detected above the cursor and averaged below the cursor. In addition, an intensified spot travels across the cursor to indicate the horizontal position at which memory is being updated.

Signal Averaging

Signal averaging is useful for suppressing noise. The number of samples averaged per digitized slot is a function of the spectrum analyzer sweep rate. (The 7L18 has 1024 horizontal slots per display.) The slower the sweep speed, the more samples averaged per resolution bandwidth. Resolution bandwidth also affects the amplitude difference between peak and average levels of cw signals. When resolution bandwidth is less than $1/30$ th the span/division (e.g. 3 kHz or less with a SPAN/DIV of 100 kHz), there will be significant differences between peak and average amplitude levels of cw signals. The peak value is the true level, the average value will be an error.

To analyze signal amplitude level, set the cursor at least $1/4$ division below the signal peak. To average noise, set the cursor at least $1/4$ division above the noise level.

Manual Scan of the Spectrum

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

Using the CAL OUT Signal Reference for Accurate Frequency and Amplitude Measurements

The accuracy of frequency measurements may be improved by using harmonics of the crystal controlled Calibrator. The Calibrator accuracy is within 0.01%. Frequency measurements within 3 MHz are possible by using the methods described below.

The setup for each of the following methods is to connect both the incoming signal and the CAL OUT signal to the RF IN connector through an appropriate tee connection. Use care to keep the cables as short as possible. Also, both signals must be at a level such that they are both visible on screen at the same time; this may entail using external attenuators.

Method One

a. Display the incoming signal and the CAL OUT signal as described above, then center the lower frequency signal.

b. Press the DEGAUSS button, then reduce the FREQ SPAN/DIV, while keeping the signal centered with the TUNING control, to the minimum span that allows Coarse TUNING of the signal (both COARSE and FINE indicators on). Write down the CENTER FREQUENCY reading.

c. Increase the frequency span, tune the higher frequency signal to center screen (approach it from the lower side) in the same manner as above, again reduce the frequency span to the same setting as above, and determine the frequency reading difference from step b.

d. Add or subtract the frequency reading difference determined in step c, according to whether the input signal is above or below the calibrator frequency used.

e. To calibrate the CENTER FREQUENCY display with the CAL OUT signal centered in the same manner as above; again press the DEGAUSS button, recenter the signal, and adjust the center frequency CAL control for the correct reading (nearest multiple of 500 MHz).

Method Two

This method is similar to method one except that the CENTER FREQUENCY display is calibrated first.

a. Display the incoming signal and the CAL OUT signal as described above, using the minimum span that displays both signals on screen.

b. Tune the calibrator signal to center screen, reducing the span to the minimum that allows tuning with the Coarse TUNING control (both COARSE and FINE indicators on).

c. Press the DEGAUSS button, retune the calibrator signal to center screen, then adjust the center frequency CAL control for the correct CENTER FREQUENCY reading (nearest multiple of 500 MHz).

d. Tune the signal to be measured to center screen from the low frequency side. The CENTER FREQUENCY should now accurately readout the signal frequency.

Method Three

This method is particularly advantageous when the signal frequency is close to a calibrator line frequency.

a. Ensure that the span is calibrated as described under Initial Operation.

b. Display the incoming signal and the CAL OUT signal as described above, using the minimum span that display both signals on screen.

c. Press the DEGAUSS button. Tune the Calibrator signal to center screen and calibrate FREQUENCY READOUT.

d. Set the FREQ SPAN/DIV for the minimum span that displays the desired signal and a calibrator marker. Adjust the TUNING as necessary. Determine the signal frequency by noting the span from the known calibrator signal (FREQ SPAN/DIV times number of divisions gives frequency above or below the calibrator).

Measuring Absolute Signal Levels

Since the top of the graticule is a calibrated reference level and the graticule is calibrated in dB/DIV, it is easy to measure the absolute level of most signals.

a. Calibrate the vertical axis of the graticule as described under Initial Operation.

b. Connect the signal source to the RF INput, as previously described, and select the 10 dB/DIV or 2 dB/DIV display mode.

