INSTRUCTION MANUAL

Serial Number ____________

TYPE
1L30
SPECTRUM
ANALYZER

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CONTENTS

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 industy. Change infomation, if any, is located at the rear of this manual.

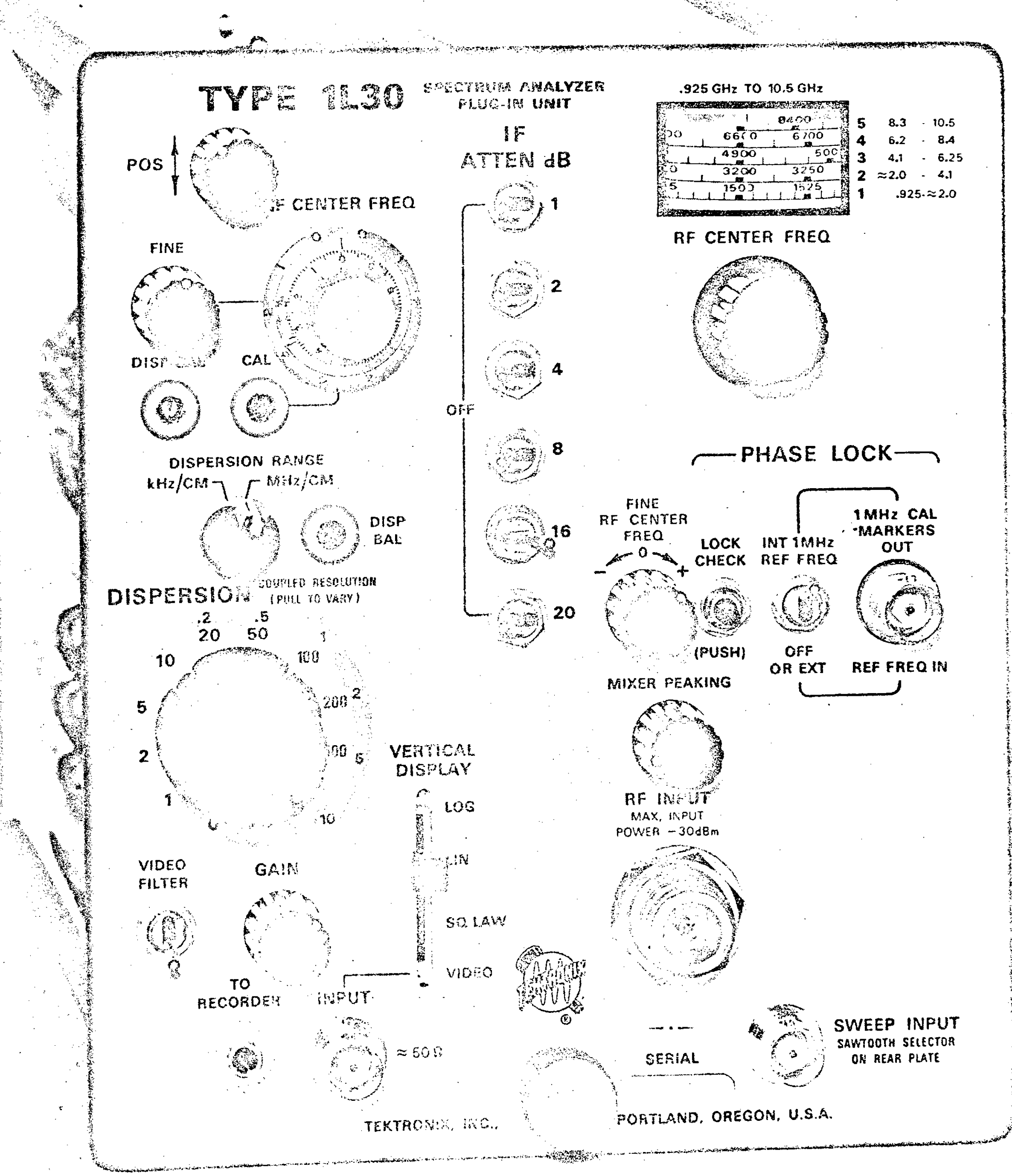


Fig. 1-1. Type 1L30 Spectrum Analyzer Plug-In Unit.

SECTION 1
CHARACTERISTICS

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

The Type 1L30 Spectrum Analyzer described in this manual is designed for use in Tektronix oscilloscopes to display the distribution of RF signals in the frequency range of 925 MHz to 10,500 MHz. The analyzer displays the frequency distribution of the applied signal along the horizontal axis of the oscilloscope CRT and displays the signal energy on the vertical axis.

The analyzer is designed for use in all Tektronix 530-, 540-, 550-, and 580-[1] Series Oscilloscope. The analyzer plugs directly into the oscilloscope and derives all its power from the oscilloscope. The Type 1L30 can also be used in an external Plug-In Unit Power Supply (such as the Tektronix Type 127 and Type 132 Power Supplies) when provided with a 100 volt sawtooth signal.

The following 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 given in Section 5 of this manual provides a convenient method to check the Operating requirements listed in this section.

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

ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement		Supplemental Information
Input Frequency			
Range	925 MHz to 10.5 GHz—See Table 1-1		
CW Sensitivity (S + N = 2N)	See Table 1-1		
Dial Accuracy	± (2 MHz + 1% of dial reading)		IF CENTER FREQ control at 000, FINE, RF and IF CENTER FREQ controls centered
Dispersion			
MHz/CM RANGE			
Range	.2 MHz/cm to 10 MHz/cm		In a 1-2-5 sequence
Accuracy	See Table 1-2		
Linearity	±3% (over a 10 centimeter display)		
kHz/CM RANGE			
Range	1 kHz/cm to 500 kHz/cm in a 1-2-5 sequence and zero dispersion		
Accuracy	±3% (with ±2.5 MHz change in IF center frequency)		
Linearity	±3% (over a 10 centimeter display)		
Resolution	≤ 1 kHz to ≥ 100 kHz; in 11 uncalibrated steps		May be coupled with the DISPERSION control or switched separately
Spurious Signals Internal Sources	≤ 2× noise amplitude with 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)	

ELECTRICAL CHARACTERISTICS (cont)

Characteristic	Performance Requirement	Supplemental Information
IF Attenuation		
Range	0 to 51 dB	In 1 dB steps: 1, 2, 4, 8, 16 and 20 dB
Accuracy	±0.1 dB/dB	
IF GAIN Control		
Range	50 dB or greater	
Display Flatness with IF CENTER FREQ at 000	±1.5 dB (3 dB total)	+ and — 50 MHz from the center frequency
Incidental FM		
IF	200 Hz or less	
IF + LO	300 Hz or less	At the LO fundamental frequency with phase lock operation
Phase Lock		
Internal Markers	1 MHz ±.01%	Crystall controlled
Stability; Ref. Osc	≤ 1 part in 10^7	
External Phase Lock		
Reference Input Frequency	1 MHz to 5 MHz	
Voltage	1 to 5 volts peak to peak	
Dynamic Range of Display Functions		
LOG	≥ 40 dB with 6 centimeter display	
LIN	≥ 26 dB with 6 centimeter display	
SQ LAW	≥ 13 dB with 6 centimeter display	
VIDEO INPUT Response	≤ 16 Hz to ≥ 10 MHz	
Maximum Input Power	—30 dBm for linear operation	
	+15 dBm power limit for diode mixer	
TO RECORDER Output	≥ 2 mV per display centimeter (amplitude) of signal; in LIN mode	
+10 V OUT	10 V ±5%	20 mA maximum load current. Discontinued after Serial No. 669

TABLE 1-1

Minimum CW Sensitivity[2] (Signal + noise = 2× noise)

Scale	RF CENTER Freq in MHz	1 kHz RESOLUTION	100 kHz RESOLUTION	Remarks
1	870-925 to 1940-2050[3]	—105 dBm	—85 dBm	MIXER PEAKING adjusted for optimum signal amplitude
2	1940-2050 to 4100-4300	—100 dBm	—80 dBm	
3	4100 to 6260	—95 dBm	—75 dBm	
4	6200 to 8400	—90 dBm	—70 dBm	
5	8300 to 10,500	—75 dBm	—55 dBm	

[2]50 Ω load impedance.

[3]The tuning range will vary between instruments. The upper frequency of scale 1 must be above the lowest frequency on scale 2. These are the allowable ranges of the end frequencies.

TABLE 1-2

DISPERSION/CM		Remarks
Setting	Accuracy	
10 MHz	±3% (±0.3 MHz/cm)	Over the 50 MHz range of the IF CENTER FREQ control. The DISPERSION CAL adjust can be reset to improve the accuracy at a specific IF CENTER FREQ control setting by using the front panel 1 MHz CAL MARKERS OUT as a calibration signal.
5 MHz	±3% (±0.15 MHz/cm)	
2 MHz	±5% (±0.1 MHz/cm)	
1 MHz	±7% (±70 kHz/cm)	
.5 MHz	±10% (±50 kHz/cm)	
.2 MHz	±15% (±30 kHz/cm)	

MECHANICAL CHARACTERISTICS

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

ENVIRONMENTAL CHARACTERISTICS

The following environmental 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	Supplemental Information
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.
Amplitude		
Non-operating	To 50,000 feet	
Operating	To 15,000 feet	
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
Shock		
Non-operating	30 g's, ½ sine, 11 ms duration, 1 shock per axis.	Gullotine-type shocks
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	Total of 10 drops

SECTION 2
OPERATING INSTRUCTIONS

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

Introduction

A Spectrum Analyzer is an instrument that graphically presents a plot or relative power distribution as a function of frequency for a selected portion of the spectrum. The Type 1L30 is designed to provide a spectral display of frequency distribution of electromagnetic energy within the frequency range of 925 MHz to 10,500 MHz. This display provides the following information: the presence or absence of signals within a frequency spectrum, their frequencies, frequency drift, relative amplitude of the signals and the nature of moduation if any, and many other characteristics.

This section of the manual covers the following: A glossary of terms; a description and function of the front panel controls and connectors; a first time operational procedure, and some basic application with signal evaluation.

Installation

The Type 1L30 is designed to operate in any Tektronix oscilloscope accepting letter- or 1-series plug-in units. It may also be used with a Tektronix Type 132 or 133 Plug-In Power Supply, with the output displayed on the CRT of any oscilloscope that has a 100 or 150 volt sweep output available.

If the Type 1L30 Spectrum Analyzer is to be used with the Tektronix Type 541, 541A, 543, 543A, 545 or 545A Oscilloscope, a modification is required to the plug-in oscilloscope to correct undesirable display distortion and dispersion nonlinearity. This distortion is caused by a part 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 settings such as 1 kHz/cm. It also appears as a nonsymmetrical 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.

Change the +225 volt supply for the Vertical Signal Out C.F. (V1223A cathode resistor) from the junction of R1008 and R1007 (R1153 and R1152, Type 545) or +225 V (DEC) and connect it to the other side of R1088 (R1153, Type 545) which is the +225 V supply. See Fig. 2-2.

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.

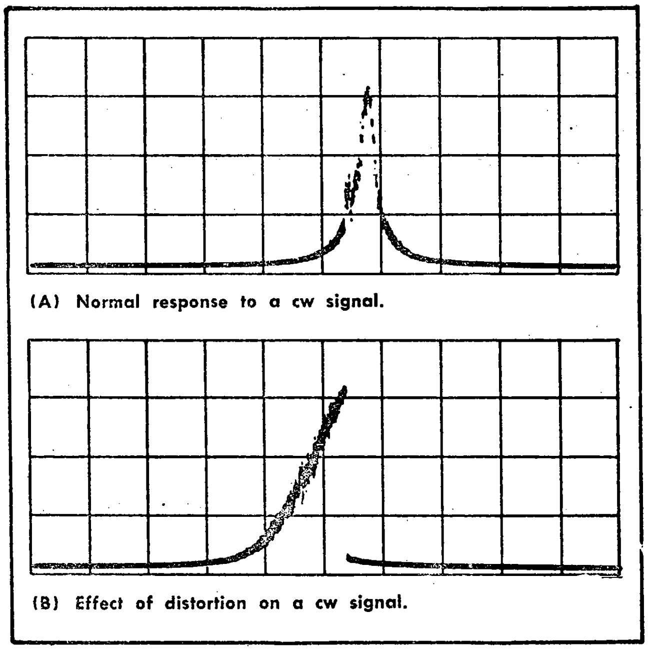


Fig. 2-1. (A) Normal response to a cw signal. (B) Effect of distortion on a cw signal.

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 continuous analysis of the incoming signal, with the time sequence of events preserved between input ond 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.

Center frequency range (radio frequency)—That range of frequencies which can be displayed at the center of the

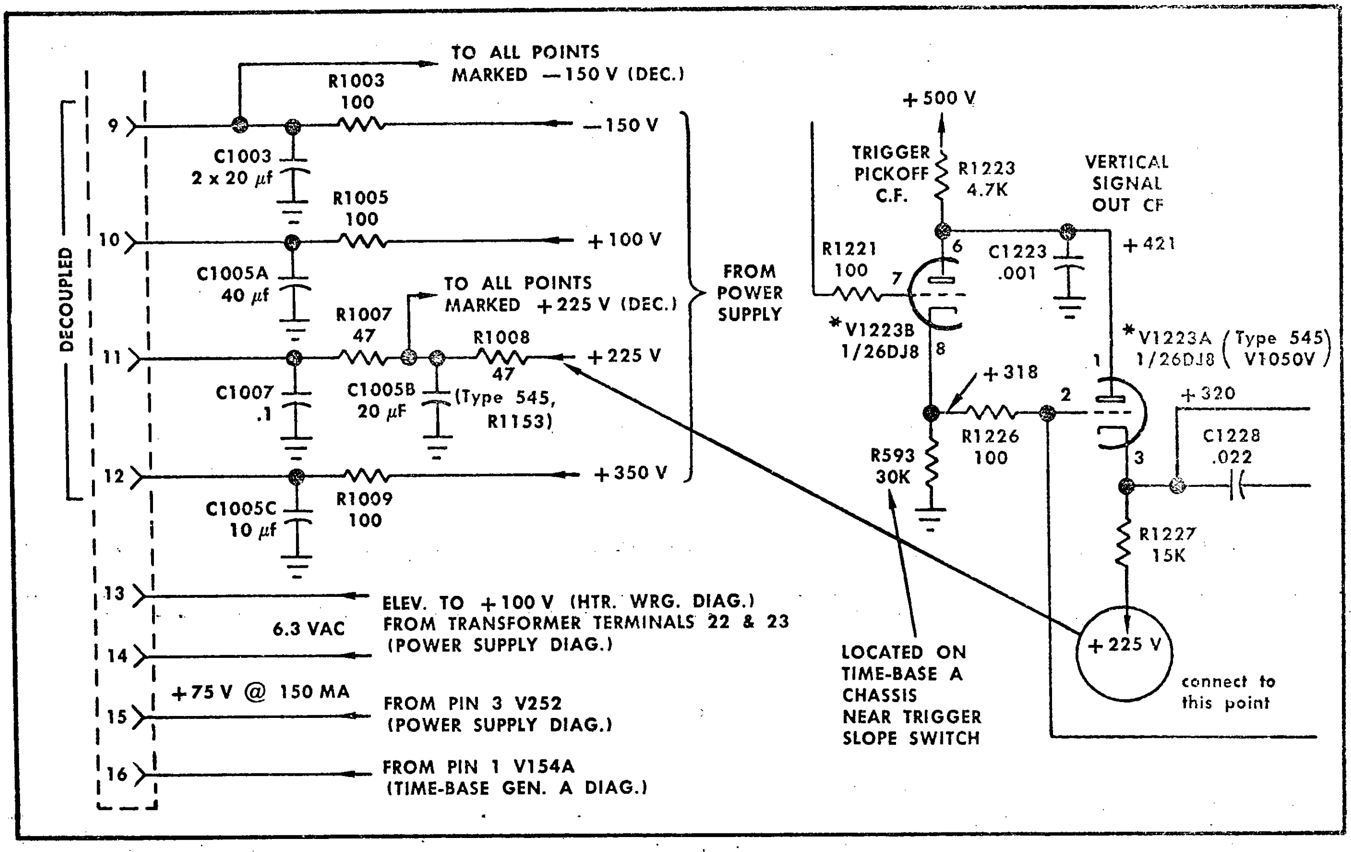


Fig. 2-2. Change as indicated on this partial schematic of the Vertical Amplifier.

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 amplitude response over the rated maximum dispersion (usually in units of dB).

Drift (frequency drift) (stability)—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 re-tuning or resetting the front panel controls (units may be Hz/s, Hz/°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 in units of dB).

Frequency band—A 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 $\frac{\Delta W}{W} \times 100\%$ 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 degradation 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 the 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: Optimum resolution bandwidth $= 0.66 \dfrac{\text{Dispersion (in Hz)}}{\text{Sweep time (in seconds)}}$

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

Spurious response (spurri, spur)—An erroneous display or signal which does not conform to the indicated frequency or dial reading. Spurri and spur are the colloquialisms used to mean spurious responses (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 response 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 passbands. 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 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 analyzers) to move across the graticule. (In a linear spectrum analyzer 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.
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

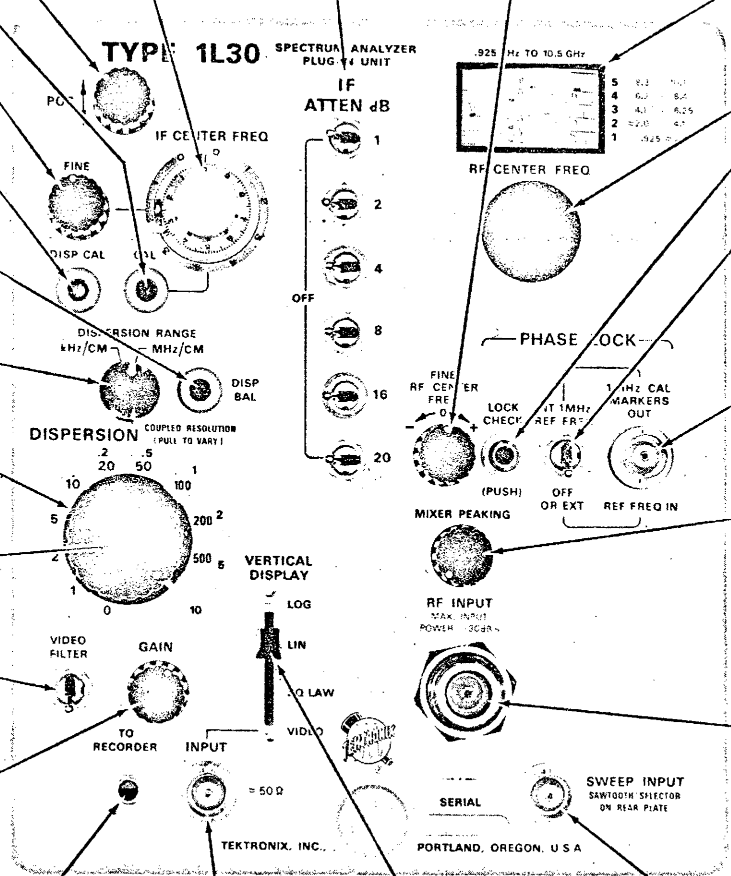


Fig. 2-3. Function of front panel controls and connectors.

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 10 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 attenuation in 1 dB steps from 1 dB to 51 dB.

GAIN — A variable control of the analyzer 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 ±10 MHz adjustment in the 10 MHz/cm dispersion positions, a ±25 MHz adjustment of the center frequency, through the 5 MHz/cm to 0.2 MHz/cm positions, and a ±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 ±1 MHz adjustment for the .2 MHz/cm through the 10 MHz/cm dispersion positions and the ±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 ≥ 40 dB. In the LIN position, a signal display amplitude is linear with a dynamic range ≥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 ≥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 925 MHz to 10,500 MHz. 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 phase lock output beat signal (between the local oscillator and reference frequency) plus the DC reference level of the phase lock amplifier and an indication of the signal location to the vertical display system. Provides a visual indication to the operator of phase lock operation.

INT 1 MHz REF FREQ — Selects either the Internal 1 MHz Reference Frequency or an externally applied reference frequency.

1 MHz CAL MARKERS OUT OR EXT REF FREQ IN — A BNC connector that provides 1 MHz marker signals from the Internal oscillator, when the switch is in the INT 1 MHz REF FREQ positions. These markers can be used to calibrate the dispersion. With the INT 1 MHz REF FREQ switch in the OFF OR EXT position, an external signal between 1 MHz and 5 MHz (1 to 5 V peak to peak) may be applied to the connector. This external signal will then become the reference frequency for phase lock operation.

RF INPUT — Coaxial connector (N type) which connects through a coaxial cable, to the signal source. Input impedance 50 Ω.

TO RECORDER — Signals on the display may be recorded by plugging into the TO RECORDER output. Provides a linear output, equal to or greater than 2 mV per displayed centimeter of signal amplitude, in the LIN mode, into a source impedance of 600 ohms.

First Time Operation

Preliminary

a. Set the Sweep Voltage selector at the rear panel (see Fig. 2-4) Type 1L30 to the correct position (100 V or 150 V) for the oscilloscope being used. Some Tektronix Type Oscilloscopes and their sweep voltage output are listed in Table 2-1 and on the back panel of the instrument. If your oscilloscope is not listed, check the specifications given in the oscilloscope instruction manual for the front panel sawtooth out signal amplitude.

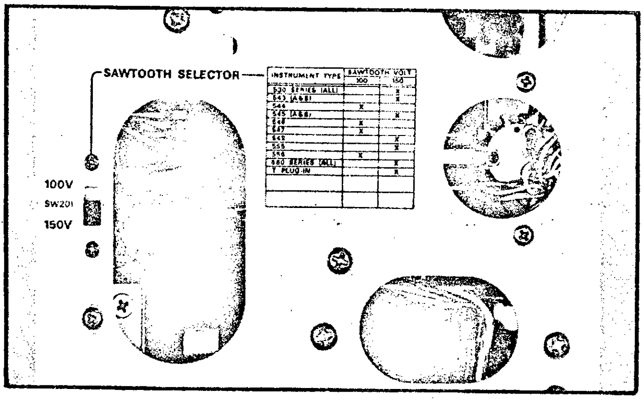


Fig. 2-4. Rear panel of the Type 1L30 showing sawtooth selector.

TABLE 2-1

100 Volt Sawtooth	150 Volt Sawtooth	Internal Sawtooth
Type 544	All 530 Series	Type 549
Type 546	Type 543	Type 556
Type 547	Type 545 (A and B)	
Type 556	Type 549	
	Type 555	
	All 580 Series	
	Type T Time-Base Plug-In	

b. Insert the Type 1L30 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 1L30 SWEEP INPUT connector. Allow approximately 20 minutes warm-up period for the instrument operation to stabilize.

d. Set the Type 1L30 and plug-in oscilloscope front panel controls as follows:

Analyzer Controls

DISPERSION RANGE	MHz/CM
DISPERSION—COUPLED RESOLUTION	Controls coupled together and in the 10 MHz/cm position
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 FREQ	Centered
INT 1 MHz REF FREQ	OFF
MIXER PEAKING	Centered

Plug-In Oscilloscope

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

1. Adjust 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. Apply a low amplitude signal (between —60 and —30 dBm) from the Signal Generator or other source, preferably, within the frequency range of the Type 1L30, through a coaxial cable to the RF INPUT connector.

5. Adjust the GAIN control for a moderate noise level (0.5 cm) on the display, then tune with RF CENTER FREQ control through the frequency range. Observe the different rate and direction of movement (left to right or right to left) of the signals across the screen when the RF CENTER FREQ control is tuned through the frequency of the band.

6. Tune the dial with the RF CENTER control 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 the 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 the DISPERSION—COUPLED RESOLUTION selector to the 5 MHz position. Tune the signal across the screen and note the total dispersion. It should decrease to ½ the 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 + or — 25 MHz with the DISPERSION controls in this position. Tune the IF CENTER FREQ control to center the signal on the screen.

11. Change the DISPERSION selector to .5 MHz/cm. Adjust the FINE IF CENTER FREQ control. Note the frequency

range of this control. This control will shift the IF center frequency approximately + or — 500 kHz with the DISPERSION RANGE in this position.

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

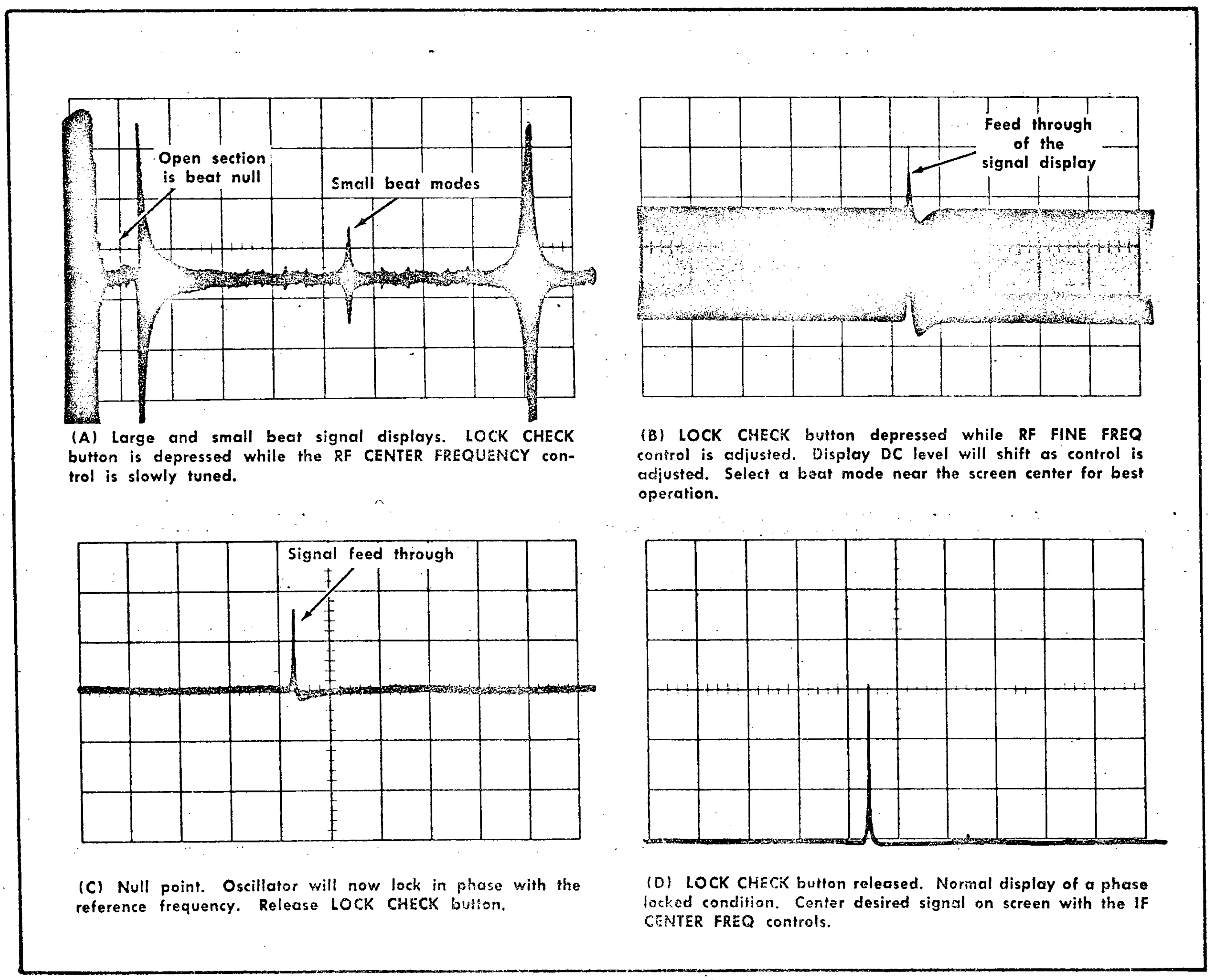
13. Turn the INT 1 MHz REF FREQ switch to INT position.

14. Push the LOCK CHECK button and tune 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. 2-5).

15. 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 within the center 4 centimeters of the graticule. Adjust for phase lock operation and release the LOCK CHECK button.

16. 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.

17. Uncouple the RESOLUTION control and turn the control clockwise. Note, the signal bandwidth increase as the resolution bandwidth is increased. The resolution bandwidth may be varied from approximately 1 kHz to 100 kHz, Re-



(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. 2-5. Lock check displays.

turn the RESOLUTION control to the coupled position with the DISPERSION selector.

GENERAL OPERATING INFORMATION

Signal Application

Signals applied to the RF INPUT connector should be applied through a 50-ohm coaxial cable with a N type connector. Impedance mismatches between the signal source and the RF INPUT connector, due to signal source output impedance, long coaxial cables, due to signal source output affect on display flatness. When optimum flatness is desired and signal strength is adequate, a 50 Ω attenuator pad (such as 10 dB pad) should be added between the signal source and the RF INPUT connector. This will minimize the reflections and optimize display flatness.

Signal input power to the analyzer should not exceed —30 dBm. Signals above this level may overload the 1st mixer and/or the 1st IF stage and generate spurious signals on the display. Add at least 10 dB attenuation to the input when signal compression is noticed (no increase in signal height with an increase in input power). A conversion chart (Fig. 2-6) may be used to calculate input signal levels.

CAUTION

Signals whose amplitudes are greater than +15 dBm applied to the INPUT may damage the diode mixers.

Front Panel Calibration Adjustments

Three screwdriver adjustments provide a means to calibrate the DISPERSION, IF CENTER FREQ and the DISPERSION RANGE balance. These front panel adjustments must be recalibrated whenever the Type 1L30 is shifted to another oscilloscope, to compensate for differences in sawtooth amplitudes and CRT deflection sensitivities. It is also advisable to check the adjustments periodically during regular use. Adjustment and a calibration check procedure may be performed as follows:

1. Balance and Calibration Check

a. Set the INT 1 MHz REF FREQ switch in the OFF position, then tune a signal on screen with the RF CENTER FREQ control.

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

c. 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 to .2 MHz positions.

d. Set the DISPERSION RANGE selector to kHz/CM position. Continue adjusting the IF CENTER FREQ control for minimum signal shift as the DISPERSION is switched from 500 kHz/cm to 5 kHz/cm.

e. Set the DISPERSION to the 500 kHz/cm position, then 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

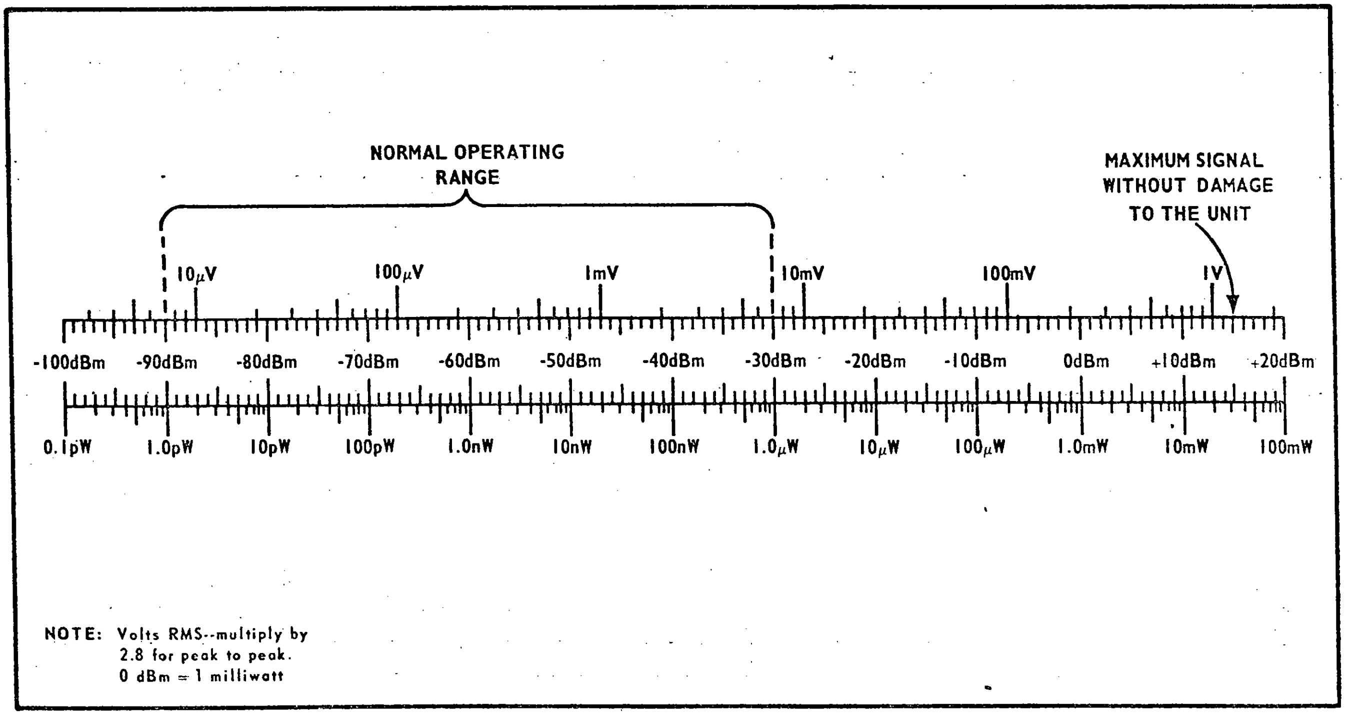


Fig. 2-6. Volts-dBm-Watts conversion chart for 50 Ω impedance.

with the sweep extending over the 10 centimeter width of the graticule. Front panel calibration is required if this requirement is not met. Proceed with 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 the 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 an RF signal that is stable in frequency to the appropriate RF INPUT connector. Adjust the GAIN control for 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 to the 5 MHz/cm position. Position the signal to the graticule center with the 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.

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 selector in the 5 MHz position, then decrease the DISPERSION to the .2 MHz - 20 kHz position.)

Final adjustment is made with the DISPERSION RANGE selector in the kHz position and the DISPERSION in the 1 kHz/cm position. Fine adjustment, with the IF CENTER FREQ set to 000, permits dispersion changes from 10 MHz/cm to 1 kHz/cm without extreme 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. Preset the front panel controls as follows:

IF CENTER FREQ	000 (centered)
DISPERSION RANGE	MHz/CM
DISPERSION	1 MHz
VERTICAL DISPLAY	SQ LAW
INT 1 MHz REF FREQ	INT

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. 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. 2-9. 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.

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 ± (2 MHz + 1% of the dail 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 (100 MHz or more) in the RF center signal frequency.

Phase Lock Operation

The phase lock circuit increases the frequency stability of the tunable local oscillator by synchronizing the oscillator with either an internal crystal-controlled 1 MHz reference oscillator, or an externally applied reference frequency.

The circuit will phase-lock the tunable local oscillator to any externally applied signal with an amplitude of 1 to 5 volts peak to peak and within the frequency range of 1 MHz to 5 MHz. The external signal is applied to the EXT REF FREQ IN connector when the INT 1 MHz REF FREQ switch is placed in the OFF OR EXT (REF FREQ IN) position. Fig. 2-5 illustrates the displays produced with the LOCK CHECK button depressed as the tunable local oscillator is tuned through the phase lock beat modes by the RF CENTER FREQ control. The small signal beats between the larger beat signals will usually phase lock the oscillator; however, this lock may not be as stable.

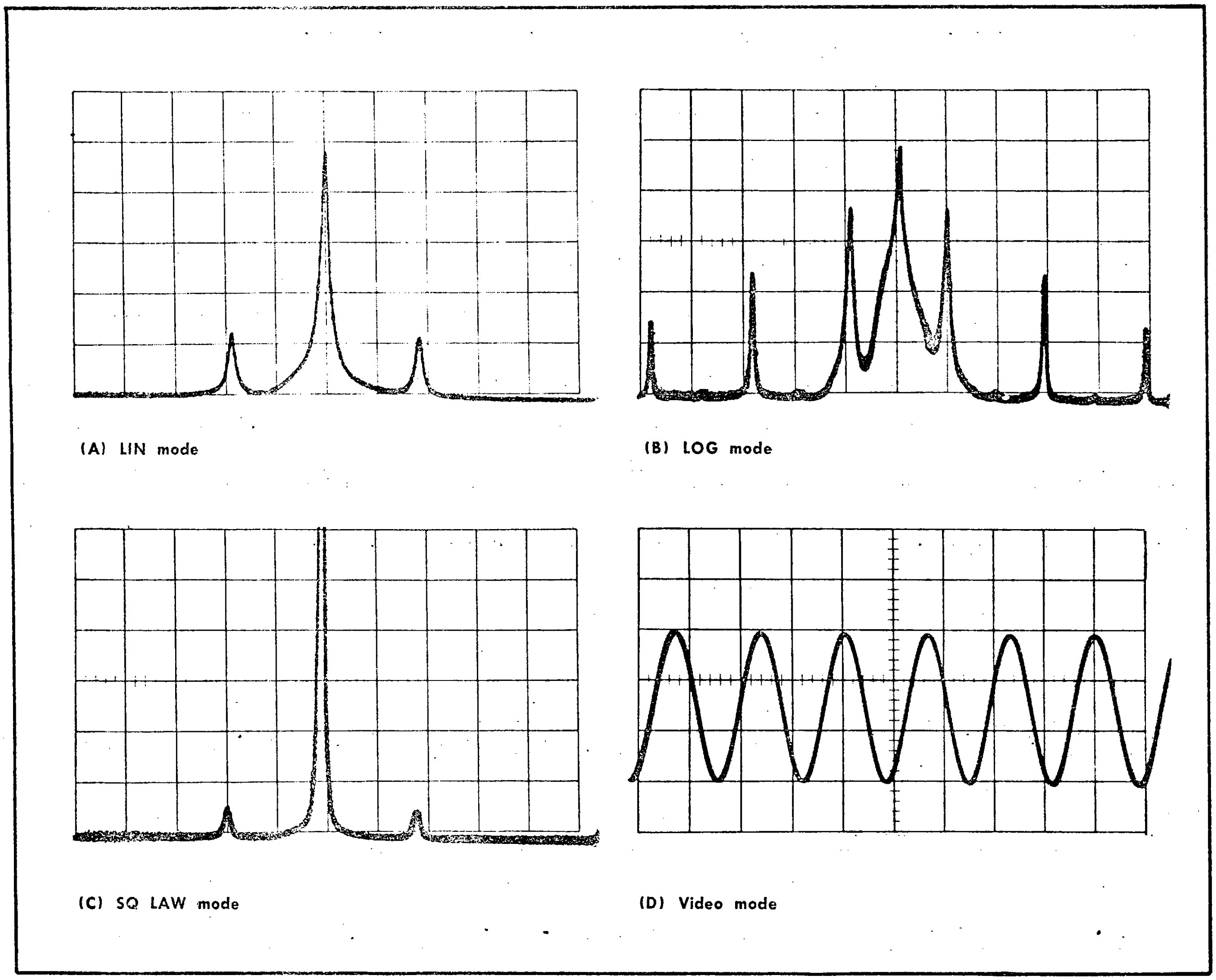


Fig. 2-7. Vertical display modes showing an amplitude modulated display. Video mode shows the modulation signal.

Oscillator phase lock operation is established as follows: Tune the desired signal to the center of the screen with the RF CENTER FREQ control. Depress the LOCK CHECK button, then adjust the FINE RF CENTER FREQ control for a beat frequency indication within the center 4 centimeters of the graticule. Adjusting the FINE RF CENTER FREQ control shifts the output DC level of the phase lock amplifier and the vertical reference level of the CRT trace. The linear operating range of the phase lock amplifier is near its limits at the extreme DC levels; therefore, phase lock operation should be set in the center of this operating range or with the display near the center of the graticule area.

If the beat indication is outside the center area of the graticule, adjust the FINE RF CENTER FREQ control to center the trace, then adjust the RF CENTER FREQ control to shift the signal towards a beat mode (Fig. 2-5) where phase lock operation can be achieved within the dynamic range of the amplifier. Adjust the FINE RF CENTER FREQ control for a phase lock condition then release the LOCK CHECK button.

After phase lock operation has been set, the dispersion may be reduced. To maintain phase lock condition, the IF CENTER FREQ controls should be used to position the desired signal to the center of the screen. With narrow dispersion settings (100 kHz or less) when the analyzer loses its lock condition, the signal will disappear off the screen. If this happens, a slight adjustment of the FINE RF CENTER FREQ control will usually return the signal to the display.

Vertical Display Modes

The dynamic range and the appearance 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. 2-7 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 by attenuating large amplitude signals more than small amplitude signals. This type of display approximates a logorithmic 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 signal amplitude. This type display provides an approximation of the input signal power and is used to accentuate small amplitude difference.

In the VIDEO mode, the spectrum display is grounded and any signal connected to the front-panel VIDEO INPUT connector will be displayed as 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. This will reduce zero beats when viewing signals close to minimum resolution bandwidth. The filter is useful in applications where the envelope of a pulsed RF spectrum is desired (Fig. 2-8) 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.

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 1L30 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. Since the IF CENTER FREQ control range ±25 MHz in most the MHz/CM position is greater than the ±2.5 MHz range in the kHz/CM position, the accuracy of the kHz/CM range is improved over the MHz/CM range.

The front panel DISP CAL adjustment may be adjusted to recalibrate dispersion for specific IF CENTER FREQ control settings when a high degree of accuracy is desired for a particular frequency setting. The procedure is as follows:

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

2. Apply the 1 MHz CAL MARKERS OUT signal to the RF INPUT connector. This should provide a picket fence display. See Fig. 2-9.

3. Adjust the RF CENTER FREQ control a slight amount to identify the fixed from the tunable signals. The fixed signals should be used, and the tunable markers should be tuned so they coincide with the fixed markers to eliminate confusion in the display.

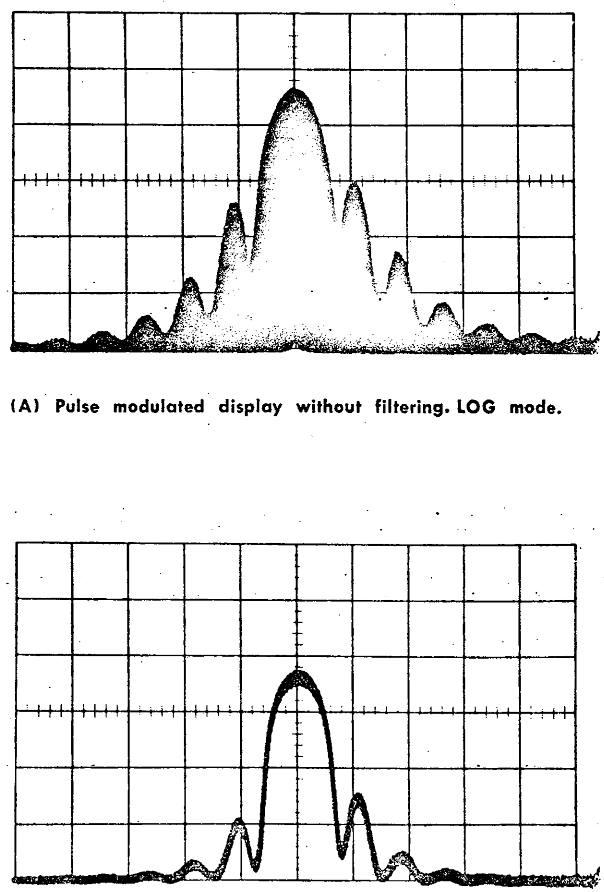
4. Calibrate the display by adjusting the DISP-CAL for the correct markers per centimeter, or read the dispersion directly from the marker picket fence.

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 the sub-title Front Panel Adjustment.

Resolution and Dispersion

Resolution is the ability of the spectrum analyzer to display adjacent signal frequencies discretely. The measure



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

(B) Display with VIDEO FILTER switch ON.

Fig. 2-8. Integrating the display with the video filter.

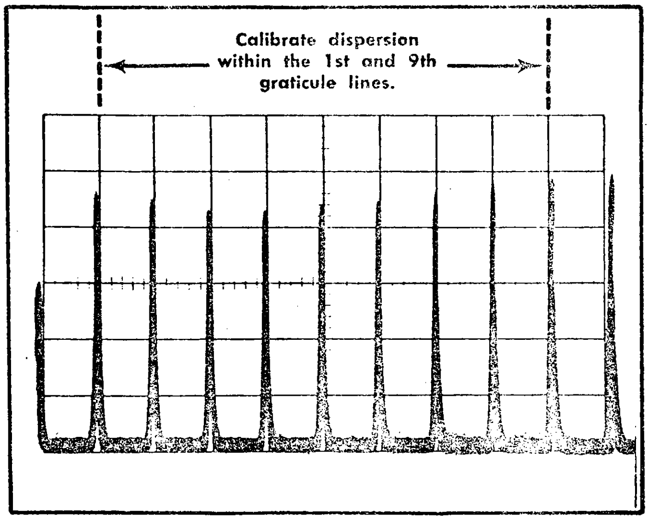


Fig. 2-9. 1 MHz Markers Output signal (phase lock reference) applied to the RF INPUT connector to check dispersion calibration.

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:

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

where 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:

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

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 1L30 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.

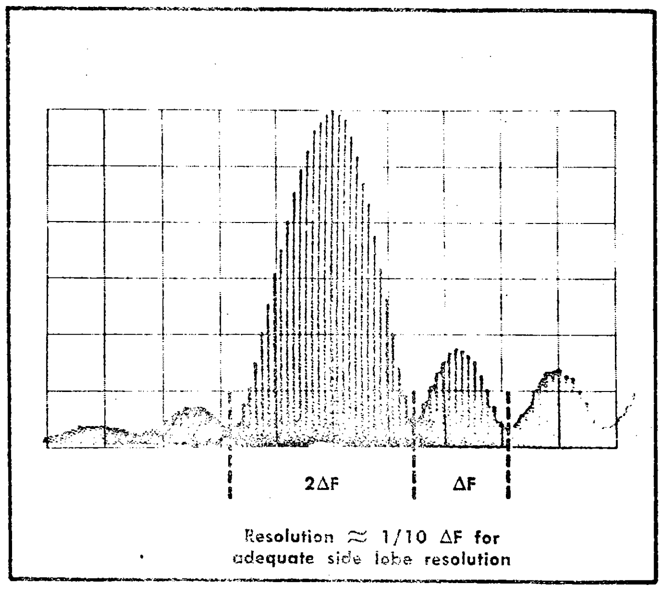


Fig. 2-10. Frequency spectrum of a pulse modulated signal.

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

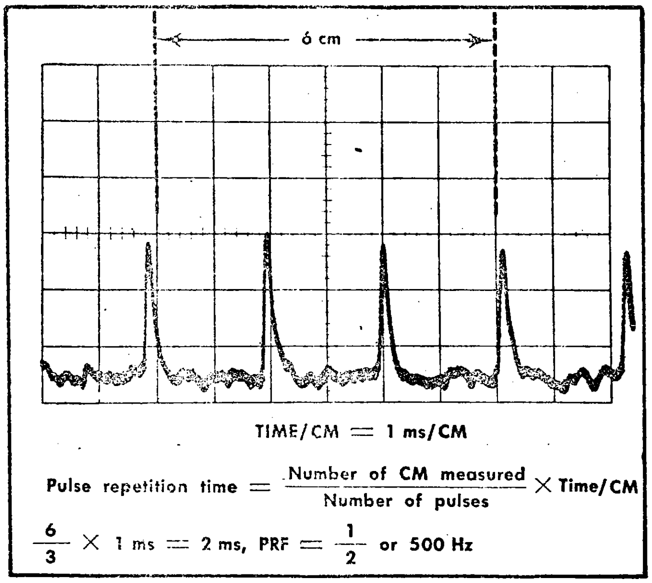


Fig. 2-11. Measuring pulse repetition time.

