

**TEKTRONIX®**

7L13

SPECTRUM  
ANALYZER

INSTRUCTION MANUAL

Tektronix, Inc.  
P.O. Box 500  
Beaverton, Oregon 97005

Serial Number \_\_\_\_\_



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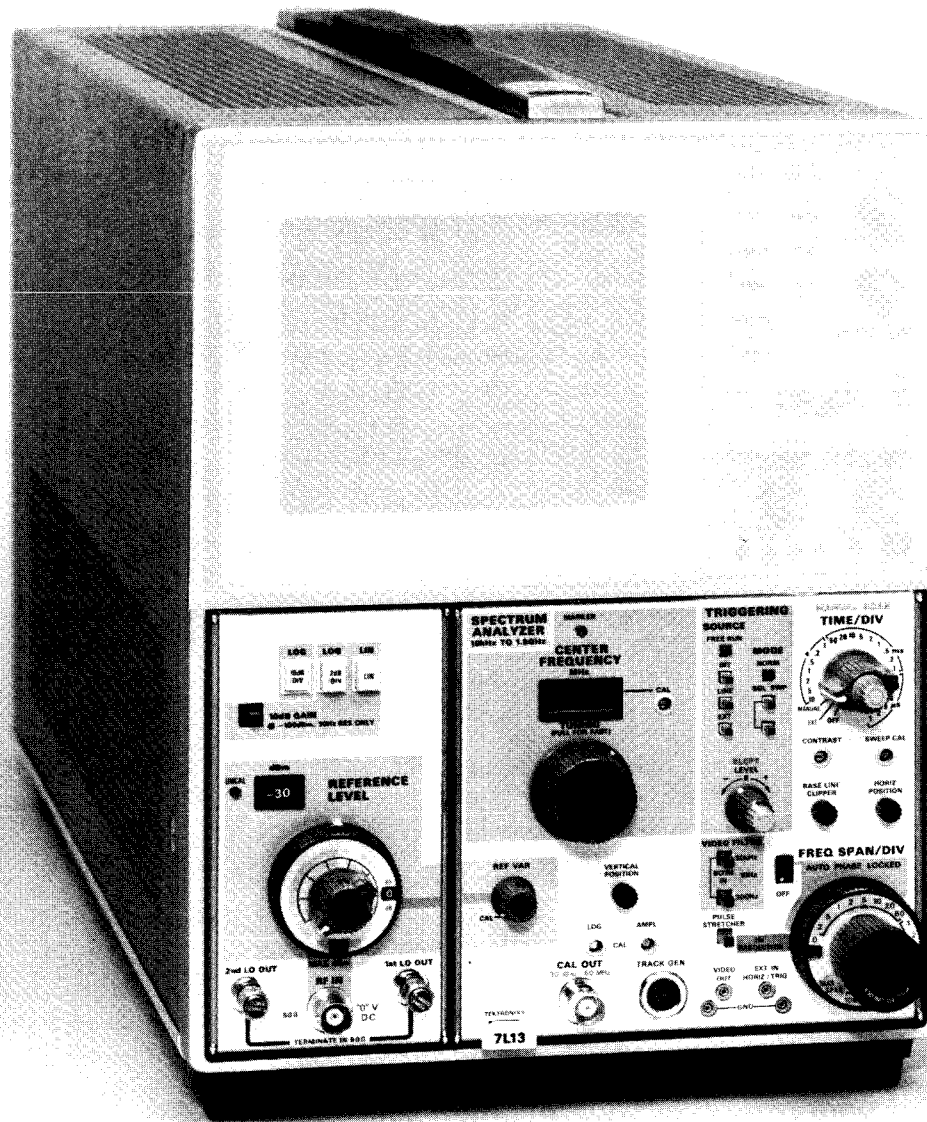


Fig. 1-1. 7L13 Spectrum Analyzer.

# GENERAL INFORMATION AND SPECIFICATIONS

## INTRODUCTION

Abbreviations used in the text and diagrams are based on ANSI Y 1.1, 1972 Standards. This manual is divided into ten major sections that provide the following information:

Section 1 — General Information and Specifications: Contains the instrument description and specifications.

Section 2 — Operation Instructions: Information relative to installing and operating the instrument.

Section 3 — Performance Check: Provides procedures to check the operational performance of the instrument plus additional performance check procedures that require test equipment to verify that instrument performance is in accordance to specifications.

Section 4 — Calibration Procedure: Describes test equipment setup and adjustment procedures required to calibrate the instrument.

Section 5 — Circuit Description: Provides basic and general circuit analysis that may be useful when servicing or operating the instrument.

Section 6 — Maintenance Instructions: Describes routine and corrective maintenance procedures with detailed instructions for replacing assemblies, sub-assemblies, and individual components. Troubleshooting procedures, plus general information that may aid in servicing the instrument, are also provided. An exploded drawing is part of Section 10.

Section 7 — Options: Describes options available for the instrument.

Section 8 — Electrical Parts List: Provides information necessary to order replaceable parts and assemblies.

Section 9 — Diagrams: Provides functional block diagram and detailed circuit schematics. Located adjacent to the diagram (usually on the back of the preceding diagram) are pictorial layout drawings that show sub-

assembly and component locations. IC logic diagrams, waveforms and voltage data, for troubleshooting or circuit analysis, are also provided adjacent to or on the diagram.

Section 10 — Mechanical Parts List, Exploded Drawings and Accessories: Provides information necessary to order replaceable parts. The Parts List is cross-referenced to the Electrical Parts List. Exploded drawing shows sequence of assembly and identifies assemblies.

Changes and Corrections: Provides updating information for the manual in the form of inserts. These inserts are incorporated into the manual text and diagrams when the manual is reprinted.

## DESCRIPTION

The 7L13 Spectrum Analyzer is a high-performance communication spectrum analyzer that plugs into and operates with the 7000-Series mainframe oscilloscopes. It is a swept front end analyzer that displays absolute amplitude information of signals within the frequency span of 0 Hz to 1.8 GHz. Time domain characteristics, within a 3 MHz bandpass, can also be displayed.

Important features of the 7L13 are: 1) Greater than 70 dB dynamic range. 2) Sensitivity down to  $-128$  dBm. 3) Resolution capability from 3 MHz to 30 Hz. 4) Incidental FM'ing less than 10 Hz. 5) Fully calibrated display modes of either 10 dB/Div, 2 dB/Div, or Linear; and a calibrated reference level in dBm. 6) Calibrated sweep spans from 100 MHz/Div to 200 Hz/Div. 7) Digital frequency readout. 8) Full range of video filtering for noise averaging. 9) Baseline clipping to subdue the bright baseline of displays when photographing. 10) Pulse stretching, to enhance pulsed spectra when using wide frequency spans and resolution bandwidths. 11) Access for a tracking generator. 12) Frequency and amplitude reference calibrator.

If the 7000-Series mainframe features crt readout, the signal parameters and other pertinent information, such as resolution bandwidth, video filtering, and frequency span, are displayed on the crt readout to simplify the operation of the instrument. Records can then be made of pertinent data by photographing the display.

## Specification—7L13

The analyzer requires three plug-in widths in the 7000-Series mainframe.

## ELECTRICAL CHARACTERISTICS

The following characteristics and features of the 7L13 Spectrum Analyzer are applicable after a warmup period of 30 minutes or more.

### CENTER FREQUENCY

Range: 1 kHz to 1.8 GHz.

Resolution of the Center Frequency Indicator: Within 1 MHz.

Accuracy:  $\pm(5 \text{ MHz} + 20\% \text{ of the Freq Span/Div})$ .

The center frequency is indicated by LED readout on the 7L13 and crt readout when the 7000-Series mainframe has this feature.

### FREQUENCY SPAN

Calibrated spans from 200 Hz/Div to 100 MHz/Div in a 1-2-5 sequence, plus 0 Hz and MAX SPAN positions. In the 0 Hz position, the analyzer is a fixed tuned receiver for time domain analysis. In the MAX SPAN position the frequency span is approximately 1.8 GHz.

Accuracy: Within 5% of the indicated frequency separation. Linearity over the center 8 divisions is within 5%.

### RESOLUTION

Six resolution bandwidth selections from 30 Hz to 3 MHz, in decade steps, are provided. Resolution bandwidth may be coupled or uncoupled from the frequency span selector.

Bandwidth accuracy: Resolution bandwidth, at the 6 dB down point, is within 20% of the resolution selected.

Shape factor (60:6 dB ratio): 12:1 or better for 30 Hz resolution and 4:1 or better with resolution of 300 Hz or more except 3 MHz. Maximum bandwidth 60 dB down with 3 MHz resolution, is 13 MHz.

Signal level change over the six resolution bandwidth selections is less than 0.5 dB.

### STABILITY (after a 2 hour warmup period)

Within 2 kHz per hour at a fixed temperature, when phase locked; within 50 kHz when not phase locked.

### INCIDENTAL FM (see Fig. 3-5)

10 Hz (peak-to-peak) or less when phase locked, and 10 kHz (peak-to-peak) or less for 5 seconds when out of phase locked mode.

### VIDEO FILTERING

Three selections of video filtering; 10 Hz, 300 Hz and 30 kHz are provided for signal or noise averaging.

### DISPLAY

LOG 10 dB/DIV: Provides a calibrated 70 dB dynamic range with an accuracy that is within 0.1 dB/1 dB to a maximum of 1.5 dB over the full dynamic range.

LOG 2 dB/DIV: Provides a calibrated 14 dB dynamic range with an accuracy that is within  $\pm 0.4 \text{ dB}/2 \text{ dB}$  to a maximum of 1.0 dB over the 14 dB dynamic range.

LIN: Provides a linear display from approximately  $0.7 \mu\text{V}$  (100 dBm) full scale, to 7.07 volts (+30 dBm). Amplitude linearity is within 10% over the graticule height.

### REFERENCE LEVEL

Reference level operation is in calibrated 10 dB steps from  $-110 \text{ dBm}$  to  $+30 \text{ dBm}$ , within  $\pm 2 \text{ dB}$ . (Accuracy includes the attenuator and gain switching effects when the two are not offsetting each other.) Reference level operation below 100 kHz becomes limited to a range from  $+30 \text{ dBm}$  to  $-50 \text{ dBm}$  as the center frequency approaches 1 kHz.

Reference level deviation, between display modes, is less than 2 dB from 2 dB/DIV to 10 dB/DIV and less than 0.5 divisions from 2 dB/DIV to LIN. This deviation is a function of the oscilloscope vertical linearity.

An UNCAL indicator signifies when the display is not calibrated.

### DISPLAY FLATNESS

+1 dB, -2 dB with respect to the level at 50 MHz, over any selected frequency span.

**CALIBRATOR**

50 MHz  $\pm 0.01\%$  with an absolute amplitude level of  $-30$  dBm  $\pm 0.3$  dB, at 25°C. 50 MHz harmonics are generated to provide a comb of markers for frequency span calibration.

**CW SENSITIVITY (Signal + noise = 2x noise, in LIN display mode)**

The following characteristics are applicable from 100 kHz to 1.8 GHz: Below 100 kHz the sensitivity degrades approximately 0.3 dB/kHz; for example, the sensitivity at 50 kHz with 30 Hz resolution is,  $-113$  dBm or better; at 1 kHz,  $-98$  dBm or better.

RESOLUTION BANDWIDTH	SIGNAL LEVEL
30 Hz	$-128$ dBm
300 Hz	$-120$ dBm
3 kHz	$-110$ dBm
30 kHz	$-100$ dBm
.3 MHz	$-90$ dBm
3 MHz	$-80$ dBm

**SPURIOUS SIGNALS FROM INTERNAL SOURCES (Residual Response)**

Equal to or less than  $-100$  dBm, referred to the 1st mixer input.

**INTERMODULATION DISTORTION (Fig. 3-6)**

100 kHz — 1.8 GHz: Third order intermodulation products are down 70 dB or more from two  $-30$  dBm signals within any frequency span, second order products are down 70 dB or more from two  $-40$  dBm signals within any frequency span.

1 kHz — 100 kHz; Intermodulation products (3rd and 2nd) are down 50 dB or more for the same input level as above.

**GAIN**

The gain range is 80 dB total. An eight position selector changes the IF gain 70 dB in 10 dB ( $\pm 1.0$  dB) steps and a 10 dB pushbutton adds an additional 10 dB of gain when the REFERENCE LEVEL is  $-100$  dBm and 30 Hz resolution bandwidth is used, in the 2 dB/DIV or LIN mode.

Four positions (blue sector) of the selector provide 30 dB of change in all display modes. The remaining four

positions provide an additional 40 dB of gain only in the 2 dB/DIV and LIN modes. The 10 dB pushbutton provides the additional 10 dB of gain, when the resolution bandwidth is 30 Hz and the REFERENCE LEVEL is  $-100$  dBm in the 2 dB/DIV or LIN mode.

The REF VARIable control provides continuous gain adjustment between each calibrated REFERENCE LEVEL setting.

**RF ATTENUATOR**

Provides 60 dB of attenuation in calibrated 10 dB steps. Accuracy is  $\pm 0.2$  dB or 1% of the dB reading, whichever is greater.

**MAXIMUM INPUT POWER LEVEL**

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

*NOTE*

*The maximum input power level to the RF Attenuator is 1 watt average and 200 watts peak.  $+13$  dBm will destroy the 1st mixer.*

**SWEEP MODES AND RATE**

Selection of an external sweep source, manual sweep, or calibrated sweep rates from 10 s/Div to 1  $\mu$ s/Div in a 1-2-5 sequence are provided. Sweep rate accuracy is within 5% of that selected.

**TRIGGERING**

Three triggering sources can be selected. INTERNAL selects the vertical or video component from either vertical plug-in compartment, EXTERNAL selects the signal applied to the EXT IN HORIZ/TRIG connector and LINE selects a sample of the mainframe line voltage. INTERNAL signal is ac coupled with an approximate frequency range from 15 Hz to 1 MHz. The external and line signals are dc coupled. Input impedance for the external input is about 30 k $\Omega$  for the trigger mode and 9 k $\Omega$  for external horizontal sweep mode.

