INSTRUCTION
MANUAL

Serial Number B010123

TYPE 1L40

Lemke

SPECTRUM ANALYZER

Tektronix, Inc.

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070-0904-00

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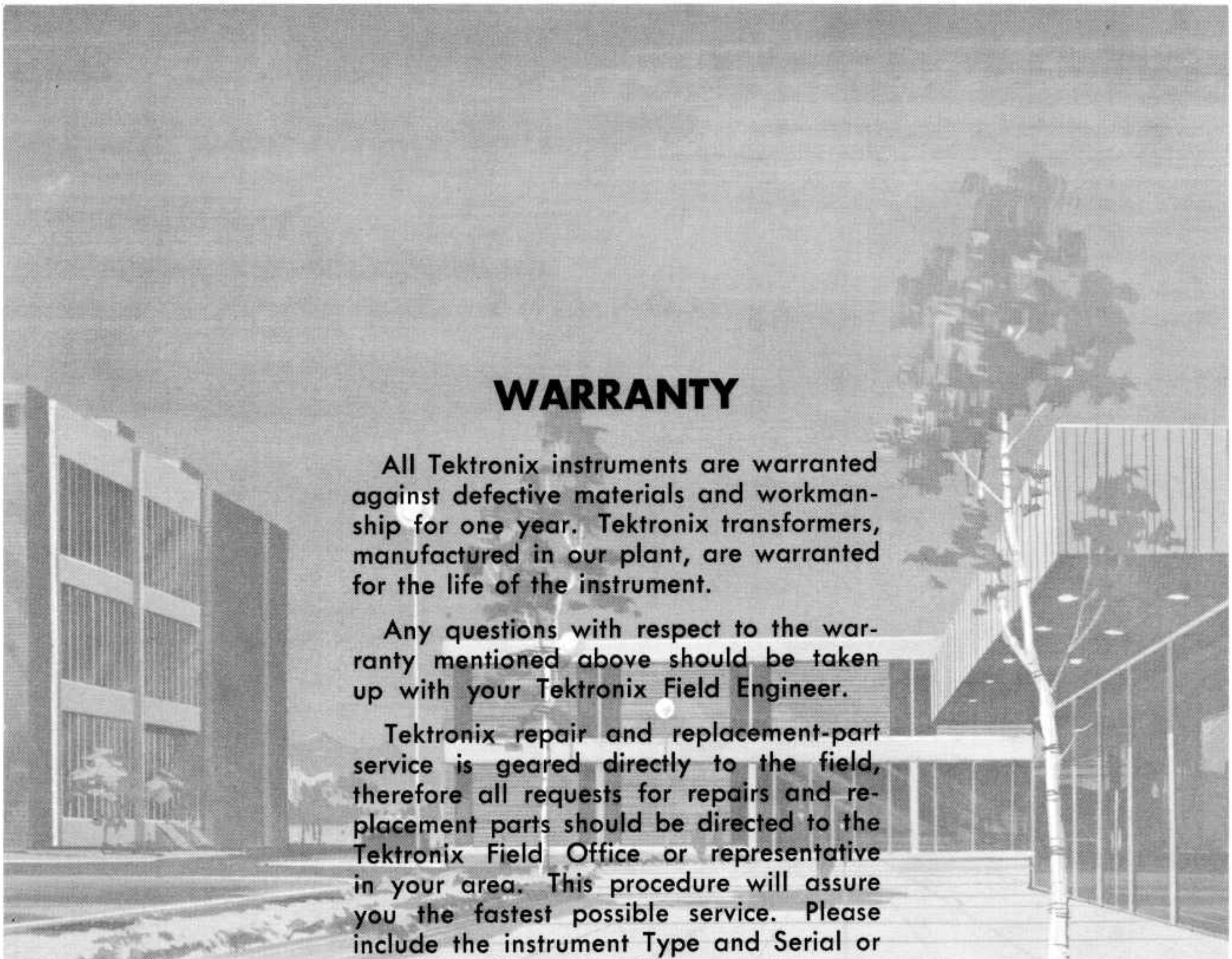

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

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Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

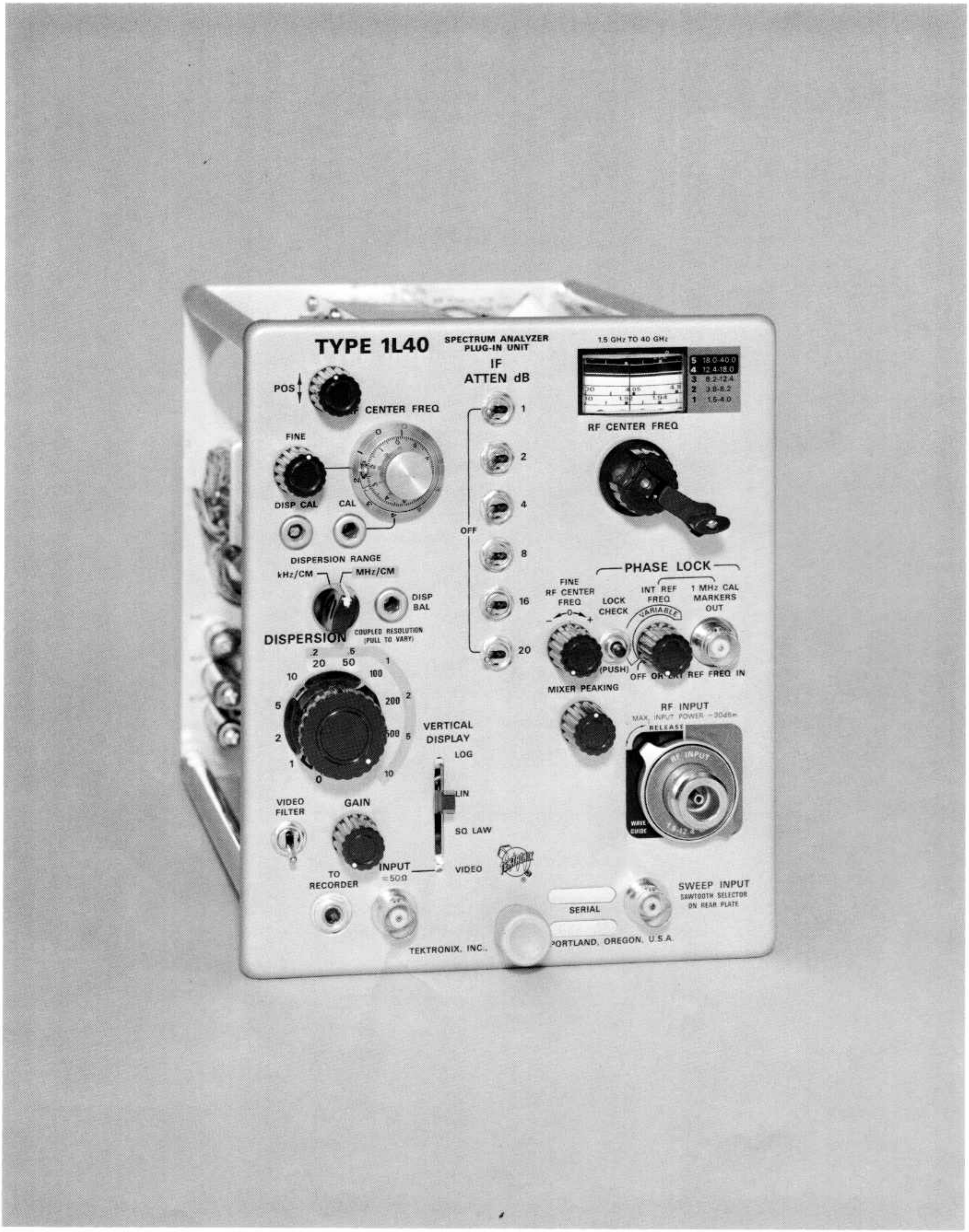

Fig. 1-1. Type 1L40 Spectrum Analyzer

SECTION 1
TYPE 1L40 SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

The Type 1L40 Spectrum Analyzer is designed as a plug-in unit for use in Tektronix Type 530-, 540-, 550- and 580-[1] Series Oscilloscopes. It can also be used in a Plug-In Unit Power Supply (such as the Type 132 or Type 133 Power Supplies) when the analyzer is provided with either a 100 V or 150 V sawtooth signal whose base is within ±2 V of ground.

When used in the above listed oscilloscopes, the analyzer displays the relative power distribution of applied signals on the CRT vertical axis as a function of frequency on the horizontal axis.

Frequency coverage within the 1.5 GHz to 40 GHz range is provided by the selection of mixers[2] and adapters which are listed in the accessories section of the manual. These mixers and accessories must be ordered separately as required.

The electrical characteristics apply over an ambient temperature range of 0° C to 50° C provided the environmental ambient temperature has been stable for 4 hours and an initial warmup period of 20 minutes with power applied is provided for the instrument to stabilize. The performance check procedure in Section 5 provides a convenient method to check the operating requirements listed in this section.

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	
RF Center Frequency Range	1.5 GHz to 40 GHz—See Table 1-1	
CW Sensitivity (S + N = 2N)	See Table 1-1	
Dial Accuracy	Within ± (2 MHz + 1% of dial reading) IF CENTER FREQ control at 000, FINE (IF) control centered and FINE RF CENTER FREQ control centered.	
Local Oscillator Frequency Range	1.7 GHz to 4.2 GHz	
Dispersion MHz/CM Range	.2 MHz/cm to 10 MHz/cm in a 1-2-5 sequence	
Accuracy	See Table 1-2	
Linearity	Within 3% over a 10 centimeter display	
kHz/CM Range	1 kHz/cm to 500 kHz/cm in a 1-2-5 sequence and zero dispersion	
Accuracy	Within 3% (with ±2.5 MHz change in IF center frequency)	
Linearity	Within 3% over a 10 centimeter display	
Resolution Bandwidth	≤1 kHz to ≥100 kHz; in 11 uncalibrated steps. May be coupled with DISPERSION control or switched separately.	
Spurious Signals Internal Sources	≤2X noise amplitude. RF INPUT terminated into 50 Ω	
With Main Response	At least —40 dB at 100 kHz resolution. DISPERSION Range at kHz/CM position. RF INPUT terminated into 50 Ω	
IF Center Frequency Control Range	IF CENTER FREQ	FINE
1 kHz/cm to 500 kHz/cm Dispersion	≥(+ and —2.5 MHz)	≥(+ and —50 kHz)
0.2 MHz/cm to 5 MHz/cm Dispersion	≥(+ and —25 MHz)	≥(+ and —1 MHz)
10 MHz/cm Dispersion	≥(+ and —10 MHz)	≥(+ and —1 MHz)
IF Attenuation Range	0 to 51 dB. In 1, 2, 4, 8, 16 and 20 dB steps.	
Accuracy	Within ±0.1 dB/dB	
IF GAIN Control Range	50 dB or greater	
Display Flatness with IF CENTER FREQ at 000	Within 3 dB from 1.5 GHz to 12.4 GHz. Within 6 dB from 12.4 GHz to 40.0 GHz. Within 50 MHz of RF Center Frequency.	
Incidental FM IF kHz/CM Dispersion	≤200 Hz	
LO + IF Without Phase Lock	≤2 kHz at local oscillator fundamental.	
Wih Phase Lock	≤300 Hz at local oscillator fundamental.	
Internal Phase Lock Internal Markers	1 MHz +0.1% (INT REF FREQ control next to the OFF position.)	

[1] **A Tektronix Type 81A Plug-In Adapter must be used with 580 Series Oscilloscopes.**

[2] **The Type 1L40 is normally supplied with a coaxial mixer, Tektronix Part No. 119-0096-00, which provides a frequency coverage range from 1.5 GHz to 12.4 GHz.**

ELECTRICAL CHARACTERISTICS *(cont)*

Characteristic	Performance Requirement
Pulling Range of INT REF FREQ Control	≥1 kHz to ≤1.3 kHz. Measured from a frequency reference established with the INT REF FREQ control fully counterclockwise next to OFF position.
Stability; Ref. Osc	≤1 part in 10^7
External Phase Lock Reference Input Frequency Range	1 MHz to 5 MHz
Voltage Required	1 to 5 volts peak to peak
Dynamic Range of Display Functions (6 cm display)	
LOG	≥40 dB
LIN	≥26 dB
SQ LAW	≥13 dB
Video Input Response	≤16 Hz to ≥10 MHz at −3 dB points
Maximum Input Power	−30 dBm for linear operation +15 dBm (25 mW) power limit for diode mixer
TO RECORDER Output	LIN mode: ≥2 mV/cm of displayed signal amplitude when connected to 600 ohm load.

TABLE 1-1

Frequency Range of Mixers and Minimum CW Sensitivity[3] (S +N = 2N)

Scale	Type and Tektronix Part Number of Mixer	RF CENTER FREQUENCY	1 kHz RESOLUTION	100 kHz RESOLUTION
1	Coaxial — 119-0096-00	1.5-4.0 GHz	−110 dBm	−90 dBm
2	Coaxial — 119-0096-00	3.8-8.2 GHz	−100 dBm	−80 dBm
3	Coaxial — 119-0096-00	8.0-12.4 GHz	−95 dBm	−75 dBm
4	Waveguide[4] 119-0097-00	12.4-18.0 GHz	−90 dBm	−70 dBm
5	Waveguide[4] 119-0098-00	18.0-26.5 GHz	−80 dBm	−60 dBm
5	Waveguide[4] 119-0099-00	26.5-40.0 GHz	−70 dBm	−50 dBm

TABLE 1-2

Dispersion/CM

Setting	Accuracy
10 MHz Within	3%
5 MHz Within	3%
2 MHz Within	5%
1 MHz Within	7%
.5 MHz Within	10%
.2 MHz Within	15%

ENVIRONMENTAL CHARACTERISTICS

The following environment test limits apply when tested in accordance with the recommended test procedure. Details on environmental test procedures, including failure criteria, etc., may be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

Characteristic	Operating Requirements
Temperature Non-operating	−40° C to +65° C
Operating	0°C to +50°C To meet operating specifications the instrument must stabilize at an ambient temperature within this range for 4 hours before operation.
Altitude Non-operating	To 50,000 feet
Operating	To 15,000 feet
Shock Non-operating	30 g's, ½ sine, 11 ms duration, 1 shock per axis. Guillotine-type shocks.
Vibration Operating	15 minutes each axis at 0.015 inches; frequency varied from 10-50-10 c/s in 1 minute cycles. Three minutes each axis at any resonant point. Tested with instrument secured to vibration platform.
Transportation Package Vibration	1 hour at 1 g
Package Drop	30 inches on 1 corner, all edges radiating from that corner and all flat surfaces.

MECHANICAL CHARACTERISTICS

Characteristic	Information
Construction Chassis	Aluminum
Front-Panel	Aluminum alloy with anodized finish
Circuit Boards	Glass-epoxy laminate

[3]50 Ω source impedance. MIXER PEAKING adjusting for optimum signal amplitude.

[4]To be used with Waveguide Mixer Adapter Tektronix Part No. 119-0104-00 and cable TNC, coaxial, Tektronix Part No. 012-0115-00.

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual presents installation instructions, a glossary of Spectrum Analyzer terms, a description and function of the Type 1L40 front panel controls and connectors, a first time operation procedure, and some basic applications for the analyzer.

Installation

The Type 1L40 is designed to operate in all Tektronix Oscilloscopes that accept the letter or 1-series plug-in units. It may also be used with Tektronix Type 132 or Type 133 Plug-In Power Supply units, with the output displayed on the CRT of any oscilloscope that has a 100 V or 150 V sweep output available.

Set the Sweep Voltage selector at the rear panel (see Fig. 2-4) to the required position for the oscilloscope the analyzer is to be operated with. If the oscilloscope sawtooth voltage output is not given on the chart, refer to the oscilloscope instruction manual.

Insert the Type 1L40 into the plug-in compartment and fasten the securing latch. Connect a cable or patch cord between the oscilloscope sweep output and the Type 1L40 SWEEP INPUT connector. Turn on the oscilloscope power and allow approximately 20 minutes warmup period for the instrument to stabilize.

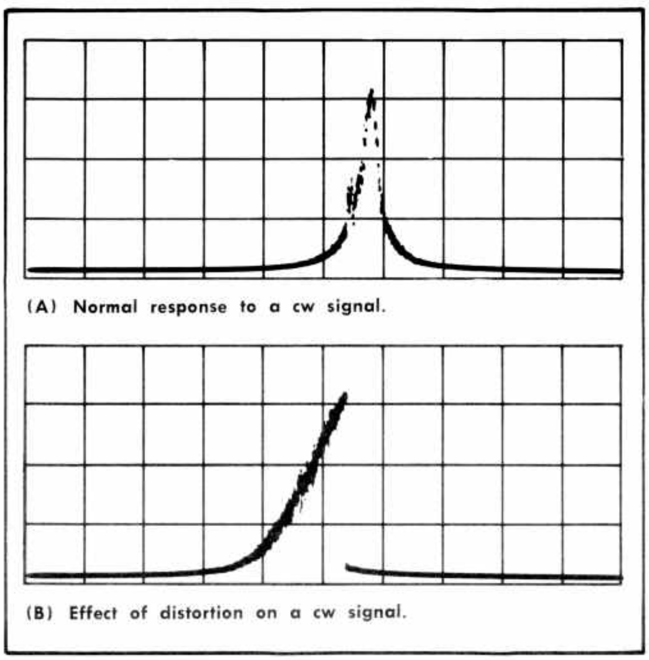

Fig. 2-1. (A) Normal response to a cw signal. (B) Effect of distortion on a CW signal.

Oscilloscope Modification

If the Type 1L40 is used with early Tektronix Type 541, 541A, 543, 543A, 545 and 545A oscilloscopes, an undesirable display distortion and dispersion non-linearity may be present. This distortion is caused by a portion of the vertical output signal from the Vertical Signal Out C. F. V1223A (V1050B Type 545), feeding into the Spectrum Analyzer on the +225 V supply. The distortion appears as a change of dispersion linearity with a change of the analyzer GAIN control setting and is most noticeable in the narrow dispersion setting such as 1 kHz/cm. It also appears as a non-symmetrical response to a CW signal in which the slope of one side of the signal drops abruptly to the base line. See Fig. 2-1.

This condition is corrected by changing the +225 volt supply for the Vertical Signal Out C. F. from the junction of R1008 and R1007 (R1153 and R1152, Type 545) to the other side of R1008 (R1153) which is the + 225 V supply. Fig. 2-2 is a diagram of the circuit involved.

Spectrum Analyzer Terms

The following glossary of spectrum analyzer terms is presented as an aid to understanding the terms as they are used in this manual.

Spectrum Analyzer—A device that displays a graph of the relative power distribution as a function of frequency, typically on a cathode-ray tube or chart recorder.

Types: Real-time and non real-time.

A real-time spectrum analyzer performs a continous analysis of the incoming signal, with the time sequence of events preserved between input and output.

A non-real-time spectrum analyzer performs an analysis of a repetitive event by a sampling process.

Methods: Swept front end and swept intermediate frequency.

A swept front end spectrum analyzer is a superheterodyne spectrum analyzer in which the first local oscillator is swept.

A swept IF spectrum analyzer is a superheterodyne spectrum analyzer in which a local oscillator other than the first is swept.

Center frequency (radio frequency or intermediate frequency)—That frequency which corresponds to the center of the reference coordinate.

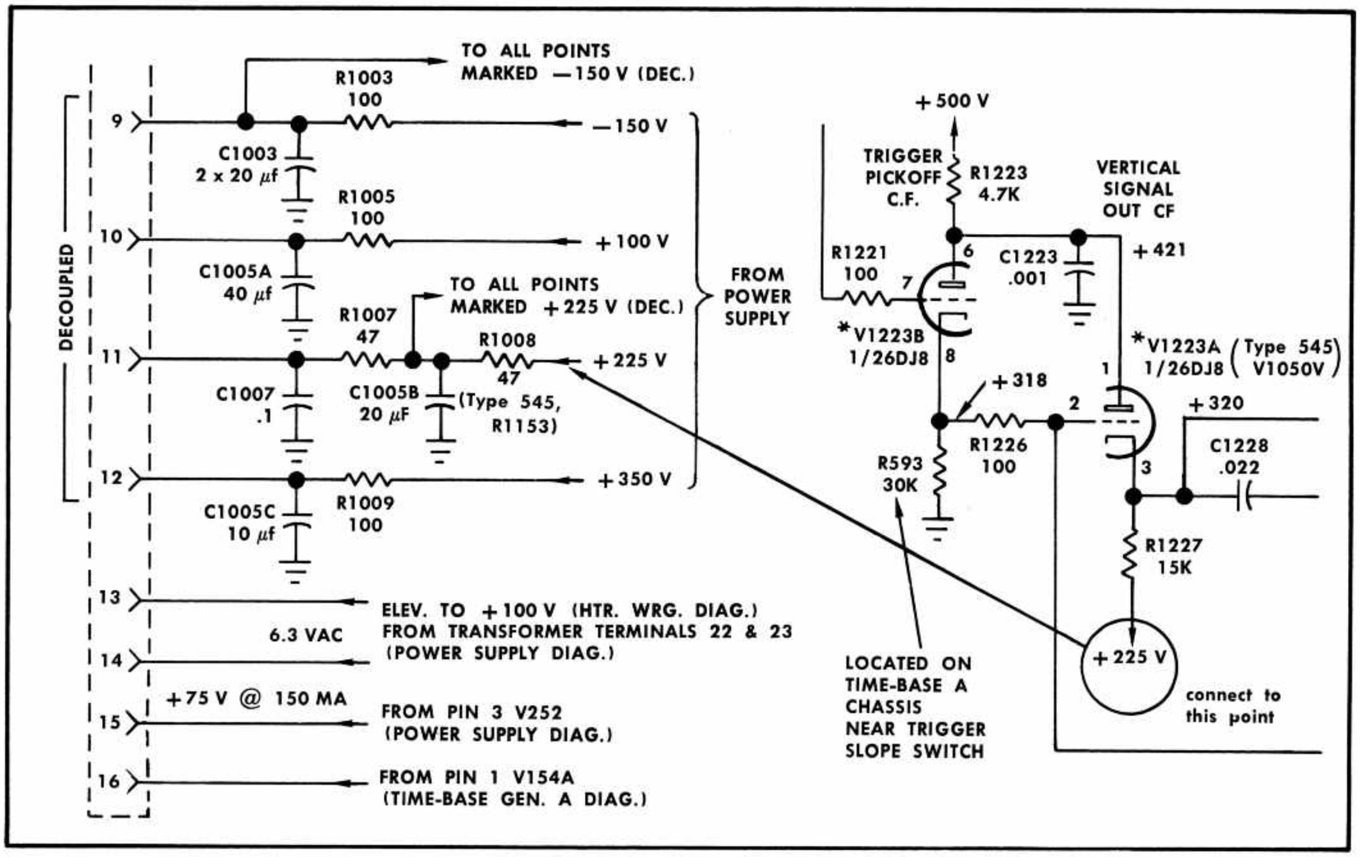

Fig. 2-2. Change as indicated on this partial schematic of the Vertical Amplifier.

Center frequency range (radio frequency)—That range of frequencies which can be displayed at the center of the reference coordinate. When referred to a control (e.g., Intermediate Frequency Center Frequency Range) the term indicates the amount of frequency change available with the control.

Dispersion (sweep width)—The frequency sweep excursion over the frequency axis of the display. Can be expressed as frequency/full frequency axis, or frequency (Hz) division in a linear display.

Display flatness—Uniformity of amplitudes response over the rated maximum dispersion (usually in units of dB).

Drift (Frequency drift)—Long term frequency changes or instabilities caused by a frequency change in the spectrum analyzer local oscillators. Drift limits the time interval that a spectrum analyzer can be used without retuning or resetting the front panel controls (units may be Hz/s, Hz/1° C, etc).

Dynamic range (on screen)— The maximum ratio of signal amplitudes that can be simultaneously observed within the graticule (usually in units of dB).

Dynamic range (maximum useful)—The ratio between the maximum input power and the spectrum analyzer sensitivity (usually expressed in dB).

Frequency band—The range of frequencies that can be covered without switching.

Frequency scale—The range of frequencies that can be read on one line of the frequency indicating dial.

Incidental frequency modulation (residual frequency modulation)—Short term frequency jitter or undesired frequency deviation caused by instabilities in the spectrum analyzer local oscillators. Incidental frequency modulation limits the usable resolution and dispersion (in units of Hz).

Incremental linearity—A term used to describe local aberrations seen as non-linearities for narrow dispersions.

Linear display—A display in which the vertical deflection is a linear function of the input signal voltage.

Linearity (dispersion linearity)—Measure of the comparison of frequency across the dispersion to a straight line frequency change. Measured by displaying a quantity of equally spaced (in frequency) frequency markers across the dispersion and observing the positional deviation of the markers from an idealized sweep as measured against a linear graticule. Linearity accuracy, expressed as a percentage is within $\frac{\Delta W}{W}$ X 100%, where ΔW is maximum positional deviation and W is the full graticule width.

Maximum input power—The upper level of input power that the spectrum analyzer can accommodate without degration in performance (spurious responses and signal compression). Usually in units of dBm.

Minimum usable dispersion—The narrowest dispersion obtainable for meaningful analysis. Defined as ten times the incidental frequency modulation when limited by "incidental frequency modulation" (in units of Hz).

Phase lock—The frequency synchronization of the local oscillator with a stable reference frequency.

Resolution—The ability of the spectrum analyzer to resolve and display adjacent signal frequencies. The measure of resolution is the frequency separation (in Hz) of two equal amplitude signals, the displays of which merge at the 3 dB-down point. The resolution of a given display depends on three factors; sweep speed, dispersion and the bandwidth of the most selective (usually last IF) amplifier.

Resolution bandwidth—The −6 dB bandwidth with Gaussian response of the analyzer, with the dispersion and sweep time adjusted for the minimum displayed bandwidth of a CW signal. Resolution and resolution bandwidth become synonymous at very long sweep times.

Optimum resolution—the best resolution obtainable for a given dispersion and a given sweep time. Theoretically or mathematically:

$$\text{Optimum resolution} = \frac{\text{dispersion (in Hz)}}{\text{sweep time (in seconds)}}$$

Optimum resolution bandwidth—The bandwidth at which best resolution is obtained for a given dispersion and sweep time.

Theoretically and mathematically:

$$\text{Optimum resolution bandwith} = 0.66\,\frac{\text{Dispersion (in Hz)}}{\text{Sweep time (in seconds)}}$$

Safe power level—The upper level of input power that the spectrum analyzer can accommodate without physical damage (usually in units of dBm).

Scanning velocity—Product of dispersion and sweep repetition rate units of Hz/unit time.

Sensitivity—Rating factor of spectrum analyzers ability to display signals.

1. Signal equals noise: That input signal level (usually in dBm) required to produce a display in which the signal level above the residual noise is equal to the residual noise level above the baseline. Expressed as: Signal + noise = twice noise.

2. Minimum discernible signal: That input signal level (usually in dBm) required to produce a display in which the signal is just visible within the noise.

Skirt selectivity—A measure of the resolution capbility of the spectrum analyzer when displaying signals of unequal amplitude. A unit of measure (usually in Hz) is the bandwidth at some level below the 6 dB down points. For example 10 dB, 20 dB or 40 dB down.

Spurious response (spurii, spur)—an erroneous display or signal which does not conform to the indicated frequency or dial reading. Spurii and spur are the colloquialisms used to mean spurious response (plural) or spurious response (singular) respectively. Spurious responses are of the following type:

1. IF feedthrough—Signal frequencies within the IF passband of the spectrum analyzer that are not converted in the first mixer but pass through the IF amplifier and produce displays on the CRT that are not tunable with the RF center frequency controls.

2. Image response—The superheterodyne process results in two major IF responses, separated from each other by twice the IF. The spectrum analyzer is usually calibrated to only one of these two responses. The other is called the image.

3. Harmonic conversion—The spectrum analyzer will respond to signals that mix with harmonics of the local oscillator and produce the intermediate frequency. Most spectrum analyzers have dials calibrated for some of these higher order conversions. The uncalibrated conversions are spurious responses.

4. Intermodulation—In the case of more than one input signal, the myriad of combinations of the sums and differences of these signals between themselves and their multiples, creates extraneous responses known as intermodulation. The most harmful intermodulation is third order, caused by the second harmonic of one signal combining with the fundamental of another.

5. Video detection—The first mixer will act as a video detector if sufficient input signal is applied. A narrow pulse may have sufficient energy at the intermediate frequency to show up as intermediate frequency feedthrough.

6. Internal—A spurious response on the display caused by a signal generated within the spectrum analyzer that is in no way connected with an external signal.

7. Anomalous IF responses—The filter characteristic of the resolution-determining amplifier may exhibit extraneous pass-bands. This results in extraneous spectrum analyzer responses when a signal is being analyzed.

8. Zero frequency feedthrough—(zero pip)—The response produced when the first local oscillator frequency is within the IF passband. This corresponds to zero input frequency and is sometimes not suppressed so as to act as a zero frequency marker.

Sweep repetition rate—The number of sweep excursions per unit of time. Approximately the inverse of sweep time for a free-running sweep.

Sweep time—The time required for the spot in the reference coordinate (frequency in spectrum analyzer) to move across the graticule. (In a linear spectrum system, sweep time is Time/Division multiplied by total divisions.)

CONTROLS AND CONNECTORS

The following is a brief description of the operation or function of these controls and connectors on the front panel. See Fig. 2-3. A more detailed description is provided later in this section under general operating information.

DISPERSION RANGE	Selects the range of the DISPERSION control; MHz/CM position provides a frequency dispersion range from 10 MHz to 0.2 MHz/cm. kHz/CM position provides frequency dispersion range from 500 kHz/cm to 0 dispersion.

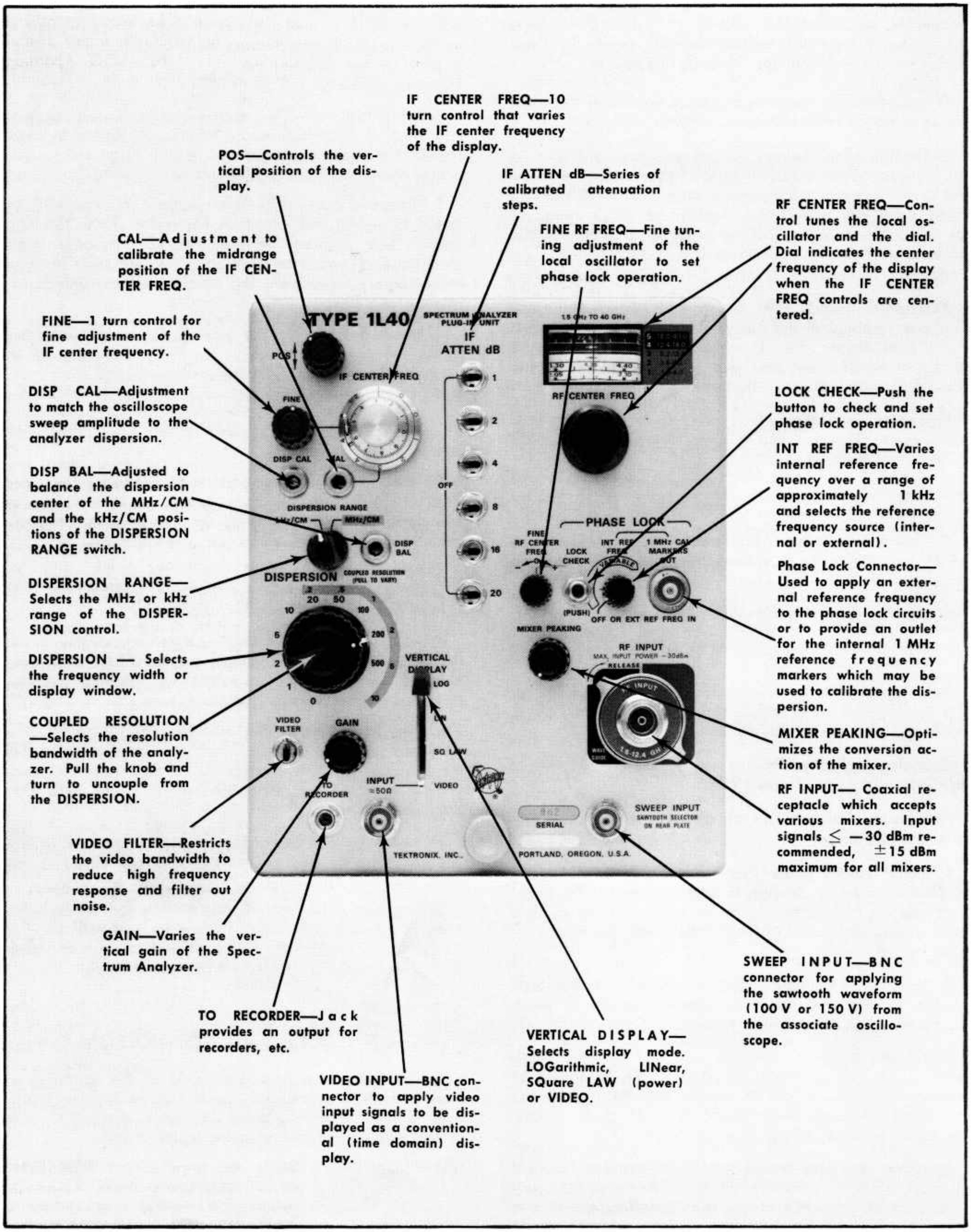

Fig. 2-3. Function of front panel controls and connectors.

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DISPERSION	Selects the dispersion (frequency width) of the display in conjunction with the DISPERSION RANGE switch. Dispersion ranges from 10 MHz/cm to 1 kHz/cm in a 1-2-5 sequence, plus an additional position of approximately zero dispersions are provided. When the DISPERSION selector is in the 0 position, the analyzer functions as a fixed tuned receiver. This provides a display that shows the time domain characteristics of modulation within the resolution bandwidth capabilities of the analyzer.
COUPLED RESOLUTION	Selects the analyzer resolution bandwidth. Eleven selectable ranges, from more than 100 kHz to less than 1 kHz are provided. The normal resolution for a given dispersion is generally obtained with the RESOLUTION control coupled to the DISPERSION selector.
DISP CAL	A screwdriver adjustment to calibrate the MHz/cm dispersion.
DISP BAL	Adjusted to balance the dispersion center (center frequency point) of the MHz/CM and kHz/CM position of the DISPERSION RANGE switch.
IF ATTEN dB	Series of six toggle switches to provide calibrated IF attentuation in 1 dB steps from 1 dB to 51 dB.
GAIN	A variable control of the analyzeı IF gain, plus a variable control over the video INPUT signal amplitude.
IF CENTER FREQ	A 10 turn control that shifts the IF center frequency. Provides a $\pm$10 MHz adjustment in the 10 MHz/cm dispersion positions, a $\pm$25 MHz adjustment of the center frequency, through the 5 MHz/cm to 0.2 MHz/cm positions, and a $\pm$2.5 MHz adjustment through the 500 kHz/cm to 1 kHz/cm DISPERSION positions.
FINE	A one turn control, that operates in conjunction with the IF CENTER FREQ control, to provide a fine adjustment of the IF center frequency. Provides $\pm$1 MHz adjustment for the .2 MHz/cm through the 10 MHz/cm dispersion positions and $\pm$50 kHz for the 1 kHz/cm through the 500 kHz/cm DISPERSION positions.
CAL	With the IF CENTER FREQ control centered, it calibrates the IF center frequency to 200 MHz.
VIDEO FILTER	With the switch in the up position the video bandwidth is restricted to reduce high frequency video components, such as noise, from distorting the display and enables easier evaluation of signal modulation when viewing signals near minimum resolution.
VERTICAL DISPLAY	Selects logarithmic, linear or square law display for the frequency domain displays, and VIDEO for a time domain display. In the LOG position, signal display amplitude is logarithmic, with a dynamic range $\geq$40 dB. In the LIN position, a signal display amplitude is linear with a dynamic range $\geq$26 dB. In the SQ LAW position signal amplitude is a square law function or the display amplitude is a function of signal power. The SQ LAW dynamic range is $\geq$13 dB. The VIDEO position connects the INPUT connector to the vertical amplifier of the plug-in oscilloscope.
RF CENTER FREQ	Tunes the RF center frequency from 1.5 GHz to 40 GHz. With the IF CENTER FREQ control in the 0 position, the RF CENTER FREQ dial indicates the center frequency of the display.
FINE RF CENTER FREQ	A fine adjustment of the RF local oscillator frequency. Especially useful in tuning the oscillator to a phase lock condition with the reference frequency.
MIXER PEAKING	A control used to optimize the conversion action of the first mixer. The control is adjusted to optimize mixer conversion for any fixed center frequency setting. This must be done for each dispersion window.
LOCK CHECK	A pushbutton switch that applies the output of the phase lock amplifier to the vertical display system, providing a visual indication to the operator. The operator can then check a particular lock point or establish a phase lock of the 1st local oscillator to the stable reference frequency. Phase Lock Operation on page 2-10, describes the procedure.
INT REF FREQ	A switch and control. The control varies the internal 1 MHz reference frequency over a range of approximately 1 kHz. With the control in the OFF position, the internal reference frequency is turned off, and an externally applied signal to the EXT REF FREQ IN (1 MHz MARKERS OUT) connector becomes the reference frequency.
1 MHz MARKERS OUT-EXT REF FREQ IN	A BNC connector that provides 1 MHz marker output signals to calibrate the dispersion. With the INT REF FREQ control in the OFF position, an external signal between 1 MHz and 5 MHz (1 to 5 V peak to peak) applied to the connector becomes the reference frequency for phase lock operation.
TO RECORDER	Signals on the display may be recorded by plugging into the TO RECORDER output. The output is linear and equals 2 mV or more per centimeter of displayed signal amplitude (in the LIN mode) into a 600 ohm load.

RF INPUT—Coaxial receptacle which connects through either a Coaxial Mixer and low loss coaxial cable to the signal source or (if above 12.4 GHz), through a Waveguide Mixer Adapter and a two-foot coaxial cable to one of three Waveguide Mixers which connect to the signal source. See Signal Applications.

Signal Application

The frequency of an RF signal determines how it will be applied to the RF INPUT. Signals in the frequency range of 1.5 GHz to 12.4 GHz are applied through a low loss coaxial cable, such as RG-9B/U, to a Coaxial Mixer Assembly which is installed into the input receptacle. Signals in the 12.4 GHz to 40 GHz range are applied to an external Waveguide Mixer which connects through a two-foot coaxial cable and a Waveguide Mixer Adapter to the input receptacle. The Waveguide Mixer Adapter replaces the Coaxial Mixer Assembly in the input receptacle.

Mixers and accessories may be ordered separately as required. The selection of mixers and adapters for the frequency coverage is as follows:

1.5 GHz to 12.4 GHz — Plug-In Coaxial Mixer, Tektronix Part No. 119-0096-00.

12.4 GHz to 40 GHz—Waveguide Mixer Adapter, Tektronix Part No. 119-0104-00; Coaxial Cable, Tektronix Part No. 012-0115-00 and one of the following Waveguide. Mixers.

Band	Wave-guide (EIA designation)	Frequency Range	Flange Type	Tektronix Part Number
Ku	WR62	12.4 GHz to 18.0 GHz	UG-419/U	119-0097-00
K	WR42	18.0 GHz to 26.5 GHz	UG-595/U	119-0098-00
Ka	WR28	26.5 GHz to 40.0 GHz	UG-599/U	119-0099-00

The Mixer Adapter or Coaxal Mixer may be removed from the input receptacle by turning the retainer ring in either direction. To replace either assembly, push the adapter or coaxial mixer against the spring until the flange bottoms, then turn until the latch snaps to hold the unit in place.

Signal input power to the analyzer should not exceed —30 dBm. Signals above this level overload the 1st mixer and/or the 1st IF stage and generate spurious signals on the display. Add at least 10 dB of attenuation to the input when the signal begins to compress (no increase of signal amplitude wth an increase of signal level). A conversion chart (Fig. 2-5) may be used to calculate input signal level.

CAUTION

Signals stronger than +15 dBm applied to the input or mixer will damage or burn out the mixer diodes.

Mismatches between the signal source and the RF INPUT connectors may be caused by signal source output impedance, long coaxal cables, etc. These mismatches will adversely affect display flatness. When optimum flatness is desired and signal strength is adequate, a 50Ω attenuator pad of approximately 6 to 10 dB should be added between the signal source and the input to the mixer. The addition of the attenuator will minimize reflections and optimize display flatness.

NOTE

Quality of attenuator used is of vital importance. It is suggested that attenuators such as Tektronix Part Numbers 011-0085-00 (10 dB), 011-0086-00 (20 dB) and 011-0087-00 (40 dB) or equivalent be used.

FIRST TIME OPERATION

Preliminary

If the instrument has not been installed into the plug-in compartment of the oscilloscope as directed under Installation, proceed as follows:

a. Set the Sweep Voltage selector at the rear panel (see Fig. 2-4) to the correct position (100 V or 150 V) for the oscilloscope being used. Some Tektronix Oscilloscopes and their sweep voltage output are listed on the back panel of the instrument. If your oscilloscope is not listed, check the specifications given in the oscilloscope instruction manual for the voltage swing of the sawtooth out signal.

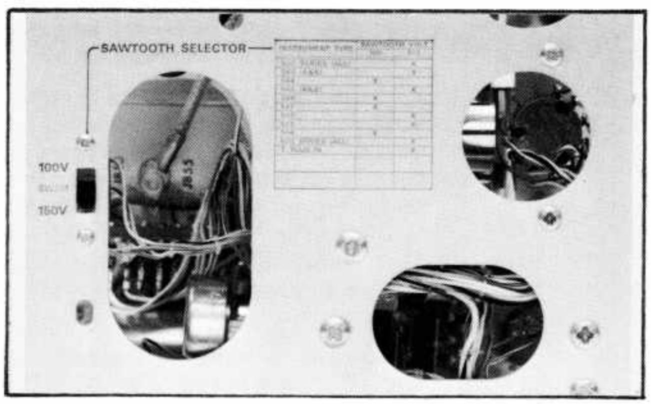

Fig. 2-4. Rear panel of the Type 1L40 showing sawtooth selector.

b. Insert the Type 1L40 into the plug-in compartment and fasten the securing latch.

c. Turn on the oscilloscope power, connect a patch cord between the Oscilloscope Sweep output and the Type 1L40 SWEEP INPUT connector. Allow approximately 20 minutes warmup period for the instrument operation to stabilize.

d. Set the Type 1L40 and plug-in oscilloscope front panel controls as follows:

DISPERSION RANGE	MHz/CM
DISPERSION—COUPLED RESOLUTION	Controls coupled together and in the 10 MHz/cm position

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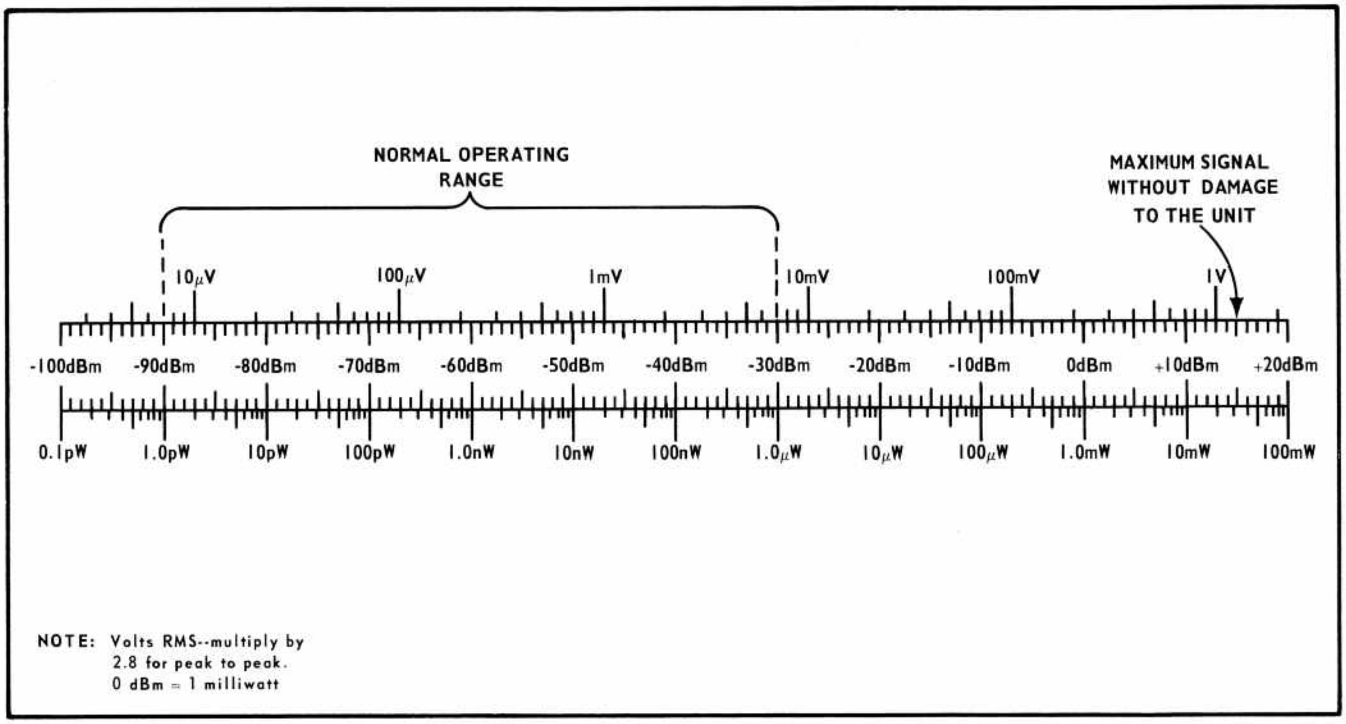


Fig. 2-5. Volts-dBm-Watts conversion chart for 50 Ω impedance.

IF ATTEN dB	All switches in OFF position
IF CENTER FREQ	Centered (000)
FINE	Midrange
POS	Centered
VIDEO FILTER	OFF
VERTICAL DISPLAY	LIN
GAIN	CCW
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF OR EXT REF FREQ IN
MIXER PEAKING	CCW

Plug-in Oscilloscope

Time/Cm	5 ms
Triggering	Adjusted for a free running sweep

1. Turn the Intensity control clockwise until a trace is visible, then adjust the Focus and Astigmatism controls for optimum trace definition.

2. Position the trace to the horizontal center and to the bottom line of the graticule with the Position controls.

3. Adjust the Scale Illum control for the desired graticule illumination.

4. Using a signal generator, apply a low amplitude signal (between —60 and—30 dBm) within the frequency range of the instrument to the Coaxial or Waveguide Mixer.

5. Adjust the GAIN control for a moderate noise level (0.5 cm) on the display, then rotate the RF CENTER FREQ control through the dial range. Note the rate and direction of movement (left to right or right to left) of the signals across the screen.

6. Tune the dial to the frequency of the applied input RF signal.

7. Adjust the MIXER PEAKING control for optimum signal amplitudes.

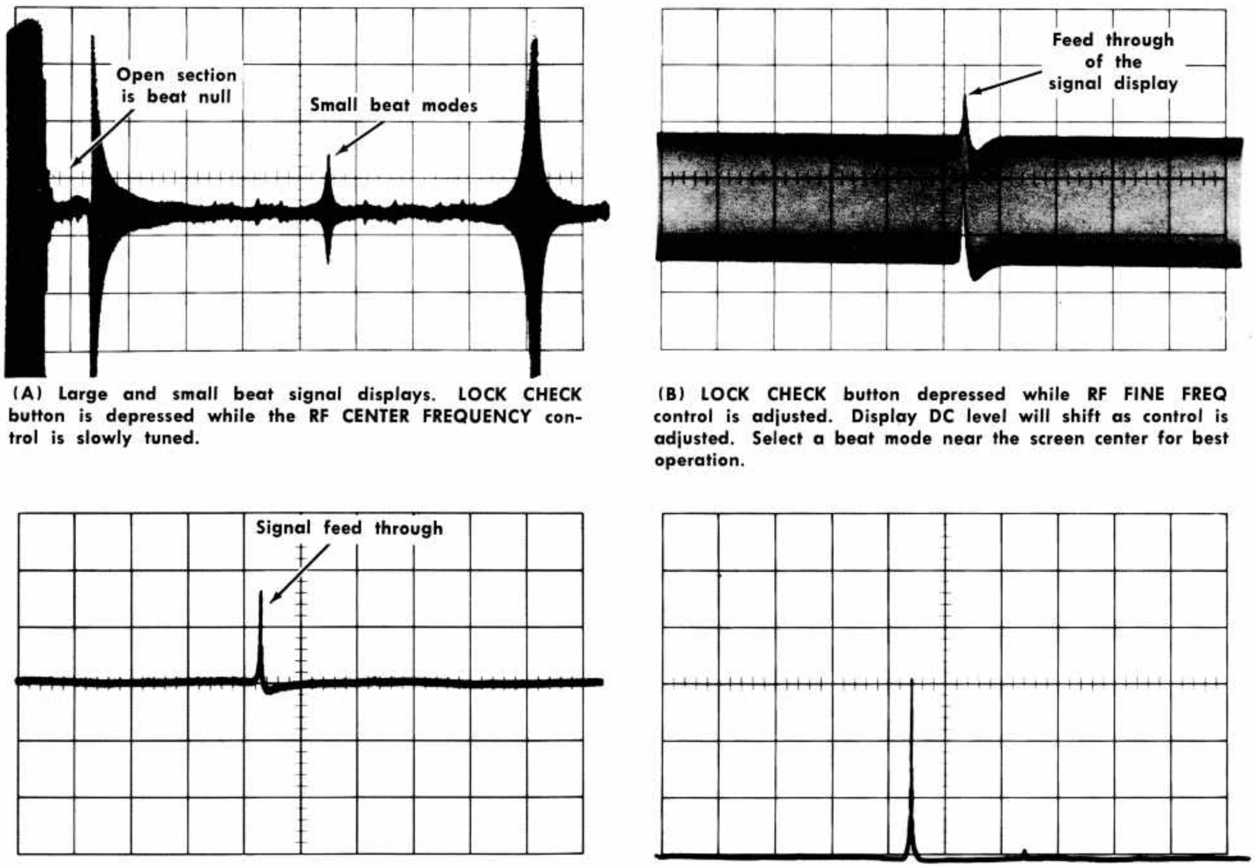
8. Adjust the GAIN and/or IF ATTEN dB switches for a signal amplitude on the display of approximately 4 centimeters.

9. Tune the signal to the extreme left graticule line with the RF CENTER FREQ control. Note the dial reading. Tune the signal to the extreme right graticule line and note the dial reading. The difference between dial readings is the total dispersion window for this 10 centimeter display. Tune the signal to the center of the screen and switch th DISPERSION--COUPLED RESOLUTION selector to the 5 MHz/cm position. It should decrease to ½ the total dispersion noted with the DISPERSION selector in the 10 MHz/cm position. Tune the signal to the center of the screen.

10. Tune the IF CENTER FREQ control through its range. Note that all signals move across the screen in the same direction and the same amount. This control will shift the IF center frequency approximately + and —25 MHz with the DISPERSION controls set to 5 MHz/cm. Tune the IF CENTER FREQ control to its centered (000) position.

11. Change the DISPERSION selector to .5 MHz/cm position. Adjust the FINE IF CENTER FREQ control. Note the frequency range of this control. This control will shift the IF center frequency approximately + or — 1 MHz with the DISPERSION selector set to .5 MHz/cm position.

12. Switch the plug-in oscilloscope Time/Cm switch between the .1 s and .1 ms positions. Note the change in signal amplitude and the resolution. Return the Time/Cm selector to the 5 ms position



(A) Large and small beat signal displays. LOCK CHECK button is depressed while the RF CENTER FREQUENCY control is slowly tuned.

(B) LOCK CHECK button depressed while RF FINE FREQ control is adjusted. Display DC level will shift as control is adjusted. Select a beat mode near the screen center for best operation.

(C) Null point. Oscillator will now lock in phase with the reference frequency. Release LOCK CHECK button.

(D) LOCK CHECK button released. Normal display of a phase locked condition. Center desired signal on screen with the IF CENTER FREQ controls.

Fig. 2-6. Lock check displays

13. Set the DISPERSION selector to 500 kHz, switch the DISPERSION RANGE switch to the kHz/CM position, then decrease the DISPERSION to kHz/cm keeping the signal centered on screen with the IF CENTER FREQ control. Uncouple the RESOLUTION control and turn clockwise. Note that the displayed bandwidth increases as the resolution bandwidth is increased. The resolution bandwidth may be varied from approximately 1 kHz to 100 kHz. Return the RESOLUTION control to the coupled position with the DISPERSION selector.

14. Turn the INT REF FREQ switch to the INT position.

15. Push the LOCK CHECK button and turn the RF CENTER FREQ control slowly through the signal frequency. Note the phase lock beat signals between the tunable local oscillator and the Internal Reference Frequency oscillator as the display blooms then snaps into the phase lock operation (Fig. 2-6). See Phase Lock Operation on page 2.

16. With the LOCK CHECK button depressed, adjust the FINE RF CENTER FREQ control. Note the beat frequency display, as the control is varied, and the vertical displacement of the display baseline. This baseline vertical shift is the change in the output DC level of the phase lock amplifier. Note the zero beat signal compression at the extreme position of this control compared to the amplitude near the center. Phase lock condition should be set with the DC level midrange between the two extreme positions noted above on the CRT as the FINE IF CENTER FREQ control was rotated. Adjust for phase lock operation and release the LOCK CHECK button.

17. Set the DISPERSION selector to 500 kHz, switch the DISPERSION RANGE switch to the kHz/CM position, then decrease the DISPERSION to 50 kHz/cm, keeping the signal centered on screen with the IF CENTER FREQ control. If the signal should suddenly shift off screen, phase lock operation has probably been lost. A slight adjustment of the FINE RF CENTER FREQ control will usually restore the phase lock condition and return the signal on screen.

18. Uncouple the RESOLUTION control and turn the control clockwise. Note the bandwidth increase as the resolution bandwidth is increased. The resolution bandwidth may be varied from approximately 1 kHz to 100 kHz. Return the RESOLUTION control to the coupled position with the DISPERSION selector.

Front Panel Calibration Adjustments

Three screwdriver adjustments provide calibration adjustments for the DISPERSION, IF CENTER FREQ and the DISPERSION RANGE balance. These front panel adjustments must be recalibrated, if the Type 1L40 is shifted to another oscilloscope, to compensate for differences in sawtooth amplitudes. It is also advisable to check the adjustments periodically during regular use. Adjustment and a calibration check may be performed as follows:

1. Balance and Calibration Check

a. Set the INT REF FREQ control to OFF position.

b. Tune a signal on screen with the RF CENTER FREQ control.

c. Tune for minimum signal shift as the DISPERSION RANGE is switched from MHz/CM to kHz/CM positions.

d. With the DISPERSION RANGE selector at the MHz/CM position, adjust the IF CENTER FREQ control for minimum signal shift as the DISPERSION selector is switched through the 10 MHz to .2 MHz positions.

e. Set the DISPERSION RANGE selector to kHz/CM position and the DISPERSION to 500 kHz/cm.

f. Center the signal in the graticule area with the Horizontal Position control. Check the signal position on the sweep. The signal should locate within ±1 cm of the sweep center with the sweep extending over the 10 centimeter width of the graticule. Front panel calibration is required if this requirement is not met. Perform the following adjustments if front panel calibration is required.

NOTE

These adjustments interact, and must be performed in sequence.

2. IF CENTER FREQ CAL Adjustment

a. Set the IF CENTER FREQ control to 000 and center the FINE control. Center DISP BAL and the IF CENTER FREQ-CAL adjustments. Set the DISPERSION RANGE switch to the MHz/CM position and the DISPERSION control to 5 MHz/cm position.

b. Apply a stable RF signal to the RF INPUT connector. Adjust the GAIN control to obtain a usable signal amplitude.

c. Adjust the RF CENTER FREQ and the FINE RF CENTER FREQ controls for minimum signal shift as the DISPERSION RANGE is switched between the MHz/CM and the kHz/CM positions.

d. With the DISPERSION RANGE in the MHz/CM position, adjust the IF CENTER FREQ-CAL for minimum signal shift as the DISPERSION control is switched through the MHz (10 MHz - .2 MHz) positions.

e. Set the DISPERSION control to the 5 MHz/cm position. Position the signal to the graticule center with the Oscilloscope Horizontal Position control. If the signal is more than 1 centimeter from the sweep center, it should be centered with the internal Sweep Center adjustment R204. See Calibration section.

3. DISP-BAL Adjustment

a. Tune the RF signal to the screen center as described in step 2.

b. Adjust the DISP BAL for minimum signal shift as the DISPERSION RANGE selector is switched between the MHz/CM and kHz/CM positions. (Start the balance adjustment with the DISPERSION RANGE switch in the kHz/CM position and the DISPERSION in the 5 MHz - 500 kHz position, then decrease the DISPERSION to the .2 MHz - 20 kHz position.)

Final adjustment is made with the DISPERSION RANGE selector in the kHz/cm position and the DISPERSION in the 1 kHz position. Fine adjustment of the DISP BAL (with the IF CENTER FREQ set to 000) permits dispersion changes from 10 MHz/cm to 1 kHz/cm with minimum shift in signal position on the screen.

NOTE

If dispersion balance cannot be achieved by the above procedure, the instrument requires internal adjustment. Refer to the Calibration section of the manual.

4. DISP-CAL Adjustment

a. Set the Analyzer front-panel controls as follows:

IF ATTEN dB	All OFF
IF CENTER FREQ	000 (centered)
DISPERSION RANGE	kHz/CM
DISPERSION-COUPLED RESOLUTION	500 (inner ring)
VERTICAL DISPLAY	SQ LAW
INT REF FREQ	CCW (next to OFF position, but not switched to OFF OR EXT REF FREQ IN position)

b. Connect the 1 MHz CAL MARKERS OUT signal through a coaxial cable to the RF INPUT connector.

c. The display will probably have one set of calibration markers superimposed with another set of markers. (One set of markers only when Waveguide Mixer Adapter is used.) If this is the case, adjust the RF CENTER FREQ controls to bring the tunable markers into horizontal alignment with the feed-through or fixed markers.

d. Adjust the DISP-CAL for 1 marker/centimeter. See Fig. 2-7. Use the Horizontal Position control or the IF CENTER FREQ control to align the markers to the graticule lines. Dispersion is calibrated over the center 8 centimeters of the display.

e. Remove the 1 MHz CAL MARKER signal from the RF INPUT connector.

This concludes the front-panel calibration adjustments for the Type 1L40.

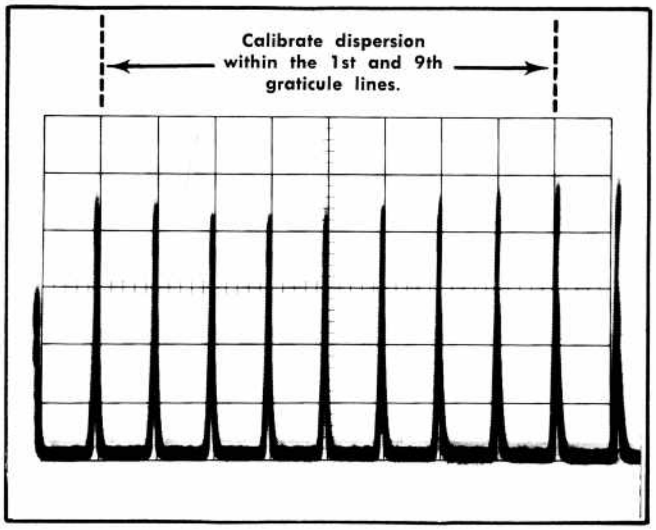


Fig. 2-7. 1 MHz Markers Output signal (phase lock reference) applied to the RF INPUT connector to check dispersion calibration.

GENERAL OPERATING INFORMATION

RF Center Frequency Tuning

The dial and the analyzer are tuned through the frequency range of each scale by the RF CENTER FREQ control. The dial frequency calibration is accurate to within $\pm$ (2 MHz + 1% of the dial reading) when the FINE RF CENTER FREQ and the IF CENTER FREQ controls are centered. As the dial knob is rotated clockwise, the dial tape increases in frequency and true signals (see spurious responses) travel across the screen from left to right.

The RF CENTER FREQ control is supplemented by a FINE RF CENTER FREQ control that provides a fine tuning adjustment, through a limited frequency range, on either side of the dial frequency. This provides a fine tuning adjustment to establish phase lock operation.

MIXER PEAKING Control

The front-panel MIXER PEAKING control provides an adjustment to improve the over-all sensitivity of the Spectrum Analyzer. Its action is broad; therefore it can usually be set to an optimum setting and left unless there is a large change in the RF center signal frequency, or a change in RF dial scale.

Phase Lock Operation

The 1st local oscillator can be phase locked to either an internal 1 MHz reference oscillator or an external frequency source when it is applied to the EXT REF FREQ IN connector. Locking the local oscillator to a stable frequency, such as the internal 1 MHz crystal controlled oscillator, reduces the local oscillator incidental frequency modulation and frequency drift. This allows narrow dispersion and high resolution settings for signal analysis.

The frequency range for an external reference frequency is 1 MHz to 5 MHz, and amplitude limitations are 1 to 5 volts peak to peak. The external signal for phase lock operation is applied to the phase lock circuit when the INT REF FREQ control is turned ccw to the OFF OR EXT REF FREQ IN position.

The LOCK CHECK pushbutton applies the output of the phase lock amplifier to the vertical display system. The output of the phase lock amplifier contains the following: (1) Beat frequency signals between the local oscillator and the reference frequency when the oscillator frequency is very close to a lock with the reference frequency. (2) A DC reference level of the output amplifier. This DC level changes as the FINE RF CENTER FREQ control is rotated and shifts the local oscillator frequency a slight amount. It also affects the vertical position of the display baseline. Thus, by depressing the LOCK CHECK button and slowly turning the FINE RF CENTER FREQ control, the operator will observe the baseline of the display shift until a lock mode is reached. The baseline will then remain stationary over a portion of the control range as the circuit holds the local oscillator locked to the reference frequency. Turning the control further causes the circuit to lose its lock and the baseline jumps from the locked position.

Beat frequency signals are usually displayed just before a lock point is reached. See Fig. 2-6B. However, through part of the Type 1L40 frequency range, the phase lock operation may be very positive and the local oscillator will jump from one lock mode to another without displaying the beat signals or the smooth shift of the display baseline between lock points.

When the DC operating level of the phase lock amplifier reaches either extreme (top or bottom of the graticule area), the operation of the amplifier becomes non-linear and compression of the beat signals will be noted. Phase lock operation becomes difficult to achieve. The displayed DC level therefore aids in setting a phase lock condition within the linear operating range of the phase lock amplifier.

Part of the input signal is coupled through and displayed when the LOCK CHECK button is pushed. This permits the operator to re-establish a particular lock point that may be lost because of oscillator drift or other reasons. The operator adjusts the FINE RF CENTER FREQ control while observing the display until the signal is again at a particular lock point (the point where the baseline or the signal position locks) is set.

The local oscillator fundamental frequency locks in 1 MHz steps, (from one lock mode to the next) when the internal 1 MHz reference frequency is used for phase lock operation. This produces gaps as much as 5 MHz in the upper frequency scale, where the upper harmonic of the local oscillator is used. Continuous tuning through these gaps is provided by the INT REF FREQ control. Rotating the control through its range pulls the crystal controlled reference frequency approximately 1 kHz. This is sufficient to shift the local oscillator frequency through these gaps and maintain phase lock operation.

Phase lock operation is established as follows:

1. Tune the desired signal to the center of the display with the RF CENTER FREQ control.

2. Depress the LOCK CHECK button and adjust the FINE RF CENTER FREQ control for a lock indication within the center (4 cm) of the graticule. If the lock indication or beat

signal is outside the linear operating range of the amplifier (baseline of display at the top or bottom of the graticule), center the display with the FINE RF CENTER FREQ control then adjust the RF CENTER FREQ control to shift the signal towards a beat mode (Fig. 2-6). Adjust the FINE RF CENTER FREQ control, while observing the desired signal, for phase lock operation then release the LOCK CHECK button.

3. Decrease the dispersion to open the screen. Keep the signal centered on screen with the IF CENTER FREQ controls. If the local oscillator should lose its lock condition, when the dispersion settings are 100 kHz or less, the signal will disappear from the screen. A slight adjustment of the FINE RF CENTER FREQ control will usually return the signal to the display.

4. If two or more high frequency (upper scale) signals are to be resolved, they can be moved on the display without losing phase lock by adjusting the INT REF FREQ control.

Vertical Display Modes

The dynamic range of the displayed signal is dependent on the mode position of the VERTICAL DISPLAY switch. For example: The LOG (40 dB full screen) position will accentuate the side lobes of a signal while the SQ LAW position will de-emphasize the side lobes. Fig. 2-8 illustrates the effect of each display mode or each position of the VERTICAL DISPLAY switch.

The LOG position increases the dynamic range of the display. Large amplitude signals are attenuated more than small amplitude signals. This type of display approximates a logarithmic response curve and is most effective when there are large signal amplitude differences.

The LIN (linear) position provides linear signal amplification, so relative amplitude measurements may be performed over the full 6 cm graticule height.