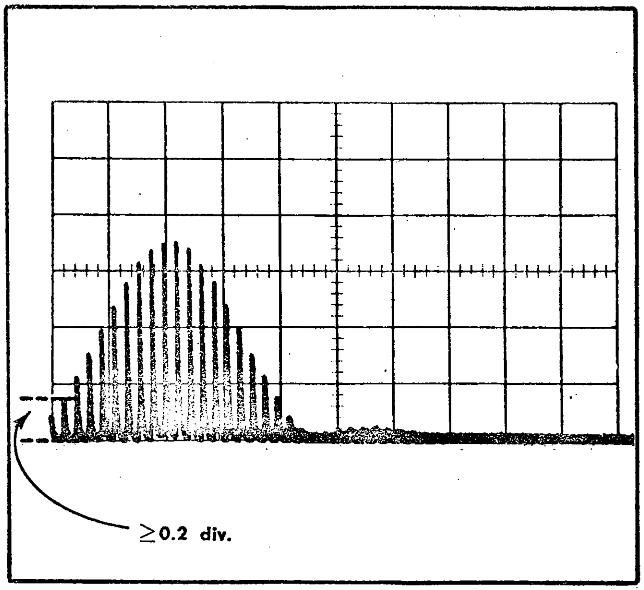


Fig. 2-12. To trigger the analyzer from the display requires 0.2 cm of signal. Tune the spectrum null point away from the sweep starting point, with the RF CENTER FREQ control.

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 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, for example; at 0 dispersion, or when slaving the Type 1L30 to a recorder, that it may be desirable or necessary to trigger the display.

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 be necessary, therefore, 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.

In applications that are single shot events, the triggering can be set for single sweep operation and the trace triggered before the event by some external source.

Recorder Out

Signals on the display may be recorded by plugging a phone plug 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 RECORDER connector is square law.

SPECTRUM ANALYZER DISPLAYS

The Spectrum Analyzer display is a plot of signal amplitude as a function of frequency. With this type of display, individual frequency components within the signal are displayed and readily analyzed. This section describes some of these basic spectrum displays and basic applications for the Type 1L30.

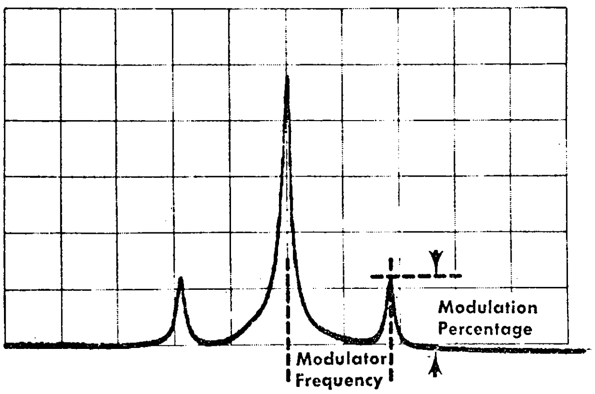
Spectra of Amplitude Modulation

When a single frequency (CW) signal is amplitude-modulated by a signal frequency, two additional frequencies will be generated; the carrier plus the two sidebands. See Fig. 2-13. The amplitude of either sideband with respect to the carrier voltage is $\frac{1}{2}$ the percentage of modulation. The frequency difference between the carrier and either sideband is equal to the modulating frequency.

Figure 2-14 illustrates how the spectrum is generated when a fundamental carrier frequency F is modulated by two frequencies F_1 and F_2.

The sideband spectrum, of a multiple frequency amplitude-modulated signal spectrum, is determined by the modulating frequencies. To resolve this complex spectrum, the analyzer resolution bandwidth must be less than the lowest modulating frequency, or the bandwidth must be less than the difference between any two modulating frequencies, whichever is the smaller.

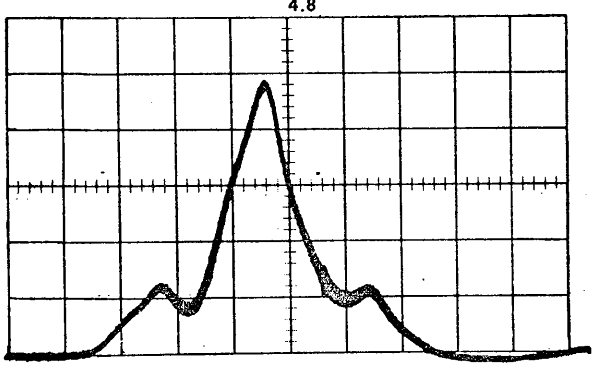
In wideband amplitude-modulation applications, such as television picture information, the spectrum analyzer may be used to measure both the sideband energy distribution and the modulation bandwidth.



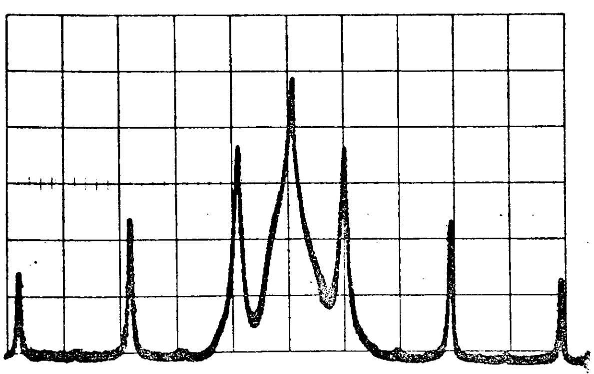
(A) CENTER FREQ 2 GHz
DISPERSION 50 kHz/CM
MODE LIN

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

% 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. 2-13. Spectrum showing series of AM signals.

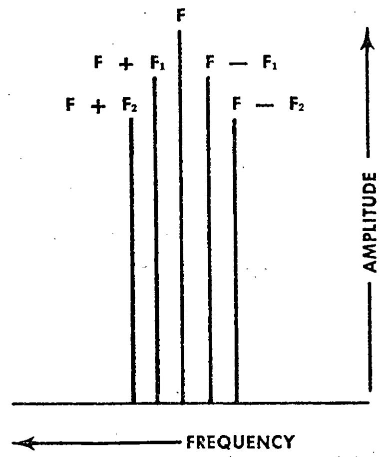


Fig. 2-14. Formation of a spectrum. F is the fundamental or carrier frequency, F_1 and F_2 are the modulating frequencies.

The amplitude modulated signal spectrum therefore furnishes the following information: 1) Fundamental or carrier frequency, 2) modulation frequency or frequencies, 3) modulation percentage, 4) sideband energy distribution and 5) modulation bandwidth. Other characteristics which may be evaluated are: Degree of incidental FM (evidenced by signal jitter), nonlinear modulation and over-modulation. These characteristics are illustrated in more detail with other types of spectrum display patterns.

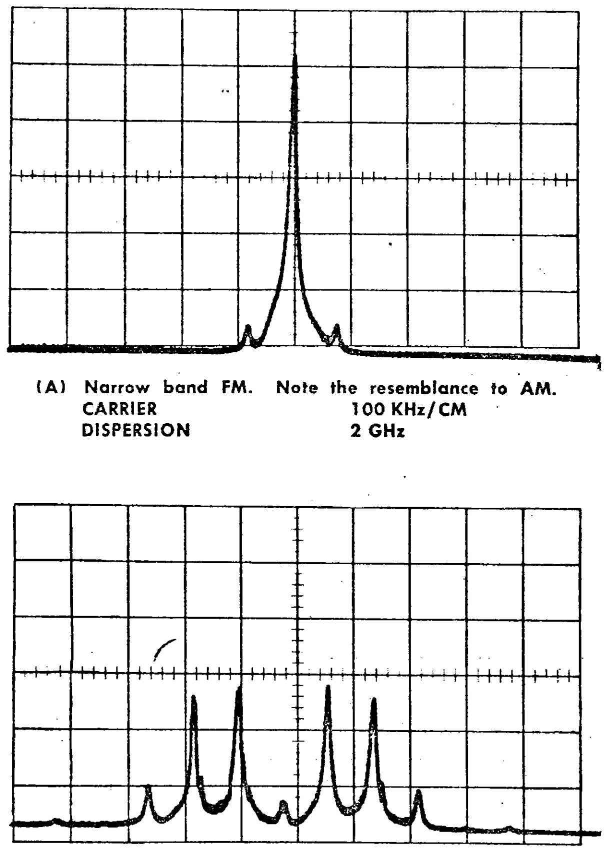
Frequency Modulated Signal Spectra

When a CW signal (F_c) is frequency modulated at a rate (F_m), it will theoretically produce an infinite number of sideband frequencies. These frequencies are equal to 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

Frequency modulated signal bandwidth is usually determined by the width of the sidebands containing 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.

To resolve adjacent sideband components in a frequency modulated display, the spectrum analyzer resolution bandwidth should be less than the lowest modulating frequency in the spectrum, which is the same as the requirements to resolve an amplitude modulated spectrum.



(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 × 100 kHz/cm = 80 kHz. Deviation 2.4 × 80 kHz = 192 kHz.

Pulse Modulated Signal Spectra

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.

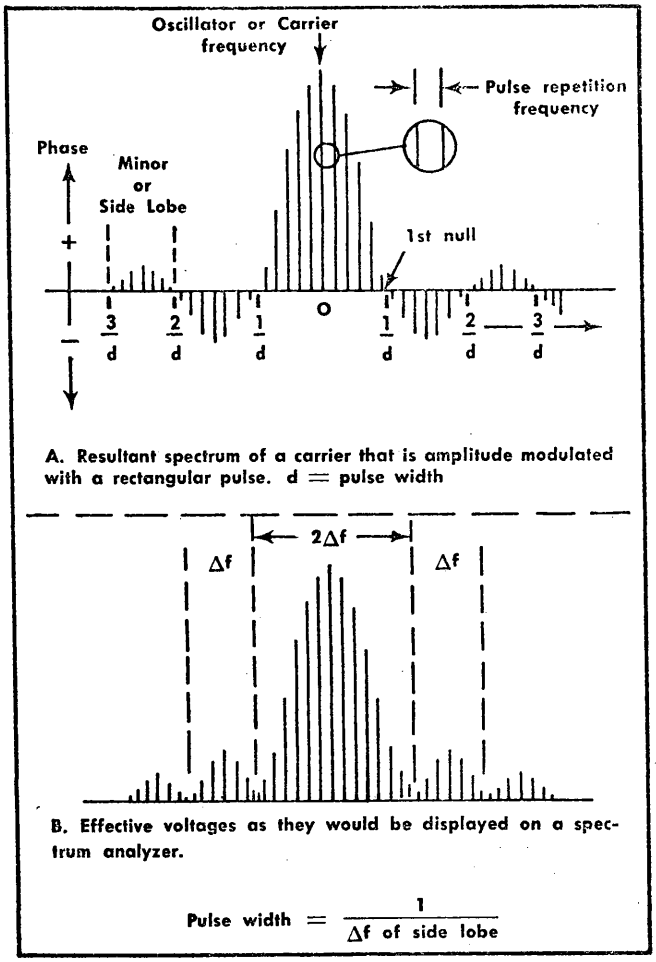
A symmetrical square wave is composed of its fundamental frequency plus the odd harmonics. If the relative amplitudes and phase of the harmonics are changed, a number of wave shapes are produced; rectangular, trapezoidal, sawtooth, etc. The spectrum of the square wave or any pulse shape, therefore, is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

Fig. 2-16A illustrates a theoretical voltage spectrum of a rectangulary-pulse, pulse-modulated oscillator 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 distance 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 one frequency component. In most instances this is impractical. The spectrum



A. Resultant spectrum of a carrier that is amplitude modulated with a rectangular pulse. d = pulse width

B. Effective voltages as they would be displayed on a spectrum analyzer.

$$\text{Pulse width} = \frac{1}{\Delta f \text{ of side lobe}}$$

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

envelope however, 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. This display simulates a pulsed spectrum and contains the same information for analysis.

This spectrum may now be resolved, since 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) resolution bandwidth), 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 to as spurii (many or plural) or spur (singular) which are colloquial terms used to relate to spurious responses. (See definitions of spectrum analyzer terms). They are the products of the following:

1. IF feedthrough: In the Type 1L30, 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 1L30 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 700 MHz signal at a dial reading of 700 MHz (oscillator frequency of 900 MHz) and at a dial reading of 300 MHz (oscillator frequency of 500 MHz). 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 also calibrated for signal frequencies that will mix with harmonics (2nd through the 4th) of the local oscillator.

3. Higher order modulation (Harmonic conversion and intermodulation) — signals: All 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 500 MHz could mix with frequencies of 300 MHz, 700 MHz, 800 MHz, 1200 MHz, 1300 MHz, 1700 MHz, etc., to produce a 200 MHz IF.

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 2× the noise level for the Type 1L30.

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 1L30 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

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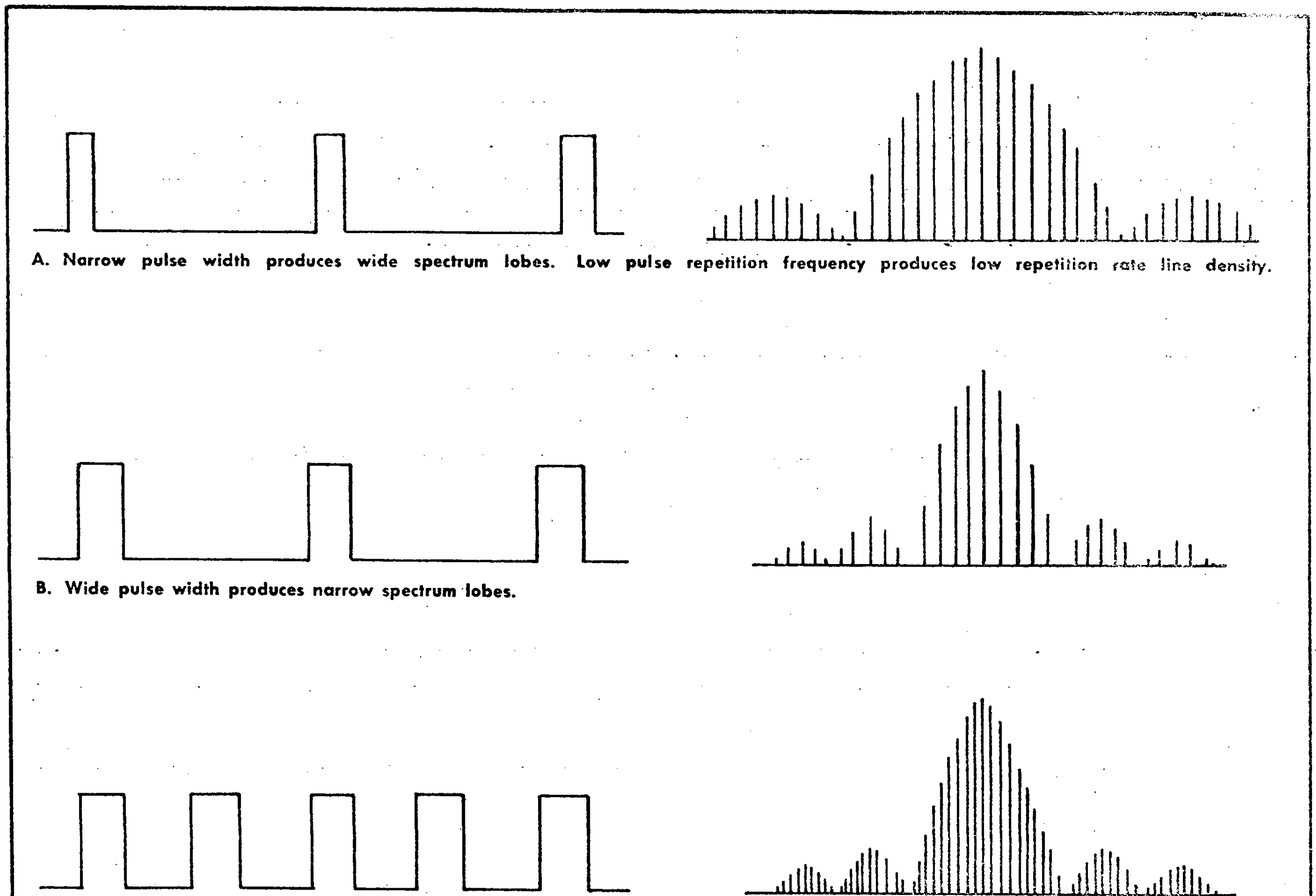


A. Narrow pulse width produces wide spectrum lobes. Low pulse repetition frequency produces low repetition rate line density.

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.

change of the dial scale as the RF center frequency is changed.

Higher order modulation or intermodulation produces spurri 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 1L30 Spectrum Analyzer are a few examples of its use and 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. With no IF ATTEN switched on, 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 attenuation 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 on is the relative amplitude difference, in dB, between the two compared signals.

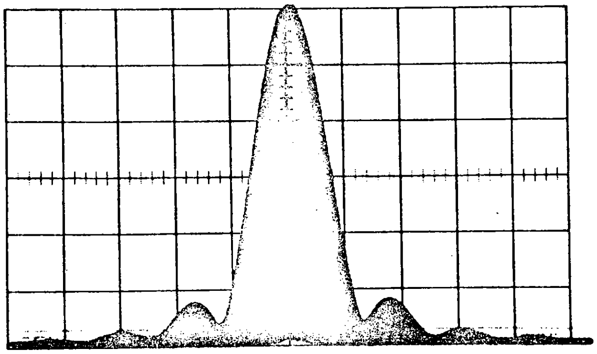
NOTE

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.

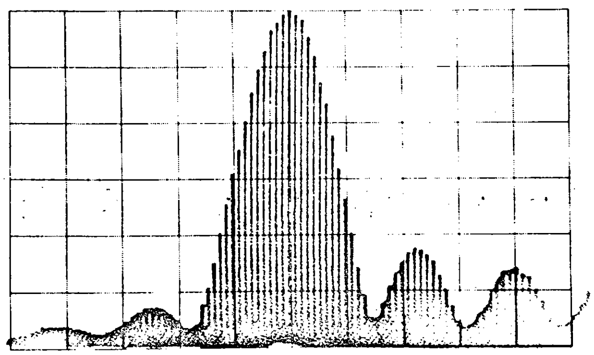
The IF CENTER FREQ, the DISPERSION-COUPLED RESOLUTION, the FINE RF CENTER FREQ, and the Time/Cm controls should not be adjusted when measuring relative signal amplitude.

Frequency Measurements

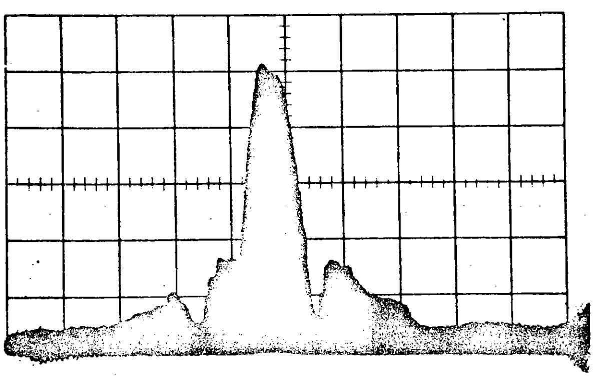
Frequency measurements taken from the RF CENTER FREQ dial are accurate to within ± (2 MHz + 1% of the dial



(A) $\frac{\text{Sin } X}{X}$ 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.

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 position.

4. Tune the RF CENTER FREQ control so the signal to be measured is centered 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 5000 MHz indicates the signal is 5000 MHz ± (2 MHz +50 MHz) or, between 4948 MHz and 5052 MHz.

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).

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.

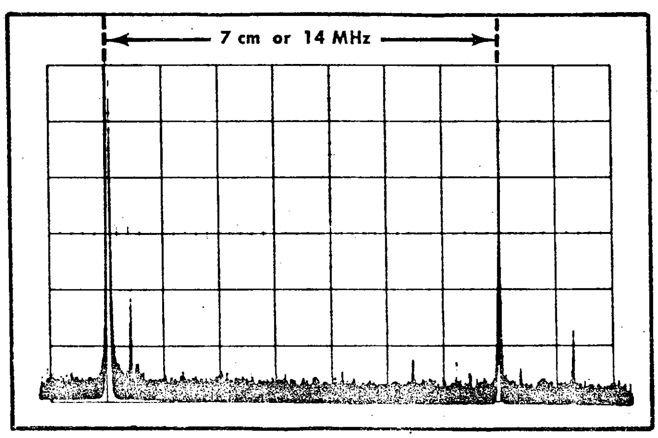


Fig. 2-19. Frequency difference measurement between two signals.
DISPERSION RANGE setting = MHz/CM
DISPERSION setting = 2
Frequency difference = (7 cm) (2 MHz/CM) = 14 MHz

NOTE

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

Frequency Stability

The Type 1L30 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 characteristics of a klystron.

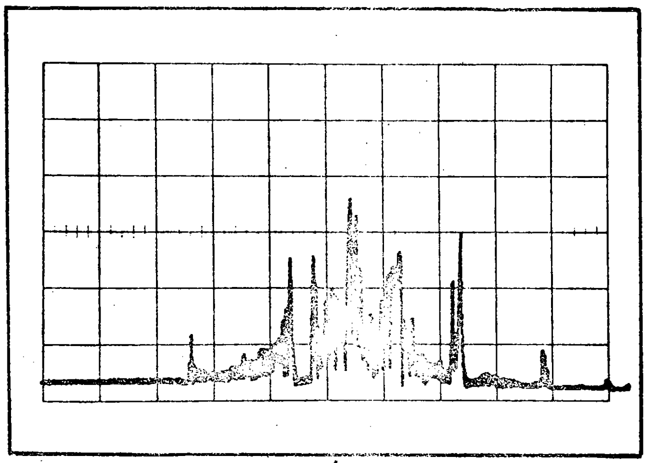


Fig. 2-20 Short term stability measurment. Random FM characteristic of a klystrom. DISPERSION is 2 kHz/CM and RESOLUTION is 1 kHz. Oscillator FM is about 6 kHz.

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. 2-13 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-modulation is 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 arbitrary unless the modulating frequencies are harmonically related. The over-modulated carrier spectrum is usually symmetrical, whereas 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 + (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 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 measurements may be performed from the spectrum of a pulse modulated display.

Pulse Width: The theoretical pulse width for a square wave 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 with the Type 1L30 as follows:

1. Adjust the 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 on 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 ½ the main lobe frequency width, on the reciprocal of the side lobe frequency width. See Fig. 2-21A.

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 the signal PRF.

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

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.

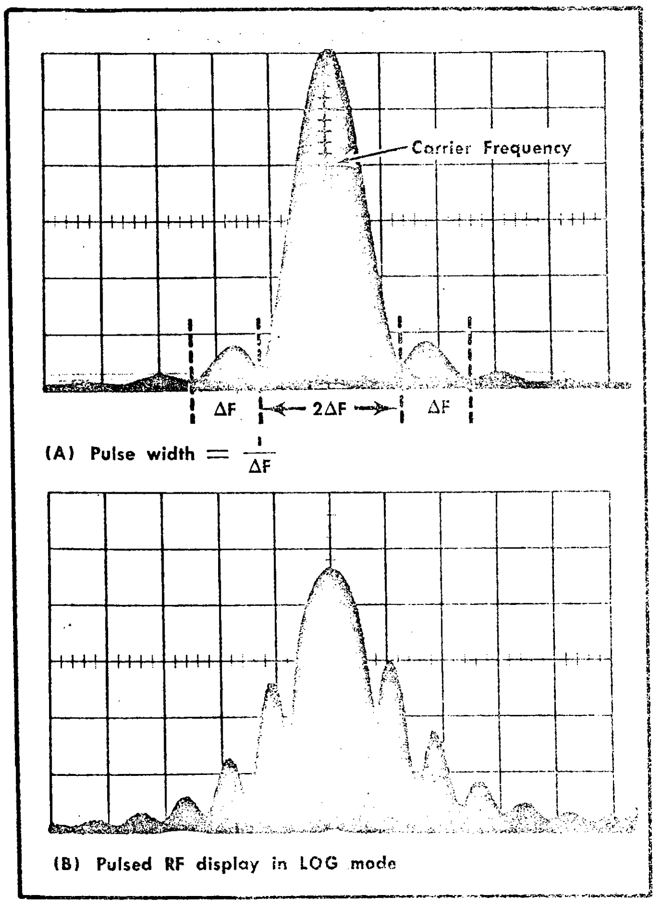


Fig. 2-21. Pulse modulated RF display. Illustrating LIN and LOG mode operation.

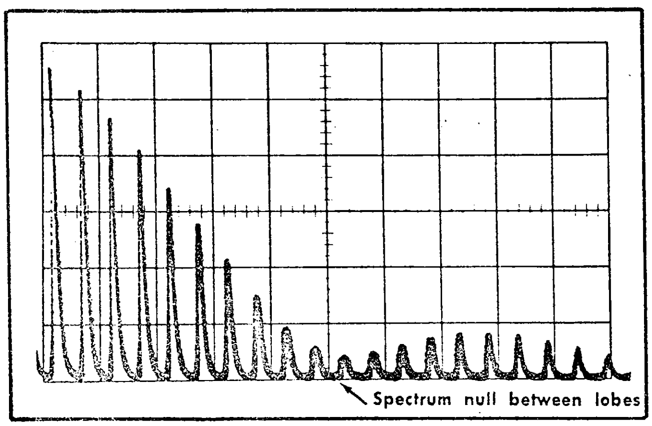
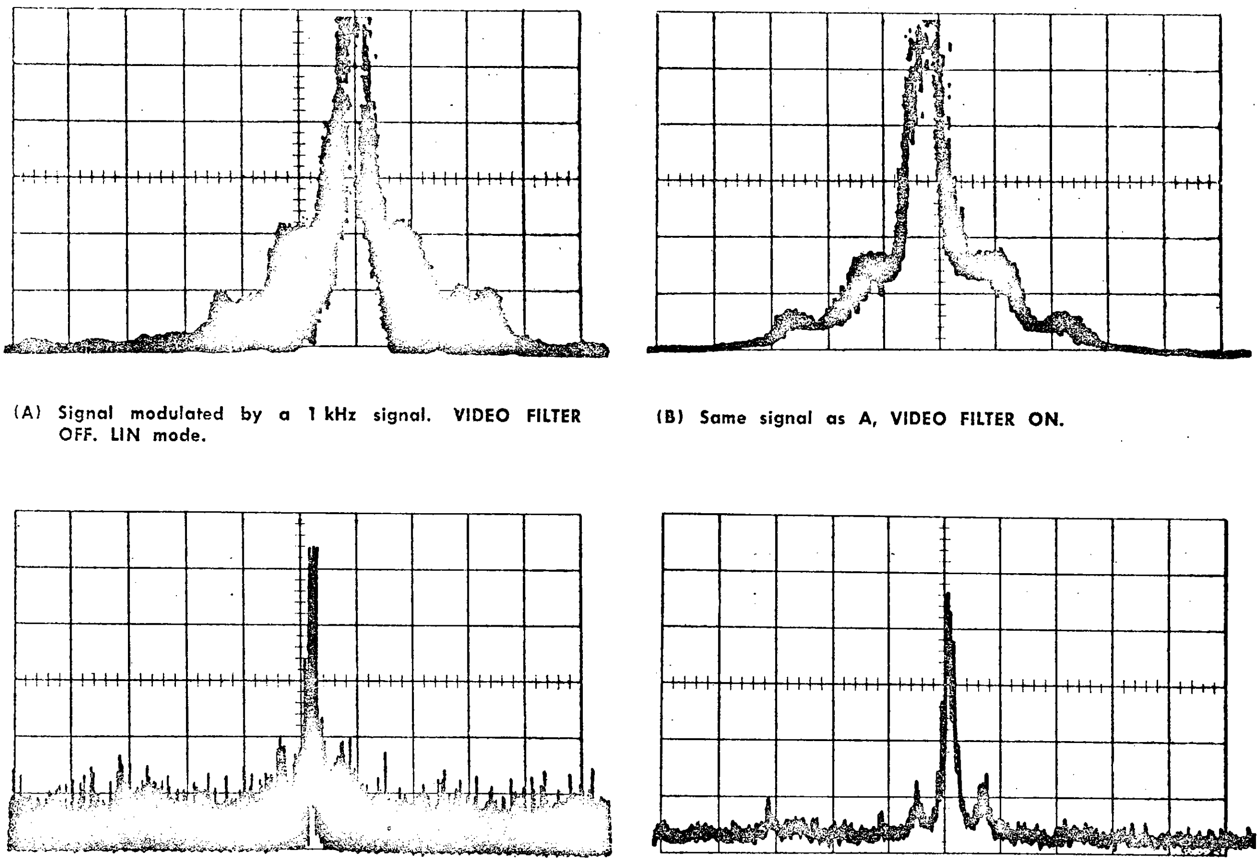


Fig. 2-22. Application of the plug-in oscilloscope magnification feature.

High Resolution Capabilities

Figure 2-23 illustrates resolution capabilities of the Type 1L30. 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.



(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.

SECTION 3

CIRCUIT DESCRIPTION

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

Introduction

The Type 1L30 Spectrum Analyzer is a swept I.F. spectrum analyzer covering the frequency range from 925 MHz to 10,500 MHz. This section presents a block diagram analysis, then a more detailed circuit description of each major section.

Basic Description

A functional block diagram of the Type 1L30 is shown in Fig. 3-1 and in the Diagrams section of this manual.

Signals within the RF spectrum that are applied to the RF INPUT of the analyzer are mixed with the local oscillator fundamental frequency and its harmonics. The converted output frequencies are then applied through a 280 MHz low pass filter so signals from the local oscillator that may generate spurious responses are attenuated before the wide band amplifier stage. The 150 to 250 MHz bandpass filter response is 100 MHz wide, so a wide flat response is applied to the wide band swept IF stage.

The swept frequency output from the second local oscillator mixes with this wide (100 MHz) IF response and generates a second IF of 75 MHz, with a bandpass that is relatively narrow. The frequency of the swept oscillator is synchronized with the horizontal sweep voltage to the CRT. This provides the calibrated dispersion and linear display of the frequency spectrum on either side of the dial or center frequency.

The vertical deflection or amplitude of the signal indicates relative signal strength within the observed frequency domain.

The frequency dispersion (width) of the spectrum window is relative to the amount by which the local oscillator frequency is swept. This dispersion is selectable from approximately 0 kHz/cm to 10 MHz/cm in a 1, 2, 5 sequence.

Calibrated attenuation (in 1 dB steps to 51 dB) is provided by the IF attenuator. 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 bandwidth of this 5 MHz IF can be varied from less than 1 kHz to more than 100 kHz by the variable resolution circuit.

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

RF Section

The RF tuner section of the Type 1L30 contains the local oscillator assembly, the 1st mixer and a 280 MHz low pass filter. The local oscillator is a triode oscillator connected to tuned grid-cathode and grid-plate lines. These lines are tuned by shorting plungers which are moved when the RF CENTER FREQ control is turned. The oscillator fundamental frequency range is 1.125 GHz to 2.25 GHz. Harmonics through the 5th are used to heterodyne with the input signal frequencies to provide the input frequency range from 925 MHz to 10.5 GHz.

Heater voltage for the oscillator is supplied by the +10 volt regulated supply. The heater supply line to V41 includes a shunt dropping resistor, R46, to reduce the voltage to 6 volts.

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 cables are factory-installed and 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.

The mixer combines the RF input signal with the output frequency of the local oscillator to produce an IF centered at 200 MHz.

A peaking circuit in the mixer is used to optimize the conversion action. Efficient mixer action depends on the diode bias and the local oscillator drive. Since bands 2, 3, 4 and 5 use higher order harmonics of the oscillator fundamental frequency range of 1.125 GHz to 2.25 GHz, mixer peaking enhances harmonic conversion. MIXER PEAKING control R66 provides control over the amount of bias to the diode D64. This enhances the harmonic content of the rectified signal and optimizes the sensitivity of the mixer at the different harmonic frequencies being used.

The output signal from the mixer is filtered through a 280 MHz low pass filter to reduce spurious signals above this desired passband. This attenuation plus the 150-250 MHz band pass filter, suppresses signals in the image frequency band of the 200 MHz IF (300 MHz to 400 MHz) amplifier.

Phase Lock Circuit

The phase lock circuit 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 so the signal may be evaluated.

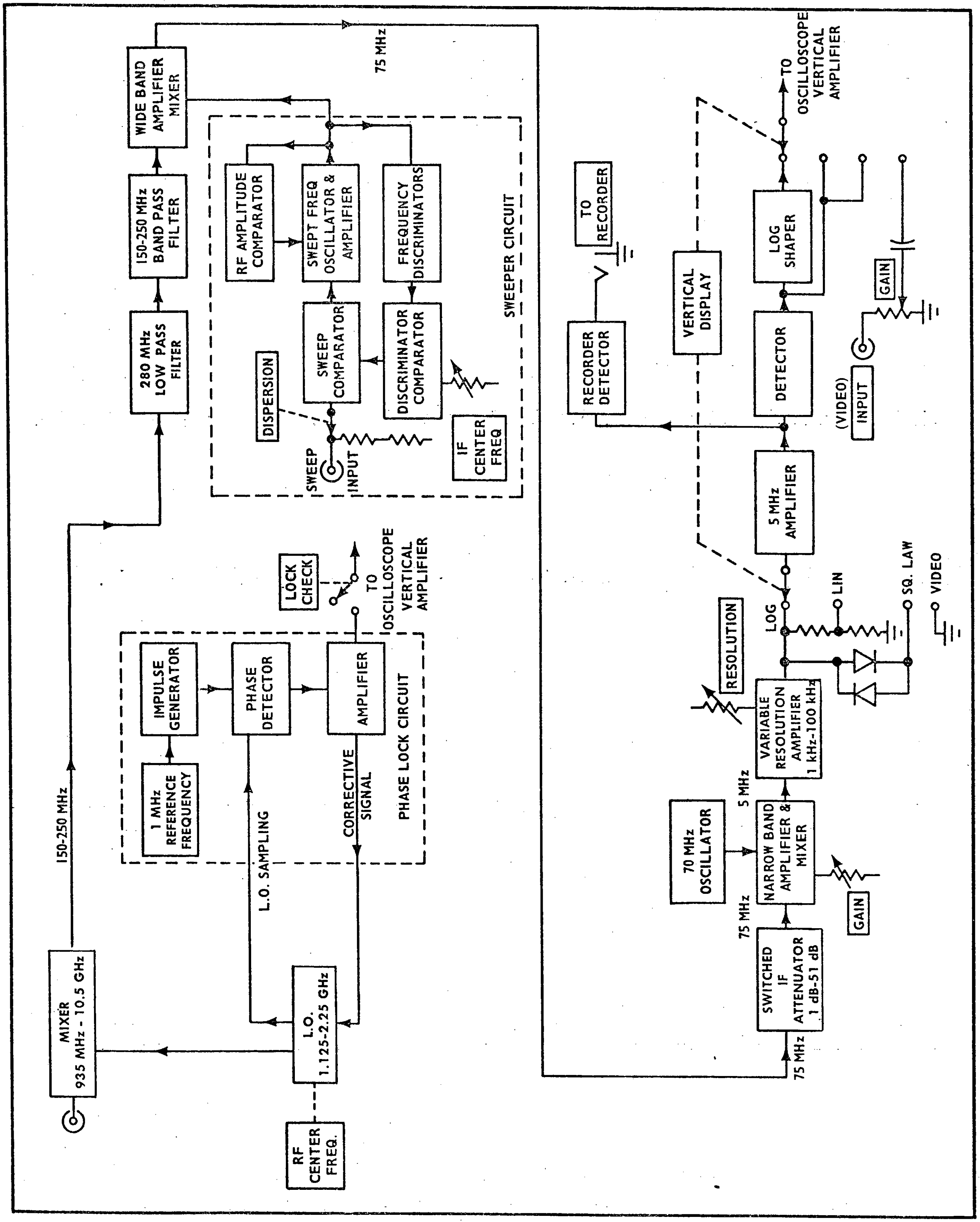


Fig. 3-1. Type 1L30 Block Diagram.

The phase detector samples the instantaneous RF voltage generated by the tunable local oscillator at a rate determined by the reference frequency. The sample voltages are then integrated and applied to a comparator which generates a corrective voltage to feed back to the local oscillator.

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 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 circuit. This corrects or shifts the phase of the oscillator so that it remains phase locked to the reference frequency. See Fig. 3-2 and Fig. 3-3.

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, and phase lock operation will occur. 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 estabilsh the dynamic operating range for the comparator amplifiers Q860-Q870. Phase lock operation should be set within the dynamic range of the amplifiers. This dynamic range is within the center 4 cm of the graticule window.

The reference frequency (either the internal 1 MHz signal from Q800-Y800 or the external REF FREQ IN signal) is converted to a train of positive trigger pulses by the trigger generator circuit of Q820. Q820 is part of a blocking oscillator circuit. In its quiescent state the transistor is turned on by the forward bias on its base circuit. As the input signal swings negative, D821 turns on, pulling the transistor base down. The emitter of Q820 follows the base down, reducing the current in transformer T820. This couples this change back to the base circuit of Q820, causing regeneration. The transistor turns off in approximately 2 or 3 nanoseconds. The third transformer winding of T820 couples the resulting positive-going trigger pulse through D841 to the base of the avalanche transistor Q840.

The quiescent voltage of Q840 is set by the Avalanche Volts adjustment R831 in the base voltage divider circuit of Q830. This sets the avalanche voltage requirements for Q840. The positive portion of the pulse from the transformer T820 triggers Q840 into avalanche, and 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 recovery step which is differentiated and coupled through C847 to the etched circuit transmission line transformer T856-T857.

These transformers provide a 2:1 voltage stepup and converts the single-ended input signal of the snap-off diode to a push-pull balanced output signal across the phase detector diodes. Refer to the swept oscillator description for the discussion on the transformer operation.

The phase detector (Fig. 3-3) consists of two diode gate and low-pass filter. The diodes are reverse biased so the local oscillator signal that is applied to the junction of the diodes will not turn the diodes on. Equal amplitude and opposite polarity strobe pulses of short duration from the pulse forming circuit are applied to the opposite ends of the diodes. These pulses gate the diodes on for the short strobe pulse period.

The voltage at the junction of the two resistors will be the summation of the strobe pulse, plus the instantaneous value of the oscillator voltage. However, since the strobe pulses

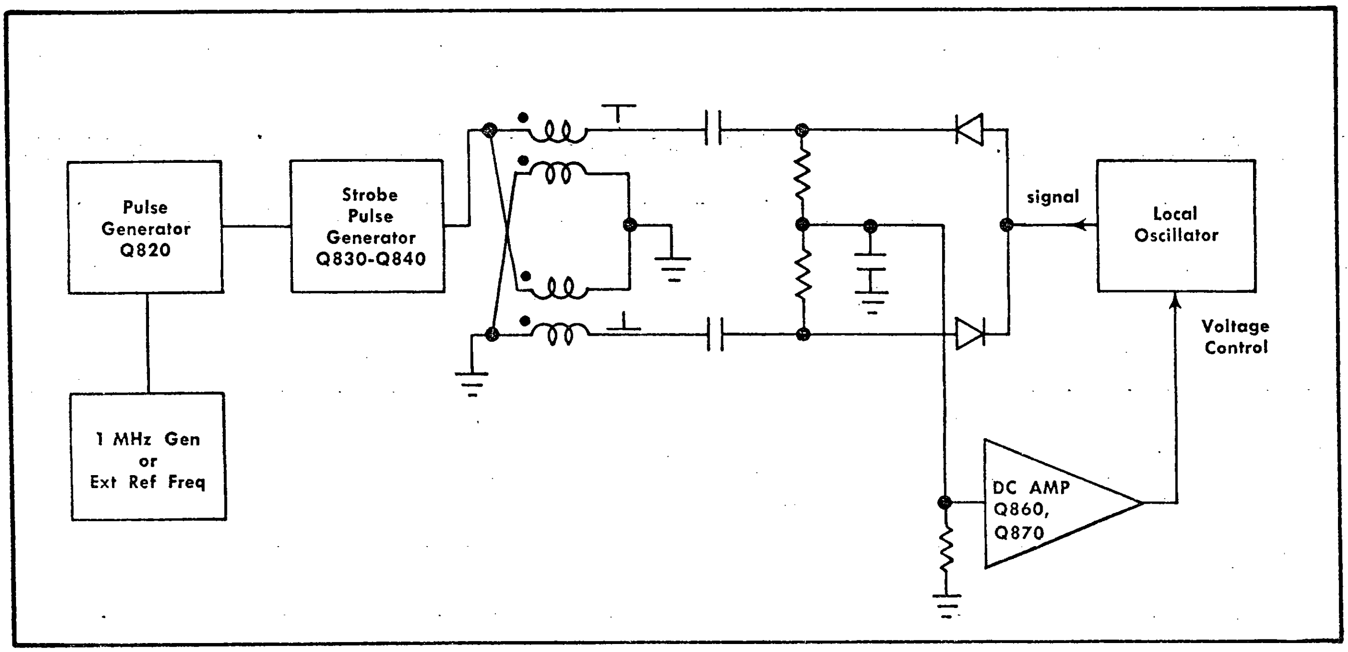


Fig. 3-2. Phase lock block diagram.

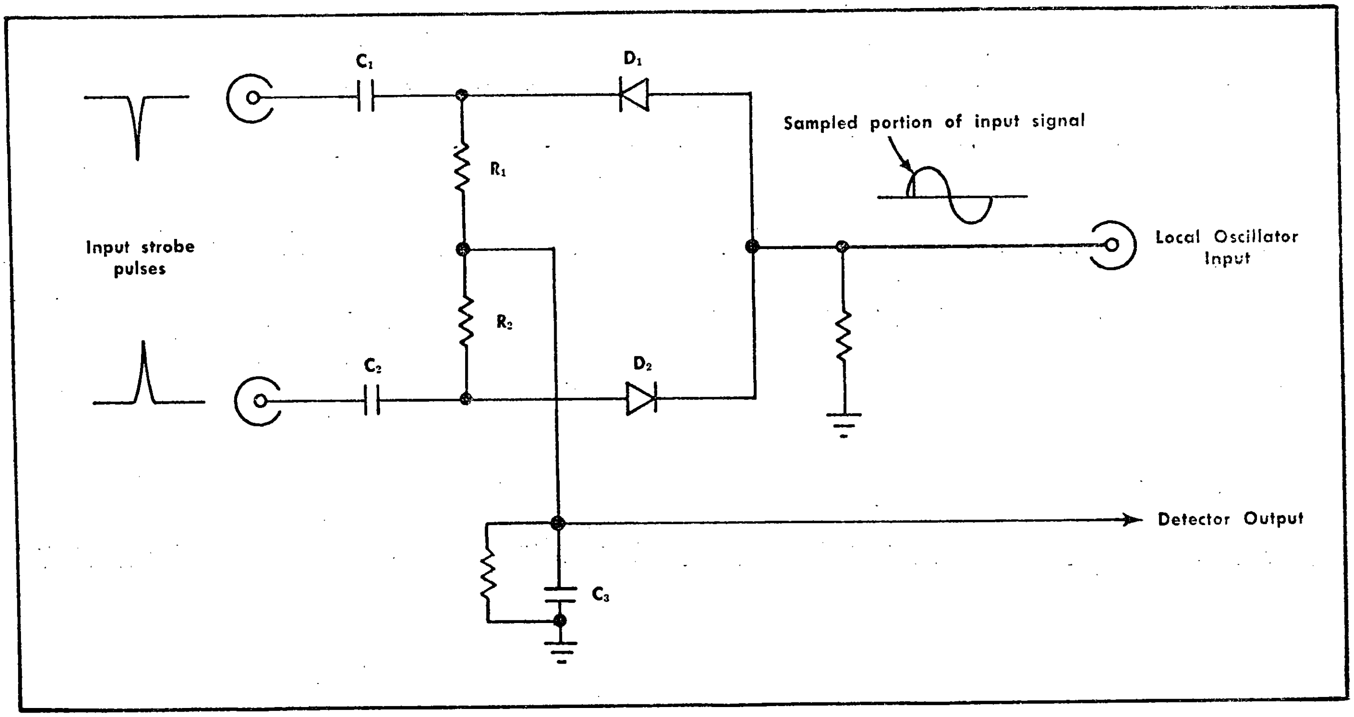


Fig. 3-3. Simplified phase detector circuit.

are of equal and opposite polarity, the resultant voltage will approximately equal the instantaneous (or sampled) oscillator voltage. The capacitor C_3 (Fig. 3-3) charges to the sampled instantaneous voltage. This voltage is applied to a DC amplifier then to the varactor to give correctional control.

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 Q860, 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 trace on the screen to indicate to the operator that a phase lock condition exists.

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 dispersions of 50 kHz/cm or less.

Sweep 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. 3-4.

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 a 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 amplitude. This sawtooth voltage is applied to the attenuation network of the DISPERSION switch SW220.

Sweep Center adjustment R204 sets the dynamic operating range of the comparator Q230-Q240 and shifts the DC level of the output current ramp to the swept oscillator. DISPERSION CAL adjustment R208 calibrates the dispersion for the 10 MHz/cm position of the DISPERSION selector. It adjusts the output amplitude of the current ramp at the collector of Q240. With the 10 MHz/cm position calibrated, the remaining positions of the DISPERSION selector will be within the calibration specifications listed in the Characteristics section.

Two dispersion ranges (MHz/CM and kHz/CM) are provided by the DISPERSION RANGE selector SW230.

Sweep Comparator. The sweep comparator Q230-Q240 output voltage is dependent on the differential amplitude between the ramp signal applied to the base of Q230 and the ramp signal applied to the base of Q240. The ramp signal that is applied to Q240 is the resultant voltage output from a frequency discriminator that is sampling the sweep oscillator output frequency. The signal voltage from the sweep comparator is applied as a bias signal to the capacitance diode D314, changing the capacitance of the circuit to tune the oscillator through the frequency dispersion range in synchronization with the horizontal sawtooth voltage that is applied to Q230.