Trigger sensitivities are: 1)  $\leq 0.5$  division of internal signal (peak-to-peak) and  $\leq 0.5$  volt of signal (peak-to-peak) of external signal for NORM mode. 2)  $\leq 0.5$  division of internal signal peak-to-peak and  $\leq 0.5$  volt of external signal for SGL SWP mode.

## Specification—7L13

In the NORM mode the sweep will automatically recur at the end of holdoff time if a trigger signal is absent, to provide a baseline on the crt.

The SGL SWP and "start" buttons function together to provide a single sweep each time the "start" button is pushed.

### VIDEO OUTPUT CONNECTOR

Provides 50 mV  $\pm 5\%$  of video signal per display division, about the crt vertical center. Source impedance is approximately 1 k $\Omega$ . A maximum of 50 mV offset may be introduced by the error from the mainframe vertical centering interface.

### EXTERNAL HORIZONTAL/TRIGGER INPUT CONNECTOR

Requires 0 V to 10 V  $\pm 1$  V, to sweep the full frequency span.

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

### ENVIRONMENTAL CHARACTERISTICS

This instrument will meet the electrical characteristics over the environmental limits of the 7000-Series mainframe. Complete details on test procedures, including failure criteria, etc., can be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

## ACCESSORIES AND OPTIONS

### STANDARD ACCESSORIES

1. Spectrum Analyzer Graticule: Clear plastic implosion shield with LOG, LIN, REF and f (frequency) direction markings. Tektronix Part No. 337-1439-01 for 7403N oscilloscope and 337-1159-02 for other 7000-Series oscilloscopes.

- |   |             |
|---|-------------|
| 2. Filter Light Amber                                     | 378-0684-01 |
| 3. 50 $\Omega$ Coaxial Cable, with BNC connectors, 6 foot | 012-0113-00 |
| 4. BNC Male to N Female Adapter                           | 103-0058-00 |
| 5. Manual   | 070-1673-00 |

### OPTIONAL ACCESSORIES

- |   |             |
|---|-------------|
| 1. DC Block (for applying signals riding on a DC potential). Maximum potential is 50 V DC | 015-0221-00 |
| 2. 75 $\Omega$ to 50 $\Omega$ minimum loss attenuator with DC block                       | 011-0112-00 |

### OPTIONS TO 7000-SERIES OSCILLOSCOPES

1. CRT with P7 phosphor and time domain graticule. The external graticule for spectrum analysis (part of standard accessories) should be used.

2. CRT with P7 phosphor and an internal spectrum analyzer graticule (designated P7SA). This is recommended when the oscilloscope mainframe is to be used exclusively with spectrum analyzer systems.

# OPERATING INSTRUCTIONS

## INTRODUCTION

This section describes: 1) Function of the front panel controls, selectors, indicators and connectors. 2) Installation of the 7L13 into a 7000-Series oscilloscope. 3) General operation information, such as: Adjustments required to mate the 7L13 to a 7000-Series oscilloscope. Signal application to the RF INput. How to use the calibrator for accurate frequency and power level measurements, etc. 4) Some typical applications.<sup>1</sup>

The first steps of the General Operating information calibrate and check the analyzer Frequency, Span/Div, and the display modes. These steps serve as part of an acceptance check and describe how to obtain a display on the oscilloscope crt.

Performing this Operational Checkout procedure will acquaint you with the functions of the controls and selectors and the overall operation of the 7L13.

### CAUTION

*A safety latch must be released before the 7L13 can be pulled from the oscilloscope compartment. The unit will pull out part way, when the front panel release is pulled, then the spring safety latch must be pushed up to free the unit so it can be pulled the rest of the way out. This safety latch is located underneath the right rail near the front corner (see Fig. 2-1B).*

## FUNCTION OF THE FRONT PANEL CONTROLS AND ADJUSTMENTS

The following is a general description of the 7L13 controls, indicators and connectors. This description will familiarize you with their function and Figs. 2-1A and 2-1B illustrate their location.

### FREQUENCY CONTROLS

**TUNING:** The center frequency is tuned by a one-speed control with a ratio of approximately 6.5:1. In addition, the tuning range is decreased to 1 MHz ( $\pm 9500$  kHz) when the FREQ SPAN/DIV is 50 kHz or less.

<sup>1</sup> A treatise on spectrum analyzer measurements and applications is contained in Tektronix Measurements Concepts Booklet; "Spectrum Analyzer Measurement Theory and Practice"; Part No. 062-1334-00.

A MARKER indicator lights when the FREQ SPAN/DIV is at the MAX SPAN position and a notch on the baseline of the display indicates the center portion of the span that will be displayed when the FREQ SPAN/DIV is reduced.

The center frequency or marker frequency is indicated by an LED digital readout dial.

**CAL:** Calibrates the frequency readout so it represents the center of the span.

### NOTE

*When operating with Freq Spans of 50 kHz/Div or less, the AUTO PHASE LOCKED switch must be OFF if you want the center frequency and LED readout to change when tuning.*

**FREQ SPAN/DIV:** This switch selects the frequency span of the display. The calibrated range of the selector is 100 MHz/DIV to 200 Hz/DIV in a 1, 2, 5 sequence. A MAX SPAN position provides approximately 1.8 GHz of spectrum and a 0 Hz position converts the analyzer to a fixed tuned receiver for time domain displays. Time analysis of the signal characteristics, within the bandwidth capabilities selected with the RESOLUTION control, can then be performed.

### CAUTION

*The FREQ SPAN/DIV knob is large enough to provide ease in switching; however, excess torque applied when the selector is at either of its extreme positions may cause the aluminum bushing inside the knob to slip. When this occurs, the selectors may double detent or switch with a grinding noise. Refer to Knob Removal and Installation instructions in the Maintenance section of the manual for realignment.*

**RESOLUTION:** This control selects the resolution bandwidth for the analyzer. The calibrated range (within 20%) is 30 Hz to 3 MHz in decade steps. The RESOLUTION is normally coupled to the FREQ SPAN/DIV control so the display amplitude remains constant as the FREQ SPAN is changed; however, a concentric sleeve labeled PULL TO UNLOCK will uncouple the two selectors when it is pulled out and allow independent settings of each control.

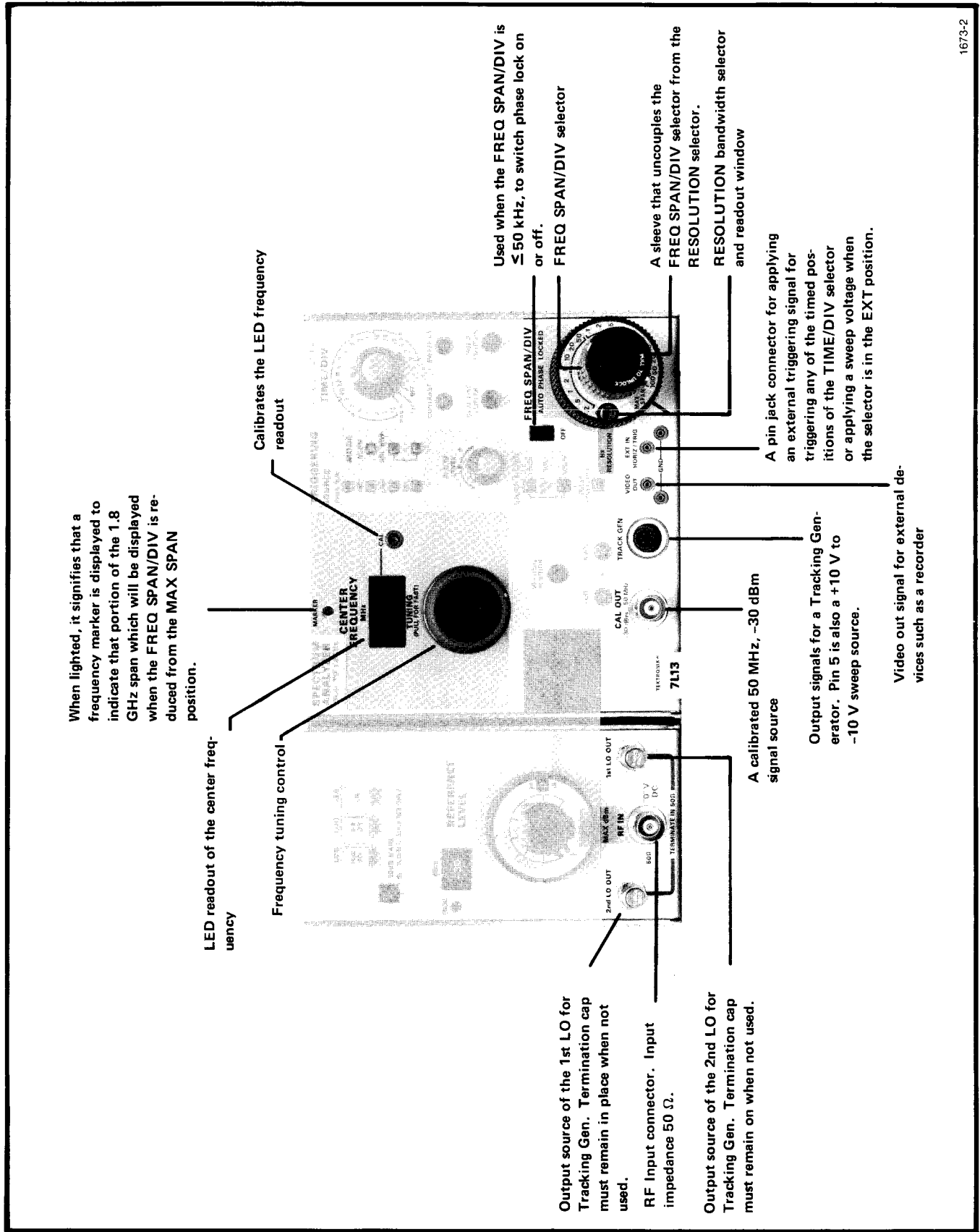


Fig. 2-1A. Front panel controls and selectors.





## Operating Instructions—7L13

### DISPLAY CONTROLS AND SELECTORS

**LOG 10 dB/DIV:** Selects a calibrated display with a dynamic range of 70 dB (to the 7th graticule line, from the reference) at 10 dB/DIV. The bottom graticule division is not calibrated.

**LOG 2 dB/DIV:** When this pushbutton is depressed, the dynamic range of the display is a calibrated 14 dB at 2 dB/DIV.

**LIN:** Selects a linear display. The LIN graticule calibration permits relative signal level measurements as follows: Adjust the level of one signal to the 1.0 line, with the gain or RF Attenuation. Read the level of the other signals as a percentage of this reference.

**REFERENCE LEVEL (RF Attenuator and IF Gain):** These are concentric controls that are connected in an electro-mechanical differential arrangement. They select input attenuation to the input mixer, and the IF gain. They indicate, via readout windows; **REFERENCE LEVEL** in dBm, of the full scale display, **MAXimum** signal input level (in dBm) for linear operation, and the input RF attenuation (from 0 to 60 dB).

The RF attenuation is in series with the input signal path to the input mixer, therefore its settings affect the maximum input signal level to the 7L13. With 0 dB attenuation, maximum input signal level for linear operation, is -30 dBm. Changing the RF Attenuator to 60 dB increases the maximum input signal level to +30 dBm.

The IF gain selector has a range of 70 dB in 10 dB steps. The combination of RF Attenuator and IF gain settings establishes the **REFERENCE LEVEL**; therefore, both controls function as **REFERENCE LEVEL** selectors. The maximum sensitivity of the display will not exceed -130 dBm. Since the dynamic window is 70 dB in the 10 dB/DIV display mode, the **REFERENCE LEVEL** readout is valid to -60 dBm. With the RF Attenuator at 0 dB and the IF gain fully ccw, the **REFERENCE LEVEL** is -30 dBm. Increasing the IF gain 30 dB, changes the **REFERENCE LEVEL** to -60 dBm, which is the limit for a calibrated reference level in the 10 dB/DIV mode. The blue tint, that borders the 10 dB/DIV switch and four positions of the gain selector, correlates **REFERENCE LEVEL** readout to the gain settings applicable in the 10 dB/DIV mode. Readings, with the gain selector outside the blue tint sector are erroneous because the gain is electrically locked out; the crt readout will display the < symbol to signify that the reading is incorrect.

In the 2 dB/DIV mode, the full 70 dB range of the gain selector is usable. Switching the gain fully cw with the RF Attenuator at 0 dB, produces an accurate -100 dBm

reference level. The dynamic range of the display is now -114 dBm (-100 dBm + 14 dB display window to the 7th graticule line). An additional 10 dB of gain, for a calibrated -124 dBm, can be switched in with the 10 dB **GAIN** pushbutton, when the **RESOLUTION** is 30 Hz.

**VIDEO FILTERS:** Three filters (30 kHz, 300 Hz, and 10 Hz) can be switched in to restrict the video bandwidth and reduce high frequency components for display noise averaging. Two pushbuttons select 30 kHz or 300 Hz when depressed, and 10 Hz when both are depressed.

**BASELINE CLIPPER:** This controls the vertical amplitude of that portion (baseline plus signal) of the display that the intensity is subdued.

**CONTRAST:** Adjusts the brightness ratio between the clipped (subdued) baseline and the unclipped display. The display intensity is set by the mainframe Intensity control.

**PULSE STRETCHER:** Switching this on, stretches the falltime of pulsed signals to enhance the visibility of pulsed RF signals that may be within wide frequency spans and resolution bandwidths.

**LOG and AMP CAL:** The LOG adjustment calibrates the logarithmic accuracy of the display. The AMP adjusts the **REFERENCE LEVEL** to the top graticule line.

**AUTO PHASE LOCKED:** This switch is used to disable the phase lock for some applications, such as tuning the analyzer more than 1 MHz when the analyzer is used as a tuned receiver (0 span).

**VERTICAL POSITION:** Positions the crt beam vertically.

**HORIZ POSITION:** Positions the crt beam horizontally.

### OUTPUT AND INPUT CONNECTORS

**VIDEO OUT:** Provides  $\pm 50$  mV of video per displayed division of signal. The amplitude and polarity of this signal is relative to the graticule vertical centerline. Source impedance is about 1 k $\Omega$ . This signal can be used to drive an external device such as a recorder.

**TRACK GEN:** A source of control signals for a Tracking Generator. Pin 5 of the connector is the source of a +10 V to -10 V sweep ramp, with +10 V representing the left edge of the display and -10 V the right side of the display.