NOTE

For maximum accuracy, use the same cable that was used to calibrate the REFERENCE LEVEL.

c. Select a REFERENCE LEVEL with the RF Attenuator and Gain selector such that the signal to be measured is within the display window. If the LOG 10 dB/DIV mode is selected, the gain selector must be within the blue or red sectors.

d. The absolute signal level equals the number of dB graticule divisions from the reference level (top of the screen) to the signal reference (usually the signal peak) plus the REFERENCE LEVEL readout in dBm. For example: A signal level 4.5 divisions below the top with a REFERENCE LEVEL readout of -60 dBm, in the 2 dB/DIV display mode, is -60 dBm + $(-9$ dB) or -69 dBm. This refers to the signal level at the RF INput connector. Add the insertion loss of any external attenuators and cables (if they are used) between the signal source and the RF INput.

CAUTION

For safe operation, the maximum input level to the RF INput is -30 dBm with 0 dB attenuation, or $+30$ dBm with 60 dB attenuation. Accurate measurement of signals above this level can be performed only if an external attenuator is used.

Measuring Signal Level Differences

For signals that are within 16 dB of the same amplitude, the most accurate method is to display them at the same time, using the LOG 2 dB/DIV mode. The dB signal difference may be easily computed by multiplying the number of vertical divisions of signal separation by 2 dB/div.

For signals with greater than 16 dB amplitude difference switch to LOG 10 dB/DIV and multiply the vertical signal separation by 10 dB/div.

The following procedure should be used with caution, especially if the signal amplitude difference is large and/or if the signals are close together. In this case, the larger signal may overdrive the amplifiers, causing compression of the smaller signal and hence measurement errors.

a. Using the 2 dB/DIV display mode, position the top of the lowest amplitude signal to a reference line within the graticule area with the REF VAR control. If display noise is excessive, use Digital Storage or decrease the RESOLUTION BANDWIDTH.

b. Reduce the amplitude of the larger signal with the RF Attenuator until the signal is within the graticule area. Note the increased attenuator reading.

c. Measure the signal level from the reference line established for the smaller signal (2 dB per graticule division) then add the change in RF Attenuator reading to obtain the dB difference between the two signals.

Measuring Signal Amplitude in LIN Mode

The vertical scale on the spectrum analyzer graticule is calibrated in increments of 0.2 for the LIN display. Absolute amplitudes can be determined by converting the reference level dBm to mV or μ V, then referring the signal level to the reference level as percent; i.e., 100% = 8 division, therefore 1 division = 12.5%. Relative signal levels can be determined by adjusting the amplitude of the larger signal to the reference level (100%), then reading from the graticule the amplitude of the other signals as a percentage of this reference.

Using an External Sweep Source

A signal source of 0 V to 10 V \pm 1 V will sweep the 7L18 through its full frequency span. 0 V corresponds to the low frequency (left side) of the display; 10 V corresponds to the high frequency (right side) of the display. External input impedance is approximately 10 k Ω .

Before switching to external sweep, calibrate the sweep span using internal sweep and the calibrator signal. Then switch the TIME/DIV control to EXT and apply the external signal to the EXT IN HORIZ/TRIG jack. Adjust the signal until the analyzer sweep span is again calibrated. Since the frequency deviation across the selected span is a linear function (within 10%) of the input voltage, +5 V \pm 0.5 V should tune the analyzer to the center frequency.

EXTERNAL WAVEGUIDE MIXERS

Introduction

Signals from 1.5 to 18 GHz can be connected via coaxial cable to the RF IN connector, and will pass through the attenuator, YIG preselector, and internal first mixer on their way to the first intermediate frequency amplifier. Since the coaxial input is not usable above 18 GHz, external waveguide mixers are used and the resultant intermediate frequency is sent directly to the IF amplifier.

Waveguide Mixer Characteristics

The waveguide mixers are optional accessories that must be purchased separately. Each mixer is supplied with a data sheet that includes complete specifications and instructions. The characteristics given in Table 3-2, and the cautions and instructions are general and not intended to be complete.

Note that there are two types of mixers available. The lower-cost (general purpose) mixers have a mixer diode that is easily field-replaceable; the high performance mixers are not field-repairable, but have better frequency response and sensitivity specifications. We recommend the high performance mixers for critical measurements, and the general purpose mixers for initial measurements or back-up units.

CAUTION

The maximum input to all waveguide mixers is 10 mW cw.

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 can not be met.

CAUTION

Bias polarity is negative-going. This is the correct polarity for TEKTRONIX Waveguide Mixers. Some commercial mixers require positive bias. Check bias requirements of non-Tektronix mixers before connecting them to the 7L18.