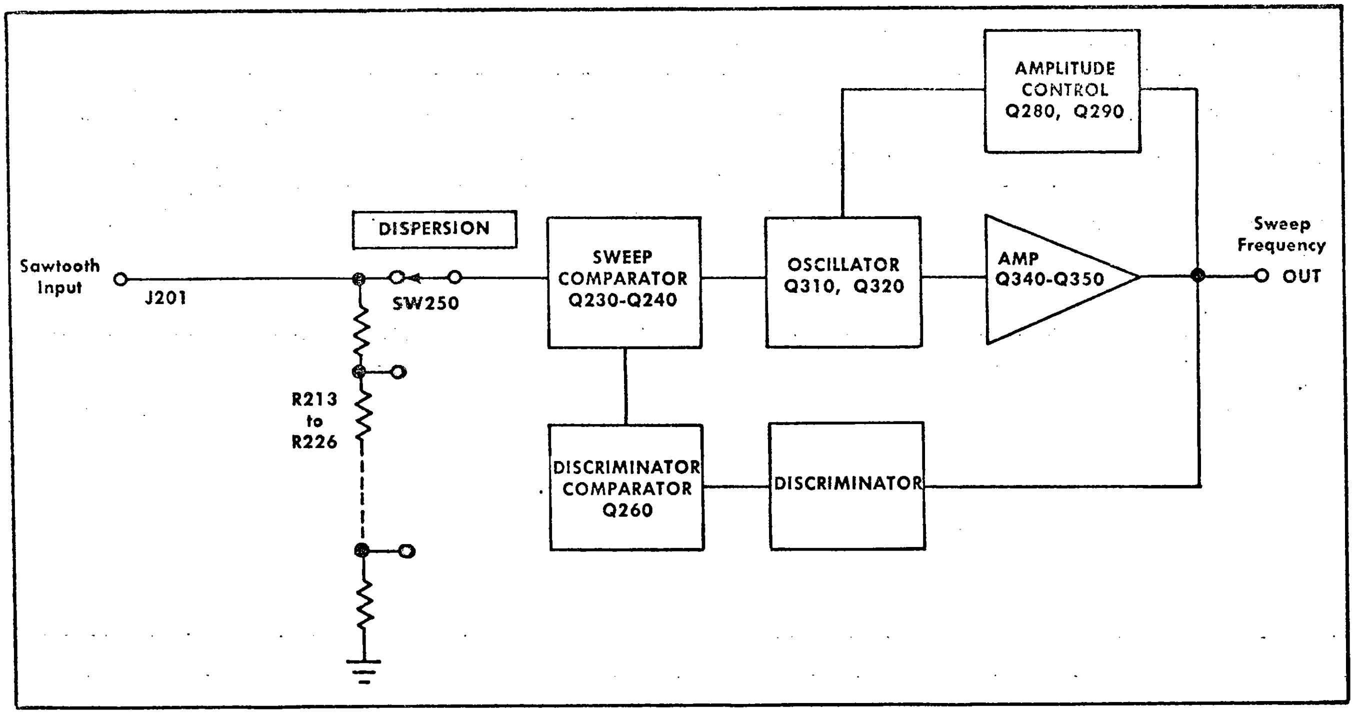


Fig. 3-4. Block diagram of the sweeper circuit.

The emitters of Q230-Q240 are long-tailed through R236 to the —150 V supply. Current through the sweep comparator is approximately 3.0 mA.

Sweep Oscillator. The frequency of the oscillator is primarily a function of the L (L314) and the C (C314) in series with 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 proporational 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 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. 3-5 is a simplified drawing of the transformer circuit. The oscillator is the signal source or generator which supplies the 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 the figure. This voltage across the input windings will produce an equal voltage (e/2) across the output windings with the polarity as indicated.

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

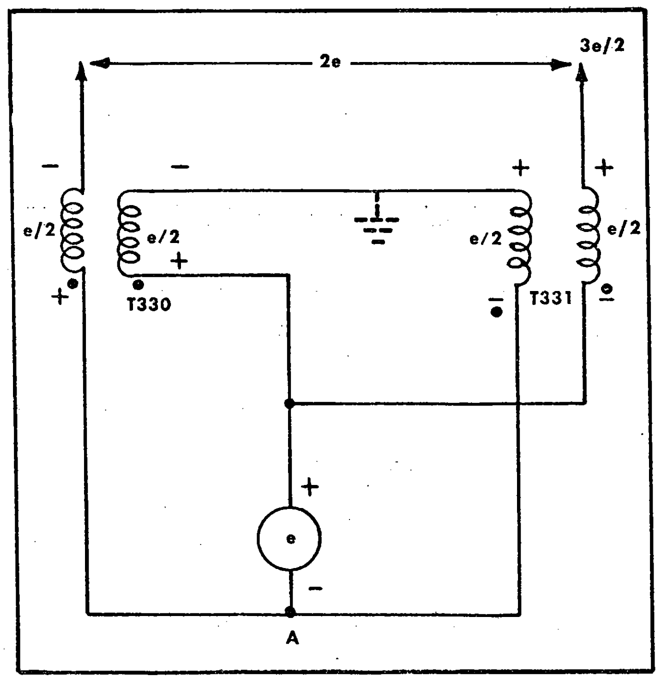


Fig. 3-5. Simplified diagram of the transformer (T330-T331) circuit from the swept oscillator to the push-pull amplifier Q340-Q350.

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 for each position of the DISPERSION RANGE selector SW230 provide an output voltage signal to the frequency discriminator comparator Q260. The output voltage from the comparator is a ramp voltage that is proportional to the sweep oscillator frequency 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 $\frac{1}{8}$ 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 $\frac{1}{4}$ 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 compartor (Q230-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 the DISPERSION RANGE switch SW230 and the DISPERSION selector SW220 setting. This voltage amplitude determines the frequency deviation of the sweep oscillator, or the dispersion of the display.

The discriminator for the kHz/CM position of the DISPERSION RANGE switch consists of two tuned circuits and detectors that operate in a manner similar to the tuned transmission lines for the MHz/CM discriminator. The parallel circuit L384-C384 is tuned slightly below the center frequency, and the circuit L385-C385 is tuned above the center of the swept oscillator frequency. The voltage output versus frequency of the detectors is shown in Fig. 3-6A and 3-6B. When the detector output is applied to the comparator, a voltage-versus frequency curve similar to Fig. 3-6C becomes the resultant output of the 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 sets the slope of the kHz/CM discriminator output to approximately twenty times the slope of the MHz/CM discriminator.

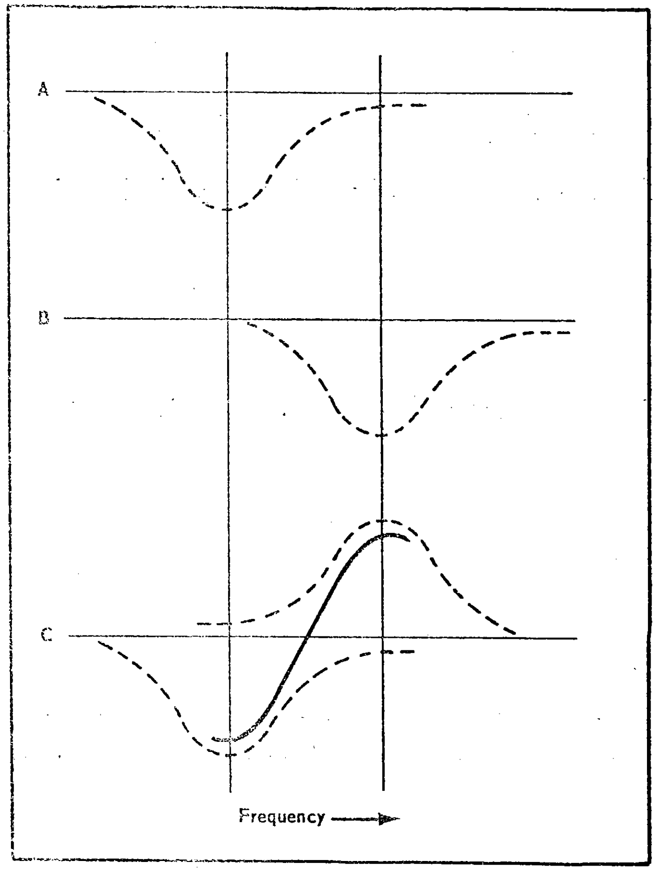


Fig. 3-6. Frequency vs Voltage curves for kHz/CM discriminator circuit. (A) Output from D383; (B) output from D386; (C) output from discriminator comparator Q260.

Diodes D380 and D387 isolate the narrow band discriminator tuned circuit when the Type 1L30 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 the RF Ampl 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 or output power.

To summarize the sequence of operation for the sweeper circuit, assume the output from the sweep comparator Q240-Q230 is a positive-going ramp. 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 (SW230) and DISPERSION (SW220) selector positions.

DISPERSION RANGE BAL adjustment R234 provides IF center frequency balance adjustment between the MHz/CM and kHz/CM dispersion positions. Center Freq Range 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 the 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 transformer 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 push 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 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 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 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 a crystal controlled 70 MHz oscillator Q440 are applied to the mixer amplifier Q450. The collector load of Q450 is T454, which is tuned to 5 MHz and 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 an insulated connector J470 to the input of the variable resolution amplifier.

Variable Resolution Amplifier

The variable resolution amplifier is designed to vary the bandwidth of the 5 MHz IF from over 100 kHz to less than 1 kHz. 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. 3-7A. Crystal Y501 is a 5 MHz crystal, connected

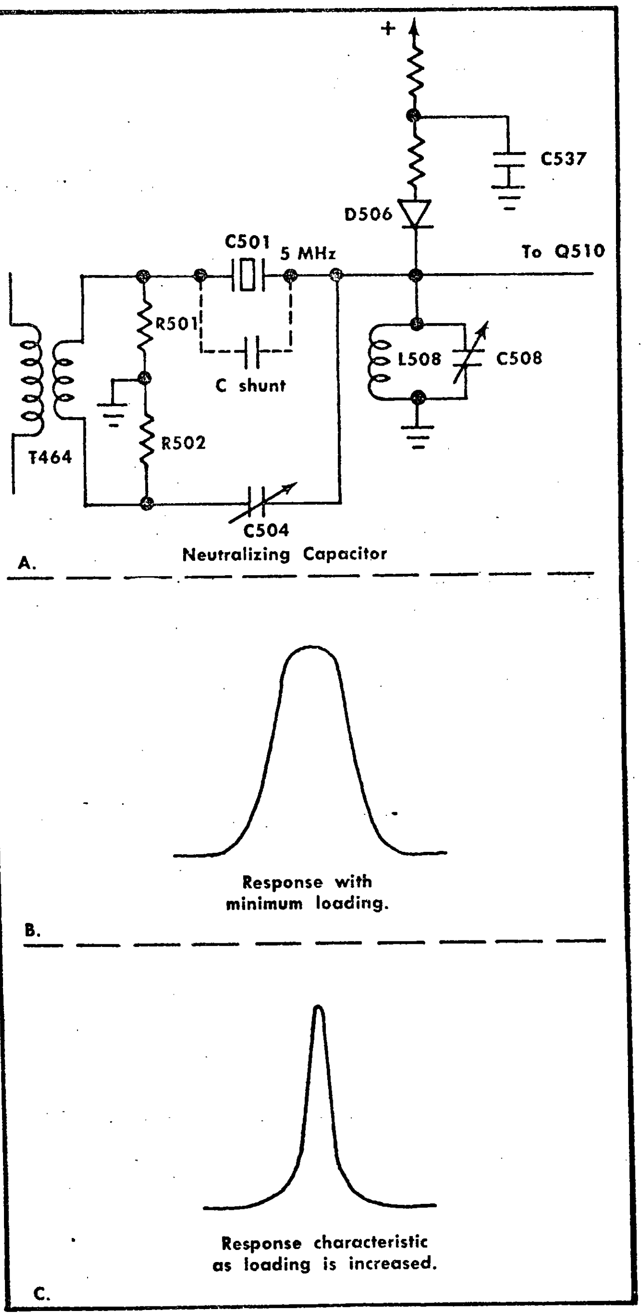


Fig. 3-7. Crystal variable resolution filter.

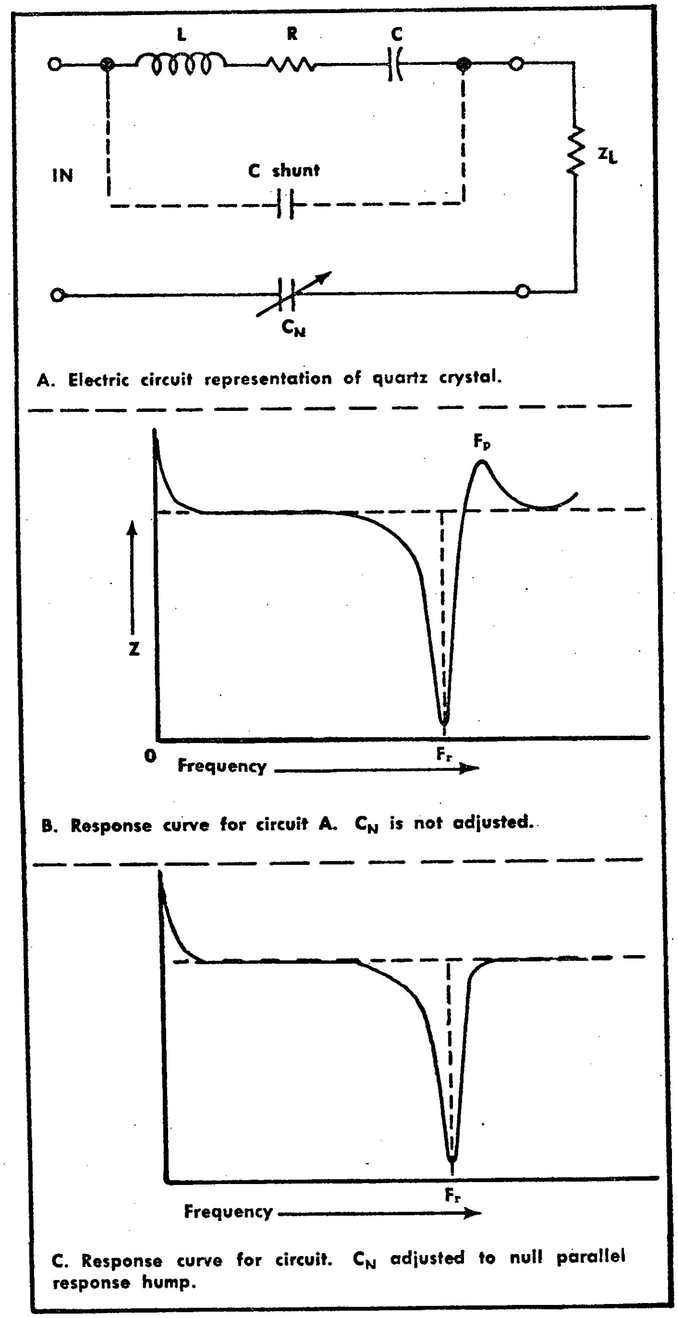


Fig. 3-8. Crystal filter, equivalent circuit and impedance response curves.

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. 3-7 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. 3-8.

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

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 display 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 fast. 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 that is approximately 60 kHz with the RESOLUTION control at the 2nd position and more than 100 kHz bandwidth with the control fully clockwise. 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.

Output and Detector

The 5 MHz IF response from the variable resolution amplifier is applied through a bandpass filter circuit to shape the response and attenuate spurious signals. VERTICAL DISPLAY switch SW660 selects one of three display modes; LOG, LIN and SQ LAW. The VIDEO position changes the display to a time domain display.

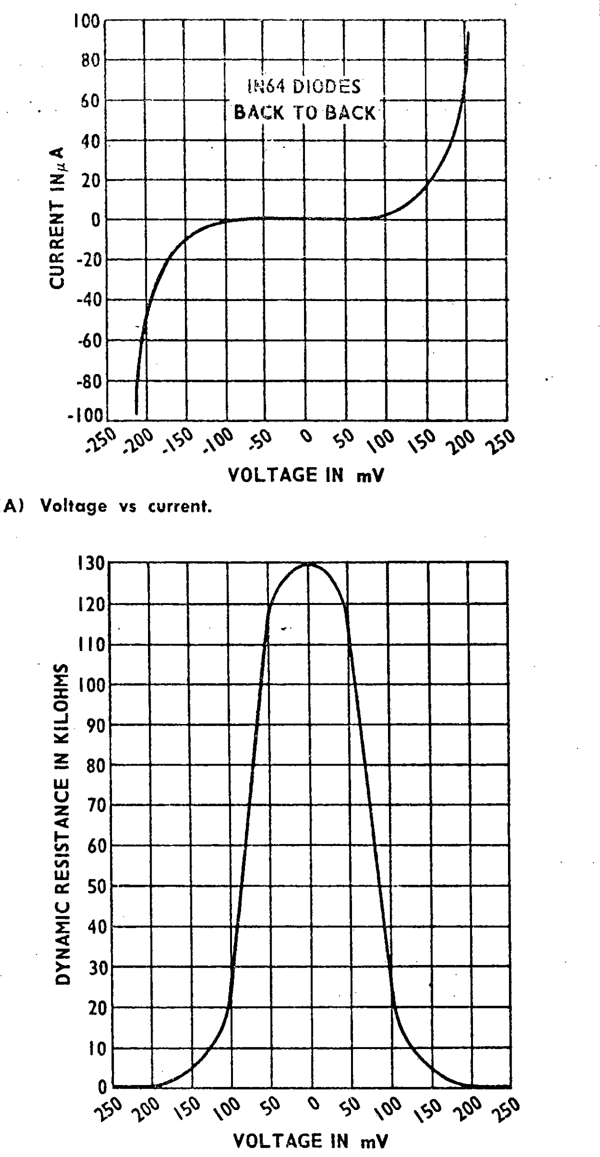
The LOG position applies the signal without attenuation to the amplifier V620. This provides the full dynamic range required for the LOG diode circuit and a logarithmic display over the 6 cm graticule height.

The signal is atttenuated by the voltage divider R606-R607, so that an approximate 4.5 centimeter display in the LIN position will provide 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. 3-9.

Note that diode resistance exceeds 100 kΩ for very low (mV) input signals. The divider ratio is approximately 200:1 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 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 for the SQ LAW display is, therefore, approximately proportional to the signal power.



(A) Voltage vs current.

(B) Voltage vs dynamic resistance.

Fig. 3-9. Diode characteristic curves.

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 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 emitter follower Q650, is longtailed through R653 to the −150 volt supply, and provides a constant DC output level to the vertical amplifier for the plug-in oscilloscope. This maintains minimum baseline shift when the VERTICAL DISPLAY selector is switched between its positions.

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. The GAIN control R411B ganged with R411A in the narrow band amplifier, provides one control to change the gain 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 vertical input so the beat signal display when phase lock operation is set, and the DC output level may be viewed on the CRT screen.

Power Distribution; +10 Volt and −10 Volt Supplies

+10 Volt. This is the reference voltage for the −10 volt supply, the voltage source for the local oscillator heaters and the positive voltage supply for the semiconductor circuits in the Type 1L30. Reference voltage for Q710 is set by the voltage divider R710-R711, between the regulated +225 volt[2] supply and ground. The collector voltage of Q710 controls the current through the series regulator Q717 to the +100 volt supply from the oscilloscope.

−10 Volt. The −10 volt supply is referenced to the +10 volts through the divider R720-R721, which sets the forward bias of Q720. Q720 controls the forward bias of the series regulator Q727 which regulates the current through R727 to the −150 volt source of the oscilloscope.

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[2]**Instruments prior to serial number 670 used +350 as the reference voltage.**

SECTION 4
MAINTENANCE

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

Introduction

This section of the manual pertains to the maintenance and troubleshooting of the Type 1L30. The first portion of the section describes some general preventive measures to help minimize major problems. This is followed with some corrective maintenance information and information on ordering parts or components. The last and major portion of the section describes the removal and replacement of the sub-assemblies and their components, and some general troubleshooting information pertinent to the Type 1L30. Trouble symptoms and possible causes are not listed for this instrument because all circuits are interrelated. Listed causes for various troubles could cause confusion.

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 ammount of use and the 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 (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 500 hours; however, if the tuning shaft tends to bind or drag it may be due to improper 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 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 500 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 are provided in Section 5, Calibration instructions are described in Section 6.

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.

NOTE

Maintenance or repair of the RF assembly, (oscillator, mixer and filter) should only be attempted if adequate facilities and qualified personnel are available. We recommend when possible that the entire unit be returned to a Tektronix Repair Center. Contact your local Field Office or Representative. Replacement instructions for the assembly, the oscillator tubes and mixer diodes are provided in this section. Test equipment and calibration fixtures required to calibrate these assemblies are listed in the Calibration section of the manual, plus a procedure to calibrate the RF section.

Obaining Replacement Parts

Local Purchase. All electrical and mechanical parts replacement 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 switch detent section.

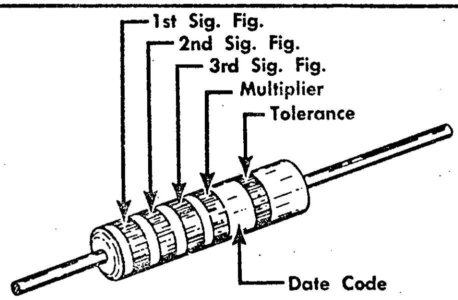
TABLE 4-1

Component Numbering

Component No. Series	Circuit	Diagram
1-99	RF Section	1
100-149	Wide-Band Amplifier & Mixer	4
150-199	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 it value printed on the resistor body. The color-coding sequence is shown in Fig. 4-1.



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 identifies the polarity of the glass diode types used in this instrument.

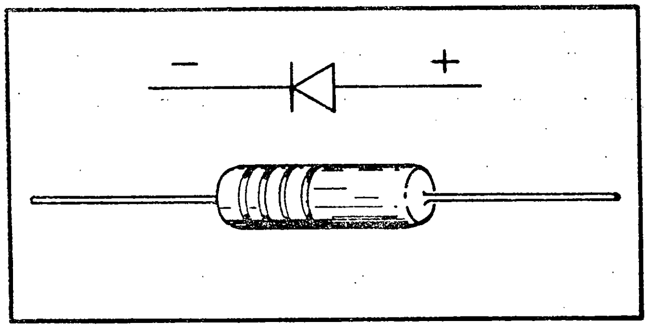


Fig. 4-2. Diode polarity for glass diodes.

Wiring Color Code

The insulated wire used in the Type 1L30 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 1L30.

TABLE 4-2

Wiring Color-Code

Supply	Background Color (Polarity)	1st Stripe	2nd Stripe	3rd Stripe (If applicable)
−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 for 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

WARNING

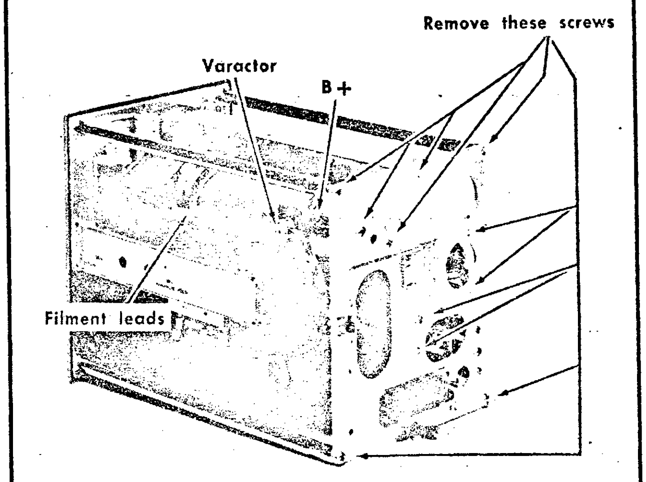
Disconnect the instrument from the power source before attempting repair and/or replacement of any sub-assembly.

Removing the Oscillator Assembly

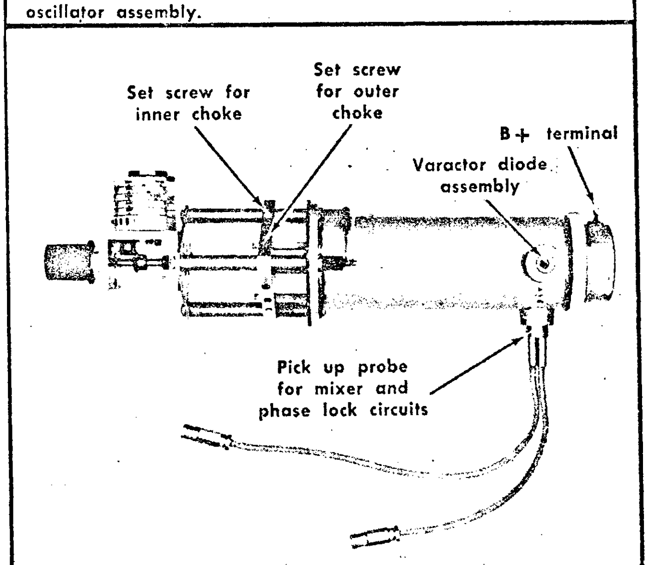
NOTE

A complete oscillator assembly is listed in the Mechanical Parts section with its sub-parts listed under the assembly number. We recommend replacing the complete assembly because it is calibrated and ready to install. If a sub-part (such as a varactor or pick-up probe) is replaced, a complete recalibration of the oscillator is usually required before it can be re-installed in the unit. This calibration requires additional test equipment that is not listed for the standard calibration procedure. See Calibration section.

1. Unsolder the connection to the feedthrough terminal at the rear section plate cap of the oscillator and disconnect the pin connector to the varactor (Fig. 4-3A).



(A) Remove the indicated screws to repair or replace the oscillator assembly.



(B) Oscillator and dial assembly.

Fig. 4-3. Oscillator assembly.

2. Loosen the two Allen screws in the rear mounting bracket on the rear panel.

3. Release the rear panel by removing all screws except the two holding the interconnecting plug, the two holding the sawtooth voltage selector switch and the screws holding resistors R40, R49 and R727. Position the rear panel so as to gain access to the rear section of the oscillator assembly.

4. Unsolder and disconnect the filament wires from the plug-in connector to the blue standoff connector.

5. Disconnect the Sealectro connectors for the two coaxial signal leads to the mixer assembly and the phase lock assembly. Pull out on the connectors to disconnect.

6. Loosen the Allen set-screw, then remove the RF CENTER FREQ tuning knob. Remove the retaining nut under the knob that holds the dial mechanism to the front panel.

7. Lift out the RF section from the rear of the plug-in unit. (Position the rear panel as necessary for adequate clearance.)

8. Re-install the new oscillator assembly using the reverse of the removal procedure. Recalibrate in accordance with the procedure outlined in the Calibration section.

Removal and/or Replacement of the Oscillator Tube

1. Perform steps 1 through 3 of the procedure for removing the oscillator assembly.

2. Carefully, (by hand) unscrew and remove the large knurled ring on the rear portion of the oscillator assembly. See Fig. 4-4.

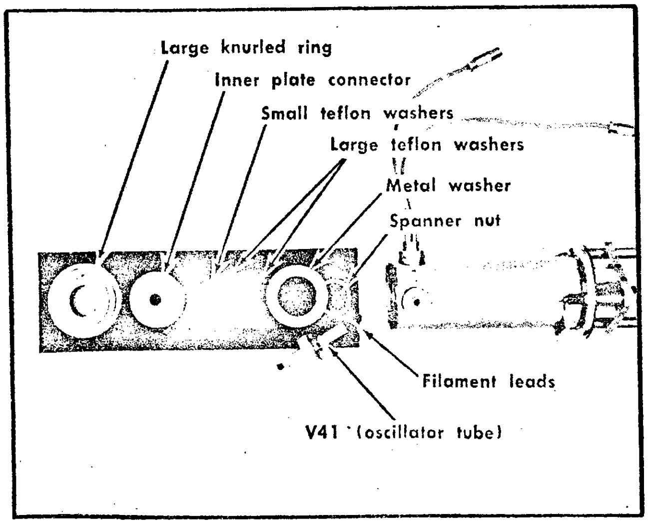


Fig. 4-4. Oscillator disassembled to show the sequence as the components are removed or installed.

3. Carefully remove the inner plate connector and lift out the large and small teflon insulating washers. This exposes the tube and spanner retaining nut.

4. Using special tool Tektronix Part No. 003-0397-00 (see Fig. 4-6) unscrew the spanner nut, then gently lift out the tube while feeding the heater wires into the opening at the front end of the oscillator.

5. Unsolder the filament leads from the tube and reconnect the leads to the new tube. Do not unsolder the wires at the standoff insulators on the outside of the oscillator. The replacement tube should be an assembly containing the feedback block and wires. See Figs. 4-4 and 4-5.

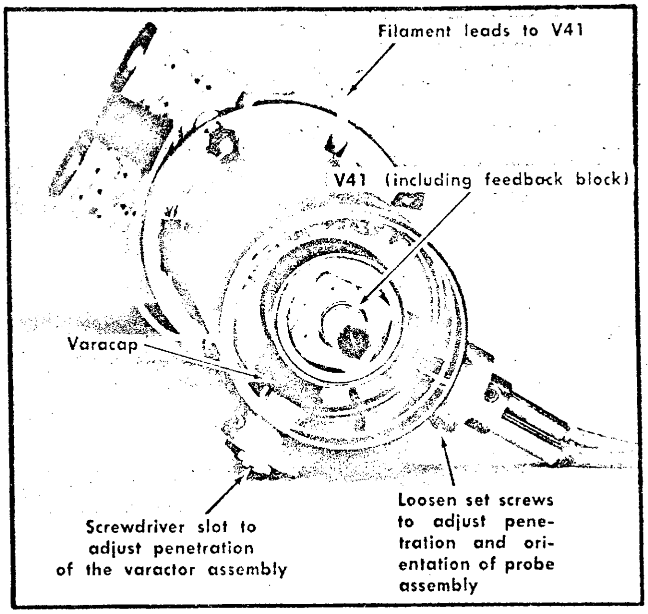


Fig. 4-5. Oscillator partially disassembled to show the position of the tube when seated properly and the location of the calibration adjustments.

6. Replace the insulation tape around the tube filament connection and carefully insert the new tube assembly into the oscillator making certain the tube is well seated in the grid connector.

7. Replace the spanner nut with the special spanner wrench and tighten by hand so the nut is snug. Tighten only enough to make a good seat; do not over-tighten.

8. Replace the two large teflon and the small teflon washers with new washers. All three washers should be inspected to insure that they are free of dirt or foreign matter that could puncture the washer.

9. Replace the internal plate connector and the large knurled nut. As the large knurled nut is tightened, the operator should move the large tuning choke in and out of the tuning chamber by turning the tuning shaft, to insure that it moves freely.

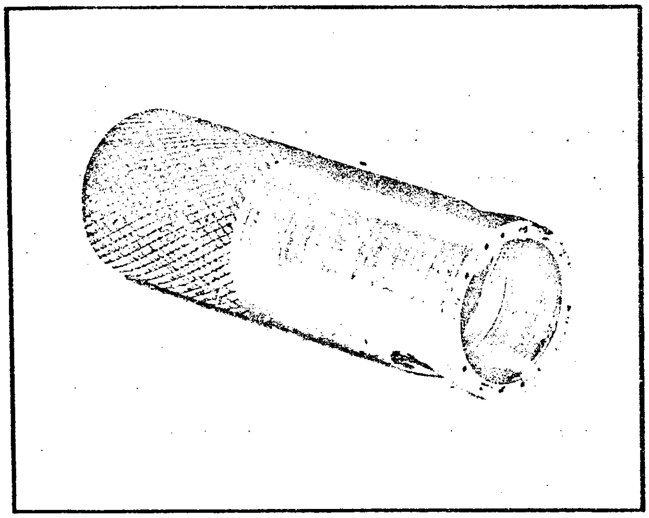


Fig. 4-6. Spanner wrench required in the removal of the oscillator tube. Tektronix Part No. 003-0397-00.

10. Recalibrate as directed in the Calibration procedure.

Replacing the Mixer Diode

1. Remove the front panel mounting nut and washer for the RF INPUT connector.

2. Slip the mixer assembly back and out of the unit.

3. Unscrew the barrel (1 dB pad) (see Fig. 4-7) and replace the mixer diode.

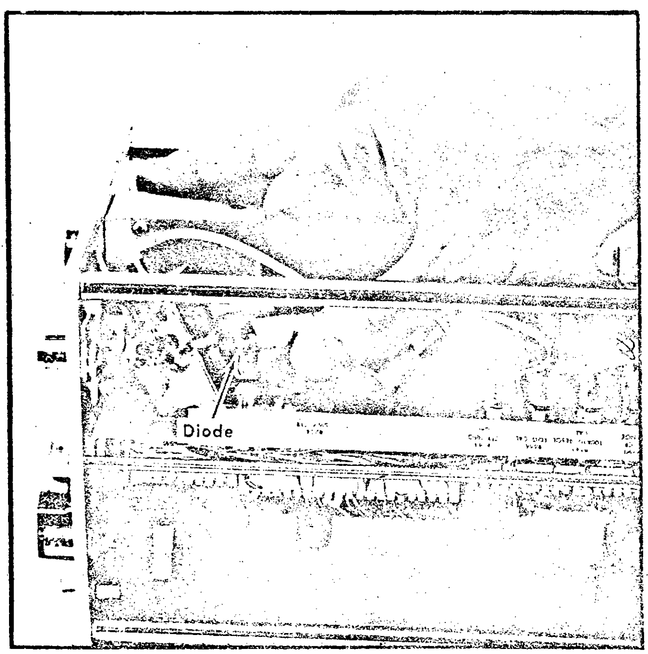


Fig. 4-7. Location of the mixer diode.

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.

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. 4-8). 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. 4-9 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. 4-15 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. Wire and cable color code are shown in Fig. 4-9.

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 (J855) 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 1 MHz REF FREQ switch). Keep the nut for the INT 1 MHz REF FREQ switch 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.

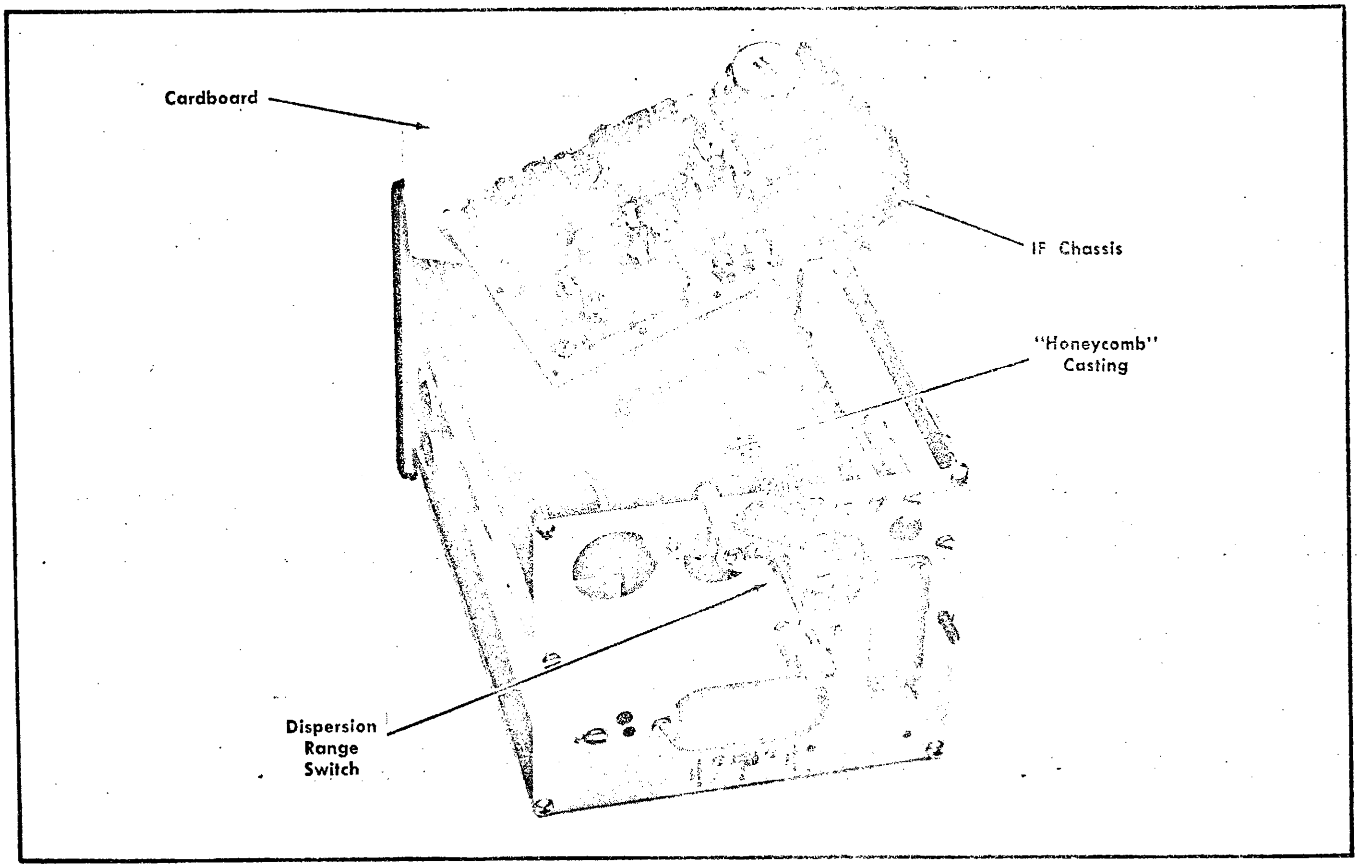


Fig. 4-8. One method of removing the IF chassis for troubleshooting.

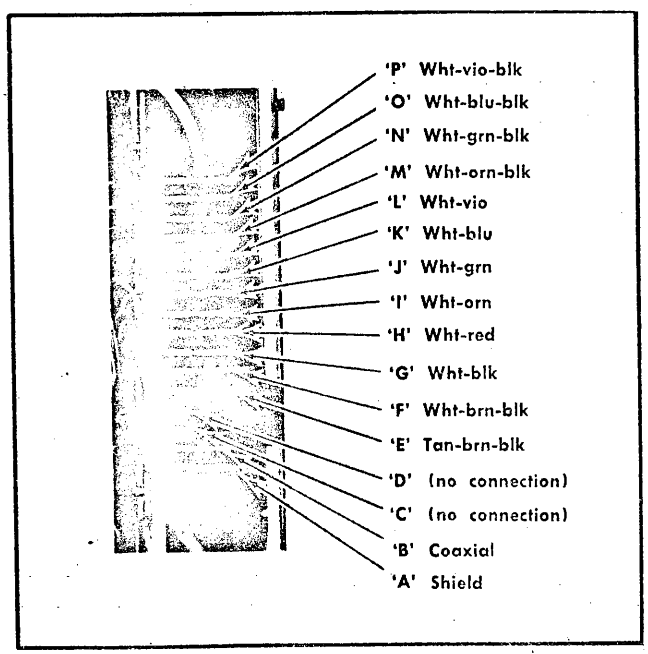


Fig. 4-9. Wire and cable color code to the honeycomb square pin connector.

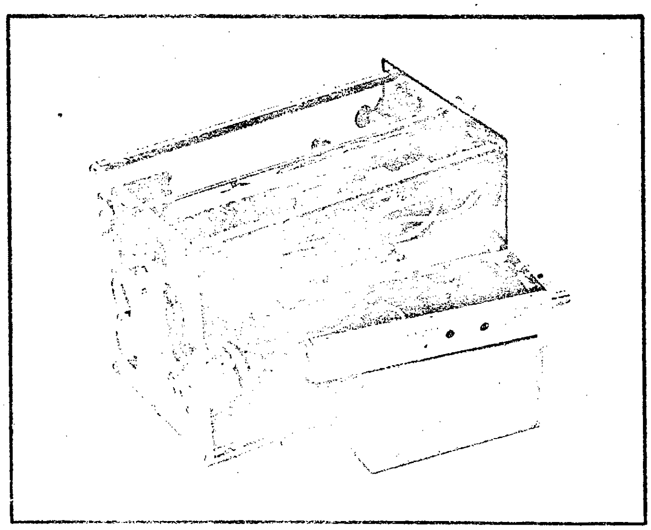


Fig. 4-10. Phase lock assembly removed and ready to troubleshoot.

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. 4-10), then connect the signal lead from the oscillator to

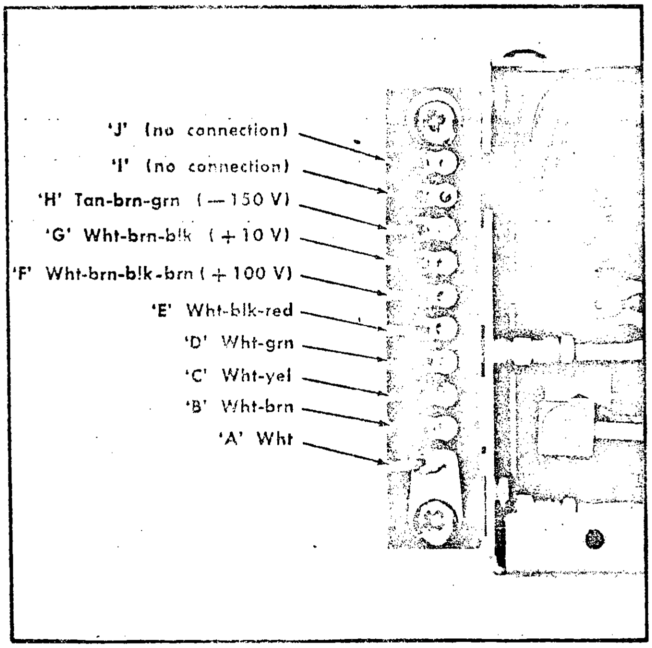


Fig. 4-11. Wiring color code to phase lock assembly square pin connector.

J855. Check the lead dress and all connectors to insure that no short circuit exists and all connections are correct (see Fig. 4-11). Power can now be applied and the phase-lock circuit checked for correct voltages and waveforms. Fig. 4-14 illustrates component layout on the circuit board.

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.

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 1 MHz REF FREQ switch.

2. Refer to the Phase Lock diagram and Fig. 4-11 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.

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. 4-12) 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 alternative 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

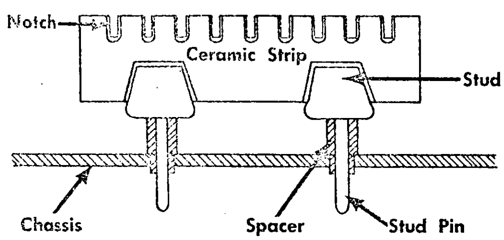


Fig. 4-12. Typical ceramic strip assembly.

oriented to reduce or control circuit capacitance and inductance. After repair, the circuits of the instrument may need recalibration.

Replacing Components on Metal Terminals

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 ⅛ 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 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.

Removing and Replacing Switches

Single wafers on the VOLTS/CM or 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 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. 4-13 illustrates the connections and positions for the types of transistors used in the Type 1L30.

TROUBLESHOOTING

Attempt to isolate trouble to one circuit through operational and visual checks. Verify that the trouble is actually a malfunction within the Type 1L30 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 9 of this manual. Figs. 4-14 and 4-15 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% for all ranges.

Connections to the honeycomb chassis and the Phase-Lock chassis are made through square-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 di-

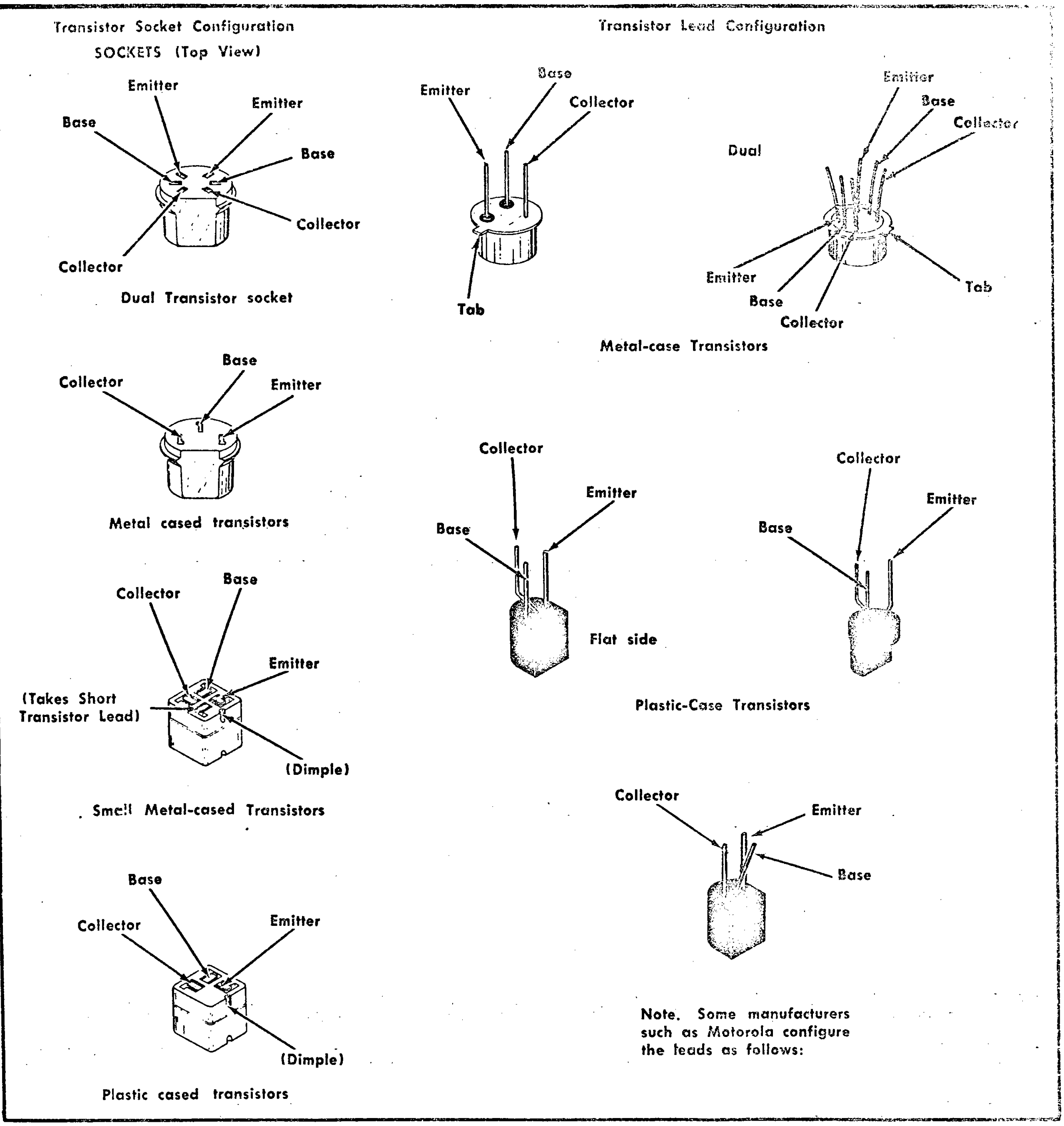


Fig. 4-13. Semiconductor base pin and socket arrangements.

ode 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.

Some Trouble Symptoms

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.