RF IN: A 50  $\Omega$  input connector for applying the input signal to the 7L13. REFERENCE LEVEL readout refers to the signal level at this connector. Any signals riding on some dc potential must be applied through a dc block. Refer to the General Operating Procedure with regard to signal applications.

1st and 2nd LO OUT: These connectors provide access to the output of the respective local oscillators. They must be terminated into 50  $\Omega$ . Keep the termination plugs on the output jacks unless these ports are connected to an external device such as a tracking generator.

CAL OUT: Provides an accurate  $-30$  dBm, 50 MHz signal source. This signal provides an absolute reference on the display to calibrate the REFERENCE LEVEL and check dBm readings. Harmonics of the 50 MHz fundamental provide a comb of markers across the frequency span for accurate frequency and span measurements.

## SWEEP CONTROLS

TRIGGERING SOURCE: Three sweep triggering sources can be selected plus a free run mode: INTERNAL selects the vertical or video component from either vertical plug-in compartment. The signal is ac coupled with an approximate frequency range from 15 Hz to 1 MHz; EXTERNAL selects the signal that is applied to the EXT IN HORIZ/TRIG connector; and LINE selects a sample of the mainframe line voltage. External and line signals are dc coupled to the triggering circuits. Maximum signal input to the external input connector should not exceed 50 volt (dc + ac peak) for triggering. Input impedance for the external input is about 30 k $\Omega$ .

The FREE RUN mode will not sync the sweep to any triggering signal.

MODE: Two modes are available, NORM and SGL SWP. In the NORM mode the sweep will automatically recur at the end of holdoff time, if a trigger signal is absent. This feature provides a baseline on the display. In this mode triggering occurs at the slope and level selected by the SLOPE/LEVEL controls unless the triggering signal is below the required amplitude or beyond the frequency limits of the circuit. Minimum signal amplitude for internal triggering is 0.5 division of signal (peak-to-peak) and 0.5 volt of signal for external triggering.

In the SGL SWP mode, the sweep is triggered by pushing the adjoining button. This button lights during sweep time and serves as an indicator to determine camera shutter time when photographing slow scan-time displays. Minimum signal amplitude for triggering is 0.5 division of signal and 0.5 volt of external signal.

TIME/DIV and MANUAL SCAN: Three sweep modes, plus an off state, are provided: A calibrated TIME/DIV in a 1, 2, 5 sequence from 10 s/DIV to 1  $\mu$ s/DIV, a manual sweep control, and an external sweep. The TIME/DIV control selects the sweep rates and the modes.

In the OFF position, the crt beam is horizontally centered and the analyzer becomes a fixed tuned receiver at the frequency indicated by the readout.

The EXT position connects any signal applied to the EXT/HORIZ TRIG connector to the horizontal deflection circuits of the 7L13. External sweep voltage (0 V to 10 V) signal can be used to slave the 7L13 to an external device such as a recorder.

The MANUAL position connects the sweep circuits of the 7L13 to the MANUAL SCAN control, so the crt beam deflection can be manually controlled.

SWEEP CAL: The adjustment calibrates the amplitude of the sweep voltage to the FREQ SPAN circuits and compensates for differences in deflection sensitivities between oscilloscopes.

## OPERATIONAL CHECK

### 1. Preliminary Operational Procedure that Calibrates the 7L13 to the Oscilloscope Mainframe

When the 7L13 plug-in unit is installed in a 7000-Series mainframe, the spectrum analyzer should be calibrated to ensure correlation between plug-in and the mainframe deflection sensitivities. We recommend that the front panel calibration procedure be performed anytime the instrument is first turned on, to ensure optimum accuracy.

a. Plug the 7L13 Spectrum Analyzer into the 7000-Series mainframe. Ensure that the 7L13 is securely latched in the compartment. This is a safeguard to ensure that the instrument does not slide out, if the mainframe is tipped forward.

#### NOTE

*A safety latch is used to reduce the possibility of the instrument slipping out of the mainframe.*

b. Connect the oscilloscope mainframe to a suitable power source and switch the power on. Allow about 30 minutes for instrument stabilization.

## Operating Instructions—7L13

c. Set the front panel controls as illustrated in Fig. 2-2 and connect the CAL OUT signal through a short coaxial cable to the RF INPUT.

d. Adjust the oscilloscope Intensity, Focus and Astigmatism controls for optimum display definition with normal intensity.

e. Depress the 2 dB/DIV display mode button. Position the baseline of the display to the bottom graticule line with the VERTICAL POSITION control and center the display with the HORIZ POSITION control.

f. Depress the 10 dB/DIV (LOG) display button. Display should now resemble that shown in Fig. 2-2.

### NOTE

*When the oscilloscope has a crt with P7 phosphor, a viewing hood will help shield ambient light and enhance the display information.*

## 2. Calibrate the Frequency Readout

Due to hysteresis in the tuning system, the calibration and accuracy of the readout must be performed and checked by approaching each check point from the same direction (low to high).

a. Apply the calibrator signal to the RF INPUT, switch the FREQ SPAN/DIV to MAX SPAN, and tune the CENTER FREQUENCY to 0000.

b. Decrease the FREQ SPAN/DIV setting to 10 MHz and increase the CENTER FREQUENCY until the 50 MHz calibrator signal is tuned to the centerline of the graticule.

### NOTE

*It is important to tune the signal from low to high. If the tuning direction is reversed, repeat the procedure by returning the FREQ SPAN/DIV to MAX SPAN and the CENTER FREQUENCY to 0000 to establish the same reference point on the hysteresis loop.*

c. When the 50 MHz signal is centered on screen, adjust the frequency CAL for a CENTER FREQUENCY readout of 50 MHz.

## 3. Calibrate the Sweep Span

a. Switch the FREQ SPAN/DIV to MAX SPAN position.

b. Position the 0 Hz response, or LO feedthrough, on the zero (left) graticule line with the HORIZ POSITION control.

c. With the CAL OUT signal applied to the RF INPUT, decrease the FREQ SPAN/DIV to 50 MHz and tune the 5th marker (250 MHz) to the center graticule line (see Fig. 2-3).

d. Calibrate the frequency span to 50 MHz/DIV by adjusting the SWP CAL for 1 marker/division. It may be necessary to keep the 250 MHz marker centered with the frequency TUNING control as the sweep is calibrated. Final display should resemble that illustrated in Fig. 2-3.

## 4. Check and Adjust LOG-AMPL Calibration

The LOG CAL adjustment calibrates the gain of the analyzer vertical output so the 2 dB/DIV and 10 dB/DIV modes may be accurately set. The AMPL CAL adjustment sets the reference level to the top graticule line. There is no interaction between these two adjustments.

a. Set the 7L13 selectors and controls as directed in step 2 and tune the fundamental 50 MHz calibrator signal to the center of the graticule.

b. Uncouple the RESOLUTION selector from the FREQ SPAN/DIV by pulling out the PULL TO UNLOCK sleeve, then switch the FREQ SPAN/DIV to 5 MHz. The RESOLUTION should remain at 3 MHz. As the FREQ SPAN is decreased, it may be necessary to re-adjust the tuning control to keep the signal centered on screen.

c. Switch the Display Mode to 2 dB/DIV and position the baseline of the display on the bottom graticule line with the VERTICAL POSITION.

d. Adjust the AMPL CAL and the LOG CAL (if necessary) to bring the 50 MHz signal within the graticule window. Adjust the AMPL CAL to establish a signal reference amplitude of 8 divisions (Fig. 2-4 shows a full screen display).

e. Switch in 10 dB of attenuation with the RF Attenuator. Amplitude change should equal 5 divisions at 2 dB/DIV.

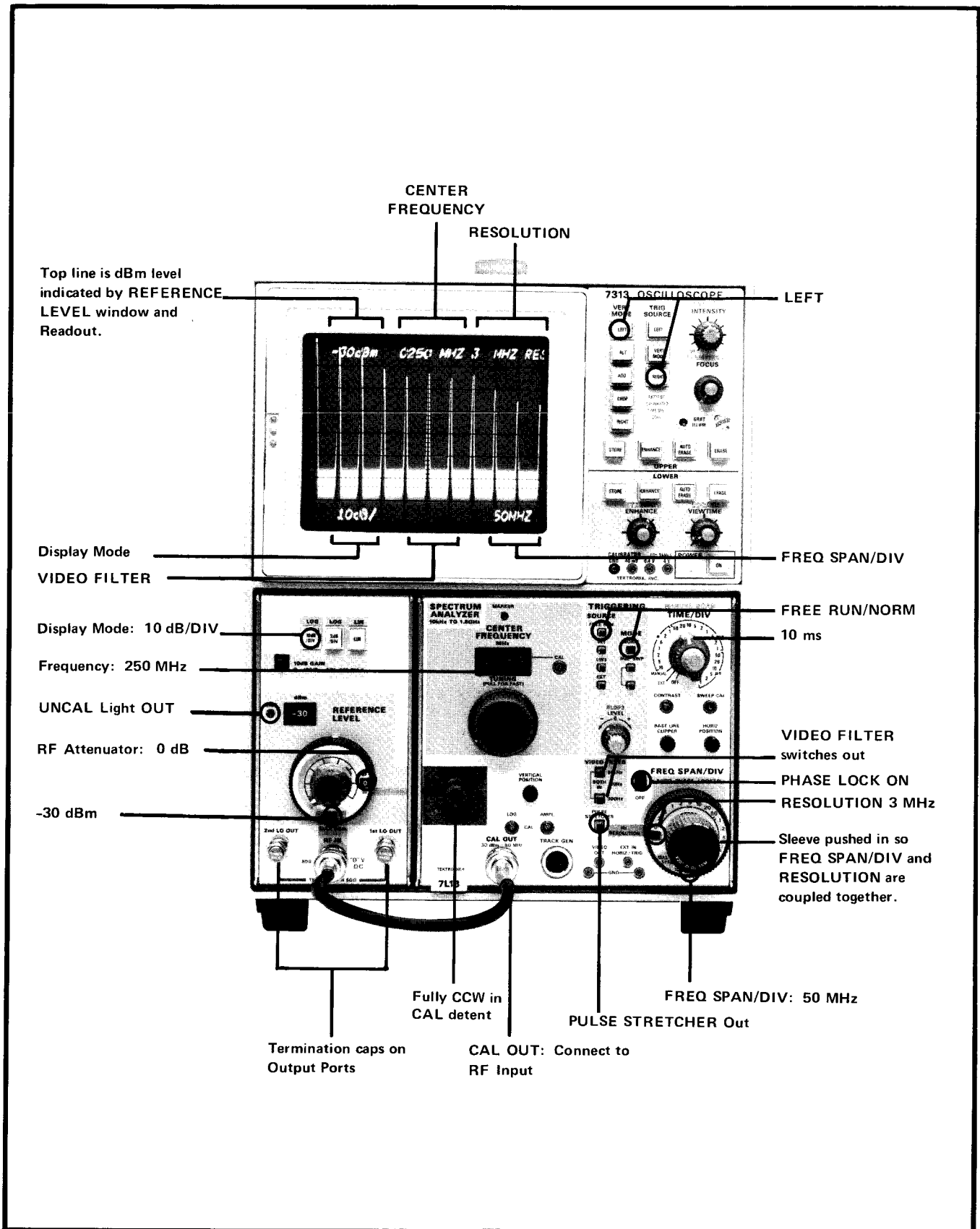


Fig. 2-2. Front panel selector positions and signal connections for initial operational check and front panel calibration.

## Operating Instructions—7L13

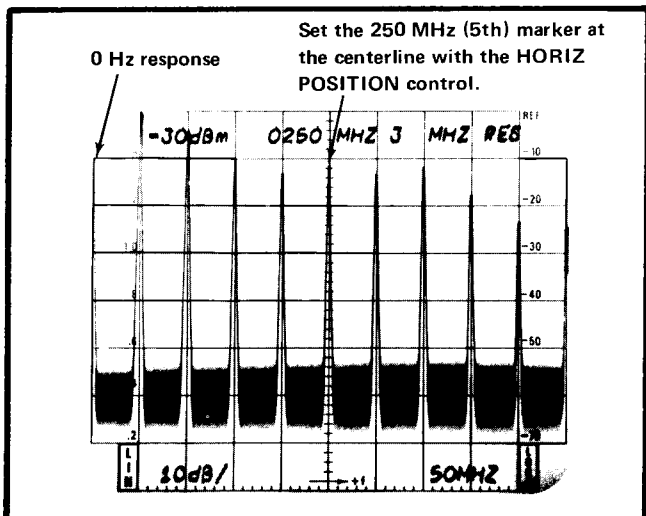


Fig. 2-3. Calibrating the sweep span.

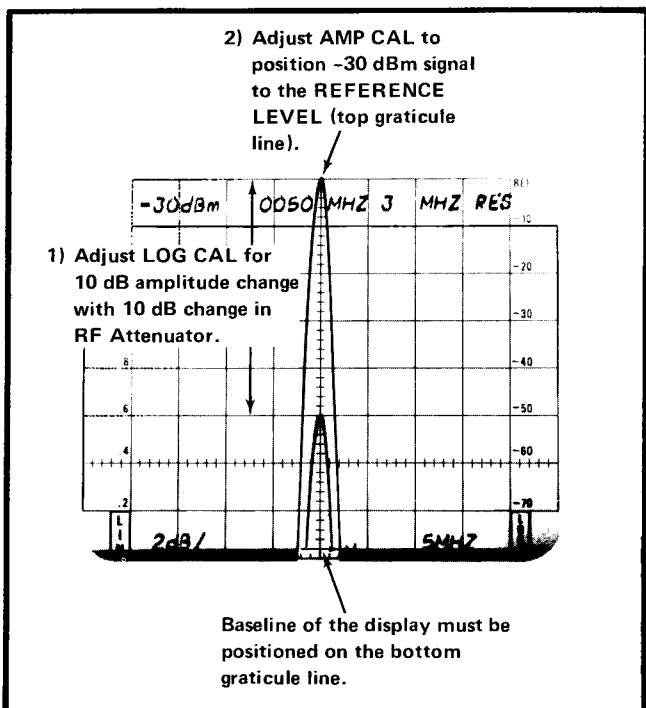


Fig. 2-4. Calibrating the LOG and REFERENCE LEVEL. (Double exposure to illustrate the relationship of the two displays.)

f. If the change is more than 5 divisions (e.g., amplitude decreases from 8 to 2.5 div), adjust LOG CAL to further increase the amplitude change (i.e., decrease the signal amplitude). Conversely, if the change is less than 5 divisions (e.g., amplitude changes from 8 to 3.5 div), adjust the LOG CAL to further decrease the amplitude change (i.e., increase the signal amplitude). Correct for approximately 1/2 the total indicated error. This adjustment may seem opposite to what is expected; however, the LOG CAL adjustment also shifts the reference level. This, therefore will require a correction to the amplitude change.

g. Switch out the 10 dB of RF Attenuation. Now adjust the AMPL CAL to return the signal level to the reference line. (Ensure that the baseline of the display is still on the bottom graticule line.)

h. Repeat these steps until the 2 dB/DIV display is calibrated (see Fig. 2-4), then return the RF Attenuator to 0 dB (REFERENCE LEVEL -30 dBm). Ensure that the -30 dBm signal is 8 divisions in amplitude.