Table 3-2

WAVEGUIDE MIXER CHARACTERISTICS

General Purpose Mixers			High Performance Mixers		
Frequency Range	Part No.	Sensitivity Avg. noise @30 kHz Bandwidth (typ)	Part No.	Sensitivity Avg. noise @30 kHz Bandwidth (max)	Frequency Response
12.4-18 GHz	119-0097-00	-75 dBm	— — —	— — —	— — —
18.0-26.5 GHz	119-0098-00	-70 dBm	016-0631-00	-80 dBm	±3.0 dB
26.5-40.0 GHz	119-0099-00	-60 dBm	016-0632-00	-75 dBm	±3.0 dB
40-60.5 GHz	— — —	— — —	016-0634-00	-65 dBm	±3.0 dB
Cable required with above mixers			012-0649-00		

Handling and Installing

CAUTION

Waveguide mixers are delicate devices that require specific handling precautions. Before using, carefully read the instruction manual enclosed with each unit.

Keep the flange cover on the the mixers when they are not in use. Use care to avoid scratches on the flange surfaces, which can degrade performance. Be sure to install and tighten all flange screws to minimize vswr. Install the waveguide mixer on the signal source, and connect it to the spectrum analyzer EXT MIXER input, using only the special cable supplied with the mixer (refer to Fig. 3-13). Since the capacitance of this cable is capable of storing enough energy to destroy the mixer diode, connect the cable to the 7L18 to discharge it before connecting to the mixer.

CAUTION

On the high-performance mixers, do NOT loosen the nut on the connector collar; this would destroy the mixer. The mixer diodes are NOT field-replaceable, and the unit must be returned to the factory for repair.

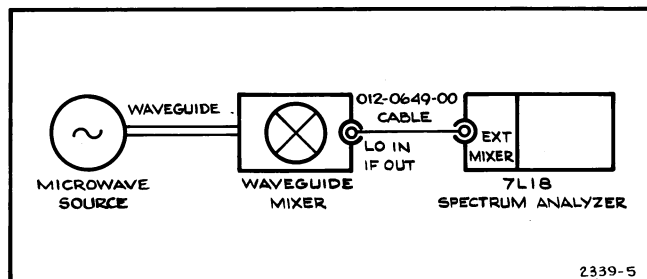


Fig. 3-13. Waveguide mixer installation.

Using the Signal Identifier

Signals in the waveguide bands are mixed with harmonics of the first local oscillator to produce an IF of 510 MHz. Since the preselector is not used on the waveguide bands, many 510 MHz signals are produced by the mixing action of incoming signals with both higher and lower order harmonics of the local oscillator. The display will consist of many spurious responses and image signals. Only the signals converted by the oscillator harmonic, used to calibrate the center frequency for the selected band, will be twice the IF away from its image. In the IDENTIFY position of the FREQ SPAN/DIV selector, the frequency span/div is 510 MHz (or IF frequency). This position is therefore used to identify the conversions that occur with the desired local oscillator harmonic.

Note the diagram in the lower right corner of the 7L18 front panel. The two signals referred to in the diagram are the conversions resulting from the input plus the desired local oscillator harmonic, and the input minus the desired local oscillator harmonic. These two signals are separated by 1020 MHz or two divisions at 510 MHz/Div. Other conversions will result in displays which are other than two divisions apart. Note that as the band number gets higher, false signals appear closer and closer to two divisions separation. When the two signals have exactly two divisions separation, the "real" signal is the one on the left of the identifier pair.

Use the band switch and TUNING control to locate the real signal, and center it on screen for the desired measurement.

NOTE

The CENTER FREQUENCY readout should be used with caution as a signal identifier for signals in the waveguide bands. The readout accuracy is 5 MHz times the harmonic number used; when N=15 (40-60 GHz band), this represents a possible error of 75 MHz. A false signal could therefore be closer than the real one to the CENTER FREQUENCY readout.

Operating Notes

It is preferable to use the waveguide mixer on a band that covers the entire range of the mixer. While other bands could be used, performance characteristics may be noticeably different if it becomes necessary to switch bands.

After any frequency change, adjust the PEAKING control for maximum signal amplitude to maintain best accuracy. This control adjusts the mixer diode bias for optimum performance. With some mixers, the signal can easily disappear in the noise if the control is misadjusted.

External Trigger/Sweep Operation

External triggering is used when it is necessary to synchronize the display to an event with an external trigger source, such as a pulse generator or modulator, (e.g. measuring the prf of a radar signal). The trigger signal (0.5 V to +50 V) is applied to the EXT IN HORIZ/TRIG jack on the front panel, and the TIME/DIV control is set to the desired sweep rate. If an internal trigger signal is also present that will arrive before the external signal, it must be removed by setting the oscilloscope triggering source to an unused channel. If time domain information is desired, set the FREQ SPAN/DIV to 0 and the RESOLUTION BANDWIDTH higher than the highest modulating frequency.