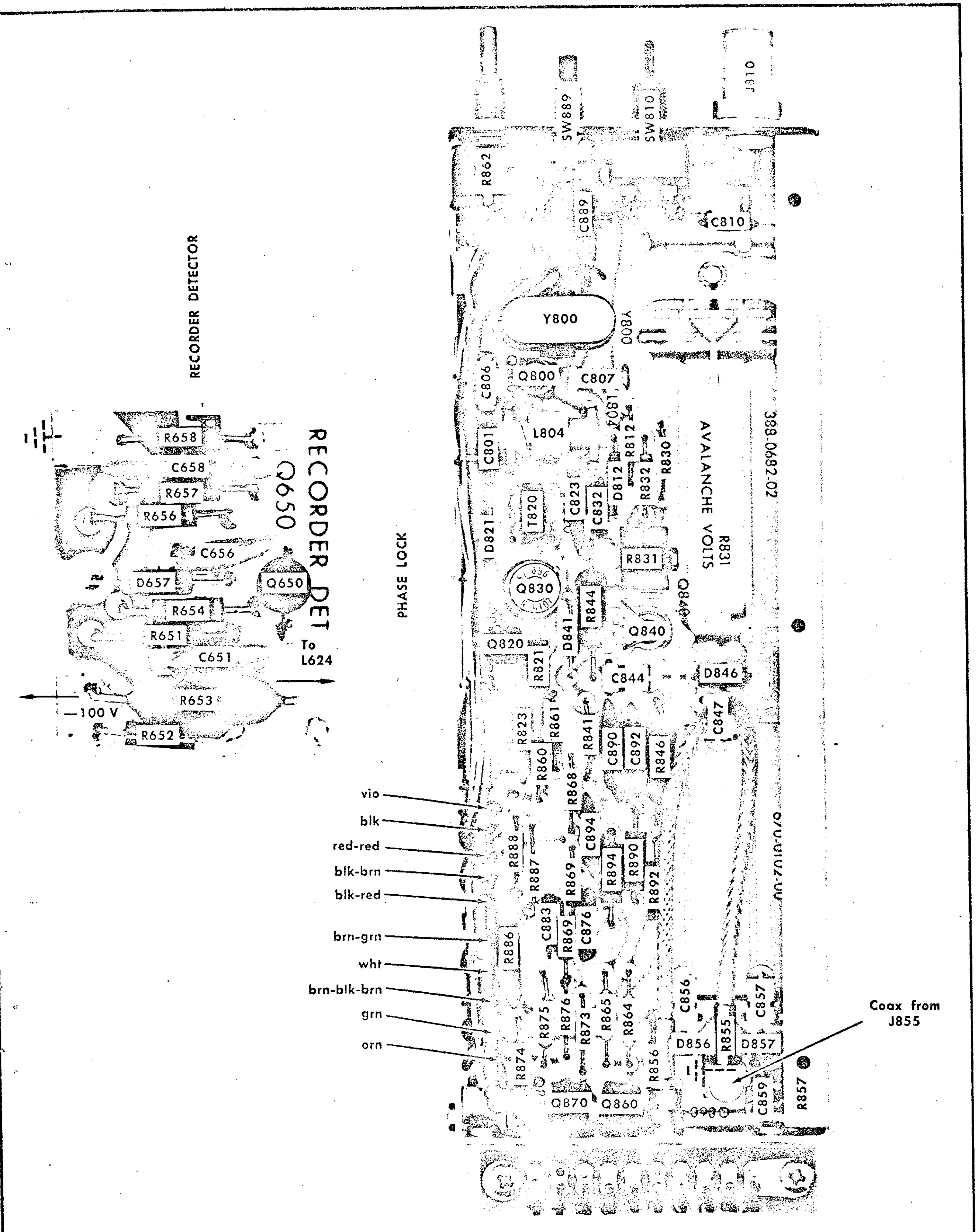


Fig. 4-14. Phase Lock and Recorder Detector circuit boards.

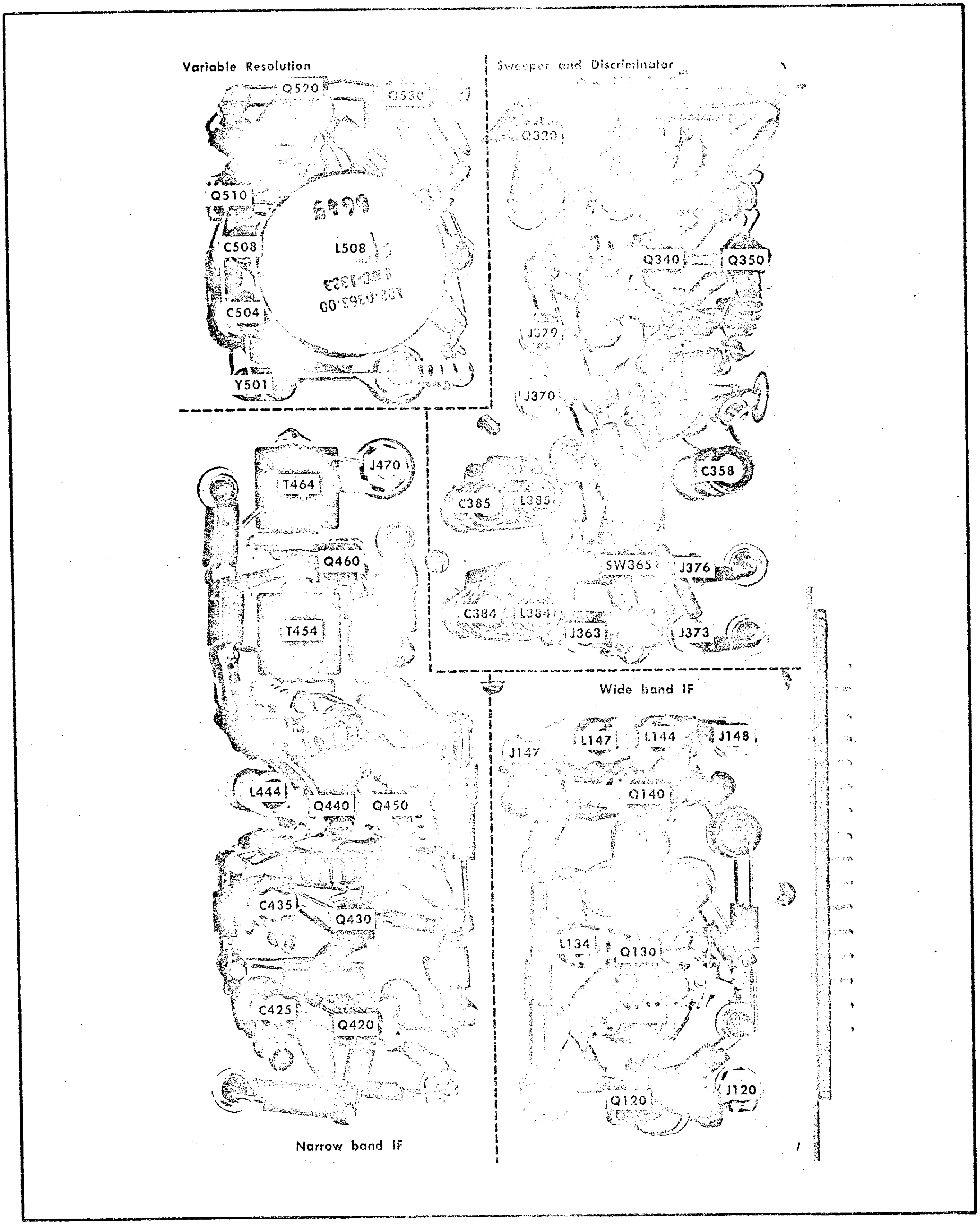


Fig. 4-15. Honeycomb assembly circuit and component layout.

SECTION 5
PERFORMANCE CHECK

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

This section of the manual provides a means to check the performance of the Type 1L30. It is intended to check the calibration of the instrument without performing the complete Calibration Procedure. The Performance Check does not include adjustment of any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, details of which will be found in the Calibration Procedure.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment must be calibrated and working within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment. Signal generators should have output signals relatively free of distortion.

1. Plug-In Oscilloscope. Oscilloscope with a 6 cm vertical display height that will accept the Type 1L30 Spectrum Analyzer. This oscilloscope should be the same as the Type 1L30, being calibrated, will normally be operated with. The front panel adjustment will require readjustment if the analyzer is changed to another oscilloscope. A Type 545B Oscilloscope is used in this procedure.

2. Test Oscilloscope and Vertical Plug-In Unit plus 1× and 10× probes; minimum sensitivity .005 V/cm, frequency response DC to 30 MHz. Tektronix Type 540-series Oscilloscope with Type 1A1 Plug-In Unit and Tektronix P6010 (10×) and P6011 (1×) test probes.

3. Time-Mark Generator. Marker outputs, .5 s to .1 μs and frequency outputs of 20 MHz, 50 MHz, 100 MHz and 200 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 ±3%. General Radio Model 1310A or Hewlett-Packard Model 241A.

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

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

7. Step Attenuator; 1 dB steps and 10 dB steps, accuracy ±1%. Hewlett-Packard Type 355D and Type 355C.

8. (Optional). Swept-frequency Generator: Frequency range: 130 MHz to 280 MHz, with amplitude variation 0.25 dB or less. Kay Type 122C Sweep Generator.

9. (Optional). Harmonic Modulator: Tektronix Calibration Fixture 067-0518-00.

10. Two (2) 10× Attenuators: Tektronix Part No. 011-0059-00.

11. 2× Attenuator: Tektronix Part No. 011-0069-00.

12. 20 dB, RF Attenuator: Tektronix Part No. 011-0086-00.

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

14. BNC T connector: Tektronix Part No. 103-0030-00.

15. Adapter, GR to N male: Tektronix Part No. 017-0021-00.

16. Adapter, GR to BNC female: Tektronix Part No. 017-0063-00.

17. Adapter, BNC female to N male: Tektronix Part No. 103-0045-00.

18. Miniature phone plug with 600 Ω load. (Test fixture to check RECORDER signal amplitude.) Consists of a 600 Ω, 5% ½ watt resistor, soldered across a miniature phone plug.

19. Two (2) adapters. Sealectro to GR: Type P6040 probe cable, Part No. 010-0133-00; or Sealectro to BNC, Type P6041 probe cable; Part No. 010-0164-00.

20. Two (2) BNC coaxial cables, 50 Ω. Tektronix Part No. 012-0057-01.

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

22. Group Two

RF Signal Generators, with calibrated frequency and output power: Frequency range 925 MHz to 10,500 MHz, accuracy ±1%; output power —100 dBm to —30 dBm, 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 Type 1107 Microwave signal generator 3.8 GHz to 8.2 GHz.

Polarad Type 1108 Microwave signal generator 6.95 GHz to 11.0 GHz.

PERFORMANCE CHECK PROCEDURE

General

In the following procedure, test equipment connections or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step (s) for setup information.

The following procedure uses the equipment listed under Recommended Equipment. If substitute equipment is used, control settings or setup may be altered to the requirements of the equipment used.

Several checks require a 200 MHz signal. This IF feedthrough signal is not tunable. To avoid interference from the converted signals, it is recommended that any tunable signals are tuned off screen or aligned with the stationary markers by adjusting the RF CENTER FREQ control.

Preliminary Procedure

a. Before inserting the Spectrum Analyzer into the oscilloscope compartment, set SW201 (slide switch mounted on the rear plate of the analyzer) to the appropriate position for the oscilloscope sweep amplitude.

b. Insert the Spectrum Analyzer into the oscilloscope, fasten the securing latch, and turn on the power. Allow 20 minutes for warm up.

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

CAUTION

Be careful when making this connection. The sawtooth voltage can give a severe shock. Insure that the cable is connected to the SWEEP INPUT, not to the nearby RF INPUT connector.

d. Set the oscilloscope Mode (or Horizontal Display) switch to A or Normal.

e. Set the sweep controls for a free-running, 10 ms/cm sweep speed.

1. Check IF Central Frequency Calibration and Dispersion Balance

a. Requirement—The IF center frequency, with the IF CENTER FREQ controls centered, must be adjustable to 200 MHz with the IF CENTER FREQ-CAL adjustment. There should be less than 2 cm horizontal display shift between the MHz/CM and kHz/CM displays.

b. Apply a 200 MHz signal (2nd harmonic of 10 ns) from the Time-Mark Generator (Type 184) through a 20 dB attenuator pad and 50 Ω termination to the RF INPUT connector. (Signal input to the Type 1L30 should be less than —30 dBm.)

c. Set the Type 1L30 front panel controls as follows:

POSITION	Position the trace to the bottom graticule line
IF CENTER FREQ	Centered (000)
FINE IF CENTER FREQ	Centered
DISPERSION RANGE	MHz/CM
DISPERSION-COUPLED RESOLUTION	10 MHz/cm
VERTICAL DISPLAY	LIN
VIDEO FILTER	OFF

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

e. With the IF CENTER FREQ controls centered, adjust the IF CENTER FREQ-CAL for minimum horizontal signal shift as the DISPERSION control 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.

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 1 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.

2. Check Dispersion Accuracy of MHz/CM Ranges and Range of IF Center Frequency Control

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

b. Apply .1 μs and 10 ns time markers from the Time-Mark Generator (Type 184) through a 20 dB attenuator and 50 Ω termination 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. 5-1 and 5-2.) 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.

f. Check the range, dispersion accuracy and linearity of the IF CENTER FREQ control 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 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

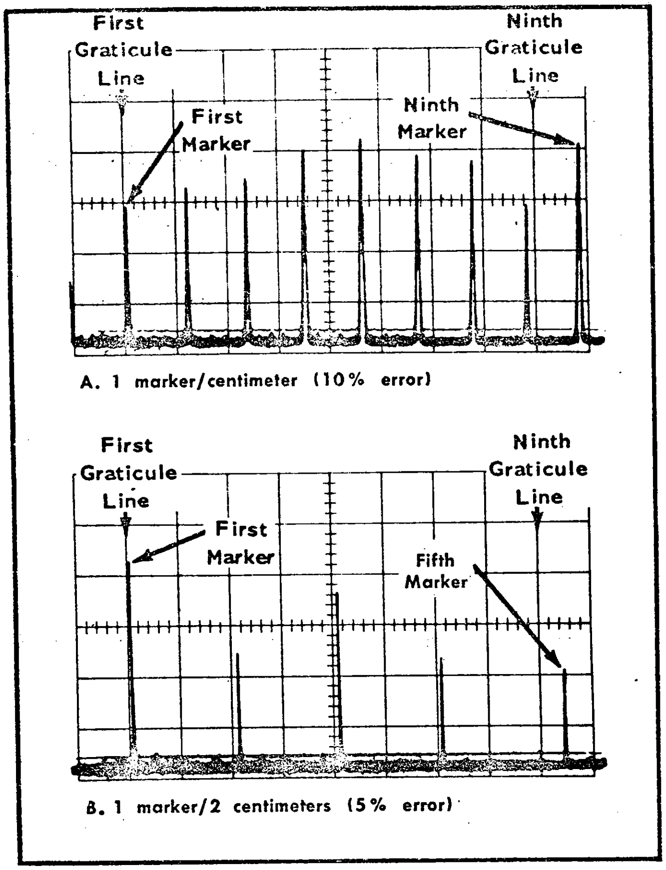


Fig. 5-1. Measuring dispersion accuracy.

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 1 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.

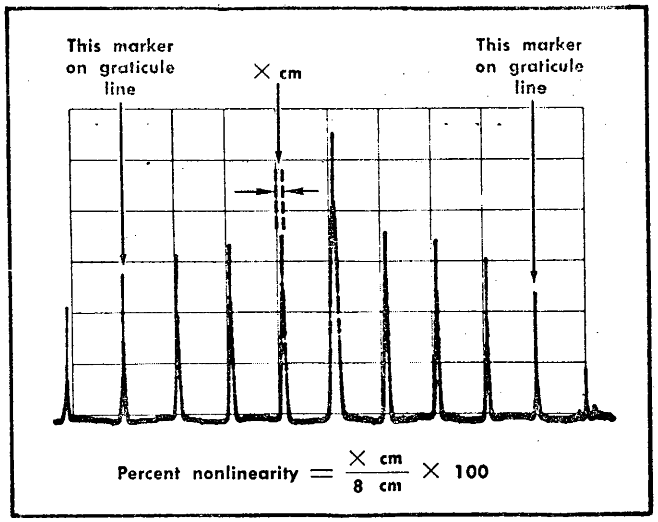


Fig. 5-2. Measuring dispersion linearity.

3. Check Resolution Bandwidth

a. Requirement—Resolution bandwidth is variable from 1 kHz or less to 100 kHz or more.

b. Apply 200 MHz signal from the Time-Mark Generator to the RF INPUT connector through a 20 dB attenuator. Switch in 20 dB of IF Attenuation on the Type 1L30. 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 100 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 1L30 to the 200 MHz signal at the —6 dB points. To check

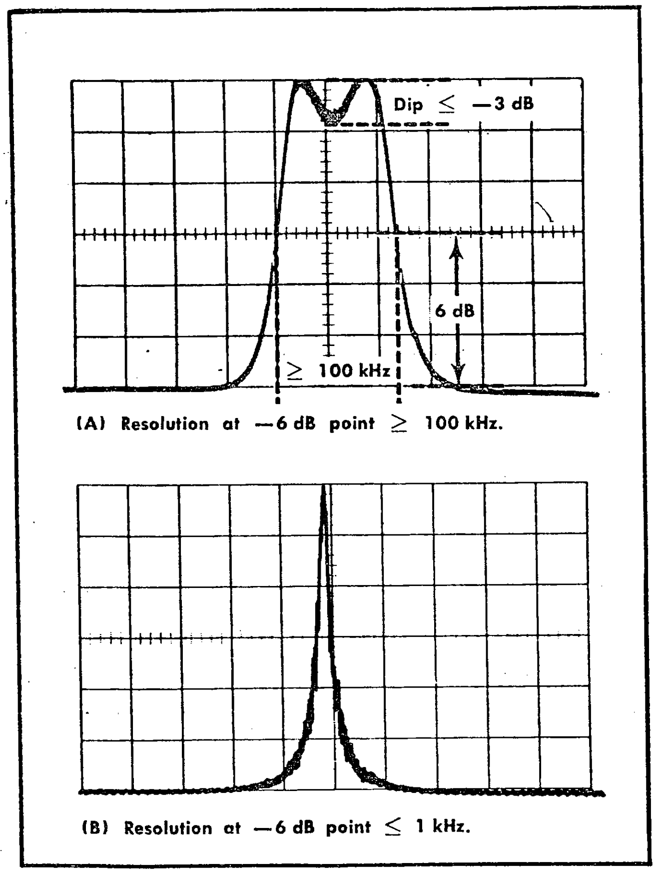
TABLE 5-1

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%	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	±5%	
.5 MHz	10 ns and 1 μs	1 marker/ 2 cm	±10%	
.2 MHz	10 ns and 5 μs	1	±15%	Display linearity over a 10 centimeter display must be within ±3%.

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 −6 dB resolution bandwidth of at least 100 kHz. See Fig. 5-3A.

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. 5-3B.



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

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

Fig. 5-3. Display pattern when resolution is correctly adjusted.

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

4. Check Dispersion Accuracy of kHz/CM Ranges

a. Requirement—Accuracy must equal or exceed ±3%.

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

c. Change the VERTICAL DISPLAY switch to the LIN position (Sweep rate 20 ms/cm or slower).

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

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

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

g. Check the range of the IF CENTER FREQ-FINE control. Frequency range must equal or exceed + and − 50 kHz from the centered position.

h. 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.

i. Check dispersion accuracy over a + and − 2.5 MHz change in the IF center frequency, at the DISPERSION selector positions listed in Table 5-2.

Dispersion accuracy must remain within ±3% (2.4 mm) for all DISPERSION settings and through + and − 2.5 MHz change in the IF center frequency.

As the dispersion is decreased, the sweep time should 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.

j. Turn the VIDEO FILTER switch to OFF.

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

5. Check Operation of Video Filter

a. Requirement—Filter should restrict the video bandwidth and reduce high frequency video components such as noise when viewing signals near minimum resolution bandwidth.

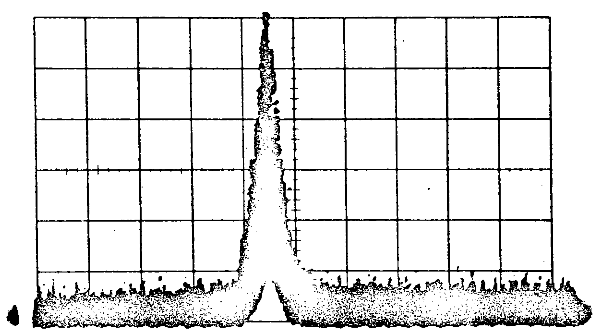
b. Apply 10 ns and 10 μs markers from the Time-Mark Generator through a 40 dB attenuator to the RF INPUT connector.

c. Set the front panel conrtols as follows:

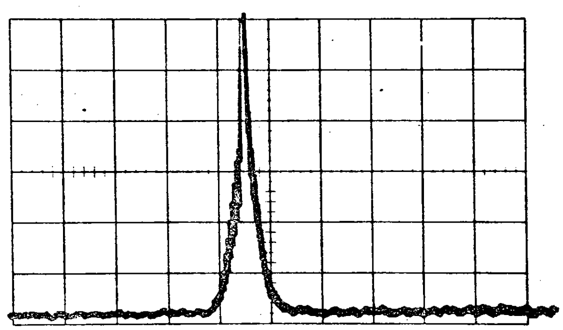
DISPERSION RANGE	MHz/CM
DISPERSION-COUPLED RESOLUTION	2 MHz
GAIN	Adjusted for a full screen display
VERTICAL DISPLAY	LIN
IF ATTEN dB Selectors	Off

d. Center the display with the IF CENTER FREQ controls. See Fig. 5-4A. Set the Time/Cm selector to 50 ms.

e. Switch the VIDEO FILTER switch to ON position. Note the action of the video filter circuit on the display. Display should resemble Fig. 5-4B, with most of the noise reduced or eliminated.



(A) Signal with high degree of noise.



(B) VIDEO FILTER removes the noise and retains the display envelope.

Fig. 5-4. Operation of the video filter.

6. Check Internal Reference Frequency

a. Requirement—Frequency is 1 MHz ±0.1%.

NOTE

This procedure checks the oscillator operation. If accuracy is to be verified a frequency counter must be used.

b. Apply 10 ns and 1 μs markers from the Time-Mark Generator to the RF INPUT connector through a 20 dB attenuator.

c. Set the DISPERSION to 1 MHz/cm and the Time/Cm to 5 ms positions. Switch the VERTICAL DISPLAY to LOG.

d. Align the 1 μs markers to the graticule lines with the IF CENTER FREQ control. If necessary, adjust the DISP CAL to calibrate the display. Note the displacement of the 9th marker at the 9th graticule line.

e. Remove the Time-Mark Generator signals and apply the 1 MHz CAL MARKERS OUT signal to the RF INPUT. Adjust the GAIN control, if required, for a satisfactory 1 MHz marker amplitude and turn the RF CENTER FREQ control to align the tunable markers with the fixed markers.

f. Check the frequency of the Internal Reference oscillator by aligning the 1st marker with the 1st graticule line and noting the displacement of the 9th marker from the 9th graticule line. There should be no noticeable difference in the position of the marker from the position noted in step e.

g. Remove the cable between the 1 MHz CAL MARKERS OUT connectors and the RF INPUT connector. Turn the INT 1 MHz REF FREQ switch to the OFF position.

7. Check Dynamic Range of Vertical Display Modes

a. Requirement—The dynamic range of the screen for the three display modes is as follows:

LIN $\geq$ 26 dB
LOG $\geq$ 40 dB
SQ LAW $\geq$ 13 dB

b. Apply a 200 MHz signal (below −40 dBm) from a VHF Signal Generator that has a calibrated variable output attenuator, to the RF INPUT connector.

c. Adjust the GAIN control and the variable attenuator of the Signal Generator for a display amplitude of 6 cm. (Full screen.)

d. Increase the output attenuation of the VHF Signal Generator until the signal is just visible (about 0.5 mm) on the display. Note the difference in the attenuator readings between the full screen display and the 0.5 mm amplitude reading. This is the dynamic range.

e. Check the dynamic range of each VERTICAL DISPLAY switch position. Must equal or exceed the ranges listed in step a.

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

8. Check Accuracy of IF ATTEN dB Selectors

a. Requirement—Accuracy of the IF ATTEN selectors is within ±0.1 dB/dB of their indicated positions.

b. Apply a 200 MHz signal from the signal generator that is 10 dB below 1 mV, through a 2× Attenuator (6 dB), a Tens and Units Step Attenuator and a 10× Attenuator (20 dB) to the Type 1L30 RF INPUT connector. (Fig. 5-5.)

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

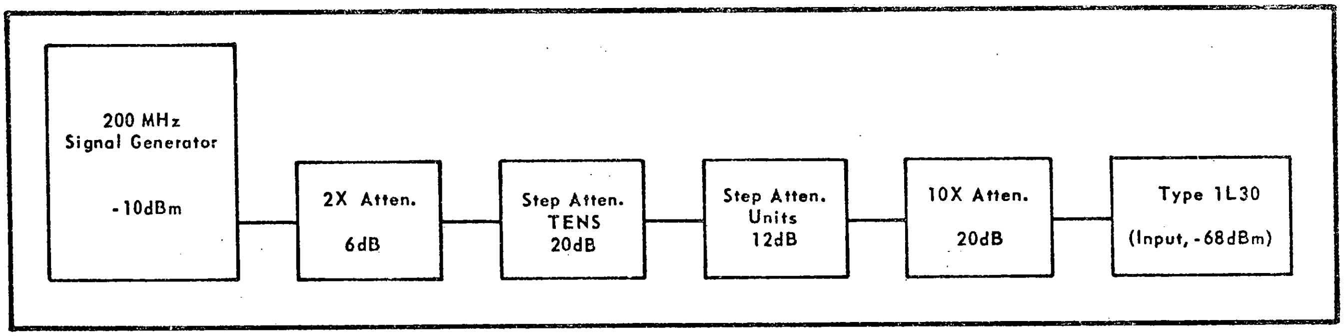


Fig. 5-5. Equipment setup to check attenuator accuracy.

d. Adjust the GAIN control for a signal amplitude of 4 cm on the plug-in oscilloscope screen.

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

1. Switch the Type 1L30 1 dB attenuator switch to ON and switch out 1 dB of attenuation through the units Step Attenuator.

2. Check the display amplitude. Must equal 4 cm, ±0.5 mm (.1 dB/dB).

3. Switch the Type 1L30 IF ATTEN switch to OFF position, then check the remaining IF ATTEN switch steps as directed in Table 5-3a.

TABLE 5-3a

Spectrum Analyzer IF ATTEN Switch On	Step Attenuators		Signal Amplitude Limits (.1 dB/dB)
	Units	Tens	
1 dB	11	20	3.95 cm to 4.05 cm
2 dB	10	20	3.9 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. For these small signal levels, the square law mode may be used to expand the screen 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 4.1	3.6 to 4.4	3.2 to 4.8	2.2 to 5.8	1.7 to 6.3

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

1. Apply a 200 MHz signal (at 60 dB below 1 mW, as shown on the Attenuator dial) from the Signal Generator to the RF INPUT connector. Adjust the Spectrum Analyzer GAIN control for a signal amplitude of 5 cm.

2. Switch the 1 dB IF ATTEN switch on and adjust the Signal Generator output attenuator control to return the signal amplitude to 5 cm.

3. Check the new reading of the attenuator dial. Should read —59 dBm ±0.1 dBm.

4. Turn the 1 dB IF ATTEN switch 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

9. Check Attenuation Range of GAIN Control

a. Requirement—The attenuation range of the GAIN control should equal or exceed 50 dB.

b. With the 200 MHz IF feedthrough signal applied as directed in step 7 and the GAIN control turned fully counterclockwise, adjust the Signal Generator Variable Attenuator control for a signal amplitude of 6 cm. Note the Attenuator reading in dBm.

c. Increase the Signal Generator output attenuation by 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 Narrow Band IF, as described in the Calibration section.

10. Check Signal Amplitude at TO RECORDER Connector

a. Requirement—Signal amplitude at the TO RECORDER output connector with a full screen display (6 cm) should measure between 12 mV and 20 mV when the output is terminated into a 600 ohm load.

b. Set the front panel controls as follows:

POS	Position the trace to the bottom line of the graticule
DISPERSION RANGE	MHz/CM
DISPERSION RESOLUTION	1 MHz/cm Uncoupled fully clockwise
VIDEO FILTER	Off
VERTICAL DISPLAY	LIN

c. Plug the special phone plug, with the 600 Ω load resistor across the output, into the TO RECORDER jack. Connect the Vertical Input of the test oscilloscope through a 1X probe, across the 600 Ω load resistor.

d. Check—Signal amplitude at the TO RECORDER connector across the 600 Ω load should measure between 12 mV and 20 mV with a full screen signal display.

e. Disconnect the test oscilloscope probe and remove the test phone plug.

11. Check Video Frequency Response

a. Requirement—Video frequency response is ≤16 Hz to ≥10 MHz.

b. Apply a 50 kHz signal from the Constant Amplitude (Type 191) Signal Generator through a coaxial cable, T connector and a 50 Ω termination, to the Video INPUT connector on the Type 1L30.

c. Monitor the input signal amplitude to the Type 1L30 by connecting a DC coupled test oscilloscope to the open end of the T connector.

d. Switch the VERTICAL DISPLAY selector to the VIDEO position, turn the GAIN control fully clockwise and adjust the Signal Generator output control for a signal amplitude of 4 cm on the analyzer plug-in oscilloscope. Adjust the test oscilloscope vertical gain to establish a signal reference amplitude of 4 divisions.

e. Increase the frequency of the Signal Generator (maintain a constant input amplitude) until the signal amplitude on the plug-in oscilloscope decreases to 2.8 cm (—3 dB point).

f. Check the input signal frequency. Must equal or exceed 10 MHz.

g. Disconnect the Constant Amplitude Signal Generator and apply the signal from an Audio Signal Generator to the Type 1L30 Video INPUT.

h. Set the frequency of the Audio Signal Generator to 50 kHz and adjust its output for the reference 4 cm signal amplitude.

i. Decrease the generator frequency (maintaining a constant input amplitude) until the signal display on the analyzer oscilloscope screen is again 2.8 cm.

j. Check the input signal frequency. Must equal or be less than 16 Hz. Remove the signal to the Type 1L30 Video INPUT and the test oscilloscope.

12. Check Incidental Frequency Modulation

a. Requirement—With the DISPERSION RANGE switch at the kHz/CM position, the IF incidental FM should not exceed 200 Hz. The incidental FM of the local oscillator plus the IF incidental FM with phase lock must not exceed 300 Hz.

NOTE

Signal source must supply a very stable signal to accurately measure this performance and the Type 1L30 and plug-in oscilloscope must be on a stable, vibration-free platform.

b. Set the DISPERSION RANGE switch to kHz/CM, the DISPERSION to 500 kHz/cm and the VERTICAL DISPLAY to the LIN position. Set the Time/Cm to 50 ms or slower.

c. Apply a 200 MHz signal from the Time-Mark Generator through a 20 dB attenuator to the RF INPUT connector. Center the IF feedthrough signal on the screen.

d. Change the DISPERSION-COUPLED RESOLUTION to 1 kHz/cm. Adjust, if required, the IF CENTER FREQ control to keep the signal centered on the screen.

e. Adjust the GAIN control for 6 cm signal amplitude.

f. Check the amount of signal frequency modulation at the steepest slope of the signal response (see Fig. 5-6). Incidental FM is displayed as short term horizontal jitter. Disregard long term horizontal drift. Must not exceed 2 mm (≤200 MHz).

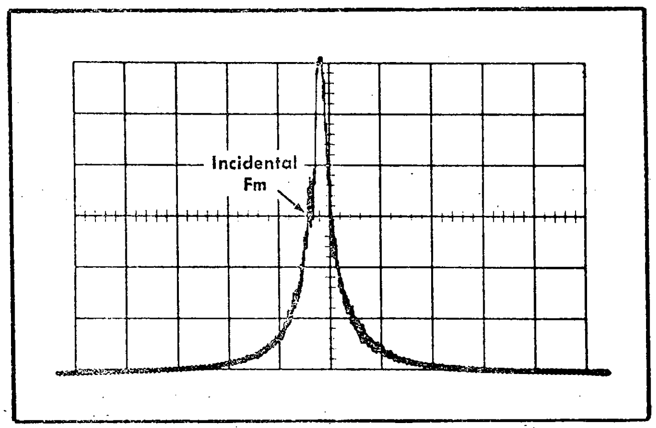


Fig. 5-6. Typical display showing incidental frequency modulation. Measure the horizontal displacement of the signal at the most vertical slope of the signal.

g. Change the DISPERSION to 100 kHz/cm and move the IF feedthrough signal off screen with the IF CENTER FREQ control. Adjust the RF CENTER FREQ controls to center a a tunable signal on screen.

h. Turn the INT 1 MHz REF FREQ on and phase lock the display. Adjust the MIXER PEAKING for maximum signal amplitude.

i. Decrease the DISPERSION to 1 kHz/cm, keeping the phase locked signal on screen by adjusting the IF CENTER FREQ controls.

j. Check the frequency modulation in the display. Must not exceed 3 mm (300 Hz).

k. Return the DISPERSION-COUPLED RESOLUTION controls to 500 kHz/cm position.

13. Check Display Flatness

a. Requirement—Display flatness with the IF CENTER FREQ controls centered, is ±1.5 dB within + and — 50 MHz of the RF center frequency.

b. Set the front panel controls as follows:

DISPERSION RANGE	MHz/CM
DISPERSION	5 MHz/cm
VERTICAL DISPLAY	LIN
IF CENTER FREQ	Centered (000)
IF ATTEN dB	20 dB
Time/Cm	5 ms

c. Apply the required signal frequency listed in Table 5-4, from the Signal Generator through a 20 dB attenuator (Part No. 011-0086-00) to the RF INPUT connector.

d. Tune the RF CENTER FREQ control to the frequency listed in Table 5-4, then adjust the Signal Generator output control until a signal is visible on the CRT.

e. Adjust the MIXER PEAKING control for optimum signal amplitude then adjust the Type 1L30 GAIN control and the generator output for a signal amplitude of 5 cm. Repeat this procedure each time the generator frequency is changed.

f. Check the display flatness by tuning the signal across the screen (from left to right edge) with the RF CENTER FREQ control. Signal amplitude should not change more than ±1.5 dB from the average amplitude, or 3 dB total.

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.

TABLE 5-4

RF Center Frequency	Applied or Signal Generator Frequency
1450 MHz - 1550 MHz (Scale 1)	1500 MHz
1950 MHz - 2050 MHz (Scale 1)	2000 MHz
2450 MHz - 2550 MHz (Scale 2)	2500 MHz
2950 MHz - 3050 MHz (Scale 2)	3000 MHz
3450 MHz - 3550 MHz (Scale 2)	3500 MHz
4200 MHz - 4300 MHz (Scale 3)	4500 MHz
4750 MHz - 4850 MHz (Scale 4)	4800 MHz
5750 MHz - 5850 MHz (Scale 4)	5800 MHz
6750 MHz - 6850 MHz (Scale 5)	6800 MHz

14. Check RF Center Frequency Calibration, System Sensitivity and Phase Lock Operation

a. Requirement—Dial accuracy within ± (2 MHz +1% of the dial reading); sensitivity within that specified in Table 5-5; phase lock operates through all frequency ranges.

b. Apply a frequency and amplitude calibrated signal, between —60 dBm and —30 dBm, to the RF INPUT connector.

NOTE

If an external attenuator is used, it must have flat high frequency characteristics: Use Tektronix 20 dB RF Attenuator Part No. 011-0086-00 or 40 dB Attenuator Part No. 011-0087-00.

c. Set the DISPERSION control to 500 kHz/cm and the RESOLUTION control for a resolution bandwidth of 100 kHz (fully clockwise).

d. Adjust the GAIN control for an average noise amplitude of one division. Center the IF CENTER FREQ and FINE RF CENTER FREQ controls. Adjust the MIXER PEAKING for maximum signal amplitude.

e. Tune the signal on the screen with the RF CENTER FREQ control. Reduce the signal amplitude with the Signal Generator output attenuator control for an on-screen display; then re-adjust the MIXER PEAKING control and sweep rate for optimum signal amplitude. (Sweep rate approximately 10 ms/cm or slower.)

f. Calibrate the Signal Generator output, then adjust the variable output attenuator control on the Signal Generator until the signal amplitude is two divisions (twice the noise amplitude). See Fig. 5-7.

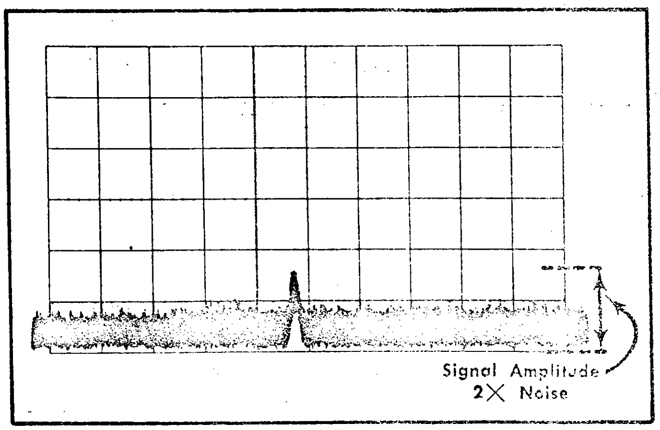


Fig. 5-7. Signal to noise ratio for measuring sensitivity.

g. Check the total signal attenuation (in dB) below 0 dBm as indicated on the Signal Generator attenuator dial. This is the sensitivity of the analyzer for the RF center frequency indicated. Check the analyzer sensitivity through the band as listed in Table 5-5 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-9B/U cable between the signal source and the RF INPUT.

15. Check Presence of Spurious Signals

a. Requirement—Spurious signals from internal source should not exceed 2× the noise level. Resolution ≥100 kHz.

b. Connect a 50 Ω termination to the RF INPUT connector.

c. Set the DISPERSION RANGE to kHz/CM, the DISPERSION to 500 kHz/cm and the RESOLUTION control fully clockwise (100 kHz).

d. Adjust the GAIN control for an average noise amplitude of 0.5 cm, then tune the RF CENTER FREQ control over the band; checking that there are no spurious signals that exceed 1 cm in amplitude. (2× average noise level.)

NOTE

If excessive spurious signals are present, refer to the Calibration procedure.

This concludes the performance check for the Type 1L30. If the instrument has met all checks, it is ready to operate and will perform to specifications listed in Section 1.

TABLE 5-5

Suggested[1] Signal Gen.	RF Center Freq. in MHz	Dial Scale	Minimum Sensitivity[2] 100 kHz Resolution	Minimum Sensitivity[2] 1 kHz Resolution	Dial Accuracy check
Type 8614A	925 1500	1	—85 dBm	—105 dBm	100 MHz steps
Type 8616A	1940-2050[3]				
	1940-2050[3] 3000 4100	2	—80 dBm	—100 dBm	1000 MHz steps
	4100	3	—75 dBm	—95 dBm	1000 MHz[4]
Type 1107	5000 6250				
	6200 7000	4	—70 dBm	—90 dBm	
Type 1108	8400				
	8300 9000 10500	5	—55 dBm	—75 dBm	

[1]Refer to equipment list for Calibration.

[2]Signal + Noise = 2× Noise amplitude.

[3]The tuning range will vary between instruments. The upper frequency limit on scale1 must be above the lowest frequency limit on scale 2.

[4]There is no need to check dial accuracy for these scales because they are multiples of scale 1 and 2.

SECTION 6
CALIBRATION

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

Introduction

This spectrum analyzer is a stable laboratory instrument which should not require frequent calibration. Its performance should be checked as directed in Section 5, approximately every 500 hours of operation or every six months if used intermittently. This will assure proper operation or indicate the section of the instrument that needs recalibration.

This calibration procedure is arranged in a sequence which will allow the instrument to be checked and calibrated with the least interaction of adjustments and reconnecting of test equipment. A single step can usually be performed, provided interaction between steps and adjustments is considered.

NOTE

Local oscillator and dial calibration procedures plus wide band amplifier and low pass filter adjustments are included in this procedure; these steps should only be performed by qualified personnel, or if the instrument cannot be returned to your Tektronix field office or representative.

Recommended Equipment

The equipment used to calibrate the Type 1L30 is listed in two groups. Group one includes basic equipment required to check and calibrate the Type 1L30 except the sensitivity and response flatness.

Group two is composed of additional equipment required to perform a complete check and calibration on the filters in the honeycomb section, and the calibration of the RF section.

The calibration of the honeycomb, local oscillator and mixer sections is complex and requires special skills and equipment. We recommend the unit be returned to Tektronix for recalibration.

Minimum specifications are listed in the procedure so the Type 1L30 may be calibrated to the accuracies listed in the Characteristics section. If substitute equipment is used, it must meet or exceed the specifications of the recommended equipment. Proper dial and equipment setup of the substitute equipment must be determined by the user. Signal generator should be stable and relatively free of distortion

Group One

1. Plug-In Oscilloscope. Oscilloscope with a 6 cm vertical height that will accept the Type 1L30 Spectrum Analyzer. This oscilloscope should be the oscilloscope the Type 1L30 being calibrated, will normally be used with. The front panel adjustments will require readjustment if the analyzer is changed to another oscilloscope. A Type 545B Oscilloscope is used in this procedure.

2. Test Oscilloscope and Vertical Plug-In unit with both the 1× and 10× probes; minimum sensitivity .005 V/cm; frequency response DC to 30 MHz. Tektronix 540-series Oscilloscope with Type 1A1 Plug-In Unit and Tektronix P6010 (10×) and P6011 (1×) test probes.

3. Time-Mark Generator. Marker outputs, .5 s to .1 μs and frequency outputs of 20 MHz, 50 MHz and 100 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 ±3%. General Radio Model 1310A or Hewlett-Packard Model 241A.

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

6. Constant Amplitude Signal Generator. 1 MHz 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 ±1%. Hewlett-Packard Type 355D and Type 355C Step Attenuators.

8. (Optional.) Swept-Frequency Generator; frequency range 130 MHz to 280 MHz, with amplitude variation ≤0.25 dB. Kay Type 122C Sweep Generator. May be used to check IF bandpass response flatness.

9. (Optional.) Harmonic Modulator: Tektronix Calibration Fixture 067-0518-00. Required if the Type 184 is not available. Use to modulate the IF feedthrough (200 MHz) with frequency markers.

10. DC Voltmeter; 0 to 10 V, sensitivity 20,000 Ω/V, accuracy ±3%. Simpson Model 262 or Triplett Model 630-PL.

11. Two (2) 10:1 Attenuators: Tektronix Part No. 011-0059-00.

12. 2:1 Attenuator: Tektronix Part No. 011-0069-00.

13. 20 dB RF Attenuator, Tektronix Part No. 011-0086-00.

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

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

16. Adapter, GR to N male; Tektronix Part No. 017-0021-00.

17. Adapter, GR to BNC female, Tektronix Part No. 017-0063-00.

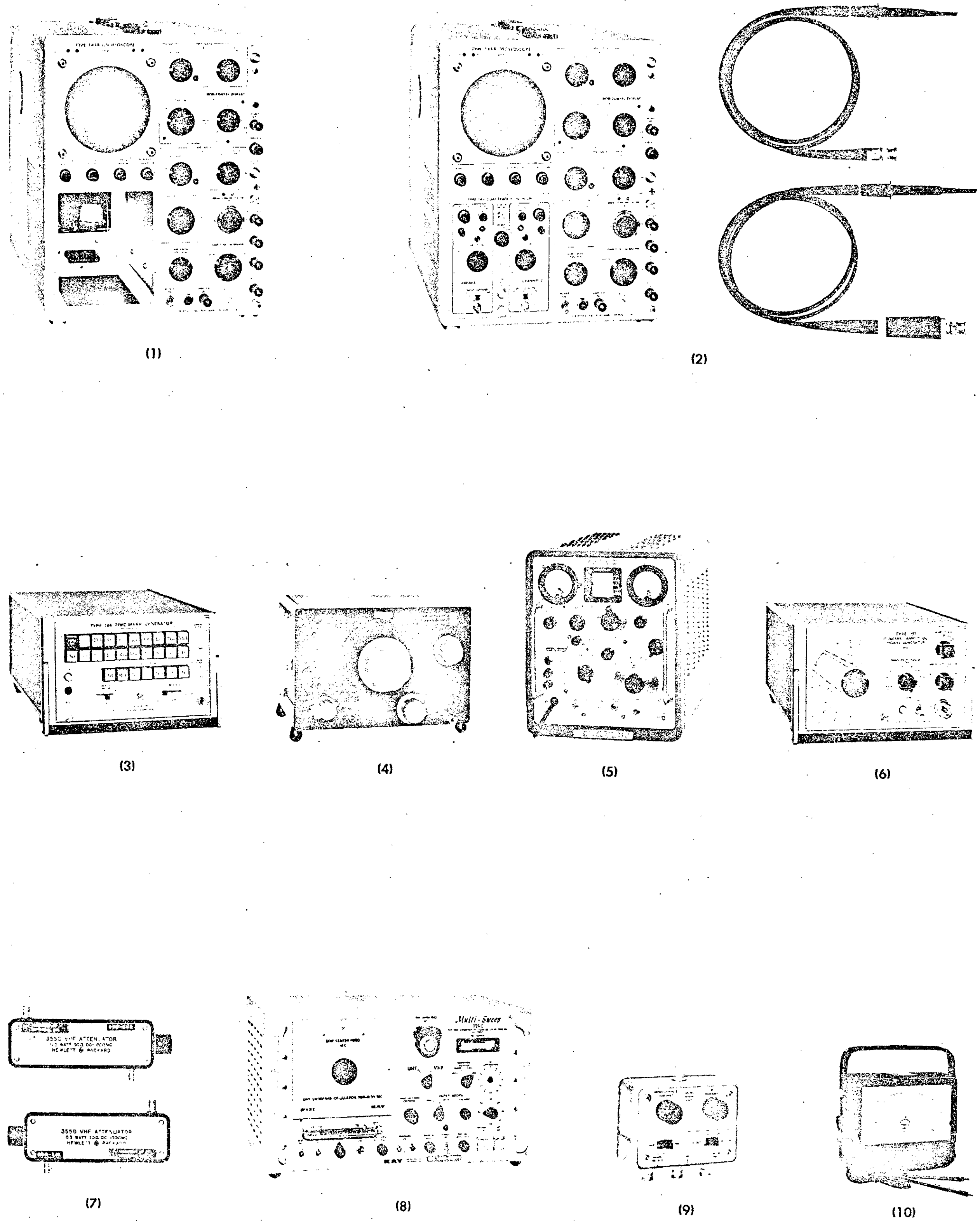
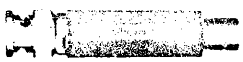


Fig. 6-1A. Test equipment required for calibration.



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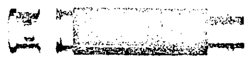

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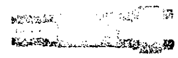

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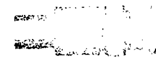

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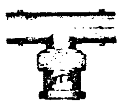

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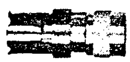

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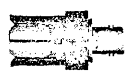

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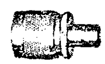

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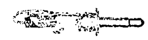

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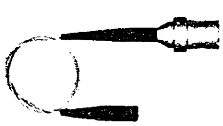

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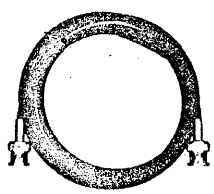

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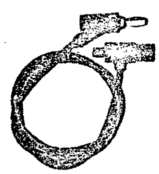

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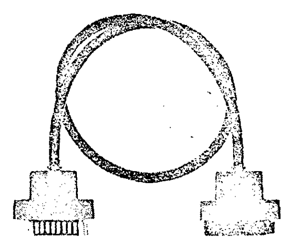

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Fig. 6-1B. Test fixtures and tools needed for calibration.