### NOTE

An alternate method of calibrating the display is to switch between the 10 dB/DIV and 2 dB/DIV display modes while adjusting the LOG CAL so the display amplitudes are equal, then adjust the AMPL CAL so the display amplitude, in 2 dB/DIV mode, equals -30 dBm reference. Check the final calibration in the 2 dB/DIV mode.

i. Switch the display modes from 2 dB/DIV to 10 dB/DIV, then from 2 dB/DIV to LIN. Signal amplitude reference level should not change more than 2 dB from 2 dB/DIV to 10 dB/DIV, or 0.5 division from 2 dB/DIV to LIN mode.

## 5. Check the 10 dB/DIV and LIN Mode Display Operation

a. After completing the LOG CAL and AMPL CAL adjustments, described in step 4, depress the 10 dB/DIV button. Ensure that the RF Attenuator is at 0 dB and the Gain selector is fully ccw so the REFERENCE LEVEL reads -30 dBm.

b. Switch the FREQ SPAN/DIV to 1 MHz and the RESOLUTION to .3 MHz. Tune the 50 MHz marker to the graticule center.

c. Increase the RF Attenuator setting in 10 dB steps and note that the signal amplitude decreases 1 division each step.

d. Switch the RF Attenuator back to 10 dB, and depress the LIN display mode button.

e. Ensure that the baseline of the display is at the bottom graticule line, and the 50 MHz signal is centered, then adjust the VARIABLE Gain control for a signal amplitude of 6.3 divisions.

f. Switch the RF Attenuator to 20 dB to add 10 dB of attenuation, and note that the signal amplitude decreases

to approximately 2 divisions for a ratio change of 3.16 (this is equivalent to 10 dB in LIN mode).

g. Return the RF Attenuator to 0 dB, the VARIABLE Gain control to CAL. The signal amplitude should return to full screen and the REFERENCE LEVEL should indicate -30 dBm.

### 6. Adjust Contrast and Check Baseline Clipper Operation

**NOTE**

*The contrast ratio between the clipped portion of the display baseline and the rest of the display is affected by the sweep rate, frequency span, resolution, and ambient light.*

a. With the BASELINE CLIPPER control set midrange, adjust the CONTRAST control for the desired ratio between the clipped or subdued portion and the rest of the display. Usually the contrast is adjusted so the clipped baseline portion is just visible.

b. Adjust the BASELINE CLIPPER control so the baseline is subdued. If there is excessive noise it may be desirable to clip noise level as well.

## USING THE ANALYZER

### 1. Signal Application

The RF INput impedance to the 7L13 is 50 Ω. At high frequencies, impedance mismatches between the RF INput and the signal source can cause reflections in the transmission line and degrade instrument performance. Flatness, sensitivity, spurious response, etc., are all affected. To reduce mismatch, use good quality 50 Ω coaxial cable to connect the signal source to the RF INput and keep the cable as short as possible. Cable losses become excessive above frequencies of 1 GHz.

Avoid applying high level signals (above -30 dBm) to the 1st mixer of the 7L13. High level signals overload the mixer and may produce spurious signals. A conversion chart shown in Fig. 2-5 will aid in determining input signal level, in dBm, μV, and μW, from a voltage or power source.

**CAUTION**

*The input maximum power level to the RF Attenuator is 1 watt average or 200 watts peak. When the RF input signals are riding on a dc potential, use the dc block (Part No. 015-0221-00), to prevent the dc from reaching the 1st mixer. When the signal source is 75 Ω and you are using the 75 to 50 Ω minimum loss attenuator, a dc block is not required because one is incorporated in the attenuator.*

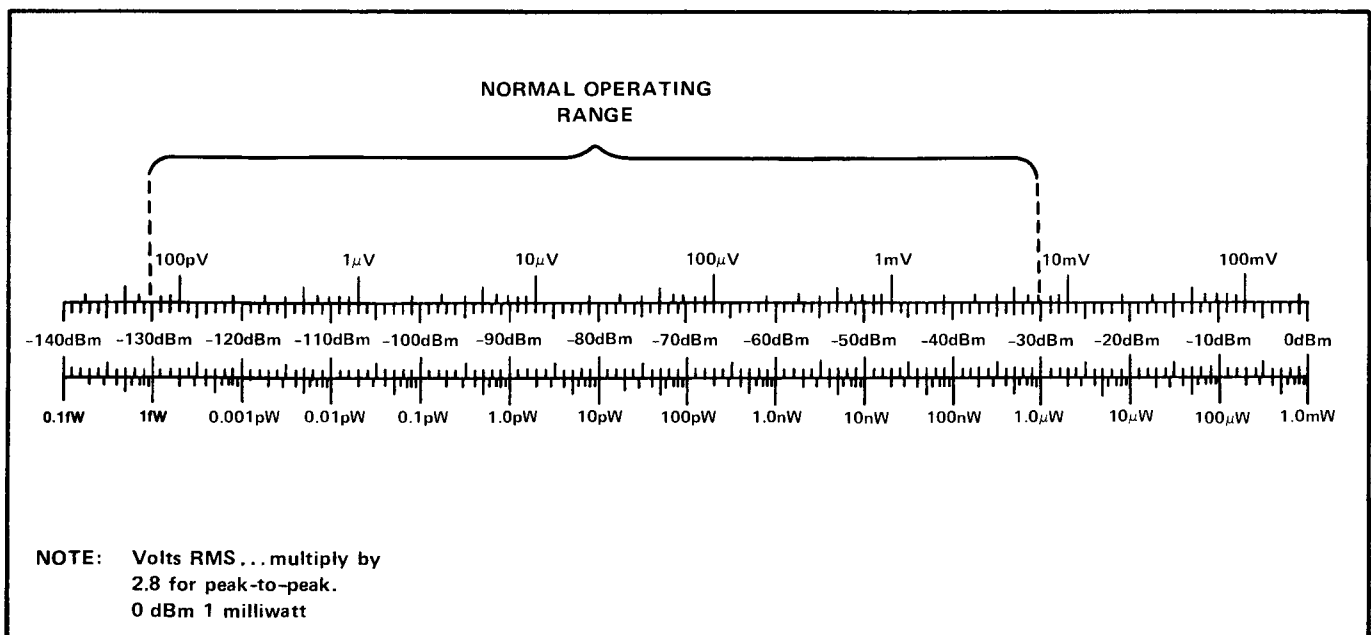


Fig. 2-5. Volts-dBm-Watts conversion chart for 50 Ω impedance.

## Operating Instructions—7L13

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

The 7L13 can be used with a 75 Ω signal source by using a 75 Ω to 50 Ω minimum loss attenuator. This attenuator is available as an optional accessory (refer to the optional accessories list in the catalog or Accessory page in the manual for ordering information). Sensitivity and power levels are often rated in dBm (dB with reference to 1 mW regardless of impedance). Sensitivity and power levels for 75 Ω systems are usually rated in dBmV (dB with reference to 1 mV across 75 Ω). Fig. 2-6 is a circuit diagram of a suitable matching pad for this purpose. The conversion from dBmV to dBm, and dBm (75 Ω) to dBm (50 Ω) through the matching attenuators, is shown in Fig. 2-7 and described as follows:

[1] (dBmV, into 75 Ω) - (dBm, at 50 Ω end) = 54.46 dB or dBmV = 54.5 dB + dBm. For example: -30 dBm @ 50 Ω = 54.5 dB + (-30 dBm) or + 24.5 dBmV at the 75 Ω input.

[2] dBm @ 75 Ω = dBm @ 50 Ω + 5.72 dB. For example: -30 dBm @ 50 Ω + 5.72 dB = 24 dBm @ 75 Ω.

[3] For some applications you may wish to know the relationship between dBm and dBμV. For 50 Ω systems  $\text{dB}\mu\text{V} = (\text{dBm}) + 107 \text{ dB}$ .

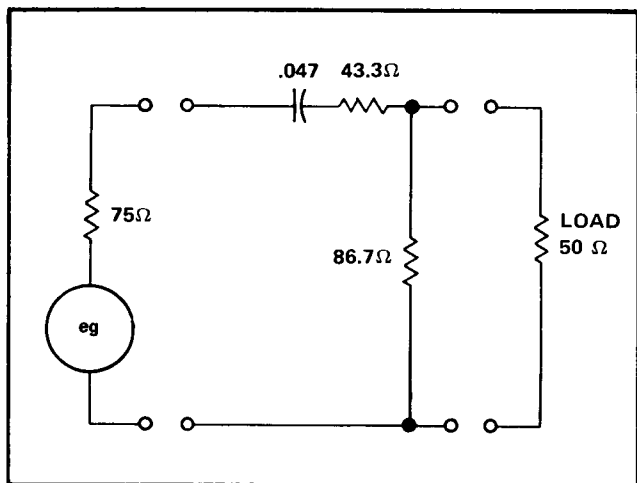


Fig. 2-6. Circuit of a 75-Ω to 50-Ω matching pad (ac coupled).

## 2. Resolution, Sensitivity, and Frequency Span

Resolution is the ability of a spectrum analyzer to discretely display adjacent signals within a frequency span. This resolution ability is a function of analyzer

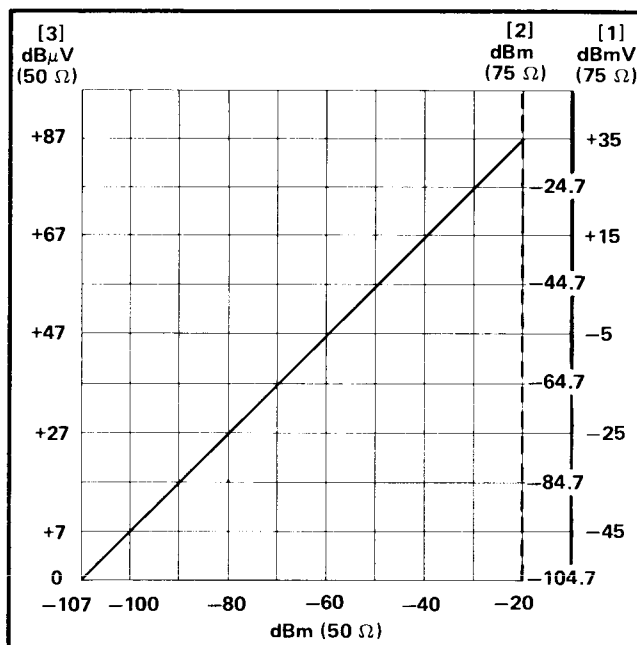


Fig. 2-7. Graph to illustrate relationship between dBm, dBmV, and dBμV.

bandwidth, sweep speed, frequency span, and incidental FM. The frequency span and sweep time are adjusted for minimum bandwidth to a cw signal. Theoretically, resolution and resolution bandwidth become synonymous at very long sweep times.

Resolution bandwidth is measured and specified for the 7L13 as the bandwidth (separation) at the 6 dB down point on the signal.

As the analyzer sweep rate is increased, the signal amplitude will decrease and bandwidth will increase, signifying that both sensitivity and resolution have been degraded.

The best resolution with no video filter, for a given frequency span and sweep time is expressed as:

$$R_o = \sqrt{\frac{\text{Frequency Span (in kHz)}}{\text{Sweep Time (in ms)}}$$

Bandwidth determines both noise level and the resolution capability of the analyzer. As the bandwidth decreases, the signal-to-noise level and, therefore, sensitivity increases. Maximum sensitivity, therefore, is obtained at the higher resolution settings.

The frequency span is symmetrical about the center frequency. The frequency span to be used, depends on the application. Wide frequency spans are used to monitor a



frequency spectrum for spurious signals, check harmonic distortion, etc. Narrow frequency spans are used to identify a particular signal; check its characteristics such as modulation, bandwidth, etc.

When wide frequency spans are displayed, sweep rate is usually increased to eliminate flicker; this requires the use of wide resolution bandwidths. When narrow frequency spans are used, high resolution capability is usually desired and slow sweep speeds are required.

The FREQ SPAN/DIV and RESOLUTION selectors for the 7L13 are normally coupled together to optimize resolution for the frequency span selected; however, either can be independently set by pulling out the "PULL TO UNLOCK" sleeve around the FREQ SPAN/DIV selector.

An UNCAL indicator will light when the sweep time is too fast for an amplitude calibrated display. Sweep speed should be reduced to maintain a calibrated reference level if the UNCAL indicator lights.

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

### 3. Gain Desensitization Near 0 Hz

If the Gain selector is set for a REFERENCE LEVEL that is  $-50$  dBm or more (e.g.,  $-60$  dBm) with the RF Attenuator at 0 dB, a decrease in sensitivity will be noticed below 1 MHz. This effect is caused by the 0 Hz response overdriving the 1st IF amplifier. If you are operating between 0 Hz and 2 MHz, do not set the Gain selector in this region.

### 4. Using the Video Filter

The video filter is used for effective averaging of distributed signals, such as noise, and high frequency components on the display (see Fig. 2-8). When signals are closely spaced, the filter may be useful in reducing modulation between the two signals so they can be more easily analyzed. The filters can also be used to average the envelope of pulsed RF spectra that has a relatively high PRF (pulse repetition frequency); however, because the filter is basically an integrating circuit, low PRF signals produce poor results.