The SQ LAW (power) position provides a display that is approximately proportional to the square of the input

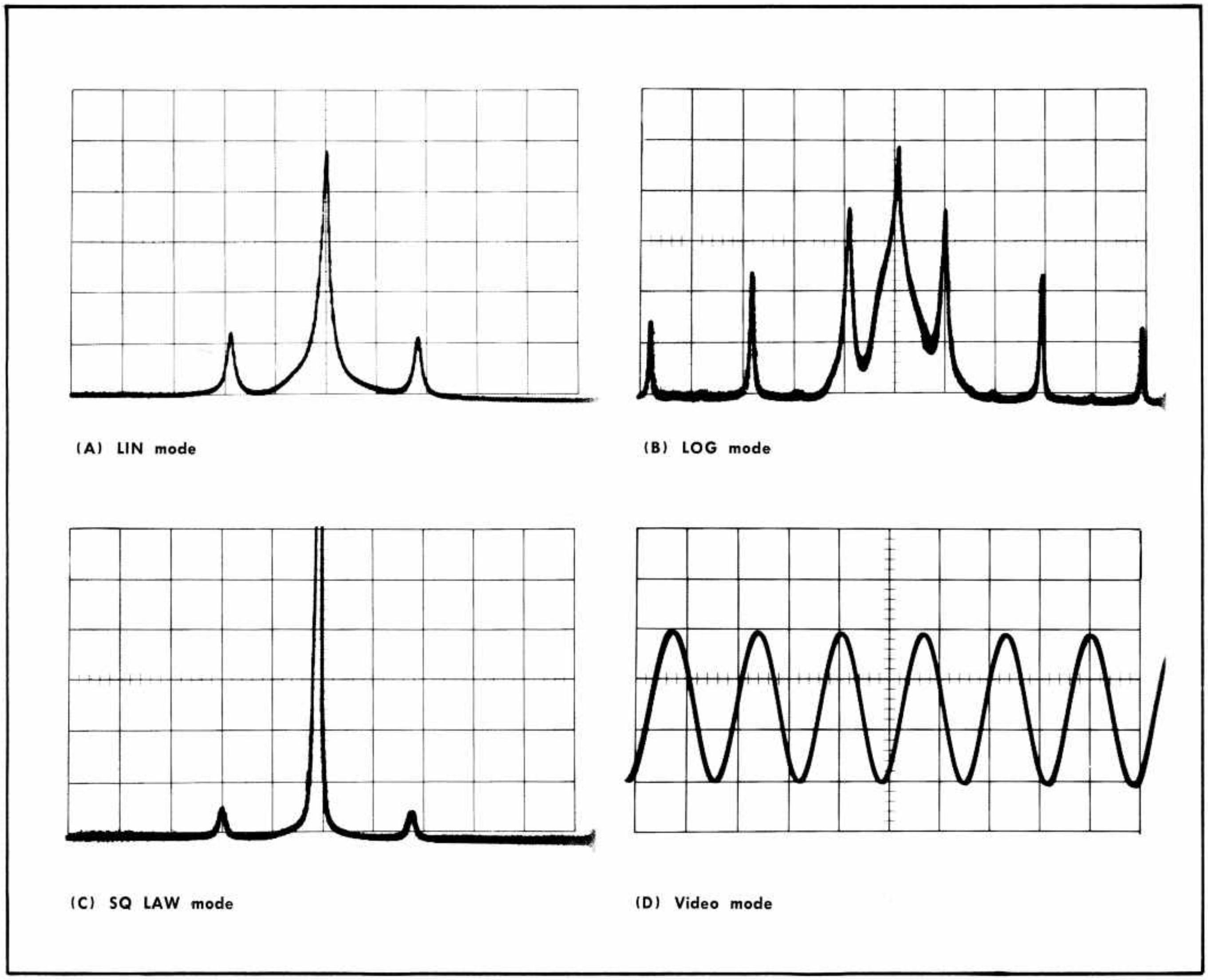


Fig. 2-8. Vertical display modes showing an amplitude modulated display. Video mode show the modulation signal.

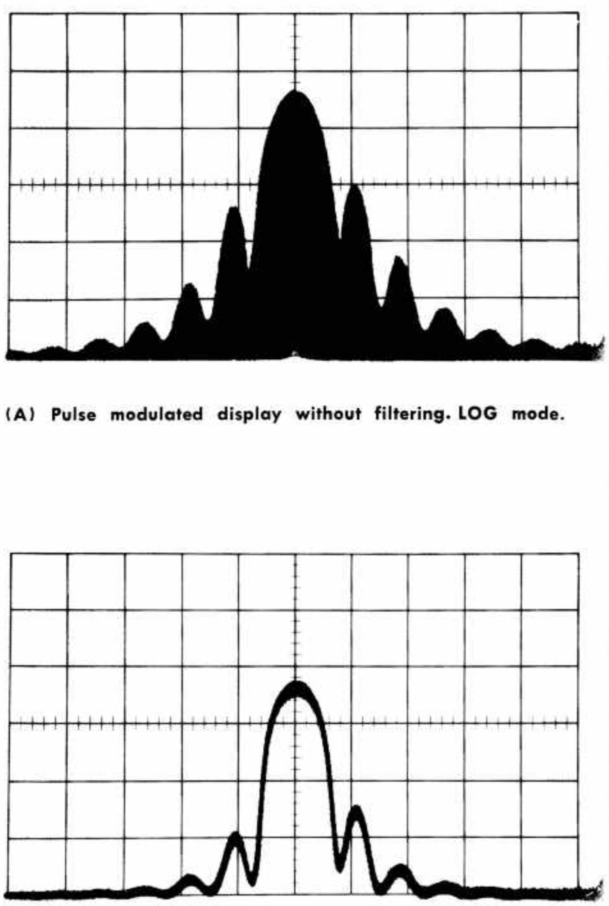
signal amplitude and may be used to compare the power level between signals. Small amplitude differences are accentuated when the analyzer is operated in this mode.

In the VIDEO mode, the spectrum display is grounded. Signals applied to the front-panel VIDEO INPUT connector will be displayed on a conventional (time versus signal amplitude) display. An uncalibrated GAIN control provides variable sensitivity adjustment. Maximum sensitivity is approximately 0.1 volt per centimeter.

The impedance of the VIDEO INPUT circuit is approximately 50 ohms; therefore high-impedance probes should not be used to couple signals to the VIDEO circuit.

Video Filter Operation

The video filter restricts the video bandwidth. The filter is useful in applications where the envelope of a pulsed RF spectrum is desired (Fig. 2-9) or in some cases it may improve the display resolution, see Fig. 2-23. It does, however, restrict the usable sweep rate because of the filter time constant. The sweep rate is usually reduced to about 50 ms/cm or slower when the filter is used.



(A) Pulse modulated display without filtering. LOG mode.

(B) Display with VIDEO FILTER switch ON.

Fig. 2-9. Integrating the display with the video filter.

Dispersion

Dispersion is the swept frequency width, or screen window. The frequency excursion of the frequency axis of the display is usually expressed as frequency per centimeter. The dispersion for the Type 1L40 is adjustable from 10 MHz/cm to 1 kHz/cm in a 1, 2, 5 sequence with an added zero dispersion position for fixed frequency operation.

Dispersion accuracy is a function of the IF CENTER FREQ control position and the DISPERSION RANGE switch setting. See Characteristics section. The kHz/CM range is more accurate than the MHz/CM range because of narrow swept frequency width. When a high degree of accuracy is desired for a particular frequency setting, the front-panel DISP-CAL may be used to calibrate the dispersion for a specific IF CENTER FREQ control setting. The procedure is as follows:

1. Adjust the front panel controls for the desired display.

2. Turn the INT REF FREQ control ccw but not OFF. Apply the 1 MHz CAL MARKERS OUT signal to the RF INPUT connector. This should provide a picket fence display. See Fig. 2-7.

3. If a coaxial mixer is being used and two sets of markers appear, a confusing display may be avoided by adjusting the RF CENTER FREQ control a slight amount to identify the feed-through or fixed markers. The tunable markers should be turned so they coincide with the fixed markers to eliminate confussion in the display.

4. Calibrate the display by adjusting the DISP-CAL for the correct markers per centimeter, or read the dispersion directly from the marker picket fence.

5. Remove the 1 MHz markers from the RF INPUT and reconnect the signal. Perform the desired dispersion measurement.

6. After the measurement, recalibrate the dispersion as described under Front Panel Adjustment.

Resolution and Dispersion

Resolution is the ability of the spectrum analyzer to display adjacent signal frequencies discretely. The measure of resolution is the frequency separation (in Hz) of two equal amplitude signals when the notch or dip between these signals is 3 dB down. The resolution for a given display is a function of sweep speed, dispersion and bandwidth of the most selective (usually the last IF) amplifier in the signal path.

Resolution bandwidth is approximately the —6 dB bandwidth (with Gaussian response) of the analyzer, with the dispersion and sweep time adjusted for the minimum displayed bandwidth to a CW signal. Resolution and resolution bandwidth become synonymous at very long sweep times.

As the analyzer sweep rate is increased, the amplitude of a CW signal decreases and the bandwidth increases; which signifies that both the sensitivity and resolution of the analyzer have been degraded by the increased sweep rate.

The loss of the analyzer sensitivity due to sweep rate and the dispersion can be expressed mathematically as:

$$\frac{S}{S_o} = \left[1 + 0.195\left(\frac{D}{TB^2}\right)^2\right]^{\frac{1}{4}}$$

where the S/S_o is the ratio of the effective sensitivity to the analyzer measured sensitivity, at very slow sweep times or with zero dispersion.

D is the dispersion in hertz

B is the —3 dB bandwidth of the analyzer in hertz

T is the sweep time in seconds, or $\frac{T}{D}$ is the scanning velocity.

These same variables also determine the resolution of the analyzer. The loss in resolution can be expressed as follows:

$$\frac{R}{R_o} = \left[1 + 0.195\left(\frac{D}{TB^2}\right)^2\right]^{\frac{1}{2}}$$

Where R/R_o is the ratio of the effective resolution of the analyzer to the analyzer measured resolution bandwidth at very slow sweep speeds. R_o is somewhat arbitrary and is taken as the displayed width of the CW signal at the —6 dB point.

The best resolution for a given dispersion and sweep time is expressed as: $\frac{\text{Dispersion (in Hz)}}{\text{Sweep Time (in s)}}$. See Spectrum Analyzer definitions.

The resolution of the Type 1L40 Spectrum Analyzer is optimized for most settings of the DISPERSION selector when the RESOLUTION control is in the coupled position. Resolution, however, can be varied from approximately 100 kHz to less than 1 kHz by uncoupling the RESOLUTION control and adjusting it as an independent function of the DISPERSION selector.

To adequately resolve pulsed spectrum information, the resolution bandwidth of the analyzer should be on the order of 1/10 of the side lobe frequency width or the reciprocal of the pulse width. The RESOLUTION control is usually set, after the sweep rate has been adjusted, for optimum main lobe detail. See Fig. 2-10.

Selecting the Sweep Rate

The sweep rate for wide resolution coupled settings is usually set just above the visual flicker setting; however, as the DISPERSION is decreased the sweep rate will begin to affect the resolution and sensitivity of the analyzer as described under Resolution. Therefore, as the DISPERSION settings are reduced the sweep rate should also be reduced to maintain sensitivity and resolution.

With the DISPERSION control set to 0, the analyzer functions as a fixed tuned receiver. The analyzer then displays time domain characteristics of the signal modulation within the bandwidth capabilities of the analyzer. Sweep time can now be set to examine the modulation pattern.

Timing information such as pulse repetition rate may be obtained by triggering the sweep on the signal source (Internal Mode) and switching the oscilloscope Time/Cm control to a calibrated sweep time that will permit time measurement between the modulation pulses. See Fig. 2-11.

Triggering the Sweep

For most applications the oscilloscope triggering is set for free run operation; however, there are applications where it may be desirable or necessary to trigger the

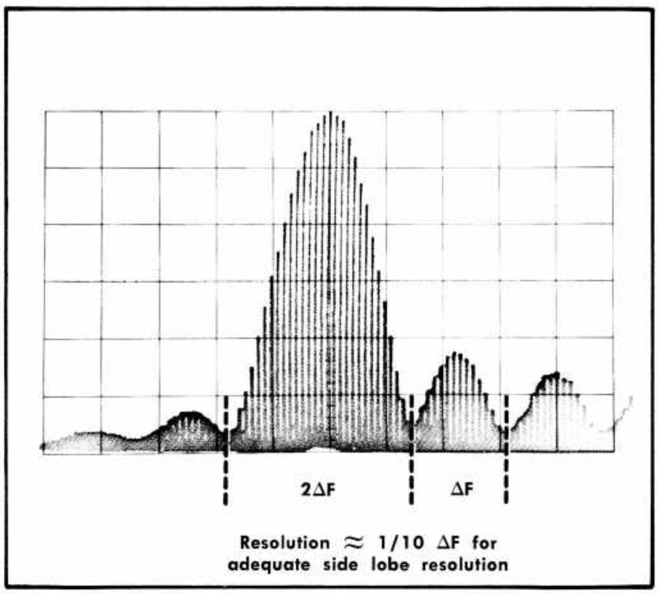


Fig. 2-10. Frequency spectrum of a pulse modulated signal.

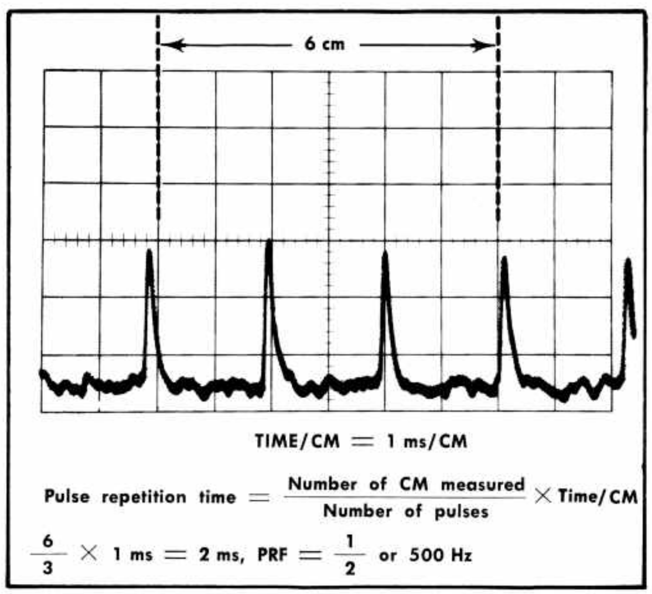


Fig. 2-11. Measuring pulse repetition time.

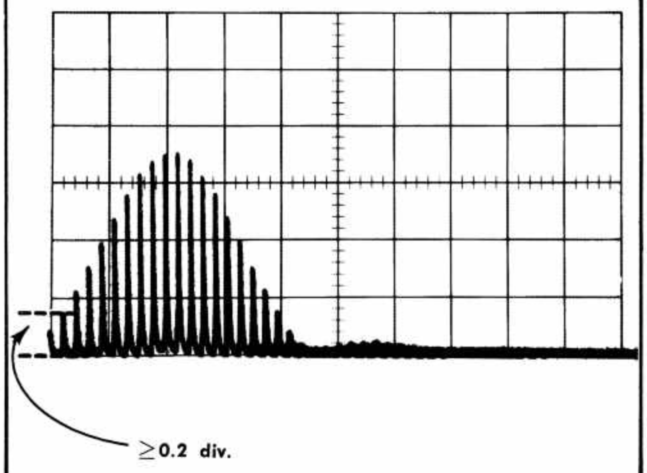


Fig. 2-12. To trigger the analyzer from the display requires 0.2 cm of signal. Tune the spectrum null point away from the sweep starting point with the RF CENTER FREQ control.

display; for example, at 0 dispersion, or when slaving the Type 1L40 to a recorder.

The display may be triggered internally by setting the oscilloscope Source switch to the Int position and adjusting the triggering controls to trigger on the display. The oscilloscope requires approximately 2 millimeters of signal amplitude to trigger satisfactorily. It may therefore be necessary to adjust the FINE RF or IF CENTER FREQ control to shift the sweep start away from a spectrum null point. See Fig. 2-12.

If the signal is time related to the power supply line frequency, it is best to trigger the oscilloscope on the Line frequency.

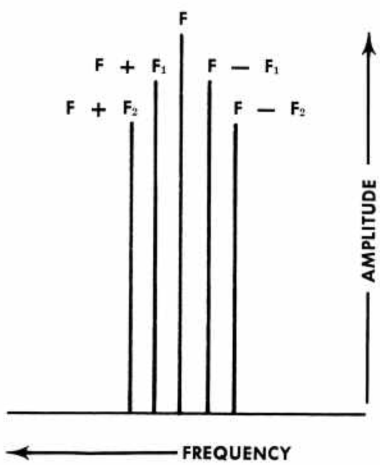
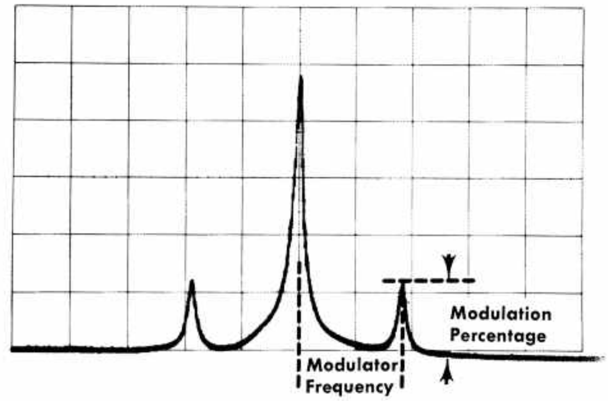


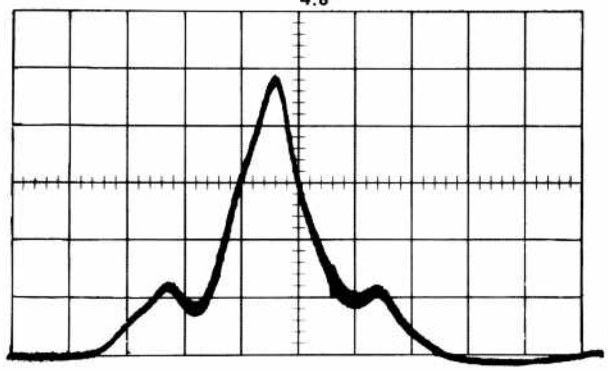
Fig. 2-13. Formation of a spectrum. F is the fundamental or carrier frequency, F_1 and F_2 are the modulating frequencies.



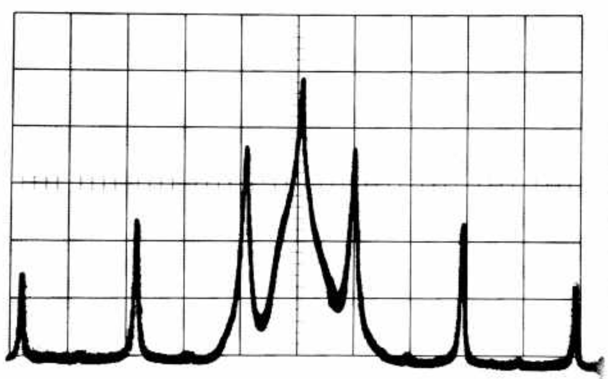
(A) CENTER FREQ 2 GHz
DISPERSION 50 kHz/CM
MODE LIN

This display shows: Carrier Frequency 2 GHz, modulating frequency (1.8cm × 50 kHz) = 90 kHz.

$$\% \text{ of modulation} = (2 \times \frac{1.2}{4.8} \times 100) = 50\%$$

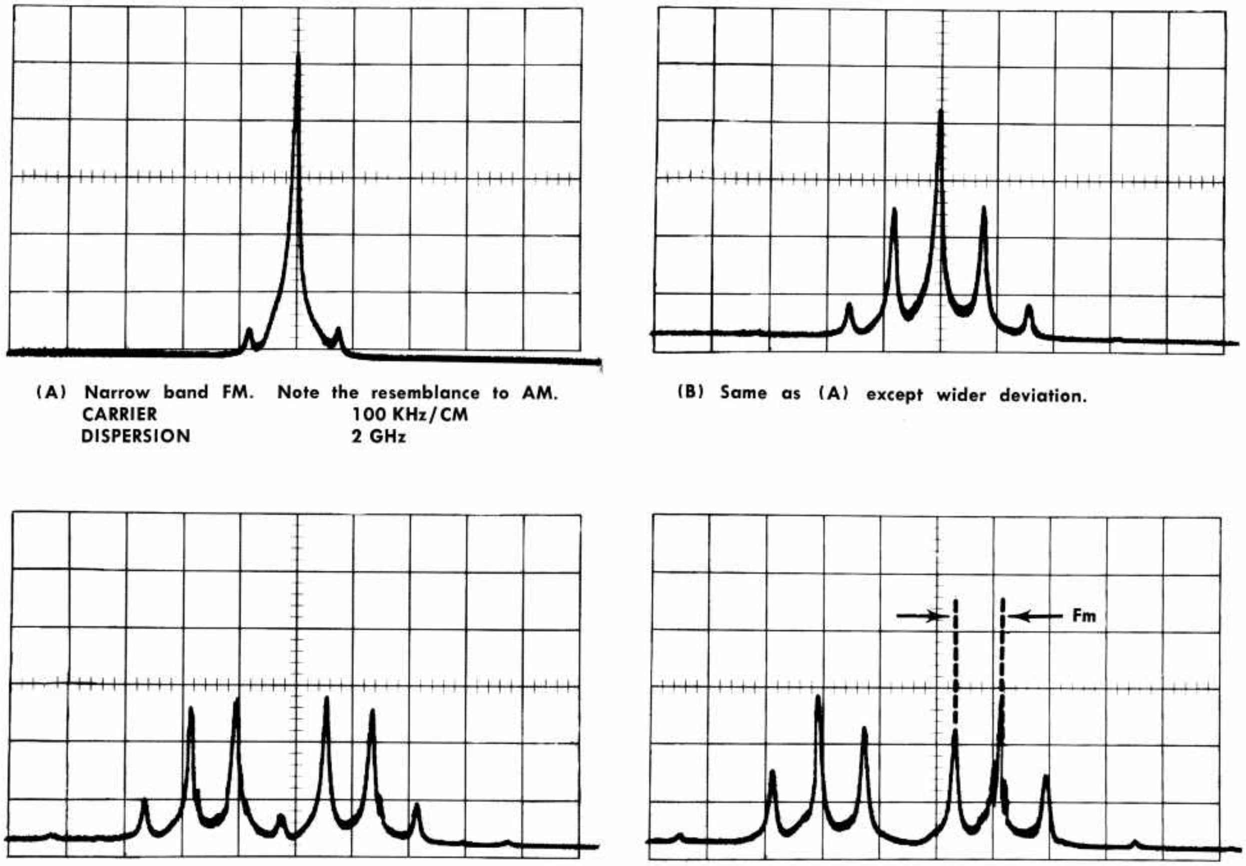


(B) Same as A but resolution bandwidth increased so that modulation is barely discernible.



(C) Over modulated signal produces extra sidebands. LOG mode.

Fig. 2-14. Spectrum showing series of AM signals.



(A) Narrow band FM. Note the resemblance to AM.
CARRIER 100 KHz/CM
DISPERSION 2 GHz

(B) Same as (A) except wider deviation.

(C) Carrier almost at a null.

(D) Carrier at null.

Fig. 2-15. Frequency modulated display. At first carrier null, index of modulation is 2.4; so ratio of deviation to rate is 2.4. Rate is 0.8 cm X 100 kHz/cm = 80 kHz. Deviation 2.4 X 80 kHz = 192 kHz.

Recorder Out

Signals on the display may be recorded by plugging a miniature phone plug from the recorded into the TO RECORDER output jack. A linear output is provided when the VERTICAL DISPLAY switch is in the LOG and LIN positions. With the DISPLAY switch in the SQ LAW position, the output to the TO RECORDER connector is square law.

SPECTRUM ANALYZER DISPLAYS

The Spectrum Analyzer display is a plot of signal amplitude as a function of frequency. This display in the frequency domain may be used to analyze the frequency characteristics of many types of RF signals. This section describes some of these basic spectrum displays and basic applications for the Type 1L40.

Spectra of Amplitude Modulation

When a CW signal is amplitude modulated by a single frequency, two additional frequencies or sidebands are generated. The frequencies of these sidebands are the sum and difference between the carrier and the modulating frequency. See Fig. 2-13. The amplitude of these sidebands depends on the percentage of modulation. Fig. 2-14 illustrates the spectrum of an amplitude modulated signal and shows how the percentage of modulation is calculated.

When the carrier is modulated by a multiple of modulating frequencies, such as television picture information, the spectrum becomes very complex. The analyzer may be used to measure sideband energy plus the modulation bandwidth. To resolve all frequencies within the spectrum the analyzer resolution bandwidth must be less than the lowest modulating frequency or the difference between two modulating frequencies, whichever is the least.

A spectrum analysis of an amplitude modulated signal furnishes the following information: The carrier or fundamental frequency, modulation percentage, modulating frequencies, sideband energy distribution and modulation bandwidth. Some other characteristics that may be evaluated from the spectrum are; degree of incidental FM (evidenced by signal jitter), non-linear modulation and overmodulation.

Spectrum of a Frequency Modulated Signal

When a CW signal (F_c) is frequency modulated at a rate (F_m), it theoretically produces an infinite number of sideband frequencies. These frequencies equal the carrier frequency plus or minus the modulating frequencies ($F_c \pm nF_m$ where n = 1, 2, 3, . . .etc). Figure 2-15 illustrates various degrees of frequency modulation.

The bandwidth of a frequency modulated signal is usually determined by the number or width of the sidebands that contain sufficient energy to dominate the display. A very approximate calculation of the signal bandwidth equals $2(\Delta F_c + F_m)$, where ΔF_c is the frequency deviation of the carrier and F_m is the frequency of the modulating signal. Frequency deviation of the carrier is primarily dependent on the modulating signal amplitude.

This ratio of frequency deviation to modulating frequency is known as modulation index. Bessel function and frequency spectra for different modulation indices may be found in the 4th edition of Reference Data for Radio Engineers, Chapter 19.

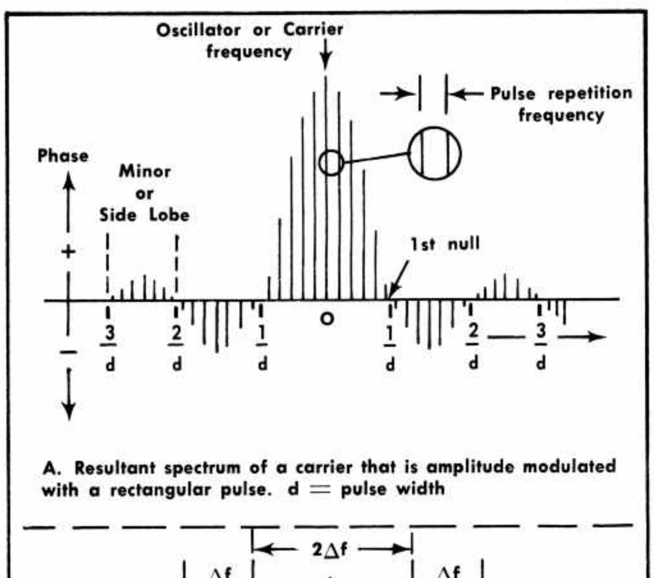


Fig. 2-16. Formation of a pulse modulated signal spectrum.

The resolution requirements for the spectrum analyzer to resolve adjacent sideband components in a frequency modulated display is the same as the requirements to resolve an amplitude modulated spectrum.

Spectra of a Pulse Modulated Signal

When a CW signal is pulse modulated, the carrier is periodically turned on and off. The on period is determined by the modulating pulse width; the off time is related to the pulse repetition time or frequency. The carrier is usually modulated by a rectangular-shaped pulse.

A symmetrical square wave is composed of its fundamental frequency plus odd harmonics. If the relative amplitudes and phase of the harmonics are changed, a number of wave shapes are produced; rectangular, trapezoidal, sawtooth, etc. The spectrum of the rectangular wave or any pulse shape is displayed according to its frequency components and their amplitudes. Common pulse forms and their spectra are also described in Reference Data for Radio Engineers, 4th edition, Chapter 35. ITT 1956.

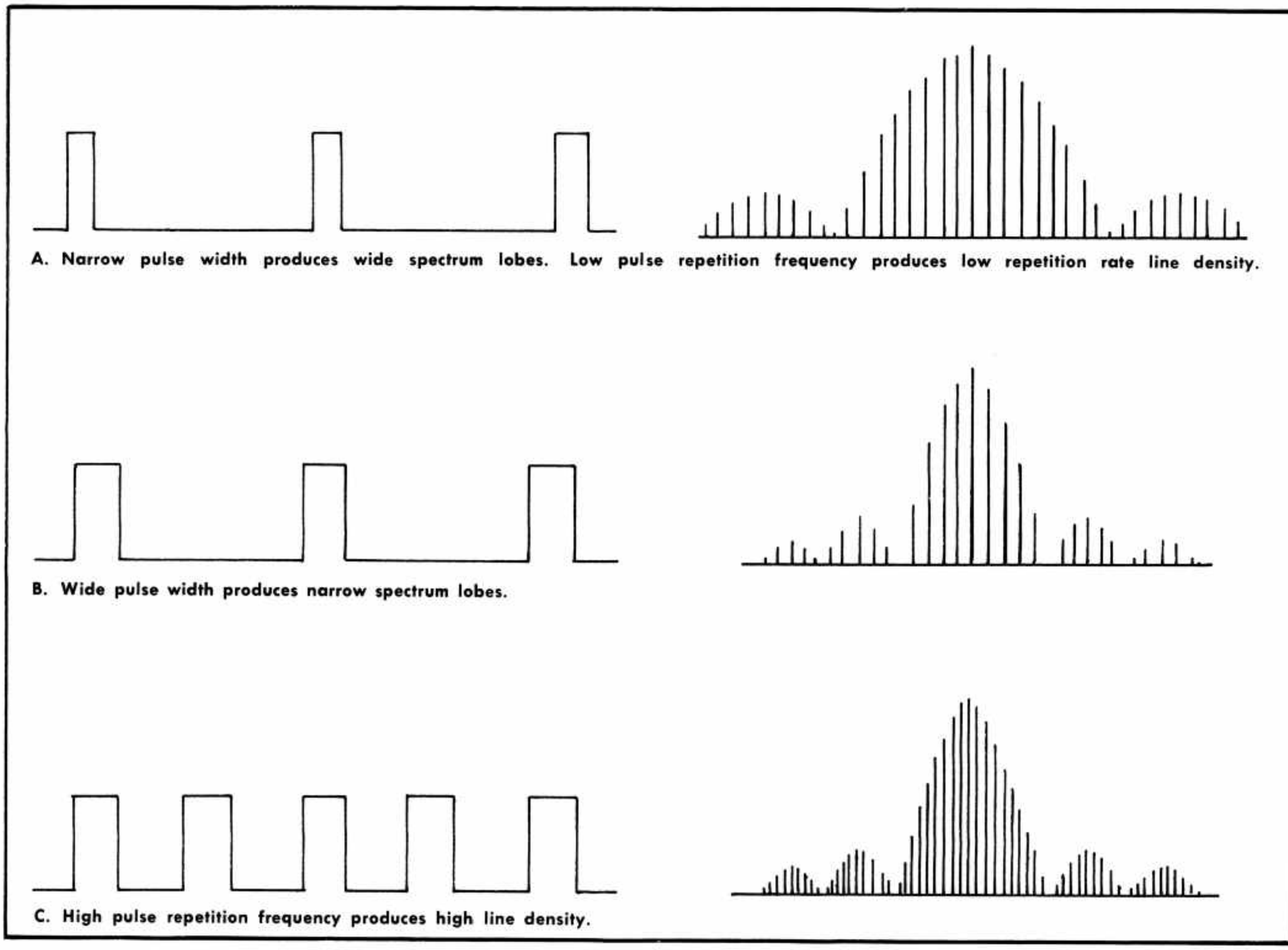
Fig. 2-16A illustrates a theoretical voltage spectrum of a pulse-modulated oscillator that is modulated by a rectangular pulse. The main lobe and the side lobes are shown as groups of spectral lines extending above and below the baseline. The number of these side lobes, for a truly rectangular pulse, approaches infinity. Any two adjacent side lobes are separated on the frequency scale by a frequency equal to the inverse of the modulating pulse width.

Fourier theory shows that adjacent lobes are 180° out of phase; however, since the spectrum analyzer is insensitive to phase, only the absolute value of the spectrum is displayed and appears as illustrated in Fig. 2-16B.

Fig. 2-17 illustrates the relative effects the pulse width and pulse repetition frequency have on a pulsed RF spectrum. Since the spacing between the spectral lines of the pulsed RF spectrum is a function of the PRF (pulse repetition frequency), the spectrum analyzer resolution bandwidth should be less than the PRF to respond to any one frequency component. This is impractical in most instances, however the spectrum envelope can be plotted with pulses. If the analyzer swept frequency is slow, it will plot a series of pips or lines, the locus of which represents the relative energy distribution of the swept spectrum. The number or density of these pips for a given PRF will depend on the sweep speed, or Time/Cm selection of the plug-in oscilloscope.

It is possible, by sweeping very slowly, to obtain the spectrum of a very low PRF signal. The display simulates a pulse spectrum and contains the same information for analysis. To resolve this spectrum the resolution bandwidth of the analyzer need only be less than the side lobe frequency width, or the reciprocal of the modulating pulse width. Fig. 2-18 illustrates the effect of frequency modulation on the pulse modulated display.

The peak amplitude of the main lobe of a pulse modulated RF spectrum represents only a portion of the total energy contained in the lobe. The main lobe is less than the amplitude of an equal peak value CW signal by an amount which is approximately 3/2 (t_p) × the resolution bandwidth,



A. Narrow pulse width produces wide spectrum lobes. Low pulse repetition frequency produces low repetition rate line density.

B. Wide pulse width produces narrow spectrum lobes.

C. High pulse repetition frequency produces high line density.

Fig. 2-17. Pulse width and PRF effects on pulse modulated spectrum.

where t_P (pulse width) is measured in seconds and bandwidth is the selected resolution bandwidth of the analyzer in hertz. Spectrum analyzer sensitivity measurements should therefore be made only with a CW signal applied, as indicated in the Performance and Calibration checks.

Signal Identification and Frequency Measurement

Spectrum Analyzers that have no preselection prior to the first mixer will display signals which do not conform to the indicated frequency reading of the dial. these signals are referred as spurii (many or plural) or spur (singular) which are colloquial terms used to relate to spurious responses. (See definitions for spectrum analyzer terms). They are the products of the following:

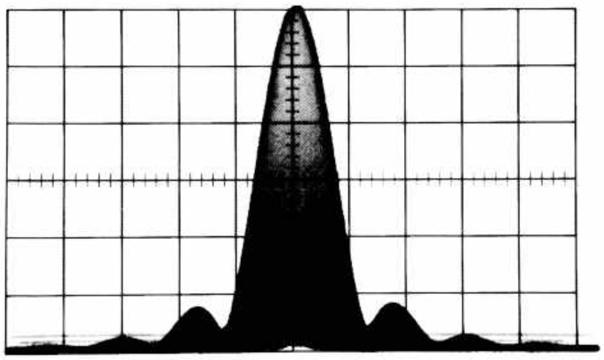
1. IF feedthrough: In the Type 1L40, the IF passband is 150 to 250 MHz. Frequencies within this passband may appear as non-tunable or IF feedthrough signals on a 100 MHz dispersion screen.

2. Signal images: The dial scales of the Type 1L40 Spectrum Analyzer are calibrated below the frequency of the tunable first local oscillator. The response to an input signal whose frequency is above the local oscillator frequency by a difference of the IF, is called an image response. The input signal that is the IF below the oscillator frequency is the true response. For example: the analyzer will receive a 2.7 GHz signal at a dial reading of 2.7 GHz (oscillator frequency of 2.9 GHz) and at a dial reading of 2.3 GHz (oscilloscope frequency of 2.5 GHz). At the image response point, the local oscillator frequency is 200 MHz (IF) below the input frequency instead of 200 MHz above the input frequency. Note that the difference between these two response points is 400 MHz or twice the IF.

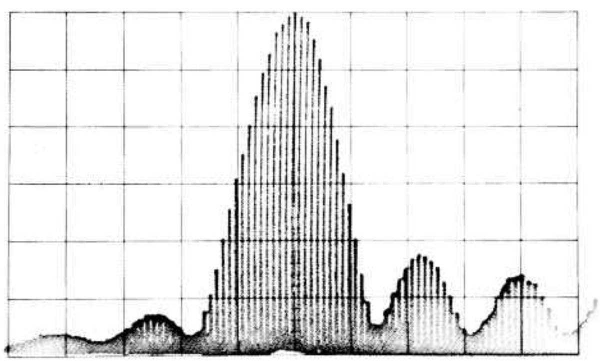
The dial is calibrated for signal frequencies that will mix with harmonics (2nd through the 10th) of the local oscillator.

3. Higher order modulation (harmonic conversion and inter-modulation)—signals: Any of the products (sums and differences) of the frequency multiples from the local oscillator and the signal, plus the myriad of combinations of more than one input signal that produce a frequency within the IF passband. The combination of the 2nd harmonic of an input signal mixing with the fundamental of another input signal to produce the IF (3rd order) is the most severe.

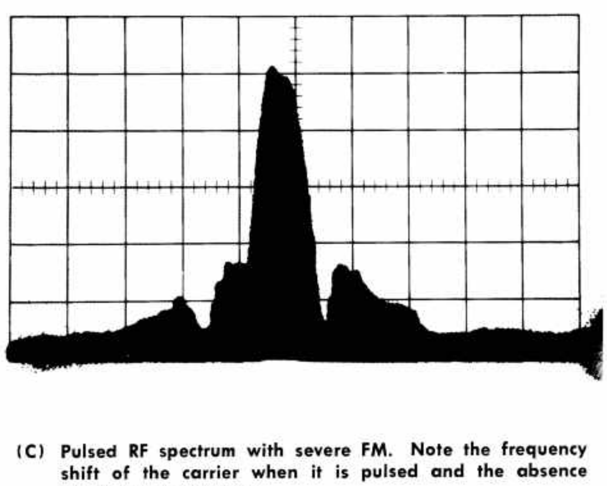
The possible combinations can be expressed mathematically as; $nf_{sig} \pm mf_{lo} = IF$; where n and m are intergers including 0 and indicate the harmonic order of the signal or local oscillator frequency. For example: A local oscillator (dial calibrated) frequency of 2.0 GHz could mix with frequencies of 2.2 GHz, 1.8 GHz, 2.2 GHz, 3.8 GHz, 6.2 GHz, 5.8 GHz, etc., to produce a 200 MHz IF.



(A) $\frac{\sin X}{X}$ spectrum of a rectangular RF pulse.



(B) Pulsed RF spectrum with some FM. Note the unbalance of the sidelobes.



(C) Pulsed RF spectrum with severe FM. Note the frequency shift of the carrier when it is pulsed and the absence of deep lobe minima.

Fig. 2-18. Pulse modulated displays.

4. Video detection: (See Spectrum Analyzer Terms.) These spurious responses are usually no problem if the input signal strength is below —30 dBm.

5. Internal: These spurious signals are normally below 2X the noise level for the Type 1L40.

Most spurious responses are easily identified as follows:

IF feedthrough signals will not tune across the display. Image signals tune across the display in the direction that is opposite to that of the true signal response. In the Type 1L40 the true signal response tunes from the left side of the display to the right as the dial frequency is increased or the RF CENTER FREQ control is turned clockwise. Their movement across the dispersion window is coincident with the frequency change of the dial scale as the RF center frequency is changed.

Higher order modulation or intermodulation produces spurii that are tunable, but their rate and amount of movement across the dispersion window, as the RF Center Frequency is tuned, is not coincident with the dial scale reading.

Most of the spurious signals described, with the exception of intermodulation products, can be reduced or eliminated by the use of external bandpass filters.

APPLICATIONS

These basic applications for the Type 1L40 Spectrum Analyzer are presented to familiarize you with its operation.

Relative Amplitude Measurements

The relative amplitudes between signals are measured as follows:

1. Center the IF CENTER FREQ controls, then tune the signal with the lowest amplitude to the center of the screen with the RF CENTER FREQ control.

2. Adjust the GAIN control so the low amplitude signal establishes some reference amplitude.

3. Tune the stronger signal to the center of the display. Add IF attentuation by switching in combinations of IF ATTEN dB switches, until the stronger signal amplitude decreases to the same reference amplitude established in step 2.

4. The total dB attenuation switched in is the relative amplitude difference, in dB, between the two compared signals.

NOTE

For maximum accuracy, the signals should be referenced and compared near the same location on the display. Tune each signal to the reference with the RF CENTER FREQ control.

The IF CENTER FREQ, the DISPERSION-COUPLED RESOLUTION, the FINE RF CENTER FREQ, and the Time/Cm controls should not be changed when measuring relative signal amplitude.

Frequency Measurements

Frequency measurements taken from the RF CENTER FREQ dial are accurate to within ± (2 MHz + 1% of the dial reading). The frequency of an applied signal is measured as follows:

1. Check the calibration of the IF CENTER FREQ CAL adjustment as described previously.

2. Set both the IF CENTER FREQ controls and the FINE RF CENTER FREQ control to their midrange (000) position.

3. Set the DISPERSION RANGE switch to kHz/CM and the DISPERSION selector to 500 kHz/cm positions.

4. Tune the RF CENTER FREQ control to center the desired signal within the graticule area.

5. Read the frequency indicated on the RF CENTER FREQ dial. This reading is accurate to within ± (2 MHz + 1% of the dial reading). For example: A dial reading of 5.0 GHz indicates the signal is 5.0 GHz ± (2 MHz +50 MHz) or, between 4.948 GHz and 5.052 GHz.

Accurate frequency measurements can be performed by applying a calibrated or crystal-controlled frequency to the RF INPUT and calibrating the dial near the frequency range of the input signal; then tune the input signal to the same screen position and note the dial reading plus or minus the measured dial error.

Frequency Difference Measurements

Frequency separation measurements to 100 MHz can be performed as follows:

1. Adjust the DISPERSION RANGE switch and the DISPERSION selector so the signals to be measured are the maximum number or graticule divisions apart on the display.

2. Set the Time/Cm selector and the RESOLUTION control for optimum signal definition.

3. Measure the distance in centimeters between the two signals (see Fig. 2-19).

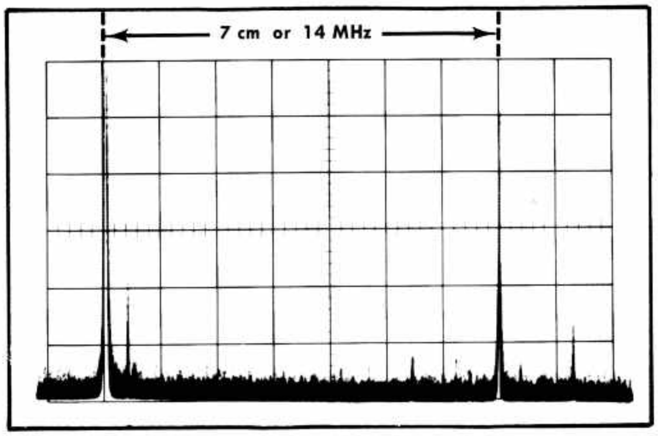


Fig. 2-19. Frequency difference measurement between two signals.
DISPERSION RANGE setting = MHz/cm
DISPERSION setting = 2
Frequency difference = (7 cm) (2 MHz/cm) = 14 MHz

4. Multiply the measured distance in step 3 by the Dispersion/Cm setting. This is the frequency separation or frequency difference between the two signals.

NOTE

Accuracy of this measurement depends on the DISPERSION RANGE settings. See Characteristics section.

Frequency Stability

The Type 1L40 may be used to measure both long and short term frequency instabilities, when the local oscillator is phase locked to a stable crystal-controlled reference frequency. See Stability in Characteristics section.

Short term stability measurements apply to fast frequency changes such as those caused by power supply noise and ripple, vibration or other random factors. Fig. 2-20 shows the random frequency modulation of a klystron.

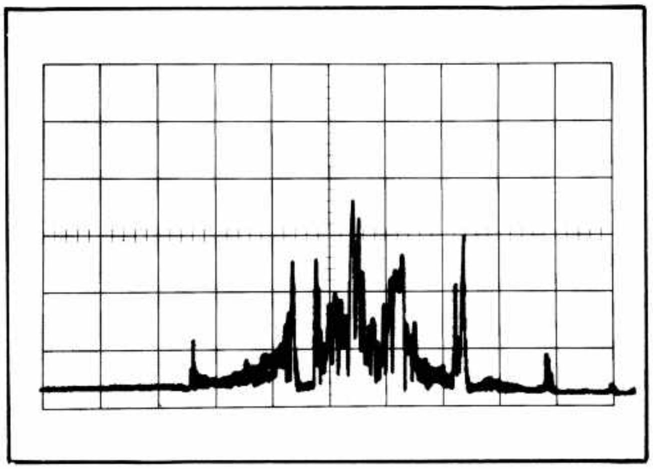


Fig. 2-20. Short term stability measurement. Random FM characteristic of a klystron. DISPERSION is 2 kHz/cm and RESOLUTION is 1 kHz. Oscillator FM is about 6 kHz.

Long term stability measurements require a recorder, a series of photographs, or the use of a storage oscilloscope to show frequency drift as a function of time. Temperature compensation can be computed by this process.

Amplitude Modulation

Modulating frequency or frequencies and modulation percentage are the quantities most often desired from an AM signal measurement. Fig. 2-14 illustrates some amplitude modulated signals, the methods to measure the modulating frequency, and modulation percentage.

Over-modulation produces extraneous sidebands resulting in a spectrum that is very similar to the spectrum of a multi-frequency modulated carrier. Over-modulations are usually distinguished from the multi-frequency modulated display because the spacing between sidebands is equal, while the sidebands in a multi-frequency spectrum will be arbitary unless the modulating frequencies are harmonically related. The over-modulated carrier spectrum is usually symmetrical where as the spectrum of a multi-frequency modulated signal is asymmetrical in amplitude.

Frequency Modulated Spectrum

FM measurements generally determines the modulating frequency, amplitude of the modulating signal or frequency deviation, and index of modulation. A typical FM spectrum is shown in Fig. 2-15. The exterior modulation envelope resembles a $\cos^2$ curve, which is an identifying feature of the frequency modulated carrier.

Frequency Deviation Measurement

There is no clear relationship between spectral width and deviation, because in theory the FM spectrum approaches infinity. In practice, however, the spectral level falls quite rapidly. See Fig. 2-15B. Accurate deviation measurements can be made if the modulating frequency and the modulation index (where the carrier goes to zero) are known.

$$\text{Modulation index} = \frac{\text{Carrier deviation}}{\text{Modulating frequency}}$$

Values of modulation index corresponding to zero carrier amplitudes are listed in Table 2-1.

TABLE 2-1

Values of modulation index for carrier null points	
Order of Carrier Null	Modulation Index
1	2.4
2	5.52
3	8.65
4	11.79
n (n > 4)	$11.79 + \pi(n - 4)$

Accurate carrier null is essential for accurate measurement.

Analysis and Measurement from the Spectrum of a Pulse Modulated Signal

An examination of the spectrum from a pulse modulated device such as a radar transmitter, provides a variety of information about the system. The amount of frequency shift (long term or short term) in the display indicates the stability of the transmitter oscillator. The absence of deep or prominent lobe minima's adjacent to the main lobe is an indication of the frequency modulation, provided the resolving power of the analyzer is sufficient. See Fig. 2-18C. Double peaks in the main lobe indicate that the oscillator is operating in two or more modes, which could be caused by some external load such as mismatched transmission lines or fluctuating supply voltages. A visual indication is provided to tune the transmitting system so that most of the output power is within the frequency bandwidth of the receiving system.

The following measurement may be performed from the spectrum of a pulse modulated display.

Pulse Width: The theoretical pulse width for a rectangular pulse is the reciprocal of the spectral side lobe frequency width. The main frequency lobe or its side lobes can therefore be used to measure the pulse width of the pulse modulated spectrum. This is accomplished as follows:

1. Adjust dispersion control and tune the RF CENTER FREQ control so the main lobe of the spectrum is displayed in the center of the graticule, and the side lobes are visible on each side.

2. Adjust the GAIN control and switch in the necessary IF ATTEN dB switches, so the main lobe and its side lobes are within the graticule height.

3. Adjust the scanning rate for optimum spectrum definition.

4. Adjust the RESOLUTION control so the minima between lobes are easily discernible without excessive loss of sensitivity. Change the mode selection of the VERTICAL DISPLAY to accentuate these minima points. (Usually LOG position.)

5. Calculate the frequency width of either the main lobe or a side lobe as directed under measuring frequency difference. The pulse width is equal to the reciprocal of 1/2 the main lobe frequency width, or the reciprocal of the side lobe frequency width. See Fig. 2-21A.

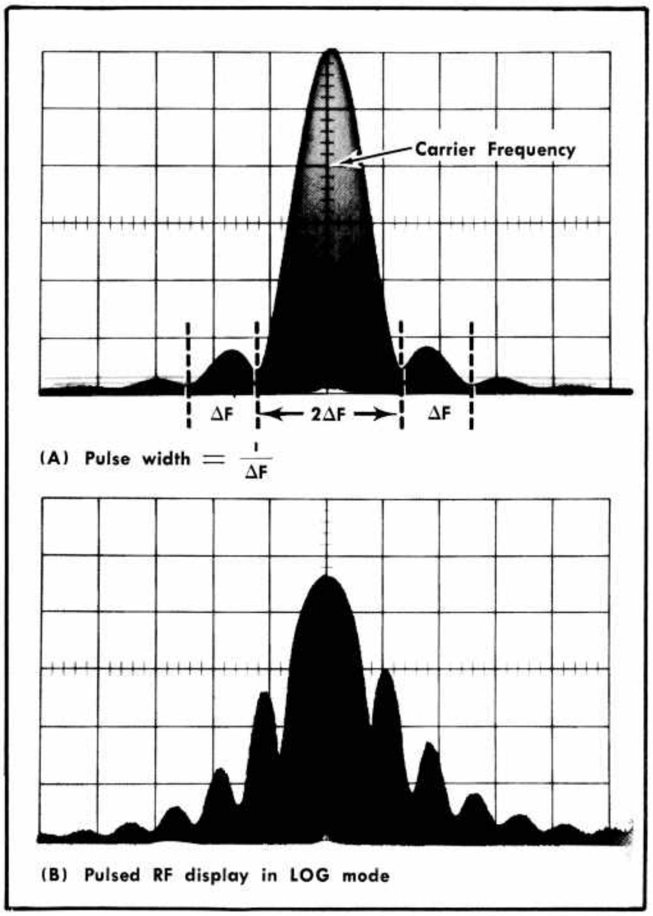


Fig. 2-21. Pulse modulated RF display illustrating LIN and LOG mode operation.

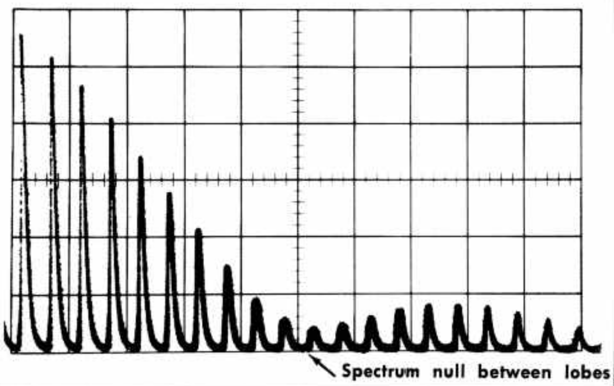


Fig. 2-22. Application of the plug-in oscilloscope magnification feature.

Repetition Rate: The pulse repetition rate is measured by switching the dispersion to zero so the analyzer becomes a fixed tuned receiver. The sweep is then triggered on the signal and the display becomes a time domain function. The procedure is as follows:

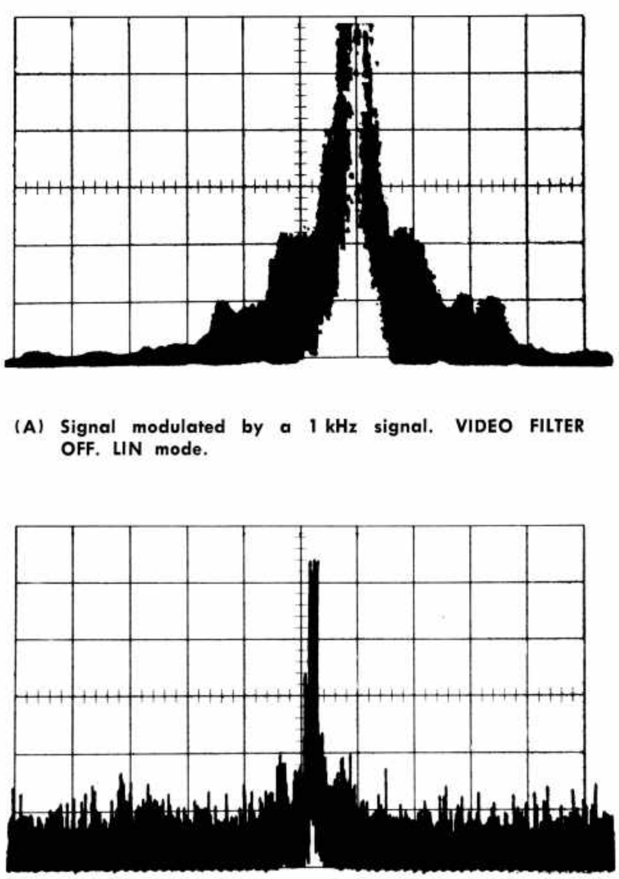
1. Tune the signal to the display center with the RF CENTER FREQ and the IF CENTER FREQ controls.

2. Change the DISPERSION RANGE switch to kHz position, then decrease the DISPERSION to 0. Uncouple the RESOLUTION control and turn to the fully clockwise position. The analyzer is now a fixed frequency device.

3. Set the plug-in oscilloscope Trigger Source selector to Int position and adjust the triggering controls for a stable triggered display. The IF CENTER FREQ—FINE control may require slight adjustment to displace the spectrum null point from the sweep start. See Fig. 2-12.

4. Set the Time/CM switch of the oscilloscope so that several pulses of the applied signal are displayed (see Fig. 2-11). Be sure the Variable Time/CM control of the oscilloscope is in the Calibrated position. The number of pulses displayed is now a function of the sweep rate and signal PRF.

5. Measure the number of centimeters between 2 or more pulses on the graticule.



(A) Signal modulated by a 1 kHz signal. VIDEO FILTER OFF. LIN mode.

(B) Same signal as A, VIDEO FILTER ON.

(C) Amplitude modulated signal. 2 kHz sidebands.

(D) Same signal as C. VIDEO FILTER ON.

Fig. 2-23. Using the VIDEO FILTER to improve the resolution capabilities of the analyzer.

6. The pulse repetition frequency is the reciprocal of the measured time between pulses.

The expanded sweep feature of some plug-in oscilloscopes can be used to analyze or examine small portions of a spectrum display. In some instances, because of signal drift or instability, it may be impractical to reduce the dispersion to make this examination. It is more practical to tune the desired portion of the display to screen center and expand the sweep.

Fig. 2-22 shows an expanded display of a pulsed RF signal. The null point can be easily examined.

High Resolution Capabilities

Figure 2-23 illustrates resolution capabilities of the Type 1L40. The DISPERSION is set to 1 kHz/cm and the RESOLUTION is uncoupled and turned fully counterclockwise. To increase the apparent resolution turn the VIDEO FILTER switch ON. Resolution is a function of the last IF amplifier stage of the analyzer; therefore, the illustrations are typical for any RF frequency with the local oscillator phase locked.

SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The Type 1L40 Spectrum Analyzer is a swept IF spectrum analyzer, covering the frequency range from 1.5 GHz to 40 GHz by means of selectable input mixer assemblies. This section describes the functional operation of each major circuit and its relation to the unit operation. A block diagram is first described to show the relationship of the circuits, then each circuit within the functional block is described in detail.

BLOCK DIAGRAM DESCRIPTION

A functional block diagram of the Type 1L40 is illustrated in Fig. 3-1 and in the Diagrams section of the manual.

The RF input section contains a local oscillator, a diplexer and a mixer assembly. The mixer assembly is selected according to the desired input frequency range. For the frequency range 1.5 GHz to 12.4 GHz a coaxial mixer assembly is plugged into the input receptacle and the signal source is connected to the input of the mixer. This is replaced with a Waveguide Mixer Adapter, a two-foot coaxial cable and one of three Waveguide Mixers for the frequency range 12.5 GHz to 40 GHz. The diplexer is a directional coupler which couples the local oscillator signal to the mixer assembly and the mixer output frequency (heterodyne frequency between the local oscillator and the incoming signal frequencies) to the 280 MHz low pass filter.

The 280 MHz low-pass filter and the 150 MHz-250 MHz bandpass filter reduce the spurious signals outside the 100 MHz IF bandpass and in most cases prevent them from reaching the 2nd mixer stage.

The wide band IF is converted to 75 MHz in the 2nd mixer by mixing the IF with the output from a swept oscillator. The swept oscillator is swept from a center frequency of 275 MHz by the sawtooth voltage that supplies the horizontal sweep to the oscilloscope CRT beam. The width or frequency dispersion the oscillator is swept depends on the setting of the DISPERSION selector. This can be varied from 0 dispersion to more than 100 MHz. The 75 MHz IF is the difference frequency between the swept oscillator frequency (at a given instant of time) and a frequency within the 150 MHz to 250 MHz wide band IF. For example: When the swept oscillator frequency is 225 MHz, the 75 MHz IF represents the conversion between 225 MHz and 150 MHz. The swept oscillator frequency of 225 MHz occurs when the CRT beam is at the sweep start. As the sweep travels across the graticule, the swept oscillator frequency increases and the 75 MHz IF represents the conversion between the swept oscillator frequency and a higher frequency portion of the wide band IF response.

Calibrated attentuation (in 1 dB steps to 51 dB) is provided by the IF attentuator. The signal output from the attenuator is then amplified and applied to the 3rd mixer stage, where it is mixed with 70 MHz and converted to a 3rd IF of 5 MHz. The output of the third mixer is applied to a 5 MHz, narrow bandwidth IF amplifier. The output of the 5 MHz IF amplifier is applied to the variable resolution circuit whose bandwidth can be varied from less than 1 kHz to more than 100 kHz.

The signal output from the resolution amplifier is amplified, detected and applied through a logarithmic, linear, or square law voltage divider circuit to the vertical amplifier of the indicator oscilloscope.

The phase lock circuit locks the local oscillator to either an internal 1 MHz reference oscillator or an externally applied reference frequency. This stabilizes the oscillator and reduces incidental frequency modulation.

CIRCUIT DESCRIPTION

RF Section

The RF section (See RF section schematic) contains the mixer assembly, the local oscillator and phase lock circuit, a diplexer, a resistive coupler, a mixer peaking circuit, and a 280 MHz low pass filter assembly.

The local oscillator for the Type 1L40 consists of a triode with its plate and cathode circuits connected to tunable resonant cavities. Frequency of oscillation can be tuned from 1.7 GHz to 4.2 GHz by means of the RF Center Freq control. The oscillator frequency is changed by varying the length of the cathode and plate cavities. Harmonics through the 10th of this fundamental frequency range are used to heterodyne with the incoming RF to provide an overall frequency range from 1.5 GHz to 40 GHz.

The 10 volt filament or heater supply for the oscillator tube (V42) is provided through the series-parallel current paths consisting of V620 filament and two dropping resistors, R47 and R49.

Two probes in the oscillator chamber couple the oscillator signal to the phase lock circuit and through a hybrid directional coupler to the mixer assembly. The directional coupler, or diplexer, see Fig. 3-2, couples the LO signal to the mixer port (OUT) and the mixer output jack through to the IF port. This permits the use of external mixer assemblies.

Four mixer assemblies are required to cover the frequency range of the unit. A coaxial mixer is used for the 1.5 GHz to 12.4 GHz frequency range. Three waveguides mixers with frequency ranges of 12.4 GHz to 18 GHz, 18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz, are used to cover the higher frequencies.

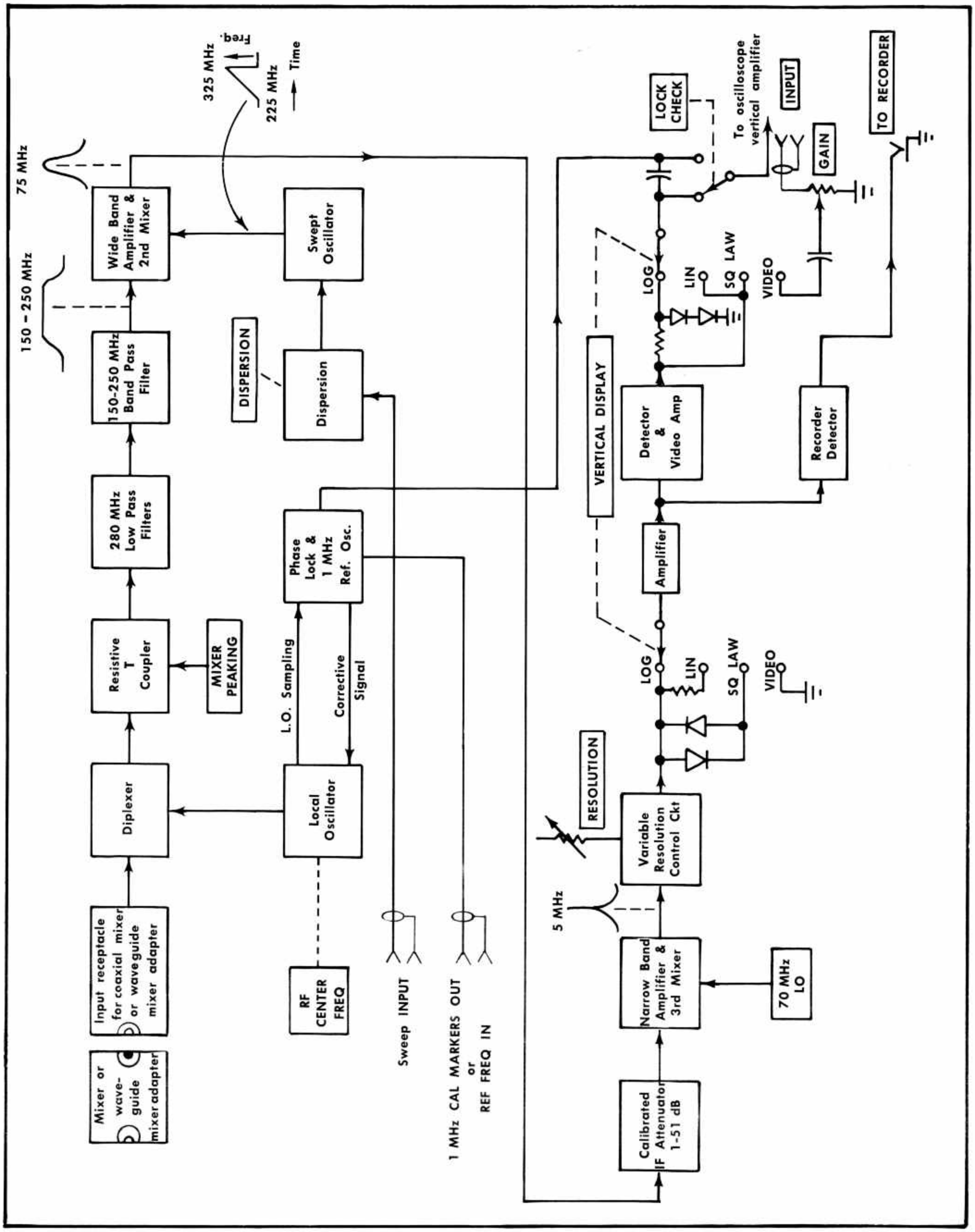


Fig. 3-1. Type 1L40 Block Diagram.

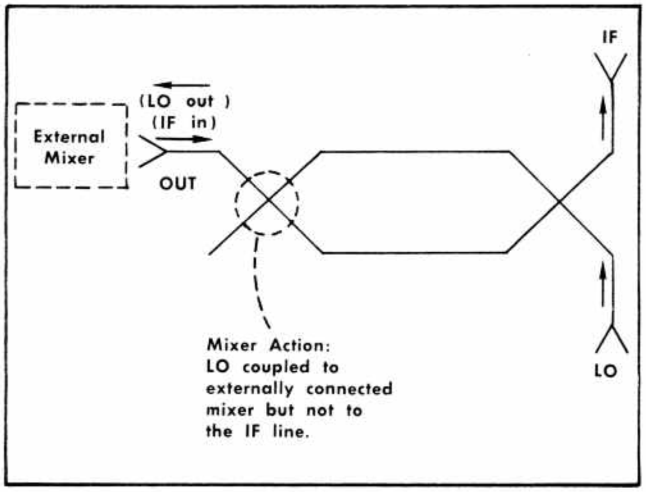


Fig. 3-2. Simplified equivalent of the hybrid directional coupler.

The mixer output frequency at the IF port of the diplexer is applied through a 1 dB resistive coupler and the 280 MHz low pass filter to the wide band IF section. The resistive coupler provides a DC return for the mixer peaking circuit.

Efficient mixer action depends on the mixer diode bias and is a function of the local oscillator drive, the desired harmonic conversion and the mixer diode current. Since scales 2, 3, 4 and 5 use higher order harmonics of the oscillator fundamental frequency range of 1.7 GHz to 4.2 GHz, mixer peaking enhances harmonic conversion. MIXER PEAKING control R66 provides control over the amount of bias to diode D64. This enriches the harmonic content of the rectified signal and optimizes the sensitivity of the mixer at the different harmonic frequencies being used.

The IF output from the diplexer is filtered through the 280 MHz low pass filter to reduce spurious signals above this passband. This attentuation, plus the 150-250 MHz bandpass filter that follows, suppresses signals in the image frequency band (300 MHz to 400 MHz) of the 200 MHz IF amplifier.

Lossy cables (such as W78, W94) are used to reduce the VSWR (voltage standing-wave ratio) caused by slight impedance mismatch between circuits that may be caused by coaxial connectors or other discontinuities.

NOTE

Lossy cables use steel wire for the center conductor. These factory-installed cables are used to optimize response flatness and sensitivity. The lossy cable is identified by the white insulating coating. The standard 50 Ω coaxial cable has clear insulation. Do not interchange these cables.

Phase Lock Circuit

The phase lock circuit (See Phase Lock Circuit Schematic) synchronizes the local oscillator frequency with a stable reference frequency. This reduces oscillator drift and incidental frequency modulation, permitting high resolution and narrow dispersion settings for signal evaluation.

The phase detector samples the instantaneous RF signal voltage generated by the tunable local oscillator at a rate determined by the reference frequency. The samples are integrated and compared to a DC reference voltage. The output from the comparator is then amplified and fed back to the local oscillator as a corrective signal.

When the local oscillator frequency is an exact multiple of the reference frequency, the phase detector output becomes a DC voltage that is proportional to the instantaneous potential of the sampled oscillator voltage. If the phase of the local oscillator frequency should drift, the phase detector output potential will change. This change is amplified through Q860-Q870 and applied as a corrective voltage to a voltage controlled capacitance diode in the oscillator tuned cirucit. This shifts the phase of the oscillator so it remains phase locked to the reference frequency. See Fig. 3-3 and Fig. 3-4.