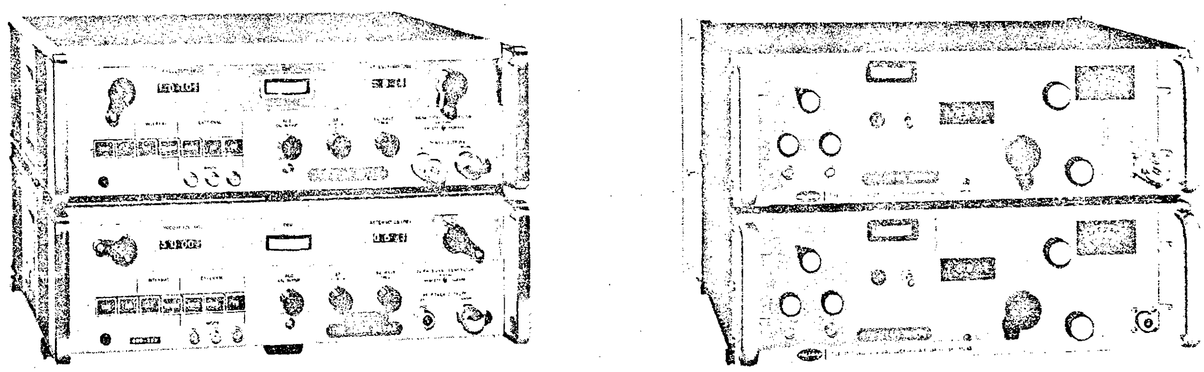


Fig. 6-2. Recommended test equipment to check dial calibration, analyzer sensitivity and response flatness.

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

19. Miniature phone plug with 600 Ω load. (Test fixture to check TO RECORDER signal amplitude.) Consist of a 600 Ω 5% 1/2 watt resistor, soldered across a miniature phone plug.

20. Two (2) adapters. Sealectro to GR: Type P6040 probe cable, Part No. 010-0133-00; or Sealectro to BNC, Type P6041 probe; Part No. 010-0164-00.

21. Two (2) BNC, coaxial cables, 50 Ω. Tektronix Part No. 012-0057-01.

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

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

24. Adjusting tools:

a. Screwdriver, 3/32 blade, 3 inch shaft	003-0192-00
b. Tuning tool	
Handle	003-0307-00
Insert for 5/64 (D) hex cores	003-0310-00
c. Low capacitance screwdriver, 1/4 inch by 8 inch fiber rod with screwdriver shaped ends	003-0209-00

Group Two

RF Signal Generators with calibrated frequency and output power: Frequency range 925 MHz to 10,500 MHz, accuracy ±1%; output power —100 dBm to —30 dBm; 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 Type 1107 Microwave signal generator 3.8 GHz to 8.2 GHz.

Polarad Tyype 1108 Microwave signal generator 6.95 GHz to 11.0 GHz.

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 1L30, Serial No. ______________

Calibration Date ______________

Calibrator ______________

☐ 1. Adjust Center Frequency — Page 6-7

Apply a 200 MHz signal to the RF INPUT connector and adjust the GAIN for a 5 cm signal amplitude. Set the DISPERSION RANGE to MHz/CM position. Adjust the Center Freq Cal R253, for minimum signal shift as the DISPERSION selector is switched through the MHz/CM range. Adjust the Sweep Center R204 to position the 200 MHz IF feedthrough signal to the display center.

☐ 2. Adjust Frequency Dispersion and Linearity — Page 6-8

Apply 10 ns and .1 μs markers from the Time-Mark Generator to the RF INPUT connector. Adjust the Disp Cal R208 for dispersion accuracy and C358 for dispersion linearity with the Type 1L30 Dispersion set to 10 MHz/CM.

☐ 3. Check Dispersion Accuracy of MHz/CM Ranges and IF CENTER FREQ controls — Page 6-9

Check the dispersion accuracy for each MHz/CM position of the DISPERSION selector as listed in Table 6-1. Check the range, dispersion accuracy and linearity through the frequency range of the IF CENTER FREQ controls.

☐ 4. Adjust IF Amplifier Response — Page 6-10

Apply a 200 MHz signal to the RF INPUT connector. Adjust L144, T464, T454, C435 and C425 in the order listed for maximum signal response. Adjust L444 midway between the 70 MHz oscillator dropout points.

☐ 5. Adjust Resolution Bandwidth — Page 6-10

Connect the test oscilloscope probe to pin B of the honeycomb assembly. Adjust C504 and C508 for optimum display symmetry on the test oscilloscope. Adjust the bandpass of the 5 MHz filter by adjusting Resol Cal R543, C610, C620 and L624 for optimum symmetry and correct bandpass of the display on the plug-in oscilloscope. Resolution bandwidth must equal or exceed 100 kHz, at the —6 dB point, with the RESOLUTION control fully clockwise and must decrease for each switch position counterclockwise until the bandwidth is equal to or less than 1 kHz with the RESOLUTION control in the fully counterclockwise position.

☐ 6. Adjust kHz/CM Dispersion — Page 6-13

Apply 10 ns and 1 μs marker from the Time-Mark Generator to the RF INPUT connector. Set the DISPERSION to 500 kHz/cm. Preset the DISPERSION BAL to its centered position. Adjust C384 and C385 simultaneously in opposite directions for 1 marker/2 centimeters. Adjust kHz/cm Cal R368, for optimum dispersion linearity.

☐ 7. Check Dispersion Accuracy for kHz/CM Range — Page 6-14

Check dispersion accuracy through the + and — 2.5 MHz range of the IF CENTER FREQUENCY at each DISPERSION selector position listed in Table 6-2. Accuracy must remain within ±3% over the center 8 divisions of the graticule.

☐ 8. Adjust Avalanche Voltage and Internal 1 MHz Reference Oscillator — Page 6-15

Set the INT 1 MHz REF FREQ selector to the EXT REF FREQ position, push the LOCK CHECK button and adjust the Avalanche Volts R831 to a position approximately 1/8 turn back from the free-running avalanche position. Adjust L804 so the oscillator starts with minimum delay when the INT REF FREQ switch is switched from the EXT REF FREQ position to the INT REF FREQ position. Check for phase lock beat signals through the frequency range of the RF CENTER FREQUENCY. Check for proper operation with an external reference signal applied.

☐ 9. Check Accuracy of IF ATTEN dB Selectors — Page 6-1,

Apply a signal through calibrated attenuators and within the frequency range of the instrument to the RF INPUT connector. Check the accuracy of each IF ATTEN dB selector. See Table 6-3. Accuracy must equal or exceed 0.1 dB/dB of attenuation.

☐ 10. Check Dynamic Range of Vertical Display Modes — Page 6-18

Dynamic range of the 6 cm screen is as follows: LIN ≥ 26 dB, LOG ≥ 40 dB and SQ LAW ≥ 13 dB.

☐ 11. Check Attenuation Range of IF GAIN Control — Page 6-18

Range of the IF GAIN control must equal or exceed 50 dB.

☐ 12. Check Signal Amplitude at RECORDER Output Jack — Page 6-18

With the VERTICAL DISPLAY selector in the LIN position, the signal amplitude to the RECORDER connector when terminated into a 600 Ω load should equal or exceed 2 mV/cm of displayed signal amplitude.

☐ 13. Check Video Filter Operation — Page 6-19

With a sweep time of 5 ms/cm or faster and the RESOLUTION control one step back from the fully clockwise position, the VIDEO FILTER should distort a 200 MHz IF feedthrough signal.

☐ 14. Check Frequency Response of Video Circuit — Page 6-20

Frequency range ≤ 16 Hz to ≥ 50 kHz.

☐ 15. Check Incidental Frequency Modulation — Page 6-22

Incidental FM for a 200 MHz IF feedthrough signal should not exceed 200 Hz. Incidental FM for a tunable or converted signal (IF + Local Oscillator) in phase lock condition should not exceed 300 Hz.

☐ 16. Adjust RF Mixer — Page 6-24

Apply a 100 MHz signal to the RF INPUT connector. Adjust MIXER PEAKING for optimum signal amplitude, then adjust C68 for optimum response and flatness across the dispersion window.

☐ 17. Adjust Wide Band Amplifier Response and Check System Response Flatness — Page 6-24

Apply a 65 MHz signal (—60 dBm) to J120. Adjust L147 for minimum response to the signal. Reconnect the coaxial cable from J109 to J120. Apply an amplitude calibrated signal that is approximately —50 dBm, within the frequency range of the analyzer to the RF INPUT. Check the response flatness over the 100 MHz dispersion window. Response flatness must remain within ±1.5 dB over the dispersion window.

☐ 18. Check RF Center Frequency Calibration, System Sensitivity and Phase Lock Operation — Page 6-27

Apply signal frequencies that are listed in Table 6-6 to the RF INPUT. Check the dial accuracy and the analyzer sensitivtiy over the frequency range. Accuracy must remain within (±2 MHz + 1% of the dial reading). Check sensitivity with the RESOLUTION control fully clockwise.

Scale 1	—105 dBm
Scale 2	—100 dBm
Scale 3	—95 dBm
Scale 4	—90 dBm
Scale 5	—75 dBm

Check phase lock operation through the frequency range of each band.

☐ 19. Check Amplitude of Spurious Signals and Adjust Mixer Balance — Page 6-29

Connect a 50 Ω termination to the RF INPUT connector. Check through the frequency range of each band for spurious signals from internal sources. Must not exceed 2× noise amplitude.

Preliminary Procedure

Determine the output amplitude of the sawtooth from the associated oscilloscope from Table 2-1 or the instruction manual for the oscilloscope, then position the slide switch SW201 (on the rear panel) to the appropriate position. Connect the Type 1L30 Spectrum Analyzer through a flexible extension (Part No. 012-0038-00) to the J11 connector of the oscilloscope plug-in compartment. Connect a patch cord from the oscilloscope Sawtooth Out connector to the Analyzer SWEEP INPUT connector.

Connect the oscilloscope to a suitable power source, turn the power on, and allow 20 minutes warm-up time at an ambient temperature of (25° C ±5° C) before making adjustments or checking the instrument to given accuracies. Adjust the oscilloscope controls for a free running, 10 ms/cm sweep.

NOTES

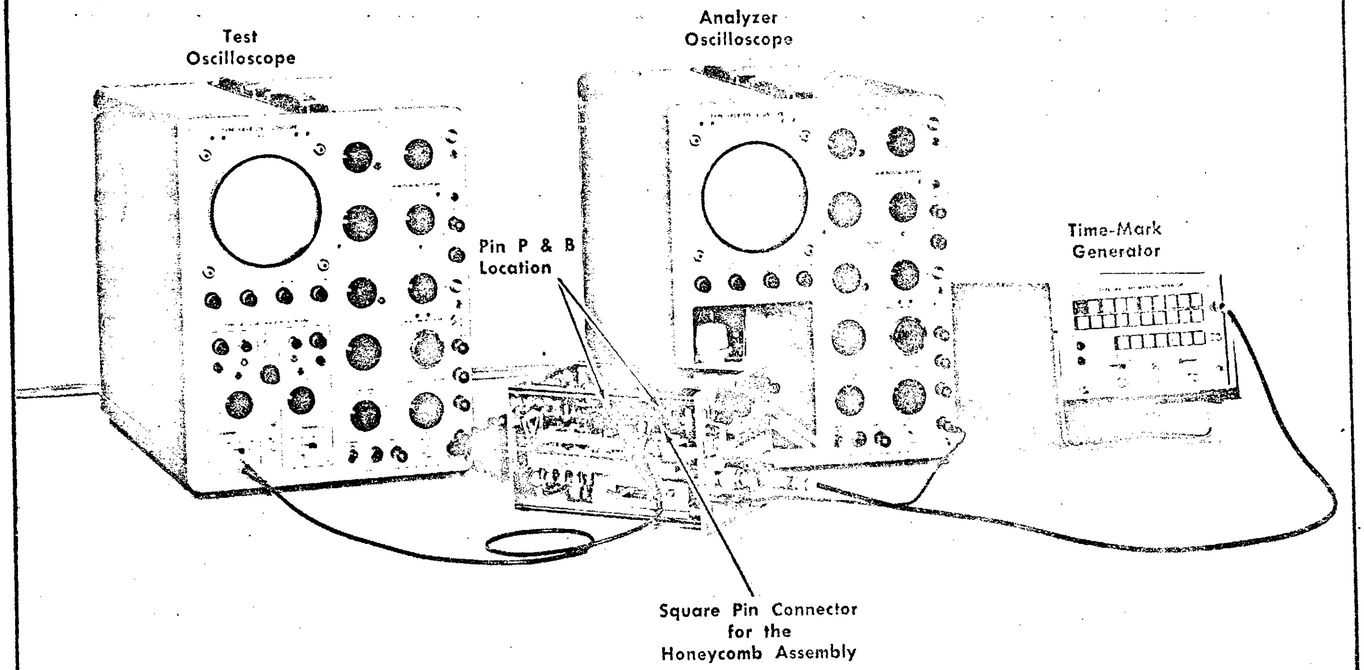


Fig. 6-3. Equipment setup to calibrate dispersion and resolution (steps 1, 2 and 3).

SWEEP CIRCUIT

Type 1L30

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	10 MHz
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT 1 MHz REF FREQ	OFF
MIXER PEAKING	Fully ccw

Oscilloscope

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

1. Adjust Center Frequency

a. Equipment setup is shown in Fig. 6-3.

b. Connect the probe of a DC coupled test oscilloscope to chassis ground on the Type 1L30. Establish 0 V reference level on the test oscilloscope, then connect the probe to pin P of the square pin connector for the honeycomb assembly.

c. Adjust the IF CF Range R290 (see Fig. 6-4) for 0.75 volts ± 0.1 V of trace deflection on the test oscilloscope.

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

e. Apply a 200 MHz signal from the Time-Mark Generator (harmonic of 10 ns marker) through a 20 dB attenuator to the RF INPUT connector.

f. Adjust the GAIN control for a display 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.

g. Adjust the Center Freq Cal R253 (Fig. 6-4) 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.

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

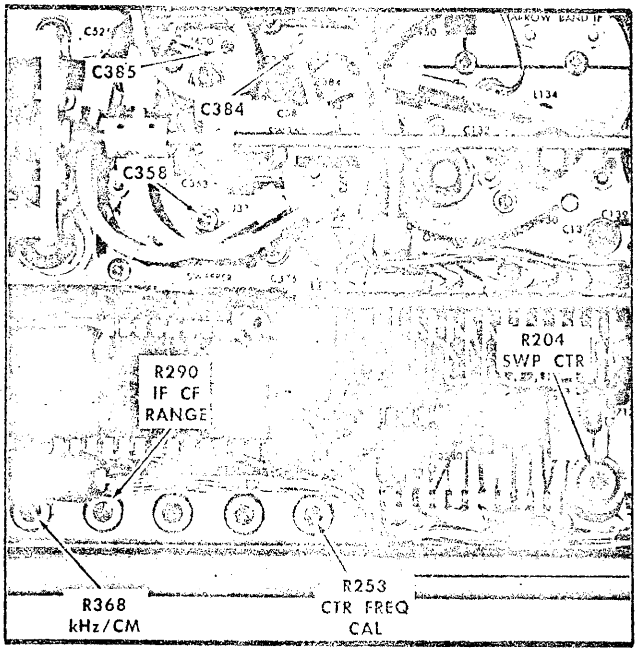


Fig. 6-4. Location of sweeper and discriminator adjustments.

i. Adjust the Sweep Center R204 (Fig. 6-4) to position the 200 MHz signal at the graticule center line.

2. Adjust Frequency Dispersion and Linearity ①

Dispersion accuracy is a measure of the frequency dispersion error within 8 centimeters of a 10 centimeter display. It is measured by positioning a frequency marker on the 1st graticule line, then noting the frequency error as the distance the respective marker is displaced from the 9th graticule line. See Fig. 6-5.

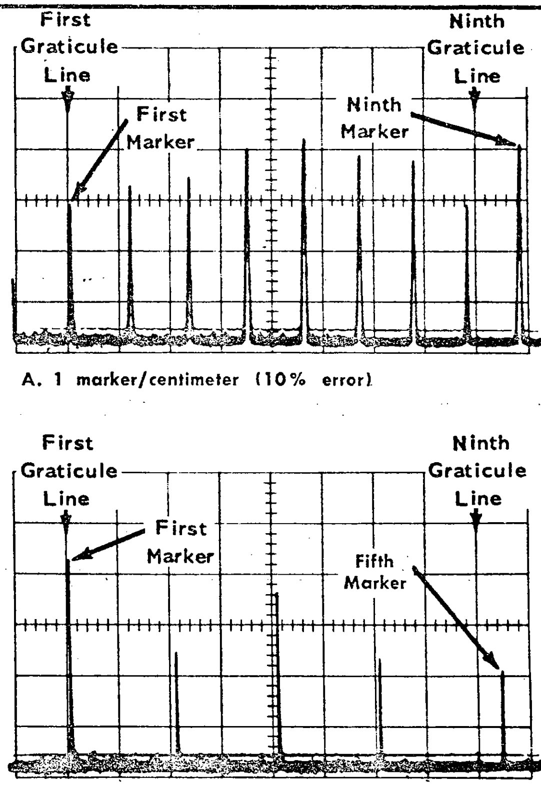
Linearity error is the measured distance that any frequency marker is displaced from its respective graticule line when compared over an 8 centimeter display. See Fig. 6-6.

Dispersion accuracy and the display linearity for the Type 1L30 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 to 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. Equipment setup is shown in Fig. 6-3.



A. 1 marker/centimeter (10% error)

B. 1 marker/2 centimeters (5% error)

Fig. 6-5. Typical dispersion accuracy displays (step 2).

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

NOTE

More than one set of 1 MHz markers may appear in the display. To avoid confusion, tune the RF center frequency with the RF CENTER FREQ and FINE FREQ controls to align the tunable markers with the fixed (IF feedthrough) markers.

c. Adjust the GAIN control for a display amplitude of approximately 3 to 4 centimeters. See Fig. 6-5. 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. 6-4) for optimum display linearity.

e. Repeat the adjustment of R208 and C358 until optimum dispersion accuracy and linearity has been achieved. If the dispersion linearity is not within tolerance, a slight re-adjustment of R290 and the Center Freq Range R253 adjustments may be required. Monitor the voltage at pin P of the honeycomb square pin connector with the test oscilloscope to keep the RF voltage amplitude within 0.7 to 1.0 volt.

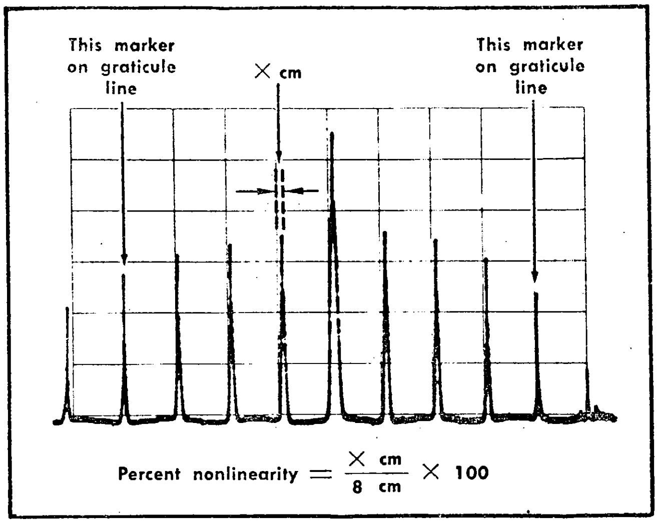


Fig. 6-6. Linearity measurement.

3. Check Dispersion Accuracy of MHz/CM Ranges and Range of IF CENTER FREQ Control

a. Test equipment setup is given in step 2.

b. Center the IF CENTER FREQ controls.

c. Check the dispersion accuracy for the MHz/CM setting of the DISPERSION selector as listed in Table 6-1. 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 in the coupled position as the DISPERSION selection is decreased and the sweep rate should be reduced to optimize marker definition.

d. Check the frequency range, dispersion accuracy and linearity over the IF CENTER FREQ control range in the 5, 2, 1, .5 and .2 MHz positions of the DISPERSION selector. See Fig. 6-5.

Range of the control should be equal or exceed + and − 25 MHz from its centered position. It is checked by rotating the control to both extreme positions from center, and noting the frequency shift of the .1 μs or 10 MHz markers as the control is rotated. Dispersion accuracy and display linearity must remain within the listed specifications of Table 6-1 to the + and − 25 MHz positions.

e. Center the IF CENTER FREQ control. Set the DISPERSION control to .1 MHz position. Apply 10 ns and 1 μs markers from the Time-Mark Generator.

f. Check—The range of the FINE IF CENTER FREQ control Must equal or exceed + and − 1 MHz.

TABLE 6-1

DISPERSION Position	Marker Selector	Markers/Cm	Allowable Error	Supplementary Notes
10 MHz	10 ns and .1 μs	1	±3%	Dispersion over 100 MHz with the IF CENTER FREQ control (000).
5 MHz	10 ns and .1 μs	1 marker/2 centimeters	±3%	Over the range of the IF CENTER FREQ control (±25 MHz). Display linearity over a 10 centimeter display must be within ±3%.
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 centimeters	±10%	
.2 MHz	10 ns and 5 μs	1	±15%	

NOTES

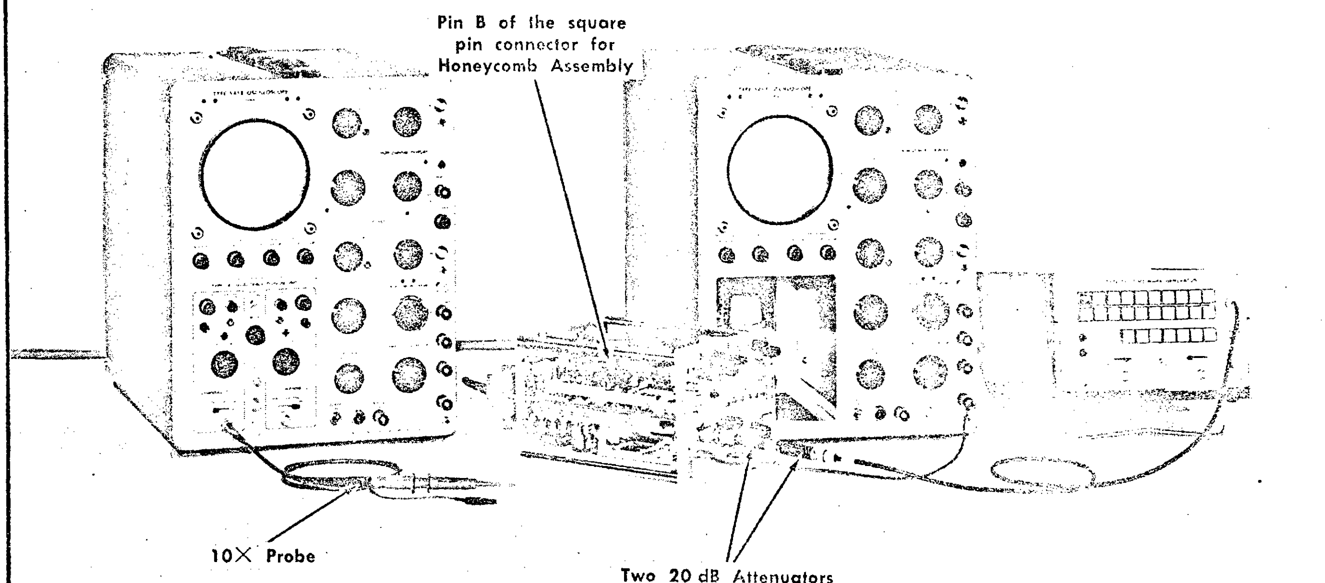


Fig. 6-7. Equipment setup to adjust the IF amplifier reponse and the resolution badwidth (steps 4 and 5).

Type 1L30

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	Midrange
FINE	Centered
DISPERSION RANGE	**kHz/CM**
DISPERSION	**100 kHz/cm**
RESOLUTION	**Fully clockwise**
VIDEO FILTER	OFF
GAIN	Fully clockwise
VERTICAL DISPLAY	LIN
IF ATTEN	As required
FINE RF CENTER FREQ	Centered
INT 1 MHz REF FREQ	OFF
MIXER PEAKING	Fully ccw

Plug-In Oscilloscope

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

4. Adjust IF Amplifier Response

a. Equipment setup is shown in Fig. 6-7.

b. Apply a 200 MHz signal from the Time-Mark Generator (2nd harmonic of the 10 ns marker) through a 40 dB attenuator (two 10× attenuators) to either RF INPUT connector.

NOTE

This 200 MHz signal may be applied through a P6040 probe cable adapter to the Sealectro connector J100, on the wide bandpass filter assembly.

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) and T464, T454, C435, C425 (narrow band IF amplifier) Fig. 6-8, in the order listed for maximum signal amplitude.

e. Adjust L444 for stable 70 MHz oscillator operation. This is usually midway between the two oscillator drop out points as the core is turned in and out through the operating range.

f. Remove the P6040 probe cable, if connected and reconnect the coaxial cable to J100.

5. Adjust Resolution Bandwidth

a. Test equipment setup is given in Fig. 6-7.

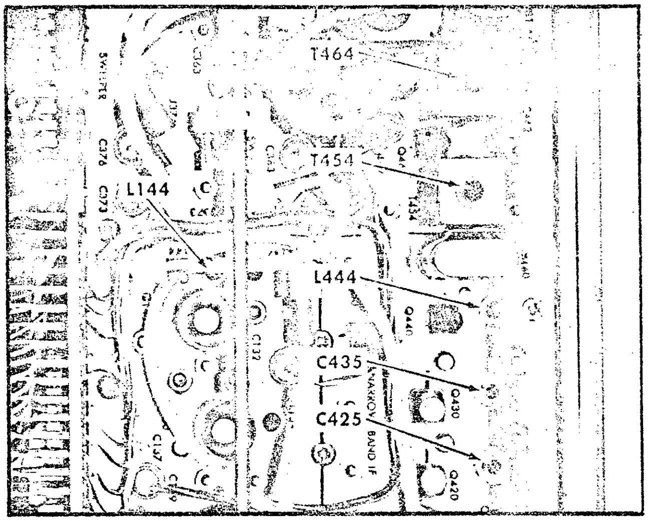


Fig. 6-8. Location of the IF amplifier peaking adjustments.

b. Apply the 10 ns signal from the Time-Mark Generator through a 40 dB attenuator to the RF INPUT connector. Set DISPERSION to 50 kHz/cm and the RESOLUTION control fully clockwise. Adjust the IF CENTER FREQ controls to center the display on screen.

c. Connect the 10× probe from the test oscilloscope to pin B of the honeycomb square pin connector.

d. Adjust the Type 1L30 GAIN control for a display amplitude of 6 cm on the plug-in 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. 6-9.

e. Adjust C504 and C508 (Fig. 6-10) for optimum display symmetry on the test oscilloscope. See Fig. 6-9. 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.

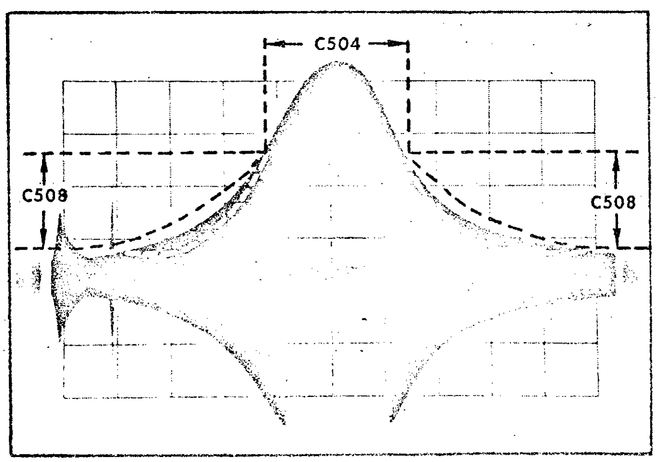


Fig. 6-9. Test oscilloscope display when C504 and C508 are correctly adjusted. DISPERSION 100 kHz/CM, RESOLUTION fully clockwise.

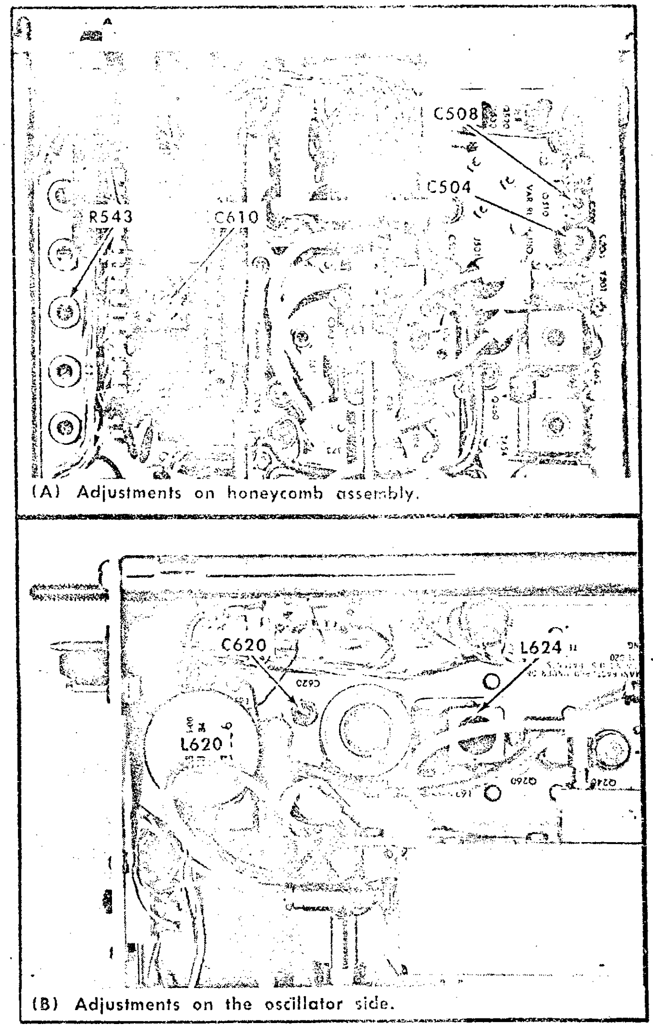


Fig. 6-10. Location of the resolution adjustments.

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

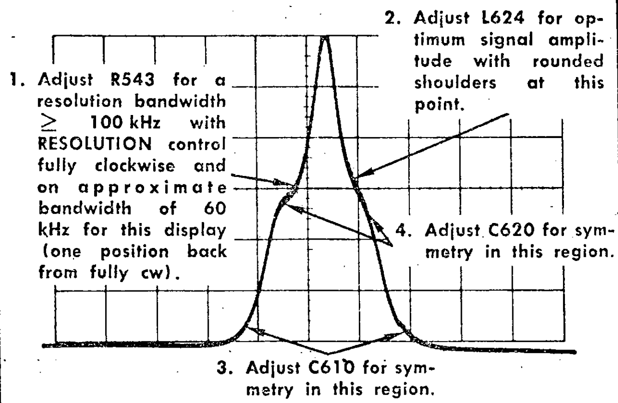
1. Adjust the 100 kHz Resol Cal R543, to obtain a bandpass between 100 kHz and 120 kHz at the —6 dB point. (Fig. 6-12A.)

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

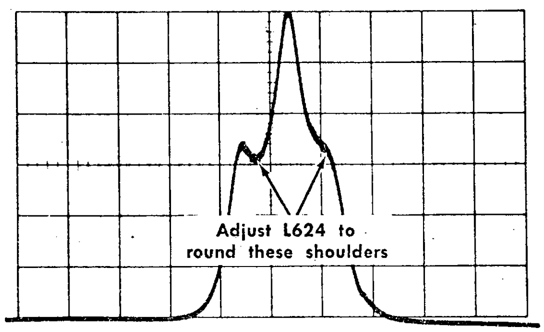
3. Adjust C610, C620 and L624 (Fig. 6-10) for a response on the plug-in oscilloscope CRT similar to Fig. 6-11A. Adjust C610 for optimum symmetry at the base of the bandpass response and adjust C620-L624 for response slope and symmetry at the upper portion of the display.

NOTE

Install the Type 1L30 into the compartment of the plug-in oscilloscope and allow the unit to stabilize to the change in the operating temperature. Check

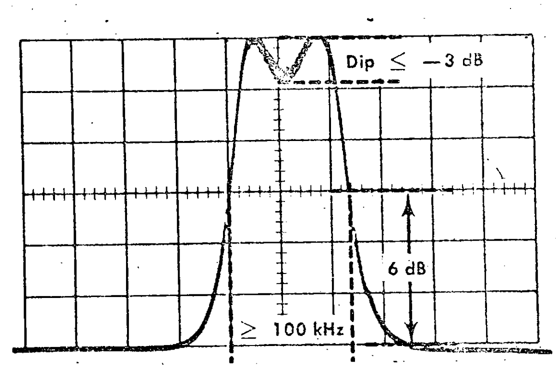


(A) Correct display with RESOLUTION control at the 1st position back from the Full clockwise (100 kHz) position.

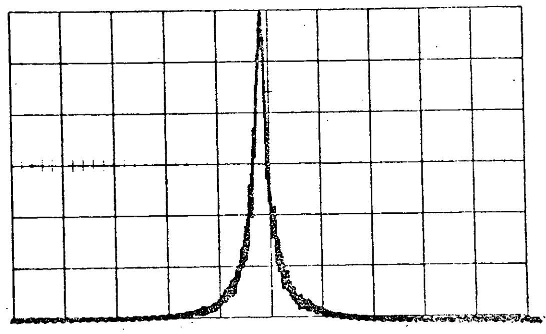


(B) Incorrect display L624 misadjusted. Shoulders are too pronounced.

Fig. 6-11. Typical displays when adjusting the resolution bandwidth with C610, C620, L624 and R543.



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



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

Fig. 6-12. Typical bandpass characteristics of the resolution amplifier at maximum and minimum resolution settings.

the bandpass response. If the response is nonsymmetrical, 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. 6-12). 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.

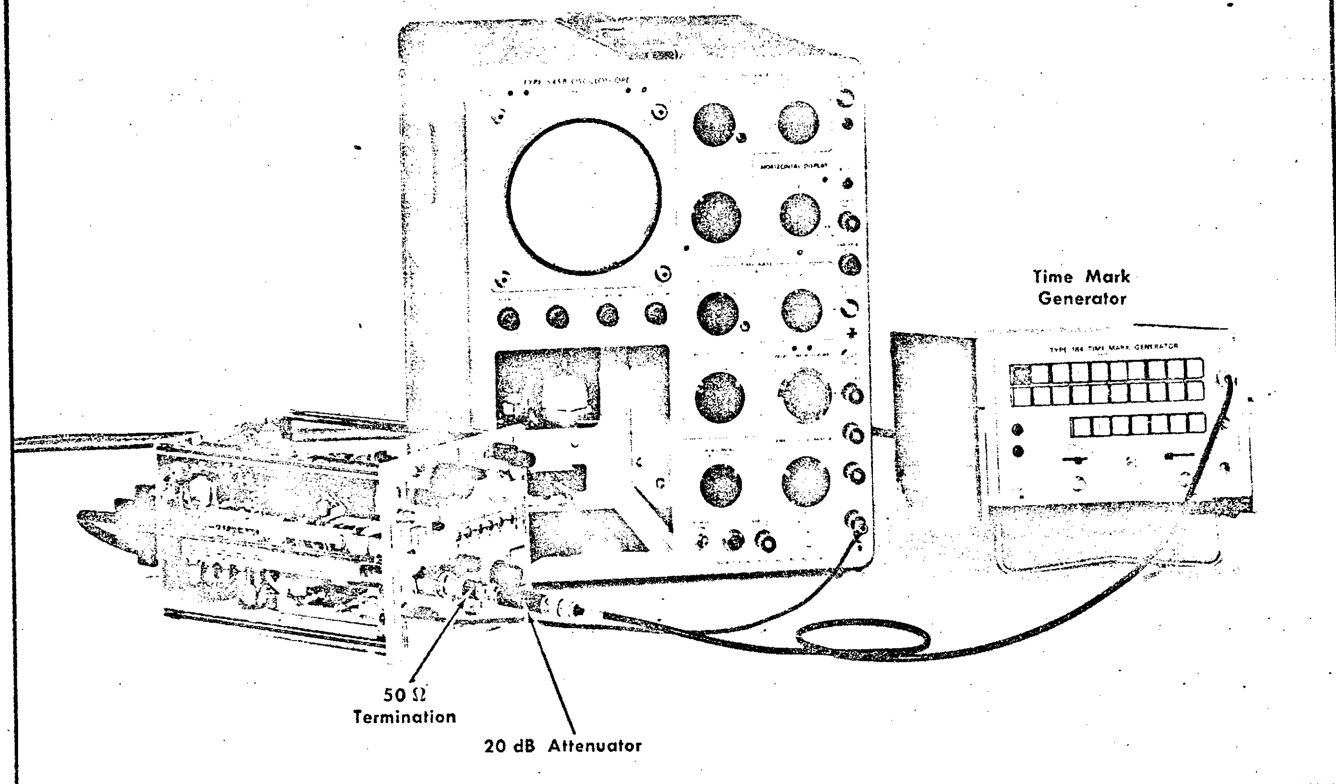


Fig. 6-13. Equipment setup to adjust and check kHz/CM dispersion accuracy (steps 6 and 7).

Type 1L30

POS	Position a free running trace to the bottom line of the graticule
IF CENTER FREQ	**Centered (000)**
FINE	Centered
CAL (Adjustment)	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 1 MHz REF FREQ	OFF
MIXER PEAKING	CCW

Oscilloscope

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

6. Adjust kHz/Cm Dispersion

a. Equipment setup is shown in Fig. 6-13.

b. Apply 10 ns and 1 μs markers from the Time-Mark Generator through a 20 dB attenuator and 50 Ω termination to the RF INPUT connector.

NOTE

The Bal adjustment should be preset to its center position and the kHz/Cm Cal R368 adjustment preset near the full clockwise position.

c. Adjust C384 and C385 (Fig. 6-14) for 1 marker/2 centimeters (Fig. 6-15). Adjust these capacitors simultaneously in opposite directions. This will keep the 200 MHz feedthrough signal centered in the graticule area.

d. Adjust the kHz/Cm Cal R368 (Fig. 6-14) for optimum dispersion linearity. See Fig. 6-15.

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

NOTE

An alternate method to apply frequency markers to the Type 1L30 is as follows:

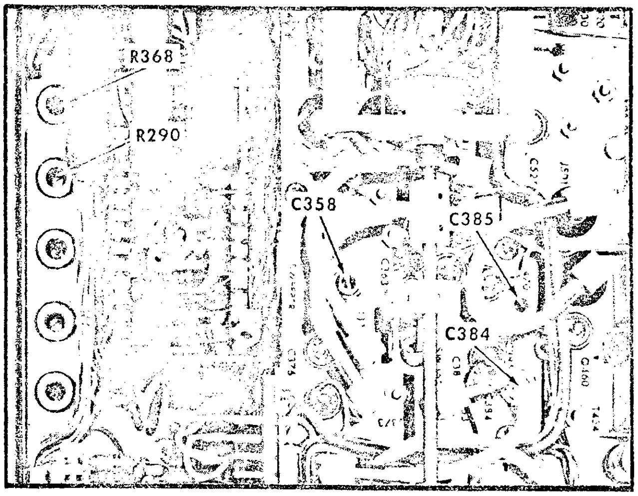


Fig. 6-14. Location of kHz/CM dispersion adjustments.

(1) Apply a calibrated 100 MHz RF signal to the RF input of the Harmonic Modulator (Test Fixture 067-0518-00) from the Signal Generator.

(2) Apply a 500 kHz signal to the Mod Freq 1 input connector of the Harmonic Modulator from an accurate Audio Signal Generator.

(3) Connect the Mod Harm Out connector through a 10× attenuator to the RF INPUT connector of the Type 1L30.

This will provide an IF feedthrough signal of 200 MHz modulated by the Audio Signal Generator frequency.

7. Check Dispersion Accuracy of kHz/CM Ranges

a. Test equipment setup is given in step 6.

b. Set the DISPERSION selector to 500. Depress the 10 ns and 1 μs Marker Selector buttons on the Time-Mark Generator.

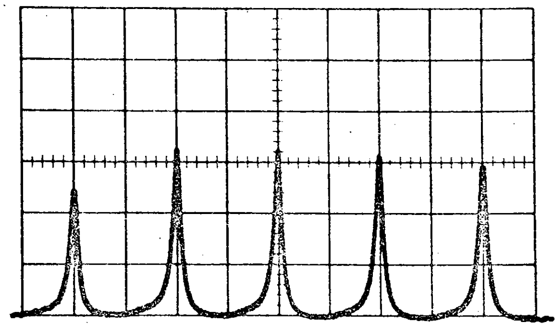
c. Check the frequency range of the IF CENTER FREQ control. Frequency range must equal or exceed + and — 2.5 MHz from its centered (000) position.

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

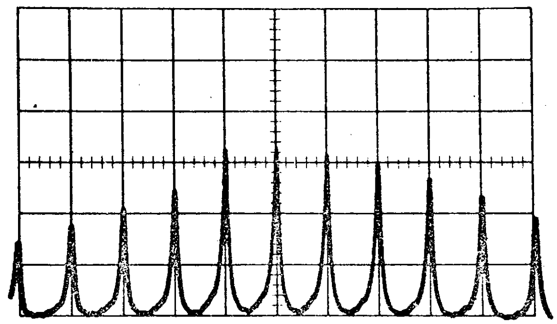
e. Check the frequency range of the IF CENTER FREQ-FINE control. Frequency range must equal or exceed + and — 50 kHz from its centered position.

f. Set the DISPERSION selector to the 500 kHz position and center the IF CENTER FREQ controls.

g. Check dispersion accuracy through + and — 2.5 MHz change in the IF center frequency, at each DISPERSION selector position listed in Table 6-2.



(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. 6-15. Typical displays when checking or adjusting kHz/CM dispersion.

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.

TABLE 6-2

DISPERSION kHz/cm	Time-Mark Generator Marker Selector	Display 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 (Turn VIDEO FILTER on)
2	10 ns and .5 ms	1

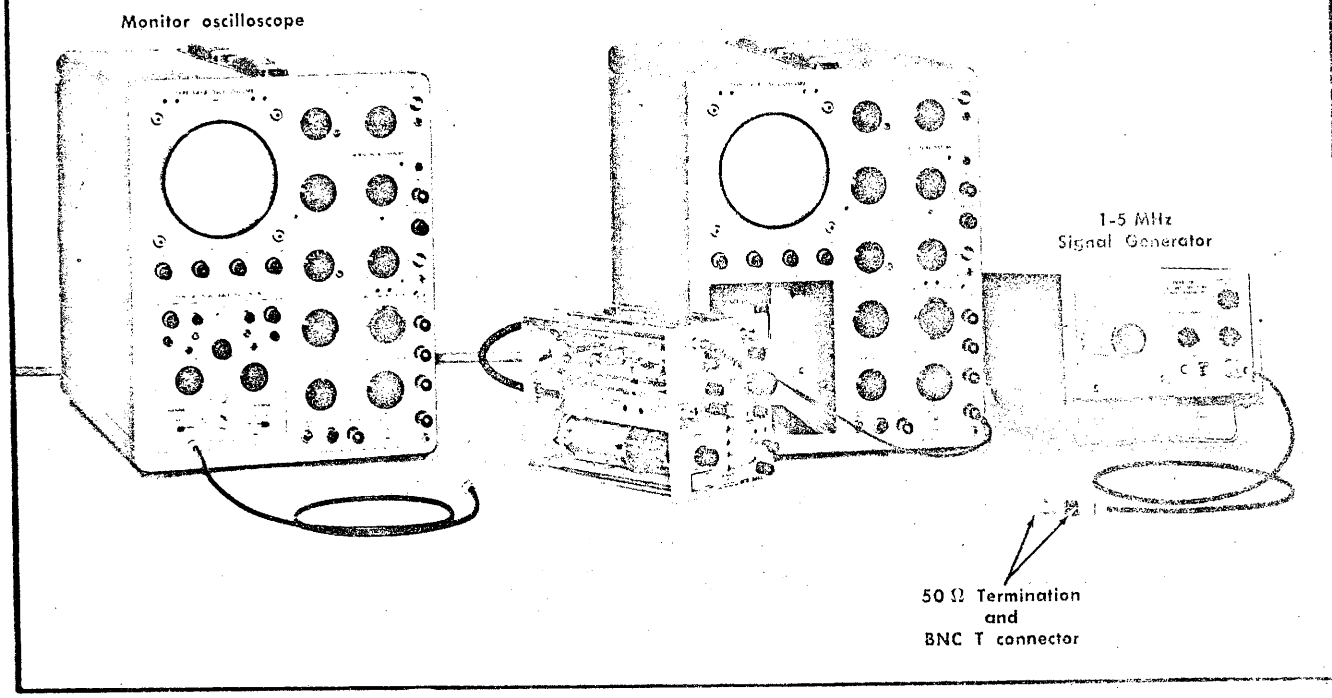


Fig. 6-16. Equipment setup to adjust avalanche voltage, 1 MHz internal reference frequency and check 1 MHz to 5 MHz external reference frequency range.

PHASE LOCK CIRCUIT

Type 1L30

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	**5 MHz**
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT 1 MHz REF FREQ	OFF

Oscilloscope

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

8. Adjust Avalanche Voltage and the 1 MHz Internal Reference Oscillator

a. Equipment setup is shown in Fig. 6-16.

b. With the INT 1 MHz REF FREQ switch in the OFF position, depress the LOCK CHECK button and adjust the Avalanche Volts adjustment R831 (Fig. 6-17) clockwise until avalanche occurs, then ccw from this point about ⅛ turn. Free running avalanche appears as a wide, noise trace or a definite increase in the noise level on the trace. See Fig. 6-18. Turn the adjustment ⅛ turn counterclockwise from the free running state.

NOTE

It is not uncommon to have instruments in which this circuit may not free run even with the adjustment fully clockwise. If this occurs, set the adjustment approximately 20° back from the full clockwise position.

c. Apply a 5 MHz signal from the Signal Generator through a T connector to the EXT FREQ IN connector. Connect the test oscilloscope to the T connector, so that the input signal amplitude to the Type 1L30 can be monitored.

d. Adjust the Signal Generator output for a 1 volt peak to peak 5 MHz signal. Check for the presence of phase-

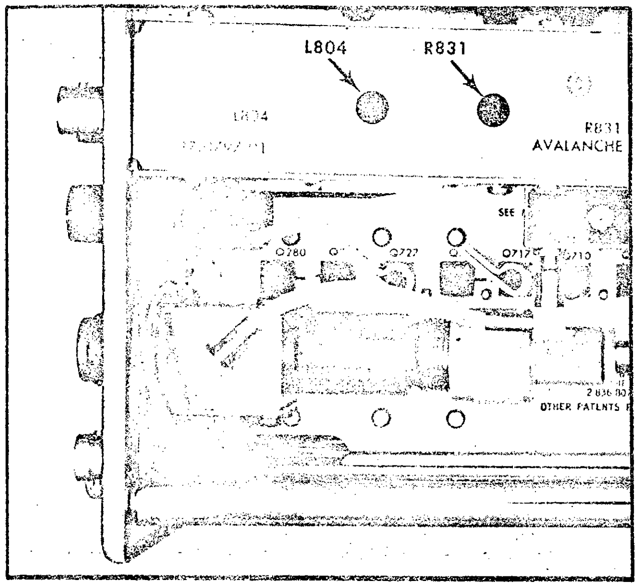


Fig. 6-17. Phase-lock circuit adjustments.

lock beats (see Fig. 6-19) as the RF CENTER FREQ control is rotated.

e. Increase the generator output signal level to 5 volts. Check for phase lock beats. There should be no sporadic noise beats due to circuit oscillation.

f. Disconnect the Signal Generator cable from the EXT REF FREQ IN connector. Switch the INT 1 MHz REF FREQ to the INT position.

g. Adjust L804 so the oscillator starts with minimum delay when the INT 1 MHz REF FREQ switch is switched to the INT position. (Use the tuning tool for the 5/64 hexagonal cores.)

h. Switch the INT 1 MHz REF FREQ to the INT position, depress the LOCK CHECK button and check for the presence of phase-lock beats as the RF CENTER FREQ control is rotated.