The use of the video filter may require a reduction in sweep speed in order to maintain a calibrated display.

Again, the UNCAL indicator will light if the sweep speed is too fast for the video filtering, RESOLUTION and FREQ SPAN/DIV selected.

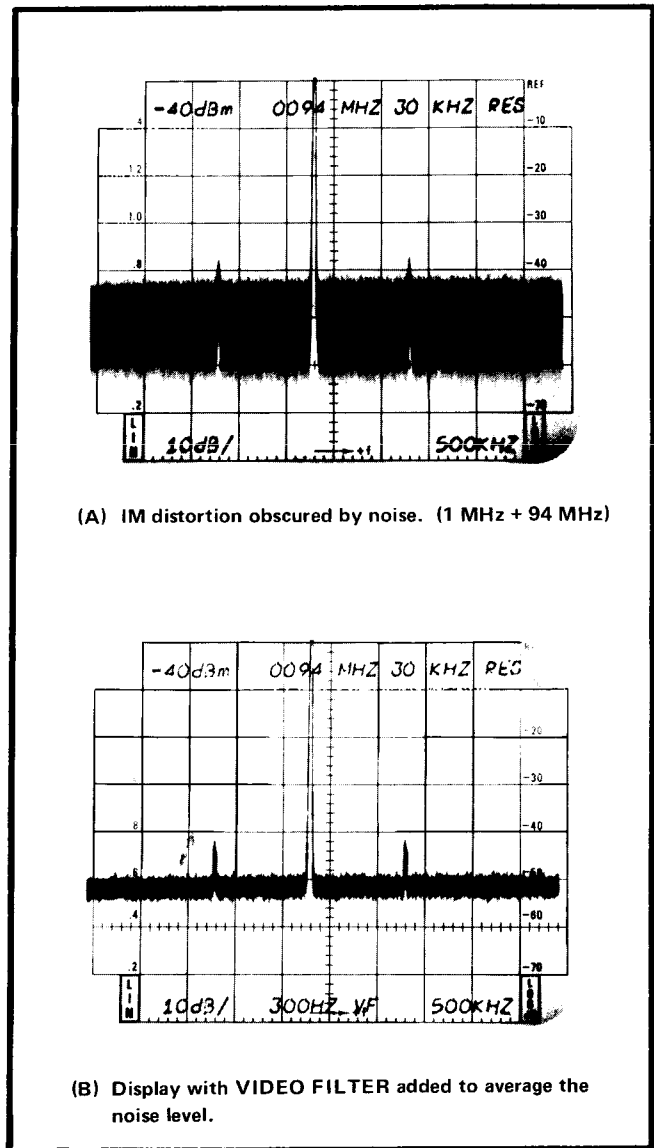


Fig. 2-8. Integrating the display with the VIDEO FILTER.

### 5. Selecting Sweep Rate

Because the FREQ SPAN changes the resolution and sensitivity, the sweep rate must be decreased as the frequency span and resolution bandwidth are decreased, or when the UNCAL indicator lights. When the FREQ SPAN is reduced to 0, the analyzer functions as a fixed tuned receiver. The analyzer now displays time domain characteristics of the signal, within the bandwidth capabilities of the analyzer. Sweep Time/Div can now be used to examine or analyze such characteristics as modulation pattern, pulsed repetition rates, etc.

## Operating Instructions—7L13

### NOTE

*The RESOLUTION bandwidth should be maximum for time domain analysis.*

## 6. Triggering the Display

The sweep trigger source is usually switched to the FREE RUN mode for normal spectrum displays; however, it may be desirable or necessary to trigger the display when the event is time related to some source, or when the frequency span has been reduced to zero and a time domain analysis is performed.

The sweep can be triggered from the vertical or video signal from either vertical plug-in compartment, from the power line voltage, or from an external source. Trigger slope for any mode can be + or -; the triggering level is adjustable over the full range of a displayed signal when using INTERNAL trigger source, over a 10 V range of an external signal when using EXTERNAL source, and over the peak-to-peak range of the line signal when using LINE.

In the NORM triggering mode, the display is triggered when the triggering signal source is within specifications. If the triggering signal is absent or outside of specifications, the sweep recurs automatically to provide a display baseline.

The amplitude of triggering signal that is required to trigger the sweep depends on the sweep mode selected. The internal signal is ac coupled; the line and external signals are dc coupled. Trigger sensitivities are: 1)  $\leq 0.5$  division of signal (peak-to-peak) and  $\leq 0.5$  volt (peak-to-peak) of external signal for NORM mode. 2)  $\leq 0.5$  division of signal (peak-to-peak) and  $\leq 0.5$  volt (peak-to-peak) of external signal for SGL SWP mode.

Maximum safe trigger input signal level to the EXT INPUT is 50 volts (dc + peak ac).

In the FREE RUN state, the sweep will not synchronize with any input trigger signal.

When the SGL SWP button is depressed, the sweep will run after the adjoining button is depressed. During the sweep cycle, the activating button lights to indicate that the sweep is running. This feature is useful when photographing displays at slow sweep rates. The activating button does not arm the trigger circuit like some time base units.

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

## 7. Manual Scan of the Spectrum

This position is used to examine a particular point or portion of the display, such as one of the null points of a frequency modulation spectrum.

a. Calibrate the sweep span with the TIME/DIV selector in one of the scan positions as previously described, then switch to the MANUAL position.

b. Use the MANUAL SCAN control to scan the selected frequency spectrum.

## 8. Using an External Sweep Source

A signal source is required to sweep the analyzer externally. A voltage ramp from 0 V to 10 V  $\pm 1$  V will sweep the analyzer through its full span. 0 V corresponds to 0 Hz and 10 V to the high frequency end of the selected span. Input impedance is approximately 12 k $\Omega$  for an external sweep signal.

Before switching to external operation, calibrate the sweep span using the internal sweep and the 50 MHz calibrator signal as described under Operational Check. Switch the TIME/DIV selector to its EXT position and apply the external voltage to the EXT IN HORIZ/TRIG jack. Adjust the upper end of the voltage (10 V) until the analyzer sweep span is calibrated.

### NOTE

*The frequency deviation across the selected span is a linear function (within 20%) of the input voltage, so +5 V dc should tune the analyzer to the center of the selected frequency span.*

## 9. External Trigger Operation

This procedure is applicable when an external trigger source, such as a pulse generator or modulator, is used to trigger the display so it can be synchronized to an event (e.g., measuring PRF of a radar signal).

a. Apply the trigger signal ( $\geq 0.5$  V peak) to the EXT IN HORIZ/TRIG jack of the 7L13. Switch the TRIGGERING SOURCE to EXT and the TIME/DIV selector to the desired sweep rate.

b. Adjust the triggering SLOPE and LEVEL for the desired triggering point.

c. If time domain information is desired, reduce the FREQ SPAN/DIV to 0 and set the RESOLUTION to 3 MHz.

The analyzer is now triggered by the external source so the display sweep rate can be controlled externally.

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

The accuracy of frequency measurements may be improved by using harmonics of the crystal controlled Calibrator. The Calibrator accuracy is within 0.01%. Frequency measurements within 2 MHz are possible by using either of the two methods described below.

**Measuring the Frequency Span between a Calibrator Marker and the Signal to Obtain an Absolute Frequency Measurement**

a. Tune the signal to the center graticule line, approaching this point from the low frequency side of the display. Couple the **FREQ SPAN/DIV** and **RESOLUTION** selectors together and open up the display to obtain an accurate setting, by reducing the **FREQ SPAN/DIV** to 5 MHz and increasing **RESOLUTION** to .3 MHz. Adjust **SWP CAL**, if necessary, to calibrate the display for 10 divisions between the 50 MHz calibration markers. (Remember to approach the center point from the low frequency side.)

b. Connect the **CAL OUT** signal and the signal source through a BNC "T" connector to the **RF IN**put so both signal and markers are displayed.

c. Measure the frequency span between the signal and the nearest 50 MHz marker. (Frequency span is 5 MHz/Div.)

d. Add or subtract the frequency span to the respective marker to obtain the signal frequency. Since the maximum frequency span between the signal and marker is 25 MHz  $\pm 5\%$ , marker accuracy is 0.01% and human observation error is approximately 1/2 a minor division or 0.5 MHz. The accuracy using this method is within 2 MHz.

**Measuring the Frequency after the Frequency Readout Correction Factor Has Been Established**

a. As described for the frequency span method, tune the signal to the graticule centerline, opening the display to 5 MHz/Div to obtain an accurate setting. Tune the signal to the center from the low frequency side.

b. Note the frequency readout (e.g., 1002 MHz).

c. Apply the **CAL OUT** signal to the **RF IN**put and tune the nearest 50 MHz marker to the graticule centerline.

d. Set the frequency readout, with the **CAL** adjustment to read the exact frequency (e.g., 1000 MHz).

e. Retune to the unknown signal, approaching it from the low side and note the frequency readout.

**Measuring Absolute Signal Levels**

Since the top of the graticule is a calibrated **REFERENCE LEVEL** and the graticule is calibrated in dB/DIV, as described in the Preliminary Front Panel Calibration procedure, at the beginning of this section, it is easy to measure the absolute level of most signals.

a. Calibrate the graticule as previously described in step 4 of the Operational Check procedure. Ensure that the **REF VARI**able (gain) control is in its **CAL** detent.

b. Connect the signal source to the **RF IN**put, as described under Signal Application. Switch to the 10 dB/DIV or 2 dB/DIV display mode.

*NOTE*

*For maximum accuracy, use the same cable that was used to calibrate the REFERENCE LEVEL and use the 2 dB/DIV display mode.*

c. Select a **REFERENCE LEVEL** with the **RF Attenuator** and gain selector to bring the signal, to be measured, within the screen or graticule window.

*NOTE*

*If you are operating in the 10 dB/DIV mode, the gain selector must be within the blue sector.*

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

*NOTE*

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

## Operating Instructions—7L13

### Accurate Signal Level Difference Measurements in dB

a. Using the 2 dB/DIV display mode, position the top of the lowest amplitude signal to a reference line within the graticule area with the REF VARIABLE or VERTICAL POSITION controls. If display noise is excessive, use the VIDEO FILTER and reduce the sweep speed to maintain signal amplitude, or decrease the RESOLUTION bandwidth.

b. Use the RF Attenuator selector to reduce the amplitude of the larger signal until it is within the graticule area, and note the increased attenuator reading.

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

### Measuring Relative Signal Amplitude in LIN Display Mode

The vertical scale on the spectrum analyzer graticule is calibrated in dB for LOG display and in increments of 0.2 for the LIN display. Relative signal levels can be made by adjusting the amplitude of one signal with the gain and attenuator controls to 1.0 division, then directly reading from the graticule, the amplitude of the other signals as a percentage of this reference.

### Using the Analyzer Below 100 kHz

The sensitivity of the analyzer degrades about 0.3 dB/kHz below 100 kHz; for example, the sensitivity is about -113 dBm at 50 kHz with 30 Hz resolution. Reference level operation becomes limited to -50 dBm as the center frequency approaches 1 kHz, because of the LO energy that exists in the 1st IF pass-band.

Figure 2-9 shows the performance of the 7L13 below 10 kHz. The center frequency is 2.5 kHz, with zero hertz marker visible at the extreme left graticule. Two signals were applied simultaneously to the input, one at 2.5 kHz and one at 3 kHz.

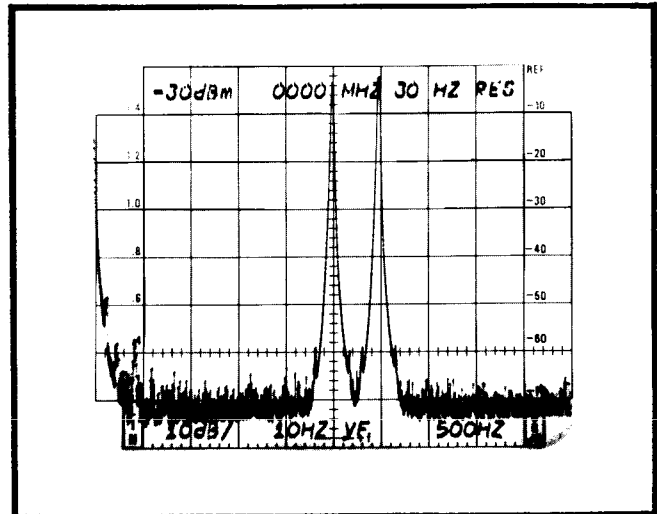


Fig. 2-9. Illustrating the dynamic range and performance at a center frequency of 2.5 kHz.

## APPLICATIONS

Applications for the spectrum analyzers, such as the 7L13, include: measuring intermodulation products, cross modulation, radiation interference, modulation percentage, modulation index, absolute and relative signal levels, etc. A treatise on measurement and signal evaluation is provided in the Tektronix Measurement Concept booklet, "Spectrum Analyzer Measurement Theory"; Part No. 062-1334-00, and Spectrum Analysis and CATV Systems brochure A2515. If you desire assistance for a specific application or current information on additional applications, contact your local Tektronix Field Office or representative.

# PERFORMANCE CHECK

## Introduction

This section consists of two parts; an operational checkout procedure for instrument familiarization and incoming inspection, and a performance check that verifies that the instrument meets specification characteristics. The first part requires the minimum of test equipment; the second part requires test equipment that will serve as a standard to verify instrument specifications. Performing this procedure will indicate if and what circuits in the instrument need calibration. We recommend performing the checks as part of your routine maintenance program.

## OPERATIONAL PERFORMANCE AND INSTRUMENT FAMILIARIZATION

This portion of the section contains a sequence of procedures that will check the operational performance of the 7L13. It provides an adequate incoming performance inspection and a good familiarization of the instrument operation. Because the 7L13 calibrator is a very accurate signal source and the RF attenuator an accurate step attenuator, they are used as the reference for this part of the check. If you wish, their accuracy can be checked by referring to the second part of this section.

## Equipment Required

The following fixtures and equipment are required for this part of the performance check. These are available through your local Tektronix Field Office or representative.

1. 80 dB of attenuation, in 20 dB increments: Four (4) 10X (20 dB) attenuators, Tektronix Part No. 011-0059-01.