The corrective signal from the comparator and amplifier is also applied to the vertical circuit when the LOCK CHECK button SW889 is depressed. This provides a beat frequency signal indication on the CRT so the operator can locate a lock point. Beat frequency displays appear on the CRT screen as the local oscillator is tuned (see Operating section). A reference voltage related to the position of the FINE RF CENTER FREQ control is also applied to the vertical deflection circuit and is used to center the error signal within the dynamic operating range of the comparator amplifier Q860-Q870. Phase lock operation should be set within the dynamic range of the amplifier, preferably in the center of the dynmaic range. This dynamic range is visually displayed on the CRT as a vertical shift of the display.

Turning the INT REF FREQ control clockwise from its OFF OR EXT REF FREQ IN position closes SW809 so collector voltage is applied to Q800. The crystal controlled 1 MHz oscillator will now operate. The output 1 MHz signal from the emitter of Q810 is applied to the trigger generator circuit. Diodes D824 and D825 limit the current through tunnel diode D826, and couples the signal to the 1 MHz MARKER OUT connector J810. If an external reference signal is applied and the INT REF FREQ control is set to OFF OR EXT REF FREQ IN, the diodes couple the external reference signal to the trigger generator circuit.

Frequency of the reference oscillator Q800 is primarily controlled by crystal Y800, inductor L800 and the capacitance of diodes D817 and D818. Diodes D817 is back biased and normally acts as a voltage-controlled capacitance diode; however, signal amplitudes across crystal Y800 may become excessive and D817 may conduct on the peak signal swing. D818 then becomes back biased and acts as the capacitance diode. The back bias for diode D817 is set by INT REF FREQ control R809. Adjusting R809 changes the back bias of the diode, which changes the capacitance in series with the crystal series-resonant and parallel-resonant operating modes. The frequency range is typically 1 MHz + 200 Hz to 1 MHz + 1.2 kHz.

With dispersion settings of 100 kHz/cm or less, high frequency RF signals mixing with the higher harmonics of the local oscillator will shift off-screen when the local oscillator shifts to the next phase lock mode. These frequency gaps between lock modes are covered by shifting the frequency of the internal phase lock reference oscillator. The INT REF

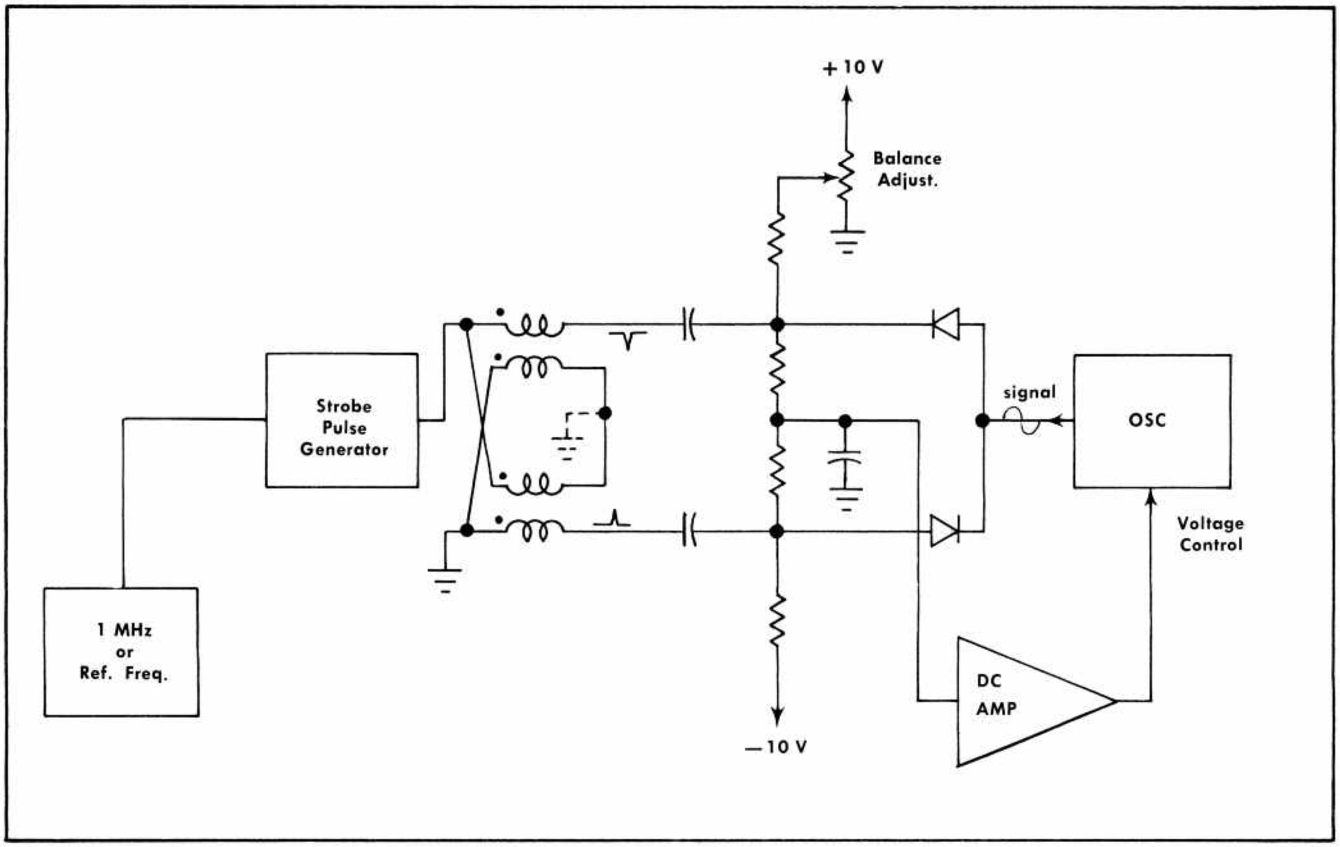


Fig. 3-3. Phase Lock block diagram.

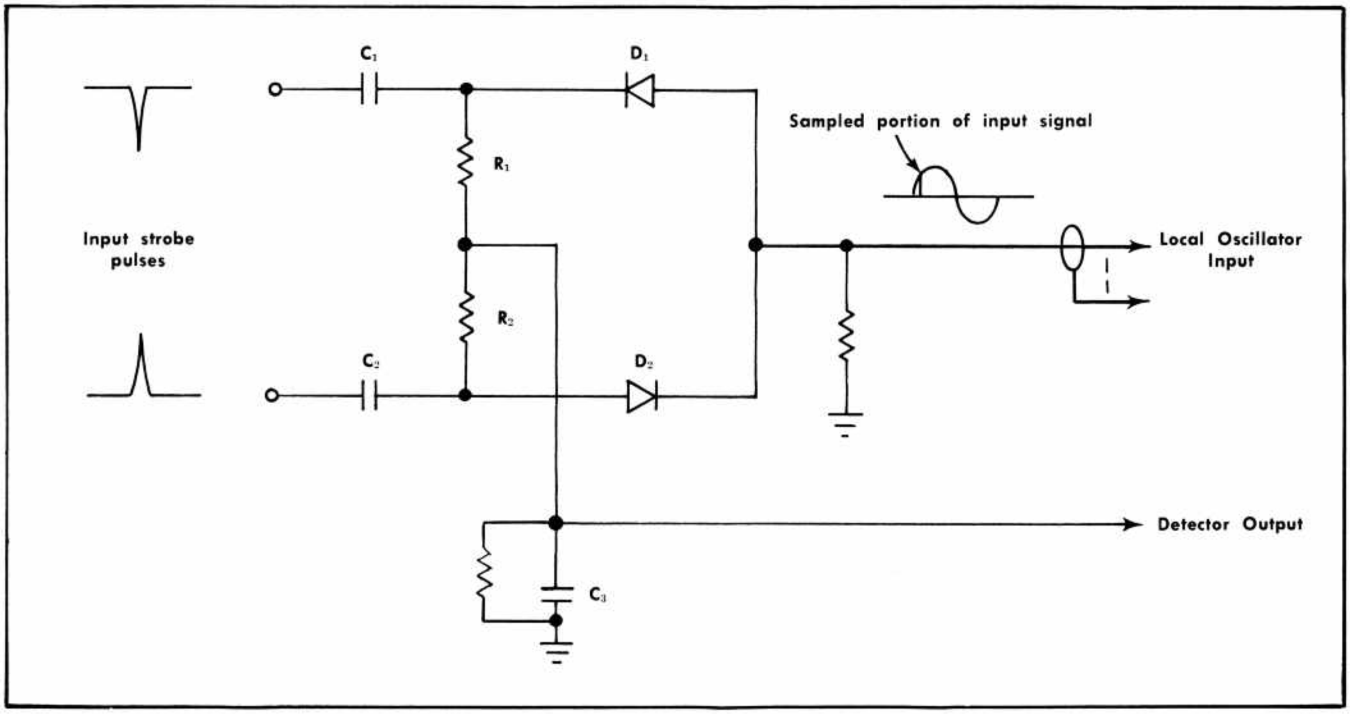


Fig. 3-4. Simplified phase detector circuit.

FREQ control provides approximately 0.1% (or 1 kHz) shift in the 1 MHz reference frequency and pulls the local oscillator fundamental frequency by the same percentage. If the input signal should shift off screen, it can be returned to the screen by adjusting the INT REF FREQ control.

The phase detector (Fig. 3-4) consists of a two diode gate and a low-pass filter. The combination of the local oscillator signal and the very narrow pulses applied to the opposite electrodes of the diodes, gates the diodes on and thereby samples the amplitude and phase of the oscillator signal.

The voltage at the junction of the two resistors will be the sum of the strobe pulse and the instantaneous value of the oscillator signal voltage. However, since the strobe pulses are of equal and opposite polarity, the resultant voltage is approximately equal to the instantaneous signal voltage. Capacitor C3 (Fig. 3-4) charges to the sampled instantaneous voltage and applies this potential to the input of a DC amplifier.

If the input signal from the local oscillator is not a harmonic of the reference frequency, the output voltage of the phase detector will be approximately zero. As the local oscillator frequency approaches a harmonic of the reference frequency, an AC voltage or beat frequency is developed at the detector output. This AC signal is amplified by Q880, and when the LOCK CHECK button is depressed, it is applied to the vertical amplifier so the operator can observe these beat indications. At the zero beat null, the output signal amplitude snaps to a minimum on the screen to indicate to the operator that a phase lock condition is set.

The FINE RF CENTER FREQ control R862 tunes the local oscillator by changing the DC output level of Q870. When a phase lock condition exists, the phase lock circuit counteracts any DC voltage shift applied by the FINE RF CENTER FREQ control so that it no longer has an effect on the oscillator frequency. If the control is moved toward its extreme positions, the circuit will lose control. The resultant jump in frequency is easily seen at dispersion of 500 kHz/cm or less.

The sample of the oscillator input signal is not instantaneous. The strobe pulses have some finite width or duration. The limits of the strobe width are determined by the highest input frequency from the local oscillators. The phase detector operates on the positive or negative slope of the input signal. The slope (+ or —) depends on the total phase inversion between the phase detector output and the voltage input of the oscillator. The width, therefore, must be less than ½ the period of the maximum input frequency. In the Type 1L40, the maximum input frequency is 4.2 GHz (period $\approx$ 0.24 ns), which means the pulse width must be less than 0.12 ns.

This fast-rise, narrow pulse is obtained by differentiating a snap-off diode recovery step. The crystal oscillator or reference signal drives a pulse generator which drives the snap-off diode. The snap-off diode supplies pulses to an etched circuit transmission line transformer. This transformer couples the single ended differentiated pulse to the phase detector as a push-pull differential signal to gate the diode phase detector on and sample the oscillator signal.

The pulse generator consists of tunnel diode D826, transistors Q820 and Q840 and associated circuit components. The quiescent current of tunnel diode D826 is approximately 2.5 mA. The positive-going portion of the input signal switches the TD to its high state and a fast-rise positive pulse is generated at the base of Q820. The pulse is amplified and differentiated by the short RC time constant in the emitter of Q820, then transformer coupled through T820 to Q840.

The quiescent voltage of Q840 is set by the Avalanche Volts adjustment R831 in the base voltage divider circuit of Q830. The positive portion of the pulse from transformer T820 triggers Q840 into avalanche. The resulting collector current of Q840 sweeps out the stored charge of the snap-off diode D846. When the charge has dissipated, the recovery pulse of the diode generates a fast negative-going step . This negative-going pulse is differentiated and coupled through C844 and C847 to the etched circuit transmission line transformer T856.

Transformer T856 provides a 2:1 voltage step-up and converts the single-ended input signal to a push-pull balanced output signal which is applied to phase detector diodes D856 and D857. Refer to the swept oscillator description for the discussion on the transformer operation.

Sweeper Circuit

The sweeper circuit provides a constant amplitude swept frequency band, centered at 275 MHz, to the wide band amplifier mixer section. The frequency deviation of the swept frequency output can be varied from approximately 0 to 10 MHz/cm (100 MHz total). A block diagram of the sweeper circuit is shown in Fig. 3-5.

Dispersion Circuitry. The sawtooth voltage from the oscilloscope is connected to the analyzer SWEEP INPUT connector by an external jumper cable. If the sawtooth amplitude is 150 V, selector switch SW201 on the back panel of the instrument switches in additional attenuation so the amplitude of the voltage to the comparator Q230-Q240 is approximately the same for either the 100 V or 150 V input sawtooth amplitudes. This sawtooth voltage is applied through the attenuation network of DISPERSION switch SW220.

The Sweep Center adjustment, R204, sets the DC reference level at the base of Q230 which sets the quiescent output level at the collector of Q240. The output level of Q240 is applied to D314, the frequency determining component of the swept oscillator circuit. The input sawtooth voltage to the sweep circuit is a positive voltage ramp which sweeps the base of Q230 above its DC reference level. The amplitude of this voltage ramp is a function of the DISPERSION selector position. The DISP CAL adjustment R208 calibrates the dispersion for the 10 MHz/cm position of the DISPERSION selector. The DISPERSION RANGE selector SW230 adds or deletes selected attenuation steps for the input sawtooth voltage to the comparator. These attenuation steps are changed by a factor of 10 by the DISPERSION RANGE switch to provide MHz/CM and kHz/CM dispersion selections.

Sweep Comparator. Q230 and Q240 are connected as a differential or comparator amplifier with their emitters connected to the common resistor R236 which connects to

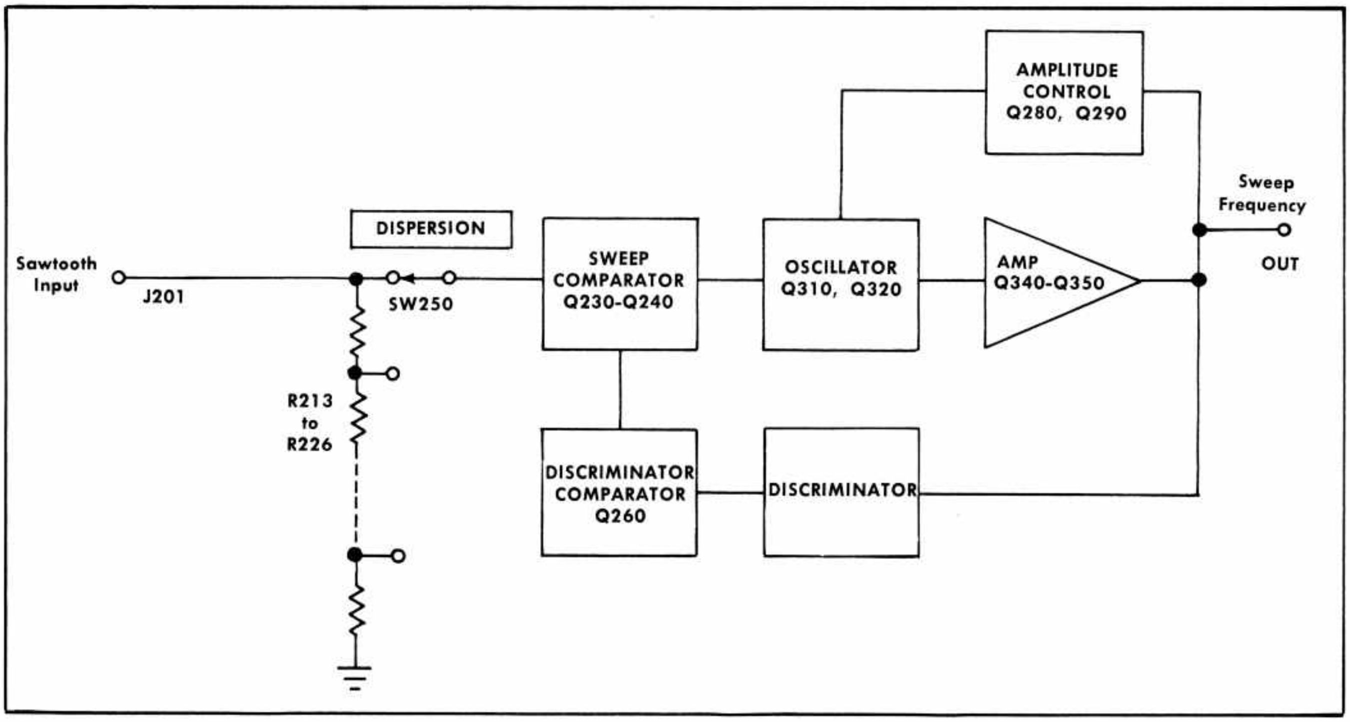


Fig. 3-5. Block diagram of the sweeper circuit.

the —150V-supply. This long-tailed configuration sets the quiescent current of the amplifier at approximately 3 mA. Output signal from the comparator is a current ramp, which is the resultant of two sawtooth voltage ramps that are applied to the two sides of the comparator (bases of Q230 and Q240). This output signal current develops a voltage ramp across collector load resistors R244-R243 which is applied to variable capacitance diode D314, changing the capacitance of the diode. The diode is part of the sweep oscillator tuned circuit, therefore the oscillator frequency is swept by the output signal from the sweep comparator.

The sawtooth waveform at the base of Q230 is the attenuated Sweep Input signal from the analyzer oscilloscope. The amount the signal is attenuated depends on the settings of the DISPERSION RANGE and the DISPERSION selectors. The sawtooth waveform at the base of Q240 is the output signal of the discriminator comparator Q260, which is amplfying the output signal from either of two (MHz/CM or kHz /CM) discriminators.

The front panel IF CENTER FREQ CAL adjustment, R252, sets the DC operating level at the base of Q240. This CAL adjustment is adjusted to center the wide band IF at 200 MHz when the IF CENTER FREQ control is at 000 and the FINE control is centered. R253 (Ctr Freq Cal) is an internal adjustment to center the range of R252.

During calibration, DISP BAL adjustment R257 is centered and the internal adjustments C284 and C385 (frequency discriminator) plus R368 (kHz/CM Cal adjustment) are adjusted to center the 150 MHz to 280 MHz sweep and obtain maximum linearity and optimum dispersion accuracy. The front panel DISP BAL R257, is then used to balance the center frequency points of the MHz/CM and kHz/CM discriminators.

Sweep Oscillator. The frequency of the oscillator is primarily a function of the inductance of L314 and the capacitance of D314 in the collector circuit of Q310. With an increase in back-bias across capacitance diode D314, the capacitance of the diode decreases and the resonant frequency of the oscillator tuned circuit increases. The capacitance change is not directly proportional to the voltage ramp across it; however, high gain in the discriminator feedback loop reduces this non-linearity.

Frequency modulation of the oscillator is dependent on the amplitude of the input sawtooth to the capacitance diode. At maximum deviation, the oscillator sweeps from 225 MHz to 325 MHz.

The output signal from the swept oscillator is tapped across the partial winding of L314 and capacitively coupled to transformers T330 and T331. The transformers provide a voltage step-up ratio of approximately 2:1 and convert the single ended input signal to a balanced push-pull output signal to drive the output amplifier Q340-Q350.

Fig. 3-6 is a simplified drawing of the transformer circuit. The oscillator is the signal source or generator which supplies a signal voltage (e). The input windings of T330 and T331 are connected in series; therefore, the voltage across each winding equals e/2 (assuming an ideal transformer). The polarity of the signal at a particular instant of time is as shown in Fig. 3-6. This voltage across the input windings produce an equal voltage (e/2) across the output windings with the polarity as indicated in Fig. 3-6.

The generator, or source, is in series with the output winding for T331; therefore, the voltage at the output with respect to point A, equals 3e/2. This voltage adds to the voltage output of T330 to provide a total output signal of 4e/2 or 2e.

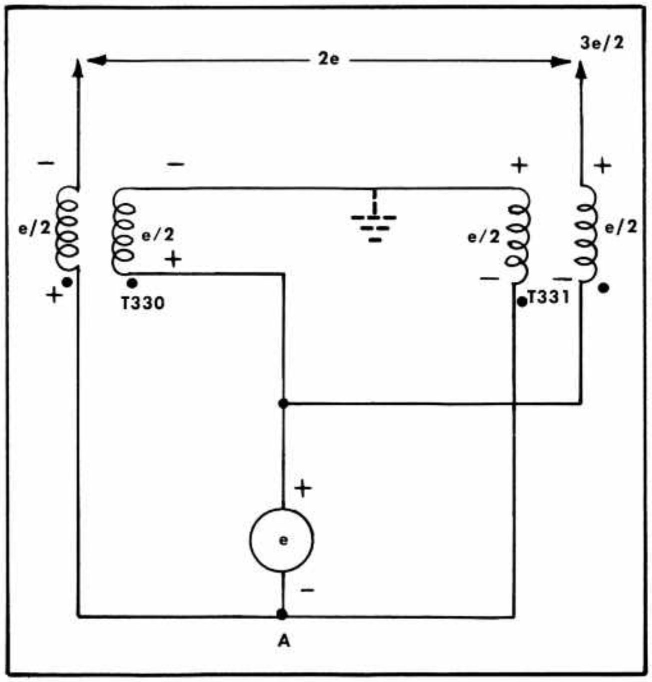


Fig. 3-6. Simplified diagram of the transformer (T330-T331) circuit from the swept oscillator to the push-pull amplifier Q340-Q350.

If the reference point is changed to the common side of the input windings of T330 and T331 (shown as a phantom ground on the simplified drawing) the impedance looking into the output terminals of the transformers is balanced, and the drive signal to the amplifiers is a balanced push-pull signal.

Transformers T343 and T354 in the collector circuit of Q340 and Q350 provide a 4:1 impedance transformation from the collectors of the transistors to the output transformer T347.

Transformer T347 provides the conversion from a push-pull to single-ended signal output. Push-pull amplification, plus filtering through the low pass filter circuit of L358-C358 and L348-C348, reduces the harmonic content of the swept frequency output signal.

Diode D334 in the base voltage divider circuit provides the temperature compensation for the transistors (Q340-Q350).

The single-ended output is coupled through a 2:1 impedance transformer (T363) to the mixer in the Wide Band IF. It is also applied through two feedback loops to frequency and amplitude control circuits.

Frequency Discriminator. Two frequency discriminators, one for each position of DISPERSION RANGE selector SW230, provide an output voltage to the frequency discriminator-comparator Q260. The output from the comparator is a ramp voltage which is applied through D240 to one side of the comparator (Q230-Q240).

The MHz/CM discriminator consists of two matched diodes, D373 and D376, at the input end of two transmission lines. The transmission lines are $1/8$ wavelength at the center frequency (275 MHz). One line is open ended and appears capacitive, the other line is shorted and appears inductive, at the center frequency. As the input frequency to the discriminator increases, the transmission line input impedance approaches the characteristics of a $1/4$ wavelength line. The shorted transmission line input impedance increases; the open ended line input impedance decreases. This produces a proportionate change to the output signal voltage from the diodes. Signal voltage output from diode D376 becomes more negative, and the signal voltage output from D373 becomes less negative. This provides a differential signal drive to the comparator Q260 which is converted to a single ended output signal for the sweep comparator (230-Q240). The IF CENTER FREQ and the FINE (IF CENTER FREQ) controls, R270 and R274, shift the current distribution through the comparator Q260 to change the average DC level of the output signal to Q240. This allows the IF center frequency to be shifted without affecting the dispersion calibration or dispersion linearity of the display.

The amplitude of the ramp signal from Q240 to the swept oscillator is a function of DISPERSION RANGE switch SW 230 and the DISPERSION selector SW220 setting. This voltage amplitude determines the frequency deviation of the sweep oscillator, or the dispersion of the display.

The discrimnator for the kHz/CM position of the DISPERSION RANGE switch consists of two tuned circuits and

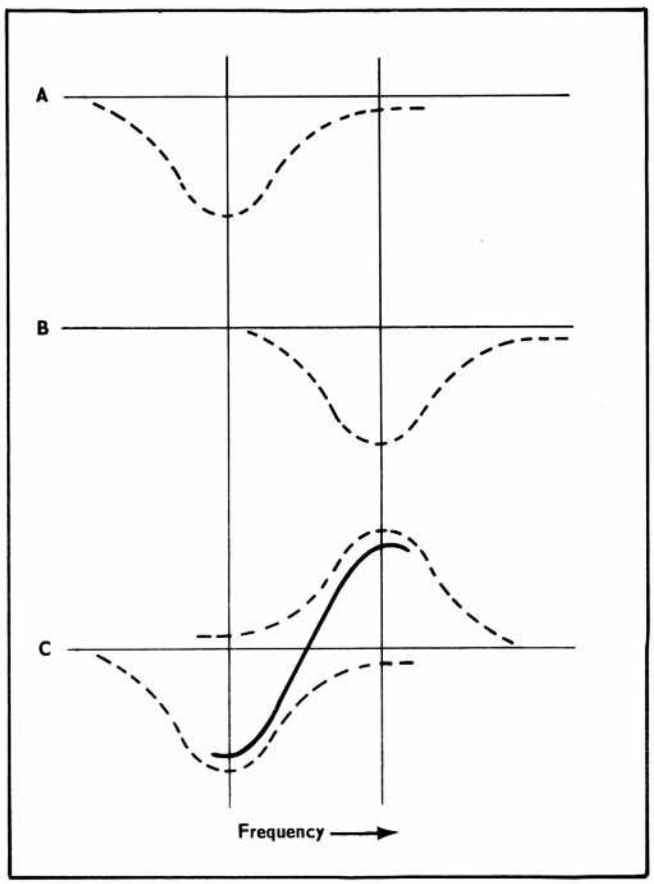


Fig. 3-7. Frequency vs Voltage curves for kHz/CM discriminator circuit. (A) Output from D383; (B) output from D386; (C) output from discriminator comparator Q260.

detectors that operate in a manner similar to the tuned transmission lines for the MHz/CM discriminator. The parallel circuit L384-C384 is turned slightly below and the circuit L385-C385 is turned above the center of the swept oscillator frequency. The voltage output versus frequency of the detectors is shown in Fig. 3-7A and 3-7B. When the detector output is applied to the comparator, a voltage versus frequency curve similar to Fig. 3-7C becomes the resultant output of comparator Q260. The circuit operates over the linear portion of the response curve. The kHz/CM Cal adjustment R368 changes the impedance across D365 which set the slope of the kHz/CM discriminator output to approximately twenty times the slope of the MHz/CM discriminator.

Diodes D380 and D387 isolate the narrow band discriminator tuned circuit when the Type 1L40 is operating in the MHz/CM dispersion range. They prevent parasitic oscillation due to circuit coupling between the wide band and narrow band discriminators. The diodes are forward biased when the DISPERSION RANGE switch is in the MHz/CM position and load the kHz/CM tuned circuit. The diodes are back-biased and disconnected from the narrow dispersion discriminator circuit when the DISPERSION RANGE switch is in the kHz/CM position.

Amplitude Comparator. Uniform sensitivity and linearity over the dispersion range is maintained by controlling or regulating the oscillator output amplitude. This is accomplished by the RF amplitude comparator circuit, Q290 and Q280. The RF output signal is detected by diode D361 and applied through diode D362 to the base of Q280. This rectified signal on the base of Q280 is compared against a reference voltage set by IF CF Range adjustment R290. The differential output signal is fed back as a correction voltage to control the forward bias of Q320. Q320 is the current source for the oscillator circuit. Amplitude changes in the oscillator output are fed back as a corrective signal to the current regulator to regulate oscillator current and output power.

To summarize the sequence of operation for the sweeper circuit, assume a positive going output ramp from the sweep comparator Q240-Q230. This voltage ramp increases the bias on the capacitance diode and decreases the circuit capacitance so the oscillator output frequency will increase. This increase in output frequency is fed back to the discriminator and detected as an increasing negative voltage output from D376 (assuming the DISPERSION RANGE switch is in the position shown in the schematic diagram) and a decreasing negative voltage output from D373. The differential output signal from Q260 is a positive-going ramp to the base of Q240, where it is compared against the input ramp on the base of Q230. The differential signal output from the sweep comparator synchronizes the sweep oscillator frequency to the horizontal sweep generator sawtooth signal and the dispersion of the display becomes a function of the DISPERSION RANGE (SW 230) and DISPERSION (SW220) selector positions.

DISP BAL adjustment R257 is a front-panel IF center frequency balance adjustment between the MHz/CM and kHz/CM dispersion positions. Center Freq Cal adjustment R253 and CAL R252 calibrate the IF center frequency range of the IF CENTER FREQ control.

Wide Band (150-250 MHz) Amplifier and Second Mixer

The wide band amplifier contains an input 150-250 MHz bandpass filter, two amplification stages and a mixer amplifier with its output tuned to 75 MHz. Gain through the amplifier is approximately 20 dB.

The wide band response from the RF section is applied through a 150-250 MHz bandpass filter to input amplifier Q120. The bandpass filter is a constant-k type, modified with m-derived input and output sections to provide a constant 50 Ω input and output impedance through the pass band. Series-tuned circuit L101-C101 and L107-C107 are tuned to the low end of the band; L102-C102 and L108-C108 primarily control the high frequency response characteristic of the filter. All of the adjustments interact and are adjusted for optimum response flatness over the pass band.

Toroid transformers T120, T124 and T134 provide the wide band characteristics for the input and output coupling. L124-C124 form a 75 MHz trap to provide additional attenuation (approximately 60 dB) to any 75 MHz signal that may pass through the filters.

C137 at the emitter and L134 at the collector of Q130 are peaking adjustments which are adjusted for optimum flatness of the IF response. C137 compensates for the transistor rolloff toward the high end of the band; however, because of the low Q in the collector circuit due to R134 and circuit loading, the overall effect of both adjustments (L134 and C137) is seen as a bandpass response adjustment.

The output from Q130 is applied through transformer T134 to the base of mixer amplifier Q140. The swept oscillator output is coupled to the emitter of Q140. The collector output load (L144 and C143) is tuned to 75 MHz, so the difference frequency of 75 MHz is coupled through the 65 MHz trap to the attenuator circuit as the 2nd IF. The 65 MHz trap (L147-C147) attenuates or rejects any 65 MHz signal component from feeding through to mix with the 70 MHz oscillator. A 65 MHz signal mixing with 70 MHz would generate a 5 MHz difference signal and pass through the narrow band IF amplifier to appear as an undesirable spurious response on the display.

IF Attenuator

The IF attenuator, (see schematic) is a six section network that provides a total signal attenuation of 51 dB. The input and output impedances to the attenuator are maintained at a constant 50 Ω, regardless of the IF ATTEN switch settings. Input and output filter sections (C151-L151-C152 and C187-L188-C188) at the input and output of the attenuator form a low pass filter to prevent high frequency signals from feeding into the 75 MHz amplifier.

Narrow Band IF Amplifier

This circuit (see schematic) contains two stages of 75 MHz IF amplification, a stable 70 MHz oscillator, a mixer amplifier with its output tuned to 5 MHz and one stage of amplification for the 5 MHz IF frequency.

Input to the amplifier is AC coupled from the IF attenuator to the base of Q420. The 75 MHz IF amplifiers are Q420

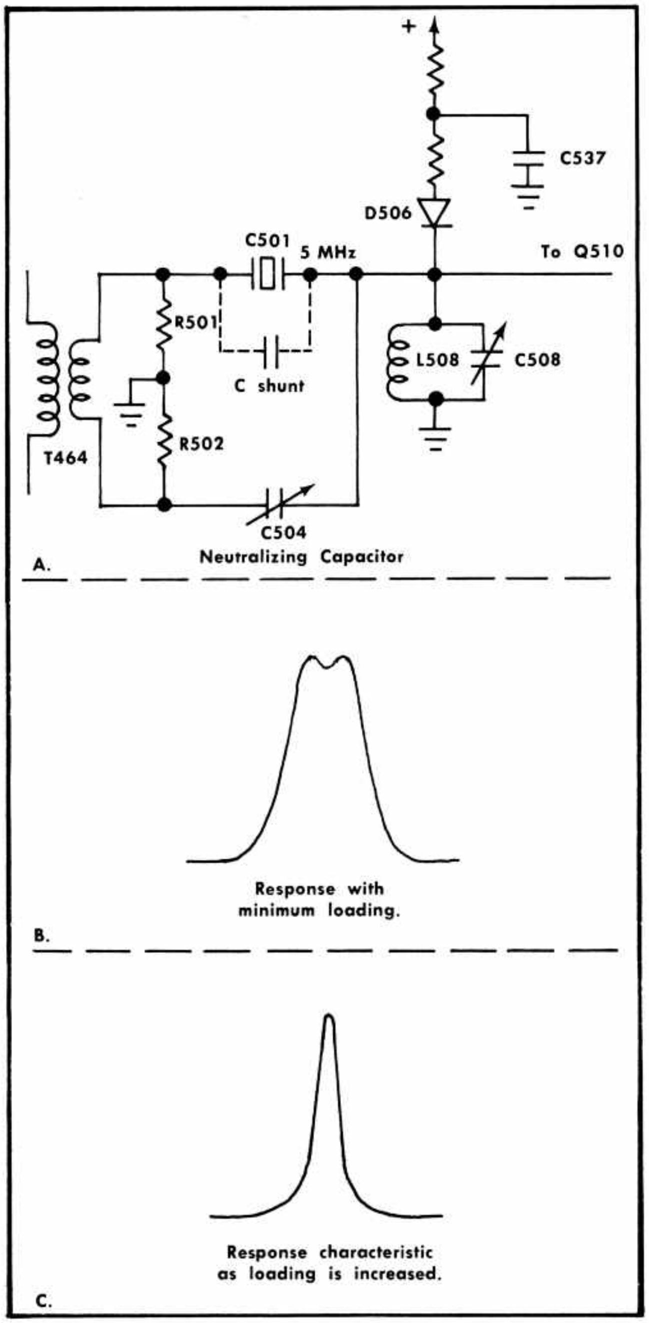


Fig. 3-8. Crystal variable resolution filter.

and Q430. The IF transformers are tuned to the IF by adjusting the capacitance of C425 and C435. Gain of the amplifier is varied by changing the forward bias of Q420, which then sets the bias of Q430 through the DC return of its base to the emitter of Q420. A feedback winding of T424 to the base of Q420 provides the neutralization for the collector to base capacitance.

The 75 MHz IF and the output from crystal controlled 70 MHz oscillator Q440, are applied to mixer amplifier Q450. The collector load of Q450 is T454, which is tuned to 5 MHz, couples the signal to the 5 MHz IF amplifier Q460. Diode D454 in the collector load of Q450 improves the overload characteristics of the amplifier. Output of the 5 MHz IF signal is applied through insulated connector J470 to the input of the variable resolution amplifier.

Variable Resolution Amplifier

The variable resolution amplifier (see schematic) is designed to vary the bandwidth of the 5 MHz IF from 100 kHz or more to 1 kHz or less. Bandwidth of the circuit is a function of the output load for a crystal filter network. By varying the output load a variable resolution bandwidth is obtained.

The signal input to the variable filter circuit is insulated from chassis ground and connects across R501-R502 as shown in Fig. 3-8A. Crystal Y501 is a 5 MHz crystal, connected in series between the input and the parallel resonant circuit L508-C508. Bandwidth or resolution of the circuit is dependent on the characteristic response of the crystal at its series resonant frequency and the Q of the parallel resonant circuit L508-C508.

Fig. 3-8 illustrates the impedance response versus frequency curve of a quartz crystal. Capacitor C504 neutralizes the stray shunt capacitance around the crystal so the response of the crystal is equivalent to a series tuned circuit with a very narrow bandpass[1]; see Fig. 3-9.

The bandwidth of the filter network is a function of the crystal output load, which is primarily the parallel resonant circuit; therefore, bandwidth becomes a function of the Q for the resonant circuit. The Q of the output load circuit for the crystal is varied by changing the bias of diode D506, which changes the shunt loading across the parallel-tuned circuit.

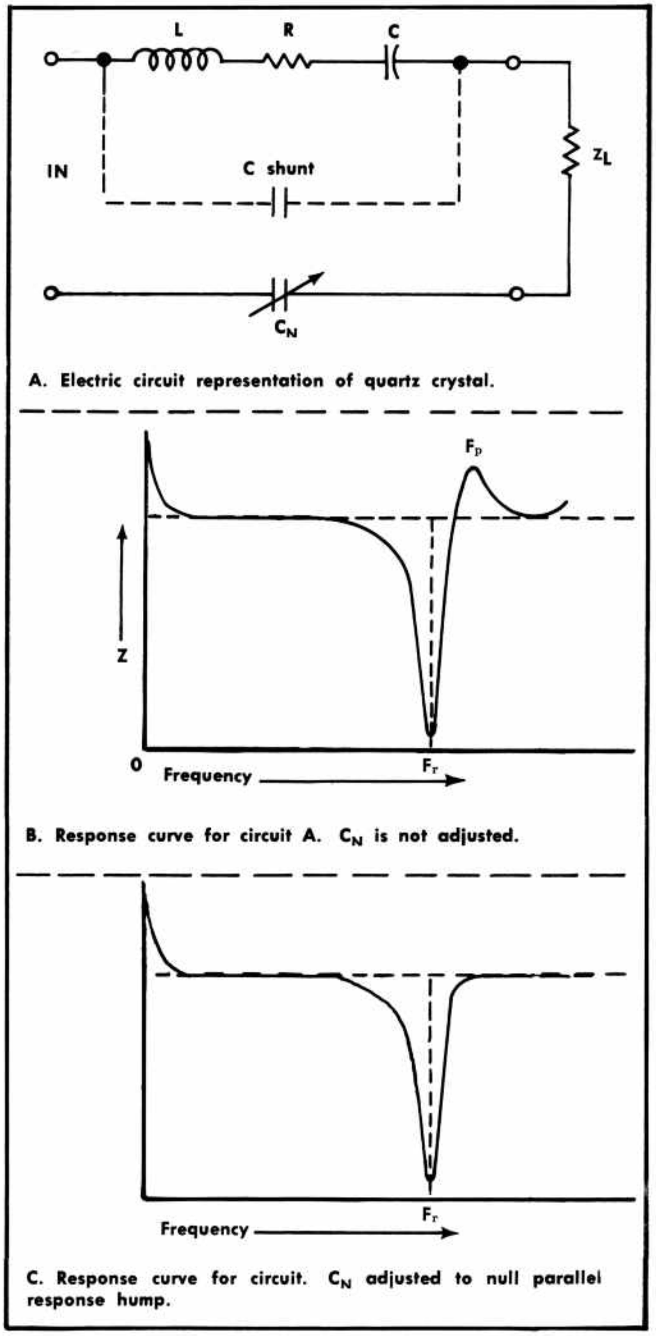
As the forward bias of D506 is increased, the Q of the parallel resonant circuit decreases and the response characteristic of the crystal becomes the dominant factor in determining the bandwidth of the filter network. The crystal response is very narrow, so the resolution is increased as the diode forward bias increases.

SW550, the RESOLUTION selector, can be coupled to the DISPERSION selector and when so coupled, provides normal resolution for each position of the DISPERSION selector provided the sweep rate is not too high. See Operating section. However, by pulling the control knob, the RESOLUTION selector is uncoupled and any desired resolution within the range of the control can be obtained for a given DISPERSION selector position.

The 100 kHz Resol Cal adjustment R543, is adjusted for a resolution bandwidth. Bandwidth should equal or exceed 100 kHz with the RESOLUTION selector fully CW and approximately 60 kHz with the control one position back from the fully CW position. The remaining positions of the control decrease the bandwidth at each successive step in the counterclockwise position. This provides adequate resolution for most displays.

Emitter followers Q510-Q520 isolate the high impedance of the filter network from the relatively low output impedance, thus minimizing circuit loading on the filter network. Q530 is a grounded-emitter operational amplifier with a relatively low output impedance to provide the power required to drive the Log and Square Law circuits.

[1] (Ref: F. Langford-Smith RAC Radiotron Designer's Handbook; fourth edition.)



A. Electric circuit representation of quartz crystal.

B. Response curve for circuit A. C_N is not adjusted.

C. Response curve for circuit. C_N adjusted to null parallel response hump.

Fig. 3-9. Crystal filter, equivalent circuit and impedance response curves.

Output and Detector

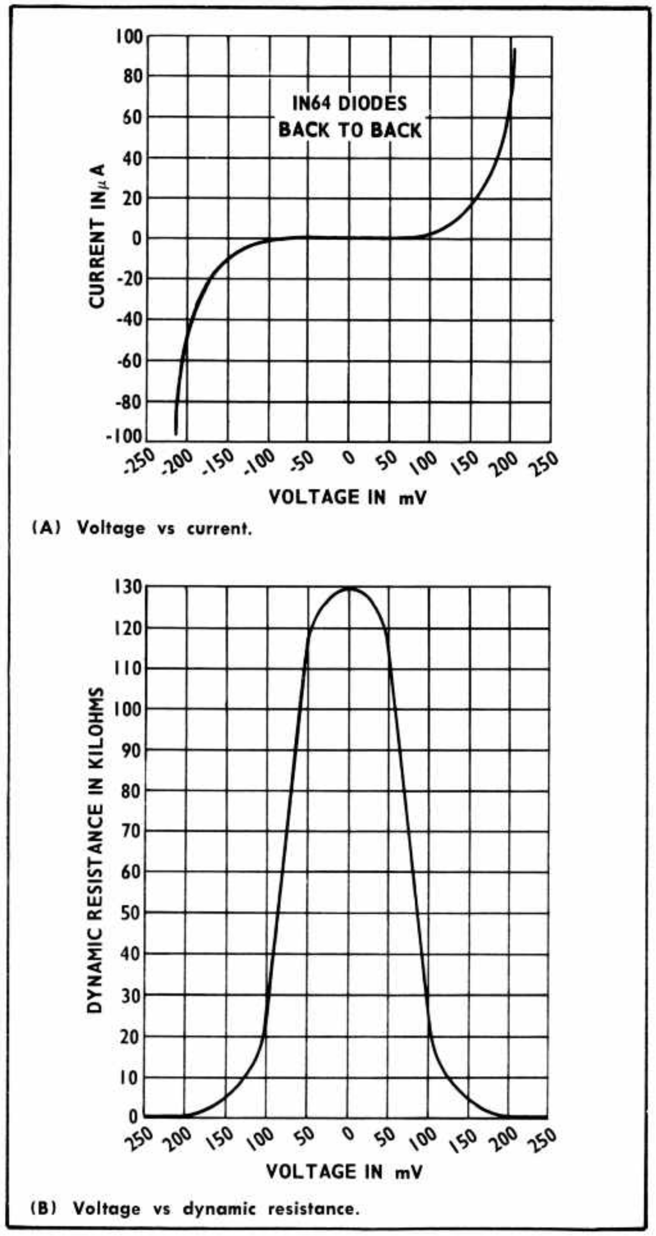
The 5 MHz IF response from the variable resolution amplifier is applied through a bandpass filter circuit which shapes the response and attenuates spurious signals (see Output Amplifier schematic). VERTICAL DISPLAY switch SW 660, selects one of four display modes; LOG, LIN, SQ LAW and VIDEO. The VIDEO position changes the display to a time domain display.

The LOG position applies the signal without attenuation to the amplifier V620. This provides the full dynamic range required for the LOG diode circuit and a logarithmic display over the 6 cm graticule height.

In the LIN position, the signal is attenuated by the voltage divider R606-R607, so an approximate 4.5 centimeter display provides approximately the same signal amplitude when the switch is changed to either of the other two positions.

In the SQ LAW position, two germanium diodes, D603-D604 are connected back to back to form a square law voltage divider. Signal voltage to the amplifier V620 in the SQ LAW mode becomes a function of the diode's dynamic resistance characteristic curve as shown in Fig. 3-10.

Note that diode resistance exceeds 100 kΩ for very low (mV) input signals. The divider ratio is approximately 200:1



(A) Voltage vs current.

(B) Voltage vs dynamic resistance.

Fig. 3-10. Diode characteristic curves.

so approximately 0.5% of the signal will be applied to V620. With a 150 mV signal, the dynamic resistance of the diode decreases to approximately 5 kΩ, so approximately 10% of the signal will be applied to V620. The circuit normally requires about 70 mV of signal for full screen display so the diodes usually operate along the steep slope of the dynamic resistance curve.

This non-linear dynamic resistance of the divider produces a display which emphasizes small signal level differences. The vertical response of the SQ LAW display is approximately proportional to the signal power.

The input signal from the VERTICAL DISPLAY selector is coupled through T610 to the 5 MHz crystal filter. The series response characteristic of the crystal determines the bandpass of this filter circuit. C610 is adjusted to shunt or reduce the parallel response point of the crystal filter. L620 and C620 are tuned to 5 MHz. The circuit shapes the response of the 5 MHz IF and attenuates any spurious signals that may pass through or are generated in the 5 MHz variable resolution circuit.

V620 is a high gain amplifier driving the emitter follower Q650. This circuit provides the voltage gain and drive required by the detectors for both the video and recorder output. L624 tunes the plate circuit to 5 MHz.

The detector diodes D660 and D661, connected as a voltage doubler circuit, provide the 40 dB dynamic range for the log display. D657 is the detector diode for the RECORDER output.

The log circuit consisting of R664, D664, D665, R665 and the Log Cal adjustment R666, provides a display that approaches a logarithmic curve when the VERTICAL DISPLAY selector is in the LOG position.

Low amplitude video signal voltages appear across D664 with little or no attenuation. As the signal amplitude increases, the current through the diode becomes an exponential function of the voltage across the diode. R664 becomes the current source for the diode, so the voltage output of the circuit becomes a logarithmic function. As the signal amplitude further increases, the diode current approaches the linear region of the voltage-current characteristic curve; however, this current through R665 develops sufficient voltage across D665 to turn this diode on, and the two diodes now operate in series to extend the range of the Log circuit to at least 40 dB.

Video Filter switch SW661 switches capacitor C661 across the detector output to restrict the video bandwidth. This prevents high frequency components from distorting the display and enables easier evaluation of signal modulation when viewing signals with minimum resolution bandwidth.

The VIDEO position of the VERTICAL DISPLAY selector connects the external video INPUT connector through the GAIN control to the vertical amplifier input of the plug-in oscilloscope. GAIN control R411B, ganged with R411A in the narrow band amplifier, provides the gain adjustment for all positions of the VERTICAL DISPLAY switch.

The DC reference level of the signal into the vertical amplifier of the oscilloscope is set by the POS control R672. With the control centered, the output DC level is approximately 67.5 volts.

The LOCK CHECK switch SW889 connects the output signal and DC reference of the phase lock circuit to the oscilloscope vertical input. This permits the beat signal display (when phase lock operation is set) and the DC output level to be viewed on the CRT screen.

Power Distribution; +10 Volt, —10 Volt and Local Oscillator Heater Supplies

+10-Volt Supply. This is the reference voltage for the —10-volt supply and the positive supply for the semiconductor circuits in this instrument. A voltage divider circuit between the +225-volt supply and ground sets the +10-volt voltage for the base of Q710. Any change in the +10-volt supply is reflected as a bias change to Q710. This is amplified and applied as an error signal to the base of Q717 to increase or decrease the current through the transistor to the +10-volt supply.

—10 -Volt Supply. Voltage divider R720-R721, between the +10-volt supply and the —10-volt bus, sets the bias of Q720. Any deviation in the —10-volt supply is amplified by Q720 and applied as a corrective signal to Q727, to increase or decrease the current through the emitter load resistor R727 to the —150-volt supply and counteract any load change in the —10-volt supply.

Local Oscillator Heater Supply

The 10-volt filament or heater supply for the oscillator tube (V42 see RF diagram) is provided by the +75-volt, 50 mA supply via voltage drops through R49 and the heater of V620, with the +75-volt supply aided by the +100-volt supply furnishing 13 mA.

NOTES

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The first portion of this section describes general preventive measures to minimize major troubles. This is followed with some corrective procedures to correct problems that may develop and a descripition on how to remove and replace assemblies or sub-assemblies within the instrument.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, lubrication, and if needed, recalibration. Preventive maintenance is generally more economical than corrective maintenance, since it can usually be done at a time convenient to the user. The preventive maintenance schedule established for the instrument should be based on the amount of use and environment in which the instrument is used.

Cleaning

Clean the instrument often enough to prevent accumulation of dirt. Dirt on the components acts as a thermal insulating blanket (preventing efficient heat dissipation) and may provide electrical conducting paths.

Clean the instrument by loosening the accumulated dust with a dry, soft paint brush. Remove the loosened dirt by vacuum and/or dry low pressure compressed air (high velocity air can damage certain components). Hardened dirt and grease may be removed with a cotton-tipped swab or a soft cloth dampened with water and a mild detergent solution (such as Kelite or Spray White). Abrasive cleaners should not be used.

CAUTION

Do not permit water to get inside controls or shaft bushings. Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Some chemicals to avoid are benzene, toluene, xylene, acetone or similar compounds.

Lubrication

The life of potentiometers and selector switches is increased if these devices are properly lubricated. Use a cleaning type lubricant (such as Cramoline) on shaft bushings and switch contacts. Lubricate the switch detents with a heavier grease (Beacon grease No. 325 or equivalent). Do not over-lubricate. The necessary materials and instructions for proper lubrication of Tektronix instruments are contained in a component lubrication kit (Tektronix Part No. 003-0342-00) which may be ordered from Tektronix, Inc.

The dial and tuning assembly should be lubricated periodically. This is normally every 6 months; however, if the tuning shaft tends to bind or drag, check that the shaft has proper lubrication.

The gears should be lubricated with a high quality lubricant such as COSMOLUBE No. 102, manufactured by E. F. Houghton and Co. The bearing surfaces and drive shafts should be oiled with a light-weight oil, such as Hoppes lubricating oil or Pfaff sewing machine oil. Lay the instrument on its side. Use a syringe or hypodermic oiler (Tektronix Part No. 003-0280-00) and apply no more than one drop to each point.

Visual Inspection

After a thorough cleaning, the instrument should be carefully inspected for such defects as poor connections, damaged parts and improperly seated transistors. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, determine the cause of overheating before the damaged parts are replaced; otherwise, the damage may be repeated.

Transistor Checks

Periodic preventive maintenance checks consisting only of removing transistors from the instrument and testing them in a tester are not recommended. The circuits within the instrument provide the only satisfactory check on transistor performance. Defective transistors are usually detected during recalibration of the instrument.

Performance Checks and Recalibration

To insure accurate measurements, the instrument performance should be checked after each 1000 hours of operation or every six months if the instrument is used intermittently. The calibration procedure is helpful in isolating major troubles in the instrument or in locating minor troubles which are not apparent during regular operation. Instructions on how to conduct a performance check or calibration procedure are provided in Section 5.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques or procedures required to replace components in this instrument are described in this section.

Obtaining Replacement Parts

All electrical and mechanical parts replacements can be obtained through your local Tektronix Field Office or representative. Many of the standard electronic components however, can be obtained locally in less time than is required to order from Tektronix, Inc. Before purchasing or ordering replacement parts, consult the Parts List for value, tolerance and rating. The Parts section contains instructions on how to order these replacement parts.

NOTE

When selecting the replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the circuit.

Component Numbering and Identification

The circuit number of each electrical part is shown on the circuit diagrams. A functional group of circuits (such as the RF Section) is assigned a particular series of numbers. Table 4-1 lists the assigned component numbers for the various circuits.

Switch wafers are identified by counting from the first wafer located behind the detent section of the switch towards the last wafer. For example, the designation 2R printed by a switch section on a schematic identifies the switch section as the rear side of the second wafer when counting back from the detent switch.

TABLE 4-1

Component Numbering

Component No. Series	Circuit	Diagram
1-99	RF Section	1
100-149	Wide-Band Amplifier & Mixer	4
150-149	IF Attenuator	5
200-399	Sweeper Circuit	3
400-499	Narrow-Band Amplifier	6
500-560	Variable-Resolution Amplifier	7
600-727	Output Amplifier	8
800-890	Phase Lock Circuit	2

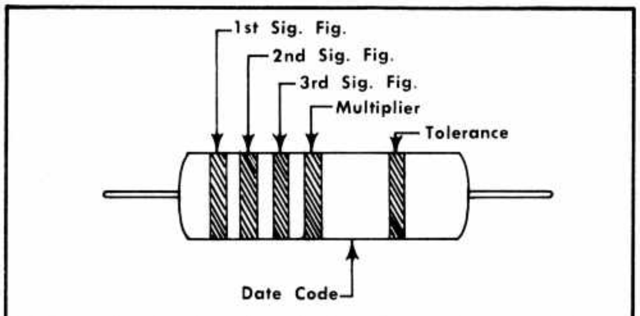
Resistor Color Code

The instrument contains a number of stable metal-film resistors identified by their gray background color and color coding. If a resistor has three significant figures and a multiplier, it will be EIA color coded. If it has four significant figures and a multiplier, the value will normally be printed on the resistor. For example, a 332 kΩ resistor will be color coded, but a 332.5 kΩ resistor will have its value printed on the resistor body. The color-coding sequence is shown in Fig. 4-1.

Fig. 4-2 identifies the polarity of the glass diode types used in this instrument.

Wiring Color Code

The insulated wire used in the Type 1L40 is color-coded according to the EIA standard color code to facilitate circuit tracing. The widest color stripe identifies the first color of the code. Power supply voltages can be identified by the color stripes and the background color. White background indicates a positive supply. A tan background indicates a negative supply. Table 4-2 shows the wiring color code for the power supply voltages used in the Type 1L40.



Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	Tolerance (±) %
Black	0	0	0	1	—
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	—
Yellow	4	4	4	10,000	—
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Gray	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	—
Gold				0.1	5
Silver				0.01	—
No Color					10

Fig. 4-1. Standard EIA color-coding of metal-film resistors.

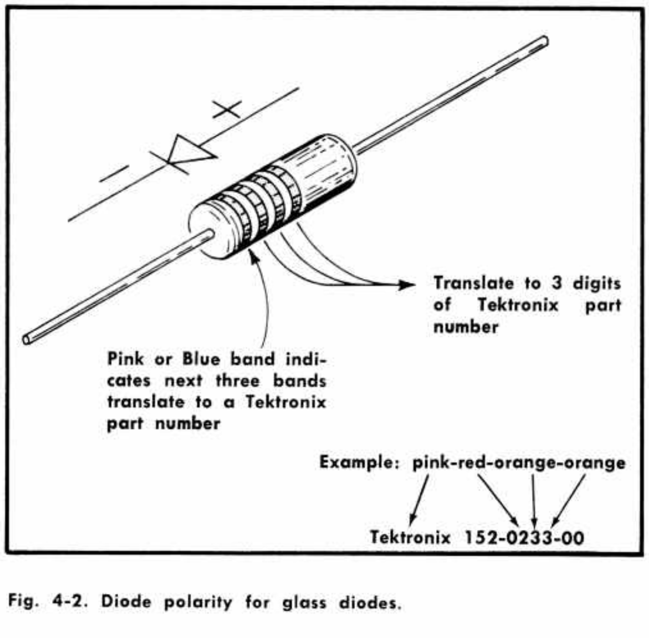


Fig. 4-2. Diode polarity for glass diodes.

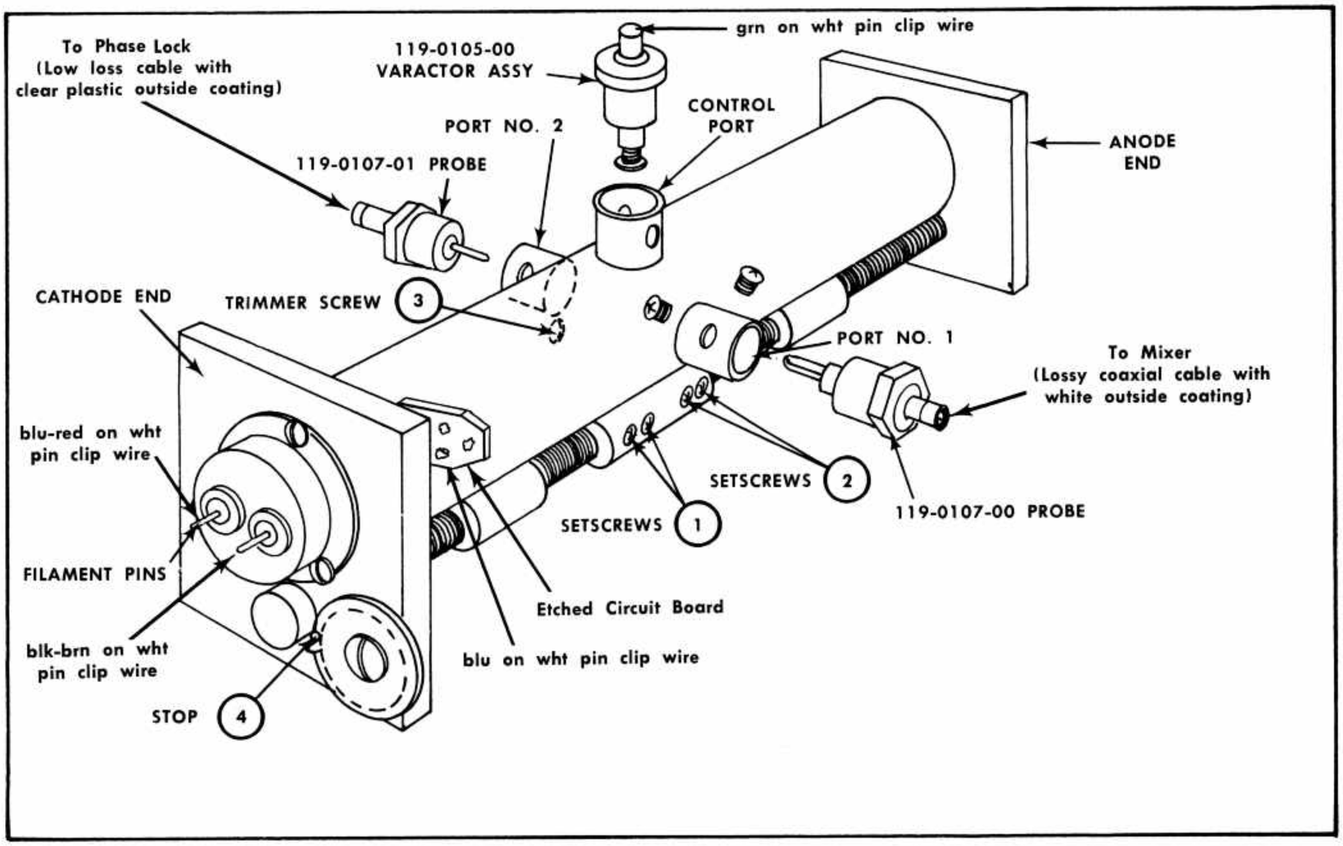


Fig. 4-3. Assembly alignment diagram.

TABLE 4-2

Wiring-Color Code

Supply	Back-ground Color Polarity	1st Stripe	2nd Stripe	3rd Stripe (If appli-cable)
—10 V	Tan	Brown	Black	
+10 V	White	Brown	Black	
+75 V	White	Violet	Green	Black
+100 V	White	Brown	Black	Brown
—150 V	Tan	Brown	Green	Brown
+225 V	White	Red	Red	Brown

RF cables in the RF and IF sections are miniature coaxial cables. Some of these cables have a lossy characteristic and are identified with a white outside coating. The standard 50 ohm low-loss coaxial cables have a clear plastic outside coating. Do not interchange the lossy type with the standard 50 Ω type when these coaxial cables are replaced.

Removing and Replacing Assemblies or Sub Assemblies

WARNING

Disconnect the instrument from the power source before attempting repair and/or replacement of any assembly or sub assembly.

Oscillator Assembly

The oscillator assembly should not be removed or replaced until tests indicate the oscillator failure is due to a faulty tube or varactor. Before removing the assembly, check the supply voltages and the filament circuit for continuity. The B+ voltage is +150 V, the filament supply is +10 V and the voltage to the variable capacitance diode should measure between +1.5 V to +14 V.

1. Disconnect the four push-on clip wires and the two push-on coaxial cables, see Fig. 4-3.

2. Remove the upper right-hand spacer rod from the plug-in.

3. Loosen the lower set screw on the rear-panel oscillator bracket.

4. Remove the tuning knob and retaining nut which holds the dial mechanism to the front-panel.

5. Pull the rear of the oscillator assembly up and to the right to remove. The locating pin on the front of the oscillator assembly may bind slightly.

To replace the asssembly, reverse the removal procedure. The retaining nut should be installed and tightened before the set screw on the rear-panel oscillator bracket is tightened. The second set screw on the top of the oscillator bracket provides assembly alignment to the front-panel.

6. Recalibrate as directed in the Calibration procedure.

Oscillator Tube Replacement

NOTE

A complete oscillator assembly and its sub parts are listed in the Mechanical Parts section. We recommend replacing the complete assembly and returning the defective assembly to your Tektronix Field office or representative. Replacing components, such as the oscillator tube, requires recalibration of the oscillator. This requires special test equipment and techniques. A calibration procedure is provided following tube replacement instructions, however, this procedure is provided for use only if it is impractical to return the oscillator assembly to Tektronix.

The procedure to replace the oscillator tube V42 is described and illustrated in Fig. 4-4A and B.

Oscillator Calibration

CAUTION

The calibration of this oscillator is very critical and should only be attempted by qualified personnel with adequate facilities.

Refer to Fig. 4-3 for the location of the sub-assemblies and ports. The oscillator assembly must be removed for calibration. The probe assemblies can be oriented within the magnetic field of the oscillator chamber by loosening set screws and positioning the probe in or out of the chamber or rotating the probe within the field.

Usually the probes are rotated for maximum power output and inserted in or out of the chamber for the specified power output. It is important to keep the output power below the maximum specifications listed in steps 1(m) and 1(o) of the following procedure. All adjustments interact; therefore, as each adjustment is made, its effect on the frequency tracking and output power over the frequency range of the oscillator must be checked. Adjust to obtain as flat an output as possible with frequency tracking within $\pm 1\%$.

Alignment Procedure for Oscillator Assembly, Tektronix Part No. 119-0108-00

This procedure should be used only after replacing the oscillator tube. Refer to Fig. 4-3 for the location of sub assemblies and ports. The oscillator assembly must be removed for calibration.

1. Alignment and Installation of the Probes and Varactor Assemblies.

a. Install probe assembly (Part No. 119-0107-01 into the No. 2 port (Fig. 4-3). Position the probe assembly approximately $^1/_{16}$ inch out from full penetration with the notch or keyway (DC return of the probe) towards the plate end of the oscillator assembly, and secure by tightening one of the two set screws.

CAUTION

Do not over-tighten set screws. They may warp the shaft if tightened too much.

b. Install probe assembly (Part No. 119-0107-00) into the No. 1 port (Fig. 4-3). Position the probe assembly approximately $^1/_{16}$ inch out from full penetration with the notch or keyway towards the plate end of the oscillator assembly, and secure by tightening one of the two set screws.

c. Install the Varactor assembly (Part No. 119-0105-00) into the control port. Position the assembly approximately $^1/_{16}$ inch out from full penetration and secure by tightening one of the two set screws.

d. Position the cathode and plate chokes to the high frequency end of the band (towards the center of the assembly) but not against the stop.

e. Connect an RF power meter through a 50 Ω, 10 dB attenuator and a 9 inch coaxial cable (clear cable covering) to the No. 2 port.

f. Connect a frequency counter or accurate frequency measuring device through a 50 Ω termination and a 9 inch lossy coaxial cable (white cable covering) to the No. 1 port.

g. Apply power (B+ and filament supply) to the oscillator. Allow approximately 10 minutes for the oscillator to stabilize.

h. Loosen the set screw to No. 2 port and rotate the probe assembly for maximum power input. Do not rotate the probe 180° from the preset position. If power output exceeds 100 mW, decrease the coupling by pulling the probe assembly out. Tighten the set screws.

i. Loosen the set screws (1) in Fig. 4-3, and position the plate choke for a frequency of 4.2 GHz.

Force the lead screw against the bearing and tighten the set screws.

j. Loosen the set screws (2) in Fig. 4-3, and position the cathode choke for maximum power output. Decrease probe coupling if power output exceeds 100 mW.

Force the lead screws against the bearing and tighten the set screws.

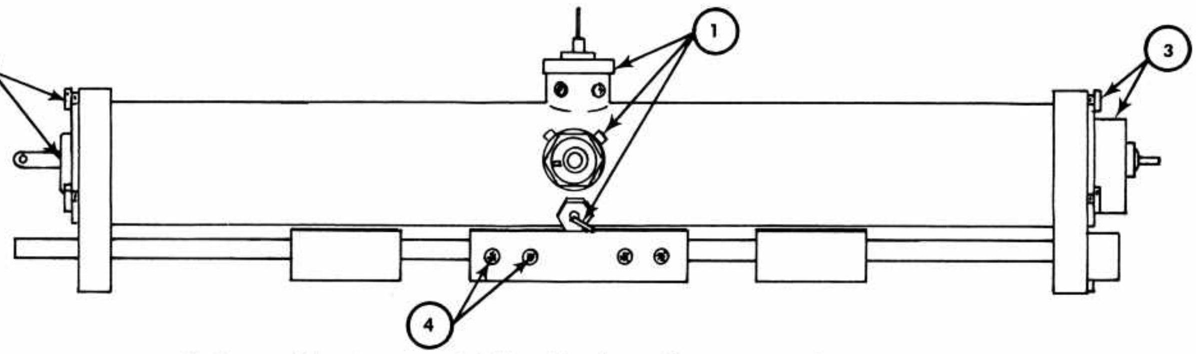
k. Connect the Varactor terminal to a +1.5 V to +14 V bias supply. The instrument bias supply is preferred. Set the Varactor bias voltage to +7 V and tune the oscillator to its mid-frequency position.

l. Vary the position of the Varactor assembly, until a bias swing from +1.5 V to +14 V, provides a frequency shift equal to or greater than 1.5 MHz. Return the bias voltage to +7 V, by adjusting the RF CENTER FREQ. control.