A signal source of 0 V to 10 V ± 1 V will sweep the 7L18 through its full frequency span. 0 V corresponds to the low frequency end at the left of the display; 10 V corresponds to the high frequency end at the right. External input impedance is approximately 10 k Ω .

Before switching to external sweep, calibrate the frequency span using internal sweep and the calibrator signal. Then switch the TIME/DIV control to EXT and apply the external sweep voltage to the EXT IN HORIZ/TRIG jack. Adjust the voltage until the analyzer span is again calibrated. Since the frequency deviation across the selected span is a linear function (within 10%) of the input voltage, +5 V ± 0.5 V should tune the analyzer to center frequency.

Pulsed Signal Applications

For pulsed applications, the resolution bandwidth of the analyzer should be on the order of 1/10 the side lobe frequency width, or the reciprocal of the pulse width, in order to ensure adequate resolution. RESOLUTION is usually selected for optimum main lobe detail after the sweep rate has been adjusted.

Operation with the TIME/DIV switch in the AUTO position will usually provide enough pulse sample lines to adequately display the spectrum envelope. However, for low repetition rate signals, it may be useful to reduce the sweep rate to increase the number of display sample lines for an improved display of the spectrum envelope.

Front Panel OPTION Plug

Access for installation of a connector which may be used in future or custom instruments.

Applications for Spectrum Analyzers

Applications for spectrum analyzers such as the 7L18 include; measuring intermodulation products, radiation interference, modulation percentage, absolute and relative signal level measurements, bandpass characteristics, etc. Numerous application notes on spectrum analyzer measurements are available from your local Tektronix Field Office or representative, including assistance for specific measurement applications you may desire.

Some references on spectrum analyzer theory and applications available from Tektronix, Inc., that are applicable to the 7L18 are as follows:

"Spectrum Analyzer Theory and Applications"; Engleson and Telewski, Artech House, 1974.

"Understand Resolution For Better Spectrum Analysis"; Engleson; reprinted from MicroWaves, December, 1974.

"Use, Do Not Abuse Your Spectrum Analyzer"; Engleson; reprinted from MicroWaves, November, 1972.

"Noise Measurements Using the Spectrum Analyzer"; Engelson:

Part One: Random Noise, Tektronix Publication No. AX-3260;

Part Two: Impulse Noise, Tektronix Publication No. AX-3259.

Operator Traps

Occasionally, an apparent instrument malfunction is in reality the operator's failure to observe operating rules.

The following are a few of these operator traps and what to do about them.

- a. Loss of signal display: Do not push DEGAUSS button when phase locked. Do not tune the Coarse control when the FINE tune indicator is on.
- b. Signal compression below 2 GHz: Do not use the red sector position of the IF Gain control when displaying signals below 2 GHz.
- c. Distorted signal, low in amplitude: (1) The sweep may be too fast; check to see if the UNCAL indicator is on. (2) If occurring with narrow RESOLUTION BANDWIDTH, signal source may be exhibiting excessive frequency modulation.
- d. Incorrect CENTER FREQUENCY readout after switching to band 1: Ensure that the BAND switch was not inadvertently switched to the OPTIONS position.
- e. With RESOLUTION BANDWIDTH $\leq 1/30$ th the Span/Div there will be an amplitude difference between averaged and peak levels. The peak value is the true value. It is also possible to lose signal information when only A or B is displayed. (See Digital Storage under General Operating Information.)

Service Manual

The 7L18 Service Instruction Manual is a separate publication that includes a circuit description, troubleshooting information, calibration procedures, schematic diagrams, and other maintenance information. It is intended for use by QUALIFIED SERVICE PERSONNEL ONLY. To avoid electrical shock, DO NOT perform any servicing unless qualified to do so.

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 outside the United States in all countries where our products are sold. Contact your local Service Center, representative or sales engineer for details regarding: Warranty, Calibration, Emergency Repair, Repair Parts, Scheduled Maintenance, Maintenance Agreements, Pickup and Delivery, On-site Service for fixed installations, and other services available through these centers.

Emergency Repair: This service provides immediate attention to instrument malfunction 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.