2. BNC to pin-jack adapter cable. Used to apply signals to the EXT IN connectors. Tektronix Part No. 175-1178-00.

### 1. Preliminary Preparation

Perform the Preliminary Front Panel Setup Procedure described in the Operating Instructions and calibrate the 7L13 sweep to the oscilloscope deflection sensitivity. Adjust the contrast ratio between the clipped (subdued) baseline and the remaining display.

### CAUTION

*The 1st and 2nd LO OUT ports must be terminated into 50  $\Omega$  at all times. For optimum performance, keep the termination caps in place when these ports are not used.*

### 2. Check the 10 dB/DIV and LIN Mode Calibration

a. Switch the RF Attenuator to 0 dB and turn the Gain selector fully ccw, so the REFERENCE LEVEL readout is  $-30$  dBm. Ensure that the REF VARIable control is in its CAL detent. Set the FREQ SPAN/DIV to 10 MHz and the RESOLUTION bandwidth to 0.3 MHz.

b. Apply the Calibrator signal to the RF INput and tune the fundamental 50 MHz signal to center screen.

c. Reduce the FREQ SPAN/DIV setting to 5 kHz and the RESOLUTION bandwidth to 3 kHz, keeping the signal centered on screen with the TUNING control.

d. Position the top of the signal to the top graticule line with the VERTICAL POSITION control to establish a reference level.

e. Increase the RF Attenuator settings in 10 dB increments, noting that the signal amplitude decreases  $1 \pm 0.1$  division between steps.

### NOTE

*It may be easier to observe the change if the VIDEO FILTER is switched in. If used, decrease the sweep speed until the UNCAL indicator light goes out.*

f. Since the RF Attenuator range is 60 dB, the last 10 dB step of the 70 dB dynamic range may be checked as follows:

(1) Return the RF Attenuator to 30 dB and add a 20 dB attenuator between the RF INput and CAL OUT signal. Adjust the signal amplitude to some reference line on the graticule with the REF VARIable control.

(2) Increase the RF Attenuator setting 20 dB and note that the signal is still visible above the noise level.

## Performance Check—7L13

The total deviation over the 70 dB dynamic range of the display must not exceed 1.5 dB or 0.75 minor divisions.

g. Remove the 20 dB attenuator and again apply the CAL OUT signal directly to the RF INput. Switch off the VIDEO FILTER and set the RF Attenuator to 10 dB. Set the FREQ SPAN/DIV to 1 MHz and the RESOLUTION to .3 MHz.

h. Change the display mode to LIN. Position the baseline of the display on the bottom graticule line then adjust the 50 MHz signal amplitude with the REF VARIable control so it is 6.3 divisions.

i. Increase the RF Attenuation 10 dB by switching to 20 dB, and note that the signal amplitude decreases to 2.0  $\pm$ 0.6 division for an amplitude change ratio of 3.16:1,  $\pm$ 10%.

j. Return the REF VARIable control to its CAL detent and the RF Attenuator to 0 dB.

### 3. Check the Frequency Readout Accuracy

#### NOTE

*Due to hysteresis in the tuning system (1st LO), the accuracy of the frequency readout should be checked by approaching each check point from the same direction (low to high). The FREQ SPAN/DIV is first switched to MAX SPAN and the center frequency tuned to 0000 before tuning to the desired check point. If for any reason the direction of tuning is reversed, this procedure must be repeated to establish the same point of reference on the hysteresis loop.*

a. Switch the display mode to 10 dB/DIV, the FREQ SPAN/DIV to MAX SPAN and tune the CENTER FREQUENCY to 0000. With the Calibrator signal applied to the RF INput, decrease the FREQ SPAN/DIV to 1 MHz and increase the CENTER FREQUENCY readout towards 50 MHz until the 50 MHz signal is centered on screen. (The signals will move from right to left as the frequency is increased.)

b. Adjust the front panel CAL for a CENTER FREQUENCY readout of 50 MHz.

c. Tune the CENTER FREQUENCY from low to high, checking the accuracy of the readout in 50 MHz increments. Readout accuracy, when the signal is centered on the screen, should be within  $\pm$ (5 MHz + 20% of the FREQ SPAN/DIV) or within  $\pm$ 5 MHz with a frequency span of 1 MHz/DIV.

### 4. Check the Range of the REF VAR control, the Range of the Gain Selector and Gain Accuracy of the 10 dB GAIN pushbutton. (Accuracy within $\pm$ 1 dB/10 dB step. Variable range $\approx$ 10 dB.)

a. Switch the display mode to 10 dB/DIV, FREQ SPAN/DIV to 0.5 MHz and the RESOLUTION bandwidth to 30 kHz. Apply the CAL OUT signal to the RF INput and tune the 50 MHz signal to the center of the screen then decrease the FREQ SPAN/DIV to 50 kHz keeping the signal centered with the TUNING control.

b. Switch the 30 kHz VIDEO FILTER in, turn the Gain selector ccw and switch the RF Attenuator to 50 dB to establish +20 dBm REFERENCE LEVEL.

c. Position the top of the signal at the 4th graticule line (center screen) with the VERTICAL POSITION control.

d. Check the REF VAR control range by turning it fully cw from its CAL detent. Gain increase should equal approximately 10 dB or the signal amplitude should increase 1 division. Return the REF VAR control to its CAL detent.

e. Position the top of the 50 MHz signal at the 6th graticule line from the reference level (top of graticule), with the VERTICAL POSITION control.

f. Check the Gain selector accuracy of the three 10 dB steps for the 10 dB/DIV display mode (blue sector). Accuracy between steps must equal 10 dB  $\pm$ 1 dB.

g. Decrease the RF Attenuator to 40 dB so the REFERENCE LEVEL is  $-20$  dBm. Change the display mode to 2 dB/DIV and position the top of the signal at the 5th graticule line from the reference, with the VERTICAL POSITION control.

h. Increase the Gain selector setting 10 dB (one step). Check that the signal amplitude increases 10 dB  $\pm$ 1.0 dB or 5 div  $\pm$ 0.5 div.

i. Increase the RF Attenuator setting to 50 dB, and if necessary, reposition the top of the signal to the 5th graticule line from the reference. Check the accuracy of the next 10 dB step of the Gain selector.

j. Increase the RF Attenuator setting to 60 dB and check the accuracy of the next 10 dB step of the Gain selector.

k. Return the RF Attenuator to 50 dB. Insert a 50 Ω, 20 dB (10X) attenuator between the CAL OUT signal and the RF INput.

l. Position the top of the 50 MHz signal at the 6th graticule line from the reference with the VERTICAL POSITION control and check the accuracy of the final 10 dB step of the Gain selector.

m. Insert four (4) 20 dB attenuators, for a total of 80 dB, in series with the Calibrator signal and switch the RF Attenuator to 0 dB so the REFERENCE LEVEL is -100 dBm.

**NOTE**

*The signal level into the 1st mixer is now approximately -100 dBm.*

n. Reduce the FREQ SPAN/DIV to 0.2 kHz and the RESOLUTION bandwidth to 30 Hz, keeping the 50 MHz signal on screen with the TUNING control. Reduce the sweep speed if necessary, until the UNCAL indicator light goes out.

o. Position the top of the signal to a reference line with the VERTICAL POSITION control (6th from the top is usually the most convenient).

p. Check for an additional 10 dB of gain when the 10 dB GAIN pushbutton is depressed.

q. Return the REFERENCE LEVEL to -30 dBm, remove the 80 dB of attenuation and reconnect the calibrator signal to the RF INput.

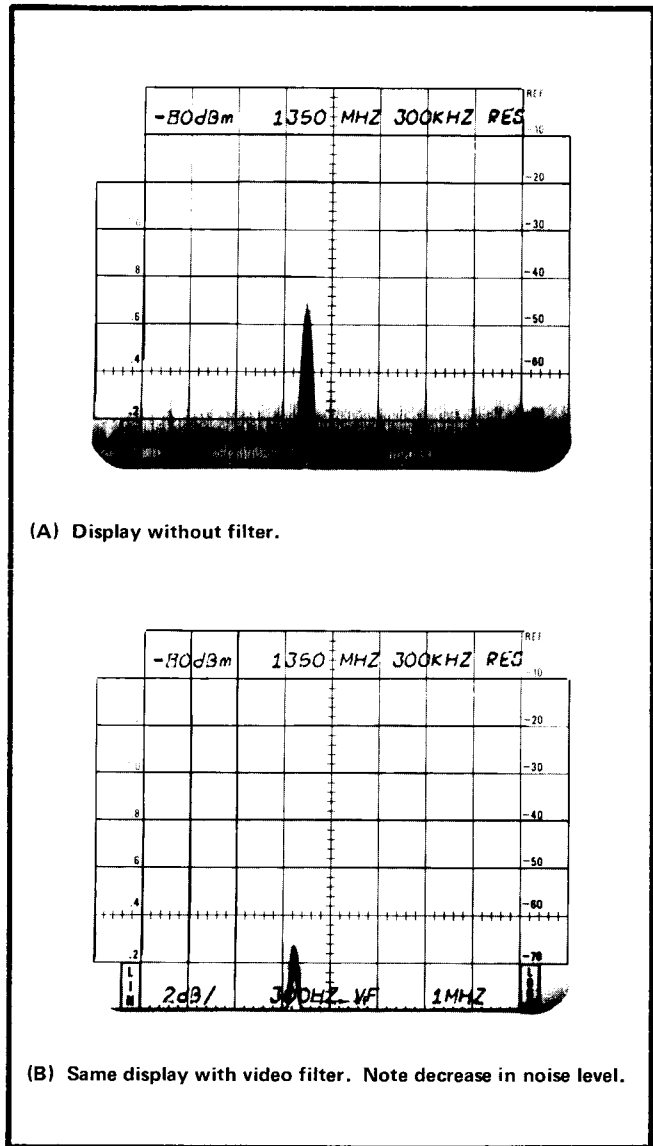
**5. Check the Operation of the VIDEO FILTERS**

The VIDEO FILTERS reduce or average the noise level on the display. See Fig. 3-1. Tune to one of the Calibrator signals and check the operation of the filters with RESOLUTION settings of 3 MHz and 3 kHz.

**6. Check Sensitivity** (-128 dBm to -80 dBm, depending on the resolution bandwidth)

**NOTE**

*Sensitivity is measured in the LIN mode, and is based on a signal amplitude that equals two times the noise level.*



**Fig. 3-1. Video Filter operation.**

a. Apply the CAL OUT signal to the RF INput and switch the display mode to LIN. Uncouple the FREQ SPAN/DIV selector from the RESOLUTION selector and set the span for 2 MHz/DIV with a RESOLUTION of 3 MHz. Switch the RF Attenuator to 0 dB and turn the Gain selector fully ccw so the REFERENCE LEVEL readout equals -30 dBm.

b. Tune to the 50 MHz fundamental signal and position the baseline of the display on the bottom graticule line. Verify that the signal amplitude is 8 divisions or -30 dBm signal level.

c. Increase the RF Attenuator setting to 50 dB so the signal level into the 1st mixer of the 7L13 is now -80 dBm (-30 dBm calibrator signal reduced 50 dB by the RF Attenuator).

## Performance Check—7L13

d. Measure the instrument sensitivity (at 50 MHz) with a resolution bandwidth of 3 MHz as follows:

(1) Adjust the Gain selector and REF VARIABLE control settings for a noise level of 1 division, in the LIN display mode. Switch the 300 Hz VIDEO FILTER in, to average the noise level. Decrease the sweep speed if the UNCAL indicator lights.

(2) Compare the signal amplitude to the noise level. Signal amplitude must equal or exceed 2X the noise level (see Fig. 3-2A).

e. Disconnect the CAL OUT signal to the RF INPUT, return the REF VAR to its CAL detent and switch the RF Attenuator to 0 dB. Set the Gain selector, if necessary, so the REFERENCE LEVEL reads -60 dBm, then switch the display mode to 10 dB/DIV.

f. Note or check the average noise level over the 20 MHz span. Noise level should be down 20 dB or more from the 60 dBm REFERENCE LEVEL (2nd graticule line from the top).

Since sensitivity is a measure of signal-to-noise amplitude [(S + N)], the noise floor is indicative of the sensitivity value. This was verified in step d; therefore, the average noise level should appear within or below the specified sensitivity level (see Fig. 3-2B).

### NOTE

*Because the gain and noise floor of the display are referenced to the top line of the graticule, the noise floor may shift with Gain selector changes.*

g. Switch the display to LIN mode, turn the Gain selector fully ccw and the REF VAR control to its CAL detent. Position the base of the display on the bottom graticule line then switch the display mode to 10 dB/DIV.

h. Switch the RF Attenuator to 0 dB and increase the Gain selector setting for a REFERENCE LEVEL readout of -60 dBm (Gain selector must be in the blue sector).

i. Reduce the FREQ SPAN/DIV to 1 MHz and the RESOLUTION bandwidth to .3 MHz. Note the average noise level below -60 dBm. Sensitivity for a resolution bandwidth of 0.3 MHz must equal or exceed -90 dBm (noise floor should be 30 dB below the reference level, or below the 3rd graticule line from the top).