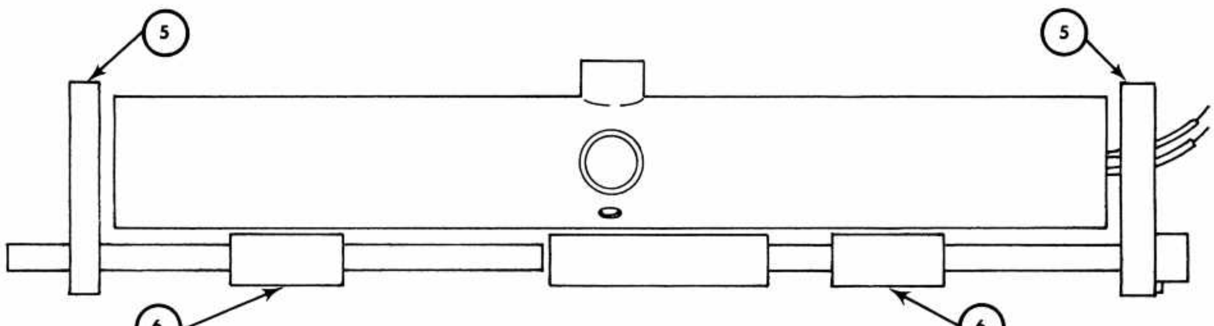
m. Tune the oscillator through its frequency range checking the output power. Power output over the range should not exceed 100 mW or decrease below 5 mW.

n. Remove the RF power meter from the No. 2 port and connect the meter through a 50 Ω, 10 dB attenuator and 9 inch lossy cable to the No. 1 port. Connect the 9 inch (not lossy) coaxial cable from the instrument phase lock circuit to the No. 2 port.

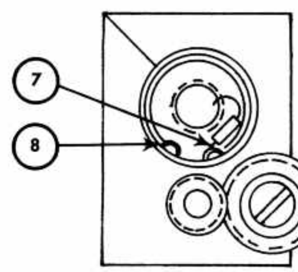
o. Tune the oscillator through its frequency range checking the output power from the No. 1 port. Power output should not exceed 16 mW or decrease below 2 mW.



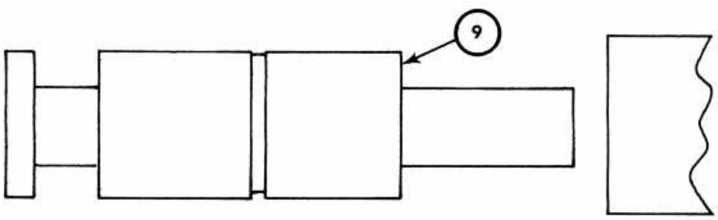
1. Remove (6) setscrews and (3) probes from collars, remove trimmer.
2. Remove (3) 2-56 screws, unsolder center lead and remove endplate.
3. Remove (3) 2-56 screws, pull end cap back, unsolder (2) wires and remove.
4. Loosen (2) setscrews. Do not intermix these with others.



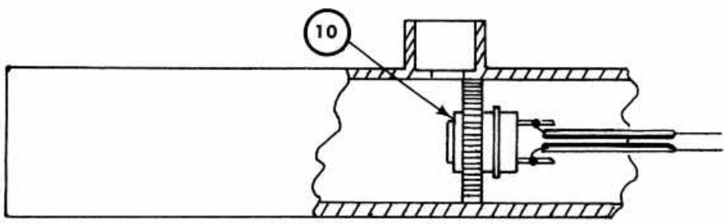
5. Loosen clamp screws on top of end blocks and slide off cavity.
6. Pull tuning nuts straight out of cavity.



7. Unsolder resistor from snap ring.
8. Remove snap ring from each end.

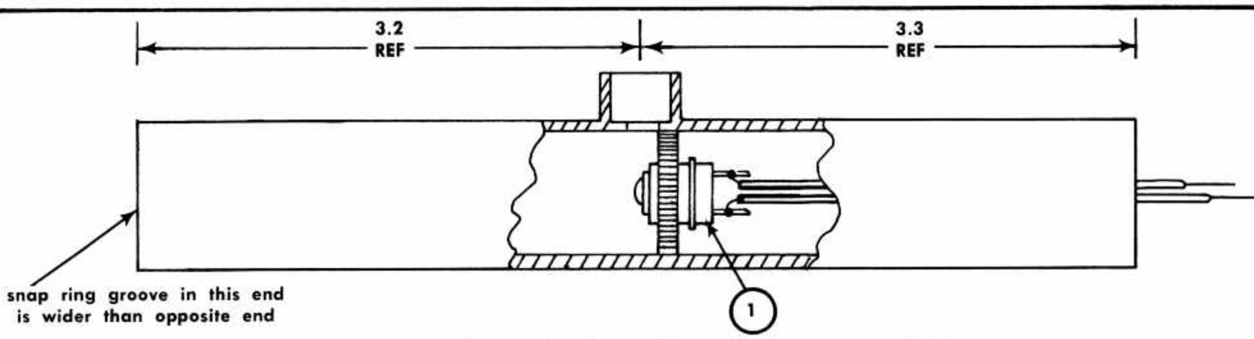


9. Remove choke assembly from each end.

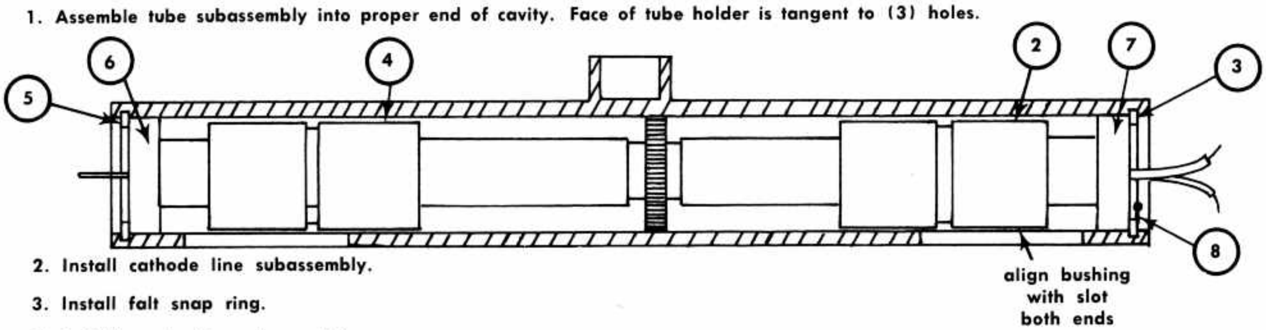


10. Push tube subassembly from cavity using .750 maximum O.D. × 6.5 min long tubing. Should have .375 min I.D.

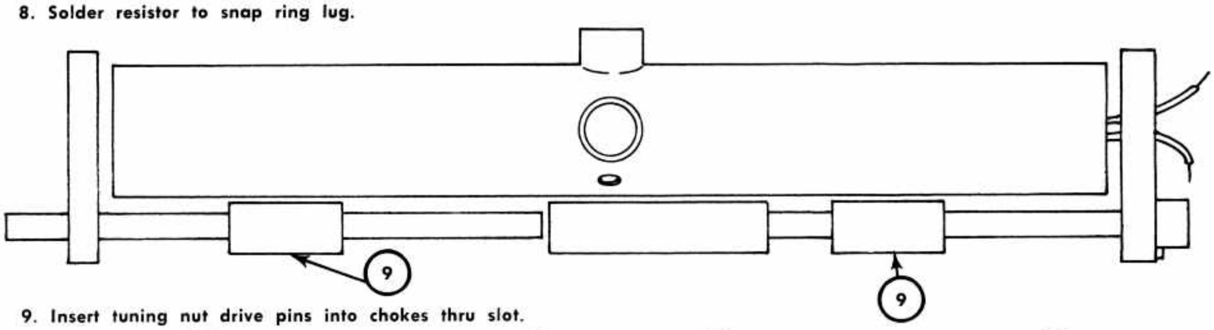
Fig. 4-4A. Tube subassembly removal procedure.



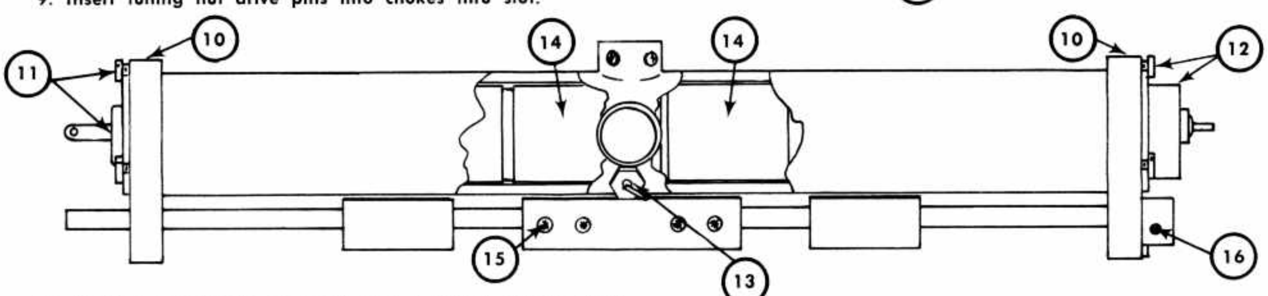
1. Assemble tube subassembly into proper end of cavity. Face of tube holder is tangent to (3) holes.



2. Install cathode line subassembly.
3. Install falt snap ring.
4. Install anode line subassembly.
5. Install bowed snap ring.
6. Adjust phenolic nut ccw against bowed snap ring.
7. If face of tube sub-assembly is not tangent to edge of hole, adjust phenolic nut at both ends for necessary amount to make tube sub-assembly tangent.
8. Solder resistor to snap ring lug.



9. Insert tuning nut drive pins into chokes thru slot.



10. Position end blocks on housing and tighten clamp screws.
11. Install B+ end cap with (3) 2-56 screws and solder resistor.
12. Solder (2) filament wires to terminals on end cap and install with (3) 2-56 screws.
13. Install trimmer screw and locknut.
14. Adjust both chokes to high frequency position.
15. Tighten setscrews in readiness for alignment procedure.
16. Loosen 2-56 setscrew on pinion gear.

Unit is now ready for alignment.

Fig. 4-4B. Tube subassembly installation procedure.

Balancing the output of ports No. 1 and No. 2 may be necessary to provide the desired output from both ports. This is done by loosening the 2-56 set screw in the probe assembly and varying the coupling. Each adjustment interacts with the other adjustments, therefore, both outputs must be checked after each adjustment.

2. Tracking the oscillator to the dial assembly.

a. Tune the oscillator to the high end of the frequency until the internal stops are reached. Do not force the tuning past the stop.

b. Back oscillator away from the internal stops. Insure the oscillator assembly is still oscillating and is above 4.2 GHz.

c. Install pinion gear so bent tooth of the spur gear makes contact with the set screw (4) Fig. 4-3, then tighten the set screw in the pinion gear.

d. Tune to the low end, insuring the oscillator assembly is operating and no internal stops are encountered before the pinion gear stop is reached.

3. Install Pinion Gear.

a. Tune the oscillator to 4.2 GHz. Set the indicated dial assembly to 4.0 GHz and lock the dial assembly to the oscillator tuning shaft.

b. Tune the dial to indicate 1.5 GHz. Adjust the trimmer screw (3) in Fig. 4-3, for an oscillator frequency of 1.7 GHz.

c. Repeat these steps until the oscillator frequency corresponds to the dial reading at both ends of the frequency band.

d. Check oscillator tracking through the frequency range. Must track within ±1% of the indicated dial reading +200 MHz. It may be necessary to introduce some error at the upper or lower frequency limits to bring the tracking within the ±1% specification.

e. Check the phase lock operation over the frequency range. Check for the presence of beat frequency signals and stable locking operation.

4. Final Check.

a. Install the oscillator assembly into the unit.

b. Check the oscillator tracking over the frequency range, the proper operation of the phase lock circuit, and analyzer sensitivity.

Removing and Remounting the Honeycomb Assembly

1. Loosen the front set-screw on the coupler to the DISPERSION RANGE switch shaft with an Allen wrench. Slide the shaft out through the front panel so it is out of the way.

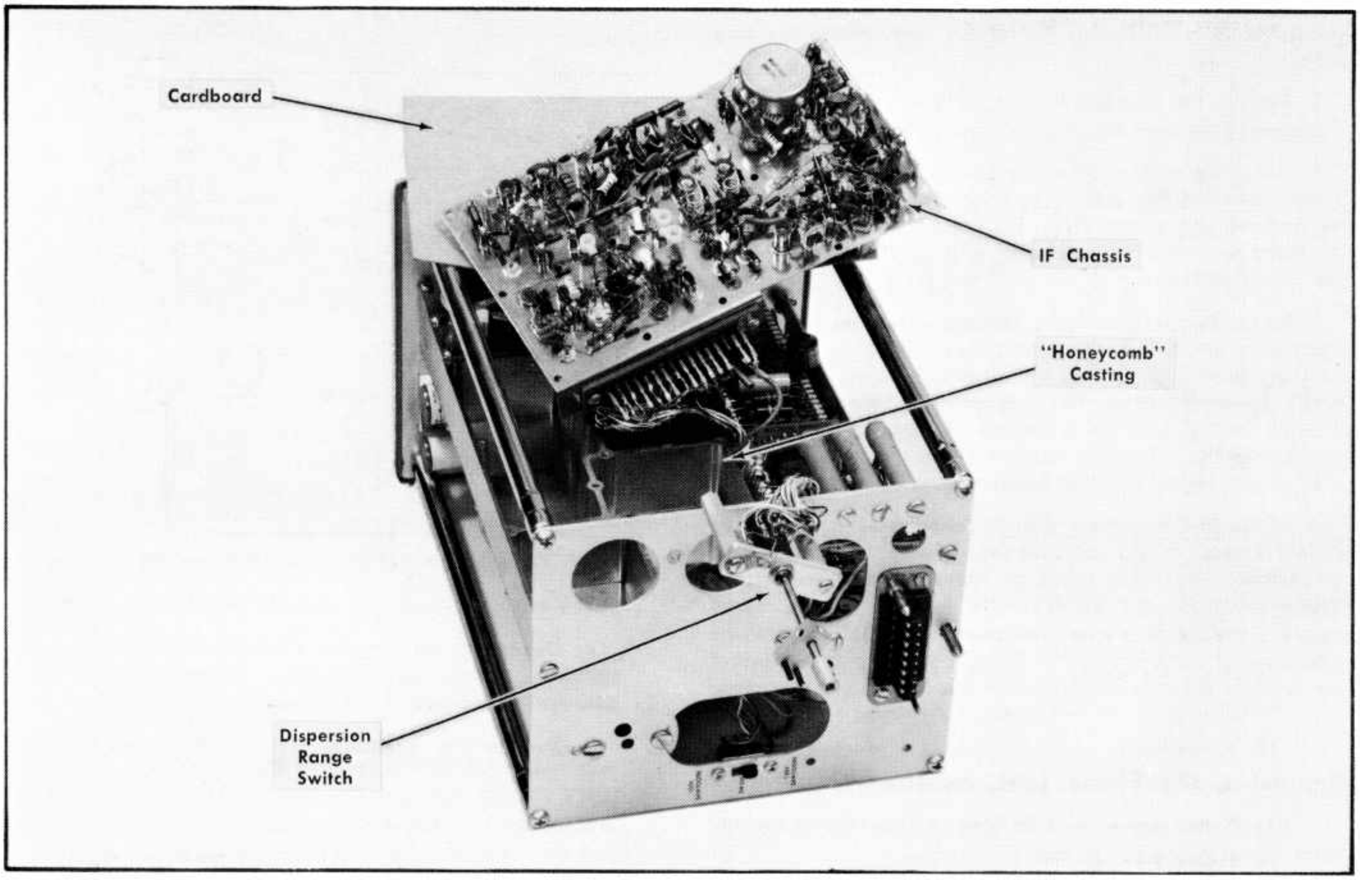


Fig. 4-5. One method of removing the IF chassis for troubleshooting.

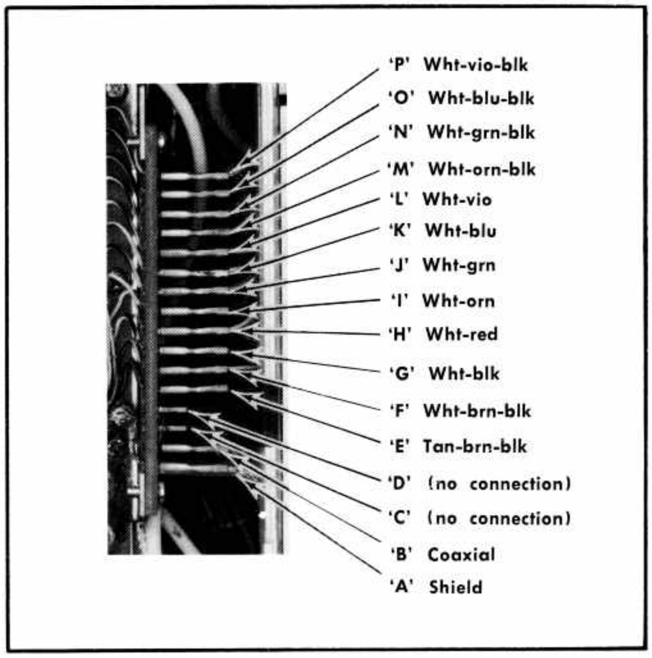


Fig. 4-6. Wire and cable color code to the honeycomb pin connectors.

2. Remove the two screws securing the DISPERSION RANGE switch mounting hardware to the rear plate and swing the switch assembly out of the way behind the rear plate.

3. Remove the fourteen Phillips head screws fastening the IF chassis to the base assembly (top plate).

4. Swing the chassis up and out, to rest on the instruments spacer bars (see Fig. 4-5). It may be necessary to disconnect the coaxial cable from J147. Do not use force, as some of the parts are critically positioned and should not be moved out of adjustment.

5. Insure that none of the terminals and tie points are shorted or grounded. Reconnect any cables or wires that may be disconnected. Fig. 4-6 illustrates wiring color code. Apply power if desired. The ground-wire on the DISPERSION RANGE switch must be grounded for proper operation of the instrument. Fig. 4-2 illustrates the component layout and circuit layout on the honeycomb chassis.

6. Remount the chassis using the reverse procedure of steps 1 through 5. Do not force the chassis into place. Check for pinched or undue strain on the wires and connectors. When replacing the DISPERSION RANGE switch, make certain its shaft is properly coupled to SW365. Check the operation of the DISPERSION RANGE switch and insure that the knob is properly indexed with the front panel markings.

Removing the Phase Lock Assembly

1. Switch the power to OFF and remove the instrument from the plug-in oscilloscope.

2. Unplug the signal lead (J885) from the phase-lock assembly.

3. Loosen the set screw for the FINE RF CENTER FREQ control and remove the knob.

4. Use a $^5/_{16}$ inch nut driver to remove the mounting nuts securing the front panel phase-lock controls (FINE RF FREQ, LOCK CHECK and INT FREQ control). Keep the nut for the INT REF FREQ control separate from the others, because it has a different thread and will bind if it is placed on the wrong control.

CAUTION

Do not loosen or move the pickup probe in the oscillator assembly. Its position is critical for proper operation of the oscillator.

5. Remove the six Phillip head screws located along the edge of the "U" shaped phase-lock assembly cover.

6. Slide the assembly back and out of the "U" shaped cover. Be careful that the mounting screws for the low pass filter do not catch the chassis.

7. Support the phase-lock assembly on a small block (see Fig. 4-7), then connect the signal lead from the oscillator to J855. Check the lead dress and all connectors to insure that no short circuit exists and all connections are correct (see Fig. 4-8). Power can now be applied and the phase-lock circuit checked for correct voltages and waveforms. Fig. 4-11 illustrates component layout on the circuit board.

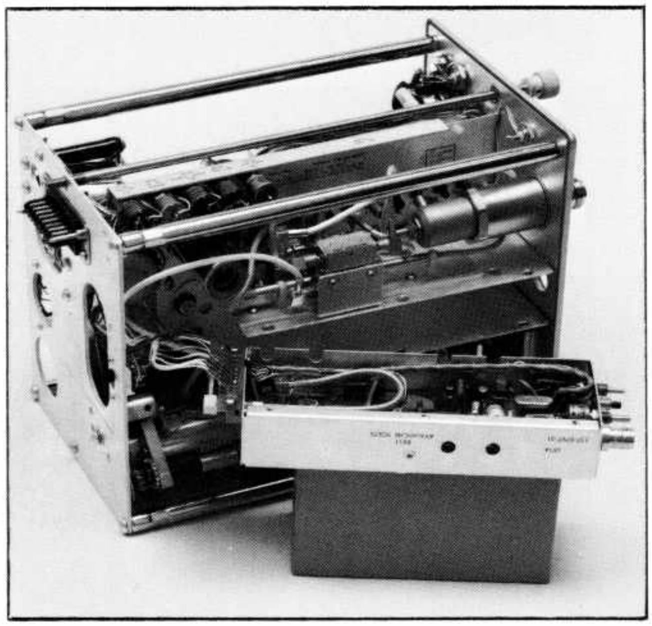


Fig. 4-7. Phase lock assembly removed and ready to troubleshoot.

8. If the circuit board is to be replaced, proceed as follows:

a. Disconnect all the signal and voltage leads to the assembly. Disconnect the Sealectro connector to the phase detector at the board.

b. Remove the mounting nuts for the three controls. Push the FINE RF CENTER FREQ potentiometer and the LOCK CHECK switch into the box. Unsolder the lead to the BNC connector. Remove the circuit board mounting screws and the mounting screws to the square pin connector.

c. Slip the circuit board out of the box. Repair or replace.

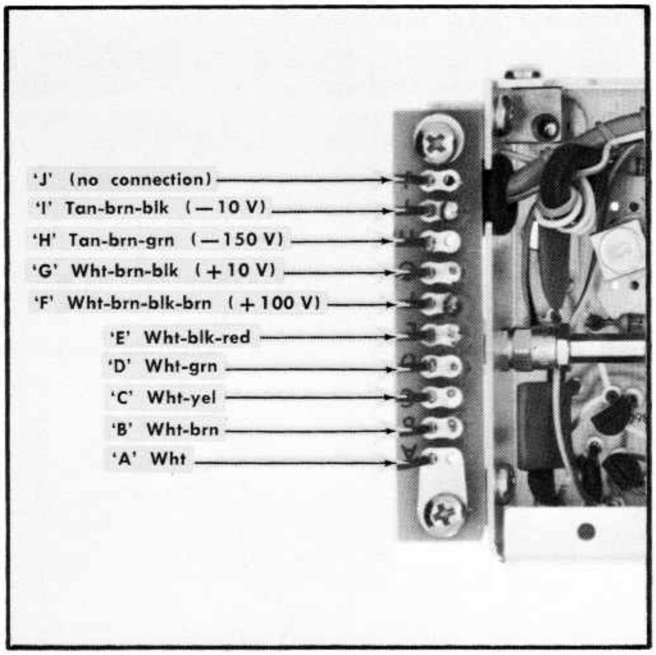


Fig. 4-8. Wiring color code to phase lock assembly pin connectors.

Remounting the Phase Lock Assembly

1. Replace and remount the assembly using the reverse of the procedure to remove the assembly. Be certain to use the correct mounting nut for the INT REF FREQ control.

2. Refer to the Phase Lock diagram and Fig. 4-8 for the correct voltage and signal cable hook up. Make certain the dot on the FINE RF CENTER FREQ control is indexed at the center of the control range when the knob is replaced.

Soldering Techniques

Ceramic Strips. A soldering iron with a wedge-shaped tip should be used because it concentrates the heat on the solder in the terminals. It is important to use as little heat as possible to produce a full flow joint. A special silver-bearing solder is used to establish a better bond to the plated notches in the ceramic strip. Occassional use of ordinary 60/40 solder will not break the bond, but it is advisable to use solder containing about 3% silver for the maintenance of Tektronix instruments. This solder may be purchased directly from Tektronix, Inc., order by Part Number 251-0514-00.

The following techniques are suggested to remove and replace components on the ceramic strips.

1. Grip the lead with needle-nose pliers. Apply the tip of the soldering iron to the connection at the notch, then pull gently to remove the lead.

2. Clean the leads on the new component and bend them to the correct shape to fit the replacement area. Insert the leads, making certain the component seats the same as the original.

3. Apply the iron to the connection; then apply only the amount of solder required to form a good electrical connection.

4. Do not attempt to fill the notch with solder; apply only enough solder to cover the wires adequately and form a small fillet. Over-filling the notches may result in cracked terminal strips. Clip off the excess lead that extends beyond the soldered joint.

NOTE

Some components can be damaged by heat. A heat sink, such as a pair of needle nose pliers, hemostat or forceps, between the component and the connection will protect the component from excessive heat.

Metal Terminal Soldering. When soldering metal terminals (e.g., switch terminals, potentiometers, etc.) ordinary 60/40 solder is satisfactory. The soldering iron should have a 40- to 75-watt rating and a 1/8 inch chisel tip.

1. Apply only enough heat to make the solder flow freely and form a good electrical connection. Do not use excessive solder. Excess solder may impair the operation of the circuit or cover a cold solder joint.

2. Clip off excess wire that may extend past the soldered connection and clean the area with flux-remover solvent.

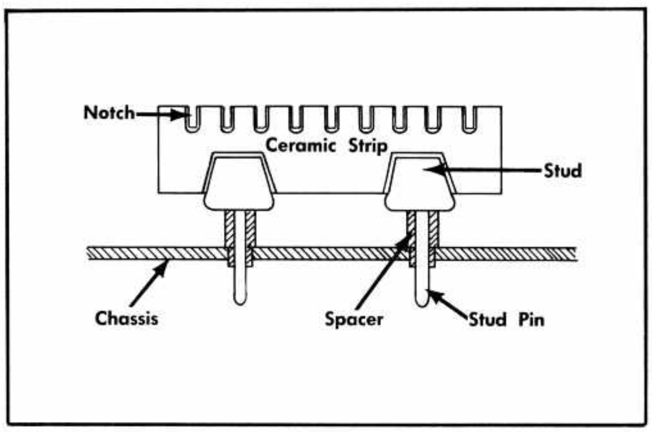


Fig. 4-9. Typical ceramic strip assembly.

Ceramic Strip Replacement

Unsolder all connections; then use a 3/8 inch diameter by 3 inch long plastic or hardwood dowel and a small (2 to 4 oz.) mallet to knock the stud pins (Fig. 4-9) out of the chassis. Place one end of the dowel on the end of the stud pin protruding through the chassis. Rap the dowel smartly with the mallet. When both studs of the strip have been loosened in this fashion, the strip is removed as a unit. The spacers will probably come out with the studs. If not, they can be pulled out separately. An alternate method to remove the terminal strip is to use diagonal cutters to clip off the studs. The ceramic strip is removed and the studs pulled from the chassis with a pair of pliers.

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until completely seated. If necessary, use a soft mallet and tap lightly, directly over the stud area of the strip.

Component Replacement

The physical size and shape of the replaced component may affect the performance of the circuit; therefore, it is best to duplicate the original component as closely as possible. Parts orientation and lead dress should also duplicate those of the original part. Many of the components are oriented to reduce or control circuit capacitance and inductance. After repair, the circuits of the instrument may need recalibration.

Removing and Replacing Switches

Single wafers on the DISPERSION-COUPLED RESOLUTION switches are not normally replaced. If any of these wafers are defective, the entire switch should be replaced. Refer to the Electrical Parts List to find the unwired or wired switch part numbers.

CAUTION

When disconnecting or connecting leads to a wafer-type switch, do not let solder flow around

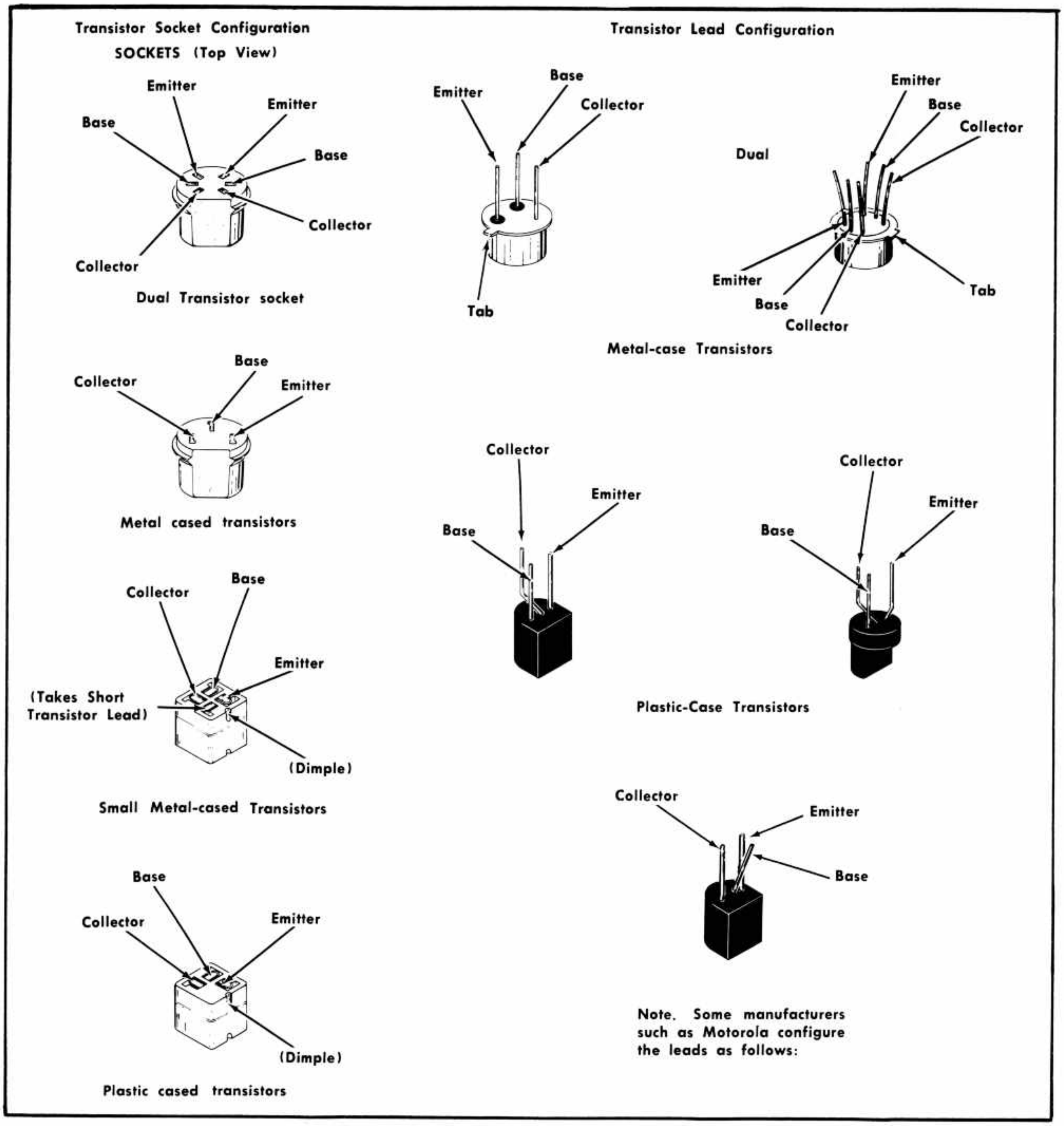


Fig. 4-10. Semiconductor base pin and socket arrangements.

and beyond the rivet on the switch terminal. Excessive solder can destroy the spring tension of the contact.

Transistor Substitution and Replacement

Transistors should not be replaced unless they are actually defective. However, temporary substitution is often a convenient way to detect defective transistors. Before substituting a transistor, it is recommended that circuit conditions be checked to be certain that an exact replacement will not be damaged. Return transistors to their original sockets if they are found to be good. Some transistors can be inserted incorrectly into their socket. Fig. 4-10 illustrates the connections and positions for the types of transistors used in the Type 1L40.

TROUBLESHOOTING

Attempt to isolate trouble to one circuit through operational and visual checks. Verify that the trouble is actually a malfunction within the Type 1L40 and not improper control setting or malfunctioning associated equipment. Note the effect the controls have on the trouble symptoms. Normal or abnormal operation of each control helps establish the location and nature of the trouble.

Check the instrument calibration or the calibration of the affected circuit. The trouble may be corrected after calibration. Before changing any adjustment during this check, note the position of the adjustment, so it can be returned to its original position after the check. This will facilitate recalibration after the trouble has been found and corrected.

Check circuit voltages and waveforms against those shown in section 8 of this manual. Figs. 4-11 and 4-12 provide circuit board wiring drawings and component layout information for the honeycomb and the phase lock assemblies. If the trouble cannot be isolated to a circuit, start with the power supply voltages, then proceed consecutively from one circuit to the next until the problem is localized.

NOTE

Voltages and waveforms shown on the diagrams are not absolute and may vary between instruments.

Most voltage measurement can be taken with a 20,000 ohms/volt DC voltmeter. Do not use a low-volts range on a high impedance circuit. Use a higher range or an oscilloscope with a 10× probe. Accuracy of the voltmeter should be within 3% of all ranges.

Connections to the honeycomb chassis and the Phase-Lock chassis are made through pin connectors and clips. These connectors make convenient test points for troubleshooting, since much of the circuitry is inaccessible with the circuit boards installed and in the assembly.

Once the trouble has been isolated, it may be desirable to refer to the Circuit Description in section 3 for a description of the normal circuit operation.

CAUTION

Use care when measuring voltages or waveforms. The small size and high density of components in this instrument establishes a condition such that an inadvertent movement of the test probe or use of oversized probes may short-circuit between components.

Check circuit conditions before disconnecting voltages to make certain bias voltages are not removed which might cause excessive overloads.

In-Circuit Diode Checks

In circuit diode checks may be performed with a voltmeter. A comparison check of the voltages on each side of the diode with the typical voltages listed on the diagram will help isolate faulty diodes. Forward-to-back resistance ratios on some diodes can be checked by referring to the schematic and pulling appropriate transistors and square pin connectors to remove low resistance loops around the diode.

CAUTION

Do not use an ohmmeter scale that has a high internal current. Do not check the forward-to-back resistance ratios of tunnel diodes or mixer diodes.

Trouble Symptom

A misleading trouble symptom may occur if one of the Varactor diodes in the oscillator circuit is shorted. This will clamp the DC output voltage from the phase lock circuit and prevent vertical trace shift as the FINE RF CENTER FREQ control is adjusted. The symptom indicates trouble in the phase lock circuit when it is actually in the tuner.

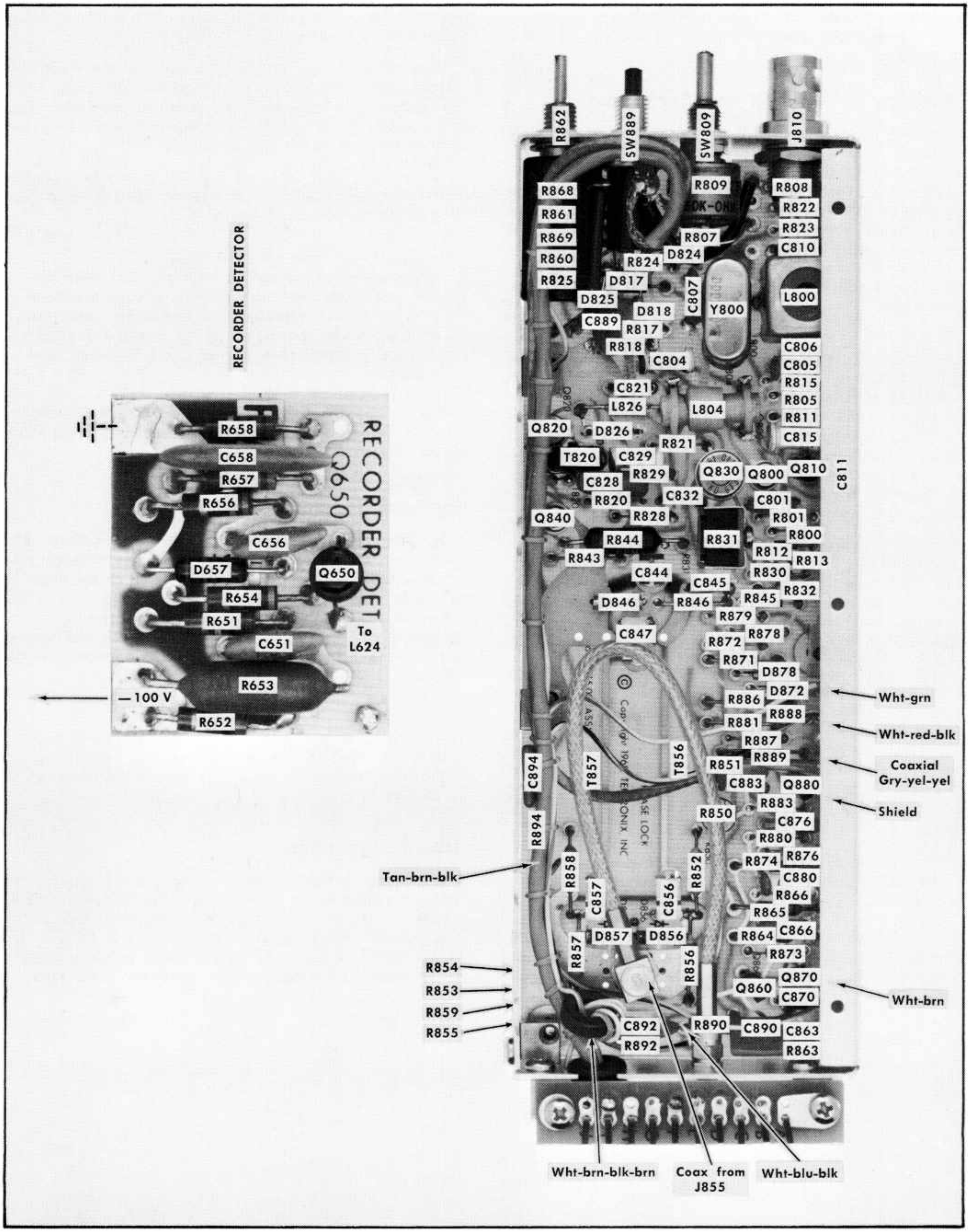


Fig. 4-11. Phase Lock and Recorder Detector circuit boards.

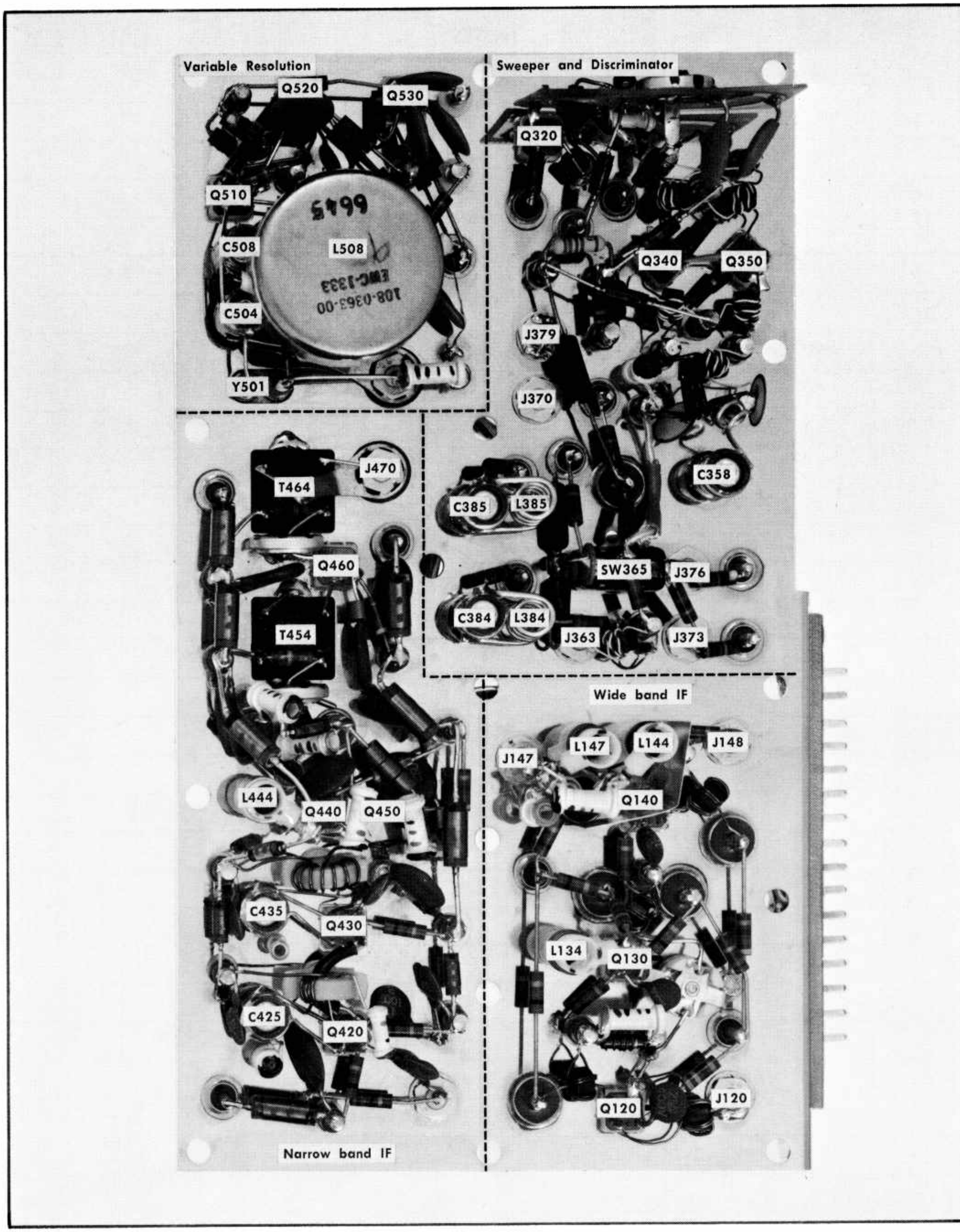


Fig. 4-12. Honeycomb assembly circuit and component layout.

NOTES

SECTION 5
PERFORMANCE CHECK AND CALIBRATION PROCEDURE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section provides both a front panel check procedure to evaluate the performance of the instrument and a complete calibration procedure. The performance check, when completed, checks the instrument to the requirements listed in the Characteristics section. Performing the complete calibration procedure in sequence returns the instrument to the performance standards listed in the Characteristics section. Limits, tolerances and typical waveforms and voltages are given as calibration aids to help understand the procedure. They are not performance requirements.

The procedure is arranged to calibrate and check the instrument performance with minimum interaction between adjustments and the minimum number of steps to connect or reconnect test equipment. A picture of the recommended or required test equipment, with settings for the front panel controls, precedes each step or group of related steps. Control settings that have changed from the pervious setup picture are printed in bold type. External controls or adjustments that are referred to in the procedure for the Type 1L40 are printed as labeled on the instrument with all letters capitalized (e.g. DISPERSION). Internal adjustments and control call outs for associated equipment have the initial letter capitalized (e.g. Time/cm or Sweep Center Adj.)

Performance Check. Perform all steps in sequence, except the internal adjust steps or as indicated in the step. When the adjustment is accessible at the front panel, and required for proper operation, it should be adjusted during the performance check. Most steps in the procedure have a check section at the beginning of the step procedure. Steps that are not applicable to a performance check will be noted as such and direct the checker to the next performance step.

Calibration. Complete each step in sequence for a complete calibration. To check or adjust a section or circuit within the instrument, turn to the desired portion of the procedure. Start with the nearest setup if the check in the step or steps indicates the Type 1L40 is not within tolerance. Adjustments that interact will be noted and the indicated interaction must be checked.

General

To ensure instrument accuracy, check the calibration every 1000 hours of operation or every six months whichever is sooner. If the instrument is used in a dusty or damp environment with extreme changes in temperature it should be checked more frequently. Before complete calibration, it is best to clean and inspect the instrument as outlined in the Maintenance section.

CALIBRATION RECORD AND INDEX

This abridged Calibration Procedure provides a record of the instrument's performance. It also serves as a ready index to specific calibration steps. An experienced calibrator may use this as a calibration guide, referring to the detailed procedure only when necessary. The listed characteristics are the same as the requirements listed in the complete procedure.

Type 1L40, Serial No. ________________

Calibration Date ________________

Calibrator ________________

SHORT FORM CALIBRATION PROCEDURE

☐ 1. Check/Adjust IF Center Frequency Calibration and Dispersion Balance (Page 5-4)
Adjust DISP BAL R257, IF CF Range R290 and Center Freq Cal R253

☐ 2(A) Check Dispersion Accuracy of MHz/CM Ranges and Range of IF Center Frequency Control (Page 5-5)

☐ 2(B) Adjust Frequency Dispersion and Linearity (Page 5-6)
Adjust DISP CAL R208, IF CF Range R290 and center Freq Cal R253

☐ 3(A) Check Resolution Bandwidth (Page 5-8)

☐ 3(B) Adjust IF Amplifier Response and the Analyzer Resolution Bandwidth (Page 5-9)
Adjust L144, T464, T454, C435, C425, L444, C504, C508, 100 kHz Resol Cal R543, C610, C620 and L624

☐ 4(A) Check Dispersion Accuracy of kHz/CM Ranges (Page 5-12)

☐ 4(B) Adjust kHz/CM Dispersion (Page 5-13)
Adjust C384, C385, and kHz/CM CAL R368

☐ 5. Check/Adjust Internal 1 MHz Reference Oscillator Operation (Page 5-14)
Adjust L804 and L800

☐ 6. Check/Adjust Phase Lock Operation (Page 5-16)
Adjust Avalanche Volts R831

- ☐ 7. Check Accuracy of IF Attenuator dB Selectors (Page 5-18)
- ☐ 8. Check Dynamic Range of Vertical Display Modes (Page 5-19)
- ☐ 9. Check Attenuation Range of IF GAIN Control (Page 5-20)
- ☐ 10. Check Amplitude of Signal at RECORDER Output Jack (Page 5-20)
- ☐ 11. Check Frequency Response of the Video Circuit (Page 5-21)
- ☐ 12. Check Incidental Frequency Modulation (Page 5-23)
- ☐ 13. Check/Adjust Response Flatness of RF Mixer and Wide Bank IF Amplifier (Page 5-25)
  Adjust L147, C137 and L134
- ☐ 14. Check RF Center Frequency Calibration, System Sensitivity and Phase Lock Operation (Page 5-27)
- ☐ 15. Check Presence of Spurious Signal (Page 5-29)

Recommended Equipment

The following equipment or its equivalent is recommended for calibrating the Type 1L40. The specifications listed are the minimum necessary for accurate calibration, therefore some of the equipment specifications may better the figures given. Substitute equipment must meet or exceed the minimum specifications given. Proper control settings and equipment setup for substitute equipment must be determined by the calibrator.

Special calibration fixtures are also listed to facilitate calibration. These fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix field Office or representative.

1. Indicator Oscilloscope: Oscilloscope with a 6 cm vertical display that will accept the Type 1L40 Spectrum Analyzer. This oscilloscope should be the one the Type 1L40 being calibrated will be used with. The front panel adjustments will require readjustment if the analyzer is changed to another oscilloscope. A Type 545B Osciloscope is used in this procedure.

2. Test Oscilloscope and Vertical Plug-In unit with both 1X and 10X probes; minimum sensitivity 0.005 V/cm; frequency response DC to 30 MHz. Tektronix 540-series Oscilloscope with Type 1A1 Plug-In Unit and Tektronix P6006 (10X) and P6011 (1X) test probes.

3. Time-Mark Generator: Marker outputs, 0.5 s to 0.1 μs and frequency outputs of 20 MHz, 50 MHz, 50 MHz; accuracy 0.001%. Tektronix Type 184 Time-Mark Generator.

4. Audio Signal Generator: Frequency range 10 Hz to 1 MHz, variable output amplitude to at least 10 volts peak to peak, accuracy $\pm$3%. General Radio Model 1310A or Hewlett-Packard Model 241A.

5. VHF Signal Generator: Frequency range 10 MHz to 400 MHz, accuracy $\pm$1%, calibrated variable output attenuator 0 to 120 dBm. Hewlett-Packard Model 608D.

6. Constant Amplitude Signal Generator: 1MHz to 10 MHz, output amplitude 1 V to 5 V peak to peak. Tektronix Type 191 Constant Amplitude Signal Generator.

7. Step Attenuators. 1 dB steps and 10 dB steps, accuracy $\pm$1.5 dB to 90 dB (below 1 GHz). Hewlett-Packard Type 355D and Type 355C Step Attenuators[1].

8. (Optional) Swept-Frequency Generator: frequency range 130 MHz to 280 MHz, with amplitude variation $\leq$ 0.25 dB. Kay Type 121C Sweep Generator. (May be used to check IF bandpass response flatness).

9. Two 10:1 Attenuators: Tektronix Part No. 011-0059-00.

10. 20 dB RF Attenuator, Tektronix Part No. 011-0086-00.

11. Termination, 50 Ω, BNC, Tektronix Part No. 011-0049-00.

12. BNC T connector; Tektronix Part No. 103-0030-00.

13. Adapter, BNC female to N male; Tektronix Part No. 103-0045-00.

14. Adapter, BNC female to BNC female; Tektronix Part No. 103-0023-00.

15. Minature phone plug with 600 Ω load. (Test fixture to check TO RECORD signal amplitude.) Consists of a 600 Ω, 5% ½ watt resistor, soldered across a miniature phone plug. To be obtained locally.

16. Adapter. Sealectro to BNC, Type P6041 probe cable, Tektronix Part No. 010-0164-00.

17. Two BNC, coaxial cables, 50 Ω. Tektronix Part No. 012-0057-01.

18. Patch cord with BNC to banana plug tips. Tektronix Part No. 012-0091-00.

19. Flexible Cable Plug-In Extension. Tektronix Part No. 012-0038-00.

20. RF Signal Generators[2], with calibrated frequency and output power: Frequency range 1.5 GHz to 40 GHz, accuracy $\pm$1%; output power —100 dBm to —30 dBm, accuracy $\pm$1 dB; output impedance 50 Ω. Suggested equipment:

Hewlett-Packard 8614A UHF Signal Generator, 800 MHz to 2400 MHz.

Hewlett-Packard 8616A UHF Signal Generator, 1800 MHz to 4500 MHz.

Polarad 1107 Microwave Signal Generator, 3.8 GHz to 8.2 GHz.

Polarad 1108 Microwave Signal Generator, 6.95 GHz to 11.0 GHz.

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[1]The low value IF Attenuator dB selectors are checked at the factory to insure they are all within the $\pm$0.1 dB/dB specification before being shipped. Any change in tolerance will be a large change resulting from component failure, therefore tight-tolerance step attenuators are not normally required in the Performance Check or Calibration Procedures. If, however, it is desired to check the exact attenuation error of the dB step selectors, then the recommended step attenuators must be accurately calibrated by the user or manufacturer, or a step attenuator having more rigid specifications must be used.

[2]Signal Generator(s) depend on frequency range of instrument.

Hewlett-Packard 626A SHF Signal Generator, 10.0 GHz to 15.5 GHz.

Hewlett-Packard 628A SHF Signal Generator, 15.0 GHz to 21.0 GHz.

Hewlett-Packard 938 Frequency Doubler, 18.0 GHz to 26.5 GHz.

Hewlett-Packard 940 Frequency Doubler, 26.5 GHz to 40.0 GHz.

Hewlett-Packard 281 Wave-guide to Coaxial Adapter.

Hewlett-Packard NP292A Wave-guide to Coaxial Adapter.

Hewlett-Packard MP292B Wave-guide to Coaxial Adapter.

Hewlett-Packard NK292A Wave-guide to Coaxial Adapter.

Hewlett-Packard 11503A Flexible Wave-guide.

Hewlett-Packard 11504A Flexible Wave-guide.

21. Adjusting tools:

a. Screwdriver, 3/32 blade, 3 inch shaft.	003-0192-00
b. Tuning tool	
Handle	033-0307-00
Insert for 5/64 (D) hex cores	033-0310-00

PRELIMINARY PROCEDURE

Performance Check

a. Set the Sawtooth Selector switch SW201 (mounted on the rear panel) to the appropriate sweep amplitude position, then plug the instrument into the oscilloscope compartment.

b. Turn the oscilloscope power on; allow 20 minutes for the instrument to warm up, at an ambient temperature of 25° C ±5° C, before making adjustments or checking the instrument to any given accuracies.

c. Connect the oscilloscope Sweep Out or Sweep A connector to the analyzer SWEEP INPUT connector.

WARNING

The sawtooth voltage can produce an electrical shock. Insure that the cable is connected to the SWEEP INPUT connector and not the RF INPUT connector.

d. Set the oscilloscope Mode or Horizontal Display switch to A or Normal, then set the sweep controls for a free-running 10 ms/cm sweep rate.

NOTE

Calibration setup pictures show the instrument out of the plug-in compartment, ready for calibration. The setup for the performance check is the same except the instrument is plugged into the oscilloscope compartment and all test equipment shown may not be required.

Calibration

Connect the Type 1L40 Spectrum Analyzer through a flexible extension (Part No. 012-0039-00) to connector J11 of the oscilloscope plug-in compartment to permit internal adjustments and measurements.

NOTES

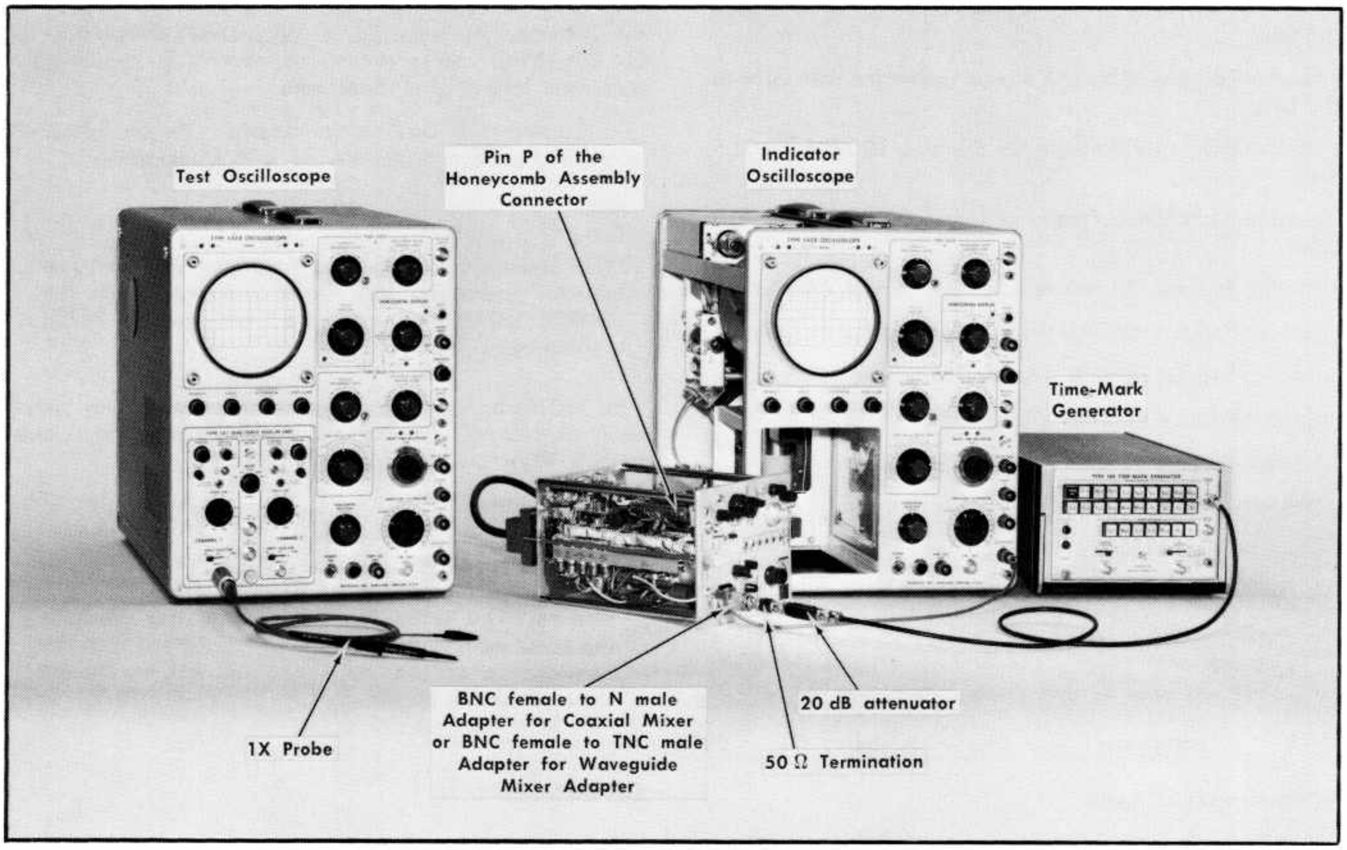


Fig. 5-1. Equipment setup to calibrate dispersion (steps 1 and 2).

Type 1L40

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Midrange (000)
FINE	Centered
CAL (Adjustment)	Centered
DIS CAL (Adjustment)	Centered
DISPERSION RANGE	MHz/CM
DISPERSION-COUPLED RESOLUTION	10 MHz
VIDEO FILTER	Off
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN dB	Switches off
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF
MIXER PEAKING	Fully CCW

Indicator Oscilloscope

Time/Cm	10 ms
Triggering	Adjusted for a free running sweep
Horizontal Position	Centered trace

1. Check/Adjust IF Center Frequency Calibration and Dispersion Balance

Requirements: With the IF CENTER FREQ controls centered (000), the IF CENTER FREQ-CAL must adjust the IF center frequency to 200 MHz. The DISP BAL adjustment must balance the IF center frequency shift to less than 2 cm between the MHz/CM and KHz/CM dispersion ranges.

a. Equipment setup is shown in Fig. 5-1.

b. Apply a 200 MHz signal (2nd harmonic of 10 ns) from the Time-Mark Generator (Type 184) through a 20 dB attenuator pad, 50 Ω termination and a BNC female to N male adapter to the RF INPUT (coaxial mixer) connector. (Signal input to the Type 1L40 should be less than —30 dBm.)

c. Adjust the GAIN control for a signal amplitude that is approximately 5 cm.

d. With the IF CENTER FREQ controls centered, adjust the IF CENTER FREQ-CAL for minimum horizontal signal shift as the DISPERSION selector is switched between the 10 MHz/CM and .2 MHz/cm positions. Position the signal to the graticule center with the oscilloscope Horizontal Position control.

e. CHECK—With the 200 MHz signal centered in the graticule area, the horizontal sweep must extend to or beyond the graticule edges.

f. Adjust the DISP BAL for minimum signal shift as the DISPERSION RANGE is switched between the MHz/CM and kHz/CM positions. Adjust until there is minimum signal movement, then make the final adjustment with the DISPERSION RANGE in the kHz/CM position and reduce the DISPERSION control to the 20 kHz/cm position.

g. Repeat the IF CENTER FREQ-CAL and the DISP BAL adjustment since there is some interaction between adjustments. Return the DISPERSION RANGE selector to the MHz/CM position and the DISPERSION-COUPLED RESOLUTION controls to the 10 MHz/cm position.

h. CHECK—The display shift between the MHz/CM and kHz/CM dispersion ranges must not exceed 2 cm. If the above requirements are not met, proceed with the following calibration procedure.

NOTE

When making a Performance Check only, omit the remainder of this step and proceed to step 2(A).

i. Set up the equipment as shown in Fig. 5-1. Set the controls and adjustments as directed for Fig. 5-1.

j. Connect the probe of a DC coupled test oscilloscope to chassis ground on the Type 1L40. Establish 0 V reference level on the test oscilloscope, then connect the probe to pin P of the pin connector on the honeycomb assembly, see Fig. 5-2.

k. ADJUST—The IF CF Range R290 (see Fig. 5-2) for —0.75 ±0.1 volt of trace deflection on the test oscilloscope.

l. Disconnect the probe from pin P of the connector.

m. Apply a 200 MHz signal from the Time-Mark Generator (harmonic of 10 ns marker) through a 20 dB attenuator, a 50 Ω termination and the proper adapter to the RF INPUT connector.

n. Adjust the GAIN control for a signal amplitude of approximately 4 cm. Tune the RF CENTER FREQ control to minimize converted signal interference. The 200 MHz IF feed-through signal should be relatively free of spurious signal interference.

o. ADJUST—the Center Freq Cal R253 (Fig. 5-2) for minimum IF signal shift as the DISPERSION selector is switched between the 10 MHz and .2 MHz positions. The DISPERSION RANGE switch must be in the MHz/CM position for this adjustment.

p. Return the DISPERSION selector to the 10 MHz position and adjust the Horizontal Position control to center the sweep on the graticule.

q. ADJUST—the Sweep Center R204 (Fig. 5-2) to position the 200 MHz signal to the graticule center line.

2(A) Check Dispersion Accuracy of MHz/CM Ranges and Range of IF Center Frequency Control

NOTE

Dispersion accuracy is a measure of the frequency dispersion error within the center 8 centimeters of a 10 centimeter display. It is measured by positioning a frequency marker on the 1st centimeter line, then noting the frequency error as the distance the respective marker is displaced from the 9th centimeter line. See Fig. 5-3.

Linearity error is the measured distance that any frequency marker is displaced from its respective graticule line when compared over an 10centimeter display. See Fig. 5-4.

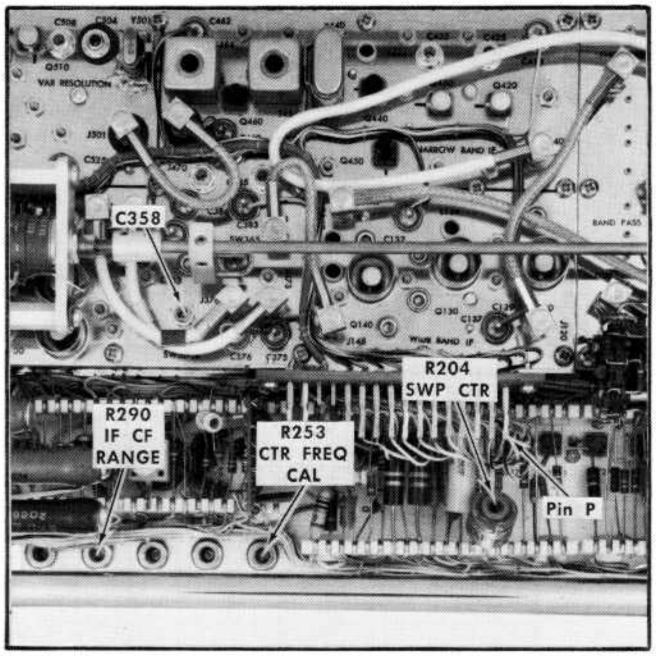


Fig. 5-2. Location of sweeper and discriminator adjustments.

REQUIREMENT—Dispersion accuracy for the MHz/CM ranges is listed in Table 5-1. IF CENTER FREQ control range for the 5 MHz/CM to .2 MHz/cm dispersion should equal or exceed + and — 25 MHz from its centered (000) position. Dispersion accuracy and display linearity must remain within the listed specifications of Table 5-1.

a. The test equipment setup is shown in Fig. 5-1.

b. Apply .1 μs and 10 ns time markers from the Time-Mark Generator (Type 184) through a 20 dB attenuator, 50 Ω termination and the proper adapter to the RF INPUT connector.

c. Set the VERTICAL DISPLAY switch to LOG position. Adjust the GAIN control for a display amplitude of approximately 4 centimeters. Set the oscilloscope Source switch to Line and adjust the Level control for a triggered display.

d. Center the IF CENTER FREQ controls. Adjust the DISP CAL adjustment for 1 marker/cm within the center 8 centimeters.

e. Check the dispersion accuracy and linearity for each MHz/cm setting of the DISPERSION selector as listed in Table 5-1, (see Fig. 5-3 and 5-4). The Horizontal position control or the IF CENTER FREQ control may be used to align the prime markers to the graticule divisions. The RESOLUTION control should remain coupled with the DISPERSION selector.

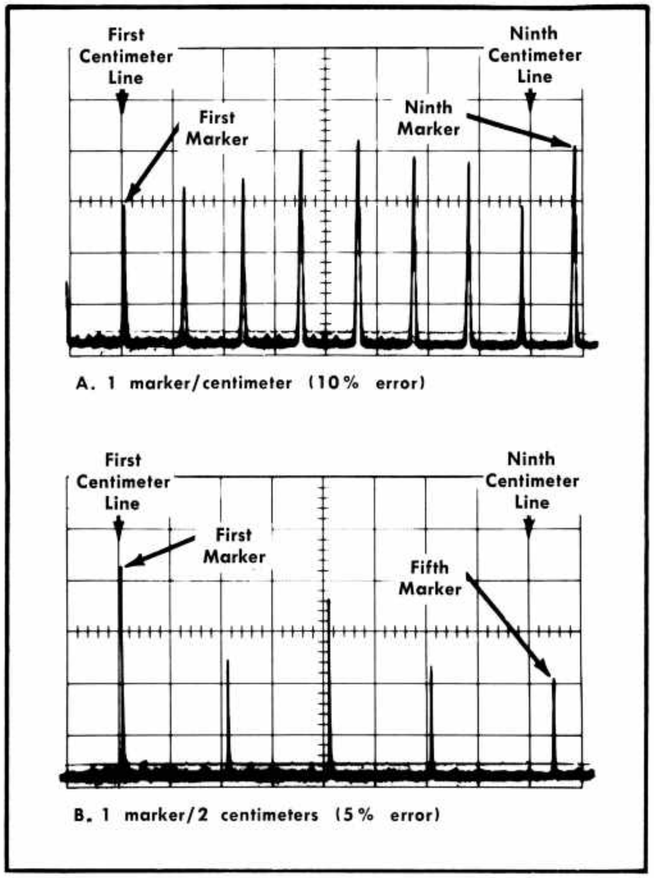


Fig. 5-3. Typical dispersion accuracy displays (step 2).

f. Check the range of the IF CENTER FREQ control plus the dispersion accuracy and linearity over this range, in the 5, 2, 1, .5 and .2 MHz positions of the DISPERSION selector.