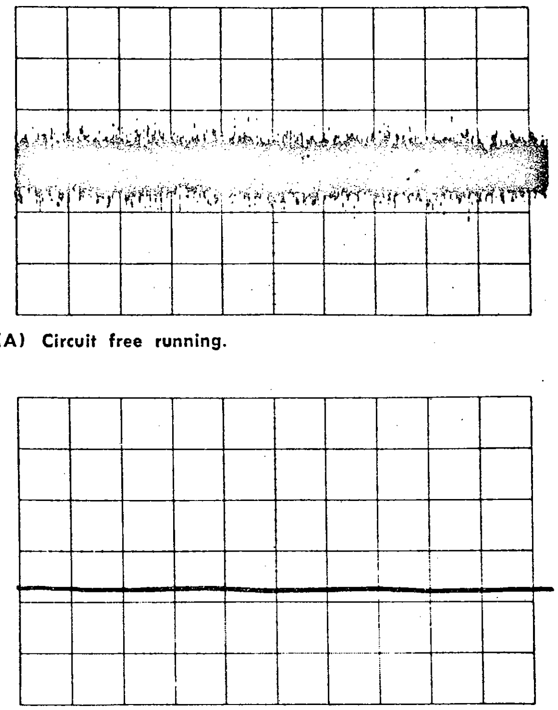
i. Check the range of the FINE RF CENTER FREQ controls as follows:

With instruments Serial No. 439 and below.

Connect the test oscilloscope probe to pin D of the phase-lock square-pin connector, switch the INT 1 MHz REF FREQ to the OFF position and check for a voltage swing that is approximately between 4 volts and 10 volts, as the FINE RF FREQ control is rotated through its range.

With instruments Serial No. 440 and above.

1. Depress the LOCK CHECK button and rotate the FINE RF FREQ control through its range. Note the DC reference level variation of the display as the control is rotated. Reference level should vary approximately ±3 cm from the center reference when the normal display baseline is at the bottom graticule line.



(A) Circuit free running.

(B) Typical display with voltage set so avalanche transistor circuit does not free run.

Fig. 6-18. Typical displays when adjusting the avalanche voltage.

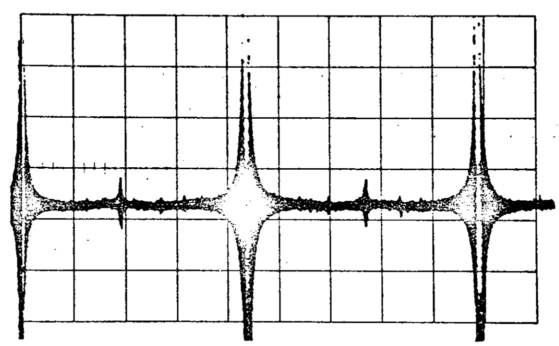


Fig. 6-19. Typical display showing presence of phase-lock beats, as the RF CENTER FREQ control is rotated. Amplitude of beat signals may vary from 1 cm to full screen depending on DISPERSION and RESOLUTION adjustments.

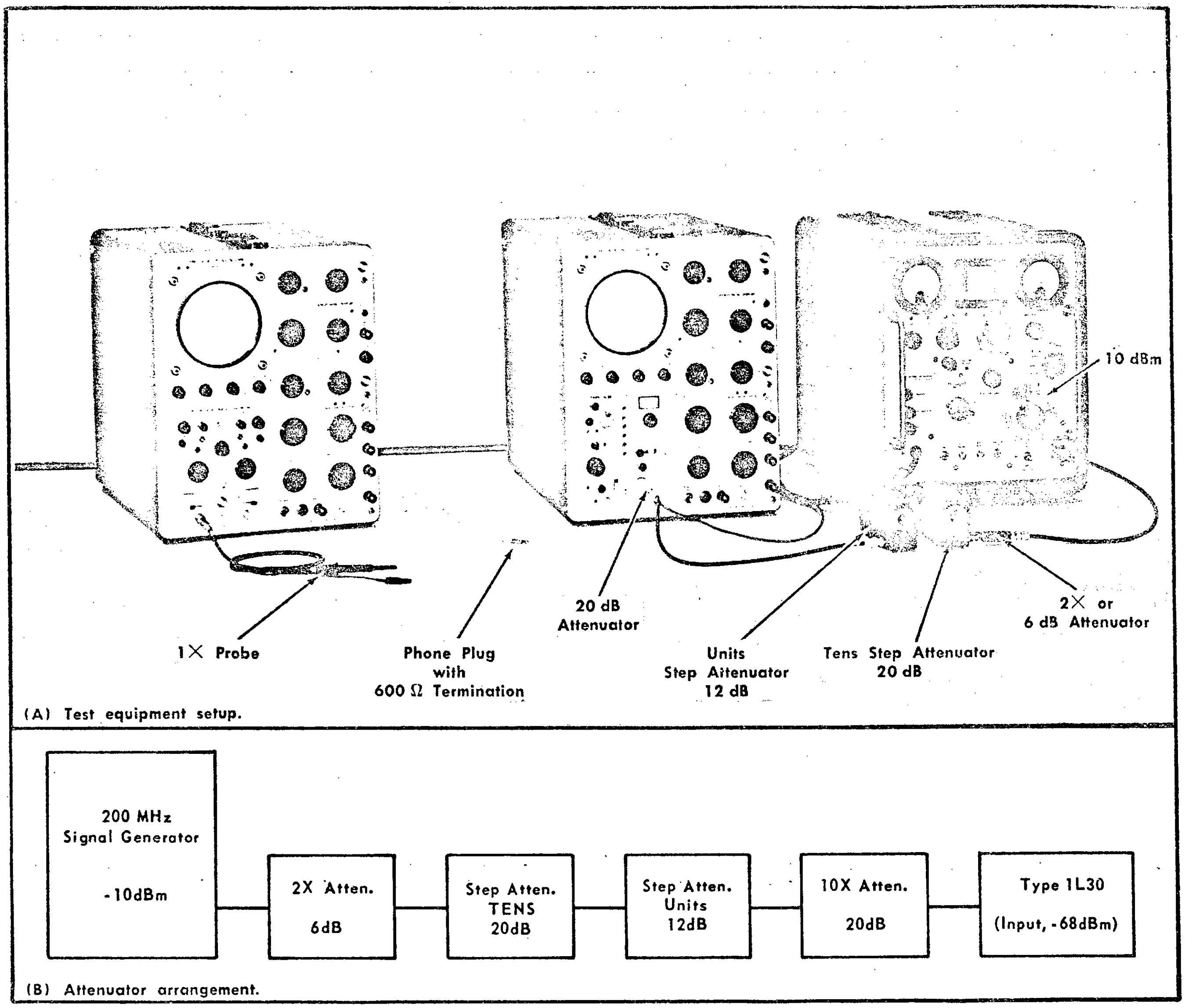


Fig. 6-20. Test equipment setup to check IF ATTEN dB accuracy, dynamic range, IF GAIN control range, RECORDER out signal level and VIDEO FILTER operation. (Steps 9 through 13.)

Type 1L30

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 1 MHz REF FREQ	OFF

Plug-in Oscilloscope

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

9. Check Accuracy of IF Attenuator dB Selectors

a. Equipment setup is shown in Fig. 6-20.

b. Apply a 200 MHz signal, that is 10 dB below 1 mW, from the signal generator through a 2× Attenuator (6 dB), a Tens and Units Step Attenuator and a 10× Attenuator (20 dB) to the Type 1L30 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 plug-in 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 1 dB attenuation through the Units Step Attenuator.

2. Check the display amplitude. Must equal 4 cm ±0.5 mm (.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 6-3a.

TABLE 6-3a

Spectrum Anayzer 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 screen changes for the same level change by the square power as listed in Table 6-3b.

TABLE 6-3b

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

1. Apply a —60 dBm, 200 MHz signal from the Signal Generator to the RF INPUT connector. Adjust the Spectrum Analyzer GAIN control, for a signal amplitude of 5 cm.

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

3. Check the new reading of the Attenuator dial. Should read —59 dBm ±0.1 dBm.

4. Turn the 1 dB ATTEN switch to OFF. Check the remainder of the IF ATTEN selector steps as directed in Table 6-3c.

TABLE 6-3c

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

10. Check Dynamic Range of Vertical Display Modes

a. Equipment setup is given in step 9.

b. Apply a —40 dBm, 200 MHz signal from the Signal Generator to the RF INPUT connector.

c. Adjust the Type 1L30 GAIN control and/or the Signal Generator Variable Attenuator for a signal amplitude of 6 cm (full screen display). Note the Attenuator reading.

d. Increase the Signal Generator Attenuator setting until the signal is just visible above the noise level (about 0.5 mm). Note the Attenuator reading. The difference in the two readings, between full screen display amplitude and the 0.5 mm amplitude, is the dynamic range.

e. Check the dynamic range of each vertical display mode.

LIN, 26 dB or greater

LOG, 40 dB or greater

SQ LAW, 13 dB or greater

11. Check Attenuation Range of IF GAIN Control

a. Equipment setup is given in step 10.

b. With the GAIN control fully counterclockwise, adjust the Signal Generator, Variable Attenuator control for a display amplitude 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 ≥50 dB.) If the range does not meet this requirement, recheck the adjustment of the IF amplifier response (step 4).

12. Check Signal Amplitude at RECORDER Output Jack

a. Equipment setup is given in Fig. 6-20.

b. Plug the test phone plug, with a 600 Ω load resistor across the terminals, into the 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 RECORDER connector should measure between 12 mV and 20 mV.

e. Remove the test oscilloscope probe and the phone plug.

13. Check Video Filter Operation

a. Equipment setup is shown in Fig. 6-20.

b. Set the DISPERSION to 100 kHz/cm, the TIME/Cm to 5 ms, uncouple the RESOLUTION control and turn one position counterclockwise from the fully clockwise position.

c. Adjust the GAIN control so the amplitude of the 200 MHz feedthrough signal is approximately 5 cm.

d. Turn the VIDEO FILTER switch to the ON position.

e. Check—The video filter circuit should attenuate and distort the 200 MHz response. See Fig. 6-21.

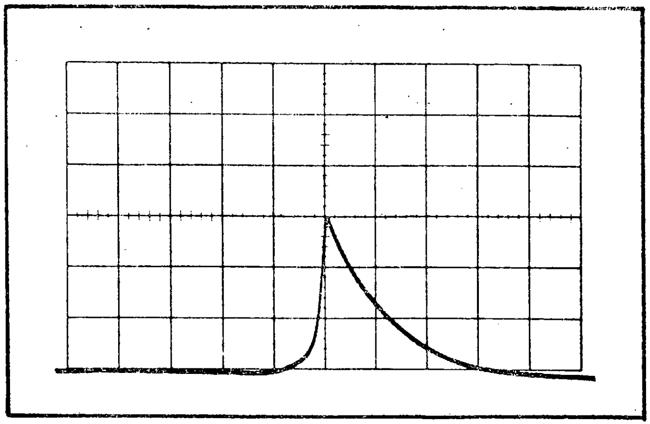


Fig. 6-21. Typical Video Filter integrated display of 200 MHz RF signal. Sweep rate 5 ms/cm.

f. Decrease the Time/Cm setting to 50 ms and check the display. The display should return to its original response curve. There should be no appreciable change in the display shape with the VIDEO FILTER switch on or off, unless noise is present in the display. Set the VIDEO FILTER switch to off.

NOTES

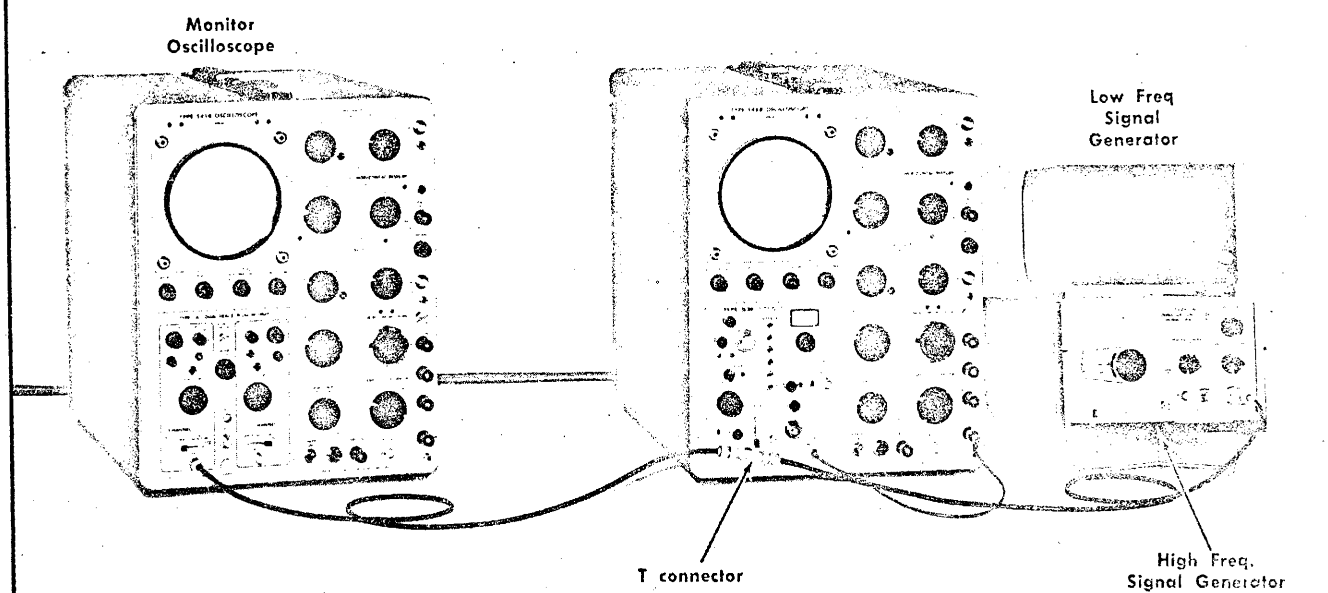


Fig. 6-22. Equipment setup to check video bandpass (step 14).

Type 1L30

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 1 MHz REF FREQ	OFF

Plug-In 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

14. Check Frequency Response of Video Circuit

a. Equipment setup is shown in Fig. 6-22.

b. Apply a 50 kHz signal from the Audio Signal Generator through a BNC T connector to both the Type 1L30 Video INPUT connector and the vertical Input of a DC coupled test oscilloscope.

c. Turn the Type 1L30 GAIN control fully clockwise. Adjust the signal generator output control for a signal amplitude of 4 cm on the plug-in 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 plug-in oscilloscope decreases to 2.8 cm. Maintain a constant 4 cm reference amplitude on the monitor oscilloscope.

e. Check—Input frequency from the signal generator should be equal to or less than 16 Hz.

f. Remove the Audio Signal Generator and apply 50 kHz signal from the Constant Amplitude Signal Generator (Type 191) through the BNC T connector to the Video INPUT.

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 plug-in oscilloscope decreases to 2.8 cm. Maintain a constant 4 cm signal amplitude on the monitor oscilloscope.

i. Check—Frequency of the signal generator must equal or exceed 10 MHz.

NOTE

The Type 1L30 Unit must be plugged directly into the oscilloscope vertical compartment for the high frequency check.

j. Remove the signal generator and the test oscilloscope from the Video INPUT of the Type 1L30.

NOTES

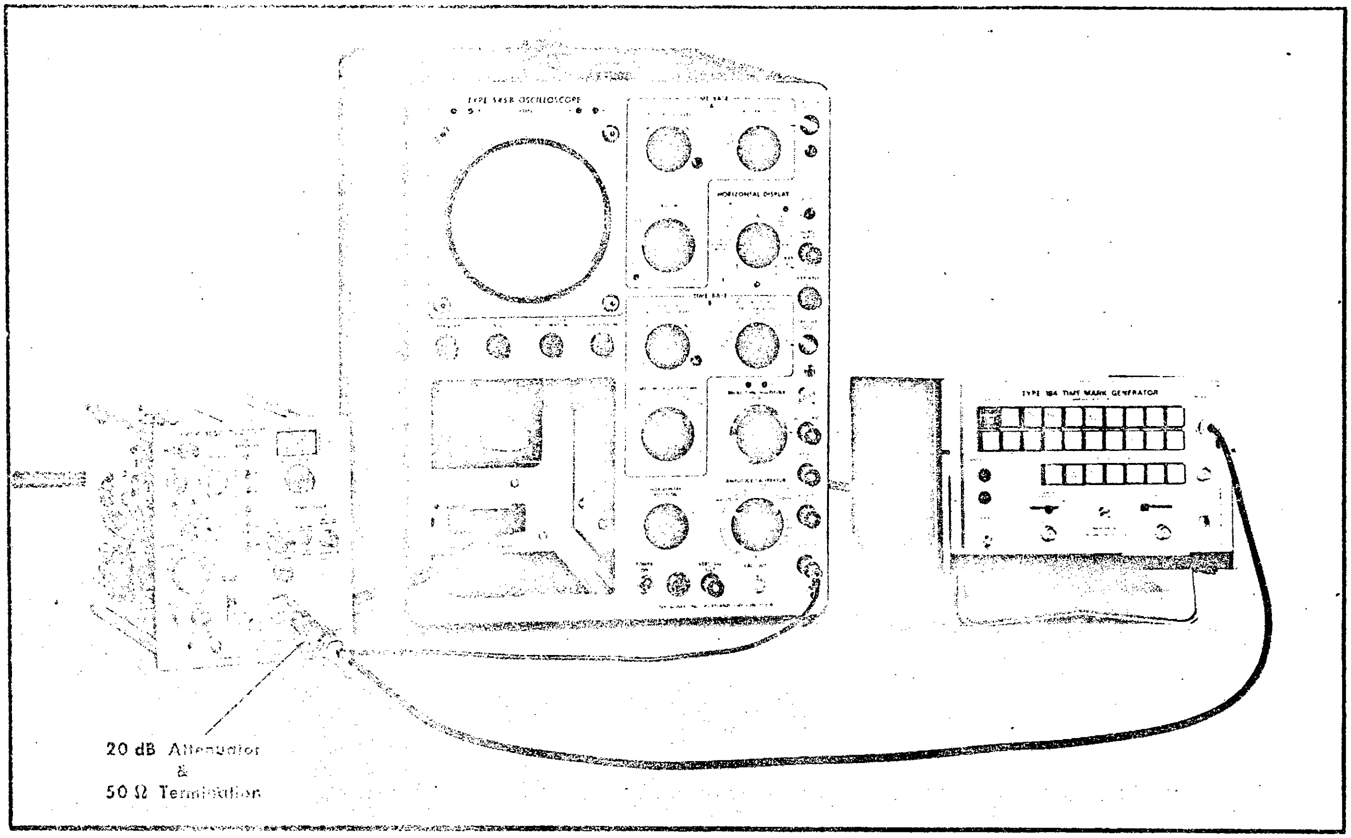


Fig. 6-23. Equipment setup for checking incidental FM (step 15).

Type 1L30

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**
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	**LIN**
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT 1 MHz REF FREQ	**INT**

Oscilloscope

Time/Cm	50 ms
Triggering	Adjusted for a free running sweep
Horizontal Position	Centered trace

15. Check Incidental Frequency Modulation

NOTE

Signal source must supply a very stable 200 MHz signal to accurately measure incidental FM and the Type 1L30 must be on a vibration-free platform.

a. Equipment setup is shown in Fig. 6-23.

b. Set the DISPERSION RANGE switch to kHz/CM and the DISPERSION to 500 kHz/cm. Set the Time/Cm to 50 ms.

c. Apply a 200 MHz signal from the Time-Mark Generator (2nd harmonic of 10 ns marker) through a 20 dB attenuator and a 50 Ω termination to the RF INPUT connector. Center the IF feedthrough signal on screen.

d. Change the DISPERSION-COUPLED RESOLUTION to 1 kHz/cm position. Adjust the IF CENTER FREQ control if required to keep the signal centered on screen.

e. Adjust the GAIN control for a full screen 6 cm signal amplitude.

f. Check the amount of frequency modulation (see Fig. 6-24) in the IF feedthrough signal. Must not exceed 2 millimeters or 1 minor division ($\leq$200 Hz).

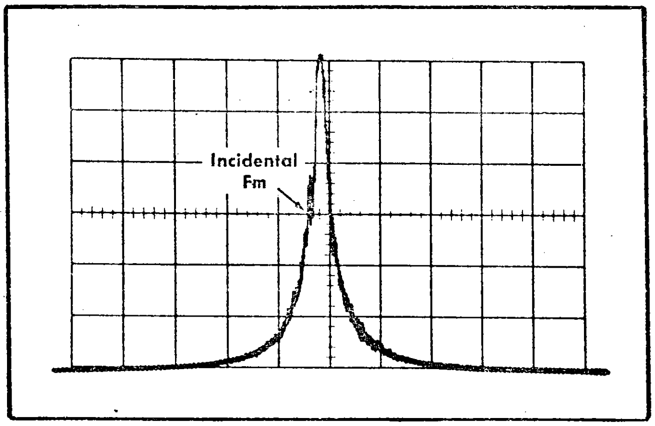


Fig. 6-24. Typical display showing identical frequency modulation. Measure the horizontal displacement of the signal at the most vertical slope of the signal.

g. Change the DISPERSION to 100 kHz/cm. Shift the IF feedthrough signal off screen by tuning the IF CENTER FREQ control. Adjust the RF CENTER FREQ control to center a converted or tunable signal display on screen. Adjust the MIXER PEAKING for maximum signal amplitude.

h. Switch the INT 1 MHz REF FREQ to the INT position and phase lock the display.

i. Decrease the DISPERSION to 1 kHz/cm, keeping the phase-locked signal on screen with the IF CENTER FREQ controls.

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).

k. Return the DISPERSION-COUPLED RESOLUTION controls to 500 kHz/cm. Remove the signal from the Time-Mark Generator.

NOTES

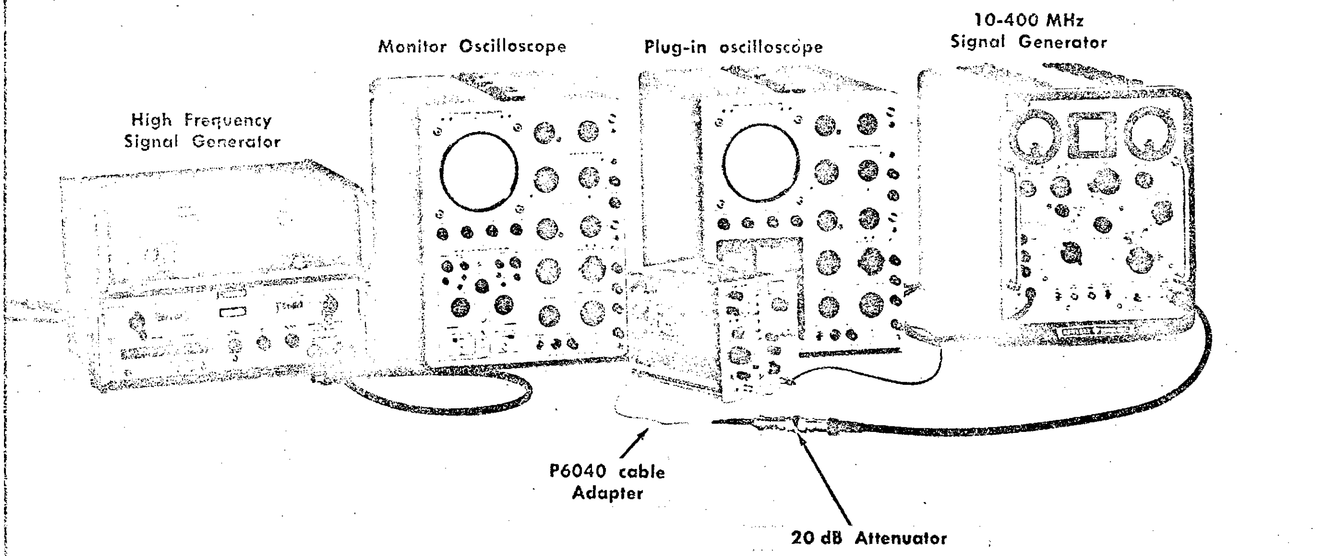


Fig. 6-25. Equipment setup to adjust the RF Mixer, the wide band IF amplifier and check response flatness (steps 16 and 17).

Type 1L30

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	**5 MHz**
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT 1 MHz REF FREQ	INT

Oscilloscope

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

16. Adjust RF Mixer

a. Equipment setup is shown in Fig. 6-25.

b. Appy a 1000 MHz signal from the Signal Generator at approximately 40 dB below 1 mW to the RF INPUT connector.

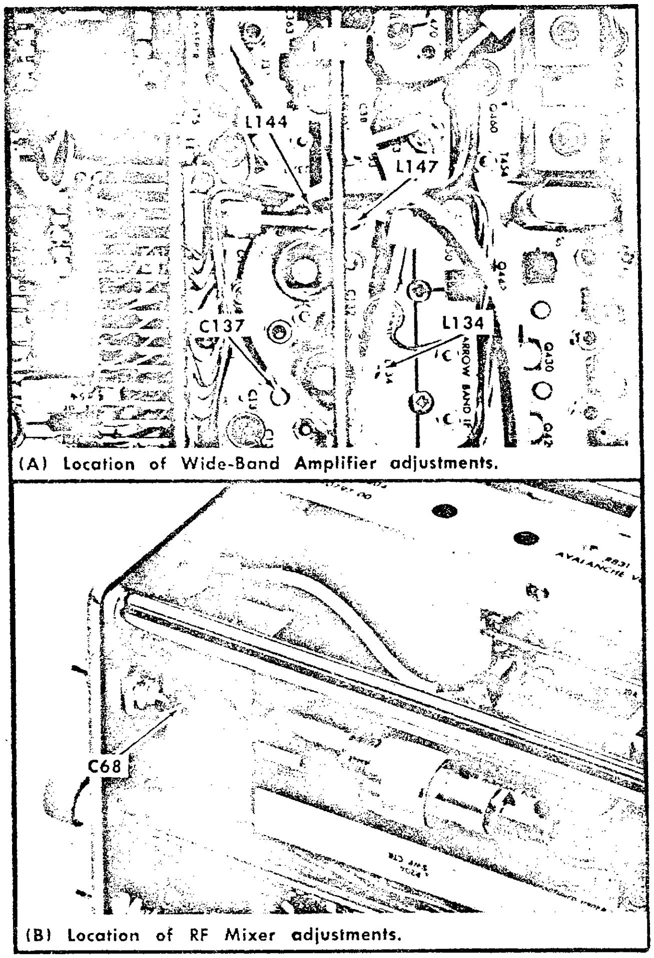
c. Tune the signal to the center of the display with the RF CENTER FREQ control, then adjust the MIXER PEAKING control for maximum signal amplitude.

d. Adjust C68 in the RF mixer (Fig. 6-26) for optimum signal amplitude and display flatness over the 100 MHz dispersion. (+ and —50 MHz either side of 1000 MHz.)

17. Adjust Wide Band Amplifier Response, Check Response Flatness of RF Mixer and Wide Band IF Amplifier

The Type 1L30 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. If recalibration is required, the analyzer should be returned to a Tektronix Field Repair Center for repair and calibration. Contact your local Field Office or representative.



(A) Location of Wide-Band Amplifier adjustments.

(B) Location of RF Mixer adjustments.

Fig. 6-26. Wide band IF amplifier and 1st mixer adjustments for response flatness.

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.

a. Equipment setup is shown in Fig. 6-25.

b. Disconnect the Sealectro connector from J120 on the honeycomb assembly and apply a calibrated 65 MHz signel (—30 dBm) from the Signal Generator through a 20 dB attenuator and Sealectro to GR adapter such as a P6040 cable to J120.

c. Switch in the 20 dB ATTEN selector. Adjust the output of the Signal Generator for an approximate vertical DC shift of 1 cm in the trace.

d. Adjust L147 (Fig. 6-26) the 65 MHz trap, 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.

e. Remove the Signal Generator connection so the Sealectro connector on the honeycomb assembly. Reconnect the honeycomb cable to J120.

f. Apply a frequency and amplitude calibrated signal (—30 dBm) within the frequency range of the Type 1L30 through a 20 dB attenuator to the RF INPUT connector.

g. 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.

h. 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 total) with a constant amplitude input signal to the RF INPUT connector.

i. If the response flatness is not within tolerance, adjust C137 and L134 (Fig. 6-26) 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.

j. Check the display flatness over the frequency range of the instrument as follows:

NOTE

Each time the Signal Generator frequency is changed it will be necessary to recalibrate the output amplitude and after each major change (100 MHz or better) of the RF CENTER FREQ, it will be necessary to readjust the MIXER PEAKING for maximum signal amplitude.

(1) Set the front panel controls as follows:

RF CENTER FREQ	975 MHz
DISPERSION RANGE	MHz
DISPERSION-COUPLED RESOLUTION	10 MHz/cm
IF ATTEN dB	20
VERTICAL DISPLAY	LIN

(2) Apply the signal frequency listed in Table 6-4 from the Signal Generator through a 20 dB attenuator (Part No. 011-0086-00) to the RF INPUT connector.

NOTE

Do not use the 10× attenuator Part No. 011-0059-00 to check flatness or sensitivity at these frequencies.

(3) Tune the Type 1L30 to the frequency of the applied signal and adjust the MIXER PEAKING control for maximum signal amplitude, then adjust the Signal Generator output control and the Type 1L30 GAIN control for a signal am-

plitude of 5 cm. This must be repeated for each Signal Generator frequency change.

(4) Check the display flatness over the dispersion window by tuning the signal across the graticule area (from the left to right side) with the RF CENTER FREQ control. Signal amplitude should not change more than ±1.5 dB from its average amplitude, or a total of 3 dB.

NOTE

It is possible that the 5 cm signal reference amplitude established in step (3) may be a minimum or maximum signal response point through the dispersion window. Check for and use the average signal amplitude over the dispersion window.

TABLE 6-4

RF Center Frequency	Applied Signal Generator Frequency
1450 MHz - 1550 MHz (Scale 1)	1500 MHz
1950 MHz - 2050 MHz (Scale 1)	2000 MHz
2450 MHz - 2550 MHz (Scale 2)	2500 MHz
2950 MHz - 3050 MHz (Scale 2)	3000 MHz
3450 MHz - 3550 MHz (Scale 2)	3500 MHz
4200 MHz - 4300 MHz (Scale 3)	4500 MHz
4750 MHz - 4850 MHz (Scale 4)	4800 MHz
5750 MHz - 5850 MHz (Scale 4)	5800 MHz
6750 MHz - 6850 MHz (Scale 5)	6800 MHz

NOTES

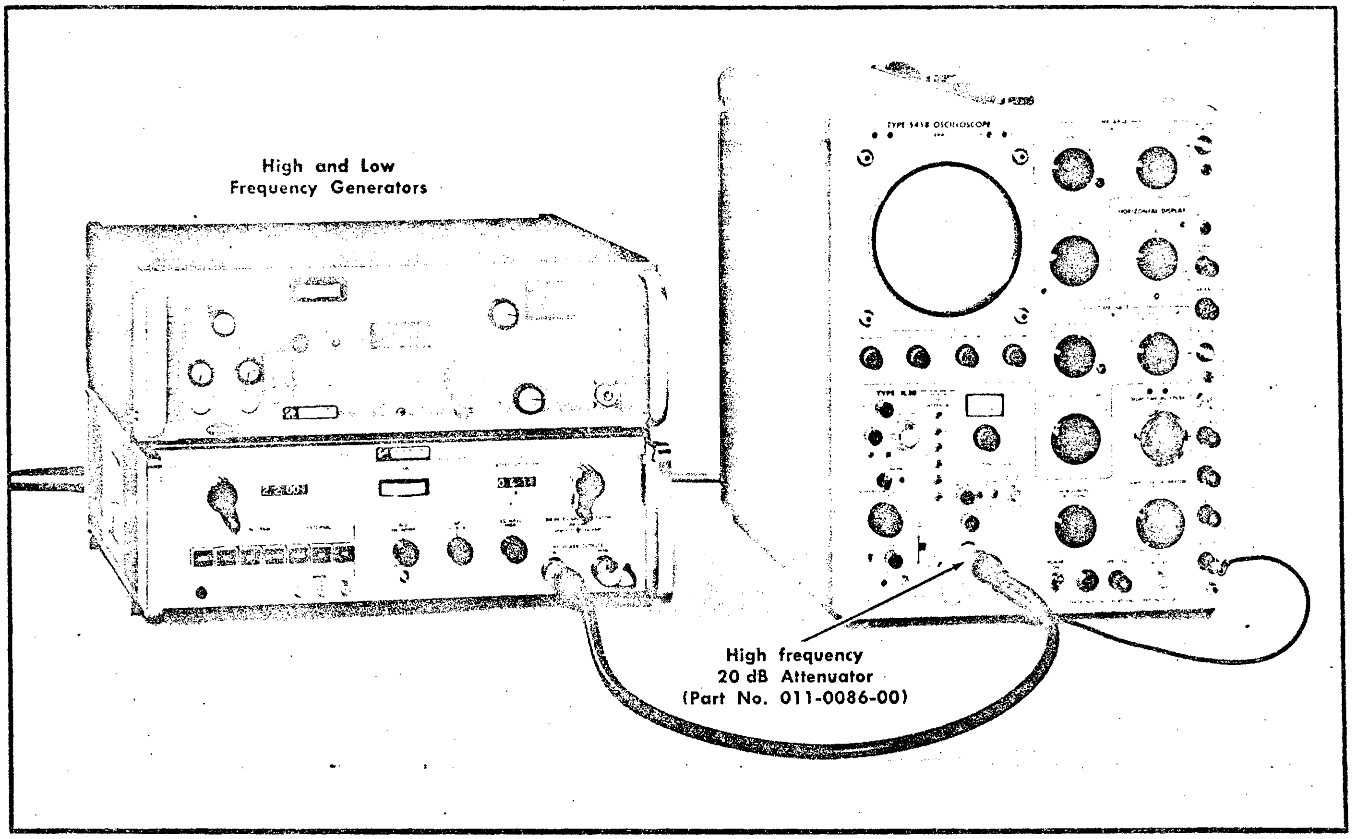


Fig. 6-27. Typical equipment setup to check sensitivity, dial accuracy and phase lock operation (step 18).

Type 1L30

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**
VIDEO FILTER	OFF
GAIN	Midrange
VERTICAL DISPLAY	LIN
IF ATTEN	Switches off
FINE RF CENTER FREQ	Centered
INT 1 MHz REF FREQ	**OFF**

Oscilloscope

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

18. Check RF Center Frequency Calibration, System Sensitivity and Phase Lock Operation

a. Equipment setup is shown in Fig. 6-27.

b. Apply a frequency and amplitude calibrated signal that is between —60 dBm and —30 dBm to the RF INPUT connector.

NOTE

If an external attenuator is used, it must have flat high frequency characteristics: Use Tektronix 20 dB Attenuator Part No. 011-0086-00, or 40 dB Attenuator Part No. 011-0087-00.

c. Set the DISPERSION control to 500 kHz/cm and the RESOLUTION control for a resolution bandwidth of 100 kHz (fully clockwise).

d. Adjust the GAIN control for an average noise amplitude of one centimeter. Center the IF CENTER FREQ and FINE RF CENTER FREQ controls.

e. Tune the signal on screen with the RF CENTER FREQ control. Reduce the signal amplitude with the signal generator output attenuator control for an on-screen display, then adjust the MIXER PEAKING control and the sweep rate selector for optimum signal amplitude. (Sweep rate approximately 20 ms/cm or slower.)

f. Calibrate the Signal Generator output signal amplitude, then adjust the variable output attenuator control on the Signal Generator until the signal amplitude is two centimeters (twice the noise amplitude). See Fig. 6-28.

g. Check the total signal attenuation (in dB) below 0 dBm as indicated on the Signal Generator attenuator dial. This is the sensitivity of the analyzer for the RF center frequency indicated. Check as listed in Table 6-6 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 12.5 GHz for a 6 foot, RG-9B/U cable between the signal source and the RF INPUT.

h. Center the IF CENTER FREQ controls and the FINE RF CENTER FREQ control, then tune the signal to the center of the screen with the RF CENTER FREQ control. (Horizontal sweep must be centered.)

i. Check the dial accuracy at frequencies listed in Table 6-6. 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.

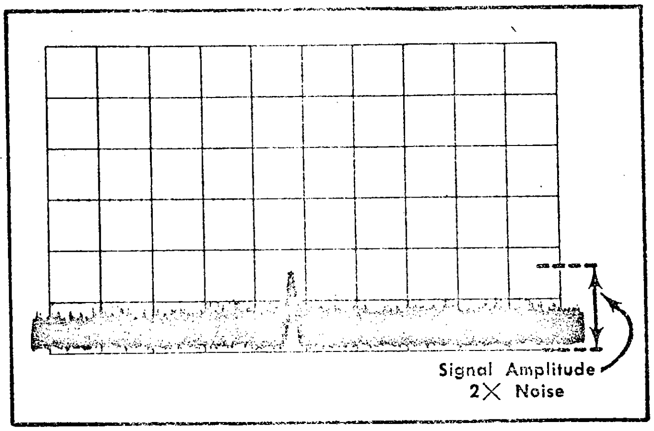


Fig. 6-28. Signal to noise ratio of 2:1 for measuring analyzer sensitivity.

NOTE

To check the dial accuracy to specifications, an accurate (within ±0.1%) signal source must be used. The listed signal generators may be used provided their frequency check points are checked by an accurate frequency counter or the internal beat indicator of the generator.

j. As the dial accuracy is checked, depress the LOCK CHECK button and check for phase lock beats as the RF CENTER FREQ is rotated to these dial check points. Check for phase lock operation at the center and the extreme frequency positions for each scale.

TABLE 6-6

Suggested[1] Signal Gen.	RF Center Freq. in MHz	Dial Scale	Minimum Sensitivity[2] 100 kHz Resolution	1 kHz Resolution	Dial Accuracy Check
Type 8614A	925	1	—85 dBm	—105 dBm	100 MHz steps
	1500				
Type 8616A	1940-2050[3]				
	1940-2050[3]	2	—80 dBm	—100 dBm	1000 MHz
	3000				
	4100				
	4100	3	—75 dBm	—95 dBm	1000 MHz[4]
Type 1107	5000				
	6250				
	6200	4	—70 dBm	—90 dBm	
	7000				
Type 1108	8400				
	8300	5	—55 dBm	—75 dBm	
	9000				
	10500				

[1]Refer to equipment list.

[2]Signal + Noise = 2X Noise amplitude.

[3]The tuning range will vary between instruments. The upper frequency limit on scale 1 must be above the lowest frequency limit of scale 2.

[4]There is no need to check dial accuracy for these scales because they are multiples of scale 1.

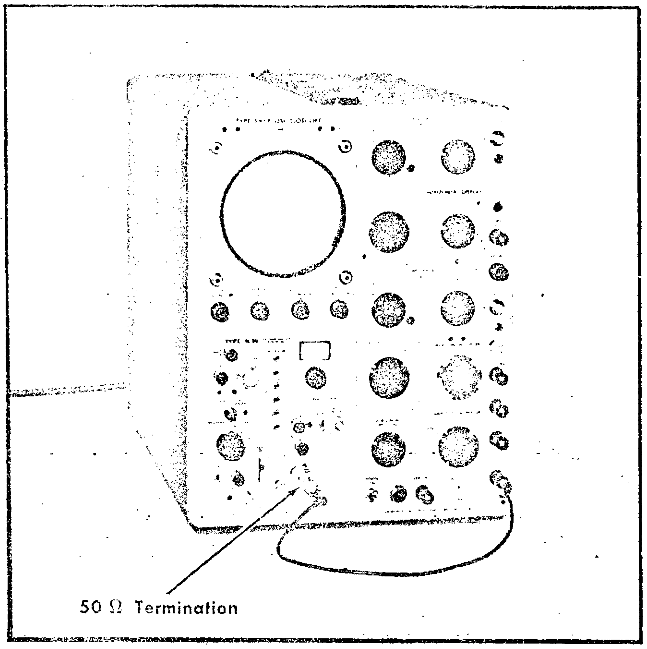


Fig. 6-29. Equipment setup to check internal spurious signal response (step 19).

Type 1L30

POS	Position of 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 1 MHz REF FREQ	OFF

Oscilloscope

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

19. Check Amplitude of Spurious Signals from Internal Sources

a. Equipment setup is shown in Fig. 6-29.

b. Install the Type 1L30 into the plug-in oscilloscope vertical compartment. Connect a 50 Ω termination on the RF INPUT connector. Set the DISPERSION RANGE selector to kHz/CM, the DISPERSION to 500 kHz/cm, uncouple the RESOLUTION control and turn fully clockwise.

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 the spurious responses should not exceed 2× the noise level. The MIXER PEAKING must be adjusted for optimum sensitivity when the RF Center Frequency has been changed more than 100 MHz.

If spurious signals appear at the low end of the frequency band, they can usually be minimized by proper dress of the oscillator filament leads.

NOTES

RF AND LOCAL OSCILLATOR CALIBRATION

The following procedure is NOT a part of the routine calibration. It provides a calibration procedure for the RF section, when adequate equipment and qualified personnel are available. (Personnel must be experienced in high frequency calibration technique.) If practical, Tektronix recommends that the RF assembly or the Plug-In Unit be returned to Tektronix for repair. See your local Tektronix Field Office or representative.

The following additional equipment or its equivalent is required to calibrate the RF section. See Fig. 6-30.

1. Sampling Oscilloscope with Plug-In Units. Frequency, DC to 3900 MHz, Dual-Trace display, sensitivity 2 mV/cm. Tektronix Type 661/4S2A/5T3.

2. Frequency Meter or Counter. Frequency Range 500 MHz to 900 MHz, accuracy .001%. PRD Type 504, Heterodyne Frequency Meter.

3. Two (2) 10X Attenuators. Tektronix Part No. 017-0044-00.

4. Two (2) 50 Ω 5 ns coaxial cables. Tektronix Part No. 017-0502-00.

5. Two (2) Adapters, Sealectro slide on plug to GR 874 connector. (General Radio Part No. 52-073-6400-813.)

Preliminary Procedure After Replacing the Oscillator Tube

1. Assemble the oscilloscope with the dial tape assembly. Install a knob on the tuning shaft. Loosen the Allen set screws on the Varactor adjustment, the pickoff probe and the inner and outer choke plunger. See Fig. 6-31.

2. Set the Varactor adjustment two full turns back from maximum pentration and the pickoff probe approximately 1/4 inch back from maximum penetration. Tighten set screws just enough to hold the adjustments in place.

3. Set the tuning to the highest frequency position (clockwise to the mechancial stop). Push the inner choke in until it bottoms against the tube; do not exert any excess pressure that might break the tube. Pull the inner choke out slightly and tighten the choke set screws. The tuning mechanism should stop the choke just short of touching the tube. Push the outer choke to its high frequency end.

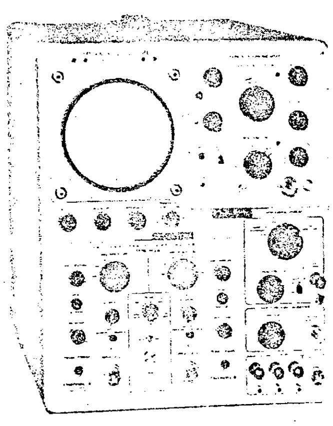
4. Connect the voltage leads (filament, B+ and Varactor) to the oscillator assembly. Replace the back panel of the Type 1L30 and install 2 to 3 screws to hold the panel in place. (This reduces the possibility of short circuits.) Fig. 6-32 illustrates the postion of the RF oscillator for calibration adjustments.

5. Connect the oscillator output (both coaxial connectors) through a Sealectro to GR adapter, a 50 Ω, 5 ns cable and a 10X attenuator to both inputs of the Sampling Unit (4S2A). Set the sweep to free run. Turn the power switch to ON, and allow a 30 minute warm-up period for the oscillator to stabilize.

6. With the oscillator tuned to the high frequency end, adjust the plate (outer) choke position for maximum oscillation amplitude, as indicated on the sampling oscilloscope system. Tighten the plate choke set screws.

NOTE

If these screws are overtightened, they will warp the plastic rods and may cause the tuning operation to bind.


Sampling Oscilloscope System 661/4S2A/5T3

FREQUENCY METER PRD 504

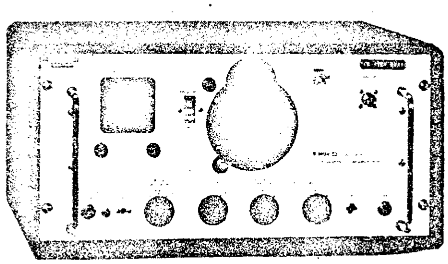


Fig. 6-30. Equipment required to calibrate the RF oscillator assembly.