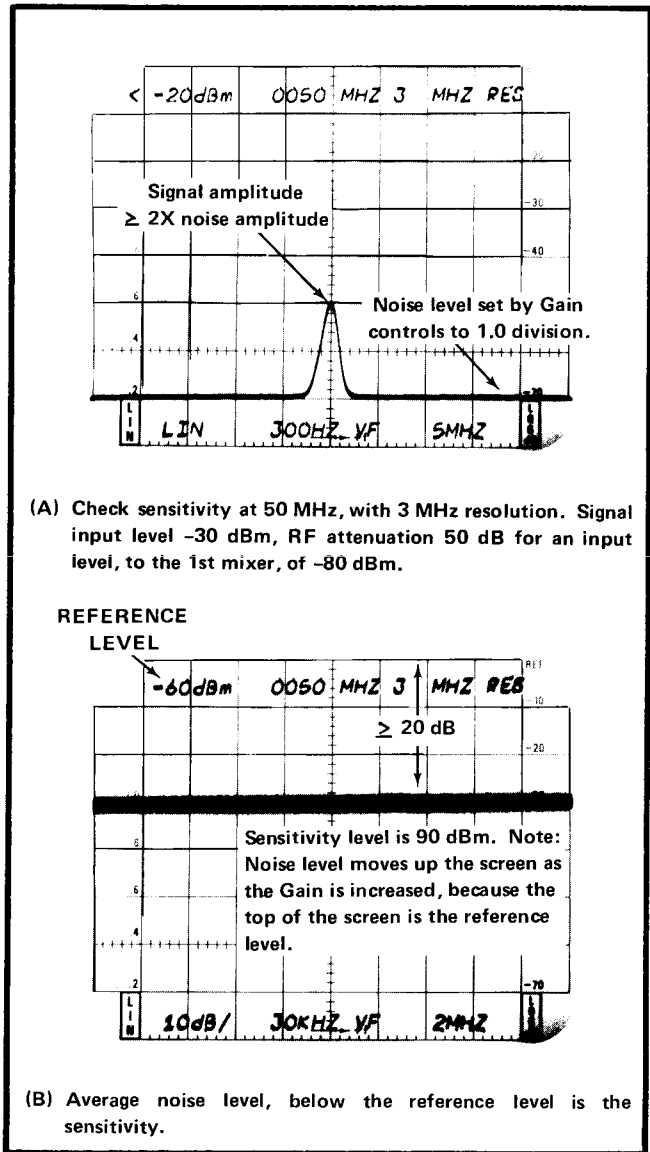


Fig. 3-2. Measuring sensitivity.

j. Decrease the FREQ SPAN/DIV to 10 kHz and the RESOLUTION bandwidth to 30 kHz. The noise floor must be below the 4th graticule line or -100 dBm (-60 dBm + 40 dB).

k. Decrease the RESOLUTION bandwidth to 3 kHz and again note the noise level. Noise floor must be below the 5th graticule line from the reference, or -110 dBm. It may be desirable to switch in 10 Hz of video filtering by depressing both VIDEO FILTER pushbuttons. Reduce the sweep speed if the UNCAL indicator lights.

l. Decrease the RESOLUTION bandwidth to 300 Hz and again note the noise level. The average noise level must be below the 6th graticule line for a sensitivity that equals or exceeds -120 dBm.



m. Decrease the RESOLUTION bandwidth to 30 Hz and the FREQ SPAN/DIV to 0.5 kHz. Note that the noise floor is 6.8 or more divisions below the reference level for a sensitivity of  $-128$  dBm or better.

## NOTE

*If the Gain selector is set so the REFERENCE LEVEL is  $-50$  dBm or more (e.g.,  $-60$  dBm) with the RF Attenuator at 0 dB, a decrease in sensitivity will be noticed below 1 MHz. This effect or desensitization, is caused by the 0 Hz response overdriving the 1st IF amplifier. If you are operating in this frequency range do not set the Gain selector this high.*

### 7. Check for Spurious Signals from Internal Sources (Residual Responses). ( $\leq -100$ dBm, referred to the RF Input)

a. Remove any signal connected to the RF Input so it is free of signals from any external source. Switch the RF Attenuator to 30 dB to further isolate the 1st mixer from the input.

b. Switch out the VIDEO FILTER, turn the Gain selector fully ccw and ensure that the REF VARIABLE control is in its CAL detent. The REFERENCE LEVEL will now read 0 dBm. The signal level at the 1st mixer of the 7L13 however represents  $-30$  dBm, because the RF Attenuator subtracts an additional 30 dB.

c. Set the FREQ SPAN/DIV to 1 MHz and the RESOLUTION bandwidth to 30 kHz. Switch the TIME/DIV to 50 ms or less so the UNCAL indicator is not lighted.

d. Switch to the 2 dB/DIV display mode, verify that the trace is on the bottom graticule line, then switch the display mode to 10 dB/DIV. The dynamic range of the graticule is now a calibrated 10 dB/DIV, with the top line representing  $-30$  dBm into the 1st mixer as described in step b.

e. Tune slowly across the frequency band (0 to 1.8 GHz) checking for spurious signals. The amplitude of any spurious signal must not exceed  $-100$  dBm (signals above the 7th graticule line from the top). NOTE: Subtract 2 dB for noise which will be riding on top of the signal. If the spur is marginal (within 3 dB of specifications) and you desire to check its amplitude more accurately, proceed as follows:

(1) Decrease the FREQ SPAN/DIV to 50 kHz or less and the RESOLUTION bandwidth to 3 kHz. (This will decrease the noise with respect to the signal amplitude.) Keep the signal centered on screen with the TUNING control as the FREQ SPAN is decreased.

(2) Decrease the sweep speed if the UNCAL indicator lights. Note the spurious response amplitude and verify that it does not exceed specifications.

f. Return the FREQ SPAN/DIV and RESOLUTION selectors to their original settings (step d).

### 8. Check Resolution Bandwidths and Shape Factor. (Bandwidth 3 MHz to 30 Hz within 20% in decade steps; shape factor 4:1 to 300 Hz except 3 MHz resolution. Maximum bandwidth 60 dB down, with 3 MHz resolution is 13 MHz. Shape factor for 30 Hz is 12:1)

a. Apply the Calibrator signal to the RF Input and set the RF Attenuator to 0 dB. Turn the Gain selector fully ccw for a REFERENCE LEVEL of  $-30$  dBm.

b. Tune the 50 MHz marker to the center of the screen, set the FREQ SPAN/DIV to 1 MHz, and the RESOLUTION bandwidth to 3 MHz.

c. Switch the display mode to 2 dB/DIV and adjust the REF VARIABLE control if necessary, for a full screen display.

## NOTE

*Ensure that the sweep rate is set so the UNCAL light is out and the baseline of the display is on the bottom graticule line.*

d. Check the bandwidth of the signal at the 6 dB down level (see Fig. 3-3A). Bandwidth must equal 3 MHz  $\pm 600$  kHz.

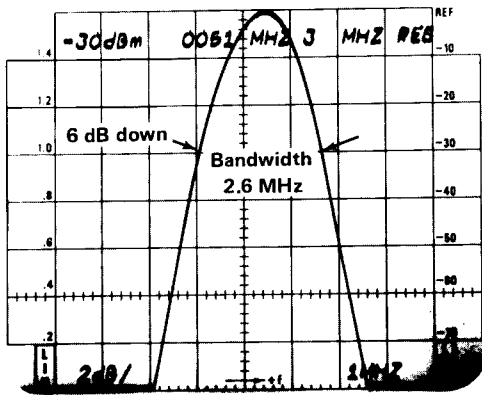
e. Switch the display mode to 10 dB/DIV and the 300 Hz VIDEO FILTER in. Switch the FREQ SPAN/DIV to 2 MHz and check the shaper factor (see Fig. 3-3B).

f. Return the display mode to 2 dB/DIV, decrease the FREQ SPAN/DIV to .1 MHz and the RESOLUTION bandwidth to .3 MHz. Keep the signal centered on screen with the TUNING control as the FREQ SPAN is decreased.

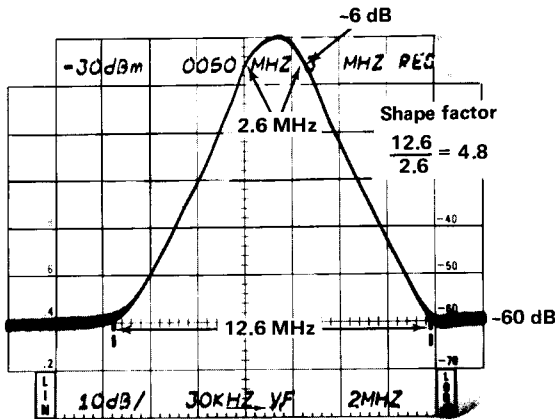
g. Check the bandwidth at the 6 dB down level. Bandwidth must equal 300 kHz  $\pm 60$  kHz.

h. Switch the FREQ SPAN/DIV to .2 MHz, display mode to 10 dB/DIV, and check the shape factor as described in step e.

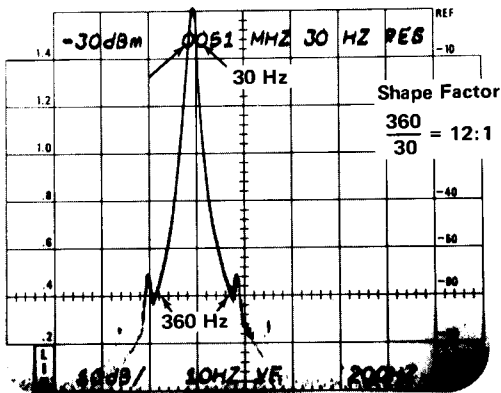
**Performance Check—7L13**



(A) Display mode LOG. Bandwidth measured at 6 dB down level. Resolution 3 MHz. Frequency Span 1 MHz/DIV.



(B) Display mode 10 dB/DIV. Shape factor is ratio of bandwidth at -60 dB to -6 dB levels.



(C) Shape factor of 12:1 with 30 Hz resolution.

1673-14

**Fig. 3-3. Three displays to illustrate how to measure bandwidth and shape factor.**

i. Reduce the FREQ SPAN/DIV to 10 kHz, the RESOLUTION bandwidth to 30 kHz, and the display mode to 2 dB/DIV.

j. Check the bandwidth. Bandwidth must equal 30 kHz  $\pm$ 6 kHz.

k. Reduce the FREQ SPAN/DIV to .2 kHz and the RESOLUTION bandwidth to 300 Hz. Center the display with the TUNING control if necessary.

l. Check the bandwidth of the response at the -6 dB level. Bandwidth must equal 300 Hz  $\pm$ 60 Hz.

m. Switch the display mode to 10 dB/DIV, depress the 30 kHz VIDEO FILTER pushbutton to increase the filtering to 10 Hz. Reduce the sweep speed to 2 s/Div to maintain a calibrated display. Measure the response shape factor.

n. Reduce the RESOLUTION to 30 Hz and change the display mode to 2 dB/DIV. Check the bandwidth at the -6 dB (half screen) level. Bandwidth must equal 30 Hz  $\pm$ 6 Hz.

o. Switch the display mode to 10 dB/DIV and measure the shape factor. Shape factor for 30 Hz resolution must equal 12:1 or better (see Fig. 3-3C).

**9. Check Incidental FM'ing.** ( $\leq$ 10 Hz for any internal sweep rate, when phase locked;  $\leq$ 20 kHz without phase lock).

**NOTE**

*A storage mainframe is desirable when measuring FM'ing.*

a. With the Calibrator signal applied to the RF INPUT, switch the RF Attenuator to 0 dB and the Gain fully ccw. Switch the FREQ SPAN/DIV to 0.1 MHz, RESOLUTION to 30 kHz, display mode to LIN, VIDEO FILTERS off, sweep rate to 20 ms/Div, and the AUTO PHASE LOCKED mode OFF.

b. Tune the CENTER FREQUENCY to one of the 50 MHz markers, then adjust the Gain selector or REF VAR control for a fully screen display. Decrease the FREQ SPAN/DIV to 10 kHz and the RESOLUTION bandwidth to 3 kHz.

c. Check the FM'ing of the displayed marker. FM'ing must not exceed 20 kHz (2.0 div). Fig. 3-4 illustrates one method of measuring FM'ing.

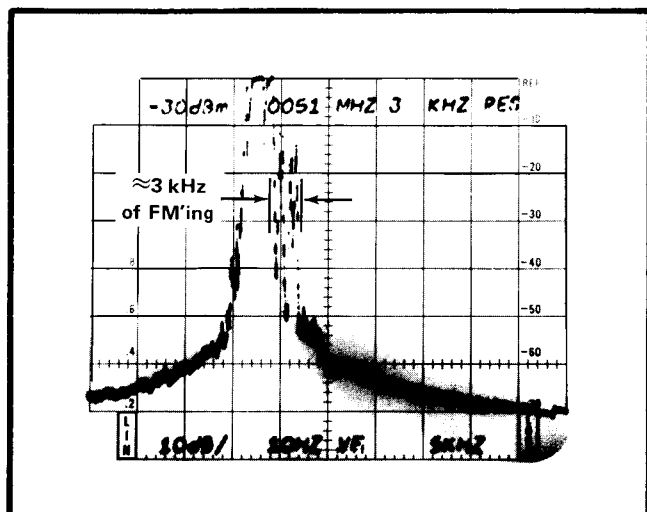


Fig. 3-4. Measuring incidental FM'ing.

d. Switch the AUTO PHASE LOCKED mode on and tune the signal to center screen. Decrease the FREQ SPAN/DIV to .2 kHz and the RESOLUTION to 30 Hz. Decrease the sweep rate to 1 s/Div or until the UNCAL light goes out and add both VIDEO FILTERS so filter bandwidth is 10 Hz. Switch the oscilloscope mainframe to store mode with auto erase, if available.

e. Switch the display mode to 10 dB/DIV. Check the FM'ing for each sweep. 10 Hz is only a trace width at 200 Hz/DIV; however, FM'ing can be checked by noting that the line frequency sidebands are down at least 40 dB from the reference level. See Fig. 3-5.

#### 10. Check Sweep Circuit Operation with the TIME/DIV Selector in the MANUAL and OFF Positions

a. Switch the TIME/DIV to the MANUAL position and rotate the MANUAL SCAN control through its range. Note that the crt beam scans the full 10 division graticule width.

b. Switch the selector to the OFF position and note that the crt beam is now centered on the screen.

c. Return the TIME/DIV selector to 50 ms position for normal operation.

This completes the verification of the major characteristics of the 7L13. The remaining characteristics have indicated by reliability tests that they can be accepted without further checks; however, the procedure to verify these characteristics is contained in the second part of this section. These checks require elaborate test equipment. If you wish to verify the remaining characteristics, continue to the next part of this section.