Range of the IF CENTER FREQ control should equal or exceed + and — 25 MHz from its centered position. Rotate the control from center and note the frequency shift of the .1 μs or 10 MHz markers, then rotate the control to the other extreme position. Dispersion accuracy and display linearity

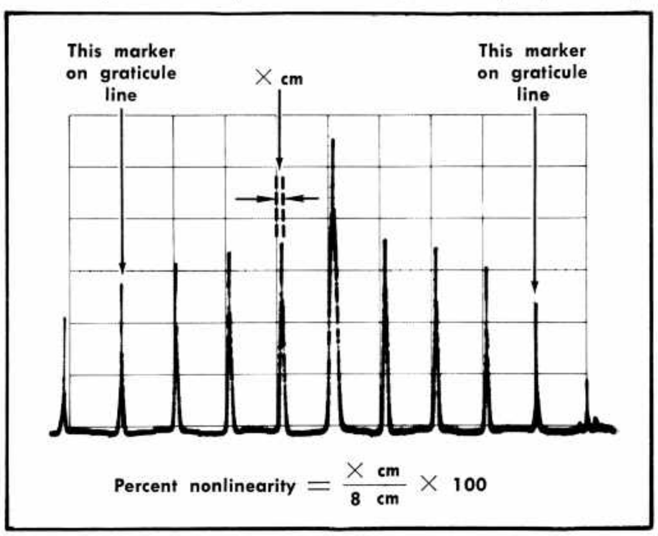


Fig. 5-4. Measuring displersion linearity.

must remain within listed specifications given in Table 5-1, to the + and —25 MHz positions.

g. Center the coarse IF CENTER FREQ control. Set the DISPERSION control to .5 MHz position and apply 10 ns and 1 μs markers from the Time-Mark Generator.

h. CHECK—The range of the IF CENTER FREQ-FINE control. Must equal or exceed + and — 1 MHz from its centered position.

i. Return the VERTICAL DISPLAY switch to the LIN position.

TABLE 5-1

DISPERSION Position	Marker Selection	Markers/ Cm	Allowable Error	Supplementary Notes
10 MHz	10 ns and .1 μs	1	3%	
5 MHz	10 ns and .1 μs	1 marker/ 2 cm	3%	Dispersion accuracy must hold over the range of the IF CENTER FREQ control (±25 MHz).
2 MHz	10 ns and .5 μs	1	5%	
1 MHz	10 ns and 1 μs	1	7%	
.5 MHz	10 ns and 1 μs	1 marker/ 2 cm	10%	Display linearity over a 10 centimeter display must be within 3%.
.2 MHz	10 ns and 5 μs	1	15%	

2(B) Adjust Frequency Dispersion and Linearity

When making a Performance Check only, omit this step and proceed to step 3 (A).

Dispersion accuracy and the display linearity for the Type 1L40 is a function of the RF output amplitude, circuit constants, etc. DISP CAL adjustment R208, primarily affects the dispersion accuracy and C358 (10 MHz/CM Linearity) the linearity. If these two adjustment will not calibrate the dispersion to specifications the following techniques may be tried.

Shift the sweep oscillator RF output voltage to a new level. (Output voltage level must remain within —0.7 and —1.0 volt.) If the level is changed, the Center Freq Range adjustment (step 1) must be repeated.

Interchange Q310, Q340 and Q350. The slight differences between the transistor parameters will have some effect on display linearity. Interchanging the discriminator cables (W375 and W370) with another length is also a possible correction. Changing these transistors or cables is only recommended after new transistors have been installed or components have been changed and linearity cannot be obtained by other means.

a. The equipment setup for this step is shown in Fig. 5-1.

b. Apply .1 μs and 10 ns markers from the Time-Mark Generator (Type 184) through a 20 dB attenuator a 50 Ω termination and the proper adapter to the RF INPUT connector. Set the VERTICAL DISPLAY switch to LOG position.

NOTE

More than one set of 1 MHz markers may appear on the display. To avoid confusion, tune the RF CENTER FREQ and FINE FREQ controls to align the tunable markers with the fixed (IF feed-through markers.) Tunable markers will only appear with the coaxial mixer installed.

c. Adjust the GAIN control for a display amplitude of approximately 3 to 4 centimeters. See Fig. 5-3. Set the oscilloscope Source switch to Line and adjust the Level control for a triggered display.

d. Adjust the DISP CAL R208, for a 1 marker/centimeter over the center 8 graticule divisions, then adjust C358 (Fig. 5-2) for optimum display linearity.

e. Repeat the adjustment of DISP CAL R208, and C358 until optimum dispersion accuracy and linearity are obtained. If the dispersion linearity is not within tolerance, a slight re-adjustment of IF CF Range R290 and the Center Freq Cal R253 adjustments may be required. Monitor the voltage at pin P of the honeycomb pin connector with the test oscilloscopes to keep the RF voltage amplitude within —0.7 to —1.0 volt.

f. Recheck dispersion accuracy for the MHz/cm ranges as per step 2(A).

NOTES

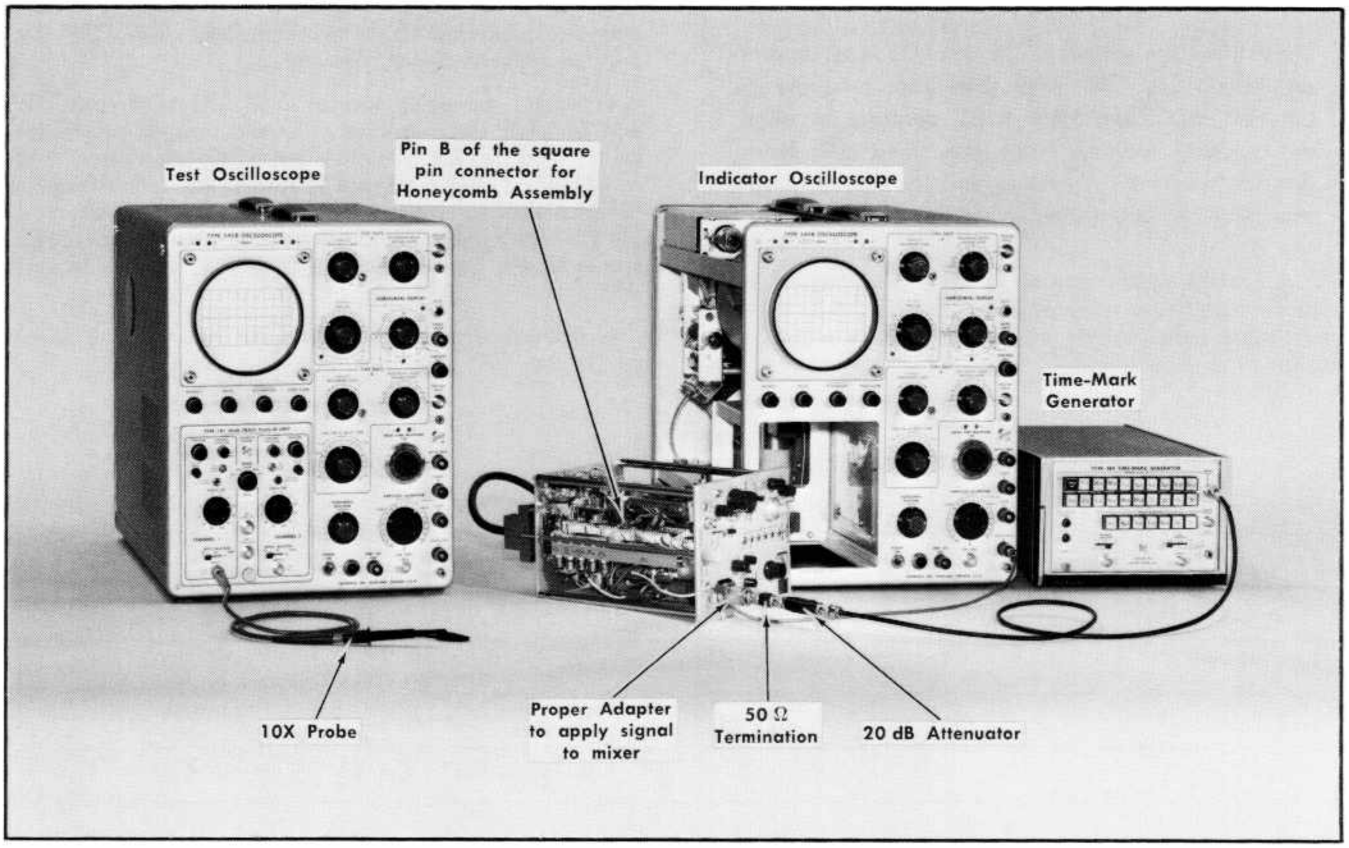


Fig. 5-5. Equipment setup to adjust the IF amplifier response and the resolution bandwidth (step 3).

Type 1L40

POS	Position a free running trace to the bottom of the graticule.
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	**kHz/CM**
DISPERSION-COUPLED RESOLUTION	**500**
VIDEO FILTER	OFF
GAIN	**Fully clockwise**
VERTICAL DISPLAY	LIN
IF ATTEN	20 dB
FINE RF CENTER FREQ	Centered (0)
INT REF FREQ	OFF
MIXER PEAKING	CCW

Indicator Oscilloscope

Time/Cm	10 ms
Triggering	**Line triggered sweep**
Horizontal Position	Centered trace

3(A). Check Resolution Bandwidth

REQUIREMENT—Resolution bandwidth range is 1 kHz or less to 100 kHz or more.

a. The equipment setup for this step is shown in Fig. 5-5.

b. Apply 200 MHz signal (2nd harmonic of 10 ns) from the Time-Mark Generator (Type 184) through a 20 dB attenuator, 50 Ω termination and the proper adapter to the RF INPUT connector. Switch in 20 dB of IF Attenuation on the Type 1L40. Tune the RF CENTER FREQ control to minimize interference of the converted signals (tunable signals).

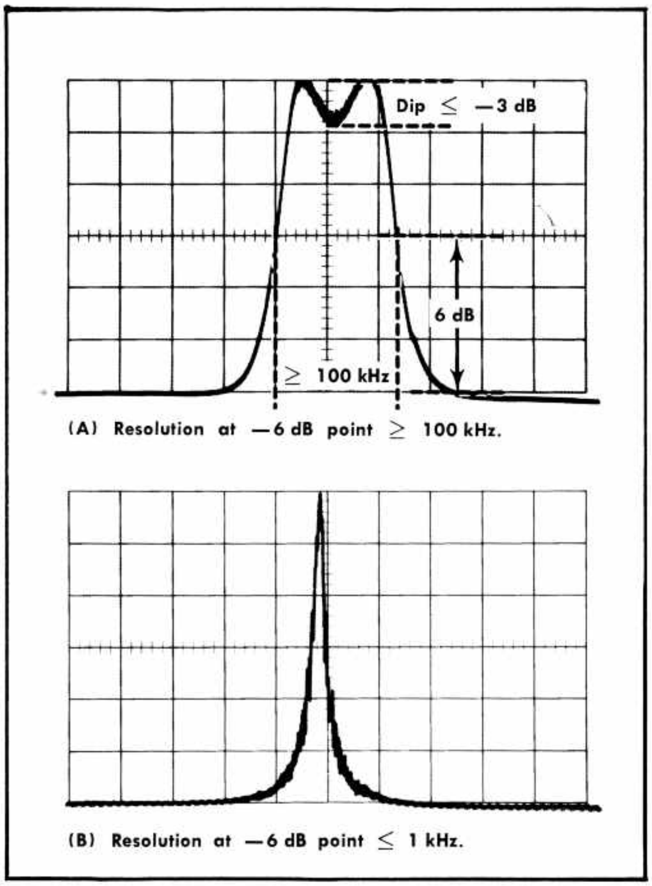
c. Set the DISPERSION RANGE to kHz/CM position and the DISPERSION to 50 kHz/cm. Uncouple the RESOLUTION and turn the control fully clockwise. Set the Time/Cm selector to .1 s.

NOTE

If a Type 549 storage oscilloscope is used, set the controls for single sweep storage and after sweep automatic erase.

d. Adjust the GAIN control for a 6 centimeter display amplitude.

e. CHECK—the resolution bandwidth response of the Type 1L40 to the 200 MHz signal at the —6 dB points. To check the vertical location of the —6 dB points, switch in an additional 6 dB of IF ATTEN and note the position of the top of the display, then remove the 6 dB of attenuation and note the points where the rising and falling portions of the display cross the 6 dB level. The crossing points should be separated (horizontally) by at least 2 cm, indicating a resolution bandwidth of at least 100 kHz. See Fig. 5-6A.



(A) Resolution at —6 dB point ≥ 100 kHz.

(B) Resolution at —6 dB point ≤ 1 kHz.

Fig. 5-6. Display pattern when resolution is correctly adjusted.

f. Change the RESOLUTION control to the 1 kHz position (fully counterclockwise) and the DISPERSION to 1 kHz/cm keeping the 200 MHz signal centered on screen with the IF CENTER FREQ controls.

g. CHECK—the resolution bandwidth at the —6 dB amplitude point. Bandwidth must not exceed 1 kHz. See Fig. 5-6B.

h. Return the RESOLUTION selector to the coupled position and set the DISPERSION-COUPLED RESOLUTION controls to 500 kHz/cm position.

3(B). Adjust IF Amplifier Response and the Analyzer Resolution Bandwidth

For Calibration only, omit for Performance Check and proceed to step 4(A).

a. The equipment setup is shown in Fig. 5-5.

b. Apply a 200 MHz signal (2nd harmonic of 10 ns) from the Time-Mark Generator (Type 184) through a 20 B attenuator, 50 Ω termination and proper adapter to the RF INPUT connector. Switch in 20 dB of IF Attenuator on the Type 1L40.

NOTE

This 200 MHz signal may be applied through a P6041 probe cable adapter to the Sealectro connector, J100, on the wide bandpass filter assembly.

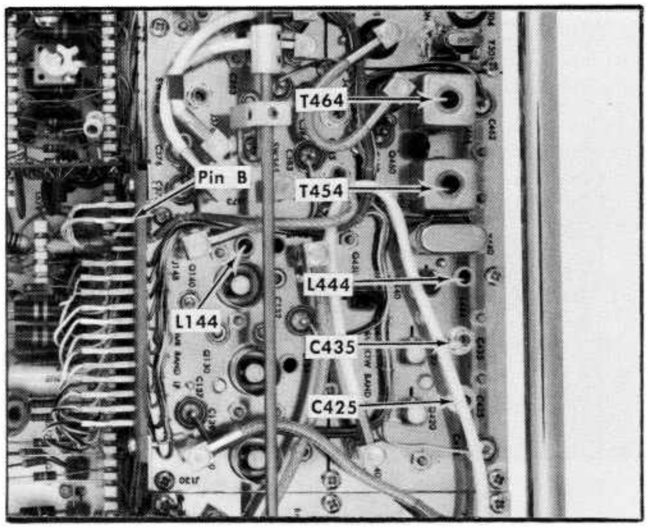


Fig. 5-7. Location of the IF amplifier peaking adjustments.

c. Turn the GAIN control fully clockwise and switch in the required IF Attenuation to reduce the signal amplitude to approximately 4 cm.

d. ADJUST—L144 (wide band amplifier) T464, T454, C435 and C425 (narrow band amplifier), see Fig. 5-7, in the order listed for maximum signal amplitude.

e. ADJUST—L444, see Fig. 5-7, for stable 70 MHz oscillator operation. The stable point is midway between the two oscillator drop out points when the core of L444 is turned in and out through the operating range.

f. Remove the P6041 probe adapter cable, if connected, and reconnect the coaxial cable to J100.

g. Set DISPERSION to 50 kHz/cm and the RESOLUTION control fully clockwise. Adjust the IF CENTER FREQ controls to center the display on graticule.

h. Connect the 10X probe from the test oscilloscope to pin B of the honeycomb pin connector, see Fig. 5-7.

I. Adjust the Type 1L40 GAIN control for a display amplitude of 6 cm on the indicator oscilloscope. Adjust the Trigger Level and Slope controls to obtain a stable display on the test oscilloscope. Adjust the test oscilloscope Volts/Cm selector for a display amplitude of approximately 6 centimeters. See Fig. 5-8.

j. ADJUST—100 kHz Resol Cal R543 so the display response is just beginning to overcouple, (slight dip in the center). Bandpass response on the analyzer oscilloscope should decrease to approximately 60 kHz at the —6 dB point when the RESOLUTION selector is turned ccw one step from the full cw position.

k. With the RESOLUTION control fully cw, adjust C504 and C508 (Fig. 5-9) for optimum display symmetry on the test oscilloscope. See Fig. 5-8. Adjust C504 for the slope of the response and C508 for symmetry. When correctly adjusted, the test oscilloscope display will remain fairly symmetrical through each position of the RESOLUTION control. Remove the test oscilloscope probe. Return the RESOLUTION control to the fully clockwise position.

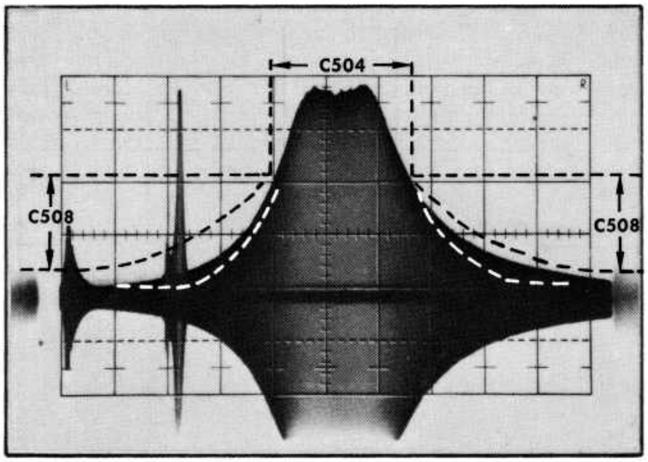


Fig. 5-8. Test oscilloscope display when C504 and C508 are correctly adjusted. DISPERSION 50 kHz/CM, RESOLUTION fully clockwise.

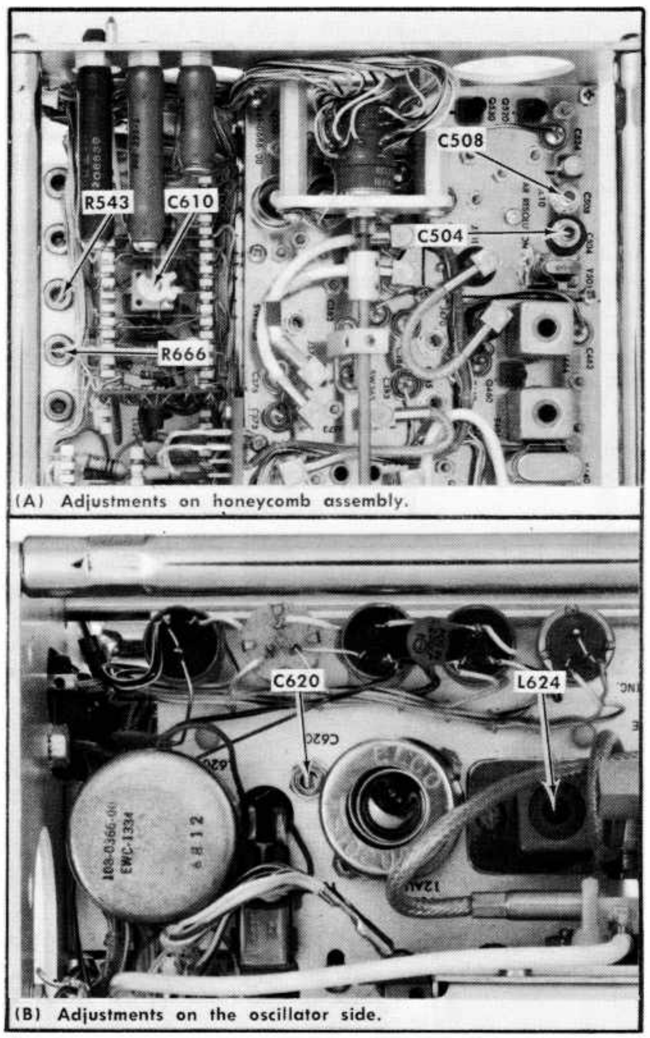


Fig. 5-9. Location of the resolution adjustments.

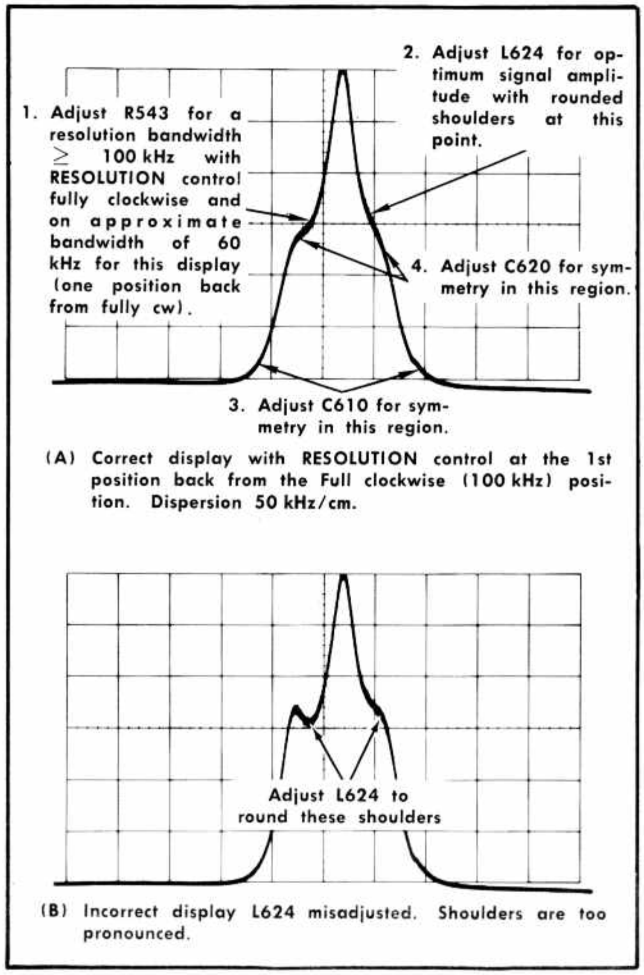


Fig. 5-10. Typical displays when adjusting the resolution bandwidth with C610, C620, L624 and R543.

I. Adjust the bandpass of the 5 MHz filter as follows:

(1). ADJUST—the 100 kHz Resol Cal R543 (Fig. 5-9), to obtain a bandpass between 100 kHz and 120 kHz at the —6 dB point. (Fig. 5-6A.)

(2). Switch the RESOLUTION control back one step from the fully clockwise position.

(3). ADJUST—C610, C620 and L624 (Fig. 5-9) for a response on the indicator oscilloscope similar to Fig. 5-10A. Adjust C610 for optimum symmetry at the base of the bandpass response and adjust C620-L624 for response slope and symmetry at the upper portion of the display.

NOTE

Install the Type 1L40 into the compartment of the analyzer oscilloscope and allow the unit to stabilize to the operating temperature. Check the bandpass response. If the response is non-symmetrical, remove the oscilloscope side panel and adjust C610 a slight amount for correct symmetry.

(4). Switch the RESOLUTION control to the fully clockwise position. Adjust the GAIN control for a 6 cm display amplitude, then check the resolution bandwidth at the —6 dB amplitude point. This point can be determined by switching in 6 dB of IF attenuation and noting the amplitude level, then switching out the attenuation to return the display to full screen. Bandwidth must equal or exceed 100 kHz at the —6 dB point and the response should be symmetrical (see Fig. 5-6A). Adjust the 100 kHz Resol Cal R543 if necessary for correct bandwidth.

(5). Turn the RESOLUTION control one position counterclockwise (dispersion 50 kHz/cm), readjust the GAIN if necessary for a 6 cm display amplitude. Check bandwidth. These adjustments interact; when properly set, the resolution must vary from a bandwidth ≥ 100 kHz with the control fully clockwise, to a bandwidth ≤ 1 kHz with the control turned fully counterclockwise. Each step counterclockwise should decrease the bandwidth. As the dispersion is reduced and the resolution increased to the 1 kHz position, the sweep rate must also be decreased to approximately .2 s/cm to maintain response symmetry and analyzer sensitivity.

NOTES

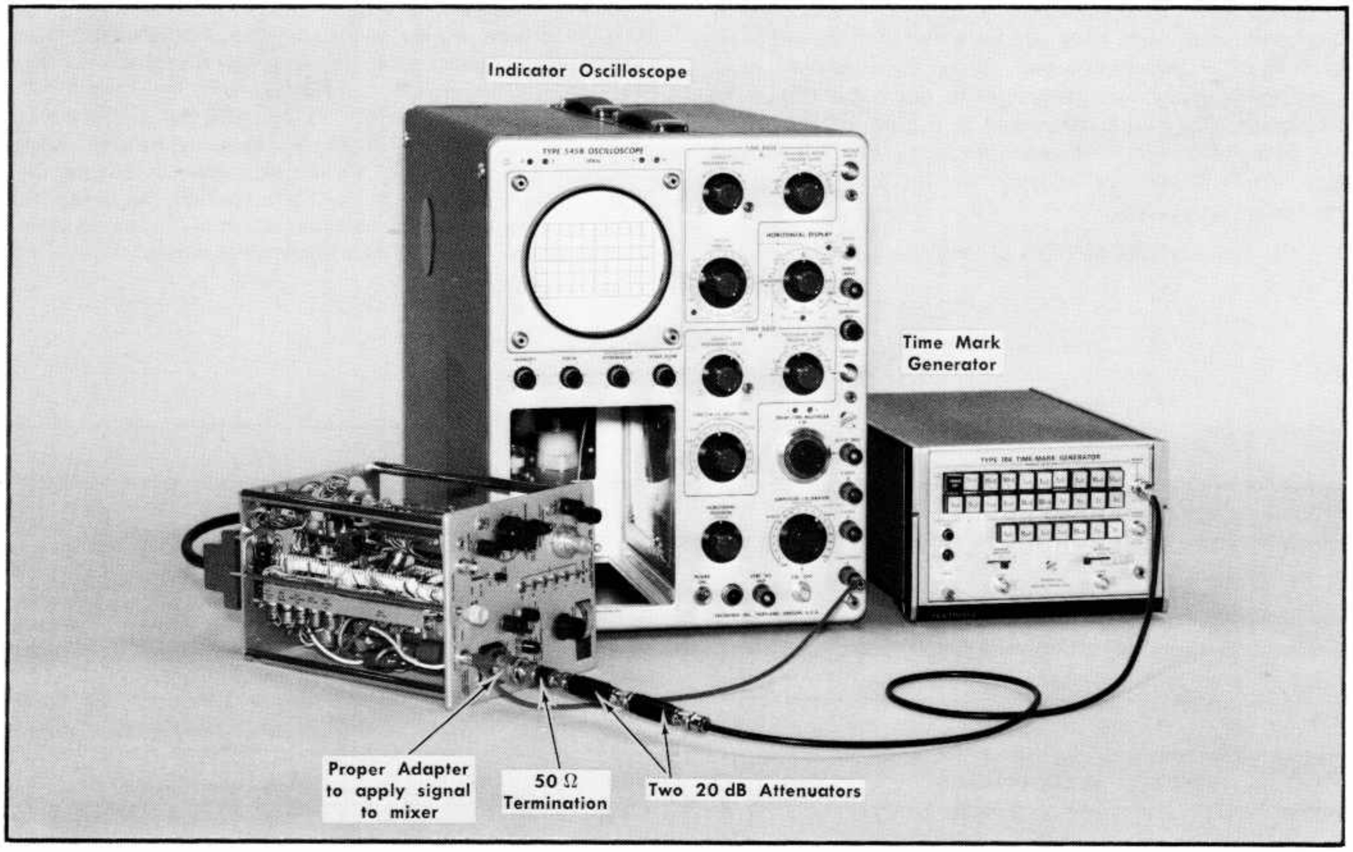


Fig. 5-11. Equipment setup to adjust and check kHz/CM dispersion accuracy (step 4).

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Centered (000)
FINE	Centered
DISPERSION RANGE	kHz/CM
DISPERSION-COUPLED RESOLUTION	500 kHz
VIDEO FILTER	OFF
VERTICAL DISPLAY	LIN
IF ATTEN	**Switches off**
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF
MIXER PEAKING	Fully CCW

Indicator Oscilloscope

Time/Cm	20 ms
Triggering	**Adjusted for a free sweep**
Horizontal Position	Centered trace

4(A). Check Dispersion Accuracy of kHz/CM Ranges.

REQUIREMENT—Dispersion accuracy must equal or exceed 3%.

a. The equipment setup for this step is shown in Fig. 5-11.

b. Apply 10 ns and 1 μs markers from the Time-Mark Generator (Type 184) through a 40 dB attenuator pad (2, 10X Attenuators), 50 Ω termination and proper adapter to the RF INPUT connector.

c. CHECK—the range of the IF CENTER FREQ control. Frequency range must equal or exceed + and — 2.5 MHz from its centered (000) position.

d. Center the IF CENTER FREQ controls. Set the DISPERSION selector to 50 kHz/cm.

e. Depress the 10 ns and 10 μs Marker Selector buttons on the Time-Mark Generator.

f. CHECK—the range of the IF CENTER FREQ-FINE control. Frequency range must equal or exceed + and — 50 kHz from the centered position.

g. Set the DISPERSION selector to the 500 kHz position and center the IF CENTER FREQ controls. Apply 10 ns and 1 μs time-markers to the RF INPUT.

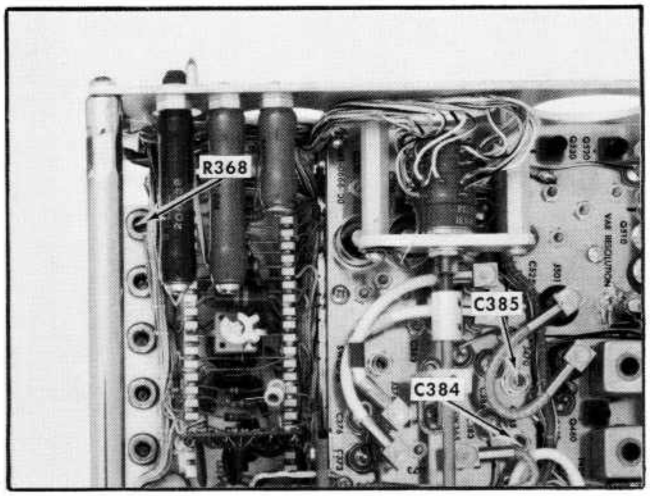


Fig. 5-12. Location of kHz/CM dispersion adjustments.

h. Check dispersion accuracy through + and — 2.5 MHz change in the IF center frequency, at each DISPERSION selector position listed in Table 5-2.

Dispersion accuracy is within 3% (2.4 mm), for the center 8 cm of the display, for all DISPERSION settings and through a + and — 2.5 MHz change in the IF center frequency.

As the dispersion is decreased, the sweep time must be increased (slower sweep rate) to maintain optimum display resolution. Uncouple the RESOLUTION control and adjust for optimum time-marker definition. Turn the VIDEO FILTER switch to the ON position at the slower rates to improve marker definition.

i. Turn the VIDEO FILTER switch to OFF, and if calibration is required proceed to step 4(B).

TABLE 5-2

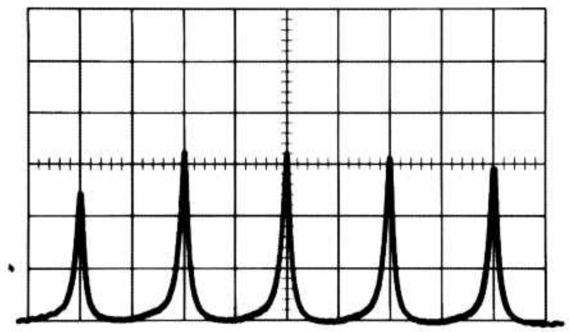
DISPERSION kHz/cm	Time-Mark Generator Marker Selector	Displays in Centimeters per marker
500	10 ns and 1 μs	2
200	10 ns and 5 μs	1
100	10 ns and 10 μs	1
50	10 ns and 10 μs	2
20	10 ns and 50 μs	1
10	10 ns and .1 ms	1
5	10 ns and .1 ms	2
2	10 ns and .5 ms	1
1	10 ns and 1 ms	1

If the kHz/Cm dispersion error exceeds 10%, repeat the Resolution Bandwidth adjustment (step 3B).

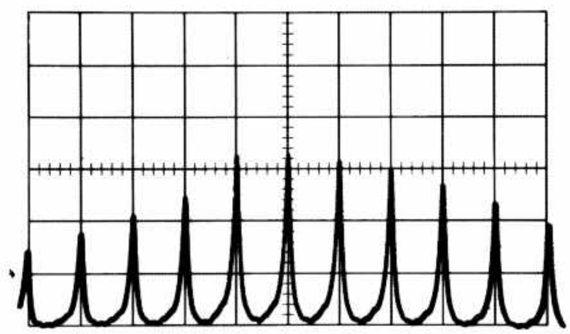
4(B). Adjust kHz/CM Dispersion. Control Settings

For Calibration only.

a. The equipment setup for this step is shown in Fig. 5-11.



(A) 1 marker/2 centimeter (Checking 500 kHz/CM dispersion.) Center marker is 200 MHz feedthrough.



(B) 1 marker/centimeter. (Checking 100 kHz/CM dispersion.)

Fig. 5-13. Typical displays when checking or adjusting kHz/CM dispersion.

b. Apply 10 ns and 1 μs markers from the Time-Mark Generator through a 40 dB attenuator (2, 10X Attenuators) 50 Ω termination, and proper adapter to the RF INPUT connector.

c. Set the DISPERSION-COUPLED RESOLUTION control to 500 kHz.

NOTE

The DISP BAL adjustment should be preset to its center position and the kHz/Cm Cal R368 adjustment preset about 10° from the full clockwise position.

d. ADJUST—C384 and C385 (Fig. 5-12) for 1 marker/2 centimeters (Fig. 5-13). Adjust these capacitors simultaneously in opposite directions. This will keep the 200 MHz feedthrough signal centered in the graticule area.

e. ADJUST—the kHz/Cm Cal R368 (Fig. 5-12) for optimum dispersion linearity. See Fig. 5-13.

f. Due to interaction of the adjustments it may be necessary to repeat steps d and e until optimum dispersion accuracy and linearity is obtained.

g. CHECK—dispersion accuracy through + and — 2.5 MHz change in the IF center frequency, at each DISPERSION selector position listed in Table 5-2.

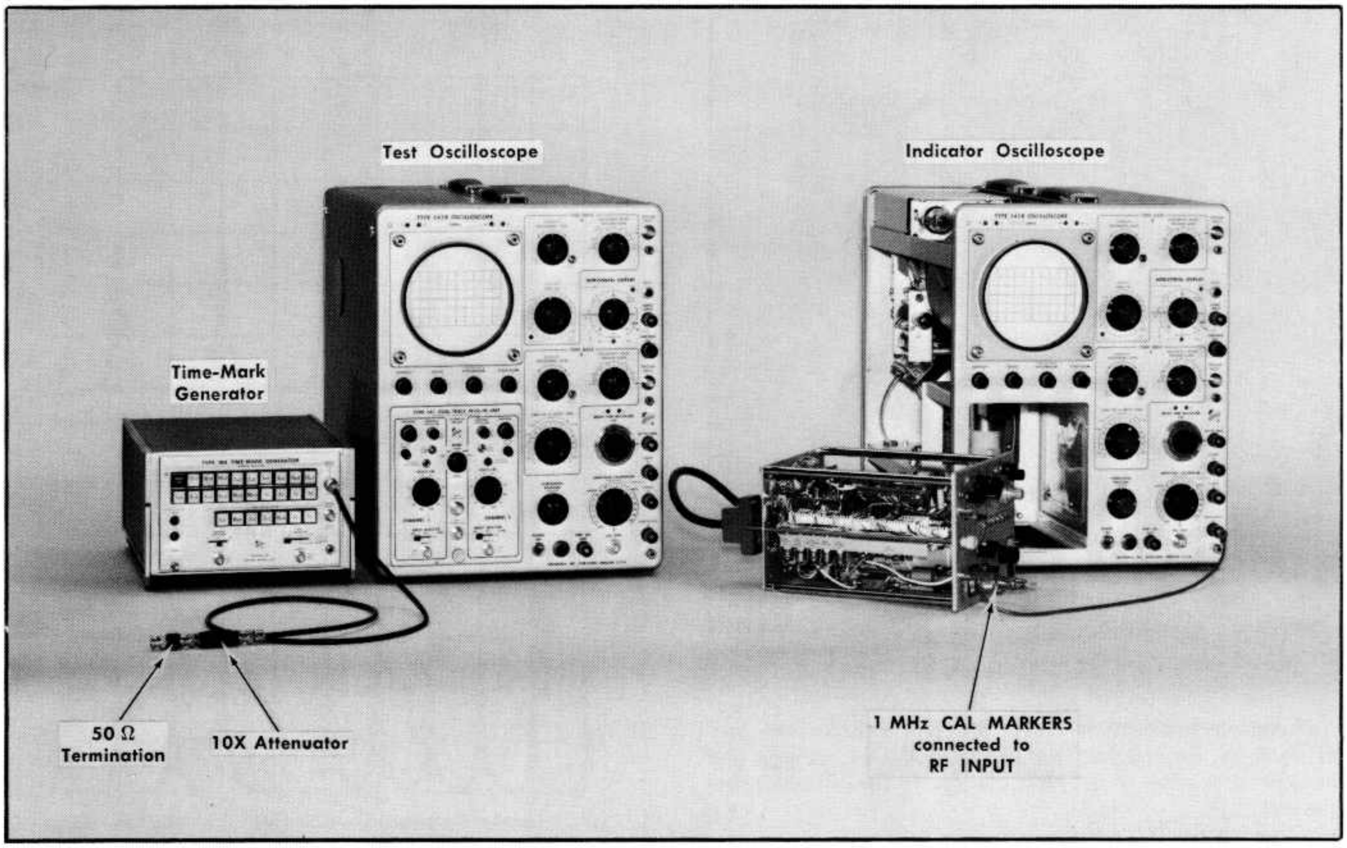


Fig. 5-14. Equipment setup to adjust the internal 1 MHz reference oscillator (step 5).

Dispersion accuracy must remain within 3%. (2.4 millimeters) for all DISPERSION selector positions.

As the dispersion is decreased the sweep time should be increased (slower sweep rate) to maintain optimum resolution. Uncouple the RESOLUTION control and adjust for optimum time marker definition. The VIDEO FILTER may improve the marker definition at the narrow dispersion settings.

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Centered (000)
FINE	Centered
DISPERSION RANGE	**MHz/CM**
DISPERSION	**1 MHz**
RESOLUTION	**Fully clockwise**
VIDEO FILTER	OFF
GAIN	**Fully clockwise**
VERTICAL.DISPLAY	LIN
IF ATTEN	**As required**
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF
MIXER PEAKING	Fully CCW

Indicator Oscilloscope

Time/Cm	**10 ms**
Triggering	**Line triggered sweep**
Horizontal Position	Centered trace

5. Check/Adjust Internal 1 MHz Phase Lock Reference Oscillator Operation

REQUIREMENTS—Frequency 1 MHz ±0.1% with the Variable control at the initial on position (ccw position of the control but not in the OFF detent).

Frequency range of the VARIABLE control is equal to or greater than 1 kHz but not more than 1.3 kHz.

a. The test equipment setup is shown in Fig. 5-14.

b. Connect a coaxial cable between the 1 MHz CAL MARKERS OUT connector and the RF INPUT connector via the proper adapter.

c. Turn the INT REF FREQ control to the initial on position.

d. CHECK—1 MHz markers should appear on the display with no delay. If this check is satisfactory proceed to step f. If markers fail to appear or there is a noticeable delay, proceed with adjustment step (e).

e. ADJUST—Insert a tuning tool (Tektronix Part No. 003-0310-00) into the access hole in the side of the phase lock assembly (Fig. 5-15) and adjust L804 so the oscillator starts

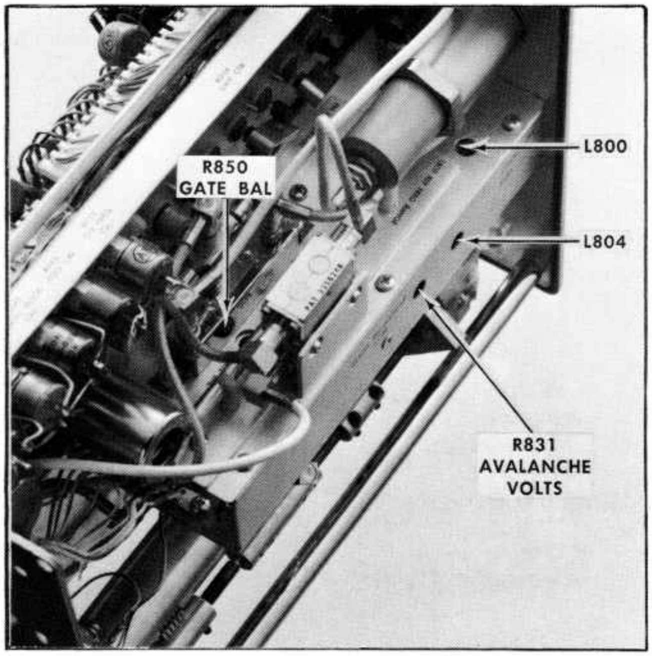


Fig. 5-15. Phase lock circuit adjustments.

with minimum delay as the INT REF FREQ control is turned from the OFF to the initial on position.

f. Set the DISPERSION RANGE to the kHz/CM position and the DISPERSION to 100 kHz/cm.

g. Position the fixed marker signal (IF feedthrough of the 200th harmonic of the 1 MHz marker) to the graticule center with the IF CENTER FREQ control. Adjust the RF CENTER FREQ to decrease the number of interfering spurious signals on the display.

h. CHECK—the pulling range of the INT REF FREQ control on the reference oscillator frequency must equal 1 kHz or more but less than 1.3 kHz.

Since the displayed signal is the 200th harmonic of the internal reference oscillator frequency, the range is also related to the 200th harmonic, therefore, 1 kHz X 200 = 200 kHz and 1.3 kHz X 200 = 260 kHz. With 100 kHz/cm dispersion the VARIABLE INT REF FREQ control should shift the marker signal from 2 cm to a maximum of 2.6 cm.

If this performance requirement is not met, perform step i.

i. ADJUST— L800 (Fig. 5-15) until the oscillator frequency shift, over the range of the INT REF FREQ control, is 1.2 kHz (2.4 cm).

j. CHECK—The accuracy of the internal 1 MHz reference frequency as follows:

(1) Apply the 1 MHz markers from the Type 1L40 to Channel 1 Input of a Dual-Trace Amplifier Plug-In Unit (Type 1A1) and 1 μs markers from the Time-Mark Generator (Type 184) through a 10X attenuator and a 50 Ω termination to Channel 2 Input of the Dual Trace Amplifier.

(2) Adjust the deflection sensitivity for both channels of the Dual-Trace Amplifier to equalize the deflection amplitude, then set the Mode switch to Add.

(3) Set the test oscilloscope Time/Cm to 1 ms and adjust the triggering controls for a triggered display.

(4) Turn the Type 1L40 INT REF FREQ control to the initial on position (ccw) and check the beat frequency display for no more than 10 cycles in 10 cm (reference frequency 1 MHz ± 1 kHz).

k. Check the electrical center of the CRT by connecting a jumper between pins 1 and 3 of P-11 (interconnecting plug). If the electrical center is more than 1 centimeter from the graticule center, the vertical output amplifiers of the oscilloscope should be checked and repaired.

l. Position the trace 3 cm below the electrical center with the POS control.

m. Turn the FINE RF CENTER FREQ control fully counterclockwise. Depress the LOCK CHECK button and adjust the Gate Bal, R840, to position the trace at or slightly below the reference level established in step l.

n. With the LOCK CHECK button depressed, rotate the FINE RF CENTER FREQ control clockwise to position the trace to the graticule center. Release the LOCK CHECK button.

NOTE

If the INT REF FREQ is turned ON, the display may jump from one lock mode to the next as the FINE RF CENTER FREQ control is rotated clockwise.

NOTES

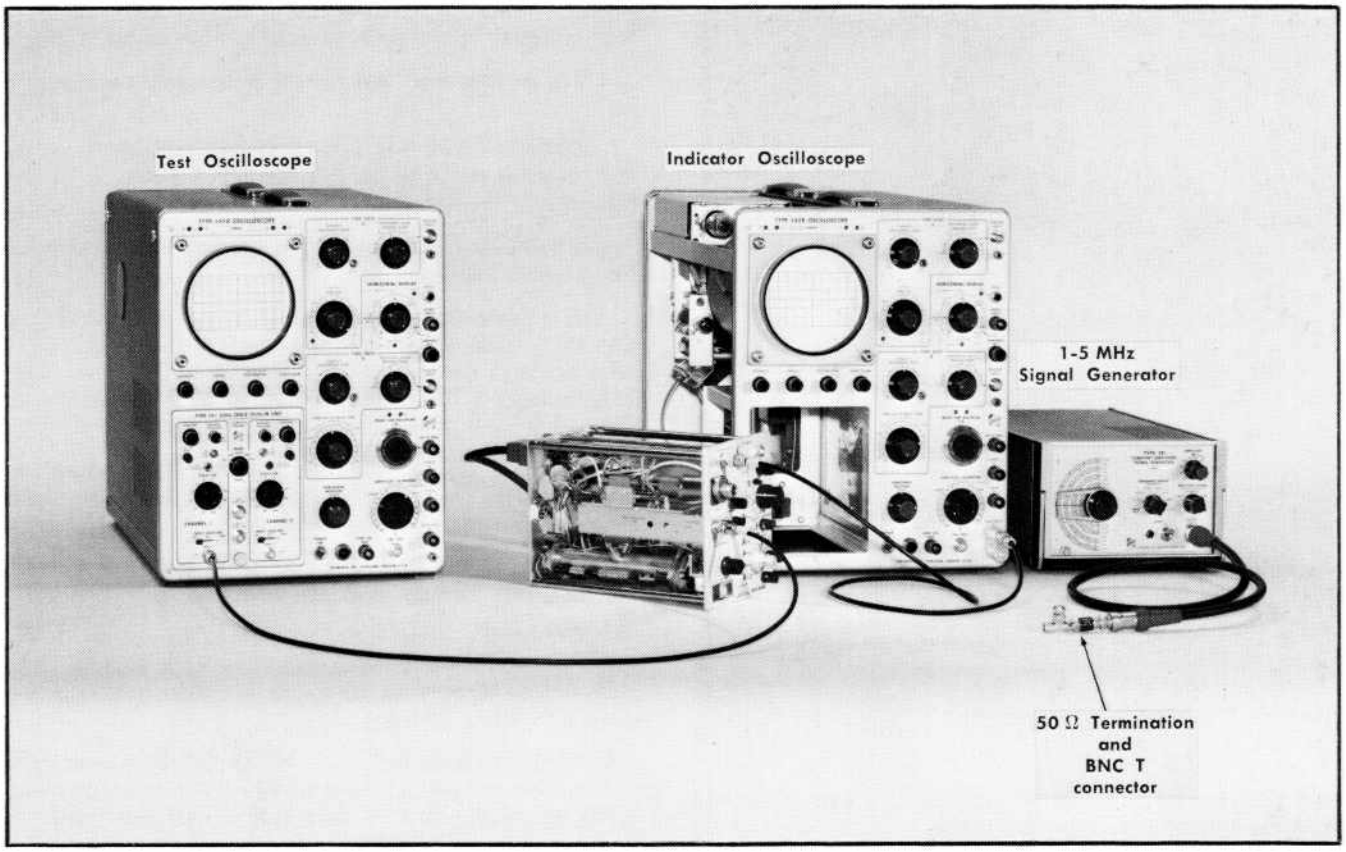


Fig. 5-16. Equipment setup to adjust avalanche voltage, 1 MHz internal reference frequency and check 1 MHz to 5 MHz external reference frequency range.

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	MHz/CM
DISPERSION-COUPLED RESOLUTION	**5 MHz**
VIDEO FILTER	OFF
GAIN	**Midrange**
VERTICAL DISPLAY	LIN
IF ATTEN	**Switches off**
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF

Indicator Oscilloscope

Time/Cm	10 ms
Triggering	**Adjusted for a free running sweep**
Horizontal Position	Centered trace

6. Check/Adjust Phase Lock Operation Control Settings

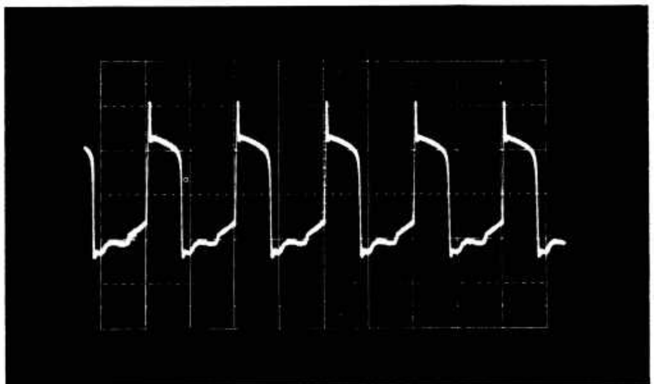
REQUIREMENT—Local oscillator must phase lock throughout its frequency range with the internal 1 MHz reference oscillator, or to an externally applied signal within the frequency range of 1 MHz to 5 MHz with an amplitude between 1 V and 5 V peak to peak.

a. The equipment setup for this step is shown in Fig. 5-16.

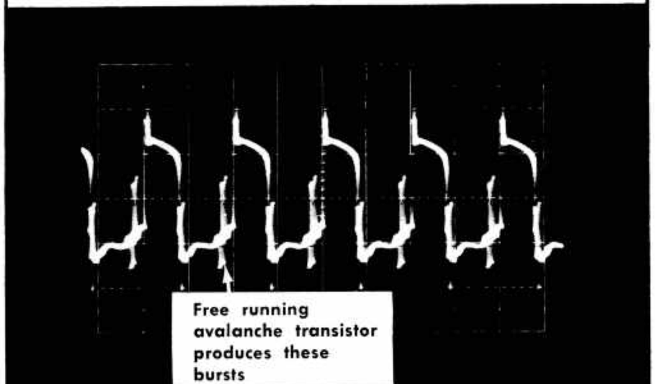
b. Connect the vertical Input of the test oscilloscope to the 1 MHz MARKERS OUT connector. Turn the INT REF FREQ control to the on position and adjust the test oscilloscope triggering for a stable display.

c. CHECK—The display must show a stable 1 MHz output signal from the Type 1L40. See Fig. 5-17. If display is not stable, perform step (d).

d. (This step is a Calibration adjustment. Proceed to part (e) for Performance Check procedure.) ADJUST—the Avalanche Volts R831 (Fig. 5-15) from a fully ccw position clock-



(A) Avalanche voltage correctly adjusted. Stable 1 MHz display.



(B) Avalanche voltage misadjustment avalanche transistor oscillating.

Fig. 5-17. Adjusting avalanche voltage.

wise until the avalanche transistor is slightly below the state of free running. Free running avalanche appears as an RF burst signal between the 1 MHz pulses as shown in Fig. 5-17. With the INT REF FREQ control turned to the OFF position, the free running avalanche transistor signal feeds through to the output connector and appears as a 2 MHz burst signal on the test oscilloscope. If free running avalanche does not occur, turn the adjustment fully clockwise.

e. Turn the INT REF FREQ control on, push the LOCK CHECK button and check for a lock indication or beat signals, displayed at intervals, as the RF CENTER FREQ control is turned through the frequency range of the instrument.

f. CHECK—phase lock operation with an external reference frequency as follows:

(1) Apply a 1 V peak to peak, 1 MHz signal, from the Constant Amplitude Signal Generator (Type 191) to the REF FREQ IN connector. Use a BNC T connector to apply the input signal to the Type 1L40 and provide a convenient monitoring point for the test oscilloscope. The input signal voltage must be measured at the REF FREQ IN connector. Turn the INT REF FREQ control to the OFF or EXT REF FREQ IN position.

(2) Center the FINE RF CENTER REQ control. Depress the LOCK CHECK button and adjust the RF CENTER FREQ control until a beat frequency is displayed.

(3) Adjust the FINE RF CENTER FREQ control for a lock condition or until the beat reduces to zero (zero beat).

(4) Repeat the above procedure with a 5 MHz signal from the signal generator.

(5) Increase the input signal amplitude to 5 V peak to peak and repeat the check with the increased signal amplitude at 5 MHz and 1 MHz.

NOTES

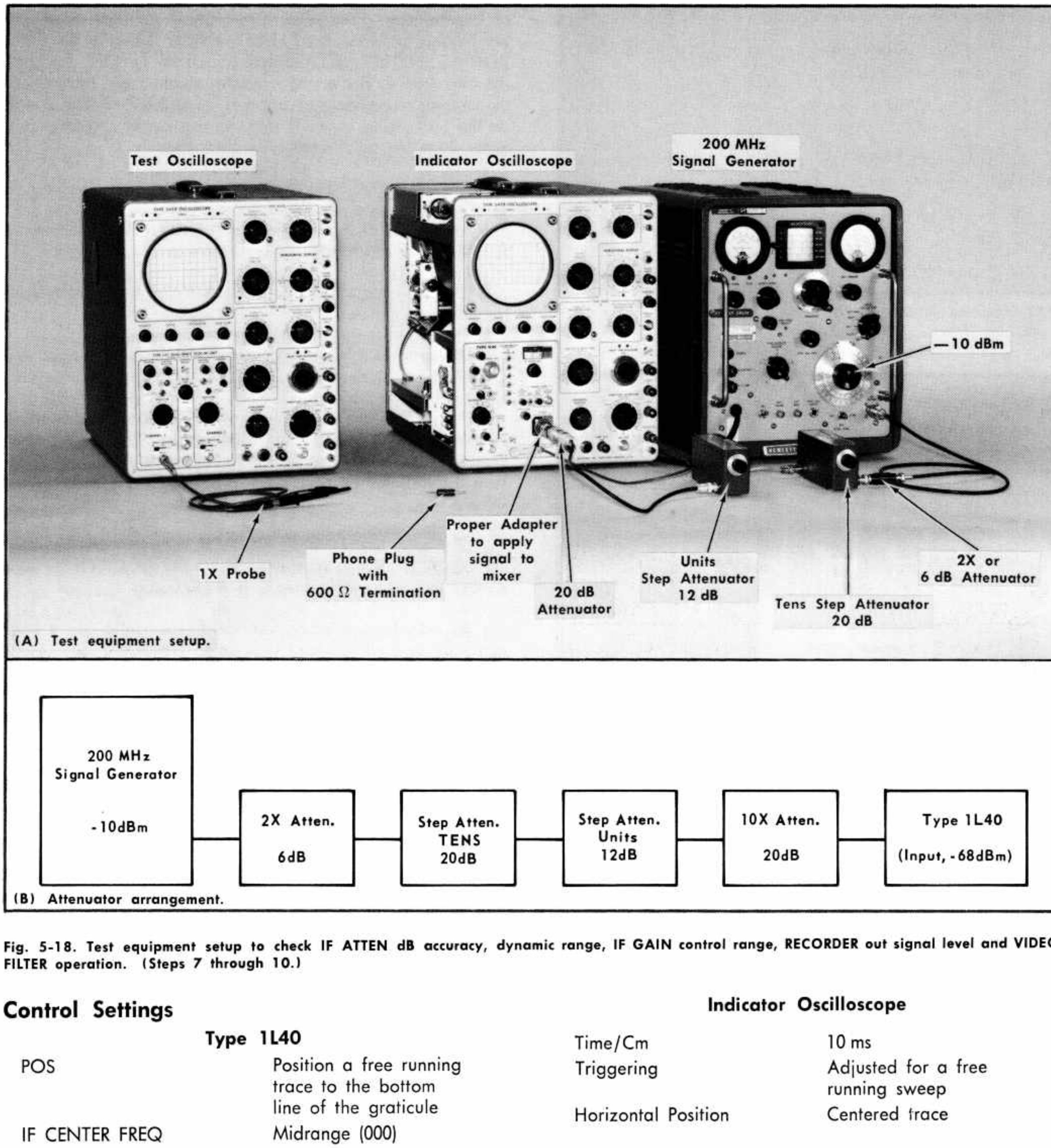


Fig. 5-18. Test equipment setup to check IF ATTEN dB accuracy, dynamic range, IF GAIN control range, RECORDER out signal level and VIDEO FILTER operation. (Steps 7 through 10.)

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	**kHz/CM**
DISPERSION-COUPLED RESOLUTION	**500 kHz**
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF

Indicator Oscilloscope

Time/Cm	10 ms
Triggering	Adjusted for a free running sweep
Horizontal Position	Centered trace

7. Check Accuracy of IF Attenuator dB Selectors

REQUIREMENT—Within ±0.1 dB/dB of the indicated attenuation.

a. The equipment setup for this step is shown in Fig. 5-18.

b. Apply a 200 MHz signal whose amplitude is 10 dB below 1 mW from the signal generator through a 2X Attenuator (6 dB), a Tens Step Attenuator and a Units Step Attenuator (20 dB) and the proper adapter to the Type 1L40 RF INPUT connector.

c. Set the Tens Step Attenuator for 20 dB and the Units Step Attenuator for 12 dB attenuation.

d. Adjust the GAIN control for a signal amplitude of 4 cm on the indicator oscilloscope.

e. CHECK—the accuracy of the IF ATTEN dB selectors as follows:

(1) Switch the 1 dB attenuator switch to ON and switch out 6 dB attenuation by means of the Units Step Attenuator.

(2) Check the display amplitude. Must equal 4 cm ± 0.5 mm (0.1 dB/dB).

(3) Switch the 1 dB IF ATTEN switch to the OFF position, then check the remaining IF ATTEN steps as directed in Table 5-3A.

TABLE 5-3A

Spectrum Analyzer IF ATTEN Switch on	Step Attenuators		Signal Amplitude Limit (.1 dB/dB)
	Units	Tens	
1 dB	11	20	3.95 cm to 4.05 cm
2 dB	10	20	3.90 cm to 4.1 cm
4 dB	8	20	3.8 cm to 4.2 cm
8 dB	4	20	3.6 cm to 4.4 cm
16 dB	6	10	3.2 cm to 4.8 cm
20 dB	2	10	2.95 cm to 5.05 cm

The 1 and 2 dB measurements are very difficult because of signal stability and the noise level. Over these small signal levels the square law mode may be used. This expands the display changes for the same level change by the square power as listed in Table 5-3B.

TABLE 5-3B

dB	1	2	4	8	16	20
Signal amplitude limits	3.95 to 4.05	3.9 to 4.2	3.6 to 4.4	3.2 to 4.8	2.2 to 5.8	1.7 to 6.3

An alternative method which is not as accurate but is sufficient for most applications is as follows:

(1) Apply a —6 dBm, 200 MHz signal directly from the Signal Generator to the RF connector via the proper adapter. Adjust the Spectrum Analyzer GAIN control for a signal display amplitude of 5 cm.

(2) Switch the 1 dB ATTEN switch on and adjust the Signal Generator Attenuator control to return the signal display amplitude to 5 cm.

(3) Check the new reading of the Attenuator dial. It should read —59 dBm ±0.1 dBm.

(4) Turn the 1 dB ATTEN to OFF. Check the remainder of the IF ATTEN selector steps as directed in Table 5-3C.

TABLE 5-3C

Spectrum Analyzer IF ATTEN switch ON	RF Generator Attenuator Control Setting
2 dB	—58 dBm ± .2 dBm
4 dB	—56 dBm ± .4 dBm
8 dB	—52 dBm ± .8 dBm
16 dB	—44 dBm ± 1.6 dBm
20 dB	—40 dBm ± 2.0 dBm

8. Check/Adjust Dynamic Range of Vertical Display Modes

a. The equipment setup for this step is given in the alternative method portion of step 7.

b. Change the VERTICAL DISPLAY selector to LOG position and apply a —100 dBm, 200 MHz signal directly from the Signal Generator to the RF INPUT connector.

c. Adjust the Type 1L40 GAIN for a signal that is just discernible above the noise peaks (approximately 1 mm). Position the top of the signal to the bottom graticule line with the POS control.

d. Decrease the Signal Generator Attenuator setting 40 dB so the generator output is —60 dBm.

e. CHECK—Signal display amplitude must equal or exceed 6 cm. The difference between the attenuator reading for a full screen (6 cm) display amplitude and the attenuator setting for the barely discernible signal in (c) above is the dynamic range. This must be ≥ 40 dB for LOG mode. If this check is satisfactory, proceed to step (i).

f. ADJUST—Log Cal R666, (Fig. 5-9) for a signal amplitude of 6 cm.

g. Change the Signal Generator attenuator control so a signal of —100 dBm is again applied to the RF INPUT.

h. CHECK—Signal should be discernible above the noise and at the bottom graticule line. Repeat step (f) through (h) until the dynamic range of 6 cm graticule height is ≥ 40 dB.

i. Change the VERTICAL DISPLAY slector to LIN. Position the top of the noise peaks at the bottom graticule line with the POS control.

j. Change the Signal Generator Attenuator setting so —40 dBm signal is applied to the RF INPUT of the Type 1L40. Adjust the GAIN control for a signal with an amplitude of 6 cm (full screen display).

k. Increase the Attenuator setting until the signal is again just discernible above the noise level. Note the Attenuator reading.

l. CHECK—The difference in the two attenuator readings must equal or exceed 26 dB.

m. Switch the VERTICAL DISPLAY selector to SQ LAW position and repeat the procedure to check the dynamic range of the SQ LAW position. The range must equal or exceed 13 dB.

9. Check Attenuation Range of IF GAIN Control

a. The equipment setup for this step is given in step 8.

b. With the GAIN control fully counterclockwise, adjust the Signal Generator VARIABLE Attenuator control for a display amplitude of 6 cm. Note the Attenuator reading in dBm.

c. Increase the Signal Generator attenuation 50 dB. Turn the GAIN control fully clockwise.

d. CHECK—Signal amplitude must equal or exceed 6 cm. (Range $\geq$ 50 dB.) If the range does not meet this requirement, recheck the adjustment of the IF amplifier response (step 3).

10. Check Amplitude of the Signal at the TO RECORDER output jack

REQUIREMENT—With the analyzer in LIN mode, the output across a 600 Ω load must equal or exceed 2 mV of signal per centimeter of display amplitude.

a. Set up the equipment as shown in Fig. 5-18.

b. Plug the test phone plug, with a 600 Ω load resistor across the terminals, into the TO RECORDER jack. Connect a 1X probe from the test oscilloscope across the 600 Ω resistor.

c. With the VERTICAL DISPLAY switch in the LIN position and 200 MHz signal applied to the RF INPUT connector, Adjust the GAIN control and/or the Signal Generator output for a display amplitude of 6 cm.

d. CHECK—Signal amplitude across the 600 Ω load resistor at the TO RECORDER connector should measure between 12 mV and 20 mV.

e. Remove the test oscilloscope probe and the test phone plug.

NOTES

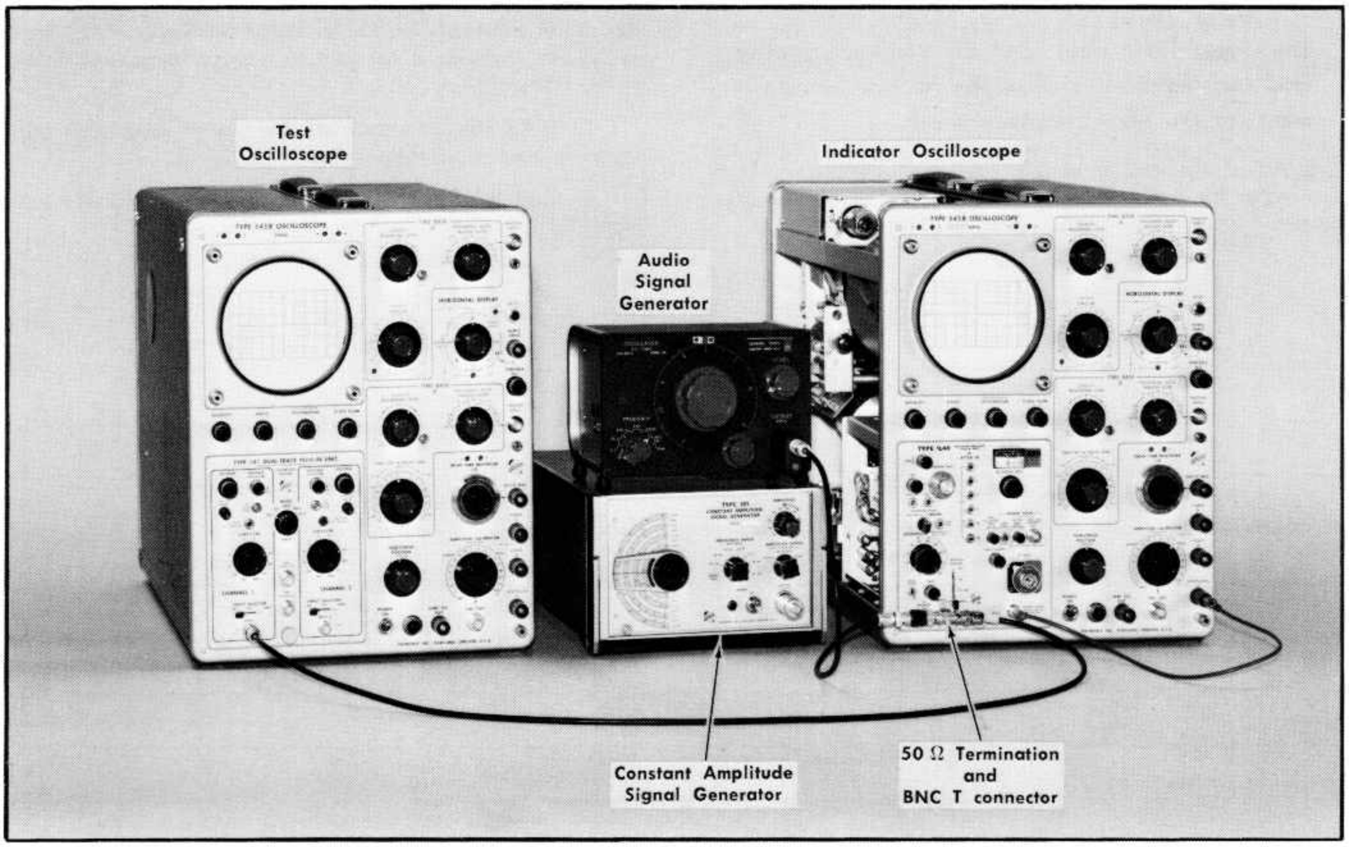


Fig. 5-19. Equipment setup to check video bandpass.