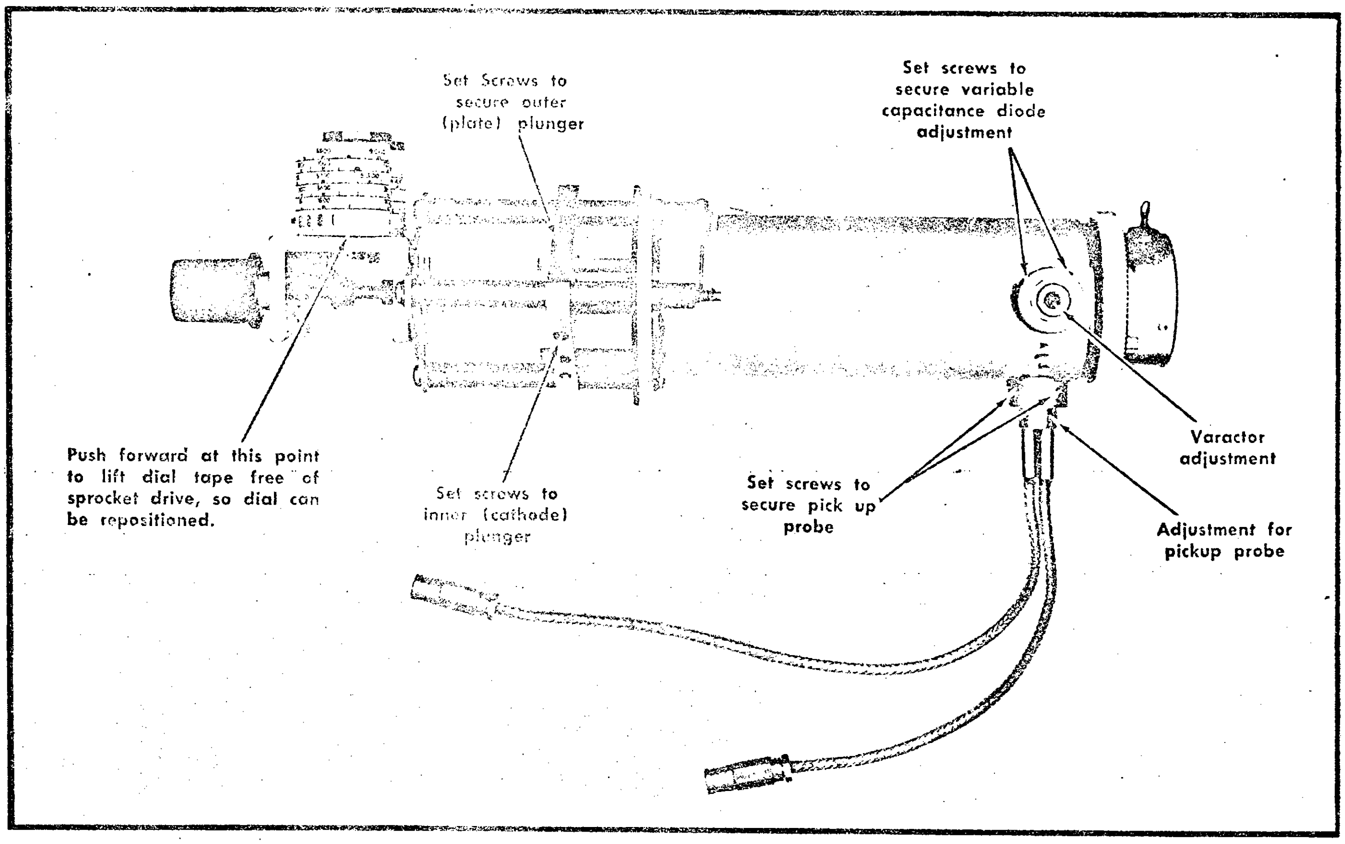


Fig. 6-31. RF oscillator assembly.

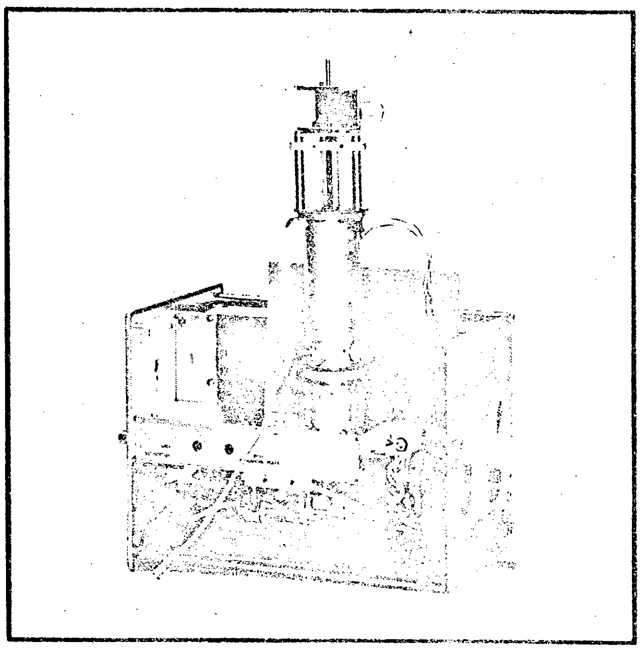


Fig. 6-32. Oscillator assembly removed and positioned ready for calibration.

7. Adjust the power output probe penetration and orientation for approximately 1 V peak to peak into 50 Ω for both output signals as indicated on the dual trace sampling oscilloscope system. Tighten the probe set screws at this point.

8. Tune the oscillator throughout its range. Check the mechanical function for smoothness of operation. If there is any binding, loosen the set screws and realign the tuning chokes. Check the electrical operation, for constant oscillation with no dead spots or backlash. Output power should remain fairly uniform and within 0.75 V to 1.5 V peak to peak throughout the tuning range.

If dead spots are noticed at either end of the tuning range, try adjusting the Varactor and/or the pick-off probe. If backlash is present, try adjusting the outer choke position.

All electrical adjustments interact; therefore, their effect should be checked throughout the tuning range before proceeding with the next adjustment.

CALIBRATION

1. Calibrate High Frequency End

a. Tune the frequency meter to 650 MHz. (The 3rd harmonic will be used to set the oscillator frequency.)

b. Tune the oscillator to a frequency of 1950 MHz as indicated by a beat mode signal on the frequency meter.

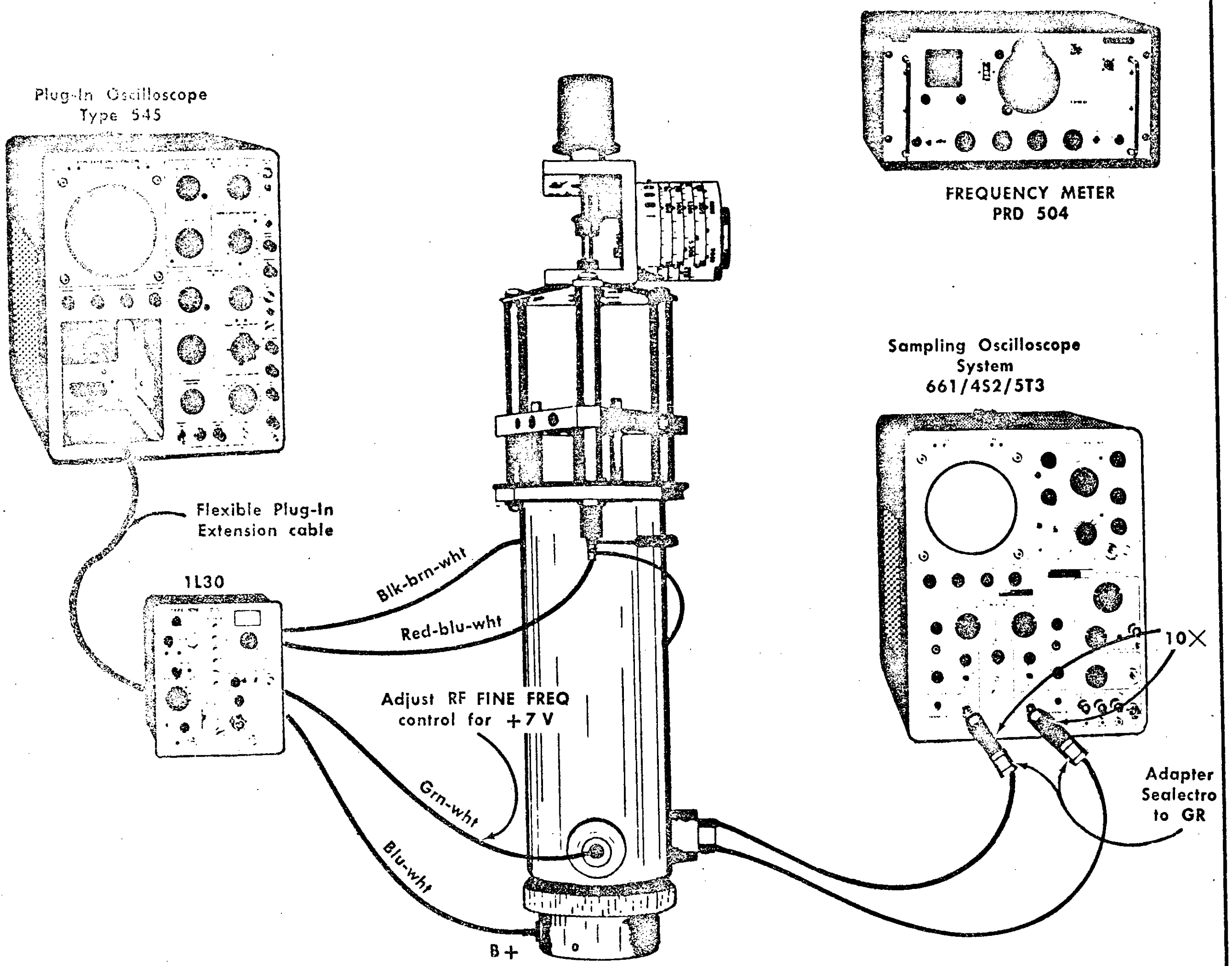


Fig. 6-33. Test equipment setup for calibrating the oscillator.

c. Push forward on the dial tape, to free the tape from the sprocket, and position the tape to read 1750.

2. Calibrate Low Frequency End

a. Tune the frequency meter to 650 MHz. (The 2nd harmonic will be used to set the oscillator frequency.)

b. Tune the oscillator to read 1100 on the dial tape.

c. Adjust the varactor until the oscillator frequency is 1300 MHz as indicated by a beat mode signal on the frequency meter.

Turning the Varactor assembly clockwise will reduce the oscillator frequency. Turning the Varactor assembly counterclockwise will increase the oscillator frequency..

3. Repeat steps 1 and 2 as necessary to track the oscillator to the tape.

4. Check Low Frequency Mechanical Stop

a. Tune the oscillator to the low frequency mechanical stop.

b. Check the frequency of the oscillator with the frequency meter. Frequency must be between 1070 MHz to 1125 MHz. The dial tape reading must equal: (Oscillator frequency — 200 MHz) ±1% of 900 MHz.

5. Check High Frequency Mechanical Stop

a. Tune the oscillator to the high frequency mechanical stop.

b. Check the frequency of the oscillator with the frequency meter. Frequency must be at least twice the lower frequency noted in step 4, plus 10 MHz. The dial tape reading must be at least twice the low frequency reading. Dial accuracy must equal the oscillator frequency — 200 MHz ±1% of 900 MHz.

6. Check Dial Tracking Error

a. Tune the oscillator to 1600 MHz.

b. Check the dial tape reading. Must read between 1386 and 1414. (1400 ±1% of 1400)

If the oscillator does not track within ±1% of dial tape, then the choke positions (with respect to each other) must be changed and the calibration procedure repeated.

7. Check Tuning Range of Varactor Control

a. Connect one oscillator output cable to the mixer in the Type 1L30, and the other output cable to the phase lock (J855).

b. Connect the frequency meter to the RF INPUT.

c. Set the Type 1L30 front panel controls as follows:

DISPERSION RANGE	MHz/CM
DISPERSION	1 MHz/cm
INT 1 MHz REF FREQ	OFF
VERTICAL DISPLAY	LIN
IF CENTER FREQ	Centered (000)
RF CENTER FREQ	1300
FINE RF CENTER FREQ	Fully clockwise

d. Set the frequency meter to 650 MHz.

e. Note the position of the signal on the analyzer display.

f. Rotate the FINE RF FREQ control from a full clockwise position to a fully counterclockwise position (this should change the Varactor bias voltage from approximately +14 V to +2 V). Note the amount of signal shift on the display.

g. The signal should decrease in frequency at least 1 MHz

h. Remove the frequency meter from the RF INPUT connector.

8. Check for Spurious Signals

a. Connect a 50 Ω termination to the RF INPUT connector.

b. Adjust the GAIN control for approximately .5 cm of noise on the display, then tune the oscillator through its range checking for internal spurious signals. Spurious signal amplitudes should not exceed 2× the noise amplitude.

This completes the oscillator test and calibration. Install the oscillator assembly using the reverse procedure used to remove the assembly. Care should be taken not to disturb the dial tape setting during the installation of the assembly.

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
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°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

SECTION 7

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description					S/N Range
				Capacitors			

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.						S/N Range
C81[1]							
C83[1]							
C86[1]							
C101	281-0101-00	1.5-9.1 pF	Air	Var			
C102	281-0099-00	1.3-5.4 pF	Air	Var			
C104	281-0101-00	1.5-9.1 pF	Air	Var			
C105	281-0648-00	56 pF	Cer			5%	
C106	281-0101-00	1.5-9.1 pF	Air	Var			
C107	281-0099-00	1.3-5.4 pF	Air	Var			
C108	281-0101-00	1.5-9.1 pF	Air	Var			
C123	281-0635-00	1000 pF	Cer		500 V		
C124	281-0523-00	100 pF	Cer		350 V		100-559
C124	283-0599-00	98 pF	Mica		500 V	5%	560-up
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		X560-up
C137	281-0063-00	9-35 pF	Cer	Var			
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%	
C231	285-0519-00	0.047 μF	Cer		400 V		100-629X
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.	Description					S/N Range
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 μF	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	Cer	Var			
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	Cer	Var			
C385	281-0105-00	0.8-8.5 pF	Cer	Var			
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	Cer	Var			
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	Cer	Var			
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.	Description					S/N Range
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	Cer	Var			
C508	281-0105-00	0.8-8.5 pF	Cer	Var			
C515	283-0065-01	0.001 µF	Cer		100 V	5%	
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	Air	Var			
C620	281-0105-00	0.8-8.5 pF	Cer	Var			
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		X310-up
C668	285-0703-00	0.1 µF	PTM		100 V	5%	
C801	283-0065-00	0.001 µF	Cer		100 V	5%	
C806	281-0543-00	270 pF	Cer		500 V	10%	
C807	281-0536-00	1000 pF	Cer		500 V	10%	
C810	283-0003-00	0.01 µF	Cer		150 V		
C823	283-0081-00	0.1 µF	Cer		25 V	+80%—20%	
C832	283-0065-00	0.001 µF	Cer		100 V	5%	
C844	283-0127-00	2.5 pF	Cer		100 V		
C847	283-0127-00	2.5 pF	Cer		100 V		
C856	283-0127-00	2.5 pF	Cer		100 V		
C857	283-0127-00	2.5 pF	Cer		100 V		

Capacitors *(Cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C859	283-0065-01	0.001 μF	Cer	100 V	5%	
C876	283-0059-00	1 μF	Cer	25 V	+80%—20%	
C883	283-0065-00	0.001 μF	Cer	100 V	5%	
C889	283-0003-00	0.01 μF	Cer	150 V		X670-up
C890	283-0081-00	0.1 μF	Cer	25 V	+80%—20%	
C892	283-0092-00	0.03 μF	Cer	200 V	+80%—20%	
C894	283-0079-00	0.01 μF	Cer	250 V		

Diodes

Ckt. No.	Tektronix Part No.	Description	S/N Range
D40	*119-0085-00	Input Frequency Control Assy.	
D64	152-0197-00	Silicon 1N415D	
D240	152-0166-00	Zener 1N753A 0.4 W, 6.2 V, 10%	100-669
D240	152-0227-00	Zener 1N753A 0.4 W, 6.2 V, 5%	670-up
D244	*152-0061-00	Silicon Tek Spec	
D314	152-0231-00	Silicon MV1872	
D334	*152-0107-00	Silicon Replaceable by 1N647	
D361	*152-0153-00	Silicon Replaceable by 1N4244	
D362	*152-0185-00	Silicon Replaceable by 1N3605	
D365	*152-0153-00	Silicon Replaceable by 1N4244	
D373 } D376 }	*153-0025-00	Silicon Selected *152-0153-00 (1 pair)	
D380	152-0238-00	Silicon 1N4442	100-439
D380	152-0246-00	Silicon Low leakage 0.25 W, 40 V	440-up
D383 } D386 }	*153-0025-00	Silicon Selected *152-0153-00 (1 pair)	
D387	152-0238-00	Silicon 1N4442	100-439
D387	152-0246-00	Silicon Low leakage 0.25 W, 40 V	440-up
D412	*152-0107-00	Silicon Replaceable by 1N647	
D454	152-0141-00	Silicon 1N3605	
D506	152-0141-00	Silicon 1N3605	
D550	*152-0107-00	Silicon Replaceable by 1N647	
D603	152-0188-00	Germanium 1N64	
D604	152-0188-00	Germanium 1N64	
D657	152-0186-00	Germanium 1N198	
D660	152-0186-00	Germanium 1N198	
D661	152-0186-00	Germanium 1N198	
D664	152-0141-00	Silicon 1N3605	
D665	152-0141-00	Silicon 1N3605	
D812	*152-0185-00	Silicon Replaceable by 1N3605	
D821	*152-0185-00	Silicon Replaceable by 1N3605	
D841	152-0079-00	Germanium HD1841	
D846	*152-0112-00	Snap Off	100-529
D846	*152-0325-00	Snap Off w/o leads	530-up
D856 } D857 }	*152-0152-00	GaAs (1 pair)	

Connectors

Ckt. No.	Tektronix Part No.	Description	S/N Range
J65	*103-0057-00	Adapter	
J80[1]			
J94[1]			
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	Chassis mtd., 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	Chassis mtd., 1 contact, female	
J720	136-0140-00	Socket, Banana Jack Assembly	
J810	131-0429-00	BNC	
J855	131-0372-00	Coaxial	100-279
J855	*175-0396-00	Cable Assembly, 6¼ inch	280-619
J855	*175-0396-01	Cable Assembly, 6¼ inch	620-up

Inductors

Ckt. No.	Tektronix Part No.	Description	S/N Range
L66	*108-0394-00	30 μH	
L81[2]			
L83[2]			
L84[2]			
L86[2]			
L87[2]			
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	*108-0373-00	56 nH	100-559
L124	*108-0374-00	55 nH	560-up

[1]Furnished as a unit with L. P. Filter (*610-0172-00).
[2]Furnished as a unit with L.P. Filter (*610-0172-00).

Inductors *(Cont)*

Ckt. No.	Tektronix Part No.	Description			S/N Range
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[3]					
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			
L358	*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 Supressor			X402-up
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	276-0507-00	Core, Ferramic Suppressor			
L676	276-0507-00	Core, Ferramic Suppressor			
L804	*114-0208-00	95-150 μH	Var	Core 276-0506-00	
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)			

Plug

P11	131-0017-00	Chassis mtd., 16 contact, male

[3]Part of Sweeper Circuit Board.

Transistors

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q120	151-0180-00	Silicon 40235(RCA)	101-559
Q120	*151-0230-00	Silicon Replaceable by 40235 (RCA)	560-up
Q130	151-0180-00	Silicon 40235(RCA)	100-559
Q130	*151-0230-00	Silicon Replaceable by 40235 (RCA)	560-up
Q140	151-0181-00	Silicon 40242(RCA)	
Q230	*151-0155-00	Silicon Replaceable by 2N2925	
Q240	*151-0096-00	Silicon Selected from 2N1893	100-309
Q240	151-0150-00	Silicon 2N3440	310-up
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	
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	
Q820	*151-0108-00	Silicon Replaceable by 2N2501	100-381
Q820	151-0190-00	Silicon 2N3904	382-up
Q830	*151-0096-00	Silicon Replaceable by 2N1893	
Q840	*151-0108-00	Silicon Replaceable by 2N2501	100-309
Q840	*153-0545-00	Silicon Selected from 2N2501	310-up
Q860	*151-0155-00	Silicon Replaceable by 2N2925	
Q870	*151-0155-00	Silicon Replaceable by 2N2925	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R40	308-0020-00	3 kΩ	10 W		WW	5%
R46	301-0221-00	220 Ω	½ W			5%
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		

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.	Description						S/N Range
R123	315-0101-00	100 Ω	¼ W				5%	
R124	315-0471-00	470 Ω	¼ W				5%	X560-up
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	315-0101-00	100 Ω	¼ W				5%	100-559
R137	315-0330-00	33 Ω	¼ W	Selected (Nominal Value)			5%	560-up
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%	
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%	

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R223	321-0068-00	49.9 Ω	1/8 W		Prec	1%	
R224	321-0047-00	30.1 Ω	1/8 W		Prec	1%	
R225	321-0001-00	10 Ω	1/8 W		Prec	1%	
R226	321-0001-00	10 Ω	1/8 W		Prec	1%	
R230	315-0512-00	5.1 kΩ	1/4 W			5%	
R231	315-0204-00	200 kΩ	1/4 W			5%	100-629X
R236	303-0513-00	51 kΩ	1 W			5%	
R240	321-0260-00	4.99 kΩ	1/8 W		Prec	1%	
R241	323-0414-00	200 kΩ	1/2 W		Prec	1%	
R241	321-0279-00	7.87 kΩ	1/8 W		Prec	1%	670-up
R242	323-0411-00	187 kΩ	1/2 W		Prec	1%	X670-up
R243	304-0124-00	120 kΩ	1 W				
R244	315-0432-00	4.3 kΩ	1/4 W			5%	
R245	315-0272-00	2.7 kΩ	1/4 W			5%	
R246	316-0102-00	1 kΩ	1/4 W				
R248	316-0101-00	100 Ω	1/4 W				
R250	315-0104-00	100 kΩ	1/4 W			5%	X670-up
R251	315-0303-00	30 kΩ	1/4 W			5%	X630-up
R252	311-0310-00	5 kΩ		Var			100-629
R252	311-0487-00	30 kΩ		Var			630-up
R253	311-0329-00	50 kΩ		Var			
R254	323-0440-00	374 kΩ	1/2 W		Prec	1%	100-629
R254	323-0409-00	178 kΩ	1/2 W		Prec	1%	670-up
R254	323-0418-00	221 kΩ	1/2 W		Prec	1%	630-up
R255	316-0101-00	100 Ω	1/4 W				
R256	323-0440-00	374 kΩ	1/2 W		Prec	1%	100-629
R256	323-0414-00	200 kΩ	1/2 W		Prec	1%	630-669
R257	311-0326-00	10 kΩ		Var			X670-up
R258	315-0222-00	2.2 kΩ	1/4 W			5%	X670-up
R260	Use 321-0423-00	249 kΩ	1/8 W		Prec	1%	
R261	Use 321-0423-00	249 kΩ	1/8 W		Prec	1%	
R262	316-0102-00	1 kΩ	1/4 W				X259-up
R263	316-0102-00	1 kΩ	1/4 W				X259-up
R264	321-0147-00	332 Ω	1/8 W		Prec	1%	100-669
R264	321-0161-00	464 Ω	1/8 W		Prec	1%	670-up
R265	321-0147-00	332 Ω	1/8 W		Prec	1%	100-669
R265	321-0161-00	464 Ω	1/8 W		Prec	1%	670-up
R266	321-0147-00	332 Ω	1/8 W		Prec	1%	
R267	323-0402-00	150 kΩ	1/2 W		Prec	1%	100-669
R267	323-0400-00	143 kΩ	1/2 W		Prec	1%	670-up
R268	321-0431-00	301 kΩ	1/8 W		Prec	1%	100-669
R268	321-0442-00	392 kΩ	1/8 W		Prec	1%	670-up
R269	321-0452-00	499 kΩ	1/8 W		Prec	1%	100-669
R269	322-0643-00	600 kΩ	1/4 W		Prec	1%	670-up
R270	311-0580-00	50 kΩ		Var			

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R271	301-0755-00	7.5 MΩ	½ W			5%	
R274	311-0590-00	2 kΩ		Var			
R276	322-0469-00	750 kΩ	¼ W		Prec	1%	100-669
R276	322-0481-00	1 MΩ	¼ W		Prec	1%	670-up
R280	321-0423-00	249 kΩ	⅛ W		Prec	1%	
R286	315-0512-00	5.1 kΩ	¼ W			5%	
R290	311-0443-00	2.5 kΩ		Var			
R291	323-0402-00	150 kΩ	½ W		Prec	1%	
R293	315-0510-00	51 Ω	¼ W			5%	
R294	316-0562-00	5.6 kΩ	¼ W				
R295	315-0202-00	2 kΩ	¼ W			5%	
R296	316-0102-00	1 kΩ	¼ W				
R300	315-0102-00	1 kΩ	¼ W			5%	
R310	315-0562-00	5.6 kΩ	¼ W			5%	
R311	315-0392-00	3.9 kΩ	¼ W			5%	
R316	315-0221-00	220 Ω	¼ W			5%	
R333	321-0233-00	2.61 kΩ	⅛ W		Prec	1%	
R334	315-0431-00	430 Ω	¼ W			5%	
R346	315-0680-00	68 Ω	¼ W			5%	
R356	315-0680-00	68 Ω	¼ W			5%	
R361	321-0395-00	127 kΩ	⅛ W		Prec	1%	
R363	315-0221-00	220 Ω	¼ W			5%	
R365	315-0102-00	1 kΩ	¼ W			5%	
R368	311-0387-00	5 kΩ		Var			
R373	Use 315-0510-00	51 kΩ	¼ W			5%	
R376	Use 315-0510-00	51 kΩ	¼ W			5%	
R380	316-0272-00	2.7 kΩ	¼ W				
R381	316-0274-00	270 kΩ	¼ W				
R383	315-0681-00	680 Ω	¼ W			5%	
R384	321-0097-00	100 Ω	⅛ W		Prec	1%	
R385	321-0097-00	100 Ω	⅛ W		Prec	1%	
R401	315-0680-00	68 Ω	¼ W			5%	
R410	315-0393-00	39 kΩ	¼ W			5%	
R411A } R411B }	311-0588-00	5 kΩ 1 kΩ		Var			
R414	315-0512-00	5.1 kΩ	¼ W			5%	
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	1/10 W			5%	

Resistors (Cont)

Ckt. No.	Tektronix Part No.	Description					S/N Range
R502	317-0151-00	150 Ω	1/10 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				
R656	316-0332-00	3.3 kΩ	¼ W				
R657	316-0332-00	3.3 kΩ	¼ W				
R658	316-0681-00	680 Ω	¼ W				
R662	316-0124-00	120 kΩ	¼ W				
R663	316-0124-00	120 kΩ	¼ W				
R664	316-0683-00	68 kΩ	¼ W				
R665	316-0102-00	1 kΩ	¼ W				
R666	311-0382-00	1 MΩ		Var			
R668	316-0104-00	100 kΩ	¼ W				100-629

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R668	315-0124-00	120 kΩ	¼ W			5%	630-up
R669	323-0071-00	53.6 Ω	½ W		Prec	1%	
R671	301-0512-00	5.1 kΩ	½ W			5%	100-629
R671	301-0472-00	4.7 kΩ	½ W			5%	630-up
R672	311-0091-00	1 kΩ		Var			
R673	303-0123-00	12 kΩ	1 W			5%	
R675	316-0471-00	470 Ω	¼ W				
R676	316-0471-00	470 Ω	¼ W				
R710	323-0438-00	357 kΩ	½ W		Prec	1%	100-629
R710	323-0419-00	226 kΩ	½ W		Prec	1%	630-up
R711	321-0288-00	9.76 kΩ	⅛ W		Prec	1%	
R714	316-0103-00	10 kΩ	¼ W				
R720	321-0289-00	10 kΩ	⅛ W		Prec	1%	
R721	321-0284-00	8.87 kΩ	⅛ W		Prec	1%	
R724	301-0154-00	150 kΩ	½ W			5%	
R727	308-0020-00	3 kΩ	10 W		WW	5%	
R800	315-0562-00	5.6 kΩ	¼ W			5%	
R801	315-0472-00	4.7 kΩ	¼ W			5%	
R805	315-0102-00	1 kΩ	¼ W			5%	
R812	315-0510-00	51 Ω	¼ W			5%	
R821	301-0183-00	18 kΩ	½ W			5%	
R823	Use 304-0181-00	180 Ω	1 W				
R830	315-0103-00	10 kΩ	¼ W			5%	
R831	311-0453-00	10 kΩ		Var			
R832	315-0333-00	33 kΩ	¼ W			5%	
R841	315-0510-00	51 Ω	¼ W			5%	
R844	308-0293-00	4 kΩ	3 W		WW	5%	
R846	308-0307-00	5 kΩ	3 W		WW	1%	
R855	317-0510-00	51 Ω	⅛ W			5%	
R856	321-0193-00	1 kΩ	⅛ W		Prec	1%	100-439
R856	321-0289-00	10 k	⅛ W		Prec	1%	440-up
R857	321-0193-00	1 kΩ	⅛ W		Prec	1%	100-439
R857	321 0289-00	10 k	⅛ W		Prec	1%	440-up
R860	315-0104-00	100 kΩ	¼ W			5%	
R861	315-0101-00	100 Ω	¼ W			5%	
R862	311-0546-00	10 kΩ		Var			
R863	315-0103-00	10 kΩ	¼ W			5%	
R864	321-0402-00	150 kΩ	⅛ W		Prec	1%	
R865	321-0277-00	7.5 kΩ	⅛ W		Prec	1%	
R868	315-0101-00	100 Ω	¼ W			5%	
R869	315-0154-00	150 kΩ	¼ W			5%	
R873	315-0753-00	75 kΩ	¼ W			5%	
R874	321-0402-00	150 kΩ	⅛ W		Prec	1%	
R875	321-0277-00	7.5 kΩ	⅛ W		Prec	1%	
R876	Use 315-0101-00	100 Ω	¼ W			5%	

Resistors *(Cont)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R877	321-1485-00	1.11 MΩ	⅛ W	Prec	1%	X440-up
R886	316-0126-00	12 MΩ	¼ W			100-439
R886	323-0446-00	432 kΩ	½ W	Prec	1%	440-up
R887	315-0104-00	100 kΩ	¼ W		5%	
R888	315-0104-00	100 kΩ	¼ W		5%	
R890	301-0100-00	10 Ω	½ W		5%	
R892	301-0101-00	100 Ω	½ W		5%	
R894	301-0101-00	100 Ω	½ W		5%	

Switches

Ckt. No.	Unwired	Wired	Description		S/N Range
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	
SW184	260-0642-00		Toggle	IF ATTEN 1 dB	
SW201	260-0583-00		Slide		
SW220[1]	260-0759-00	*262-0763-00	Rotary	DISPERSION	100-339
SW220[1]	260-0759-01	*262-0763-00	Rotary	DISPERSION	340-up
SW230	260-0757-00		Rotary	DISPERSION RANGE	100-669
SW230	260-0866-00		Rotary	DISPERSION RANGE	670-up
SW365	260-0643-00		Toggle		
SW550[1]			Rotary	COUPLED RESOLUTION	
SW660	260-0758-00	*262-0762-00	Lever	VERTICAL DISPLAY	
SW661	260-0643-00		Toggle	VIDEO FILTER	
SW810	260-0642-00		Toggle	INT 1 MHz REF FREQ	
SW889	260-0689-00		Push	LOCK CHECK	

Transformers

Ckt. No.	Tektronix Part No.	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

[1]SW220 and SW550 furnished as a unit.

Transformers *(Cont)*

Ckt. No.	Tektronix Part No.	Description		S/N Range
T424	*120-0425-00	Toroid, 4 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	*120-0370-00	Toroid, 3 windings		

Electron Tubes

V41	119-0072-00	Oscillator Tube Assy.		
V620	154-0040-00	12AU6		

Cable Assemblies

W42	*175-0359-00	RF Probe, 5.5 and 7.5 inch		
W78	*175-0367-00	3.25 inch	Lossy	
W94	*175-0364-00	12.25 inch	Lossy	
W110	*175-0308-00	3.25 inch	Coaxial	
W150	*175-0313-00	4.37 inch	Coaxial	
W200	*175-0358-00	2.812 inch	Coaxial	
W300	*175-0358-00	2.812 inch	Coaxial	100-669
W300	*175-0413-00	8.23 inch	Lossy	670-up
W370[5]				
W375[5]				
W500	*175-0358-00	2.812 inch	Coaxial	

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		

Mixer

	*119-0064-01	925 MHz—10.5 GHz (includes D64)		

Oscillator

	*119-0150-00	Oscillator (includes V41 and D40)		

Low Pass Filter

	*610-0172-00	280 MHz	L.P. Filter	

[5]Selected. See Mechanical Parts List.

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INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

SECTION 8

MECHANICAL PARTS LIST

FIG. 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-1	333-0925-00	100	479	1	PANEL, front
	333-0925-02	480	669	1	PANEL, front
	333-1062-01	670		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	- - - - - -			3	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-4	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
-5	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-6	366-0153-00			1	KNOB, charcoal—DISPERSION RANGE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 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	366-0295-00	100	629	1	KNOB, charcoal—COUPLED RESOLUTION
	- - - - - -			-	knob includes:
	213-0048-00	100	629	1	SCREW, set, 4-40 x 1/8 inch, HSS
	366-0422-00	630		1	KNOB, charcoal—COUPLED RESOLUTION
	- - - - - -			-	knob includes:
	213-0153-00	630		2	SCREW, set, 5-40 x 1/8 inch, HSS
-11	366-0296-00	100	629	1	KNOB, charcoal—DISPERSION
	- - - - - -			-	knob includes:
	213-0048-00	100	629	1	SCREW, set, 4-40 x 1/8 inch, HSS
	366-0423-00	630		1	KNOB, charcoal—DISPERSION
	- - - - - -			-	knob includes:
	213-0153-00	630		2	SCREW, set, 5-40 x 1/8 inch, HSS

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5 Description
1-12	262-0763-00			1	SWITCH, wired—COUPLED RESOLUTION—DISPERSION
	- - - - - -			-	switch includes:
	260-0759-00	100	339	1	SWITCH, unwired
	260-0759-01	340		1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch
-13	366-0153-00			1	KNOB, charcoal—MIXER PEAKING
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-14	331-0168-00	100	499	1	DIAL, w/o brake—IF CENTER FREQ
	331-0168-01	500		1	DIAL, w/brake—IF CENTER FREQ
	- - - - - -			-	dial includes:
	213-0048-00			1	SCREW, set, 4-40 x 1/8 inch, HSS
-15	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
	210-0471-00			1	NUT, hex., 1/4-32 x 5/16 inch
	358-0054-02			1	BUSHING, 1/4-32 x 3/32 inch
-16	366-0153-00			1	KNOB, charcoal—GAIN
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-17	260-0643-00			1	SWITCH, unwired—VIDEO FILTER
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0562-00			1	NUT, hex., 1/4-40 x 5/16 inch
-18	366-0215-01			1	KNOB, charcoal—VERTICAL DISPLAY
-19	262-0762-00			1	SWITCH, lever—VERTICAL DISPLAY
	- - - - - -			-	switch includes:
	260-0758-00			1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
	211-0005-00			2	SCREW, 4-40 x 1/8 inch, PHS
-20	366-0284-00	100	669	1	KNOB, charcoal—RF CENTER FREQ
	- - - - - -			-	knob includes:
	213-0020-00	100	669	1	SCREW, set, 6-32 x 1/8 inch, HSS
	366-0487-00	670		1	KNOB, charcoal, crank—RF CENTER FREQ
	- - - - - -			-	knob includes:
	213-0153-00	670		2	SCREW, set, 5-40 x 1/8 inch, HSS

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
	119-0068-00			1	ASSEMBLY, oscillator & dial tape
	- - - - - -			-	assembly includes:
	119-0150-00			1	ASSEMBLY, oscillator
	- - - - - -			-	assembly includes:
-21	- - - - - -			1	OSCILLATOR
-22	119-0085-00			1	ASSEMBLY, input frequency control
-23	175-0359-00			1	ASSEMBLY, cable, RF probe (OSC to J65 & J855)
-24	214-0535-00			1	GEAR
	- - - - - -			-	mounting hardware: (not included w/gear)
-25	213-0140-00			1	SCREW, set, 2-56 x $^3/_{32}$ inch, HSS
	331-0201-00			1	ASSEMBLY, dial tape
	- - - - - -			-	assembly includes:
-26	214-0522-00			1	GEAR
-27	384-0635-00			1	ROD, sprocket
-28	210-1011-00			1	WASHER, plastic, 0.130 ID x 0.375 inch OD
-29	210-0992-00			1	WASHER, spacer, plastic, 0.265 ID x 0.437 inch OD
-30	214-0520-00			1	SPROCKET, tape
	- - - - - -			-	mounting hardware: (not included w/sprocket)
	213-0075-00			1	SCREW, set, 4-40 x $^3/_{32}$ inch, HSS
-31	214-0521-00	100	399	2	ROLLER, idler tape
	214-0521-01	400		2	ROLLER, idler tape
	- - - - - -			-	mounting hardware for each: (not included w/roller'
-32	384-0636-00	100	399	1	ROD, idler standoff
	384-0636-01	400		1	ROD, idler standoff
-33	380-0076-00	100	399	1	HOUSING, dial
	380-0076-01	400		1	HOUSING, dial
	- - - - - -			-	housing includes:
-34	214-0564-00			1	PIN, roll
-35	211-0595-00			2	SCREW, 6-32 x $^1/_4$ inch, socket head cap
-36	331-0167-00			1	TAPE, dial
-37	358-0298-00			1	BUSHING
	- - - - - -			-	mounting hardware: (not included w/assembly)
-38	406-0112-00			1	BRACKET, mounting
-39	213-0020-00			2	SCREW, set, 6-32 x $^1/_8$ inch, HSS
	210-0840-00			1	WASHER, flat, 0.390 ID x $^9/_{16}$ inch OD (not shown)
	212-0004-00			2	SCREW, 8-32 x $^5/_{16}$ inch, PHS (not shown)

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-40	386-1026-00	100	479	1	PLATE, sub-panel, front
	386-1026-01	480		1	PLATE, sub-panel, front
-41	131-0106-00			1	CONNECTOR, coaxial, 1 contact, BNC, w/hardware
	- - - - - -			-	mounting hardware: (not included w/connector)
-42	210-0255-00			1	LUG, solder, 3/8 inch
-43	131-0106-00			1	CONNECTOR, coaxial, 1 contact, BNC, w/hardware
	- - - - - -			-	mounting hardware: (not included w/connector)
-44	407-0443-00			1	BRACKET
-45	352-0086-00			1	HOLDER, toroid
-46	366-0125-00			1	KNOB, plug-in securing
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
	210-0894-00			1	WASHER, plastic, 0.190 ID x 7/16 inch OD
-47	384-0510-00			1	ROD, securing
	- - - - - -			-	rod includes:
	354-0025-00			1	RING, retaining
-48	136-0094-00			1	SOCKET
	- - - - - -			-	mounting hardware: (not included w/socket)
	210-0940-00			2	WASHER, flat, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-49	136-0140-00	100	669X	1	SOCKET, banana-jack
	- - - - - -			-	mounting hardware: (not included w/socket)
	210-0895-00	100	669X	1	WASHER, insulating, 0.375 diameter x 0.105 inch thick
	210-0465-00	100	669X	2	NUT, hex., 1/4-32 x 3/8 inch
	210-0223-00	100	669X	1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-50	384-0631-00			4	ROD, spacer
	- - - - - -			-	mounting hardware for each: (not included w/rod)
	212-0044-00			1	SCREW, 8-32 x 1/2 inch, RHS (not shown)
-51	386-0115-01			1	PLATE, dial window
	- - - - - -			-	mounting hardware: (not included w/plate)
	213-0138-00			2	SCREW, sheet metal, #4 x 3/16 inch, PHS
	119-0143-00			1	ASSEMBLY, mixer, 925 MHz-10.5 GHz
	- - - - - -			-	assembly includes:
-52	119-0064-01			1	MIXER, w/crystal
-53	103-0053-00			1	ADAPTER
	- - - - - -			-	mounting hardware: (not included w/mixer)
-54	210-0579-00			1	NUT, hex., 5/8-24 x 3/4 inch
	210-1010-00			1	WASHER, flat, 0.643 ID x 0.875 inch OD

FIG. 1 FRONT *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-55	103-0057-00			1	ADAPTER, connector
-56	179-1049-00			1	CABLE HARNESS, phase lock
	- - - - - -			-	cable harness includes:
-57	131-0371-00			8	CONNECTOR, single contact
-58	132-0014-00			1	CONNECTOR, sleeve
-59	175-0367-00			1	ASSEMBLY, cable, 3.250 inches (J69 to J80)
-60	366-0153-00			1	KNOB, charcoal—FINE FREQ
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HHS
-61	- - - - - -	X670		1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	358-0054-02	X670		1	BUSHING, 1/4-32 x 3/32 inch
	210-0046-00	X670		1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
	210-0471-00	X670		1	NUT, hex., 1/4-32 x 5/16 inch
	210-0223-00	X670		1	LUG, solder, 1/4 ID x 7/16 inch OD, SE

FIG. 2 REAR & CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-1	386-1025-00			1	PLATE, rear
-2	131-0017-00			1	CONNECTOR, 16 contact, male
	- - - - - -			-	mounting hardware: (not included w/connector)
-3	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
-4	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-5	260-0583-00			1	SWITCH, unwired—SAWTOOTH 100-150 V
	- - - - - -			-	mounting hardware: (not included w/switch)
-6	211-0022-00			2	SCREW, 2-56 x 3/16 inch, RHS
	210-0405-00			2	NUT, hex., 2-56 x 3/16 inch
-7	- - - - - -			2	RESISTOR
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-8	211-0533-00			1	SCREW, 6-32 x 1 1/2 inches, RHS
-9	210-0601-00			1	EYELET
-10	210-0478-00			1	NUT, hex., 5/16 x 21/32 inch long
-11	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-12	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
-13	211-0504-00			1	SCREW, 6-32 x 1/4 inch, PHS
-14	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-15	386-1031-00			1	PLATE, switch mount
-16	384-0616-00			2	ROD, spacer, hex., 1/4 x 1.370 inches long
-17	211-0008-00			4	SCREW, 4-40 x 1/4 inch, PHS
-18	210-0201-00			1	LUG, solder, SE #4
-19	260-0757-00	100	669	1	SWITCH, unwired—DISPERSION RANGE
	260-0866-00	670		1	SWITCH, unwired—DISPERSION RANGE
	- - - - - -			-	mounting hardware: (not included w/switch)
-20	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-21	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-22	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-23	- - - - - -			5	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-24	210-0046-00			2	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-25	210-0471-00			1	NUT, hex., 1/4-32 x 13/32 inch long
-26	358-0054-00			1	BUSHING, 1/4-32 x 13/32 inch long
-27	136-0235-00			1	SOCKET, transistor, dual
	- - - - - -			-	mounting hardware: (not included w/socket)
-28	354-0234-00			1	RING, socket mounting
-29	136-0181-00			1	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
-30	354-0234-00			1	RING, socket mounting

FIG. 2 REAR & CHASSIS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
2-31	136-0218-00			7	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-32	354-0285-00			1	HOLDER, socket
-33	136-0009-00			1	SOCKET, tube, 7 pin, w/shield
	- - - - - -			-	mounting hardware: (not included w/socket)
-34	211-0033-00			2	SCREW, sems, 4-40 x $^5/_{16}$ inch, PHS
	210-0004-00			1	LOCKWASHER, internal, #4 (not shown)
	210-0201-00			1	LUG, solder, SE #4 (not shown)
	210-0406-00			2	NUT, hex., 4-40 x $^3/_{16}$ inch (not shown)
-35	337-0007-00			1	SHIELD, tube, $^7/_8$ ID x 1$^3/_4$ inches h, w/spring
-36	136-0208-00			1	SOCKET, crystal
	- - - - - -			-	mounting hardware: (not included w/socket)
-37	213-0055-00			1	SCREW, thread forming, 2-32 x $^3/_{16}$ inch, PHS
-38	- - - - - -			1	COIL
	- - - - - -			-	mounting hardware: (not included w/coil)
-39	385-0150-00			1	ROD, spacer, $^3/_8$ x $^5/_8$ inch
-40	210-0204-00			1	LUG, solder, DE #6
-41	210-0201-00			1	LUG, solder, SE #4
-42	211-0008-00			1	SCREW, 4-40 x $^3/_{16}$ inch, PHS
-43	407-0138-00			1	BRACKET, coil mounting
	- - - - - -			-	mounting hardware: (not included w/bracket)
-44	213-0088-00			2	SCREW, thread forming #4 x $^1/_4$ inch, PHS
-45	348-0056-00			1	GROMMET, plastic 0.354 ID x 0.406 inch OD
-46	210-0259-00			5	LUG, solder, #2
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-47	213-0055-00			1	SCREW, thread forming, 2-32 x $^3/_{16}$ inch, PHS
-48	441-0668-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/chassis)
	211-0538-00			2	SCREW, 6-32 x $^5/_{16}$ inch, 100° csk, FHS (not shown)
-49	213-0138-00			1	SCREW, sheet metal, #4 x $^3/_{16}$ inch, PHS
-50	211-0504-00			1	SCREW, 6-32 x $^1/_4$ inch, PHS
	210-0457-00			1	NUT, keps, 6-32 x $^5/_{16}$ inch (not shown)
-51	670-0099-00			1	ASSEMBLY, circuit board—RECORDER DETECTOR
	- - - - - -			-	asembly includes:
	388-0650-00			1	BOARD, circuit
-52	124-0148-00			2	STRIP, ceramic, $^7/_{16}$ inch h, w/9 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

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FIG. 2 REAR & CHASSIS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
2-53	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
-54	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
-55	179-1044-00	100	229	1	CABLE HARNESS, chassis
	179-1041-01	230	629	1	CABLE HARNESS, chassis
	179-1044-02	630		1	CABLE HARNESS, chassis

FIG. 3 IF CHASSIS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
3-	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 ATTEN dB
-2	337-0799-00			1	SHIELD, switch
	610-0174-00			1	ASSEMBLY, BANDPASS FILTER
	- - - - - -			-	assembly includes:
-3	131-0372-00			4	CONNECTOR, coaxial, w/hardware
-4	210-0206-00			2	LUG, solder, SE #10 long
-5	- - - - - -			6	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-6	214-0456-00			1	FASTENER, plastic
-7	124-0181-00			2	STRIP, terminal
-8	337-0802-00			1	SHIELD, filter
-9	441-0667-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/assembly)
-10	211-0065-00			8	SCREW, 4-40 x 3/16 inch, PHS
	610-0483-00			1	ASSEMBLY, sweeper
	- - - - - -			-	assembly includes:
-11	131-0182-00			2	CONNECTOR, terminal feed thru
	- - - - - -			-	mounting hardware for each: (not included w/connector)
	358-0135-00			1	BUSHING, plastic
-12	131-0372-00			11	CONNECTOR, coaxial, w/hardware
-13	210-0206-00			2	LUG, solder, #10 long
-14	210-0812-00			3	WASHER, fiber, #10
-15	210-0813-00			3	WASHER, fiber, shouldered, #10
-16	131-0373-00			30	CONNECTOR, terminal stand-off
-17	136-0153-00			1	SOCKET, crystal, w/clamp
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0022-00			1	SCREW, 2-56 x 3/16 inch, RHS
	210-0405-00			1	NUT, hex., 2-56 x 3/16 inch
	210-0001-00			1	LOCKWASHER, internal, #2
-18	136-0217-00			9	SOCKET, transistor, 4 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0285-00			1	HOLDER, socket
-19	136-0218-00			6	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0285-00			1	HOLDER, socket
-20	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
-21	426-0121-00			2	MOUNT, toroid
	- - - - - -			-	mounting hardware for each: (not included w/mount)
	361-0007-00			1	SPACER, plastic, 0.188 inch long

FIG. 3 IF CHASSIS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Q t y	Description 1 2 3 4 5
3-22	- - - - -			1	COIL
	- - - - - -			-	mounting hardware: (not included w/coil)
-23	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
-24	210-0001-00			9	LOCKWASHER, internal, #2
-25	210-0259-00			32	LUG, solder, #2
-26	210-0405-00			31	NUT, hex., 2-56 x 3/16 inch, PHS
-27	213-0055-00			6	SCREW, thread forming, 2-32 x 3/16 inch, PHS
-28	136-0208-00			1	SOCKET, crystal
-29	337-0801-00			1	SHIELD
-30	179-1046-00			1	CABLE HARNESS
-31	388-0683-00			1	BOARD, connector
	- - - - - -			-	board includes
-32	214-0506-00			16	PIN, connector
	- - - - - -			-	mounting hardware: (not included w/board)
-33	213-0141-00	100	539	2	SCREW, thread forming, 4-40 x 1/4 inch, PHS
	213-0088-00	540		2	SCREW, thread forming, 4-40 x 1/4 inch, PHS
-34	670-0100-00			1	ASSEMBLY, circuit board—SWEEPER
	- - - - - -			-	assembly includes:
	388-0684-00			1	BOARD, circuit
-35	441-0666-00			1	CHASSIS
	- - - - - -			-	mounting hardware: (not included w/assembly)
-36	211-0065-00			16	SCREW, 4-40 x 3/16 inch, PHS
-37	175-0308-00			1	ASSEMBLY, cable, 3.250 inches (J120 to J109)
	175-0313-00			1	ASSEMBLY, cable, 4.375 inches (J147 to J151)
	175-0384-00			-	[1]ASSEMBLY, cable, black band
	175-0384-01			-	[1]ASSEMBLY, cable, brown band
	175-0384-02			-	[1]ASSEMBLY, cable, red band
	175-0384-03			-	[1]ASSEMBLY, cable, orange band
	175-0384-04			-	[1]ASSEMBLY, cable, yellow band
	175-0358-00			1	ASSEMBLY, cable, 2.812 inches (J363 to J148)
	175-0358-00			1	ASSEMBLY, cable, 2.812 inches (J501 to J470)
	175-0358-00			1	ASSEMBLY, cable, 2.812 inches (J188 to J401)
-38	337-0803-01			1	SHIELD
-39	386-1032-00			1	PLATE, IF chassis cover
	- - - - - -			-	mounting hardware: (not included w/plate)
-40	211-0065-00			16	SCREW, 4-40 x 3/16 inch, PHS
-41	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)
-42	175-0364-00			1	ASSEMBLY, cable, 12.250 inches (J100 to J94)

[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.