Maintenance Agreements—Your instrument is initially covered by warranty (see Warranty statement on the inside of the title page). After the warranty period, 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-frame. Any Service Center can furnish complete information on costs and types of maintenance programs.

a frequency which varies in proportion to the magnetic field caused by a current through an electromagnet. The preselector is a tunable bandpass filter with a bandwidth of about 50 MHz, that tunes through the range of 1.5 GHz to 18 GHz. The oscillator tunes through the range of 2 GHz to 4 GHz; harmonics of this fundamental are used for band 3 and up (see Table 1-1). The preselector is swept synchronously with the oscillator, but the sweep voltage is offset and scaled according to the band in use. Since the mixer purposely produces many harmonics, the instrument is potentially capable of many conversions other than the one intended. The preselector selects which conversion is allowed. This results in a spurious signal-free, unambiguous display.

The preselector and first local oscillator utilize YIG (Yttrium-Iron-Garnet) spheres. This material resonates at



Phase Lock System

Because it must tune and sweep, the first local oscillator does not have the stability of a fixed oscillator. Drift of the oscillator is indistinguishable from drift of a signal. Therefore, the 7L18 includes a system which, at narrower spans, phase locks the first local oscillator to a stable sweeping source. This gives the locked oscillator approximately the same fractional stability as a crystal oscillator. The sweep is then applied to the phase locked loop, rather than to the oscillator directly.

Mixer

Incoming signals out of the preselector are mixed with the first local oscillator to produce a 510 MHz intermediate frequency (IF).

Intermediate Frequency Amplifiers

The 510 MHz IF signals are amplified by gain setting stages, controlled by the microprocessor in the block.

Second Local Oscillator, Mixer, and Calibrator

The second local oscillator consists of a 125 MHz crystal controlled oscillator and a x4 multiplier chain. This combination has an output frequency of 500 MHz.

The second local oscillator signal is also the basis for the calibrator signal. The level of the CAL OUT signal is calibrated at 2.0 (1.5) GHz, and the calibrator produces picket-fence type markers every 500 MHz to over 6 GHz.

Variable Resolution Filters

Bandwidth and filter shape factor determine the ability of the analyzer to display discrete characteristics of the signal, or small segments of the frequency spectrum. Wide bandwidth is needed for wide spans and for time domain analyses. Narrow bandwidths allow the user to separate signals within narrow spans, to observe signal characteristics such as power related sidebands, to increase signal to noise ratio for higher sensitivity, etc. This block provides resolution bandwidths from 30 Hz to 3 MHz.

Noise Filters

The noise filter reduces the bandwidth of the amplifiers driving the log amplifier. This function minimizes the baseline noise that would result from noise generation in the latter stages of the variable resolution amplifiers.

Log Amplifier and Detector

The log amplifier compresses the input signal to make it possible for the input signal to vary over a 90 dB range while feeding the detector, which is linear over a 35 dB range. By carefully controlling the characteristics of the compression curve, each dB change in input results in an equal increment of change in the output. For instance; in the 10 dB/DIV mode, a change of 10 dB in signal level produces one division of change in the output. The detector changes the IF to a video signal.

Video Amplifier

The video amplifier sets the gain for the display in use (10 dB/Div or 2 dB/Div). If Lin mode is selected, a shaper un-logs the video. The pulse stretcher and deflection amplifiers are also in this block.

Sweep Generator

A sawtooth generator is used to sweep the crt horizontal axis, the YIG oscillator, and the YIG preselector. An attenuator changes the oscillator sweep amplitude, and hence its frequency deviation, to set the span or frequency/division. Spans range from 0.2 kHz to 500 MHz/division plus zero span position, in which the analyzer functions as a tunable receiver for time domain analysis. This circuit also includes the triggering circuits for the analyzer.

Digital Storage

The 7L18 has digital storage, so a storage mainframe is not required. When digital storage is selected, the display is a presentation of a large number of memory locations, which stay at the same amplitude until updated.

Microcomputer

The microcomputer takes care of a variety of housekeeping functions within the 7L18. It reads the settings of most of the front panel controls and appropriately services the sweep generator, span attenuator, YIG drivers, IF amplifier gains and bandwidths, center frequency dvm, and crt and front panel readouts. From the user's point of view the microcomputer is most apparent in the 7L18's AUTO modes: when AUTO BANDWIDTH and AUTO TIME/DIV are selected, these functions are based upon the BAND, FREQ SPAN/DIV, and PHASE LOCK control settings.

OPTION INFORMATION

No option information available at this time.