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	**MHz/CM**
DISPERSION-COUPLED RESOLUTION	**10 MHz**
VIDEO FILTER	OFF
GAIN	**Fully clockwise**
VERTICAL DISPLAY	**VIDEO**
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF

Indicator Oscilloscope

Time/Cm	**50 ms**
Triggering	Adjust for a free running sweep
Horizontal Position	Centered trace

Test Oscilloscope

Time/Cm	**50 ms**
Triggering	**Adjust for a free running sweep**

11. Check Frequency Response of the Video Circuit

REQUIREMENT—The —3 dB down points must be equal to or less than 16 Hz and 10 MHz or greater with a 50 Ω source impedance.

a. Set up the equipment as shown in Fig. 5-19.

b. Apply a 50 kHz signal from the Audio Signal Generator through a 50 Ω Termination and BNC T connector to both the Type 1L40 Video INPUT connector and the vertical input of a DC coupled test oscilloscope.

c. Turn the Type 1L40 GAIN control fully clockwise. Adjust the Signal Generator output control for a signal amplitude of 4 cm on the indicator oscilloscope, then adjust the test oscilloscope sensitivity for a 4 cm display reference amplitude.

d. Decrease the Signal Generator frequency until the signal amplitude on the indicator oscilloscope decreases to 2.8 cm. Maintain a constant 4 cm reference amplitude on the test oscilloscope.

e. CHECK—The input frequency from the Signal Generator should be equal to or less than 16 Hz.

f. Remove the Audio Signal Generator and apply a 50 kHz signal from the Constant Amplitude Signal Generator (Type 191) through the 50 Ω Termination and the BNC T connector to the Video INPUT.

NOTE

The Type 1L40 Unit must be plugged directly into the indicator oscilloscope vertical compartment for the high frequency check.

g. Adjust the output of the Constant Amplitude Signal Generator for a signal amplitude of 4 cm on both oscilloscopes.

h. Increase the frequency of the Signal Generator until the signal amplitude on the indicator oscilloscope decreases to 2.8 cm. Maintain a constant 4 cm signal amplitude on the test oscilloscope.

i. CHECK—The frequency of the Signal Generator must equal or exceed 10 MHz.

j. Remove the Signal Generator and the test oscilloscope from the Video INPUT of the Type 1L40.

NOTES

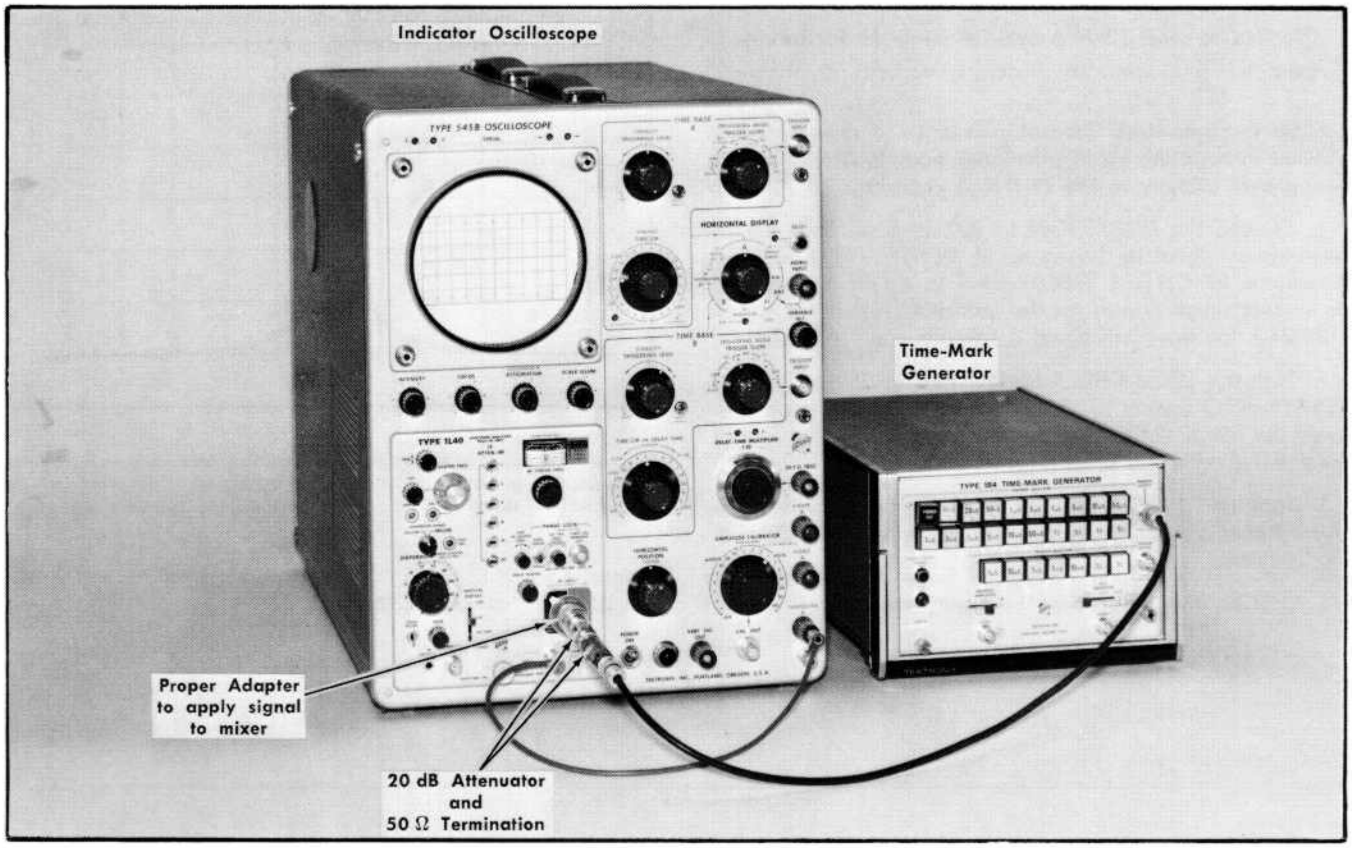


Fig. 5-20. Equipment setup for checking incidental FM.

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule.
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	**kHz/CM**
DISPERSION-COUPLED RESOLUTION	**500 kHz**
VIDEO FILTER	OFF
GAIN	**Midrange**
VERTICAL DISPLAY	**LIN**
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT REF FREQ	On

Indicator Oscilloscope

Time/Cm	50 ms
Triggering	Adjusted for a free running sweep.
Horizontal Position	Centered trace

12. Check Incidental Frequency Modulation

NOTE

Signal source must supply a very stable 200 MHz signal to accurately measure incidental FM and the Type 1L40 must be on a vibration-free platform.

REQUIREMENT—Incidental FM of the IF is not more than 200 Hz. Incidental FM of the IF + LO, with phase locked operation at the local oscillator fundamental frequency, is not more than 300 Hz.

a. Equipment setup is shown in Fig. 5-20.

b. Apply a 200 MHz signal from the Time-Mark Generator (2nd harmonic of 10 ns marker) through a 20 dB attenuator pad, a 50 Ω termination and the proper adapter to the RF INPUT connector. Center the IF feedthrough signal on the graticule.

c. Change the DISPERSION-COUPLED RESOLUTION to 1 kHz/cm position. Adjust the IF CENTER FREQ control to keep the signal centered on the graticule.

d. Adjust the GAIN control for a full 6 cm signal amplitude.

e. CHECK—The amount of frequency modulation (see Fig. 5-21) in the IF feedthrough signal, must not exceed 2 millimeters or 1 minor division ($\leq$ 200 Hz).

NOTE

Proceed to step 13 if a coaxial mixer is not being used.

f. Set the Time-Mark Generator so that 2 ns sinewaves are applied through the 20 dB attenuator pad, 50 Ω termination and proper adapter to the RF INPUT connector.

g. Change the DISPERSION to 200 kHz/cm. Shift the IF feedthrough signal by tuning the IF CENTER FREQ controls. Adjust the RF CENTER FREQ control to center a converted or tunable signal display on the graticule. Adjust the MIXER PEAKING for maximum signal amplitude.

h. Push the LOCK CHECK button and adjust the FINE RF CENTER FREQ control to phase lock the local oscillator. Release the LOCK CHECK button and adjust the GAIN control for a full 6 cm signal amplitude.

i. Decrease the DISPERSION to 1 kHz/cm, keeping the phase-locked signal within the graticule with the IF CENTER FREQ control.

j. CHECK—The amount of frequency modulation in the converted signal (IF + LO) display. Must not exceed 3 mm or 1.5 minor divisions (300 Hz.).

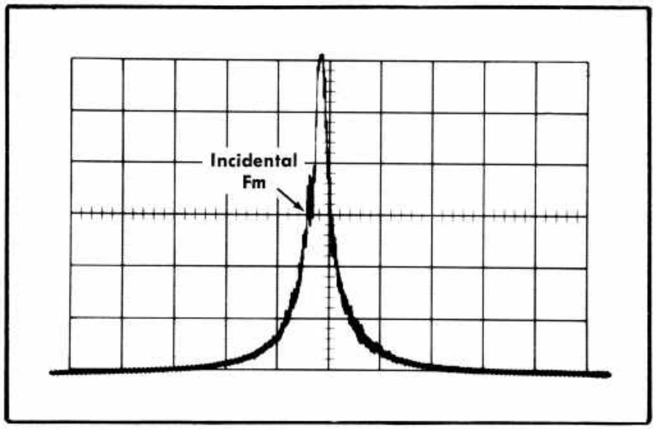


Fig. 5-21. Typical display showing identical frequency modulation. Measure the horizontal displacement of the signal at the most vertical slope of the signal.

NOTES

NOTE

Proceed to step 13 if a coaxial mixer is not being used.

f. Set the Time-Mark Generator so that 2 ns sinewaves are applied through the 20 dB attenuator pad, 50 Ω termination and proper adapter to the RF INPUT connector.

g. Change the DISPERSION to 200 kHz/cm. Shift the IF feedthrough signal by tuning the IF CENTER FREQ controls. Adjust the RF CENTER FREQ control to center a converted or tunable signal display on the graticule. Adjust the MIXER PEAKING for maximum signal amplitude.

h. Push the LOCK CHECK button and adjust the FINE RF CENTER FREQ control to phase lock the local oscillator. Release the LOCK CHECK button and adjust the GAIN control for a full 6 cm signal amplitude.

i. Decrease the DISPERSION to 1 kHz/cm, keeping the phase-locked signal within the graticule with the IF CENTER FREQ control.

j. CHECK—The amount of frequency modulation in the converted signal (IF + LO) display. Must not exceed 3 mm or 1.5 minor divisions (300 Hz.).

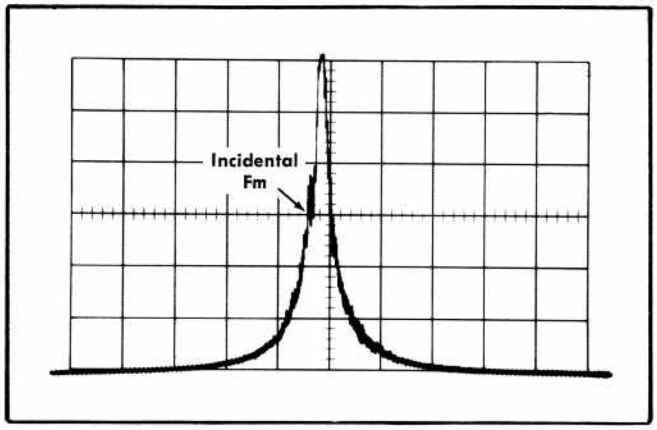


Fig. 5-21. Typical display showing identical frequency modulation. Measure the horizontal displacement of the signal at the most vertical slope of the signal.

NOTES

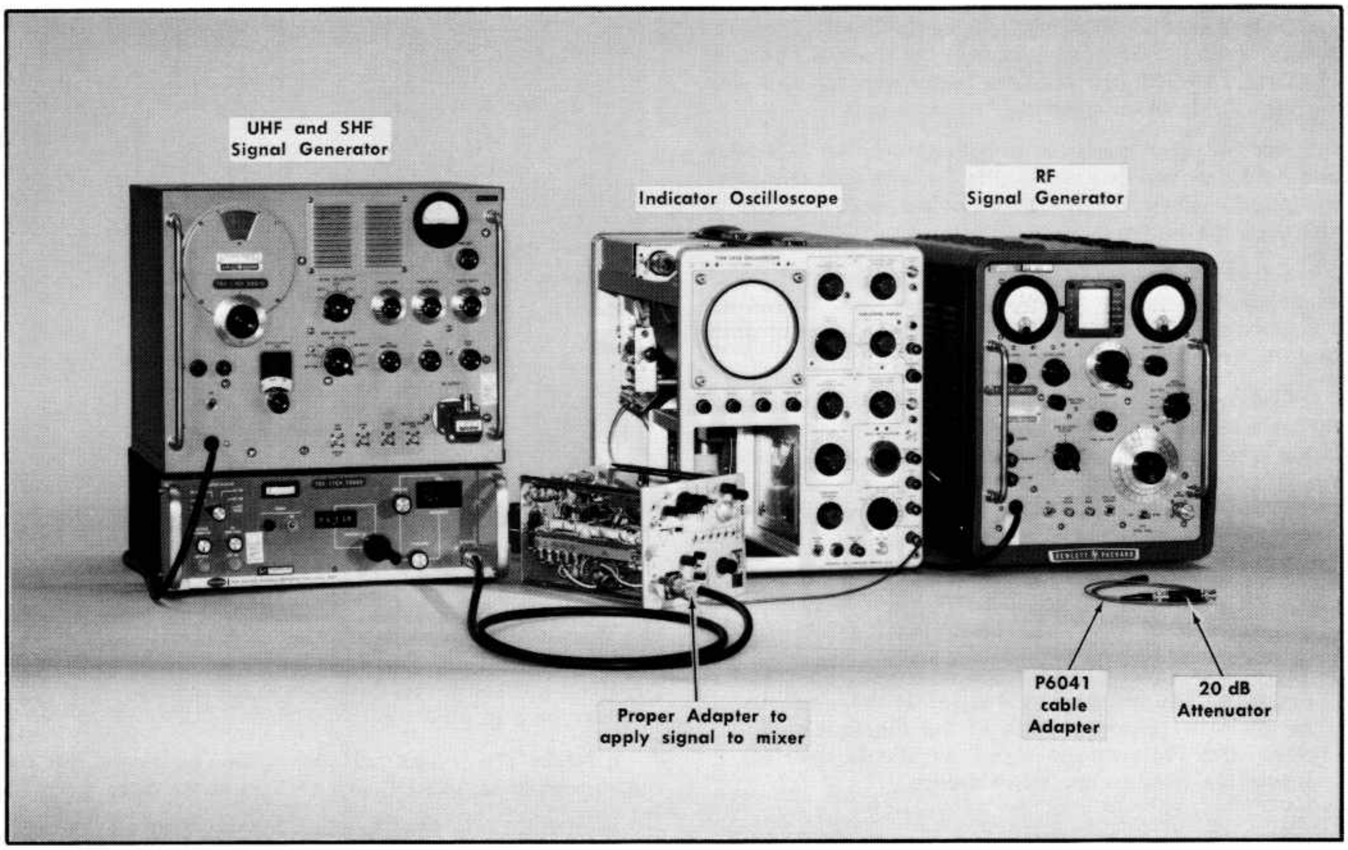


Fig. 5-22. Equipment setup to adjust the wide band IF amplifier and check RF Mixer and wide band IF amplifier response flatness (step 13).

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	**MHz/CM**
DISPERSION-COUPLED RESOLUTION	**5 MHz**
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN	**20 dB**
FINE RF CENTER FREQ	Centered
INT REF FREQ	On

Indicator Oscilloscope

Time/Cm	**20 ms**
Triggering	Adjusted for a free running sweep
Horizontal Position	Centered trace

13. Check/Adjust Response Flatness of RF Mixer and Wide Band IF Amplifier

REQUIREMENT—Flatness with the IF CENTER FREQ controls centered is within 3 dB within 50 MHz of the RF center frequency to a frequency of 12.4 GHz and within 6.0 dB to 40 GHz.

a. Equipment setup is shown in Fig. 5-22.

NOTE

Display flatness check must be made with the MIXER PEAKING control adjusted for maximum signal amplitude for each display window.

b. Apply the appropriate signal frequency from the required signal generator to either the Coaxial Mixer (for frequencies from .5 GHz to 12.4 GHz) or to the appropriate Waveguide Mixer (frequencies from 12.4 GHz to 40 GHz).

NOTE

If the Coaxial Mixer is used, it must be plugged into the RF INPUT receptacle. If one of the Waveguide Mixers is used, it should be connected through the two foot cable with the TNC connectors to the Waveguide Mixer Adapter which is plugged into the RF INPUT receptacle.

c. Tune the RF CENTER FREQ to the low end of the frequency band (1.5 GHz for units with the Coaxial Mixer, or 12.4 GHz, 18.0 GHz and 26.5 GHz respectively for units with the Waveguide Mixer assembly).

d. Set the signal generator to a frequency that is 50 MHz above this low limit (e.g. 1.550 GHz for units with the Coaxial Mixer). Adjust the generator output until a signal is visible on the display.

e. Adjust the MIXER PEAKING control for maximum signal amplitude, then adjust the GAIN and generator output for a signal amplitude of 4 cm. (Repeat this adjustment each time the generator frequency is changed.)

f. CHECK—The response flatness across the displayed spectrum by tuning the RF CENTER FREQ, 25 MHz either side of the applied signal generator frequency. Signal amplitude should not change more than ±1.5 dB from the average amplitude or a total of 3 dB for units with the Coaxial Mixer. Amplitude must not change more than ±3 dB for units with the Waveguide Mixer assembly.

NOTE

There is a possibility that the reference 5 cm signal amplitude adjustment was set at the maximum or minimum response point of the dispersion window. Use the average signal amplitude over the dispersion window as the reference.

g. Increase the applied frequency in approximately 2.5 GHz steps for the Coaxial Mixer and in approximately 5 GHz steps for Waveguide Mixers for checking the flatness over the frequency band. The MIXER PEAKING must be set for best response at each step.

If the response flatness is not within tolerance, perform the remaining steps.

When making only a Performance Check, omit the remainder of this step and proceed to step 14.

The Type 1L40 response flatness and sensitivity is dependent on the combined response of the wide band amplifier, the band pass filter, the low pass filters and the RF mixer. Each circuit must be adjusted as part of the complete system, since the circuit response is dependent on the impedance presented by the circuits preceding and following the circuit that is being adjusted.

The low-pass and bandpass filters should require recalibration only after circuit components have been replaced. Component replacement and recalibration requires special equipment and techniques, therefore the analyzer should be returned to a Tektronix Field Repair Center for repair and calibration. Contact your local Field Office or representative.

This procedure does not require a sweep generator to check flatness; however, if a sweep generator such as the Kay model 121C is available it may be used.

h. Equipment setup is shown in Fig. 5-22.

i. Disconnect the Sealectro connector from J120 on the honeycomb assembly and apply an amplitude calibrated 65 MHz signal (—30 dBm) from the signal generator through a 20 dB attenuator and Sealectro to GR adapter such as a P6041 cable to J120.

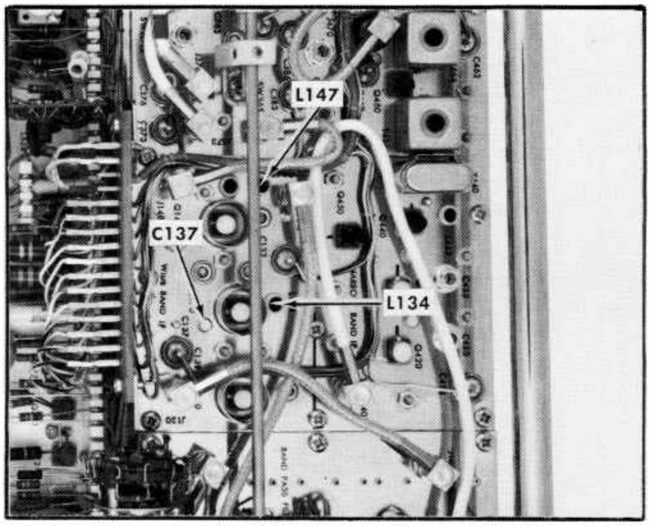


Fig. 5-23. Wide band IF amplifier adjustments for response flatness.

j. Adjust the output of the signal generator for an approximate vertical DC shift of 1 cm in the trace.

k. ADJUST—The 65 MHz trap, L147 (Fig. 5-23) for minimum response to the 65 MHz signal. This will be indicated by a decrease in the vertical displacement of the plug-in oscilloscope trace.

l. Remove the signal generator connection to the Sealectro connector on the honeycomb assembly. Reconnect the honeycomb cable to J120.

m. Apply a frequency and amplitude calibrated signal (—30 dBm) within the frequency range of the Type 1L40 through a 20 dB attenuator and the proper adapter to the RF INPUT connector.

n. Set the DISPERSION to 10 MHz/cm. Tune the RF center frequency to the applied signal frequency. Adjust the MIXER PEAKING control for maximum signal amplitude. Adjust the GAIN and/or the Variable Attenuator of the signal generator for a signal amplitude of 4 centimeters.

o. Check the response flatness over the 100 MHz dispersion by tuning the RF CENTER FREQ or the signal generator frequency over the frequency width of the dispersion window. Signal amplitude should not vary over ± 1.5 dB (±3 dB for frequencies above 12.4 GHz) with a constant amplitude input signal to the RF INPUT connector.

p. If the response flatness is not within tolerance, adjust C137 and L134 (Fig. 5-23) for maximum sensitivity and analyzer response flatness. Adjusting C137 will usually produce a noticeable effect on the response slope. Adjust L134 for optimum sensitivity at the high frequency portion of the IF response.

q. Check the display flatness over the frequency range of the instrument as described in the preceeding steps.

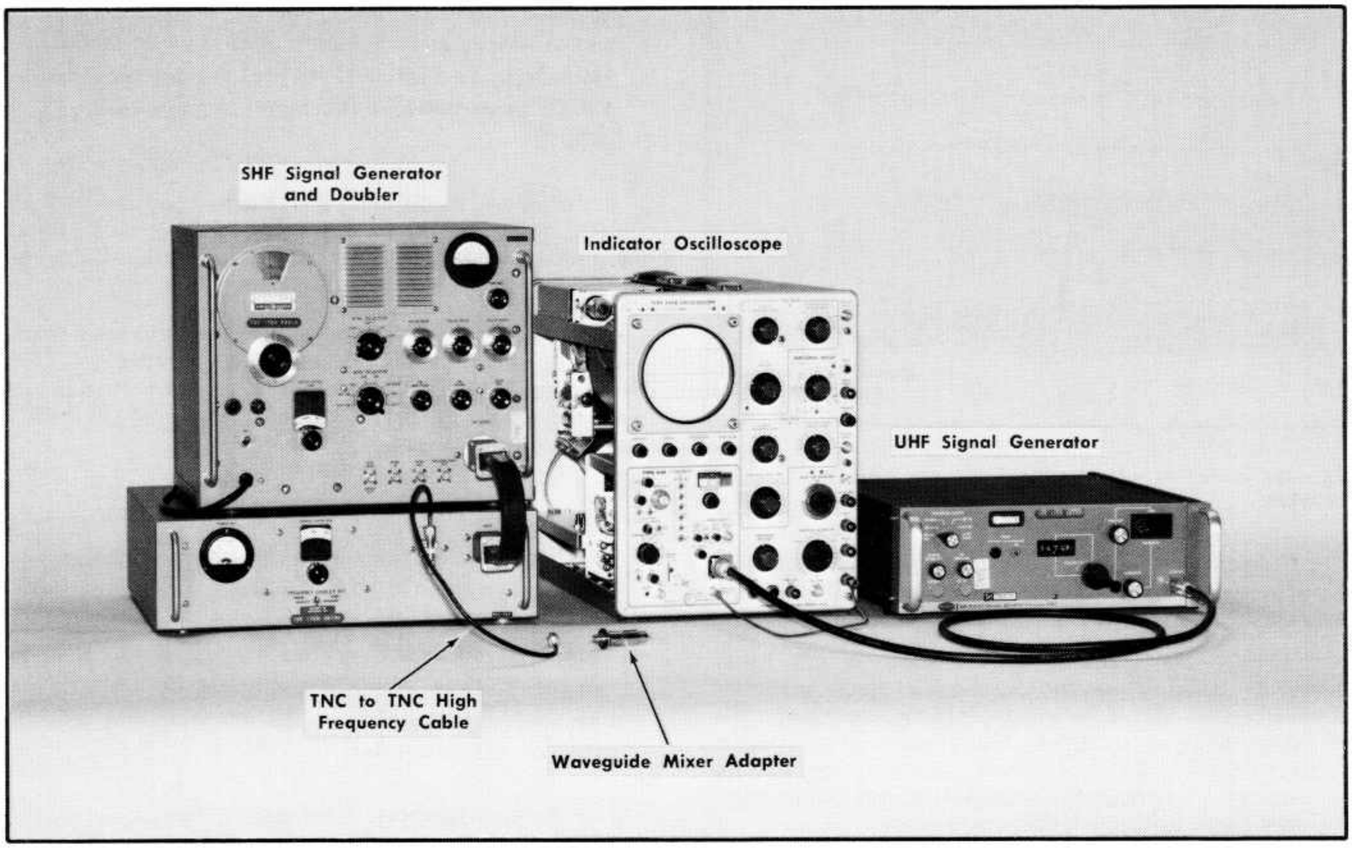


Fig. 5-24. Typical equipment setup to check sensitivity, dial accuracy and phase lock operation. (If Waveguide Mixer is used, connect mixer to Waveguide Adapter through the 2 foot coaxial cable with the TNC connectors.)

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule.
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	**kHz/CM**
DISPERSION	**500 kHz**
RESOLUTION	**Fully clockwise**
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN	**Switches off**
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF

Indicator Oscilloscope

Time/Cm	**10 ms**
Triggering	Adjusted for a free running sweep
Horizontal Position	Centered trace

14. Check RF Center Frequency Calibration, System Sensitivity and Phase Lock Operation

a. Equipment setup is shown in Fig. 5-24.

b. Apply a frequency and amplitude calibrated signal that is between —60 dBm and —30 dBm via the proper adapter to the RF INPUT connector.

NOTE

When checking the sensitivity of the 12.4 GHz to 40 GHz band, apply the signal source to the Waveguide Mixer. Connect the Waveguide Mixer to the Waveguide Mixer Adapter through the 2 foot cable with the TNC connectors.

If an external attenuator is used, it must have flat high frequency characteristics: Use Tektronix 20 dB Attenuator Part No. 001-0086-00, or 40 dB Attenuator Part No. 011-0087-00.

c. Adjust the GAIN control for an average noise amplitude of one centimeter.

d. Tune the signal on graticule with the RF CENTER FREQ control. Reduce the signal amplitude with the signal generator output attenuator control for an on-graticule display, then adjust the MIXER PEAKING control and the sweep rate selector for optimum signal amplitude. (Sweep rate approximately 20 ms/cm or slower.)

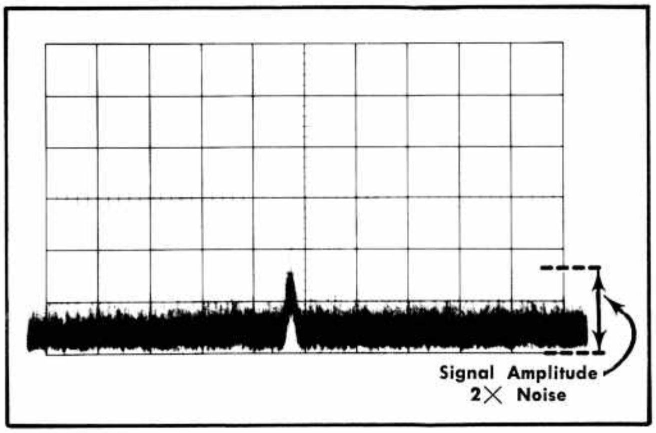


Fig. 5-25. Signal to noise ratio of 2:1 for measuring analyzer sensitivity.

e. Calibrate the signal generator output, then adjust the variable output attenuator control until the signal amplitude is two centimeters (twice the noise amplitude). See Fig. 5-25.

f. CHECK—the total signal attenuator (in dB) below 0 dBm as indicated on the calibrated signal generator attenuator dial. This is the sensitivity of the analyzer for the RF center frequency indicated. Check sensitivity as listed in Table 5-4 under 100 kHz resolution. Sensitivity can also be checked for 1 kHz resolution; however, a very stable signal source is required at the higher frequencies.

NOTE

Cable losses for frequencies of 10 GHz and higher become significant and must be added for correct sensitivity measurements. Add 3 dB at 10 GHz (increasing to 5 dB at 12.4 GHz) for a 6 foot, RG-58C/U cable between the signal source and the RF INPUT.

g. Center the IF CENTER FREQ controls and the FINE RF CENTER FREQ control, then tune the signal to the center of the graticule with the RF CENTER FREQ control. (Horizontal sweep must be centered.)

h. CHECK—The dial accuracy at frequencies listed in Table 5-4. Accuracy must equal or check within ±(2 MHz + 1% of the dial reading). Dial accuracy need only be checked for scale 1, the other scales are harmonic settings of this fundamental range.

NOTE

To check the dial accuracy to specifications, an accurate (within ±0.1%) signal source must be used. The listed signal generators in the equipment required listed may be used provided their frequency check points are checked by an accurate frequency counter or the internal beat indicator of the generator.

i. At the dial accuracy check points, depress the LOCK CHECK button and check for phase lock beat signals as the RF CENTER FREQ is rotated to these dial check points. Check for phase lock operation at the center and the extreme frequency position of each scale.

TABLE 5-4

Suggested Signal Generator (Refer to equipment list)	Frequency in GHz	Scale	Sensitivity (Equal to or better than)		Dial Accuracy Check Frequency
			100 kHz	1 kHz	
Hewlett-Packard Model 8614A	1.5	1			
Hewlett-Packard Model 8616A	2.5 4.0		—90 dBm	—110 dBm	1.0 GHz Steps
	3.8				
Polarad Type 1107	6.0 8.2	2	—80 dBm	—100 dBm	2.0 GHz Steps
Polarad Type 1108	8.2 10.0	3	—75 dBm	—95 dBm	2.0 GHz Steps
Hewlett-Packard Model 626A	12.0				
	12.4 15.0	4	—70 dBm	—90 dBm	3.0 GHz Steps
Hewlett-Packard Model 628A	18.0				
	18.0				
Hewlett-Packard Model 938	26.5	5	—60 dBm	—80 dBm	3.0 GHz Steps
Hewlett-Packard Model 940	26.5 40.0	5	—50 dBm	—70 dBm	5.0 GHz Steps

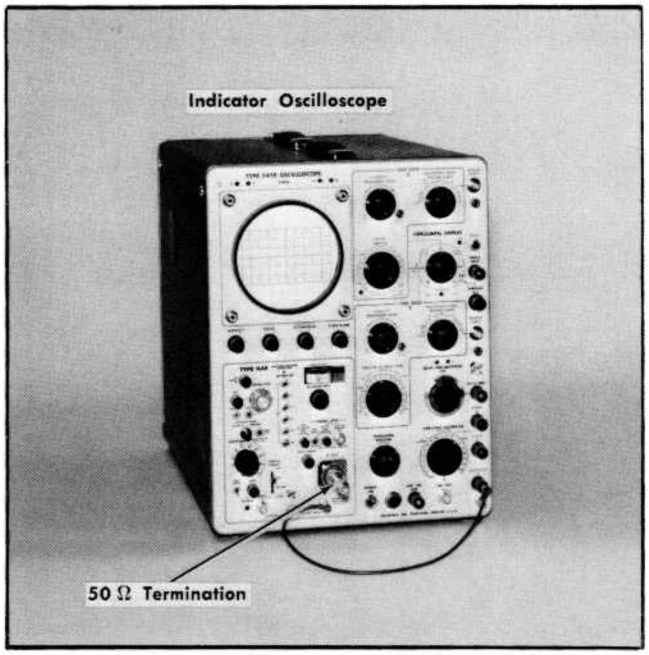


Fig. 5-26. Equipment setup to check internal spurious signal response.

Control Settings

Type 1L40

POS	Position a free running trace to the bottom line of the graticule.
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	kHz/CM
DISPERSION	500 kHz
RESOLUTION	Fully clockwise
VIDEO FILTER	OFF
VERTICAL DISPLAY	LIN
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT REF FREQ	OFF

Indicator Oscilloscope

Time/Cm	**20 ms**
Triggering	Adjusted for a free running sweep
Horizontal Position	Centered trace

15. Check Amplitude of Spurious Signal

REQUIREMENT—Spurious signals from internal source should not exceed 2X the noise level. Resolution $\geq$ 100 kHz.

a. Equipment setup is shown in Fig 5-26.

b. Install the Type 1L40 into the indicator Oscilloscope vertical compartment. Connect a 50 Ω termination via the proper adapter to the RF INPUT connector.

c. Adjust the GAIN control for approximately 1 centimeter of noise level. Adjust the MIXER PEAKING control for maximum signal amplitude, then check across the frequency band for internal spurious signals. Amplitude of any spurious signal should not exceed 2X the noise level. The MIXER PEAKING must be re-adjusted for optimum sensitivity as the RF Center Frequency is tuned across the band.

If spurious signals in excess of 2X noise level appear at the low end of the frequency band, they can usually be minimized by proper dress of the oscillator filament leads.

This concludes the performance check and calibration procedure for the Type 1L40. If the instrument has met all checks, it is ready to operate and will perform to specifications listed in Section 1.

NOTES

NOTES

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
$^\circ$	degrees
$^\circ$C	degrees Celsius (degrees centigrade)
$^\circ$F	degrees Fahrenheit
$^\circ$K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz

L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
$+$	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
◐	Screwdriver adjustment.
▭	Control, adjustment or connector.

SECTION 6
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C81[1]							
C83[1]							
C86[1]							
C101	281-0101-00			1.5-9.1 pF, Var	Air		
C102	281-0099-00			1.5-5.4 pF, Var			
C104	281-0101-00			1.5-9.1 pF, Var			
C105	281-0648-00			56 pF	Cer	50 V	50%
C106	281-0101-00			1.5-9.1 pF, Var			
C107	281-0099-00			1.5-5.4 pF, Var			
C108	281-0101-00			1.5-9.1 pF, Var			
C123	281-0635-00			1000 pF	Cer	500 V	
C124	283-0599-00			98 pF	Mica	500 V	5%
C128	283-0065-01			0.001 μF	Cer	100 V	5%
C130	283-0103-00			180 pF	Cer	500 V	5%
C132	283-0039-00			0.001 μF	Cer	500 V	
C133	281-0635-00			1000 pF	Cer	500 V	
C136	281-0616-00			6.8 pF	Cer	200 V	
C137	281-0063-00			9-35 pF, Var	Cer		
C138	281-0635-00			1000 pF	Cer	500 V	
C139	283-0039-00			0.001 μF	Cer	500 V	
C140	283-0103-00			180 pF	Cer	500 V	5%
C143	281-0635-00			1000 pF	Cer	500 V	
C145	281-0558-00			18 pF	Cer	500 V	
C146	281-0549-00			68 pF	Cer	500 V	10%
C147	281-0523-00			100 pF	Cer	350 V	
C148	283-0065-01			0.001 μF	Cer	100 V	5%
C149	281-0635-00			1000 pF	Cer	500 V	
C151	281-0549-00			68 pF	Cer	500 V	10%
C152	281-0549-00			68 pF	Cer	500 V	10%
C187	281-0549-00			68 pF	Cer	500 V	10%
C188	281-0549-00			68 pF	Cer	500 V	10%
C245	283-0065-00			0.001 μF	Cer	100 V	5%
C246	283-0003-00			0.01 μF	Cer	150 V	
C248	285-0703-00			0.1 μF	PTM	100 V	5%
C255	283-0001-00			0.005 μF	Cer	500 V	

[1]Furnished as a unit with L.P. Filter (*610-0172-00).

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C274	281-0605-00			200 pF	Cer	500 V	
C293	283-0010-00			0.05 μF	Cer	50 V	
C300	283-0039-00			0.001 F	Cer	500 V	
C310	283-0065-00			0.001 μF	Cer	100 V	5%
C311	281-0613-00			10 pF	Cer	200 V	10%
C314	283-0563-00			1000 pF	Mica	500 V	10%
C315	281-0610-00			2.2 pF	Cer	200 V	
C320	283-0039-00			0.001 μF	Cer	500 V	
C330	283-0003-00			0.01 μF	Cer	150 V	
C331	283-0003-00			0.01 μF	Cer	150 V	
C346	283-0050-00			0.008 μF	Cer	200 V	
C347	283-0050-00			0.008 μF	Cer	200 V	
C349	281-0503-00			8 pF	Cer	500 V	±0.5 pF
C357	283-0050-00			0.008 μF	Cer	200 V	
C358	281-0105-00			0.8-8.5 pF, Var	Cer		
C361	283-0039-00			0.001 μF	Cer	500 V	
C362	281-0635-00			1000 pF	Cer	500 V	
C363	283-0039-00			0.001 μF	Cer	500 V	
C365	283-0025-00			0.0005 μF	Cer	500 V	5%
C367	283-0039-00			0.001 μF	Cer	500 V	
C368	283-0003-00			0.01 μF	Cer	150 V	
C373	283-0039-00			0.001 μF	Cer	500 V	
C376	283-0039-00			0.001 μF	Cer	500 V	
C383	283-0039-00			0.001 μF	Cer	500 V	
C384	281-0105-00			0.8-8.5 pF, Var	Cer		
C385	281-0105-00			0.8-8.5 pF, Var	Cer		
C386	283-0039-00			0.001 μF	Cer	500 V	
C401	283-0065-01			0.001 μF	Cer	100 V	5%
C412	283-0003-00			0.01 μF	Cer	150 V	
C413	283-0039-00			0.001 μF	Cer	500 V	
C416	283-0001-00			0.005 μF	Cer	500 V	
C422	281-0599-00			1 pF	Cer	200 V	±0.25 pF
C423	283-0065-01			0.001 μF	Cer	100 V	5%
C424	281-0564-00			24 pF	Cer	500 V	5%
C425	281-0105-00			0.8-8.5 pF, Var	Cer		
C426	283-0065-01			0.001 μF	Cer	100 V	5%
C427	283-0065-01			0.001 μF	Cer	100 V	5%
C433	283-0065-01			0.001 μF	Cer	100 V	5%
C434	281-0645-00			8.2 pF	Cer	500 V	±0.25 pF
C435	281-0105-00			0.8-8.5 pF, Var	Cer		
C436	283-0065-01			0.001 μF	Cer	100 V	5%
C437	283-0001-00			0.005 μF	Cer	500 V	
C443	283-0001-00			0.005 μF	Cer	500 V	
C445	281-0564-00			24 pF	Cer	500 V	5%
C446	281-0579-00			21 pF	Cer	500 V	5%

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C447	281-0550-00			120 pF	Cer	500 V	10%
C450	281-0511-00			22 pF	Cer	500 V	10%
C453	283-0001-00			0.005 μF	Cer	500 V	
C454	283-0566-00			100 pF	Mica	500 V	5%
C456	283-0001-00			0.005 μF	Cer	500 V	
C457	283-0001-00			0.005 μF	Cer	500 V	
C462	283-0039-00			0.001 μF	Cer	500 V	
C463	283-0001-00			0.005 μF	Cer	500 V	
C464	283-0566-00			100 pF	Mica	500 V	5%
C466	283-0001-00			0.005 μF	Cer	500 V	
C467	283-0001-00			0.005 μF	Cer	500 V	
C469	283-0039-00			0.001 μF	Cer	500 V	
C501	281-0523-00			100 pF	Cer	350 V	
C502	281-0523-00			100 pF	Cer	350 V	
C504	281-0105-00			0.8-8.5 pF, Var	Cer		
C508	281-0105-00			0.8-8.5 pF, Var	Cer		
C515	283-0065-01			0.001 μF	Cer	500 V	
C524	283-0039-00			0.001 μF	Cer	500 V	
C525	283-0039-00			0.001 μF	Cer	500 V	
C527	283-0003-00			0.01 μF	Cer	150 V	
C530	283-0003-00			0.01 μF	Cer	150 V	
C534	283-0003-00			0.01 μF	Cer	150 V	
C537	283-0003-00			0.01 μF	Cer	150 V	
C539	283-0003-00			0.01 μF	Cer	150 V	
C610	281-0099-00			1.3-5.4 pF, Var	Air		
C620	281-0105-00			0.8-8.5 pF, Var	Cer		
C623	283-0003-00			0.01 μF	Cer	150 V	
C626	283-0003-00			0.01 μF	Cer	150 V	
C651	283-0001-00			0.005 μF	Cer	500 V	
C656	283-0001-00			0.005 μF	Cer	500 V	
C658	283-0083-00			0.0047 μF	Cer	500 V	5%
C660	281-0629-00			33 pF	Cer	600 V	5%
C661	283-0081-00			0.1 μF	Cer	25 V	+80%—20%
C662	283-0001-00			0.005 μF	Cer	500 V	
C666	283-0028-00			0.0022 μF	Cer	50 V	
C668	285-0703-00			0.1 μF	PTM	100 V	5%
C801	283-0003-00			0.1 μF	Cer	150 V	
C804	281-0638-00			240 pF	Cer	500 V	5%
C805	281-0523-00			100 pF	Cer	350 V	
C806	283-0003-00			0.01 μF	Cer	150 V	
C807	283-0003-00			0.01 μF	Cer	150 V	
C810	283-0003-00			0.01 μF	Cer	150 V	
C811	283-0067-00			0.001 μF	Cer	200 V	10%
C815	281-0602-00			68 pF	Cer	500 V	5%
C821	283-0067-00			0.001 μF	Cer	200 V	10%

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C828	283-0024-00			0.1 μF	Cer	30 V	
C829	281-0528-00			82 pF	Cer	500 V	10%
C832	283-0067-00			0.001 μF	Cer	200 V	10%
C844	283-0146-00			4.7 pF	Cer	50 V	±0.5 pF
C845	283-0067-00			0.001 μF	Cer	200 V	10%
C847	283-0146-00			4.7 pF	Cer	50 V	±0.5 pF
C856	283-0127-00			2.5 pF	Cer	100 V	
C857	283-0127-00			2.5 pF	Cer	100 V	
C863	283-0067-00			0.001 μF	Cer	200 V	10%
C866	283-0003-00			0.01 μF	Cer	150 V	
C870	283-0067-00			0.001 μF	Cer	200 V	10%
C876	283-0059-00			1 μF	Cer	25 V	+80%—20%
C880	281-0523-00			100 pF	Cer	350 V	
C883	283-0003-00			0.01 μF	Cer	150 V	
C889	283-0003-00			0.01 μF	Cer	150 V	
C890	283-0059-00			1 μF	Cer	25 V	+80%—20%
C892	283-0092-00			0.03 μF	Cer	200 V	+80%—20%
C894	283-0059-00			1 μF	Cer	25 V	+80%—20%

Semiconductor Device, Diodes

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
D42	152-0272-00			Silicon	Varicap 6.8 pF
D240	152-0227-00			Zener	1N753A 0.4 W, 6.2 V, 5%
D244	*152-0061-00			Silicon	Tek Spec
D314	152-0231-00			Silicon	Varicap MV1872, 60 V, 22 pF
D334	*152-0107-00			Silicon	Replaceable by 1N647
D361	*152-0153-00			Silicon	Replaceable by 1N4244
D362	*152-0185-00			Silicon	Replaceable by 1N4152
D365	*152-0153-00			Silicon	Replaceable by 1N4244
D373 } D376 }	*153-0025-00			Silicon	Selected 1N4244 (1 pair)
D380	152-0246-00			Silicon	Low Leakage 0.25 W, 40 V
D383 } D386 }	*153-0025-00			Silicon	Selected 1N4244 (1 pair)
D387	152-0246-00			Silicon	Low Leakage 0.25 W, 40 V
D412	*152-0107-00			Silicon	Replaceable by 1N647
D454	152-0141-02			Silicon	1N4152
D506	152-0141-02			Silicon	1N4152
D550	*152-0107-00			Silicon	Replaceable by 1N647
D603	152-0079-00			Germanium	HD 1841
D604	152-0079-00			Germanium	HD 1841
D657	152-0186-00			Germanium	1N198
D660	152-0186-00			Germanium	1N198
D661	152-0186-00			Germanium	1N198
D664	152-0141-02			Silicon	1N4152
D665	152-0141-02			Silicon	1N4152

Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
D817	*152-0107-00			Silicon	Replaceable by 1N647
D818	*152-0107-00			Silicon	Replaceable by 1N647
D824	152-0141-02			Silicon	1N4152
D825	152-0141-02			Silicon	1N4152
D826	152-0125-00			Tunnel	Selected TD3A 4.7 mA
D846	*152-0325-00			Snap Off w/o Leads	
D856 } D857 }	*152-0152-00			GaAs (1 pair)	
D872	*152-0185-00			Silicon	Replaceable by 1N4152
D878	*152-0185-00			Silicon	Replaceable by 1N4152

Connectors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
J42[2]				
J43[2]				
J45[3]				
J46[3]				
J47[3]				
J60[4]				
J61[4]				
J62[4]				
J80[5]				
J94[5]				
J100	131-0372-00			Coaxial
J109	131-0372-00			Coaxial
J120	131-0372-00			Coaxial
J147	131-0372-00			Coaxial
J148	131-0372-00			Coaxial
J151	131-0372-00			Coaxial
J188	131-0372-00			Coaxial
J201	131-0106-00			1 Contact, female
J363	131-0372-00			Coaxial
J370	131-0372-00			Coaxial
J373	131-0372-00			Coaxial
J376	131-0372-00			Coaxial
J379	131-0372-00			Coaxial
J401	131-0372-00			Coaxial
J470	131-0372-00			Coaxial
J501	131-0372-00			Coaxial
J658	136-0094-00			Socket w/hardware
J669	131-0106-00			1 Contact, female
J810	131-0352-02			BNC
J855	*175-0396-01			Cable assembly, 6¼ inch

[2]Furnished as a unit with Oscillator (119-0108-00).
[3]Furnished as a unit with Diplexer (119-0100-00).
[4]Furnished as a unit with 1 dB Pad (119-0091-00).
[5]Furnished as a unit with L.P. Filter (*610-0172-00).

Inductors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
L66	*108-0437-00			RF Choke
L81[6]				
L83[6]				
L84[6]				
L86[6]				
L87[6]				
L101	*108-0371-00			0.23 μH
L102	*108-0370-00			0.14 μH
L104	*108-0369-00			0.12 μH
L105	*108-0401-00			14 nH
L106	*108-0369-00			0.12 μH
L107	*108-0370-00			0.14 μH
L108	*108-0371-00			0.23 μH
L124	*108-0374-00			55 nH
L134	*114-0205-00			54-66 nH, Var, Core 276-0506-00
L144	*114-0206-00			234-286 nH, Var, Core 276-0506-00
L147	*114-0205-00			54-66 nH, Var, Core 276-0506-00
L151	*108-0310-00			0.09 μH
L188	*108-0310-00			0.09 μH
L313	*108-0215-00			1.1 μH
L314[7]				
L320	*108-0215-00			1.1 μH
L325	276-0507-00			Core, Ferramic Suppressor
L333	*108-0215-00			1.1 μH
L343	*108-0215-00			1.1 μH
L348	*108-0304-00			45 nH
I358	*108-0372-00			27 nH
L384	*108-0374-00			55 nH
L385	*108-0374-00			55 nH
L444	*114-0207-00			180-220 nH, Var, Core 276-0506-00
L446	*108-0215-00			1.1 μH
L450 (3)	276-0507-00			Core, Ferramic Suppressor
L456	276-0507-00			Core, Ferramic Suppressor
L466	276-0507-00			Core, Ferramic Suppressor
L508	108-0363-00			67 μH
L534	108-0226-00			100 μH
L620	108-0366-00			67 μH
L624	114-0209-00			28-60 μH, Var, Core not available separately
L675 (3)	276-0507-00			Core, Ferramic Suppressor
L676 (3)	276-0507-00			Core, Ferramic Suppressor

[6] **Furnished as a unit with L.P. Filter (*610-0172-00).**
[7] **Part of Sweeper Circuit Board.**

Inductors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
L800	114-0178-00			1300-3000 μH, Var, Core not available separately
L804	*114-0208-00			95-140 μH, Var, Core 276-0506-00
L826	*108-0215-00			1.1 μH
L875[8]				
LR413	*108-0368-00			10 μH (wound on a 1 kΩ, ½ W resistor)
LR423	*108-0367-00			1 μH (wound on a 1 kΩ, ¼ W resistor)
LR427	*108-0367-00			1 μH (wound on a 1 kΩ, ¼ W resistor)
LR433	*108-0367-00			1 μH (wound on a 1 kΩ, ¼ W resistor)
LR437	*108-0368-00			10 μH (wound on a 1 kΩ, ½ W resistor)
LR443	*108-0368-00			10 μH (wound on a 1 kΩ, ½ W resistor)
LR453	*108-0368-00			10 μH (wound on a 1 kΩ, ½ W resistor)
LR457	*108-0368-00			10 μH (wound on a 1 kΩ, ½ W resistor)
LR463	*108-0368-00			10 μH (wound on a 1 kΩ, ½ W resistor)
LR467	*108-0368-00			10 μH (wound on a 1 kΩ, ½ W resistor)

Plugs

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
P11	131-0017-00			16 Contact, male
P60[9]				

Transistors

Ckt. No.	Tektronix Part No.	Eff	Disc	Description	
Q120	*151-0230-00			Silicon	Replaceable by 40235 (RCA)
Q130	*151-0230-00			Silicon	Replaceable by 40235 (RCA)
Q140	151-0181-00			Silicon	40242 (RCA)
Q230	*151-0155-00			Silicon	Replaceable by 2N2925
Q240	*151-0150-00			Silicon	Selected from 2N3440
Q260	*151-0104-00			Silicon	Replaceable by 2N2919
Q280	*151-0155-00			Silicon	Replaceable by 2N2925
Q290	*151-0155-00			Silicon	Replaceable by 2N2925
Q310	151-0173-00			Silicon	2N3478
Q320	*151-0153-00			Silicon	Replaceable by 2N2923
Q340	151-0173-00			Silicon	2N3478
Q350	151-0173-00			Silicon	2N3478
Q420	151-0181-00			Silicon	40242 (RCA)
Q430	151-0181-00			Silicon	40242 (RCA)
Q440	151-0175-00			Silicon	2N3662
Q450	151-0175-00			Silicon	2N3662
Q460	151-0175-00			Silicon	2N3662
Q510	151-0181-00			Silicon	40242 (RCA)
Q520	151-0175-00			Silicon	2N3662
Q530	151-0175-00			Silicon	2N3662

[8]Furnished as a unit with Phase Lock Board Harness (*179-1342-00).

[9]Furnished as a unit with L66.

Transistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Q650	151-0175-00			Silicon	2N3662
Q710	151-0164-00			Silicon	2N3702
Q717	151-0174-00			Silicon	2N3403
Q720	151-0164-00			Silicon	2N3702
Q727	151-0174-00			Silicon	2N3403
Q800	*151-0108-00			Silicon	Replaceable by 2N2501
Q810	*151-0192-00			Silicon	Replaceable by MPS-6521
Q820	151-0181-00			Silicon	40242 (RCA)
Q830	*151-0150-00			Silicon	Selected from 2N3440
Q840	*153-0545-00			Silicon	Selected from 2N2501
Q860	*151-0192-00			Silicon	Replaceable by MPS-6521
Q870	*151-0192-00			Silicon	Replaceable by MPS-6521
Q880	*151-0192-00			Silicon	Replaceable by MPS-6521

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
R42	*308-0217-00			5.5 kΩ	5 W	WW	5%
R43[10]							
R47	308-0258-00			6 kΩ	3 W	WW	5%
R49	308-0395-00			300 Ω	10 W	WW	
R66	311-0546-00			10 kΩ, Var			
R123	315-0101-00			100 Ω	¼ W		5%
R124	315-0471-00			470 Ω	¼ W		5%
R128	315-0332-00			3.3 kΩ	¼ W		5%
R130	315-0221-00			220 Ω	¼ W		5%
R133	315-0101-00			100 Ω	¼ W		5%
R134	315-0131-00			130 Ω	¼ W		5%
R137	315-0330-00			33 Ω (nominal value) Selected			
R138	315-0182-00			1.8 kΩ	¼ W		5%
R140	315-0221-00			220 Ω	¼ W		5%
R143	315-0101-00			100 Ω	¼ W		5%
R148	315-0101-00			100 Ω	¼ W		5%
R149	315-0472-00			4.7 kΩ	¼ W		5%
R158	315-0620-00			62 Ω	¼ W		5%
R159	315-0241-00			240 Ω	¼ W		5%
R160	315-0620-00			62 Ω	¼ W		5%
R163	315-0680-00			68 Ω	¼ W		5%
R164	315-0151-00			150 Ω	¼ W		5%
R165	315-0680-00			68 Ω	¼ W		5%
R168	315-0121-00			120 Ω	¼ W		5%
R169	315-0510-00			51 Ω	¼ W		5%

[10]Furnished as a unit with Oscillator (119-0108-00).

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R170	315-0121-00			120 Ω	¼ W		5%
R173	315-0221-00			220 Ω	¼ W		5%
R174	315-0240-00			24 Ω	¼ W		5%
R175	315-0221-00			220 Ω	¼ W		5%
R178	315-0431-00			430 Ω	¼ W		5%
R179	315-0120-00			12 Ω	¼ W		5%
R180	315-0431-00			430 Ω	¼ W		5%
R183	315-0911-00			910 Ω	¼ W		5%
R184	307-0107-00			5.6 Ω	¼ W		5%
R185	315-0911-00			910 Ω	¼ W		5%
R201	321-0332-00			28 kΩ	⅛ W	Prec	1%
R202	321-0358-00			52.3 kΩ	⅛ W	Prec	1%
R204	311-0465-00			100 kΩ, Var			
R205	323-0395-00			127 kΩ	½ W	Prec	1%
R206	315-0362-00			3.6 kΩ	¼ W		5%
R208	311-0310-00			5 kΩ, Var			
R209	315-0512-00			5.1 kΩ	¼ W		5%
R213	321-0231-00			2.49 kΩ	⅛ W	Prec	1%
R214	321-0164-00			499 Ω	⅛ W	Prec	1%
R215	321-0193-00			1 kΩ	⅛ W	Prec	1%
R217	321-0164-00			499 Ω	⅛ W	Prec	1%
R219	321-0135-00			249 Ω	⅛ W	Prec	1%
R220	321-0068-00			49.9 Ω	⅛ W	Prec	1%
R221	321-0097-00			100 Ω	⅛ W	Prec	1%
R223	321-0068-00			49.9 Ω	⅛ W	Prec	1%
R224	321-0047-00			30.1 Ω	⅛ W	Prec	1%
R225	321-0001-00			10 Ω	⅛ W	Prec	1%
R226	321-0001-00			10 Ω	⅛ W	Prec	1%
R230	315-0512-00			5.1 kΩ	¼ W		5%
R236	303-0513-00			51 kΩ	1 W		5%
R241	321-0279-00			7.87 kΩ	⅛ W	Prec	1%
R242	323-0411-00			187 kΩ	½ W	Prec	1%
R243	304-0124-00			120 kΩ	1 W		
R244	315-0432-00			4.3 kΩ	¼ W		5%
R245	315-0272-00			2.7 kΩ	¼ W		5%
R246	316-0102-00			1 kΩ	¼ W		
R248	316-0101-00			100 Ω	¼ W		
R250	315-0104-00			100 kΩ	¼ W		5%
R252	311-0487-00			30 kΩ, Var			
R253	311-0329-00			50 kΩ, Var			
R254	323-0409-00			178 kΩ	½ W	Prec	1%
R255	316-0101-00			100 Ω	¼ W		
R257	311-0326-00			10 kΩ, Var			
R258	315-0222-00			2.2 kΩ	¼ W		5%
R260	321-0423-00			249 kΩ	⅛ W	Prec	1%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R261	321-0423-00			249 kΩ	1/8 W	Prec	1%
R262	316-0102-00			1 kΩ	1/4 W		
R263	316-0102-00			1 kΩ	1/4 W		
R264	321-0161-00			464 Ω	1/8 W	Prec	1%
R265	321-0161-00			464 Ω	1/8 W	Prec	1%
R266	321-0147-00			332 Ω	1/8 W	Prec	1%
R267	323-0400-00			143 kΩ	1/2 W	Prec	1%
R268	321-0442-00			392 kΩ	1/8 W	Prec	1%
R269	322-0643-00			600 kΩ	1/4 W	Prec	1%
R270	311-0580-00			50 kΩ, Var			
R271	301-0755-00			7.5 MΩ	1/2 W		5%
R274	311-0590-00			2 kΩ, Var			
R276	322-0481-00			1 MΩ	1/4 W	Prec	1%
R280	321-0423-00			249 kΩ	1/8 W	Prec	1%
R286	315-0512-00			5.1 kΩ	1/4 W		5%
R290	311-0443-00			2.5 kΩ, Var			
R291	323-0402-00			150 kΩ	1/2 W	Prec	1%
R293	315-0510-00			51 Ω	1/4 W		5%
R294	316-0562-00			5.6 kΩ	1/4 W		
R295	315-0202-00			2 kΩ	1/4 W		5%
R296	316-0102-00			1 kΩ	1/4 W		
R300	315-0102-00			1 kΩ	1/4 W		5%
R310	315-0562-00			5.6 kΩ	1/4 W		5%
R311	315-0392-00			3.9 kΩ	1/4 W		5%
R316	315-0221-00			220 Ω	1/4 W		5%
R333	321-0233-00			2.61 kΩ	1/8 W	Prec	1%
R334	315-0431-00			430 Ω	1/4 W		5%
R346	315-0680-00			68 Ω	1/4 W		5%
R356	315-0680-00			68 Ω	1/4 W		5%
R361	321-0395-00			127 kΩ	1/8 W	Prec	1%
R363	315-0221-00			220 Ω	1/4 W		5%
R365	315-0102-00			1 kΩ	1/4 W		5%
R368	311-0387-00			5 kΩ, Var			
R373	315-0510-00			51 Ω	1/4 W		5%
R376	315-0510-00			51 Ω	1/4 W		5%
R380	316-0272-00			2.7 kΩ	1/4 W		
R381	316-0274-00			270 kΩ	1/4 W		
R383	315-0681-00			680 Ω	1/4 W		5%
R384	321-0097-00			100 Ω	1/8 W	Prec	1%
R385	321-0097-00			100 Ω	1/8 W	Prec	1%
R401	315-0680-00			68 Ω	1/4 W		5%
R410	315-0393-00			39 kΩ (nominal value) Selected			
R411A } R411B }	311-0588-00			5 kΩ Var 1 kΩ Var			
R414	315-0512-00			5.1 kΩ	1/4 W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R416	315-0102-00			1 kΩ	¼ W		5%
R426	315-0102-00			1 kΩ	¼ W		5%
R436	315-0102-00			1 kΩ	¼ W		5%
R448	315-0472-00			4.7 kΩ	¼ W		5%
R454	315-0103-00			10 kΩ	¼ W		5%
R456	315-0472-00			4.7 kΩ	¼ W		5%
R464	315-0103-00			10 kΩ	¼ W		5%
R466	315-0472-00			4.7 kΩ	¼ W		5%
R501	317-0151-00			150 Ω	¼ W		5%
R502	317-0151-00			150 Ω	¼ W		5%
R514	315-0470-00			47 Ω	¼ W		5%
R516	315-0242-00			2.4 kΩ	¼ W		5%
R517	315-0242-00			2.4 kΩ	¼ W		5%
R524	315-0470-00			47 Ω	¼ W		5%
R525	315-0202-00			2 kΩ	¼ W		5%
R530	315-0301-00			300 Ω	¼ W		5%
R531	315-0203-00			20 kΩ	¼ W		5%
R532	315-0562-00			5.6 kΩ	¼ W		5%
R534	315-0102-00			1 kΩ	¼ W		5%
R537	315-0101-00			100 Ω	¼ W		5%
R539	315-0102-00			1 kΩ	¼ W		5%
R540	301-0433-00			43 kΩ	½ W		5%
R541	315-0204-00			200 kΩ	¼ W		5%
R543	311-0326-00			10 kΩ, Var			
R550	315-0151-00			150 Ω	¼ W		5%
R551	315-0161-00			160 Ω	¼ W		5%
R552	315-0111-00			110 Ω	¼ W		5%
R553	315-0151-00			150 Ω	¼ W		5%
R554	315-0331-00			330 Ω	¼ W		5%
R555	315-0511-00			510 Ω	¼ W		5%
R556	315-0561-00			560 Ω	¼ W		5%
R557	315-0104-00			100 kΩ	¼ W		5%
R558	315-0394-00			390 kΩ	¼ W		5%
R559	315-0394-00			390 kΩ	¼ W		5%
R606	316-0102-00			1 kΩ	¼ W		
R607	316-0471-00			470 Ω	¼ W		
R610	316-0102-00			1 kΩ	¼ W		
R623	316-0101-00			100 Ω	¼ W		
R624	316-0103-00			10 kΩ	¼ W		
R626	316-0680-00			68 Ω	¼ W		
R628	316-0101-00			100 Ω	¼ W		
R651	316-0104-00			100 kΩ	¼ W		
R652	316-0105-00			1 MΩ	¼ W		
R653	308-0313-00			20 kΩ	3 W	WW	1%
R654	316-0471-00			470 Ω	¼ W		

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R656	316-0332-00			3.3 kΩ	1/4 W		
R657	316-0332-00			3.3 kΩ	1/4 W		
R658	316-0681-00			680 Ω	1/4 W		
R662	316-0124-00			120 kΩ	1/4 W		
R663	316-0124-00			120 kΩ	1/4 W		
R664	316-0683-00			68 kΩ	1/4 W		
R665	316-0102-00			1 kΩ	1/4 W		
R666	311-0382-00			1 MΩ, Var			
R668	315-0124-00			120 kΩ	1/4 W		5%
R669	323-0071-00			53.6 kΩ	1/2 W	Prec	1%
R671	301-0472-00			4.7 kΩ	1/2 W		5%
R672	311-0091-00			1 kΩ, Var			
R673	303-0123-00			12 kΩ	1 W		5%
R675	316-0471-00			470 Ω	1/4 W		
R676	316-0471-00			470 Ω	1/4 W		
R710	323-0419-00			226 kΩ	1/2 W	Prec	1%
R711	321-0288-00			9.76 kΩ	1/8 W	Prec	1%
R714	316-0103-00			10 kΩ	1/4 W		
R720	321-0289-00			10 kΩ	1/8 W	Prec	1%
R721	321-0284-00			8.87 kΩ	1/8 W	Prec	1%
R724	301-0154-00			150 kΩ	1/2 W		5%
R727	308-0020-00			3 kΩ	10 W	WW	5%
R800	317-0562-00			5.6 kΩ	1/8 W		5%
R801	317-0472-00			4.7 kΩ	1/8 W		5%
R805	317-0102-00			1 kΩ	1/8 W		5%
R807	315-0104-00			100 kΩ	1/4 W		5%
R808	317-0473-00			47 kΩ	1/8 W		5%
R809[11]	311-0645-00			50 kΩ, Var			
R811	317-0101-00			100 Ω	1/8 W		5%
R812	317-0104-00			100 kΩ	1/8 W		5%
R813	317-0104-00			100 kΩ	1/8 W		5%
R815	317-0100-00			10 Ω	1/8 W		5%
R817	317-0473-00			47 kΩ	1/8 W		5%
R818	317-0511-00			510 Ω	1/8 W		5%
R820	317-0510-00			51 Ω	1/8 W		5%
R821	317-0102-00			1 kΩ	1/8 W		5%
R822	317-0510-00			51 Ω	1/8 W		5%
R823	317-0101-00			100 Ω	1/8 W		5%
R824	317-0332-00			3.3 kΩ	1/8 W		5%
R825	317-0162-00			1.6 kΩ	1/8 W		5%
R828	317-0101-00			100 Ω	1/8 W		5%
R829	317-0163-00			16 kΩ	1/8 W		5%
R830	317-0153-00			15 kΩ	1/8 W		5%
R831	311-0453-00			10 kΩ, Var			
R832	315-0333-00			33 kΩ	1/4 W		5%

[11]Furnished as a unit with SW809.