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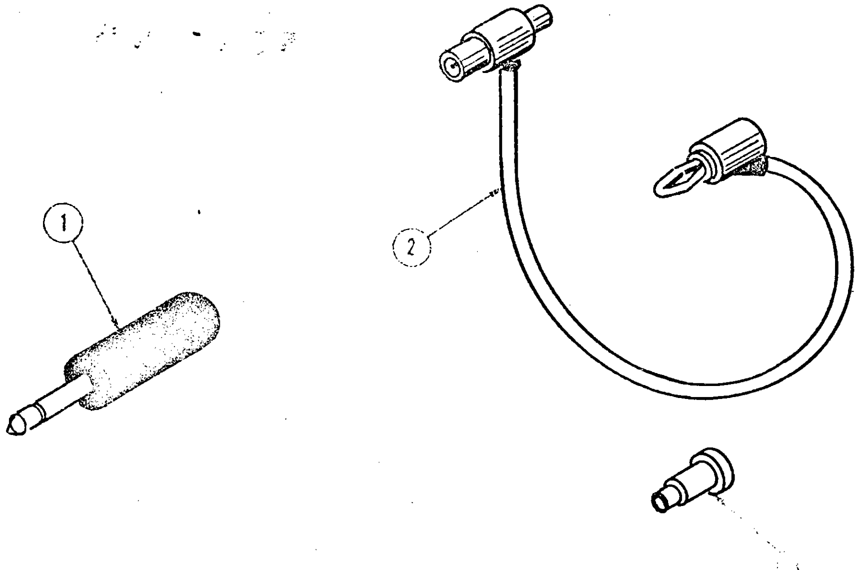
FIG. 4 WIDE BAND FILTER & PHASE LOCK ASSEMBLY

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
4-	644-0015-00	100	479	1	ASSEMBLY, PHASE LOCK
	644-0015-01	480		1	ASSEMBLY, PHASE LOCK
	- - - - - -			-	assembly includes:
-1	131-0372-00	100	399X	1	CONNECTOR, coaxial, w/hardware
-2	131-0429-00	100	479	1	CONNECTOR, BNC
	131-0352-01	480		1	CONNECTOR, BNC, w/hardware
-3	348-0003-00			1	GROMMET, rubber, 5/16 inch
-4	388-0688-00			1	BOARD, connector
	- - - - - -			-	board includes:
-5	214-0507-00			10	PIN, connector
	- - - - - -			-	mounting hardware: (not included w/board)
-6	211-0065-00			4	SCREW, 4-40 x 3/16 inch, PHS
-7	220-0455-00			2	NUT, block
-8	- - - - - -			1	RESISTOR, variable—FINE FREQ
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
-9	210-0583-00			2	NUT, hex., 1/4-32 x 5/16 inch
-10	260-0689-00			1	SWITCH, unwired—LOCK CHECK
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
	210-0583-00			2	NUT, hex., 1/4-32 x 5/16 inch
-11	260-0642-00			1	SWITCH, unwired—INT 1 MHz, REF FREQ
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0046-00			1	LOCKWASHER, internal, 1/4 ID x 0.400 inch OD
	210-0562-00			2	NUT, hex., 1/4-32 x 5/16 inch
-12	337-0797-00	100	479	1	SHIELD
	337-0797-01	480		1	SHIELD
-13	179-1048-00			1	CABLE HARNESS, phase lock board
-14	670-0101-00			1	ASSEMBLY, circuit board
	- - - - - -			-	assembly includes:
	388-0682-01			1	BOARD, circuit
-15	136-0183-00			1	SOCKET, transistor, 3 pin
-16	136-0220-00			4	SOCKET, transistor, 3 pin
-17	344-0108-00			10	CLIP, diode mounting
-18	352-0041-00			7	HOLDER
-19	136-0234-00			2	SOCKET, receptacle
-20	352-0096-00			1	HOLDER, crystal
-21	175-0396-00	X280	619	2	ASSEMBLY, cable, (w/connectors)
	175-0396-01	620		2	ASSEMBLY, coaxial
	131-0391-00	X620		2	CONNECTOR, coaxial
	- - - - - -			-	mounting hardware: (not included w/assembly)
-22	211-0105-00			3	SCREW, 4-40 x 3/16 inch, 100° csk, FHS
-23	220-0455-00			4	NUT, block
-24	211-0065-00			6	SCREW, 4-40 x 3/16 inch, PHS
-25	337-0800-00			1	SHIELD, PHASE LOCK
	- - - - - -			-	mounting hardware: (not included w/shield)
-26	213-0138-00			6	SCREW, sheet metal, #4 x 3/16 inch, PHS
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
	210-0909-00			1	WASHER, mica, 0.196 ID x 0.625 inch OD
	210-0935-00			1	WASHER, fiber, 0.140 ID x 0.375 inch OD

FIG. 4 WIDE BAND FILTER & PHASE LOCK ASSEMBLY *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
4-27	------			-	ASSEMBLY, cable (J855 to OSC) (see FIG. 1 FRONT)
-28	610-0172-00			1	ASSEMBLY, WIDE BAND FILTER
	------			-	mounting hardware: (not included w/assembly)
-29	213-0138-00			2	SCREW, sheet metal, #4 x 3/16 inch, PHS
-30	------			-	ASSEMBLY, cable, 12.250 inches (J94 to J100) (see FIG. 3 IF CHASSIS
-31	------			-	ASSEMBLY, cable, 3.250 inches (J80 to J69) (see FIG. 1 FRONT)

FIG. 5 STANDARD ACCESSORIES



B

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
5-1	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
	070-0520-01			2	MANUAL, instruction (not shown)

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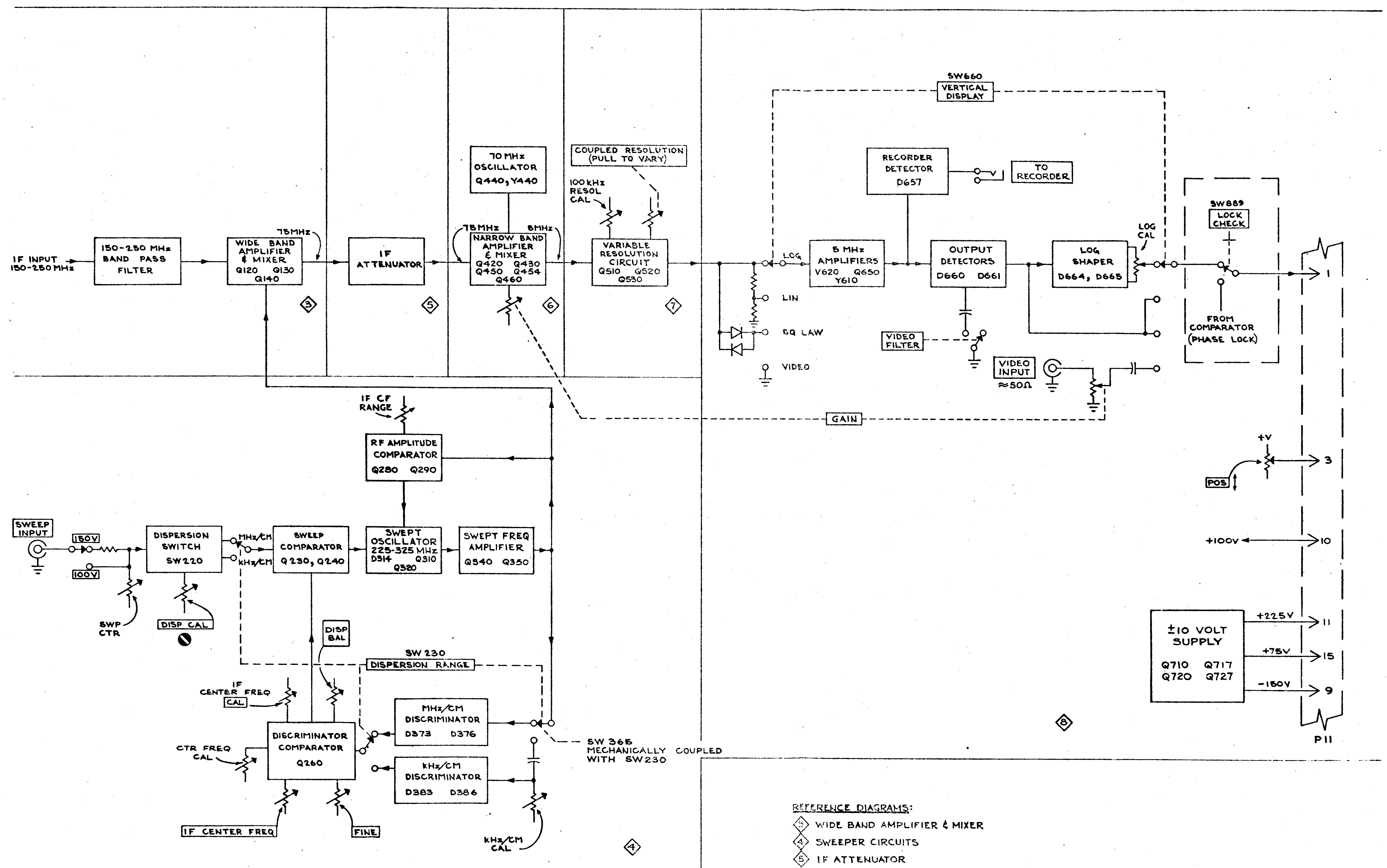
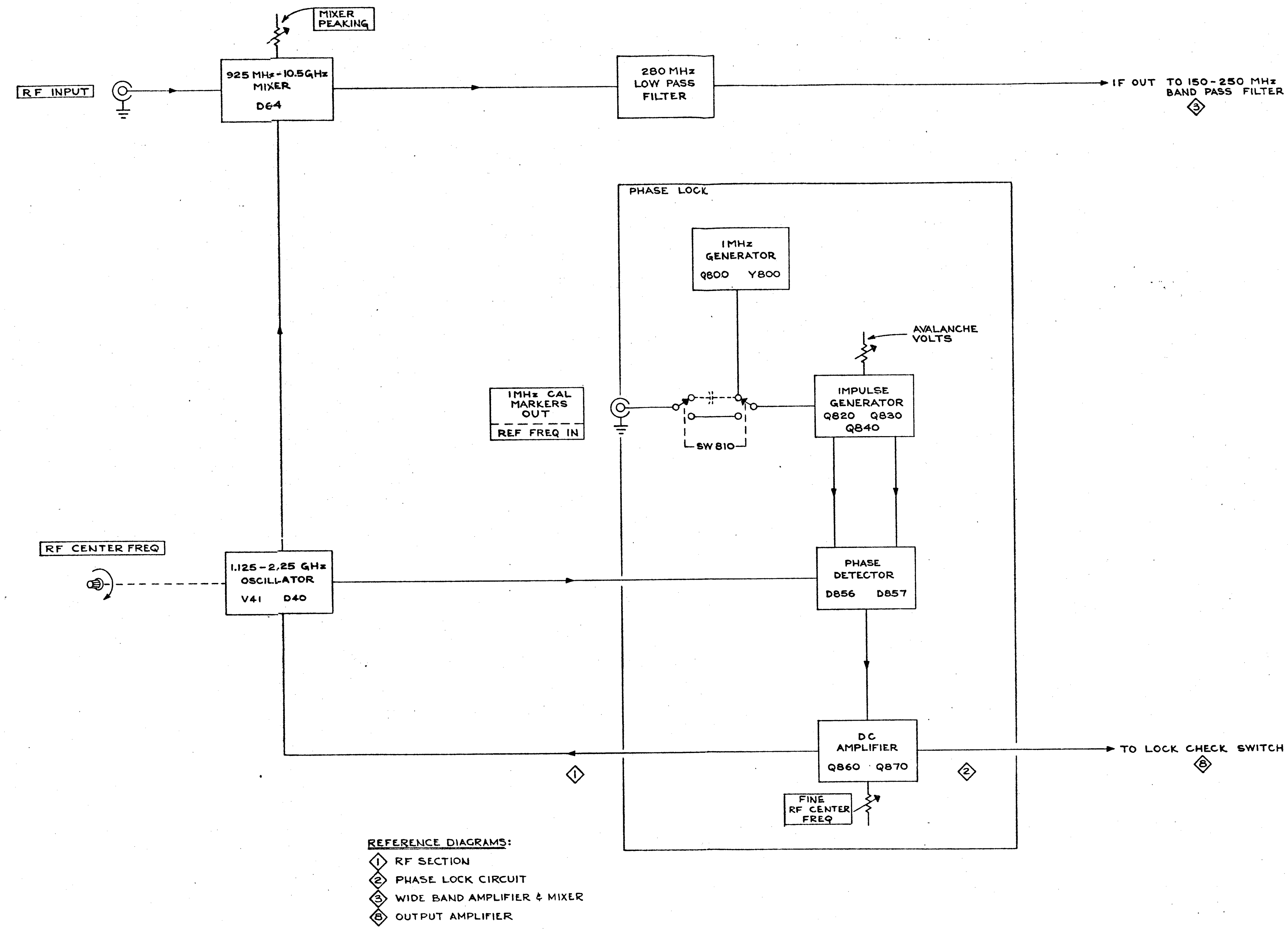


REFERENCE DIAGRAMS:
- ③ WIDE BAND AMPLIFIER & MIXER
- ④ SWEEPER CIRCUITS
- ⑤ IF ATTENUATOR
- ⑥ NARROW BAND IF AMPLIFIER 70MHz OSCILLATOR & MIXER
- ⑦ VARIABLE RESOLUTION CIRCUITS
- ⑧ OUTPUT AMPLIFIER

1267

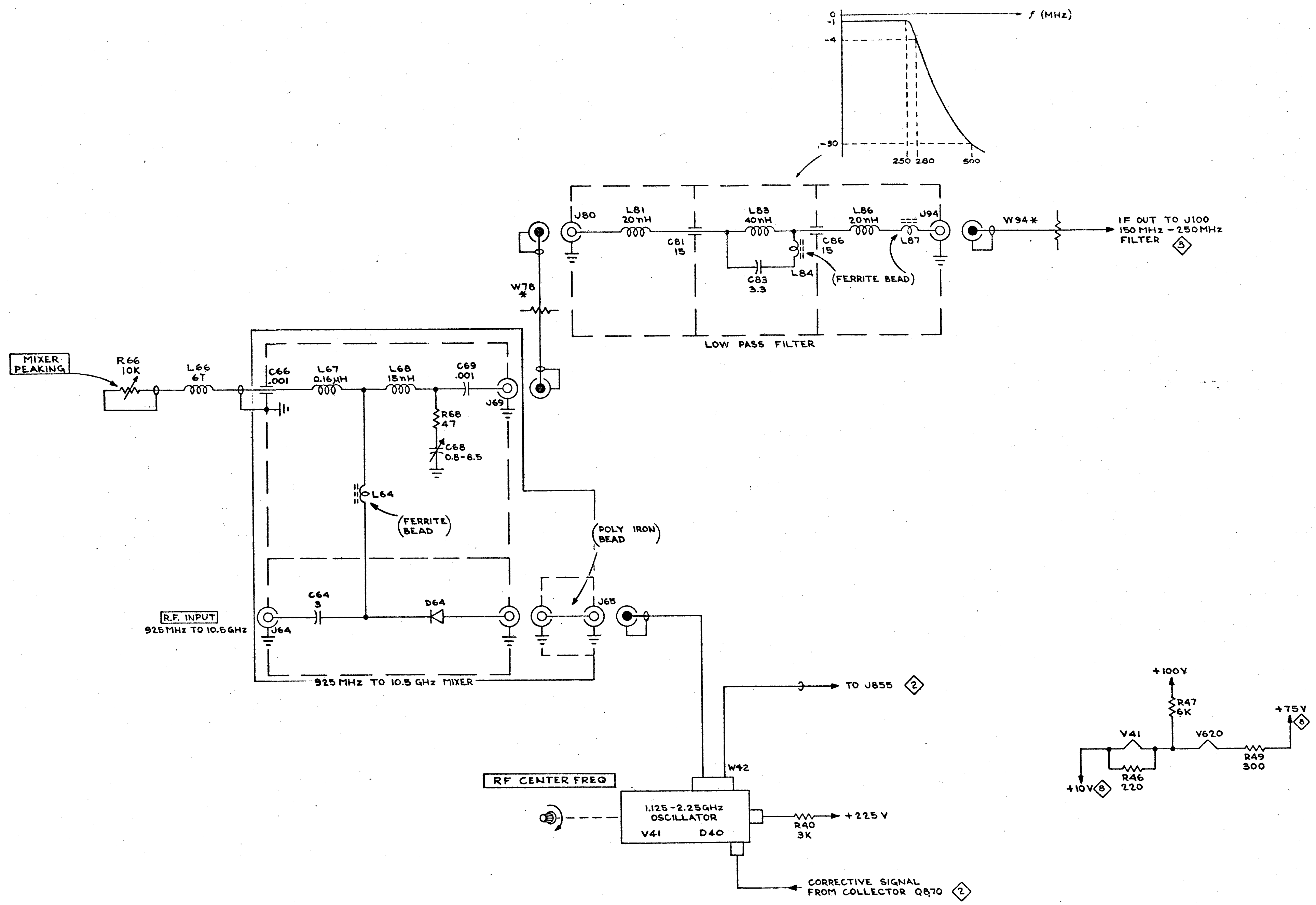


TYPE 1L30 SPECTRUM ANALYZER

B

1267

R F AND PHASE LOCK BLOCK DIAGRAM



SEE PARTS LIST FOR SEMICONDUCTOR TYPES

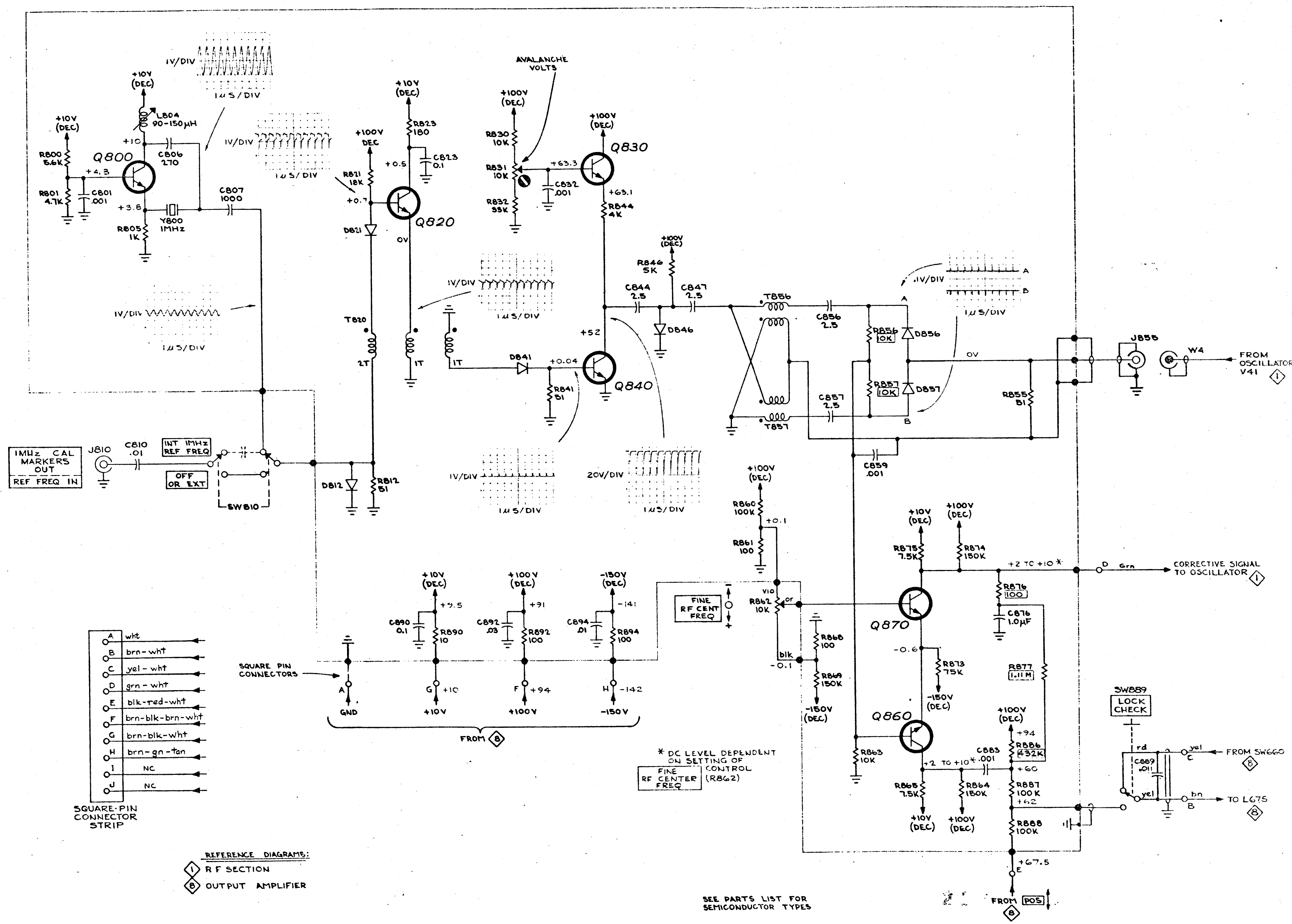
* DENOTES SELECTED LOSSY COAX

REFERENCE DIAGRAMS:

2 PHASE LOCK CIRCUIT

3 WIDE BAND AMPLIFIER & MIXER

8 OUTPUT AMPLIFIER



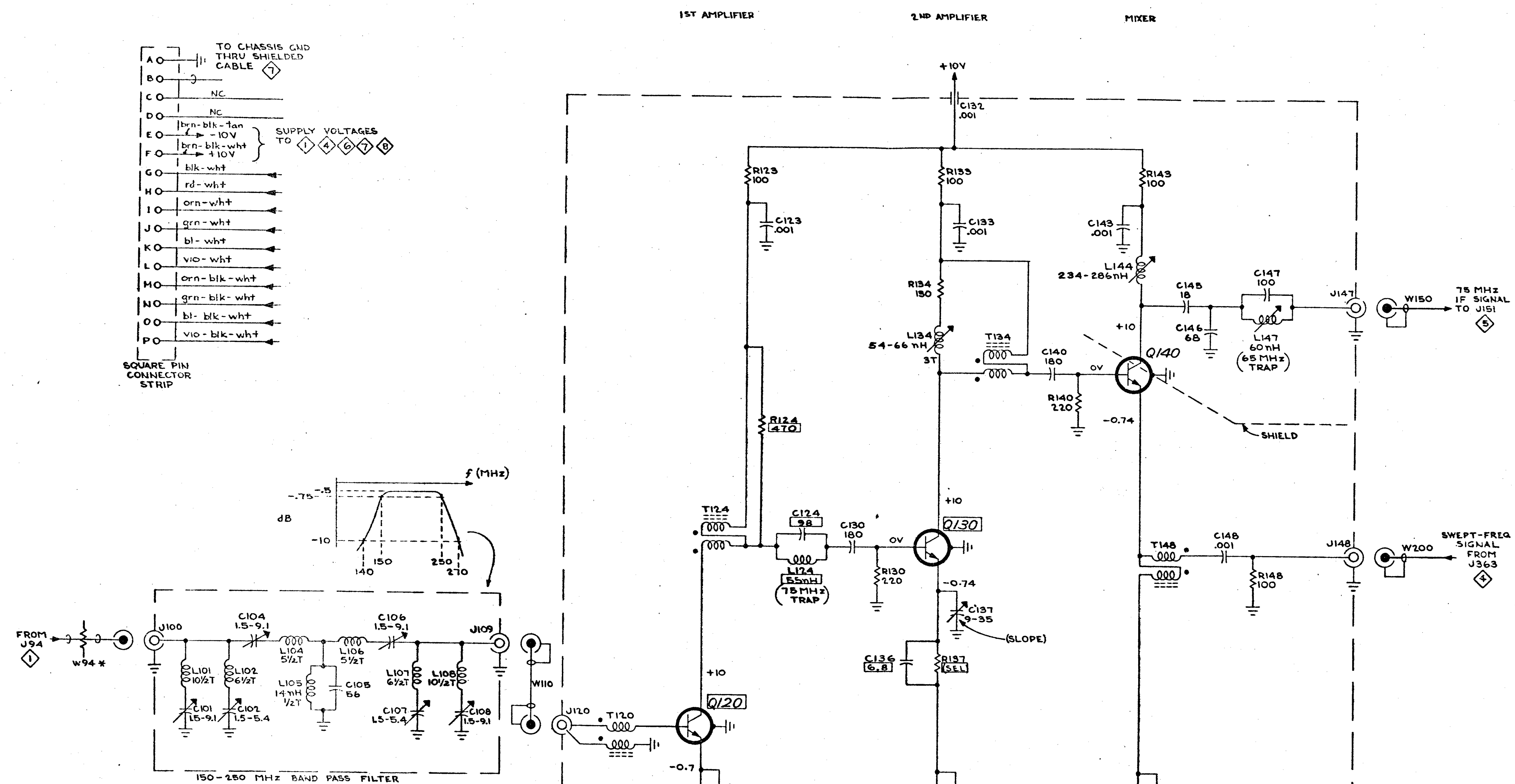
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

TYPE 1L30 SPECTRUM ANALYZER

D

1267

PHASE LOCK CIRCUIT 2



REFERENCE DIAGRAMS

1. RF SECTION
4. SWEEPER CIRCUITS
5. IF ATTENUATOR
6. NARROW BAND AMPLIFIER
7. VARIABLE RESOLUTION CIRCUIT
8. OUTPUT AMPLIFIER

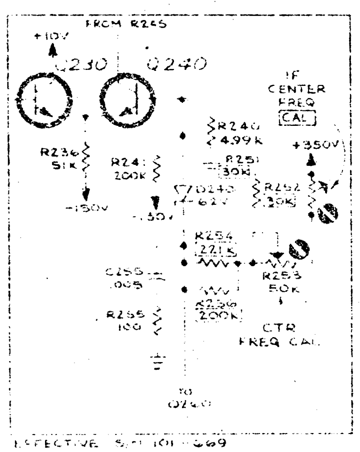
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

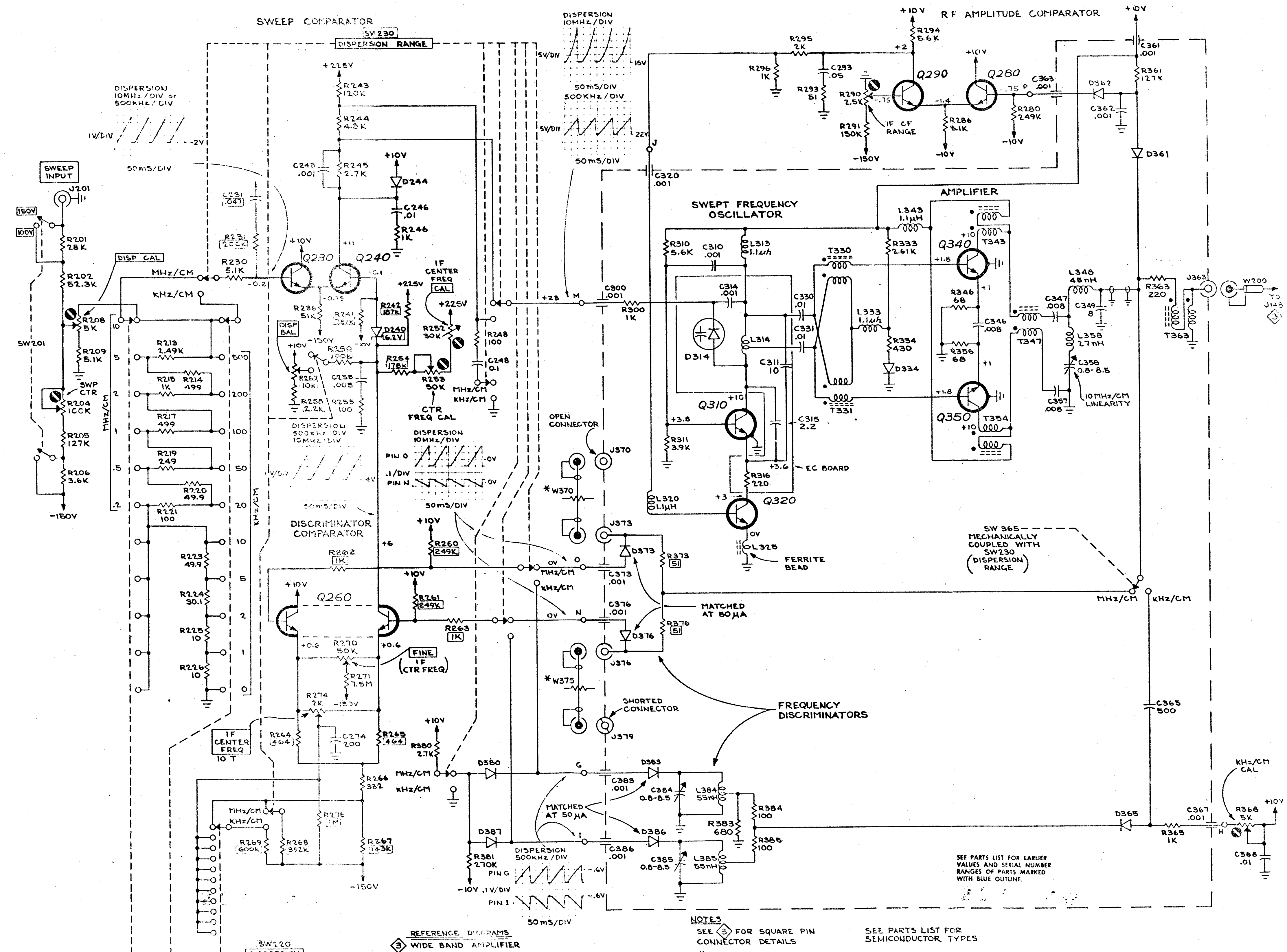
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
* DENOTES SELECTED LOSSY COAX

TYPE 1L30 SPECTRUM ANALYZER

B1

WIDE BAND AMPLIFIER AND MIXER (3)





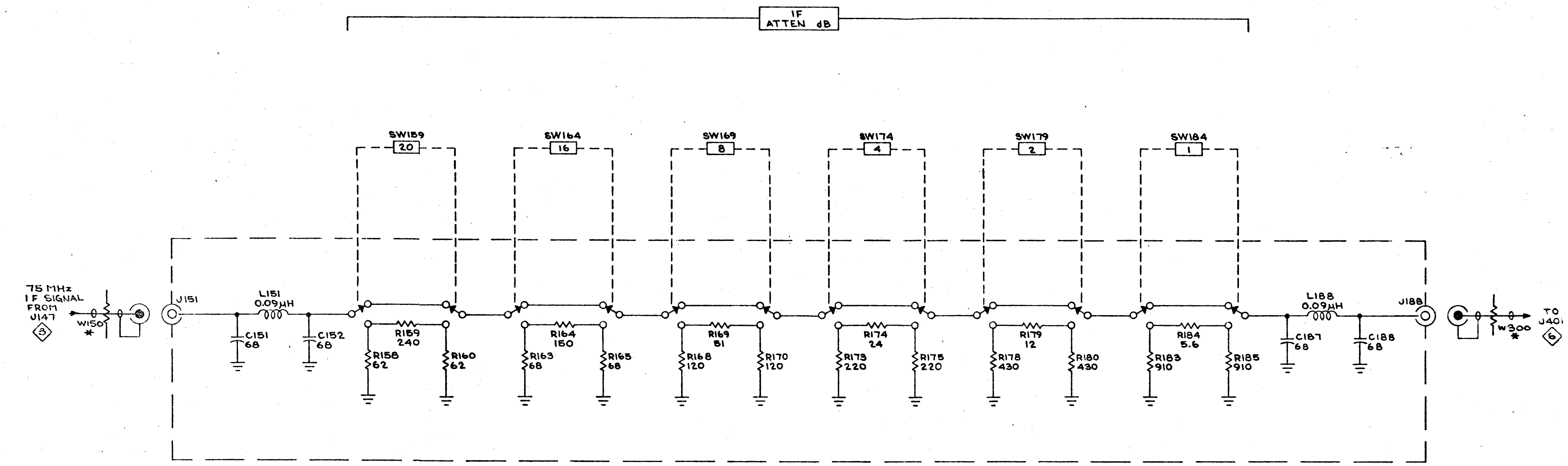
REFERENCE DIAGRAMS
(3) WIDE BAND AMPLIFIER

NOTES
SEE (3) FOR SQUARE PIN CONNECTOR DETAILS
* LOSSY COAX SELECTED FOR BEST LINEARITY OF DISCRIMINATOR

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

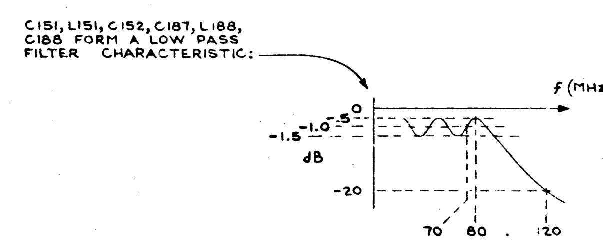
TYPE 1L30 SPECTRUM ANALYZER

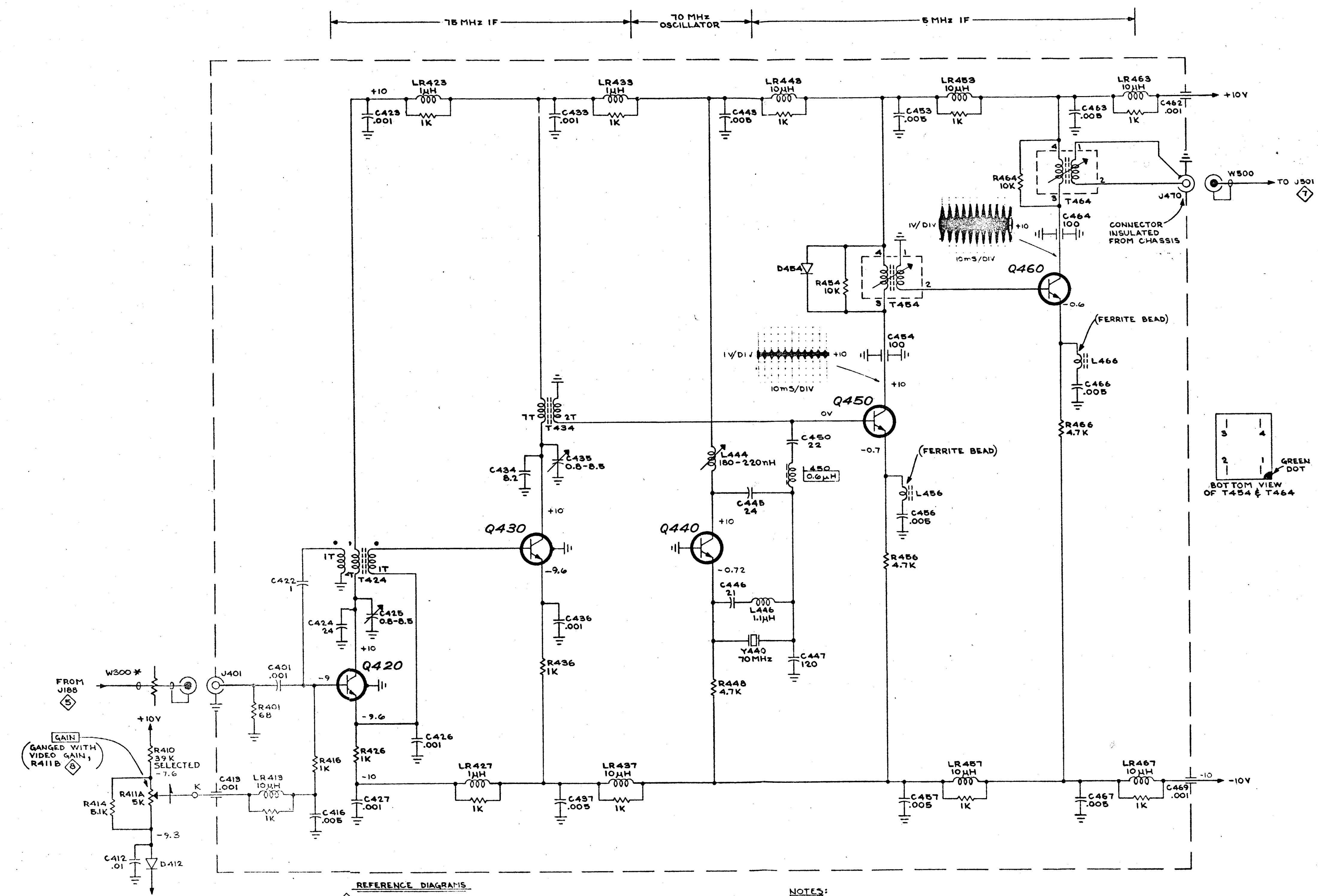
SWEEPER CIRCUITS (4)



REFERENCE DIAGRAMS
3 WIDE BAND AMPLIFIER & MIXER
6 NARROW BAND IF AMPLIFIER 70MHz OSCILLATOR & MIXER

* DENOTES SELECTED LOSSY COAX





REFERENCE DIAGRAMS

3 WIDE BAND AMPLIFIER & MIXER
5 IF ATTENUATOR
7 VARIABLE RESOLUTION CIRCUITS
8 OUTPUT AMPLIFIER

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

NOTES:

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE 3 FOR SQUARE PIN CONNECTOR DETAILS

* DENOTES SELECTED LOSSY COAX

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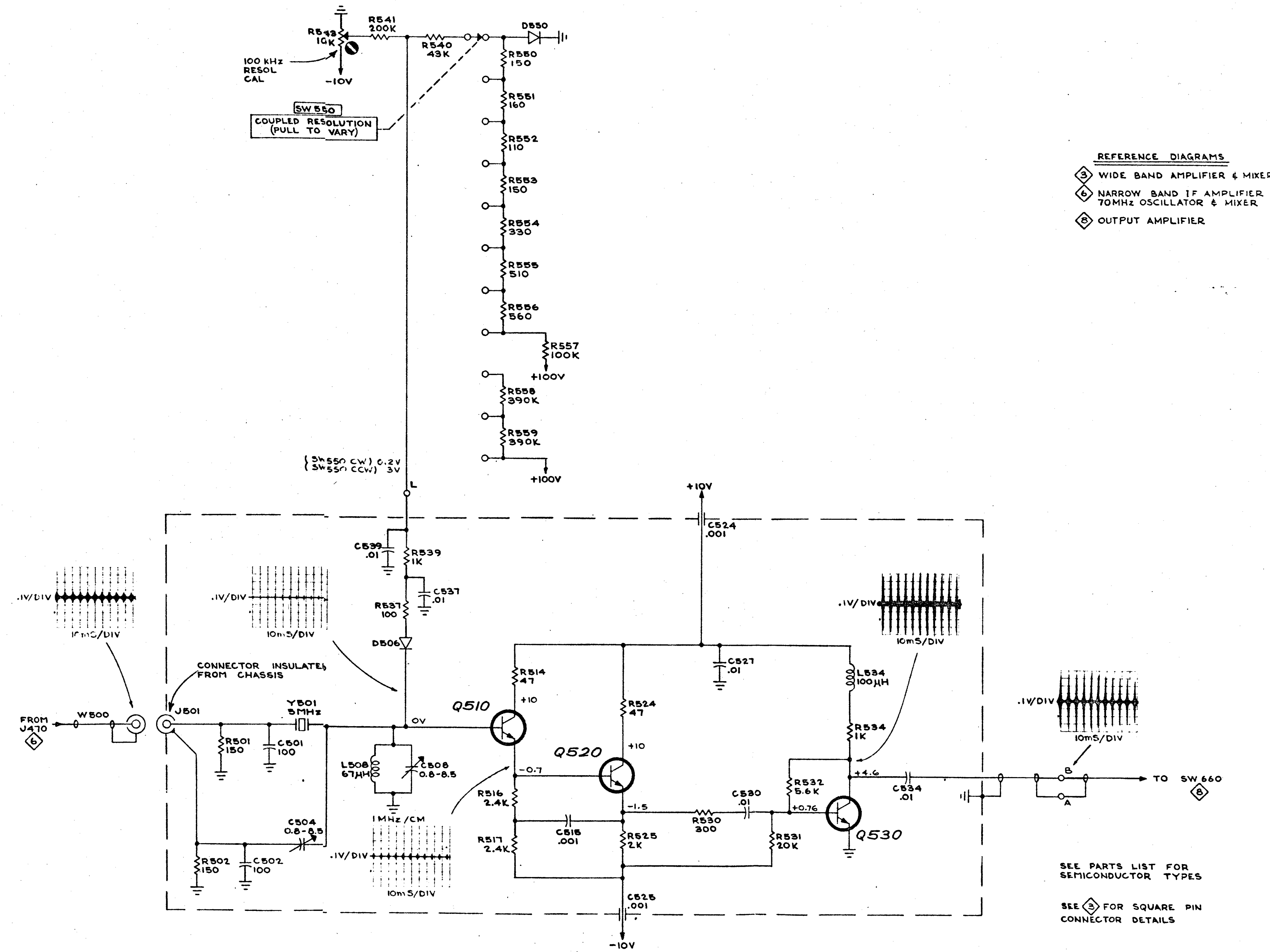
TYPE 1L30 SPECTRUM ANALYZER

B1

NARROW BAND IF AMPLIFIER
70 MHz OSCILLATOR & MIXER 6



REFERENCE DIAGRAMS

3. WIDE BAND AMPLIFIER & MIXER
6. NARROW BAND IF AMPLIFIER 70MHz OSCILLATOR & MIXER
8. OUTPUT AMPLIFIER

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

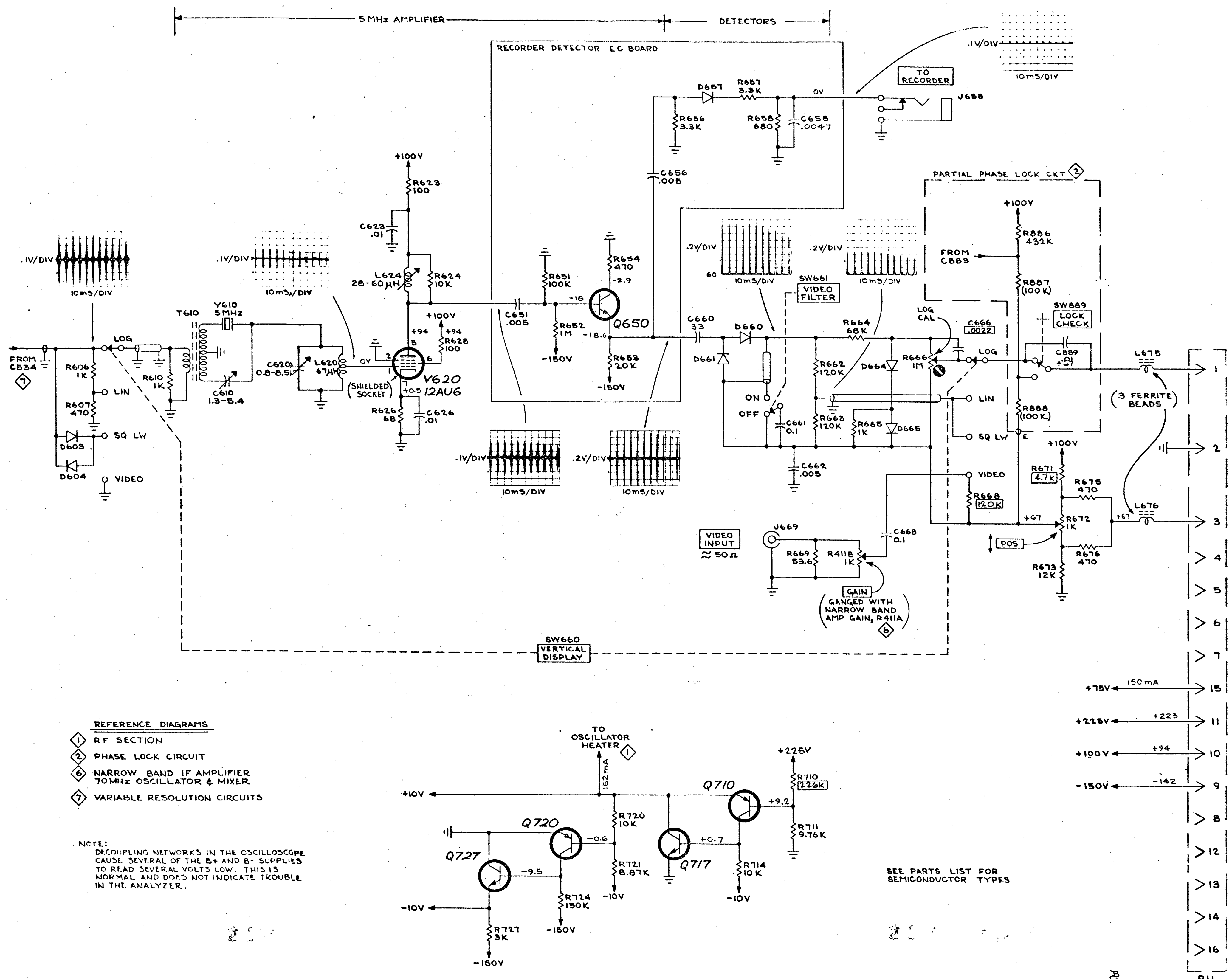
SEE 3 FOR SQUARE PIN CONNECTOR DETAILS

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

B1

1266

VARIABLE RESOLUTION CIRCUITS 7



TYPE 1L30 SPECTRUM ANALYZER

OUTPUT AMPLIFIER ⑧