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R843	315-0510-00			51 Ω	¼ W		5%
R844	308-0437-00			4 kΩ	3 W	WW	1/10%
R845	317-0100-00			10 Ω	⅛ W		5%
R846	315-0511-00			510 Ω	¼ W		5%
R850	311-0635-00			1 kΩ, Var			
R851	317-0392-00			3.9 kΩ	⅛ W		5%
R852	321-0417-00			215 kΩ	⅛ W	Prec	1%
R853	317-0511-00			510 Ω	⅛ W		5%
R854	317-0511-00			510 Ω	⅛ W		5%
R855	317-0101-00			100 Ω	⅛ W		5%
R856	321-0376-00			80.6 kΩ	⅛ W	Prec	1%
R857	321-0376-00			80.6 kΩ	⅛ W	Prec	1%
R858	321-0433-00			316 kΩ	⅛ W	Prec	1%
R859	317-0101-00			100 Ω	⅛ W		5%
R860	317-0103-00			10 kΩ	⅛ W		5%
R861	317-0621-00			620 Ω	⅛ W		5%
R862	311-0668-00			2 kΩ, Var			
R863	317-0104-00			100 kΩ	⅛ W		5%
R864	321-0385-00			100 kΩ	⅛ W	Prec	1%
R865	321-0279-00			7.87 kΩ	⅛ W	Prec	1%
R866	317-0203-00			20 kΩ	⅛ W		5%
R868	317-0621-00			620 Ω	⅛ W		5%
R869	317-0103-00			10 kΩ	⅛ W		5%
R871	315-0124-00			120 kΩ	¼ W		5%
R872	317-0302-00			3 kΩ	⅛ W		5%
R873	317-0472-00			4.7 kΩ	⅛ W		5%
R874	321-0385-00			100 kΩ	⅛ W	Prec	1%
R876	317-0471-00			470 Ω	⅛ W		5%
R878	317-0682-00			6.8 kΩ	⅛ W		5%
R879	317-0302-00			3 kΩ	⅛ W		5%
R880	317-0104-00			100 kΩ	⅛ W		5%
R881	315-0204-00			200 kΩ	¼ W		5%
R883	317-0103-00			10 kΩ	⅛ W		5%
R886	321-0447-00			442 kΩ	⅛ W	Prec	1%
R887	317-0104-00			100 kΩ	⅛ W		5%
R888	317-0104-00			100 kΩ	⅛ W		5%
R889	321-1485-00			1.11 MΩ	⅛ W	Prec	1%
R890	307-0103-00			2.7 Ω	¼ W		5%
R892	317-0101-00			100 Ω	⅛ W		5%
R894	317-0100-00			10 Ω	⅛ W		5%

Switches

	Wired or Unwired		
SW159	260-0642-00	Toggle	IF ATTEN 20 dB
SW164	260-0642-00	Toggle	IF ATTEN 16 dB
SW169	260-0642-00	Toggle	IF ATTEN 8 dB
SW174	260-0642-00	Toggle	IF ATTEN 4 dB
SW179	260-0642-00	Toggle	IF ATTEN 2 dB

Switches *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
SW184	260-0642-00			Toggle	IF ATTEN 1 dB
SW201	260-0583-00			Slide	100 V - 150 V
SW220[12] Wired	*262-0763-00			Rotary	DISPERSION
SW220	260-0759-01			Rotary	DISPERSION
SW230	260-0866-00			Rotary	DISPERSION RANGE
SW365	260-0643-00			Toggle	
SW550[12]					COUPLED RESOLUTION
SW660 Wired	*262-0762-00			Lever	VERTICAL DISPLAY
SW660	260-0758-00			Lever	VERTICAL DISPLAY
SW661	260-0643-00			Toggle	VIDEO FILTER
SW809[13]					
SW889	260-0689-00			Push	LOCK CHECK

Transformers

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
T120	*120-0428-00			Toroid, 4 turns bifilar
T124	*120-0325-00			Toroid, 5 turns bifilar
T134	*120-0325-00			Toroid, 5 turns bifilar
T148	*120-0325-00			Toroid, 5 turns bifilar
T330	*120-0340-00			Toroid, 5 turns bifilar
T331	*120-0340-00			Toroid, 5 turns bifilar
T343	*120-0340-00			Toroid, 5 turns bifilar
T347	*120-0340-00			Toroid, 5 turns bifilar
T354	*120-0340-00			Toroid, 5 turns bifilar
T363	*120-0340-00			Toroid, 5 turns bifilar
T424	*120-0425-00			Toroid, 5 turns-1 turn
T434	*120-0426-00			Toroid, 7 turns-2 turns
T454	120-0356-00			3.45 MHz
T464	120-0356-00			3.45 MHz
T610	*120-0427-00			Toroid, 12 turns trifilar
T820	*120-0194-01			Toroid, 4 turns trifilar
T856[14]				
T857[14]				

Electron Tubes

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
V42	154-0506-00			1641
V620	154-0040-00			12AU6

Cable Assemblies

Ckt. No.	Tektronix Part No.	Eff	Disc	Description
W42	*175-0309-00			5 inch
W45	*175-0312-00			9 inch
W46[15]				
W50	*175-0308-00			2 inch
W75	*175-0308-00			2 inch

[12]SW220 and SW550 furnished as a unit.

[13]Furnished as a unit with R809.

[14]Part of Phase Lock Circuit Board.

[15]Furnished as a unit with Mixer (119-0096-00).

Cable Assemblies *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
W94	*175-0312-00			9 inch
W110	*175-0308-00			2 inch
W150	*175-0313-00			3 inch
W200	*175-0358-00			1 9/16 inch
W300	*175-0413-00			8 inch
W370[16]				
W375[16]				
W500	*175-0358-00			1 9/16 inch

Crystals

Y440	158-0024-00			70 MHz
Y501	158-0019-00			5 MHz
Y610	158-0027-00			5 MHz
Y800	158-0025-00			1 MHz

Diplexer

	119-0100-00			Multiplexer, IF dual hybrid

Low Pass Filter

	*610-0172-00			280 MHz

Mixer

	119-0096-00			1.5-12.4 GHz

Oscillator

	119-0108-00			Oscillator

1 dB Pad

	119-0091-00			Attenuator Pad

[16]Selected. See Mechanical Parts List.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
  Detail Part of Assembly and/or Component
  mounting hardware for Detail Part
    Parts of Detail Part
    mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

Fig. 1 FRONT & REAR

Fig. 2 IF CHASSIS & PHASE LOCK ASSEMBLIES

Fig. 3 STANDARD ACCESSORIES

SECTION 7
MECHANICAL PARTS LIST

FIG. 1 FRONT & REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-1	333-1149-01			1	PANEL, front
-2	366-0153-00			1	KNOB, charcoal—POS
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-3	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-4	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-5	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-6	366-0455-00			1	KNOB, charcoal-DISPERSION RANGE
	- - - - - -			-	knob includes:
	213-0153-00			1	SCREW, set, 5-40 x 0.125 inch, HSS
-7	384-0394-00			1	ROD, shaft
-8	214-0694-00			1	CAM, control actuator
	- - - - - -			-	cam includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch, HSS
-9	376-0029-00			1	COUPLING, shaft
	- - - - - -			-	coupling includes:
	213-0075-00			2	SCREW, set, 4-40 x 3/32 inch, HSS
-10	260-0866-00			1	SWITCH, unwired—DISPERSION RANGE
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-11	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-12	386-1031-00			1	PLATE, switch mount
	- - - - - -			-	mounting hardware: (not included w/plate)
-13	211-0008-00			4	SCREW, 4-40 x 1/4 inch, PHS
-14	210-0201-00			1	LUG, solder, SE #4
-15	384-0616-00			2	ROD, spacer, hex., 1/4 x 1.370 inches long
-16	366-0153-00			1	KNOB, charcoal—FINE IF CENTER FREQ
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-17	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-18	210-0223-00			1	LUG, slder, 1/4 ID x 7/16 inch OD, SE
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-19	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-20	366-0422-01			1	KNOB, charcoal—COUPLED RESOLUTION
	- - - - - -			-	knob includes:
	213-0153-00			2	SCREW, set, 5-40 x 1/8 inch, HSS

FIG. 1 FRONT & REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-21	366-0423-00			1	KNOB, charcoal—DISPERSION
	- - - - - -			-	knob includes:
	213-0153-00			1	SCREW, set, 5-40 x $^1/_8$ inch, HSS
-22	262-0763-00			1	SWITCH, wired—COUPLED RESOLUTION
	- - - - - -			-	switch includes:
	260-0759-01			1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
-23	210-0590-00			1	NUT, hex., $^3/_8$-32 x $^7/_{16}$ inch
-24	366-0153-00			1	KNOB, charcoal—MIXER PEAKING
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
-25	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0940-00			1	WASHER, flat, $^1/_4$ ID x $^3/_8$ inch OD
-26	210-0583-00			1	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch
-27	366-0153-00			1	KNOB, charcoal—GAIN
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x $^3/_{16}$ inch, HSS
-28	331-0168-01			1	DIAL, w/brake—IF CENTER FREQ
	- - - - - -			-	dial includes:
	213-0048-00			1	SCREW, set, 4-40 x $^1/_8$ inch, HSS
-29	- - - - - -			1	RESISTOR, variable, w/hardware
-30	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-31	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
-32	210-0471-00			1	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch
-33	358-0054-02			1	BUSHING, $^1/_4$-32 x $^3/_{32}$ inch
-34	260-0643-00			1	SWITCH, toggle—VIDEO FILTER
	- - - - - -			-	mounting hardware: (not included w/switch)
-35	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x $^3/_8$ inch OD
	210-0940-00			1	WASHER, flat, $^1/_4$ ID x $^3/_8$ inch OD
-36	210-0562-00			1	NUT, hex., $^1/_4$-40 x $^5/_{16}$ inch
-37	366-0215-01			1	KNOB, charcoal—VERTICAL DISPLAY
-38	262-0762-00			1	SWITCH, lever—VERTICAL DISPLAY
	- - - - - -			-	switch includes:
	260-0758-00			1	SWITCH, lever
	- - - - - -			-	mounting hardware: (not included w/switch)
-39	211-0005-00			2	SCREW, 4-40 x $^1/_8$ inch, PHS
-40	131-0106-00			1	CONNECTOR, coaxial, 1 contact, BNC, w/hardware
-41	136-0094-00			1	SOCKET
	- - - - - -			-	mounting hardware: (not included w/socket)
	210-0940-00			1	WASHER, flat, $^1/_4$ ID x $^3/_8$ inch OD
-42	210-0583-00			1	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch

FIG. 1 FRONT & REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-43	131-0106-00			1	CONNECTOR, coaxial, 1 contact, BNC w/hardware
	- - - - - -			-	mounting hardware: (not included w/connector)
-44	210-0255-00			1	LUG, solder, 3/8 inch
-45	119-0096-00			1	MIXER, crystal, coaxial, 1.5 to 12.4 GHz
	136-0246-00			1	ASSEMBLY, receptacle, locking, coaxial, mixer
	- - - - - -			-	assembly includes:
-46	220-0467-00			1	NUT, sleeve, 0.875 x 1 x 1 inch long
-47	210-0467-00			1	LOCKWASHER, internal, 0.880 ID x 1.110 inches OD
-48	175-0420-00			1	ASSEMBLY, cable, 4.375 inches (Assembly to J46)
-49	354-0303-00			1	RING, retaining
-50	354-0303-01			1	RING, locking
-51	205-0077-00			2	SHELL
-52	214-0862-00			1	SPRING, locking
-53	214-0861-00			1	SPRING, compression
-54	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-55	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-56	210-0471-00			1	NUT, hex., 1/4-32 x 5/16 inch
-57	358-0054-00			1	BUSHING, 1/4-32 x 3/32 inch
-58	366-1098-00			1	KNOB, charcoal—FINE RF CENTER FREQ
	- - - - - -			-	knob includes:
	213-0153-00			1	SCREW, set, 5-40 x 1/8 inch, HSS
-59	366-1099-00			1	KNOB, charcoal—PHASE LOCK (INT REF FREQ)
	- - - - - -			-	knob includes:
	213-0153-00			1	SCREW, set, 5-40 x 1/8 inch, HSS
-60	386-1448-00			1	PLATE, subpanel, front
-61	366-0125-00			1	KNOB, plug-in securing
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-62	210-0894-00			1	WASHER, plastic, 0.190 ID x 7/8 inch OD
-63	384-0510-00			1	ROD, securing
	- - - - - -			-	rod includes:
-64	354-0025-00			1	RING, retaining
-65	386-0115-01			1	PLATE, dial window
	- - - - - -			-	mounting hardware: (not included w/plate)
-66	213-0138-00			2	SCREW, sheet metal, #4 x 3/16 inch, PHS
-67	384-0631-00			4	ROD, spacer
	- - - - - -			-	mounting hardware for each: (not included w/rod)
-68	212-0023-00			1	SCREW, 8-32 x 3/8 inch, RHS
-69	386-1025-00			1	PLATE, rear
-70	131-0017-00			1	CONNECTOR, 16 contact, male
	- - - - - -			-	mounting hardware: (not included w/connector)
-71	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-72	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch

FIG. 1 FRONT & REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-73	260-0583-00			1	SWITCH, slide—SAWTOOTH 100-150V
	- - - - - -			-	mounting hardware: (not included w/switch)
-74	211-0022-00			2	SCREW, 2-56 x 3/16 inch, RHS
-75	210-0405-00			2	NUT, hex., 2-56 x 3/16 inch
-76	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
-77	211-0504-00			1	SCREW, 6-32 x 1/4 inch
-78	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-79	- - - - - -			2	RESISTOR
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-80	211-0553-00			1	SCREW, 6-32 x 1 1/2 inches, RHS
-81	210-0601-00			1	EYELET
-82	210-0478-00			1	NUT, hex., 5/16 x 21/32 inch long
-83	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-84	- - - - - -			1	RESISTOR
	- - - - - -			-	mounting hardware: (not included w/resistor)
-85	211-0544-00			1	SCREW, 6-32 x 3/4 inch, THS
	210-0601-00			1	EYELET
-86	210-0478-00			1	NUT, hex., 5/16 x 21/32 inch long
-87	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-88	136-0009-00			1	SOCKET, tube, 7 pin w/shield
	- - - - - -			-	mounting hardware: (not included w/socket)
-89	211-0033-00			2	SCREW, sems, 4-40 x 5/16 inch, PHS
-90	210-0004-00			1	LOCKWASHER, internal, #4
-91	210-0201-00			1	LUG, solder, SE #4
-92	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-93	136-0181-00			1	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
-94	354-0234-00			1	RING, socket mounting
-95	136-0208-00			1	SOCKET, crystal
	- - - - - -			-	mounting hardware: (not included w/socket)
-96	213-0055-00			1	SCREW, thread forming, 2-32 x 3/16 inch, PHS
-97	136-0218-00			7	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-98	354-0285-00			1	HOLDER, socket

FIG. 1 FRONT & REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
-99	136-0235-00			1	SOCKET, transistor, dual
	- - - - - -			-	mounting hardware: (not included w/socket)
-100	354-0234-00			1	RING, socket mounting
-101	348-0056-00			1	GROMMET, plastic, 0.354 ID x 0.406 inch OD
-102	- - - - - -			1	CAPACITOR, variable, w/hardware
-103	407-0138-00			1	BRACKET, coil mounting
	- - - - - -			-	mounting hardware: (not included w/bracket)
-104	213-0088-00			2	SCREW, thread forming, #4 x 1/4 inch, PHS
-105	- - - - - -			5	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-106	210-0046-00			2	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
-107	210-0471-00			1	NUT, hex., 1/4-32 x 5/16 inch
-108	358-0054-02			1	BUSHING, 1/4-32 x 3/32 inch
-109	- - - - - -			1	COIL
	- - - - - -			-	mounting hardware: (not included w/coil)
-110	385-0150-00			1	ROD, spacer, 3/8 x 5/8 inch
-111	210-0204-00			1	LUG, solder, DE #6
-112	210-0201-00			1	LUG, solder, SE #4
-113	211-0008-00			1	SCREW, 4-40 x 3/16, PHS
-114	210-0259-00			4	LUG, solder, #2
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-115	213-0055-00			1	SCREW, thread forming 2-32 x 3/16 inch, PHS
-116	441-0668-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/chassis)
-117	211-0538-00			2	SCREW, 6-32 x 5/16 inch, 100° csk, FHS
	213-0138-00			1	SCREW, sheet metal, #4 x 3/16 inch, PHS
-118	211-0504-00			1	SCREW, 6-32 x 1/4 inch, PHS
-119	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-120	179-1044-03			1	CABLE HARNESS, chassis
	- - - - - -			-	cable harness includes:
	131-0371-00			14	CONNECTOR, single contact
-121	670-0099-00			1	ASSEMBLY, circuit board—RECORDER DETECTOR
	- - - - - -			-	assembly includes:
	388-0650-00			1	BOARD, circuit
-122	124-0145-00			4	STRIP, ceramic, 7/16 inch h, w/20 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 0.406 inch long

FIG. 1 FRONT & REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-123	124-0148-00			2	STRIP, ceramic, $^{7}/_{16}$ inch h, w/4 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0008-00			2	SPACER, plastic, 0.281 inch long
-124	124-0162-00			1	STRIP, ceramic, $^{7}/_{16}$ inch h, w/4 notches
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0009-00			1	SPACER, plastic, 0.406 inch long
-125	337-0007-00			1	SHIELD, tube, $^{7}/_{8}$ ID x 1$^{3}/_{4}$ inch h, w/spring
	119-0164-00			1	ASSEMBLY, oscillator & dial tape
	- - - - - -			-	assembly includes
-126	119-0108-00			1	OSCILLATOR
-127	388-0817-00			1	BOARD, circuit
	- - - - - -			-	mounting hardware: (not included w/board)
-128	211-0602-00			1	SCREW, sems, 6-32 x $^{3}/_{8}$ inch, PHB
-129	166-0029-00			1	TUBE, spacer, 0.180 ID x $^{1}/_{4}$ inch OD
-130	214-0506-00			1	PIN, connector
-131	380-0143-00			1	HOUSING, mechanical drive
	- - - - - -			-	mounting hardware: (not included w/housing)
-132	211-0513-00			2	SCREW, 6-32 x $^{5}/_{8}$, PHS
-133	210-0055-00			2	LOCKWASHER, #6 split
-134	214-1052-01			2	GEAR
	- - - - - -			-	mounting hardware for each: (not included w/gear)
	213-0075-00			2	SCREW, set, 4-40 x $^{3}/_{32}$ inch, HSS
-135	214-1051-01			1	GEAR
	- - - - - -			-	mounting hardware: (not included w/gear)
-136	211-0564-00			1	SCREW, 6-32 x $^{3}/_{8}$ inch, socket head cap
-137	358-0339-00			1	BUSHING, sleeve, 0.437 OD x 0.225 inch long
-138	214-0535-00			1	GEAR
	- - - - - -			-	mounting hardware: (not included w/gear)
	213-0140-00			2	SCREW, set, 2-56 x $^{3}/_{32}$ inch, HSS
-139	384-0699-00			1	SHAFT, 0.125 OD x 2.337 inches long
	- - - - - -			-	mounting hardware: (not included w/shaft)
-140	210-0991-00			1	WASHER, spring
-141	354-0163-00			1	RING, retaining
-142	386-1451-00			1	SUPPORT, oscillator
	- - - - - -			-	support includes:
	213-0004-00			2	SCREW, set, 6-32 x $^{3}/_{16}$ inch, HSS

FIG. 1 FRONT & REAR *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-	331-0239-00			1	ASSEMBLY, dial tape
	- - - - - - -			-	assembly includes:
-143	214-0522-00			1	GEAR
-144	384-0635-00			1	ROD, sprocket
-145	210-0992-00			1	WASHER, spacer, plastic, 0.265 ID x 0.437 inch OD
	210-1011-00			1	WASHER, plastic, 0.130 ID x 0.375 inch OD
-146	214-0520-01			1	SPROCKET, tape
	- - - - - - -			-	mounting hardware: (not included w/sprocket)
	213-0075-00			2	SCREW, set, 4-40 x $^{3}/_{32}$ inch, HSS
-147	214-0521-01			1	ROLLER, idler tape
	- - - - - - -			-	mounting hardware for each: (not included w/roller)
-148	384-0636-01			1	ROD, idler standoff
-149	380-0076-01			-	HOUSING
	- - - - - - -			-	housing includes:
-150	214-0564-00			1	PIN, roll
-151	331-0209-00			1	TAPE, dial
-152	358-0298-00			1	BUSHING
	- - - - - - -			-	mounting hardware: (not included w/assembly)
-153	211-0564-00			2	SCREW, 6-32 x $^{3}/_{8}$ inch, socket head cap
	- - - - - - -			-	mounting hardware: (not included w/assembly)
-154	211-0507-00			1	SCREW, 6-32 x $^{5}/_{16}$ inch, PHS
	210-0006-00			1	LOCKWASHER, internal, #6
-155	210-0803-00			1	WASHER, flat, 0.150 ID x $^{3}/_{8}$ inch OD
-156	366-0487-00			1	KNOB, charcoal, crank—RF CENTER FREQ
	- - - - - - -			-	knob includes:
	213-0153-00			2	SCREW, set, 5-40 x $^{1}/_{8}$ inch, HSS
-157	175-0309-00			1	ASSEMBLY, cable, 6.250 inches, (J43 to J45)
-158	175-0312-00			1	ASSEMBLY, cable, 9 inches, (J42 to J855)

FIG. 2 IF CHASSIS & PHASE LOCK ASSEMBLY

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-	610-0175-00			1	ASSEMBLY, IF CHASSIS
	- - - - - -			-	assembly includes:
	610-0173-00			1	ASSEMBLY, IF ATTENUATOR
	- - - - - -			-	assembly includes:
-1	260-0642-00			6	SWITCH, toggle—IF ATTENUATOR dB
-2	337-0799-00			1	SHIELD, switch
	- - - - - -			-	mounting hardware: (not included w/assembly)
-3	210-0562-00			2	NUT, hex., $^1/_4$-40 x $^5/_{16}$ inch
	610-0174-00			1	ASSEMBLY, BANDPASS FILTER
	- - - - - -			-	assembly includes:
-4	131-0372-00			4	CONNECTOR, coaxial, w/hardware
-5	210-0206-00			2	LUG, solder, SE #10
-6	- - - - - -			6	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-7	214-0456-00			1	FASTENER, plastic
-8	124-0181-00			2	STRIP, terminal
-9	337-0802-00			1	SHIELD, filter
-10	441-0667-00			1	CHASSIS
	- - - - - -			-	mounting hardware (not included w/assembly)
-11	211-0065-00			8	SCREW, 4-40 x $^3/_{16}$ inch, PHS
	610-0483-00			1	ASSEMBLY, sweeper
	- - - - - -			-	assembly includes:
-12	131-0182-00			2	CONNECTOR, terminal feed through
	- - - - - -			-	mounting hardware for each: (not included w/connector)
	358-0135-00			1	BUSHING, plastic
-13	131-0372-00			11	CONNECTOR, coaxial, w/hardware
-14	210-0206-00			2	LUG, solder, SE #10
-15	210-0812-00			2	WASHER, fiber, #10
-16	210-0813-00			2	WASHER, fiber, shouldered, #10
-17	131-0373-00			30	CONNECTOR, terminal stand-off
-18	136-0153-00			1	SOCKET, crystal
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0022-00			1	SCREW, 2-56 x $^3/_{16}$ inch, RHS
	210-0001-00			1	LOCKWASHER, internal, #2
-19	210-0405-00			1	NUT, hex., 2-56 x $^3/_{16}$ inch
-20	136-0325-00			1	SOCKET, crystal
	- - - - - -			-	mounting hardware: (not included w/socket)
	352-0130-01			1	HOLDER
-21	136-0217-00			9	SOCKET, transistor, 4 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0285-00			1	RING, socket mounting
-22	136-0218-00			6	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0285-00			1	RING, socket mounting

FIG. 2 IF CHASSIS & PHASE LOCK ASSEMBLIES *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-23	- - - - - -			6	CAPACITOR, variable, w/hardware
-24	- - - - - -			1	CAPACITOR, variable, w/hardware
	- - - - - -			-	mounting hardware: (not included w/capacitor)
	210-0812-00			1	WASHER, fiber, #10
	210-0813-00			1	WASHER, fiber, shouldered, #10
-25	210-0405-00			31	NUT, hex., 2-56 x 3/16 inch
-26	210-0259-00			32	LUG, solder, #2
-27	210-0001-00			8	LOCKWASHER, internal, #2
-28	213-0055-00			6	SCREW, thread forming, 2-56 x 3/16 inch, PHS
-29	- - - - - -			1	COIL
	- - - - - -			-	mounting hardware: (not included w/coil)
-30	385-0150-00			1	ROD, spacer, 3/8 x 5/8 inch
	210-0004-00			1	LOCKWASHER, internal, #4
	211-0008-00			1	SCREW, 4-40 x 1/4 inch, PHS
-31	426-0121-00			2	HOLDER, toroid
	- - - - - -			-	mounting hardware for each: (not included w/holder)
	361-0007-00			1	SPACER, plastic, 5/32 inch long
-32	260-0643-00			1	SWITCH, toggle—DISPERSION RANGE
	- - - - - -			-	mounting hardware: (not included w/switch)
	214-0695-00			1	WASHER, key, 0.255 ID x 0.375 inch OD
	210-0562-00			1	NUT, hex., 1/4-40 x 5/16 inch
-33	388-0683-00			1	BOARD, connector
	- - - - - -			-	board includes:
-34	214-0506-00			16	PIN, connector
	- - - - - -			-	mounting hardware: (not included w/board)
-35	213-0088-00			2	SCREW, thread forming, 4-40 x 1/4 inch, PHS
-36	337-0801-00			1	SHIELD
-37	670-0100-00			1	ASSEMBLY, circuit board—SWEEPER
	- - - - - -			-	assembly includes:
	388-0684-00			1	BOARD, circuit
-38	179-1046-00			1	CABLE HARNESS
-39	441-0666-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/assembly)
-40	211-0065-00			16	SCREW, 4-40 x 3/16 inch, PHS
-41	175-0308-00			1	ASSEMBLY, cable, 3.250 inches (J120 to J109)
-42	175-0313-00			1	ASSEMBLY, cable, 4.375 inches (J147 to J151)
-43	175-0358-00			1	ASSEMBLY, cable, 2.812 inches (J501 to J470)
-44	175-0358-00			1	ASSEMBLY, cable, 2.812 inches (J363 to J148)
-45	175-0384-00			1	[1]ASSEMBLY, cable, black band
	175-0384-01			1	[1]ASSEMBLY, cable, brown band
	175-0384-02			1	[1]ASSEMBLY, cable, red band
	175-0384-03			1	[1]ASSEMBLY, cable, orange band
	175-0384-04			1	[1]ASSEMBLY, cable, yellow band

[1]**This is a specially selected cable assembly connected from J370 to J373 and J376 to J379. Replace only with a part bearing the same color band as the original part in your instrument.**

FIG. 2 IF CHASSIS & PHASE LOCK ASSEMBLIES *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
2-46	175-0413-00			1	ASSEMBLY, cable, 8.250 inches (J188 to J401)
-47	337-0803-01			1	SHIELD
-48	386-1032-00			1	PLATE, IF CHASSIS
	- - - - - - -			-	mounting hardware: (not included w/plate)
-49	211-0065-00			16	SCREW, 4-40 x $^3/_{16}$ inch, PHS
-50	211-0105-00			5	SCREW, 4-40 x $^3/_{16}$ inch, FHS
	- - - - - - -			-	mounting hardware: (not included w/assembly)
	211-0507-00			2	SCREW, 6-32 x $^5/_{16}$ inch, PHS (not shown)
	210-0562-00			6	NUT, hex., $^1/_4$-40 x $^5/_{16}$ inch (not shown)
-51	175-0364-00			1	ASSEMBLY, cable, 12.250 inches (J100 to J94)
	644-0020-00			1	ASSEMBLY, PHASE LOCK
	- - - - - - -			-	assembly includes:
-52	131-0352-02			1	CONNECTOR, coaxial, BNC
	- - - - - - -			-	mounting hardware: (not included w/connector)
-53	210-1055-00			1	WASHER, flat, 0.375 ID x 0.500 inch OD
	210-0012-00			1	LOCKWASHER, internal, $^3/_8$ ID x $^1/_2$ inch OD
-54	210-0413-00			1	NUT, hex., $^3/_8$-32 x $^1/_2$ inch
-55	- - - - - - -			1	RESISTOR, variable
	- - - - - - -			-	mounting hardware: (not included w/resistor)
-56	210-1078-00			1	LOCKWASHER, internal, 0.290 ID x 0.500 inch OD
-57	210-0583-00			1	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch
-58	260-0689-00			1	SWITCH, push—LOCK CHECK
	- - - - - - -			-	mounting hardware: (not included w/resistor)
-59	210-0223-00			1	LUG, solder, $^1/_4$ ID x $^7/_{16}$ inch OD, SE
-60	210-0583-00			1	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch
-61	- - - - - - -			1	RESISTOR, variable
	- - - - - - -			-	mounting hardware: (not included w/switch)
-62	210-0583-00			2	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch
-63	220-0455-00			3	NUT, block
	- - - - - - -			-	mounting hardware for each: (not included w/nut)
-64	211-0105-00			1	SCREW, 4-40 x $^3/_{16}$ inch, 100° csk, FHS
-65	220-0455-00			1	NUT, block
	- - - - - - -			-	mounting hardware: (not included w/nut)
-66	211-0065-00			2	SCREW, 4-40 x $^3/_{16}$ inch, PHS
-67	670-1015-00			1	ASSEMBLY, circuit board—PHASE LOCK
	- - - - - - -			-	assembly includes:
	388-1107-00			1	BOARD, circuit
-68	344-0108-00			6	CLIP, diode mounting
-69	352-0041-00			4	HOLDER
-70	136-0252-00			24	SOCKET, pin connector
-71	136-0234-00			2	SOCKET, receptacle
-72	131-0391-00			1	CONNECTOR, coaxial
	- - - - - - -			-	mounting hardware: (not included w/assembly)
-73	211-0065-00			4	SCREW, 4-40 x $^3/_{16}$ inch, PHS

FIG. 2 IF CHASSIS & PHASE LOCK ASSEMBLIES *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
2-74	179-1342-00			1	CABLE HARNESS, circuit board
-75	175-0396-01			1	ASSEMBLY, cable, 6.250 inches
-76	348-0003-00			1	GROMMET, rubber, $^5/_{16}$ inch diameter
-77	388-0688-00			1	BOARD, circuit, connector
	- - - - - -			-	board includes:
-78	214-0507-00			10	PIN, connector
	- - - - - -			-	mounting hardware: (not included w/board)
-79	211-0065-00			4	SCREW, 4-40 x $^3/_{16}$ inch, PHS
-80	220-0455-00			2	NUT, block
-81	337-0797-01			1	SHIELD
	- - - - - -			-	mounting hardware: (not included w/assembly)
	210-0583-00			3	NUT, hex., $^1/_4$-32 x $^5/_{16}$ inch (not shown)
-82	179-1049-00			1	CABLE HARNESS, phase lock chassis
	- - - - - -			-	cable harness includes:
	131-0371-00			9	CONNECTOR, single contact
-83	337-0800-00			1	SHIELD, PHASE LOCK
	- - - - - -			-	mounting hardware: (not included w/shield)
	210-0935-00			1	WASHER, fiber, 0.140 ID x 0.375 inch OD
-84	210-0909-00			1	WASHER, mica, 0.196 ID x 0.625 inch OD
-85	210-0457-00			1	NUT, keps, 6-32 x $^5/_{16}$ inch
-86	213-0138-00			6	SCREW, sheet metal, #4 x $^3/_{16}$ inch, PHS
-87	610-0172-00			1	ASSEMBLY, LOW PASS FILTER, 280 MHz
	- - - - - -			-	mounting hardware: (not included w/assembly)
-88	210-0586-00			2	NUT, keps, 4-40 x $^1/_4$ inch
-89	407-0563-00			1	BRACKET, component
	- - - - - -			-	mounting hardware: (not included w/bracket)
-90	213-0138-00			4	SCREW, sheet metal, #4 x $^3/_{16}$ inch, PHS
-91	352-0071-00			2	HOLDER
	- - - - - -			-	mounting hardware: (not included w/holder)
-92	211-0101-00			1	SCREW, 4-40 x $^1/_4$ inch, 100° csk, FHS
-93	119-0100-00			1	DIPLEXER
	- - - - - -			-	mounting hardware: (not included w/diplexer)
-94	211-0022-00			2	SCREW, 2-56 x $^3/_{16}$ inch, RHS
-95	119-0091-00			1	DIVIDER, resistive
-96	175-0308-00			1	ASSEMBLY, cable, 2 inches (J62 to J80)
-97	175-0308-00			1	ASSEMBLY, cable, 2 inches (J47 to J61)
-98	- - - - - -			1	ASSEMBLY, cable, 6.250 inches (J855 to J42)
	- - - - - -			-	(see FIG. 1 FRONT)
-99	- - - - -			1	ASSEMBLY, cable, 9 inches (J45 to J43)
	- - - - - -			-	(see FIG. 1 FRONT)
-100	108-0437-00			1	R.F. CHOKE

SECTION 8
DIAGRAMS

The following symbols are used on the diagrams:


Screwdriver adjustment


Front panel control or connector


Clockwise control rotation in direction of arrow


Refer to indicated diagram


Connection to circuit board made with pin connector at indicated pin

Blue line encloses components located on circuit board

IMPORTANT

VOLTAGE AND WAVEFORM CONDITIONS

Circuit voltages were measured with a 20,000 Ω/V DC VOM. All readings are in volts and are measured with respect to ground.

Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera, equipped with a projected graticule. Each major division represents one cm.

Voltages and waveforms on the schematics (shown in blue) are not absolute and may vary between instruments. Any apparent differences between voltage levels measured and those shown on the waveforms may be due to circuit loading of the measuring device.

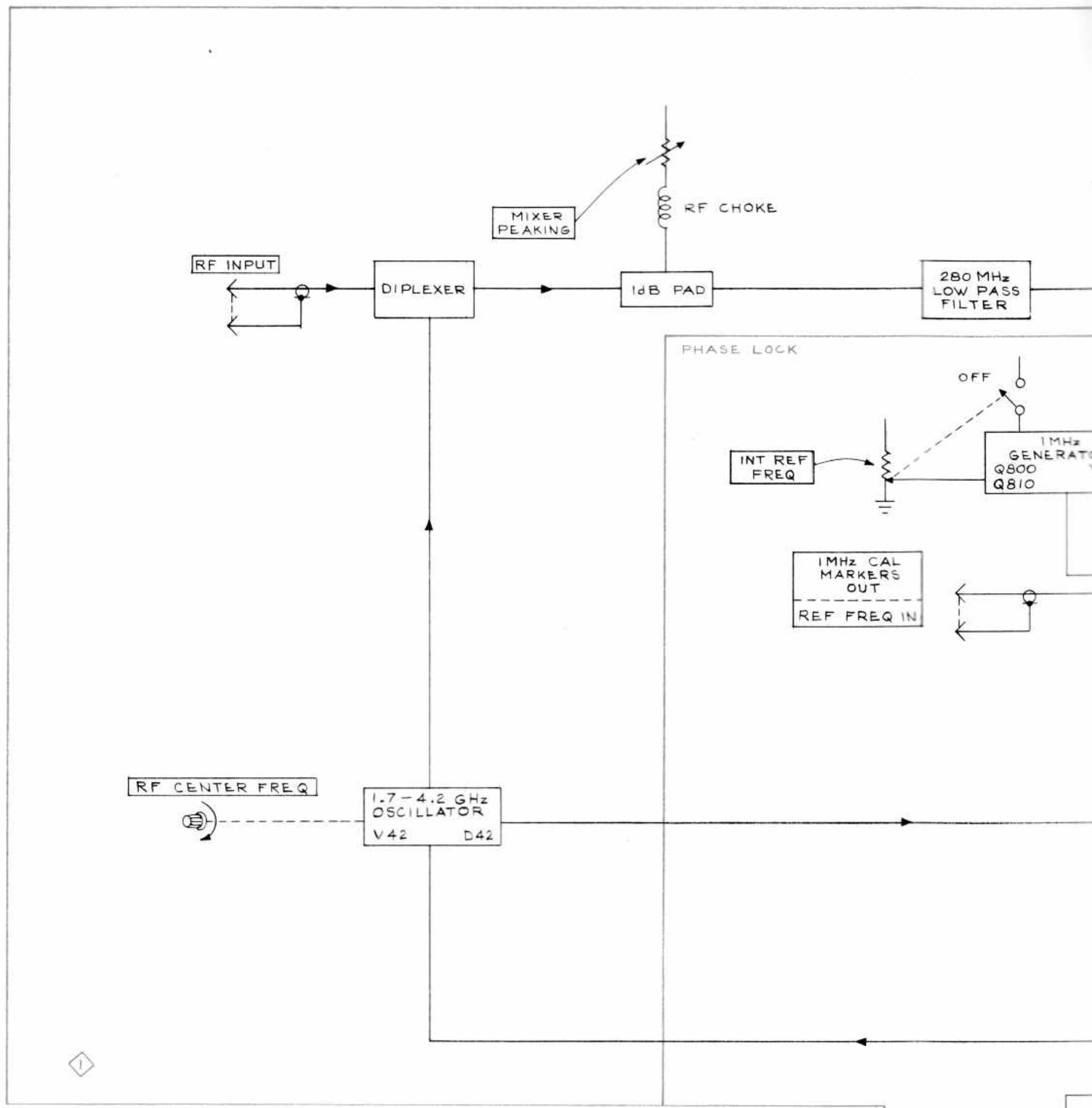
The waveforms were obtained using a Type 545B Oscilloscope, 10× probe and a Type 1A1. The system characteristics are as follows: Minimum vertical deflection of 0.1 V/cm with the 10× probe attenuation factor included. Frequency response - DC to at least 33 MHz.

Controls whose setting will affect a voltage or waveform are listed on the individual diagrams where the effect would be noticed.

Input Signals

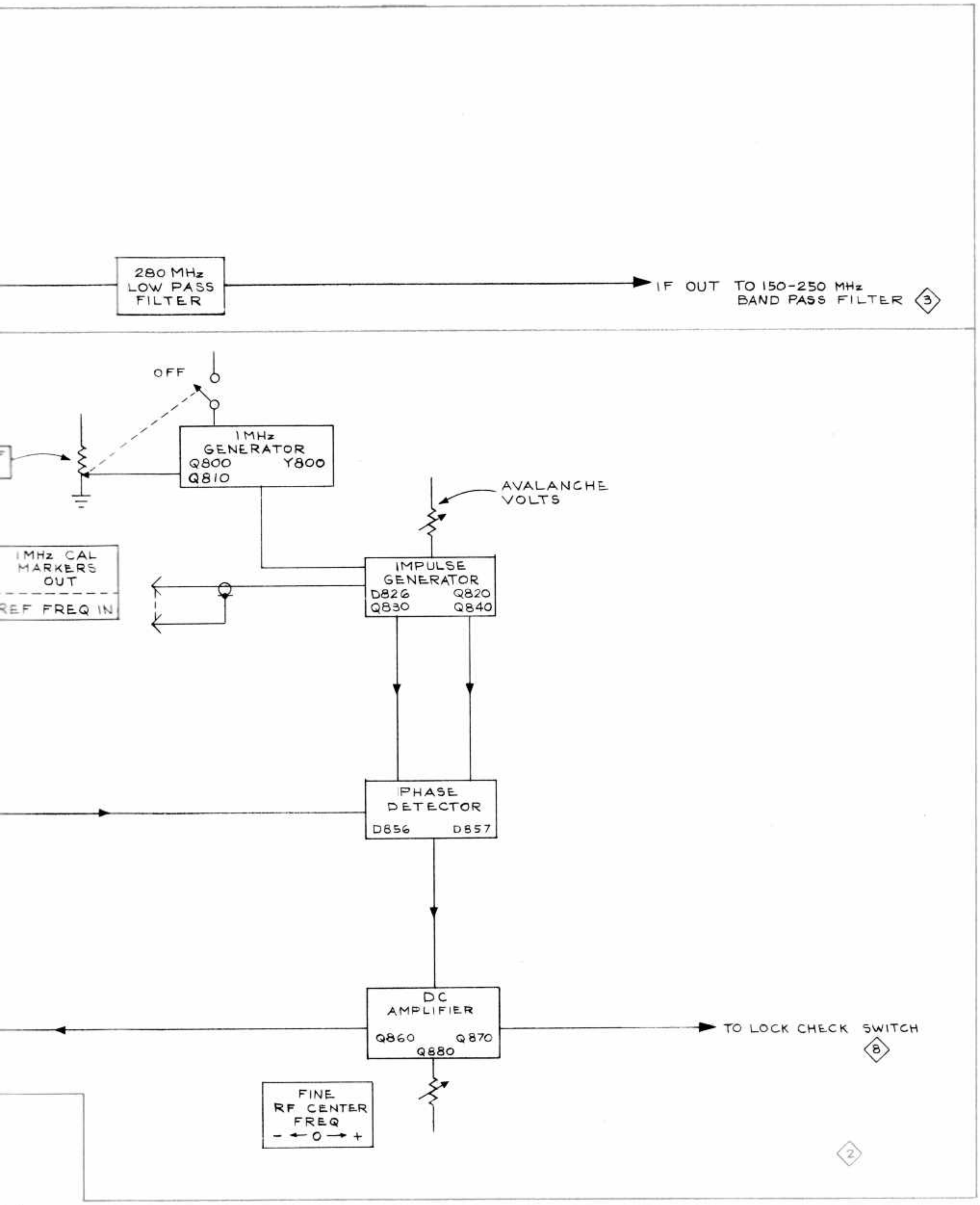
Voltages and Waveforms	200 MHz signal to the RF INPUT connector. Second harmonic of 10 ns time markers was actually used.

(Cont on next diagram)



REFERENCE DIAGRAMS:

- ⟨1⟩ RF SECTION
- ⟨2⟩ PHASE LOCK CIRCUIT
- ⟨3⟩ WIDE BAND AMPLIFIER & MIXER
- ⟨8⟩ OUTPUT AMPLIFIER



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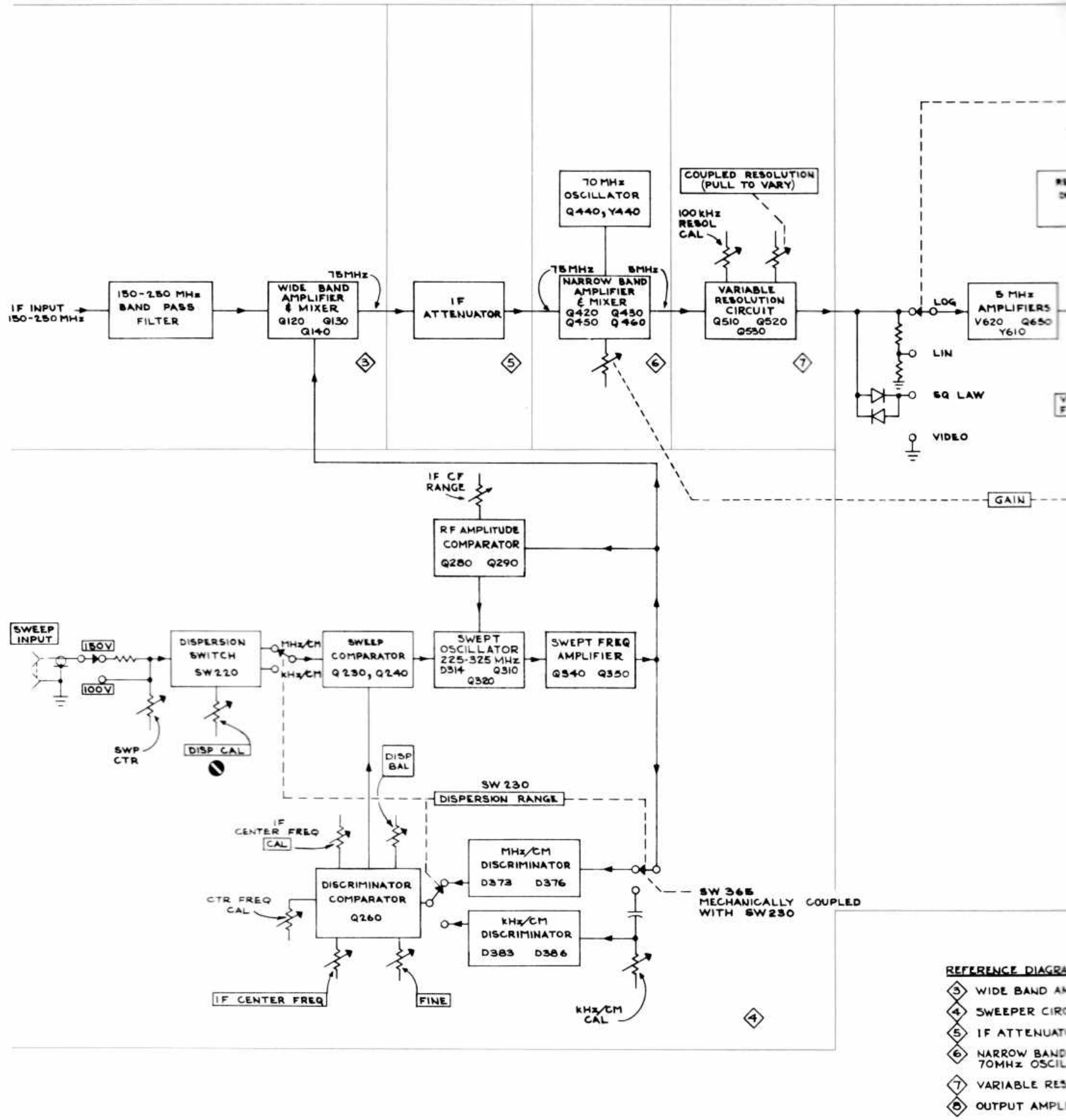
RF & PHASE BLOCK DIAGRAM

TYPE 1L40

POS	Position a free running trace to the bottom line of the graticule.
IF CENTER FREQ	Midrange (000)
FINE	Centered
DISPERSION RANGE	kHz/CM
DISPERSION	100 kHz except for Sweeper Circuits diagram where control setting is noted above waveform.
RESOLUTION	Fully CCW
VIDEO FILTER	OFF
GAIN	Adjusted for full screen display
VERTICAL DISPLAY	LIN
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT 1 MHz REF FREQ	On
MIXER PEAKING	Fully CCW

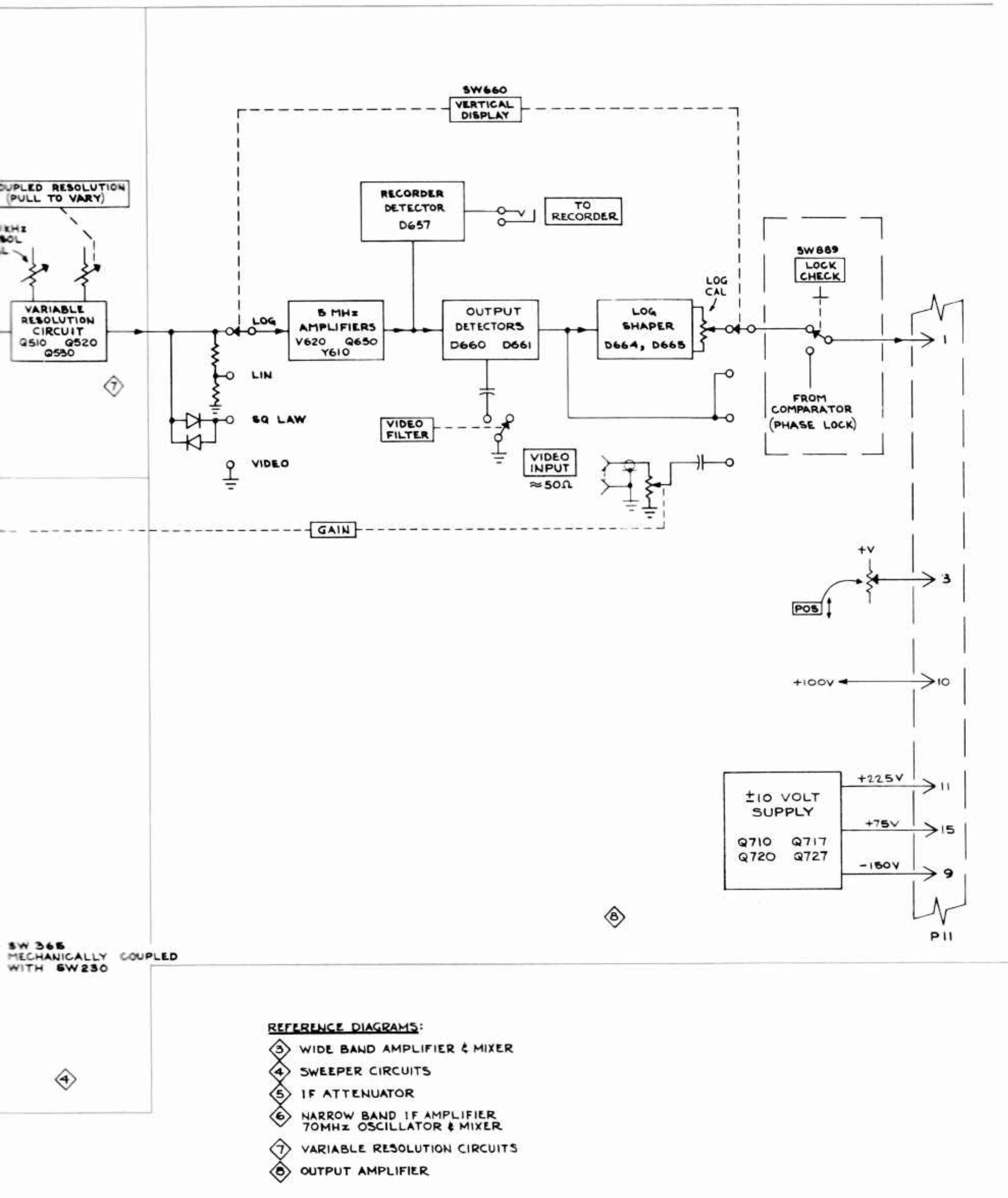
Oscilloscope

Time/Cm	10 ms
Triggering	Adjusted for a free running sweep
Horizontal Position	Centered trace



TYPE 1L40 SPECTRUM ANALYZER

A



REFERENCE DIAGRAMS:

- ③ WIDE BAND AMPLIFIER & MIXER
- ④ SWEEPER CIRCUITS
- ⑤ IF ATTENUATOR
- ⑥ NARROW BAND IF AMPLIFIER 70MHz OSCILLATOR & MIXER
- ⑦ VARIABLE RESOLUTION CIRCUITS
- ⑧ OUTPUT AMPLIFIER

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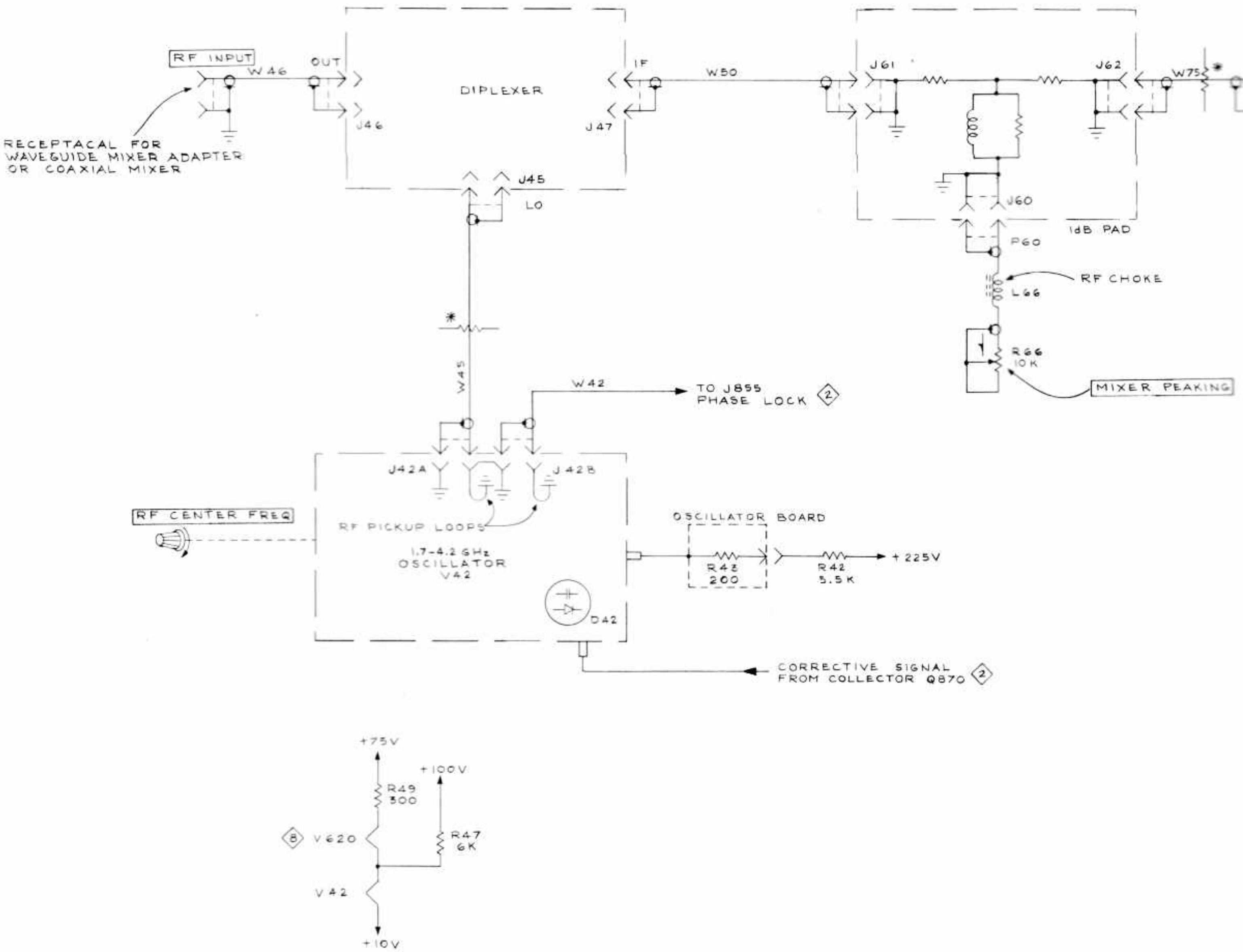
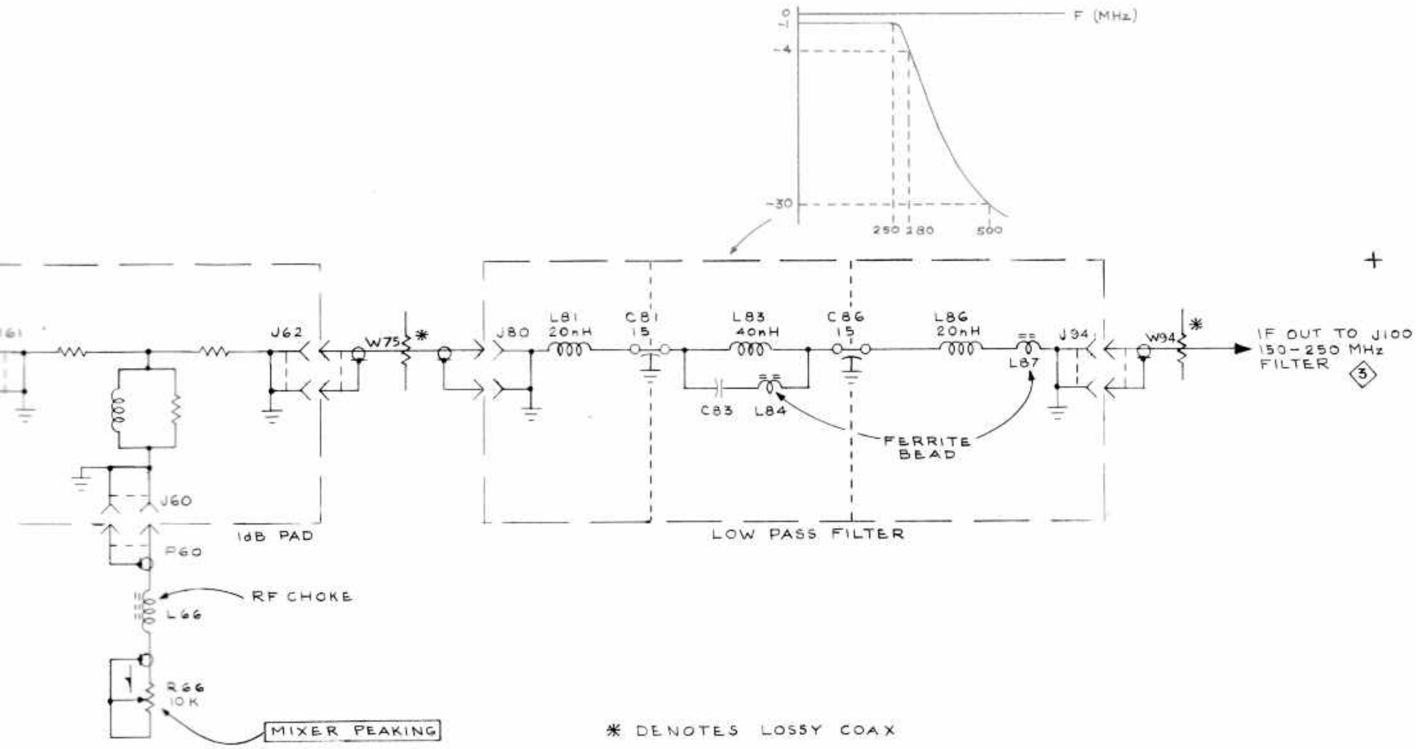
IF SYSTEM BLOCK DIAGRAM

A



TYPE 1L40 SPECTRUM ANALYZER

A



✱ DENOTES LOSSY COAX

REFERENCE DIAGRAMS

2 PHASE LOCK CIRCUIT

3 WIDEBAND AMPLIFIER & MIXER

8 OUTPUT AMPLIFIER

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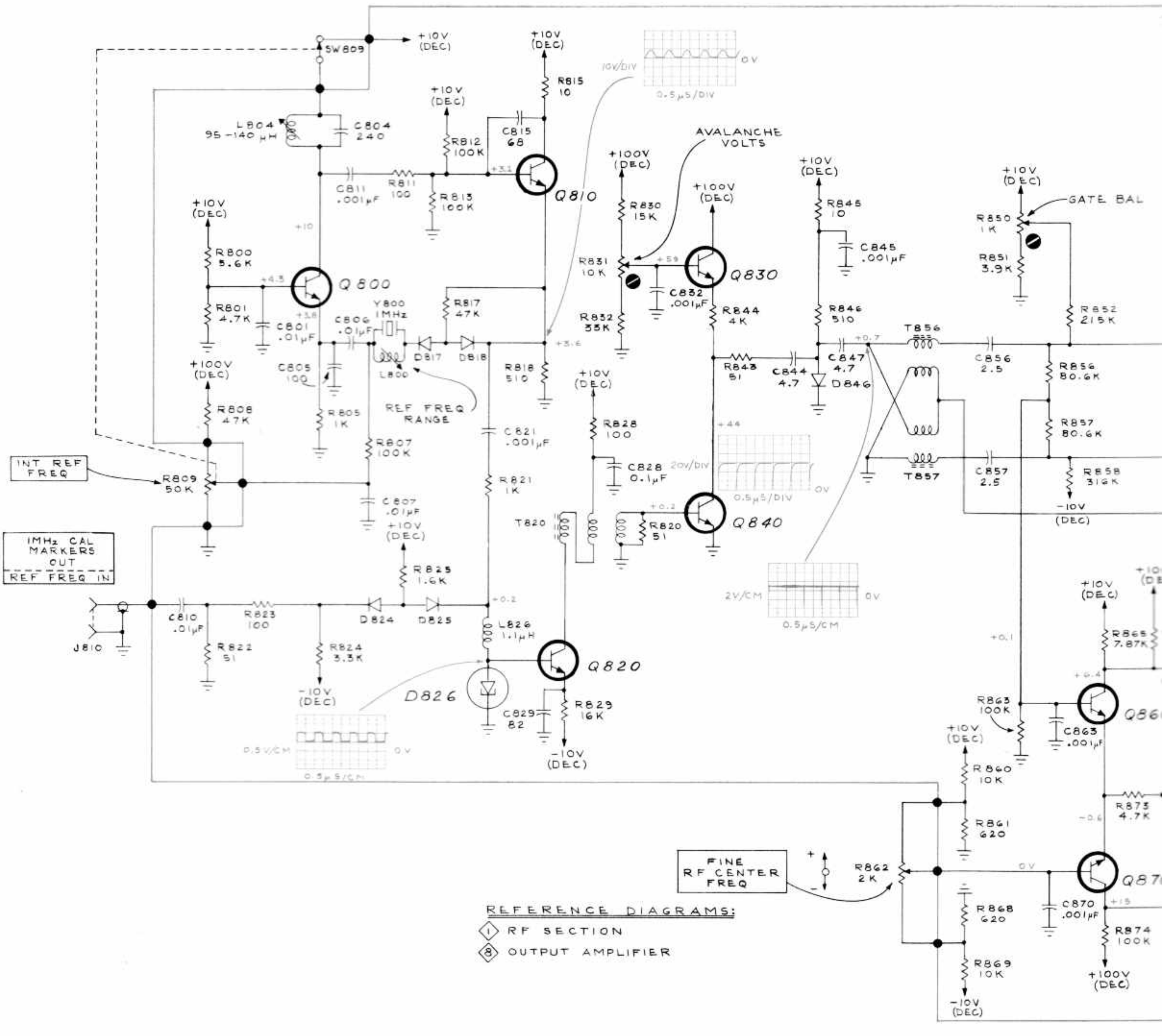
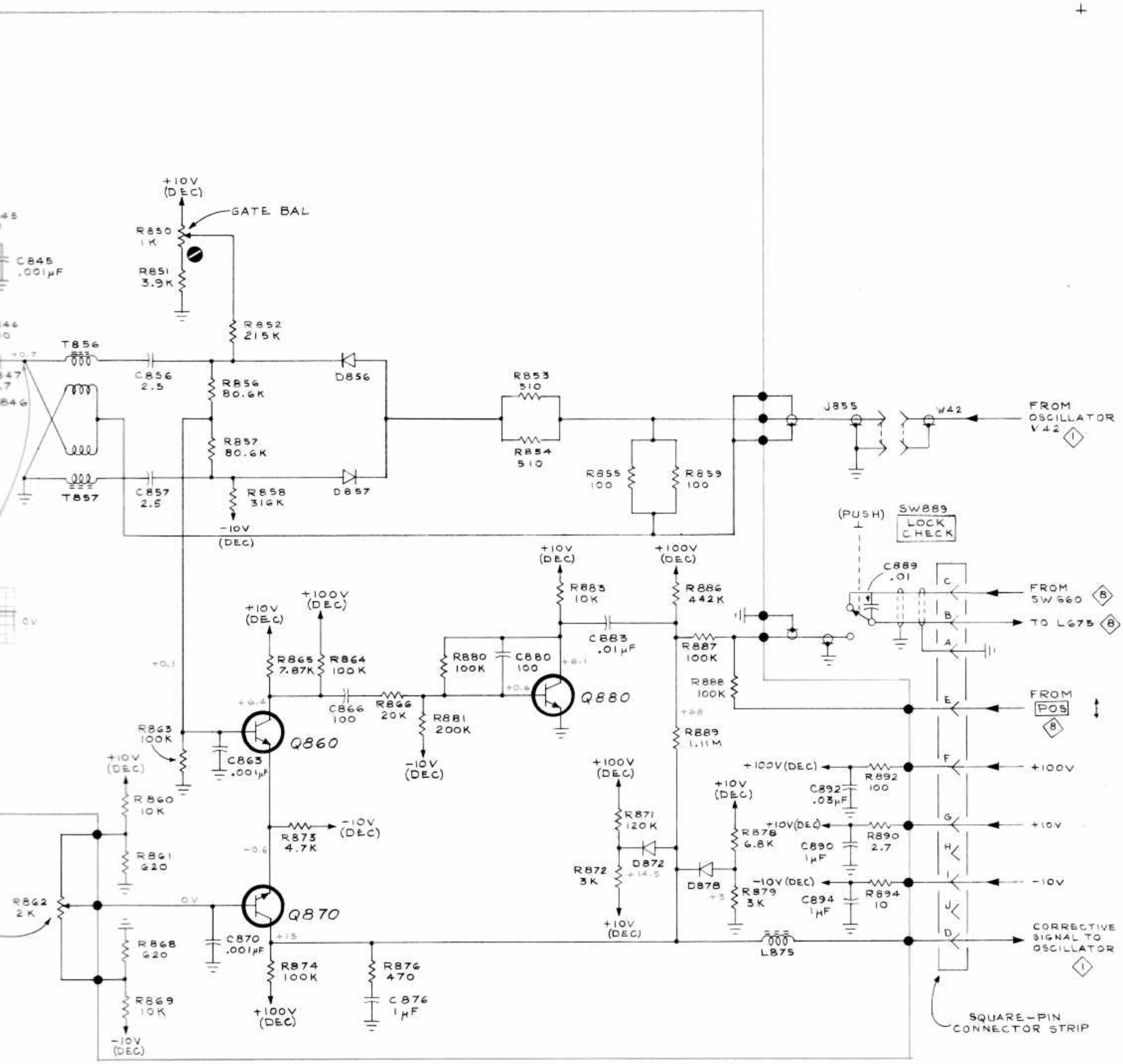
RF SECTION 1

A

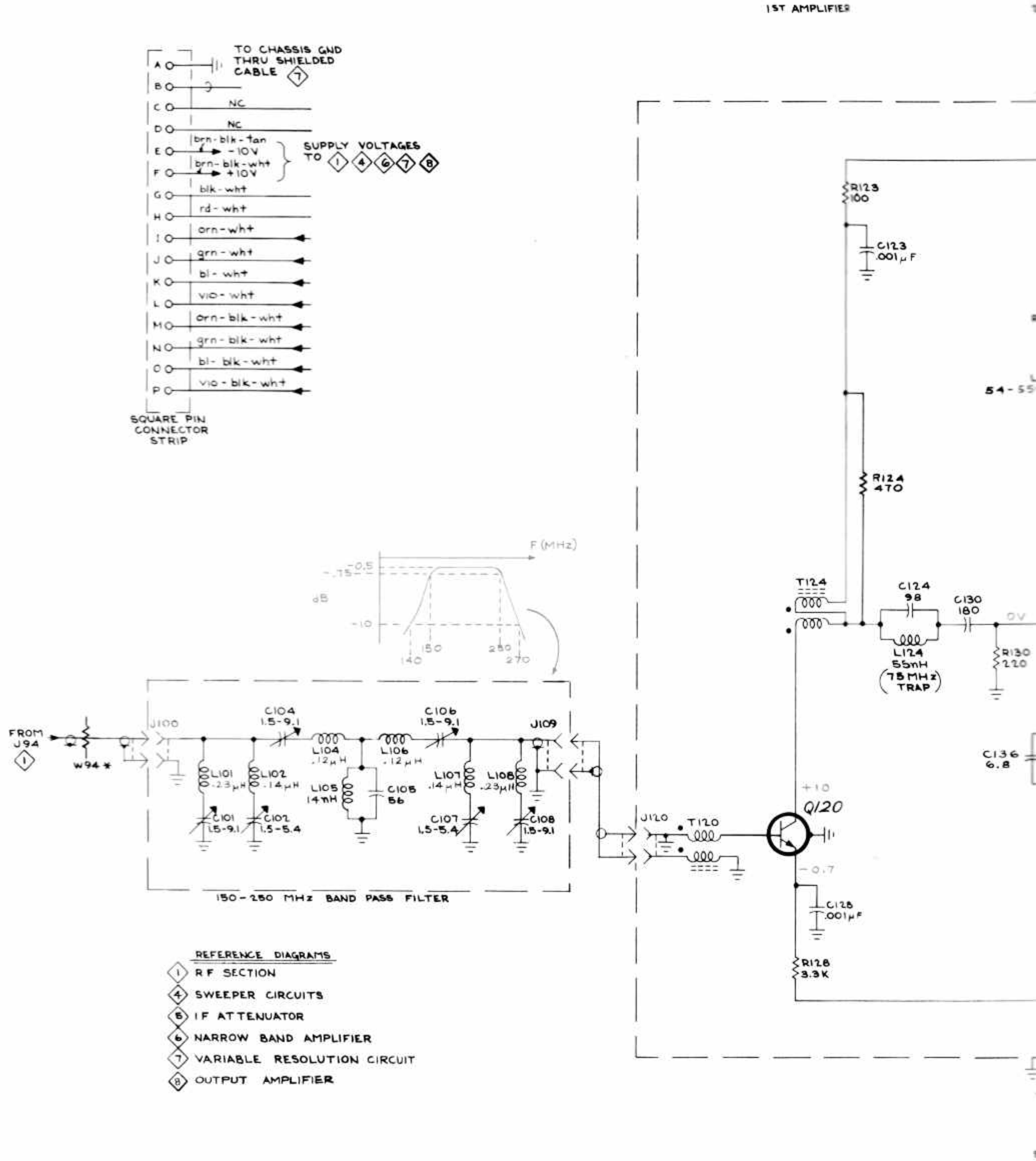

SW809
+10V (DEC)
L804 95-140 μH
C804 240
C811 .001μF
R811 100
R812 100K
R813 100K
C815 68
R815 10
Q810
R800 5.6K
R801 4.7K
C801 .01μF
Q800
Y800 1MHz
C806 .01μF
L800
D817
D818
R817 47K
R818 510
C805 100
R805 1K
R807 100K
C807 .01μF
REF FREQ RANGE
+100V (DEC)
R808 47K
INT REF FREQ
R809 50K
1MHz CAL MARKERS OUT
REF FREQ IN
J810
C810 .01μF
R822 51
R823 100
R824 3.3K
-10V (DEC)
D824
D825
R825 1.6K
C821 .001μF
R821 1K
L826 1.1μH
D826
Q820
C829 82
R829 16K
T820
R828 100
C828 0.1μF
R820 51
Q840
AVALANCHE VOLTS
R830 15K
R831 10K
R832 33K
C832 .001μF
Q830
R844 4K
R843 51
C844 4.7
R845 10
C845 .001μF
R846 510
C847 4.7
D846
T856
T857
C856 2.5
C857 2.5
GATE BAL
R850 1K
R851 3.9K
R852 215K
R856 80.6K
R857 80.6K
R858 316K
R865 7.87K
R863 100K
C863 .001μF
R860 10K
R861 620
FINE RF CENTER FREQ
R862 2K
R868 620
R869 10K
C870 .001μF
R873 4.7K
R874 100K
10V/DIV
0.5μS/DIV
20V/DIV
2V/CM
0.5μS/CM
0.5V/CM
REFERENCE DIAGRAMS:
1 RF SECTION
8 OUTPUT AMPLIFIER

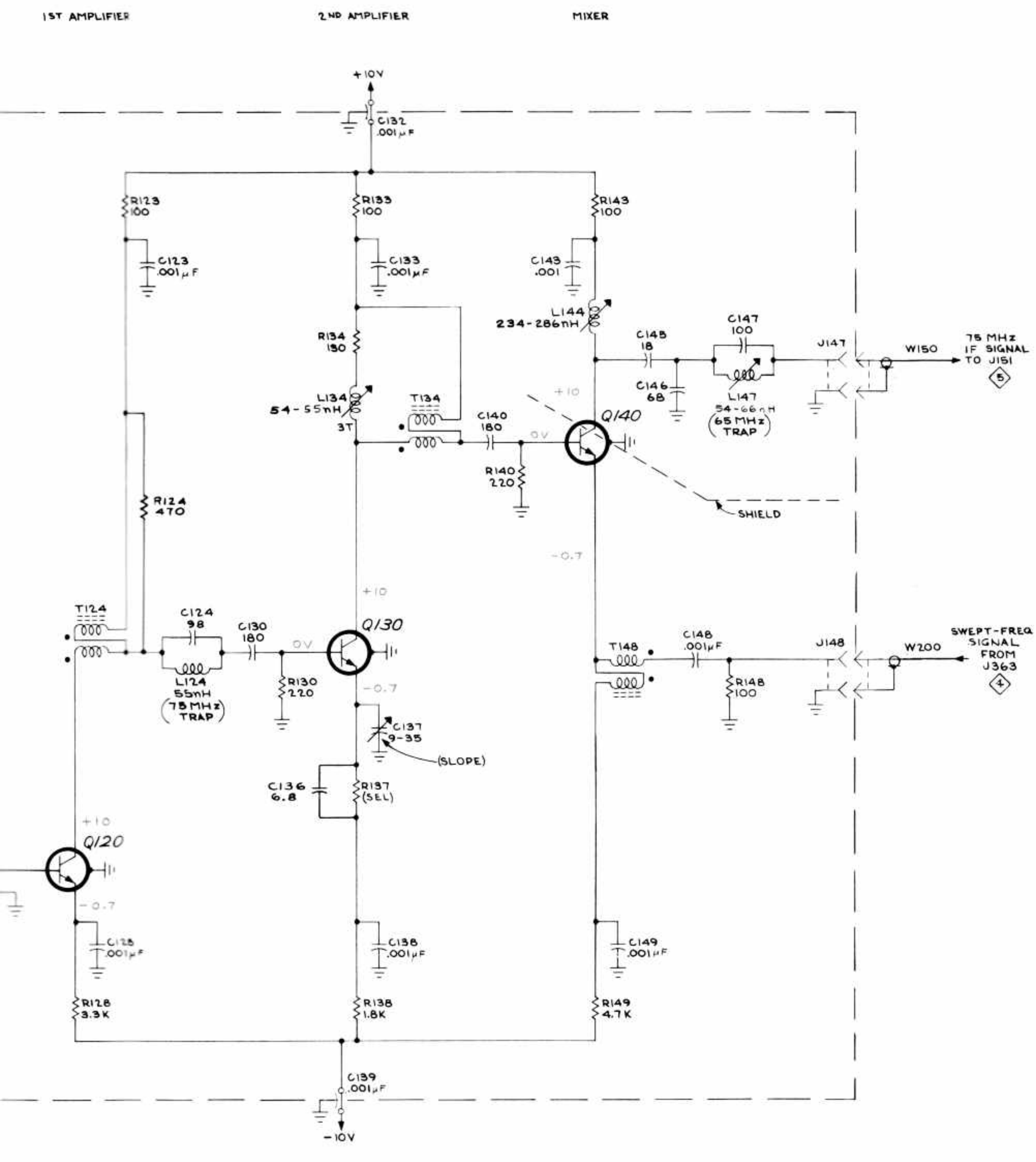


1068

A

PHASE LOCK CIRCUIT ⟨2⟩


1ST AMPLIFIER
TO CHASSIS GND THRU SHIELDED CABLE 7
NC
NC
brn-blk-tan -10V
brn-blk-wht +10V
SUPPLY VOLTAGES TO 1 4 6 7 8
blk-wht
rd-wht
orn-wht
grn-wht
bl-wht
vio-wht
orn-blk-wht
grn-blk-wht
bl-blk-wht
vio-blk-wht
SQUARE PIN CONNECTOR STRIP
R123 100
C123 .001μF
R124 470
F (MHz)
dB
-.5
-.75
-10
140
150
250
270
T124
C124 98
L124 55nH (75 MHz TRAP)
C130 180
0V
R130 220
C136 6.8
FROM J94 1
W94 *
J100
C104 1.5-9.1
L104 .12μH
C106 1.5-9.1
L106 .12μH
J109
L101 .23μH
L102 .14μH
L105 14nH
C105 56
L107 .14μH
L108 .23μH
C101 1.5-9.1
C102 1.5-5.4
C107 1.5-5.4
C108 1.5-9.1
J120
T120
+10
Q120
-0.7
C128 .001μF
R128 3.3K
150-250 MHz BAND PASS FILTER
REFERENCE DIAGRAMS
1 RF SECTION
4 SWEEPER CIRCUITS
5 IF ATTENUATOR
6 NARROW BAND AMPLIFIER
7 VARIABLE RESOLUTION CIRCUIT
8 OUTPUT AMPLIFIER



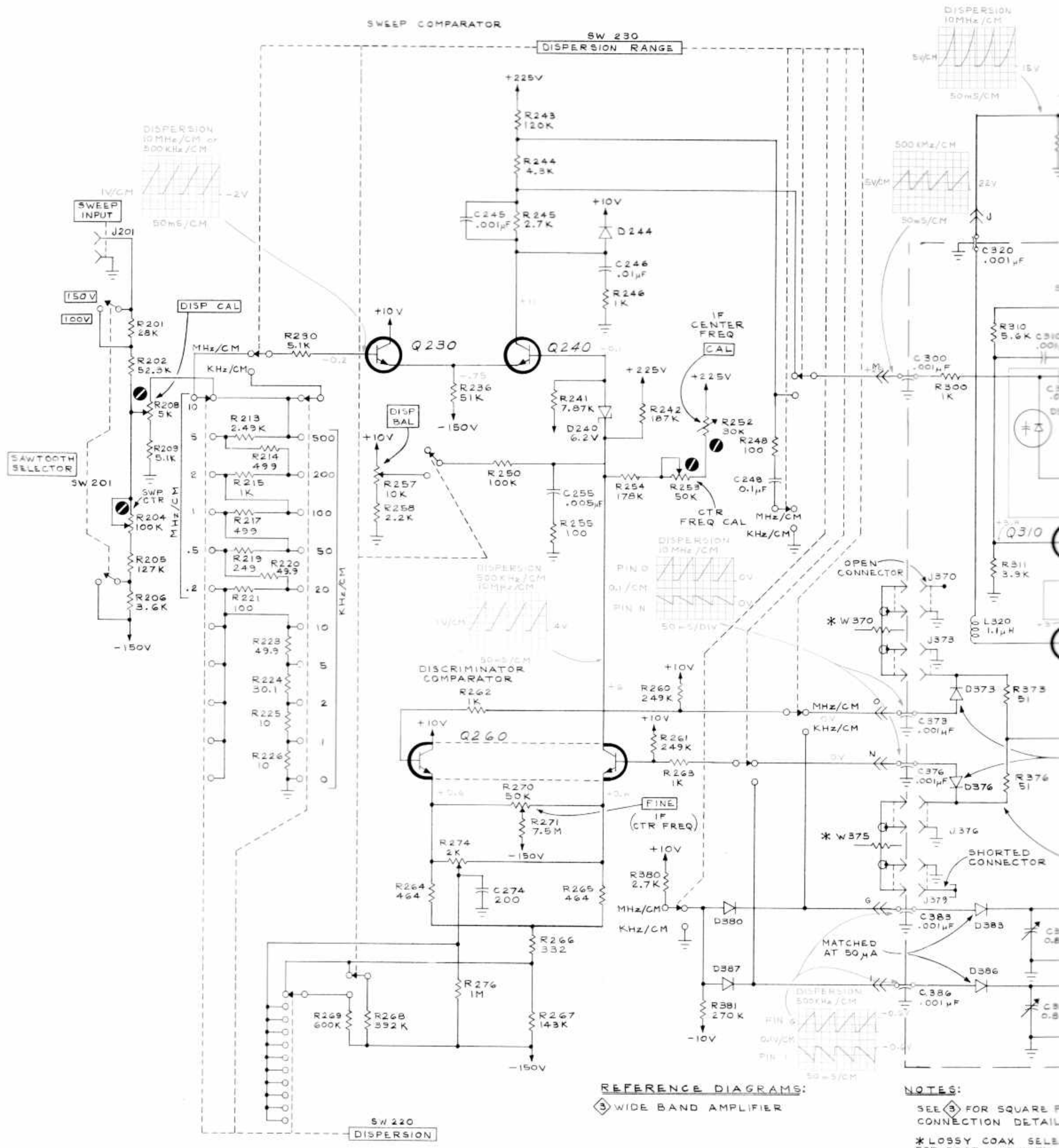
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

* DENOTES LOSSY COAX

A

1068

WIDE BAND AMPLIFIER AND MIXER ③



REFERENCE DIAGRAMS:

(3) WIDE BAND AMPLIFIER

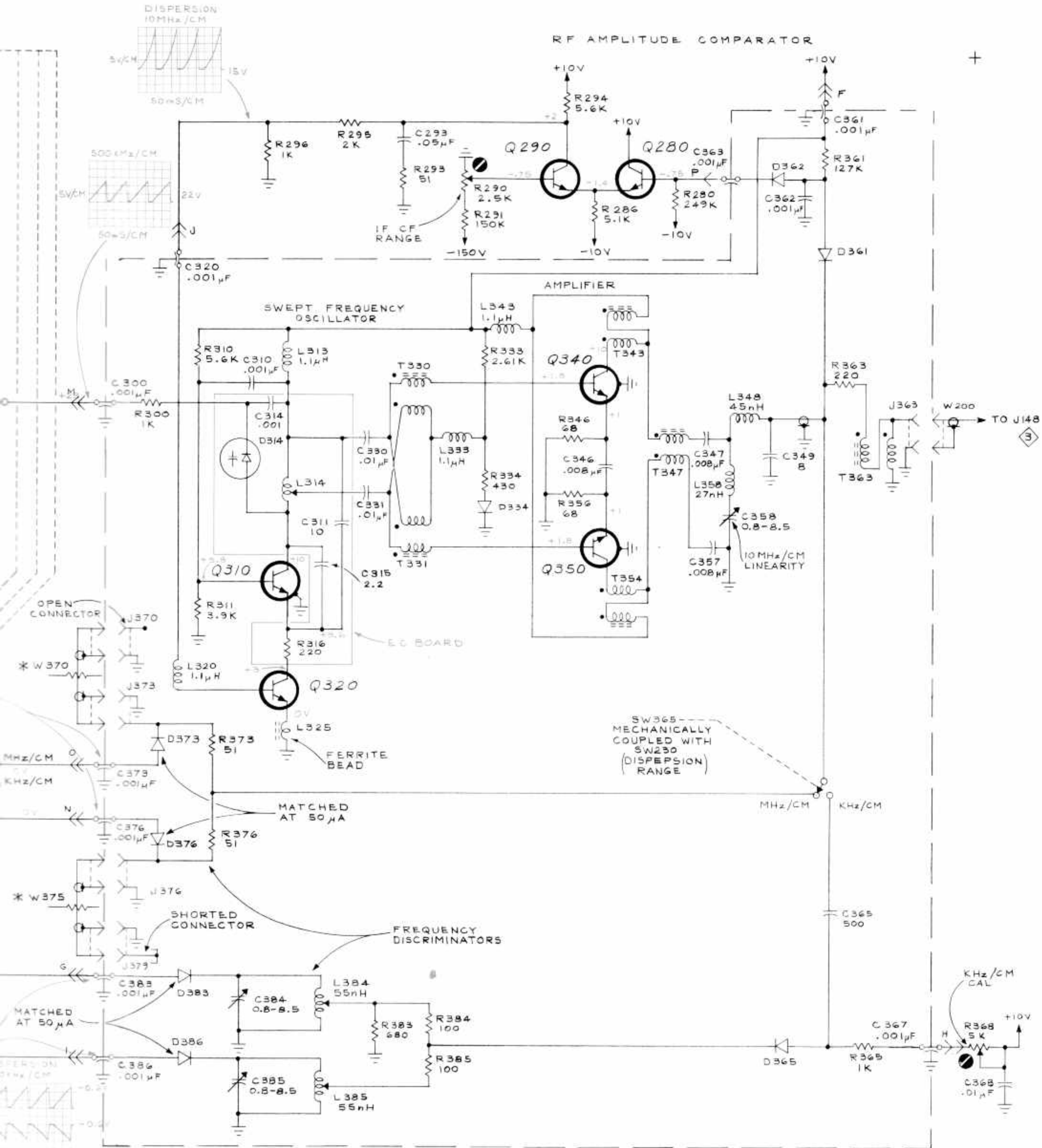
NOTES:

SEE (3) FOR SQUARE F
CONNECTION DETAIL

* LOSSY COAX SELE
FOR BEST LINEARITY
DISCRIMINATOR

TYPE 1L40 SPECTRUM ANALYSER

A



NOTES:

SEE ③ FOR SQUARE PIN CONNECTION DETAILS

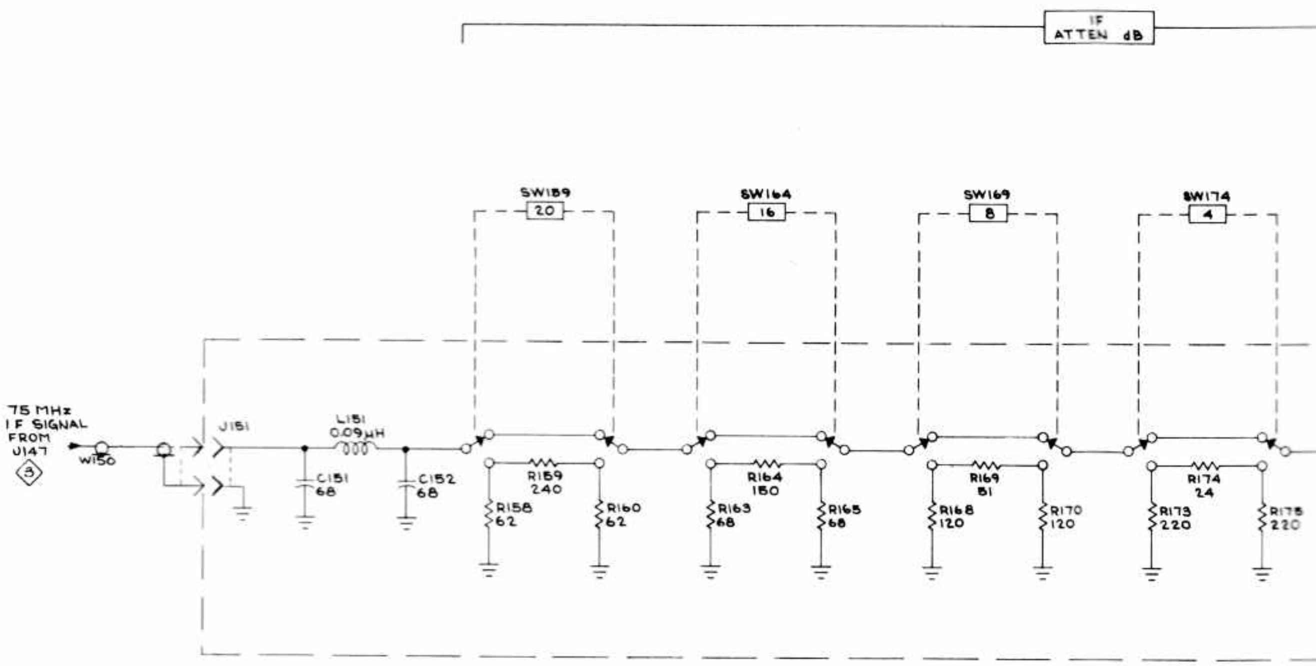
* LOSSY COAX SELECTED FOR BEST LINEARITY OF DISCRIMINATOR

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

1068

SWEEPER CIRCUIT ④

A



REFERENCE DIAGRAMS

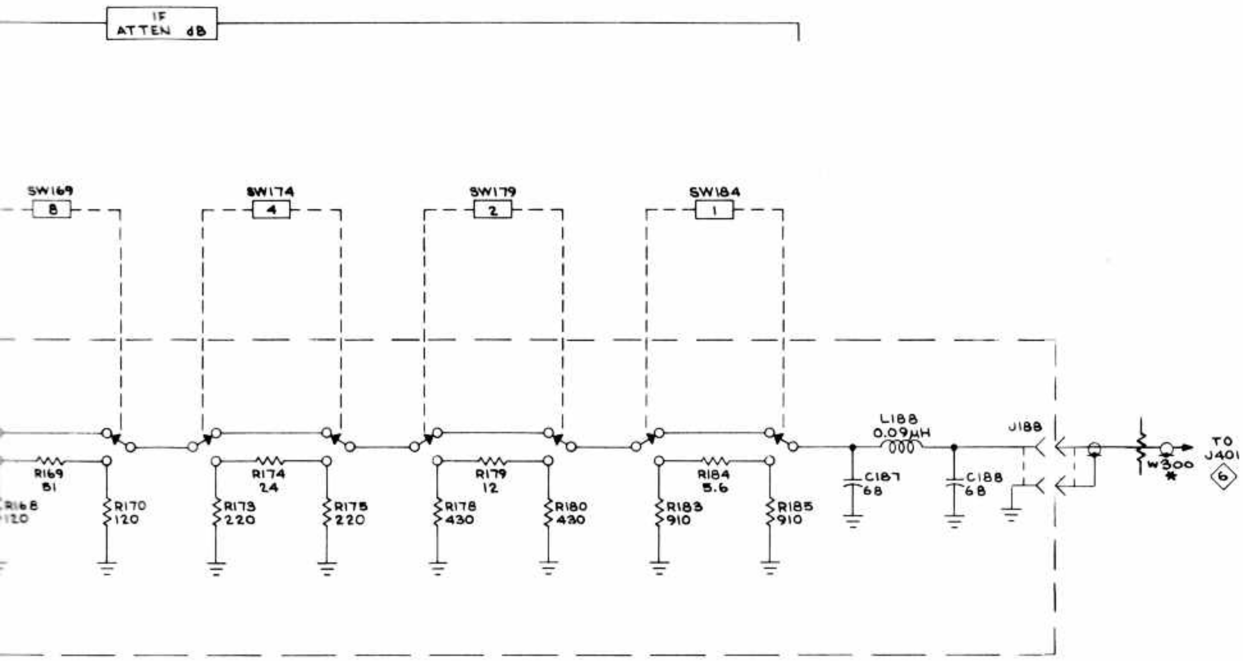
(3) WIDE BAND AMPLIFIER & MIXER

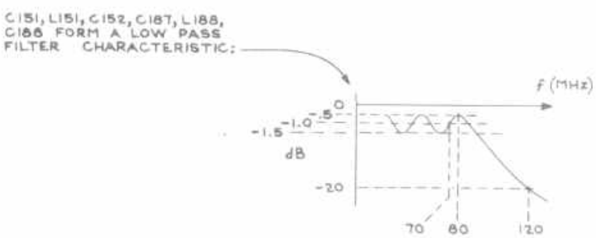
(6) NARROW BAND IF AMPLIFIER 70MHz OSCILLATOR & MIXER

* DENOTES LOSSY COAX

TYPE 1L40 SPECTRUM ANALYZER

A

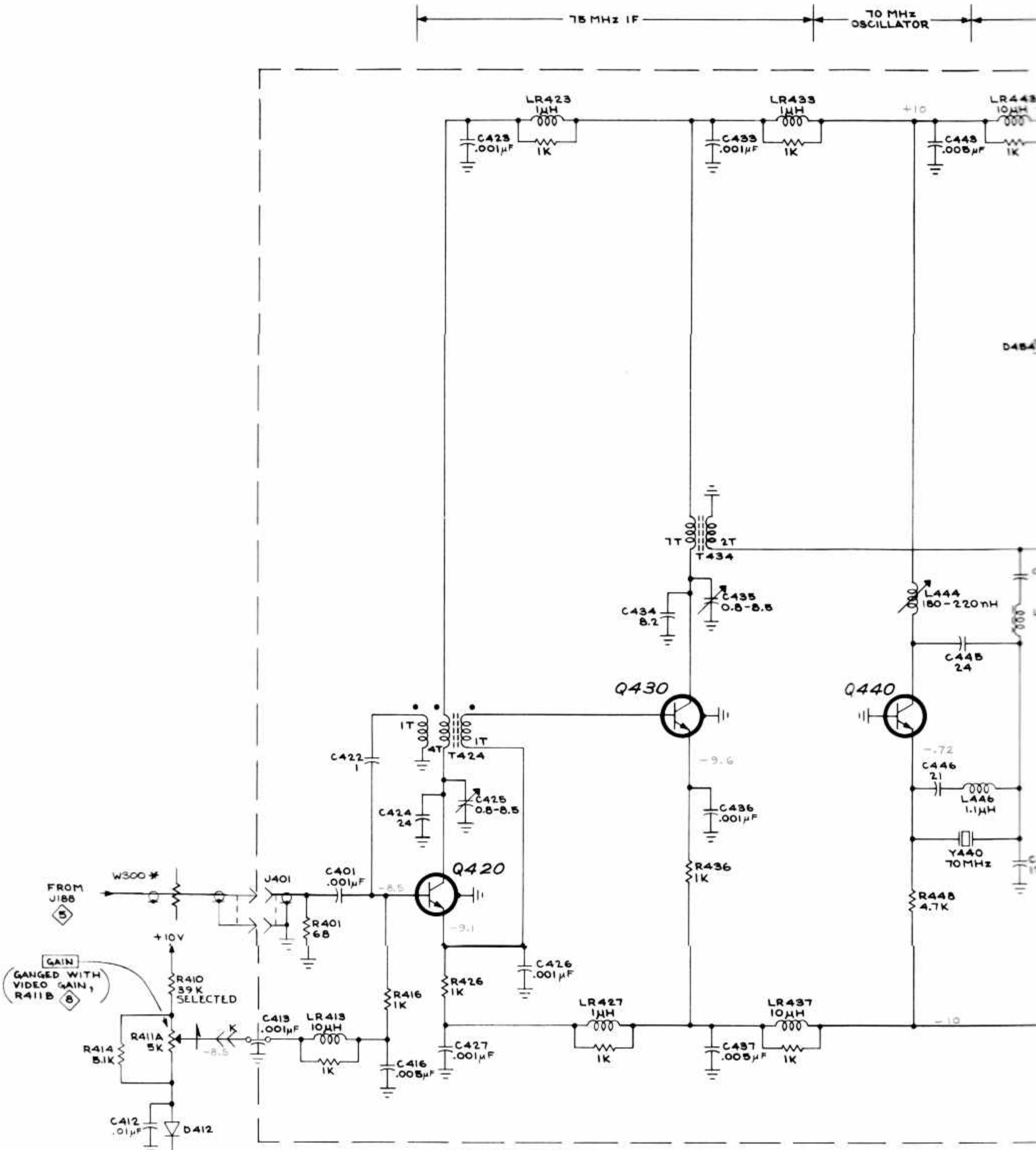




1068

IF ATTENUATOR ⑤

A



REFERENCE DIAGRAMS

⑤ WIDE BAND AMPLIFIER & MIXER

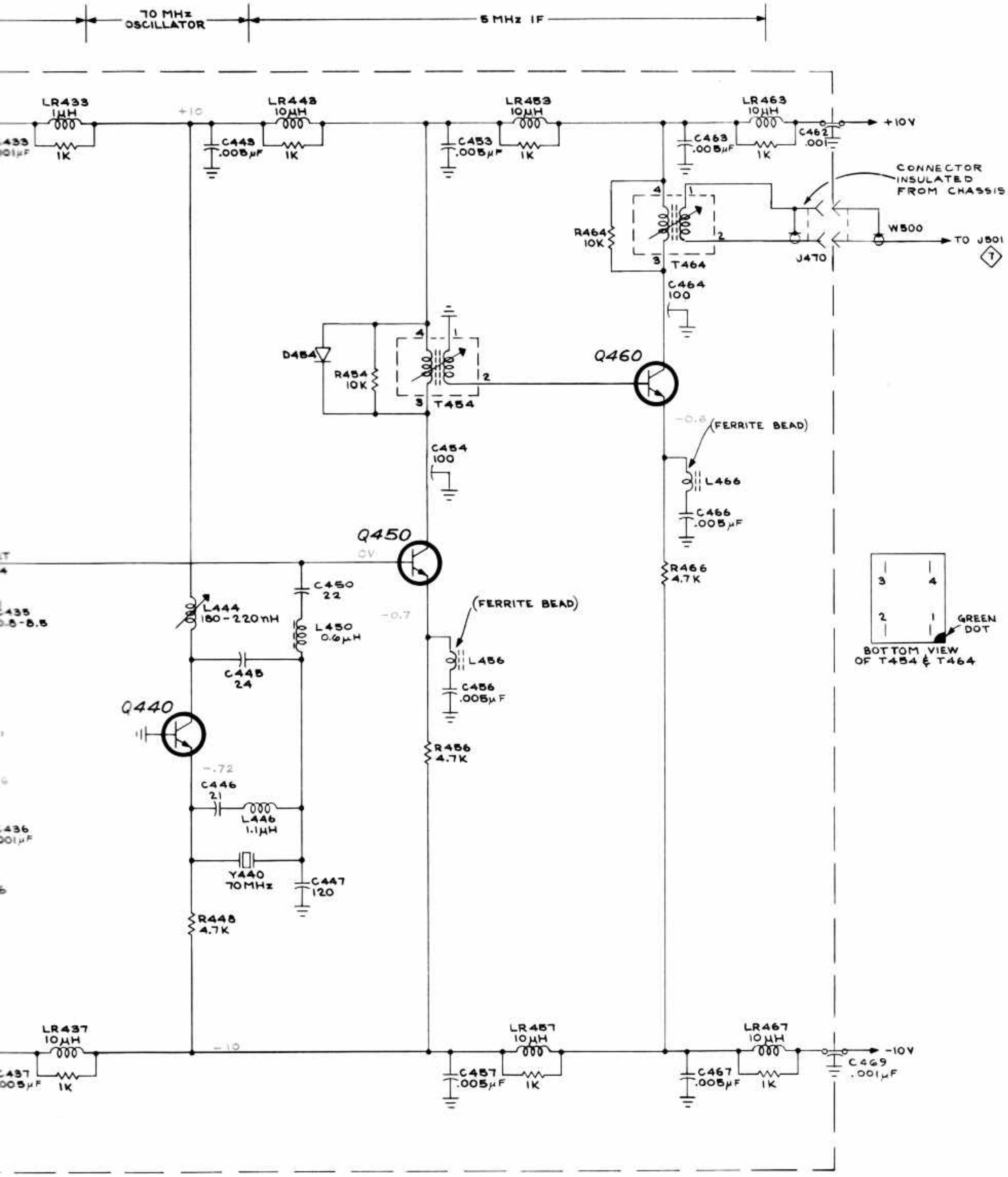
⑥ IF ATTENUATOR

⑦ VARIABLE RESOLUTION CIRCUITS

⑧ OUTPUT AMPLIFIER

TYPE 1L40 SPECTRUM ANALYZER

A



NOTES:

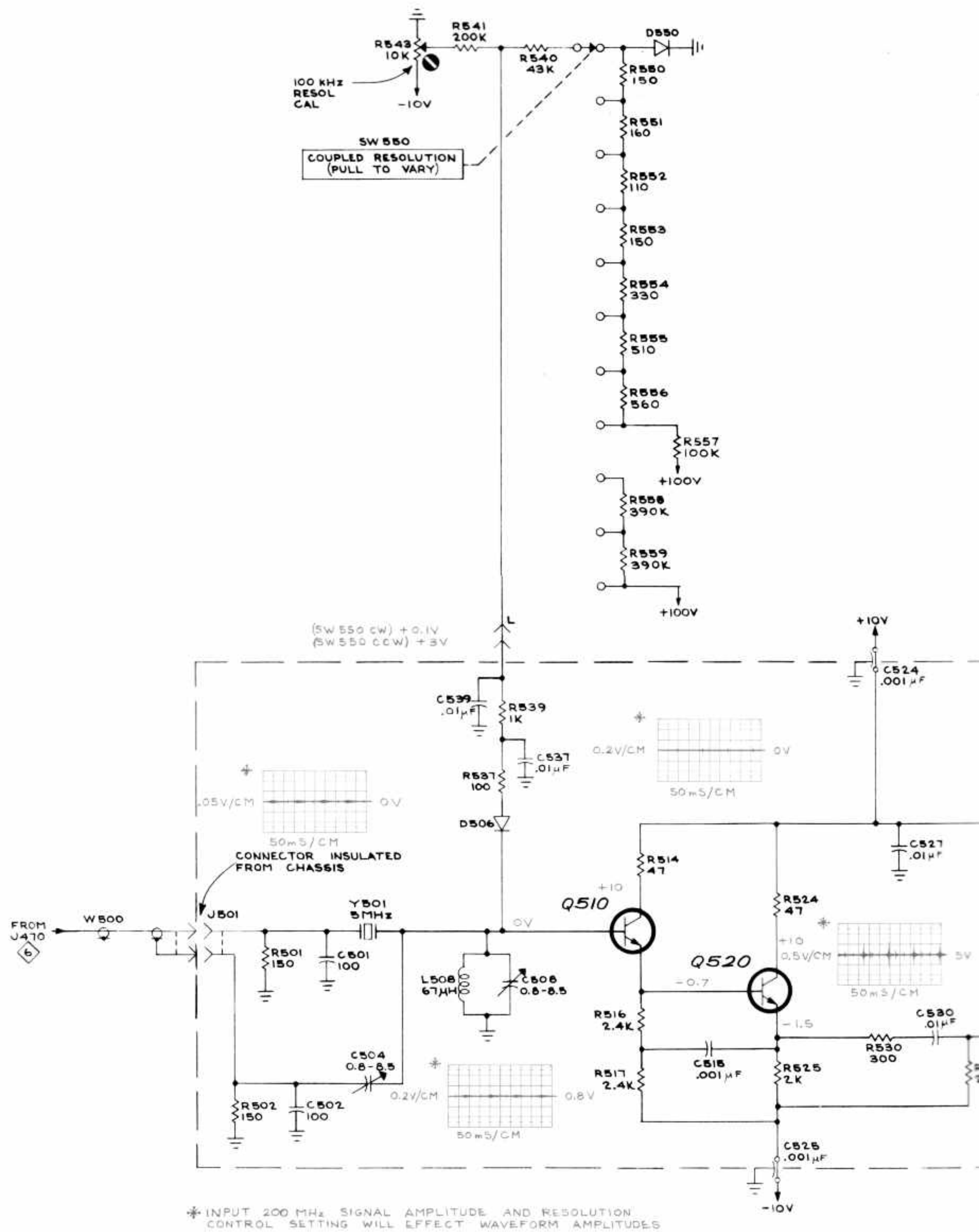
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

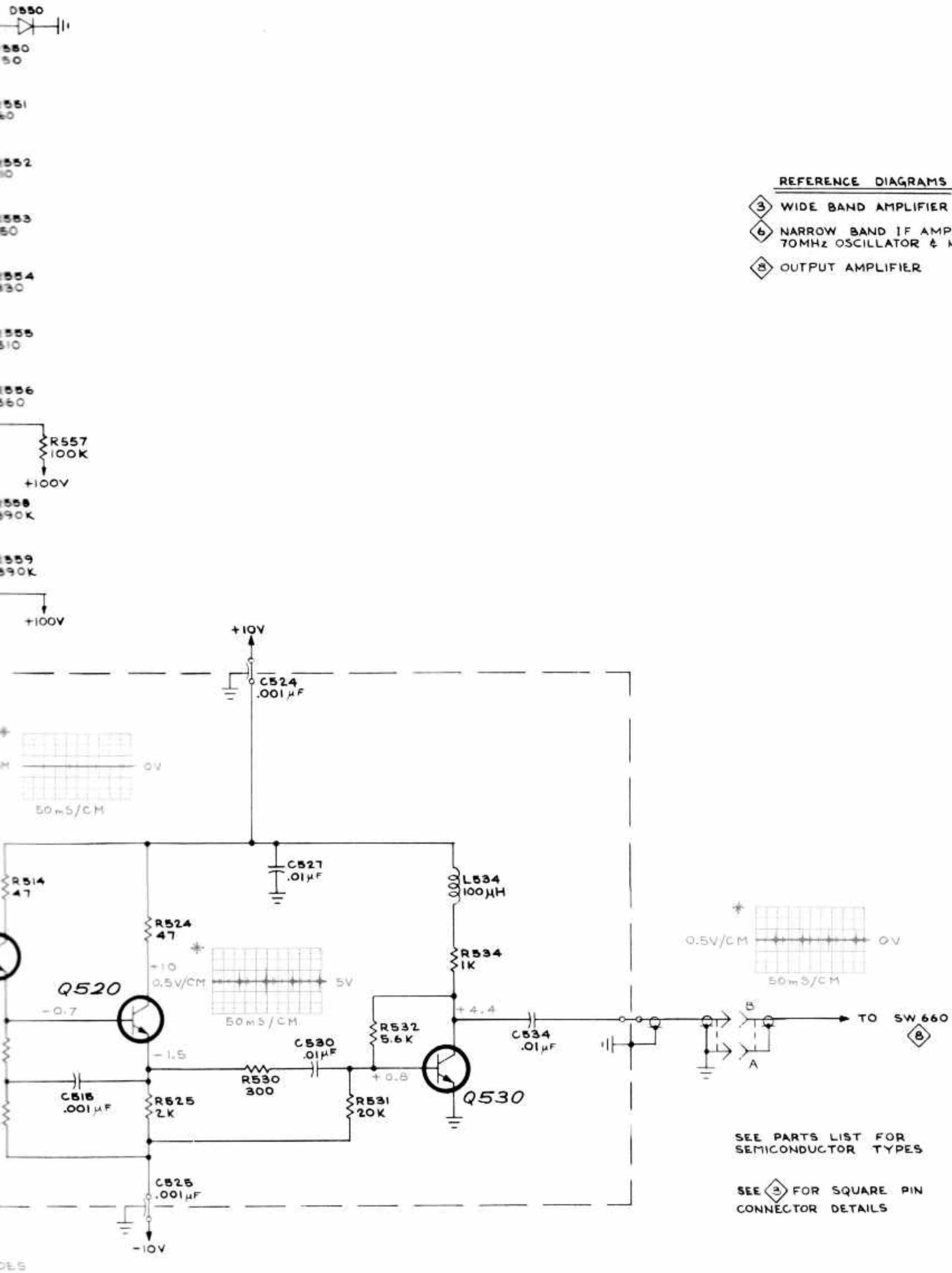
SEE ③ FOR SQUARE PIN CONNECTOR DETAILS

* DENOTES LOSSY COAX

1068

NARROW BAND IF AMPLIFIER
70MHz OSCILLATOR & MIXER ⑥


R543
10K
100 kHz
RESOL
CAL
-10V
R541
200K
R540
43K
D550
R550
150
R551
160
R552
110
R553
150
R554
330
R555
510
R556
560
R557
100K
+100V
R558
390K
R559
390K
+100V
SW550
COUPLED RESOLUTION
(PULL TO VARY)
(SW 550 CW) +0.1V
(SW 550 CCW) +3V
L
+10V
C524
.001μF
C539
.01μF
R539
1K
C537
.01μF
R537
100
D506
0.2V/CM
0V
50mS/CM
.05V/CM
0V
50mS/CM
CONNECTOR INSULATED
FROM CHASSIS
FROM
J470
6
W500
J501
Y501
5MHz
R501
150
C501
100
0V
L508
67μH
C508
0.8-8.5
R514
47
+10
Q510
Q520
-0.7
R524
47
C527
.01μF
+10
0.5V/CM
5V
50mS/CM
R516
2.4K
R517
2.4K
C518
.001μF
-1.5
R530
300
C530
.01μF
R525
2K
C504
0.8-8.5
R502
150
C502
100
0.2V/CM
0.8V
50mS/CM
C525
.001μF
-10V
INPUT 200 MHz SIGNAL AMPLITUDE AND RESOLUTION
CONTROL SETTING WILL EFFECT WAVEFORM AMPLITUDES



REFERENCE DIAGRAMS

⟨3⟩ WIDE BAND AMPLIFIER & MIXER

⟨6⟩ NARROW BAND IF AMPLIFIER 70MHz OSCILLATOR & MIXER

⟨8⟩ OUTPUT AMPLIFIER

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE ⟨3⟩ FOR SQUARE PIN CONNECTOR DETAILS

A

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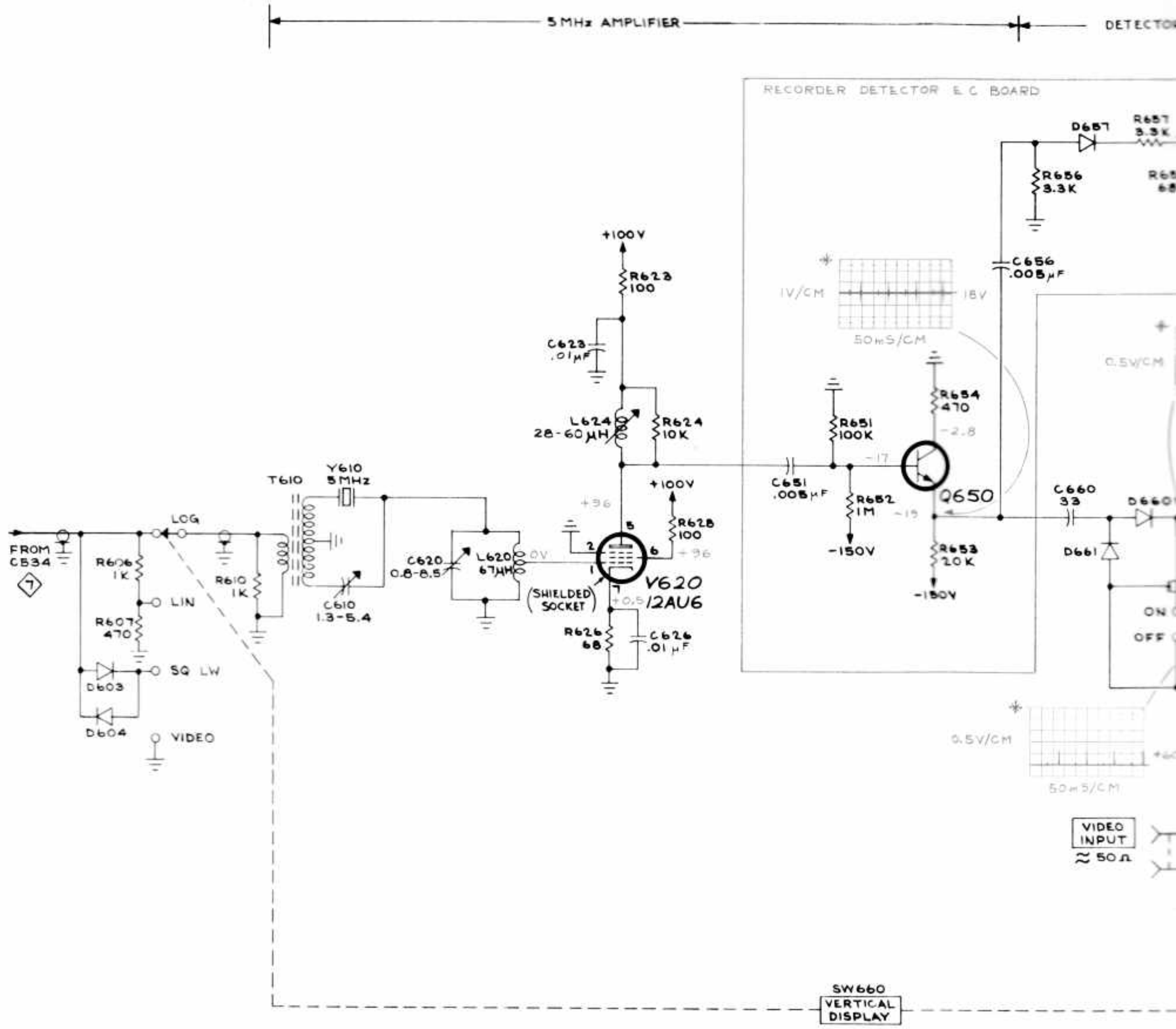
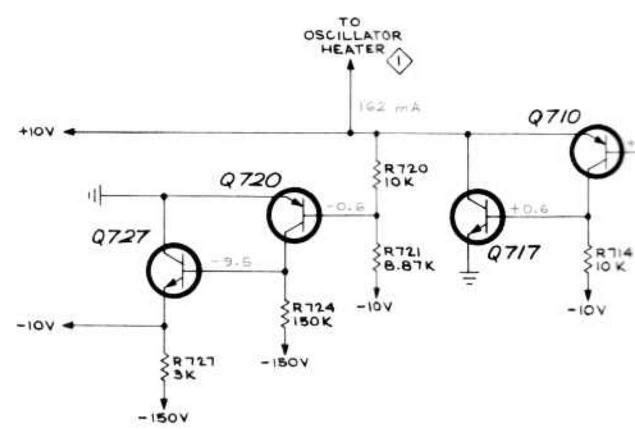
VARIABLE RESOLUTION CIRCUITS ⟨7⟩

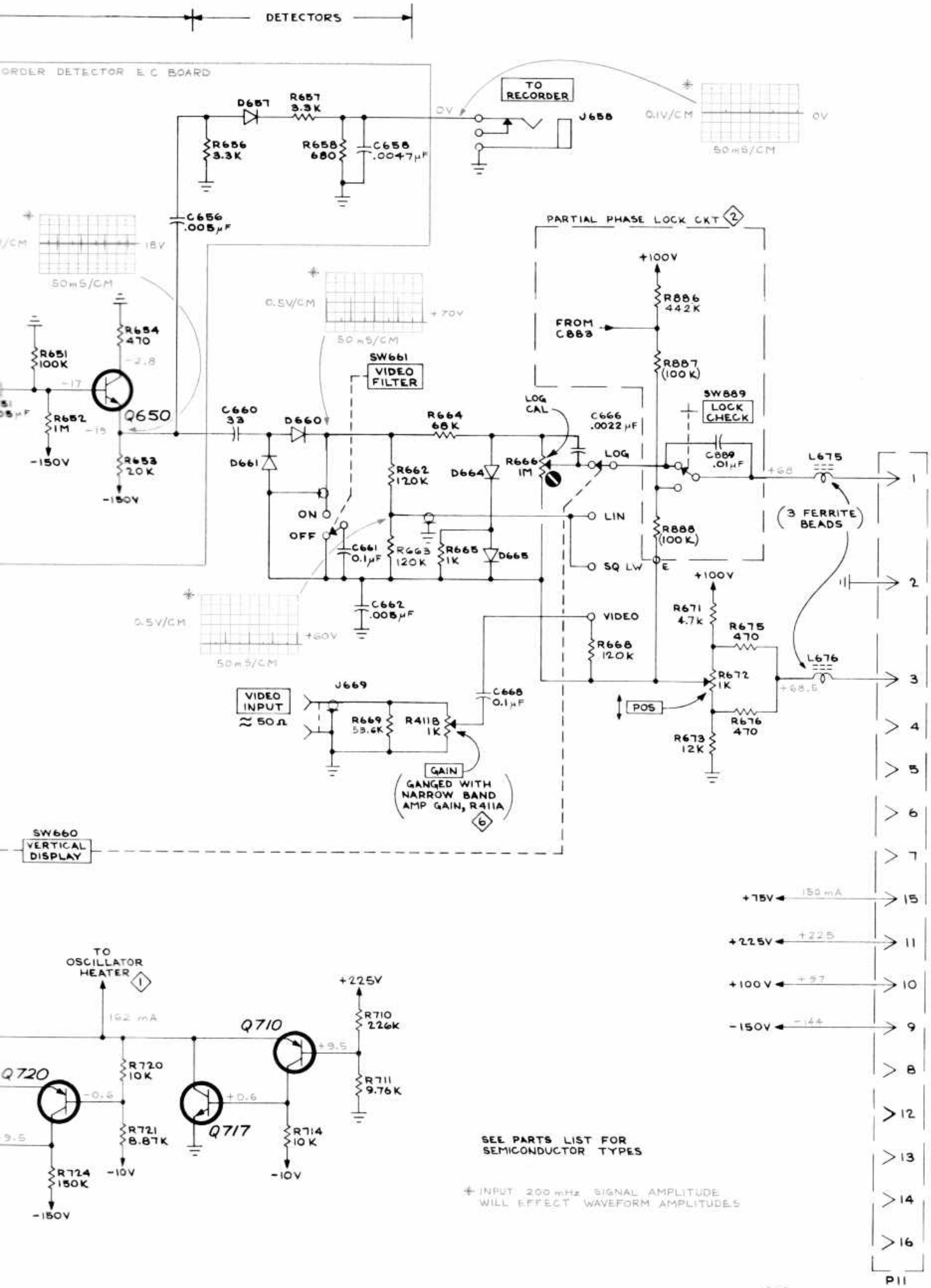


REFERENCE DIAGRAMS

1. RF SECTION
2. PHASE LOCK CIRCUIT
6. NARROW BAND IF AMPLIFIER 70MHz OSCILLATOR & MIXER
7. VARIABLE RESOLUTION CIRCUITS

NOTE:
DECOUPLING NETWORKS IN THE OSCILLOSCOPE CAUSE SEVERAL OF THE B+ AND B- SUPPLIES TO READ SEVERAL VOLTS LOW. THIS IS NORMAL AND DOES NOT INDICATE TROUBLE IN THE ANALYZER.





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A

OUTPUT AMPLIFIER ⑧

FIG. 1 FRONT & REAR

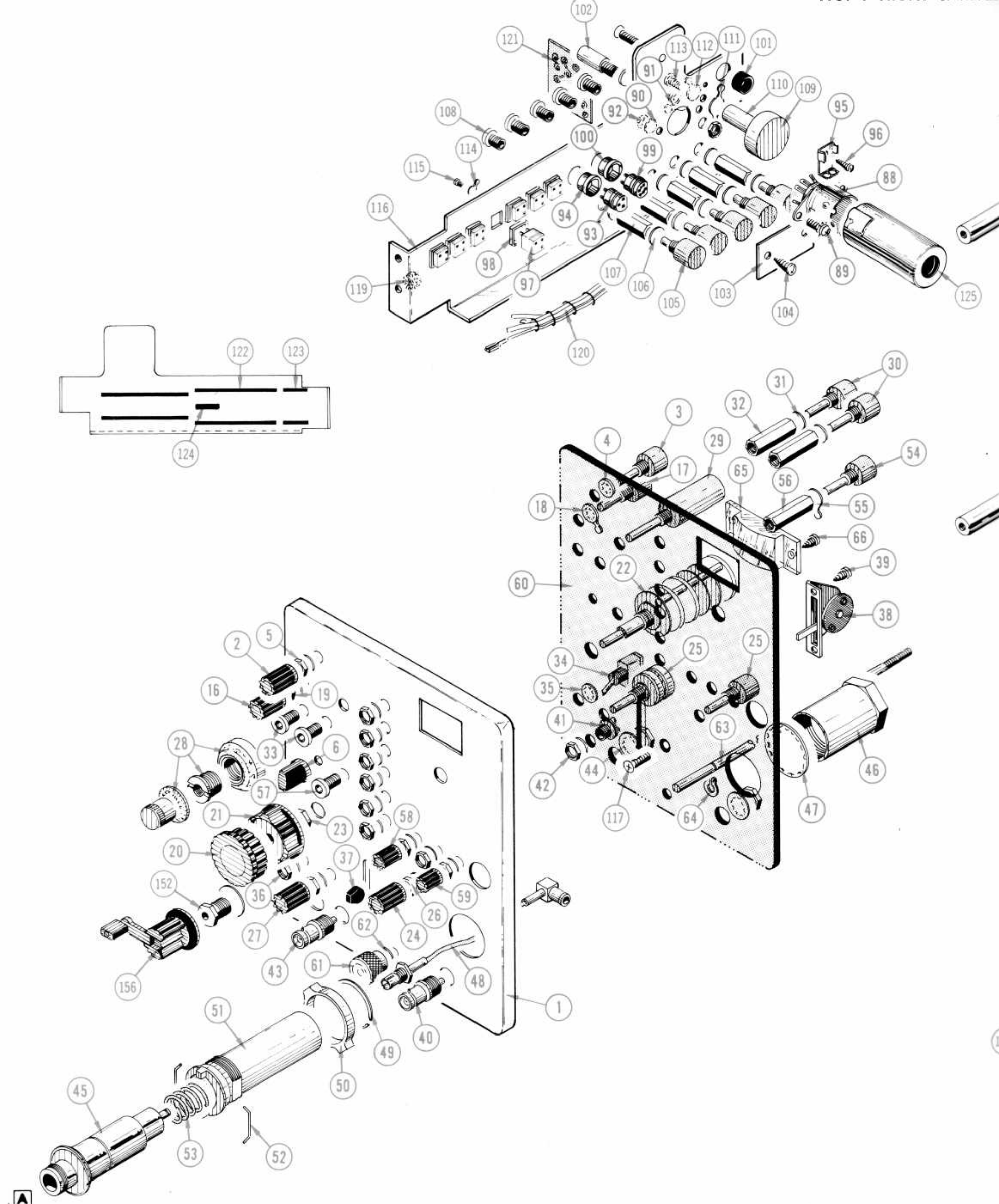


FIG. 1 FRONT & REAR

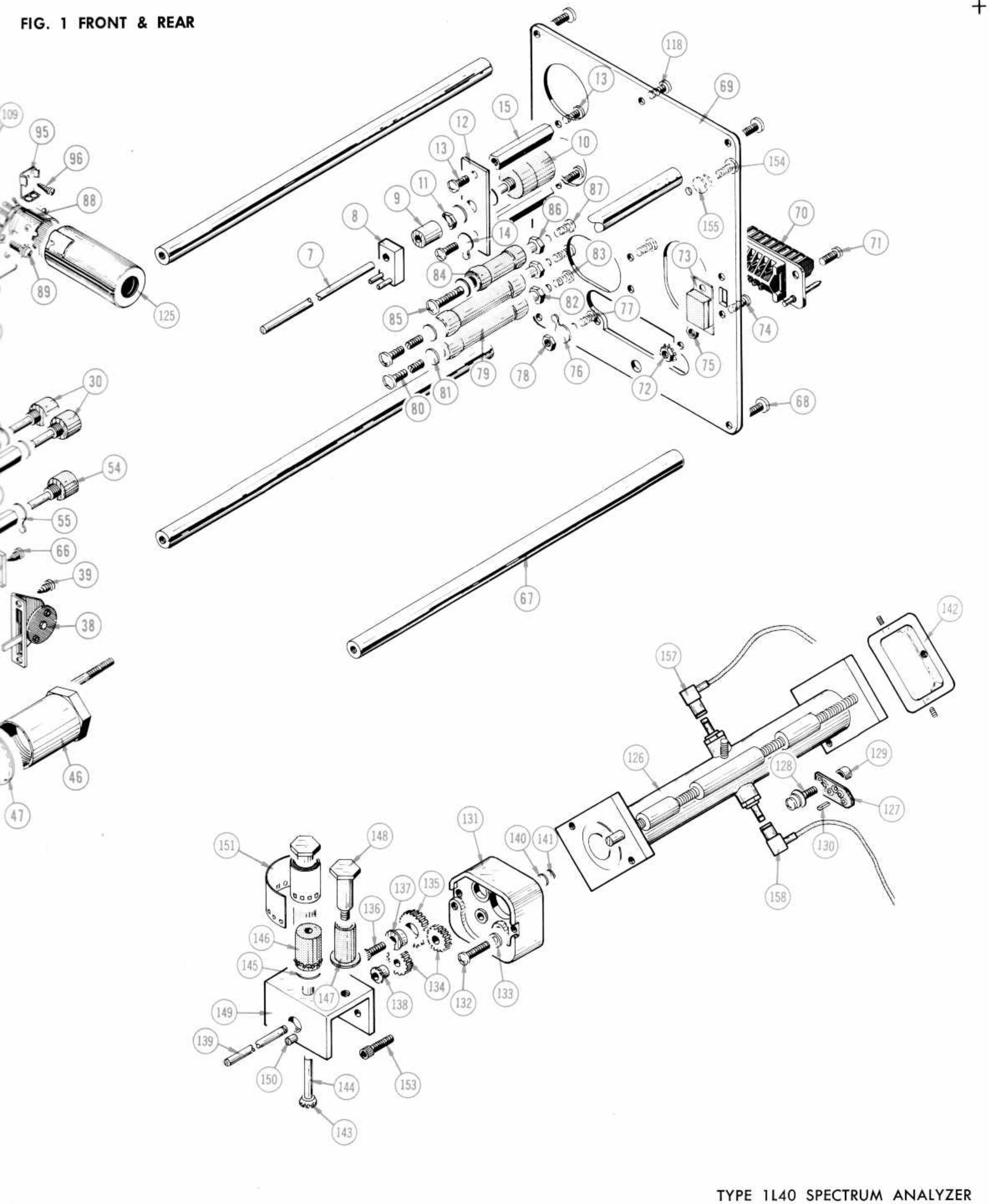
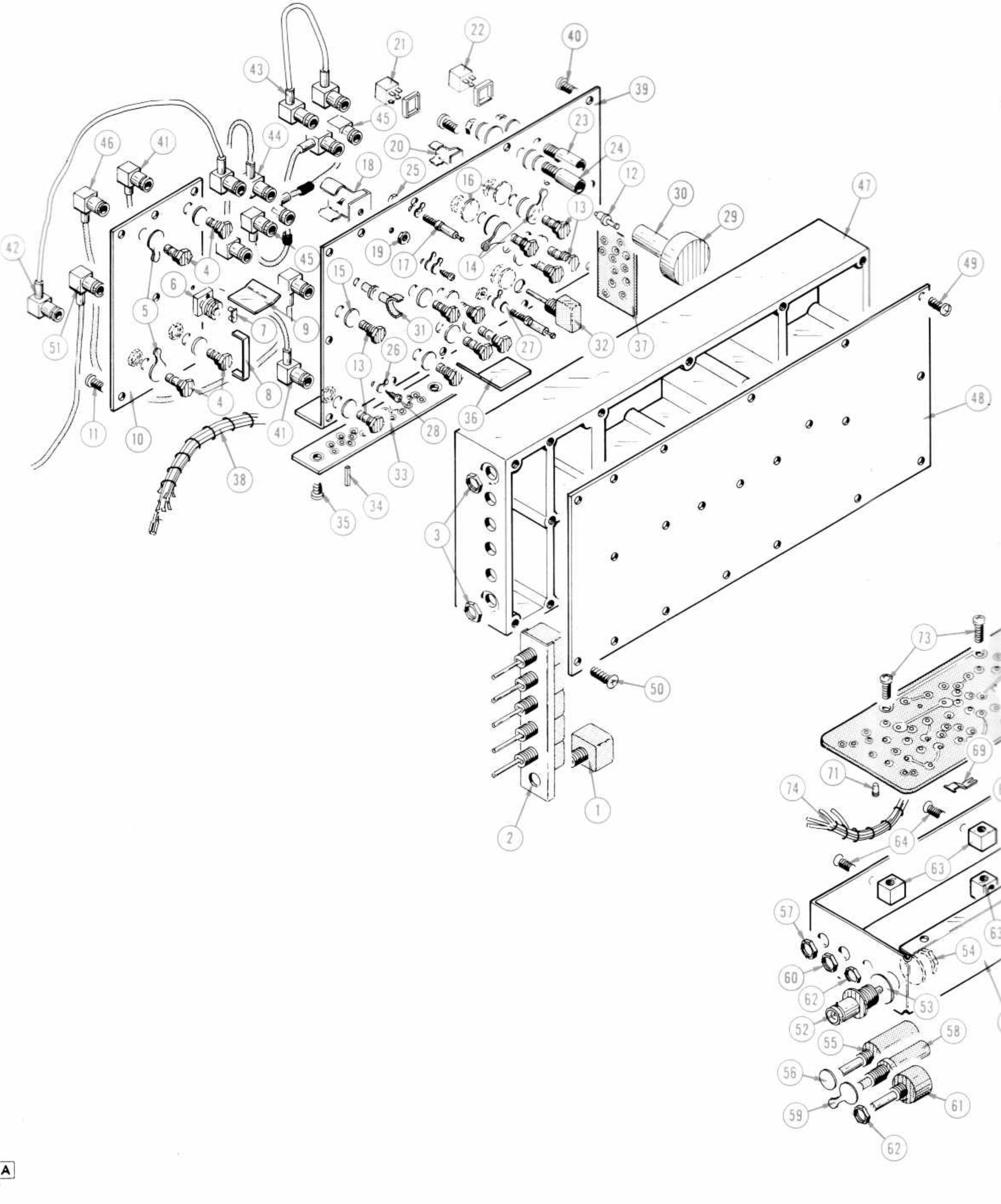


FIG. 2 IF CHASSIS & PHASE LOCK AS



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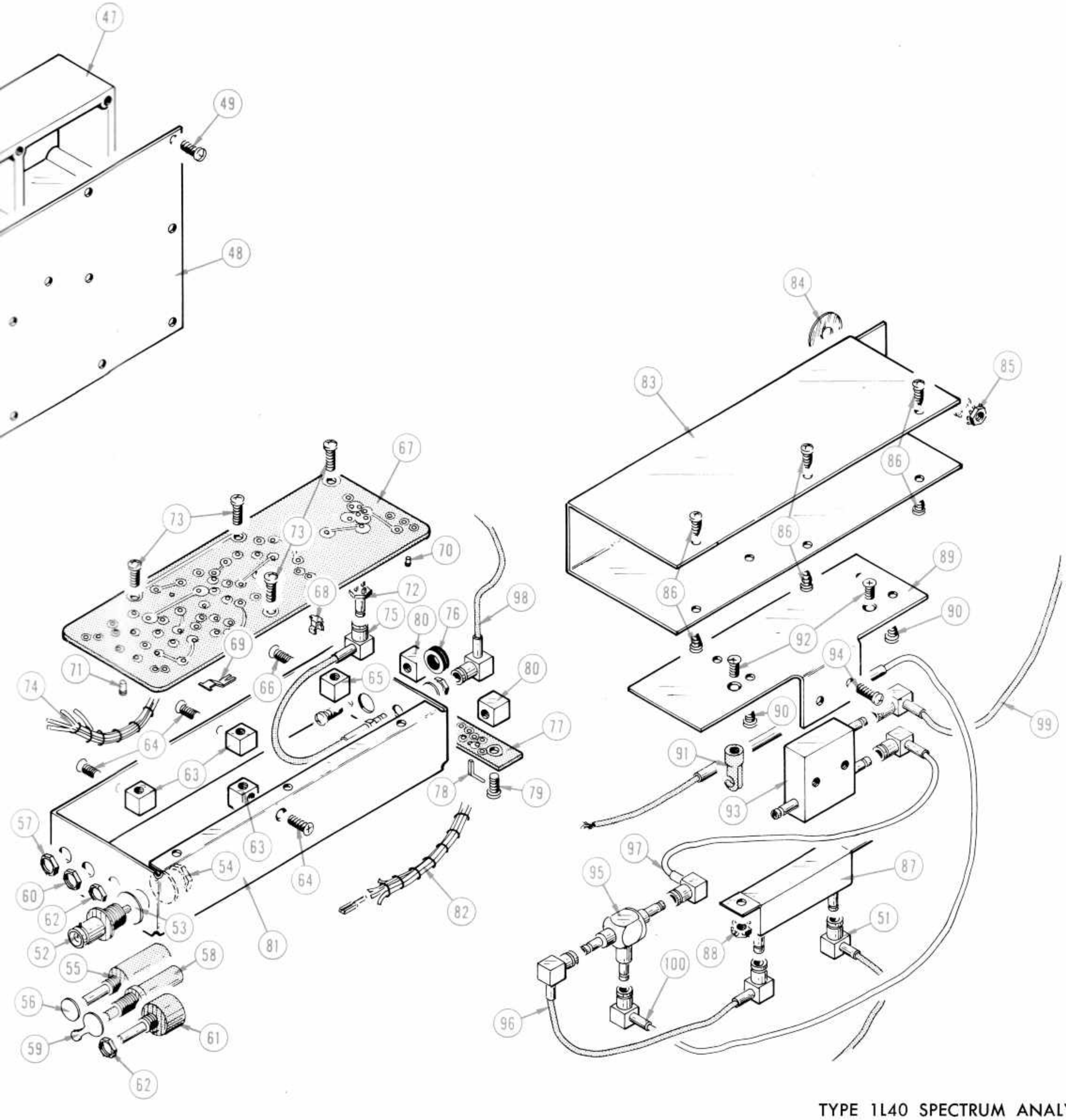
47
49
48
84
85
83
86
67
73
70
72
68
98
75
80
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66
71
74
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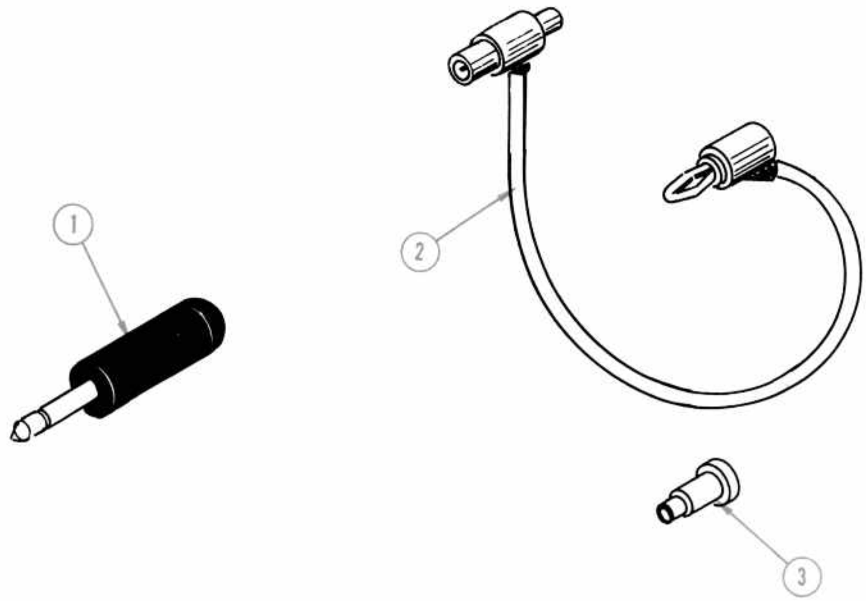
100
96

FIG. 3 STANDARD ACCESSORIES



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STANDARD ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
3-1	134-0052-00			1	PLUG, red
-2	012-0091-00			1	CORD, patch, BNC to banana, red, 18 inches long
-3	134-0076-00			1	PLUG, protector
	070-0904-00			2	MANUAL, instruction (not shown)

MANUAL CHANGE INFORMATION

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

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