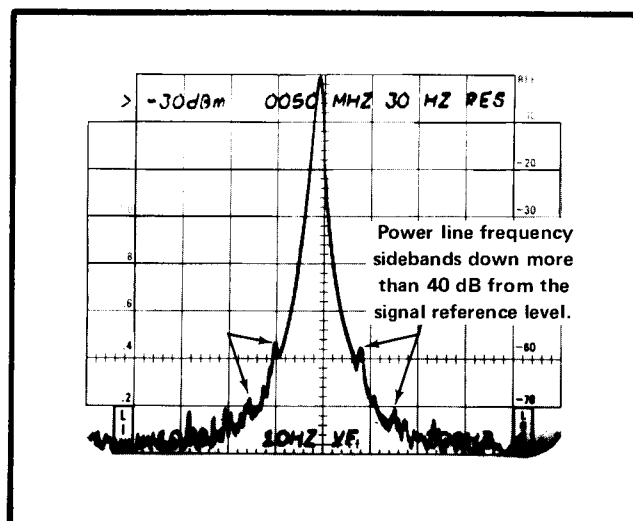


Fig. 3-5. Illustration to show how FM'ing is measured with a resolution bandwidth of 30 Hz.

## PERFORMANCE CHECKS THAT REQUIRE TEST EQUIPMENT

### Introduction

The following procedures check the accuracy of the 7L13 calibrator and RF Attenuator, the display flatness, intermodulation distortion, video output amplitude, sweep triggering operation, sweep Time/Div accuracy, and external sweep operation. It does not include any internal adjustment or checks. If the instrument fails to meet a specified performance requirement, the adjustment procedure for the related circuits will be found under a similar title in the Calibration Procedure, Section 4.

### History Information

The instrument and manual are continually evaluated and updated. Circuits as well as procedures are modified. Procedures and information, applicable to earlier instruments, are included as deviations within these steps or as subparts of the steps. These are indicated in the procedure.

### Equipment Required and Recommended

The following test equipment and fixtures are recommended to perform this portion of the performance check. Test equipment specifications are the minimum for accurate checks. Substitute equipment must meet or exceed these specifications.

Special calibration fixtures are used where necessary to facilitate the procedure. These are available from Tektronix, Inc., and may be ordered through your local Tektronix Field Office or representative.

**Performance Check—7L13**

When equipment is required to check or verify close tolerance specifications, a compromise is made. Any compromise is indicated by a footnote to the equipment

list, along with a statement that the high tolerance specification is not checked because of the compromise.

**TABLE 3-1  
EQUIPMENT LIST**

*NOTE*

*This equipment is also required to recalibrate the instrument.*

EQUIPMENT OR TEST FIXTURE	CHARACTERISTICS REQUIRED	TYPE OR MODEL RECOMMENDED
7000-Series Storage or Variable Persistence Oscilloscope with Readout	Frequency bandwidth: 50 MHz	Tektronix 7313, 7613 mainframe
Test Oscilloscope	Vertical sensitivity: 50 mV/Div to 5 V/Div Bandwidth: 50 MHz	Any Tektronix 7000-Series Oscilloscope with plug-in units for a real time display
Time Mark Generator	Marker outputs: 1 s to 1 $\mu$ s Accuracy: 0.001%	Tektronix 2901 with Harmonic Modulator, Part No. 067-0640-00 (Used to check TIME/DIV and FREQ SPAN/DIV accuracies)
Pulse Generator	Pulse period: 40 $\mu$ s Pulse duration: 0.2 $\mu$ s Pulse amplitude: 0.5 V P-P	Tektronix 2101 Pulse Generator (Used to check PULSE STRETCHER)
Digital Counter	To 50 MHz	Tektronix 7D14 Digital Counter with a readout 7000-Series Oscilloscope and Vertical Amplifier Unit. (Used to check 50 MHz accuracy of the Calibrator)
Signal Generators	Frequency range: 10 Hz to 1.8 GHz.  Output amplitude: 0 V to 5 V (10 Hz to 10 MHz); -110 dBm to 0 dBm (10 MHz to 1.8 GHz). Output variable and calibrated in dBm from 10 MHz to 1.8 GHz. Accuracy $\pm$ 1.0 dB.  LF  HF	Used to check intermodulation, triggering, and flatness characteristics  General Radio Model 1310A or Hewlett Packard Model 202C  Hewlett Packard Model 8651A

TABLE 3-1 (cont)

EQUIPMENT OR TEST FIXTURE	CHARACTERISTICS REQUIRED	TYPE OR MODEL RECOMMENDED
VHF	10 MHz to 480 MHz	Hewlett Packard Model 608D or 608E
UHF	450 MHz to 1230 MHz and 800 MHz to 4500 MHz	Hewlett Packard Model 612A and HP Model 8614A or 8614B
Power Meter with 50 MHz Low Pass Filter; or –30 dBm, 50 MHz Signal Source or Vector Voltmeter <sup>1</sup>	Measure –30 dBm within $\pm 0.1$ dB. Filter must have rolloff $\geq 40$ dB at 100 MHz.  Power source may be calibrated by Power Meter.  Frequency: 50 MHz	General Microwave Model 454A; or Hewlett Packard Model 432A  Hewlett Packard Model 608D or 608E  Hewlett Packard Model 8405A
Two 18 inch 50 $\Omega$ low loss coaxial cables BNC-to-BNC connectors	RG-58C/U	Tektronix Part No. 012-0076-00
Two 10:1 50 $\Omega$ Attenuators		Tektronix Part No. 011-0031-00
BNC "T" connector		Tektronix Part No. 103-0030-00
Pin-jack to BNC Adapter cable; 20 inch	Signal application to the EXT IN pin jacks or connect an external device to the VIDEO OUT jack	Tektronix Part No. 175-1178-00

<sup>1</sup>Three methods are described to check output power level of the Calibrator. Refer to this step in the procedure to determine which test equipment you desire.

## 1. Check the Calibrator Frequency

- a. Frequency check: (Accuracy 50 MHz  $\pm 0.01\%$ )

The frequency of the calibrator may be checked by an accurate frequency counter, such as Tektronix 7D14 Digital Counter Plug-In Unit with a readout 7000-Series oscilloscope and a 50 MHz vertical plug-in unit. The Vertical Amplifier (e.g., 7A15) is used to amplify the –30 dBm 50 MHz signal to approximately 30 mV peak-to-peak to trigger the 7D14. No procedure for this check is provided because the CAL OUT signal frequency can be measured by connecting through an amplifier unit to the input of the counter.

## 2. Check Calibrator Output Level (–30 dBm $\pm 0.3$ dB)

Three procedures are given: Vector Voltmeter method, Power Meter method, and the use of an accurate –30 dBm source. The output of the calibrator contains harmonics; therefore, direct measurement is not possible.

- a. Vector Voltmeter Method (Hewlett Packard Model 8405A Vector Voltmeter)

(1) Terminate the "A" probe with a BNC 50  $\Omega$  feedthrough termination and connect the probe, through the termination, to the CAL OUT connector on the 7L13.

## Performance Check—7L13

(2) Switch the Vector Voltmeter frequency to 50 MHz.

(3) Check for an RMS reading between 6.85 mV to 7.3 mV (−30 dBm is 7.07 mV—RMS, into 50 Ω). If output is out of specification refer to Calibrator Output adjustment in the Calibration Procedure.

b. Accurate Power Meter (within 0.1 dB) and a 50 MHz Low Pass Filter with 40 dB or more rolloff at 100 MHz (General Microwave Power Meter Model 454A, or Hewlett Packard Model 432A Power Meter).

### NOTE

*The insertion loss, of the filter, must be accounted for to an accuracy of 0.1 dB*

(1) Connect the power meter through the filter to the CAL OUT connector.

(2) Measure the output level.

c. Using a −30 dBm Signal Source to check the Output by Signal Substitution Method.

### NOTE

*The power meters suggested for the second method can be used to verify the signal source output level.*

(1) Set the FREQ SPAN/DIV to 0.5 MHz and the RESOLUTION bandwidth to .3 MHz. Switch the RF Attenuator to 10 dB and the Gain selector fully ccw. Push the 2 dB/DIV LOG display button.

(2) Apply 50 MHz, from the calibrated − dBm source, to the RF INput of the 7L13 and tune the signal to the graticule center. Adjust the REF VAR control to position the top of the signal to some reference line (2nd or 3rd from the top).

(3) Disconnect the −30 dBm reference signal, then apply the 7L13 CAL OUT signal to the RF INput connector.

(4) Check—The displacement of the 7L13 calibrator 50 MHz signal level, from the reference signal level must not exceed ±0.3 dB (0.75 minor divisions with a 2 dB/DIV display mode).

(5) If necessary, adjust the output of the calibrator as described in the Vector Voltmeter method, for −30 dBm.

## 3. Check RF Attenuator Accuracy (Within ±0.2 dB +1% of the dB readout whichever is greater.)

### NOTE

*The RF Attenuator accuracy is checked at the factory to ensure that it is within specifications. This check will detect any component failure within the attenuator but it will not check the tolerance characteristics. If the exact attenuation error of the selector is required, a reference attenuator, calibrated by the user or manufacturer to more rigid specifications than the 7L13 attenuator, must be used.*

a. Set the front panel controls and selectors as follows:

RF Attenuator	0 dB
Gain	ccw
Display Mode	LOG 2 dB/DIV
FREQ SPAN/DIV	1 MHz
RESOLUTION	.3 MHz
Center Frequency	200 MHz

b. Apply a −60 dBm, 200 MHz signal from the VHF signal generator to the RF INput. Adjust the Gain selector and REF VAR control for a signal amplitude of 4 divisions.

c. Check the RF Attenuator selector accuracy by increasing the RF Attenuator setting in 10 dB increments, and decreasing the Variable Attenuator setting (on the VHF generator) 10 dB. The display amplitude should remain at 4 division ±0.2 dB or 1% of the RF Attenuator setting, whichever is greater.

## 4. Check Display Flatness

(Maximum amplitude variation over the 100 kHz to 1.8 GHz frequency span is +1 dB, −2 dB, with respect to the reference level established at 50 MHz.)

a. Set the front panel controls and selectors as follows:

CENTER FREQUENCY	50 MHz
Display Mode	2 dB/DIV
RF Attenuator	10 dB
Gain	Fully ccw
FREQ SPAN/DIV	MAX SPAN
RESOLUTION	3 MHz

b. Apply a  $-30$  dBm, 50 MHz signal from the VHF signal generator to the RF INput of the 7L13. Adjust the REF VAR control for an amplitude of 6 divisions.

c. Check the flatness response, by tuning the signal generator across its frequency range, maintaining a constant output level, and noting signal amplitude variations. Amplitude variations about the reference 6 division level should not exceed  $+1$  dB,  $-2$  dB.

d. Change to a UHF signal generator, then a SHF signal generator as required, to check flatness over the remaining frequency span of the 7L13.

**NOTE**

*Cable losses become significant at frequencies above 1.0 GHz. Use RG-8C cable with BNC to N adapter, or use very short cable lengths ( $\leq 1$  foot) between the signal generator and the 7L13 RF INput connector. Impedance levels between the source and RF INput are also important; refer to General Operating Information, "Signal Application".*

**5. Check Intermodulation Distortion**

(Third order distortion, 100 kHz—1.8 GHz, is down 70 dB or more from two  $-30$  dBm signals within any frequency span. Second order distortion is down 70 dB or more from two  $-40$  dBm signals. Intermodulation products, 1 kHz to 100 kHz, (3rd and 2nd) are down 50 dB or more for the same input level. Fig. 3-6 illustrates third and second order intermodulation products.)

a. Set the FREQUENCY SPAN to 1 MHz/Div and RESOLUTION bandwidth to 30 kHz. Set the RF Attenuator to 0 dB and the Gain selector fully ccw. The REFERENCE LEVEL should read out  $-30$  dBm. Switch the 300 Hz VIDEO FILTER on and the display mode to 10 dB/DIV. Decrease the sweep speed until the UNCAL indicator light goes out.

b. Apply two signals that are separated approximately 2 MHz, from the output of two  $50 \Omega$  signal sources, through 10X attenuators (for isolation), then through a BNC "T" connector, to the RF INput of the 7L13. Fig. 3-7 illustrates this setup.

c. Adjust the output of both generators for  $-30$  dBm signal amplitude (full screen).

d. Check the amount of third order intermodulation distortion, by noting the amplitude of the IM products. The amplitude of these IM products must be down 70 dB from

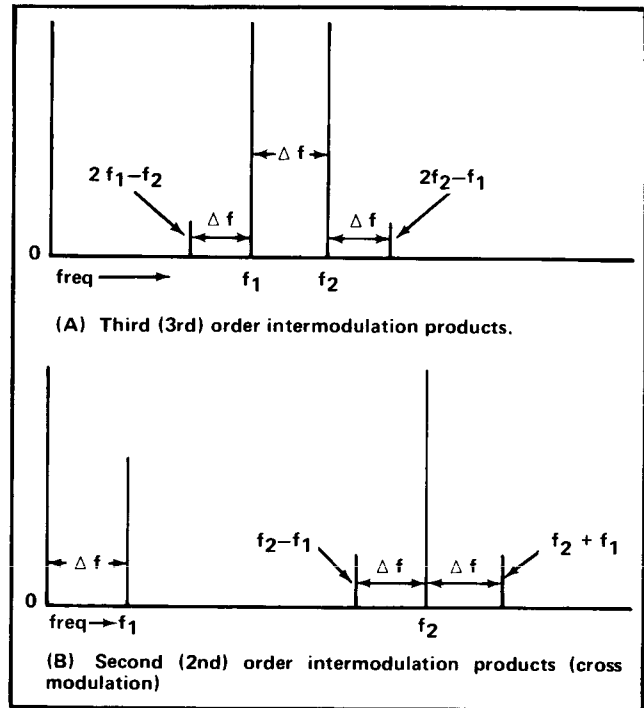


Fig. 3-6. Intermodulation products (distortion).

the level of the two signals, or below the 7th graticule line from the top.

**NOTE**

*Typically these intermodulation products are difficult to see. An alternate procedure, which will average noise level, is to switch the 300 VIDEO FILTER on and use a very slow sweep, looking for any sidebands. If your oscilloscope has storage or variable persistence, use the storage mode.*

e. Tune the CENTER FREQUENCY towards 10 MHz until the 0 Hz response is on screen.

f. Tune one signal generator frequency to approximately 500 kHz and adjust its output for a signal level of  $-40$  dBm or 1 division below the top of the graticule ( $-30$  dBm reference).

**NOTE**

*Both generators must be connected as described in step b.*

g. Tune the CENTER FREQUENCY of the 7L13 to the frequency of the second signal generator and adjust the generator output for a signal level of  $-40$  dBm.

## Performance Check—7L13

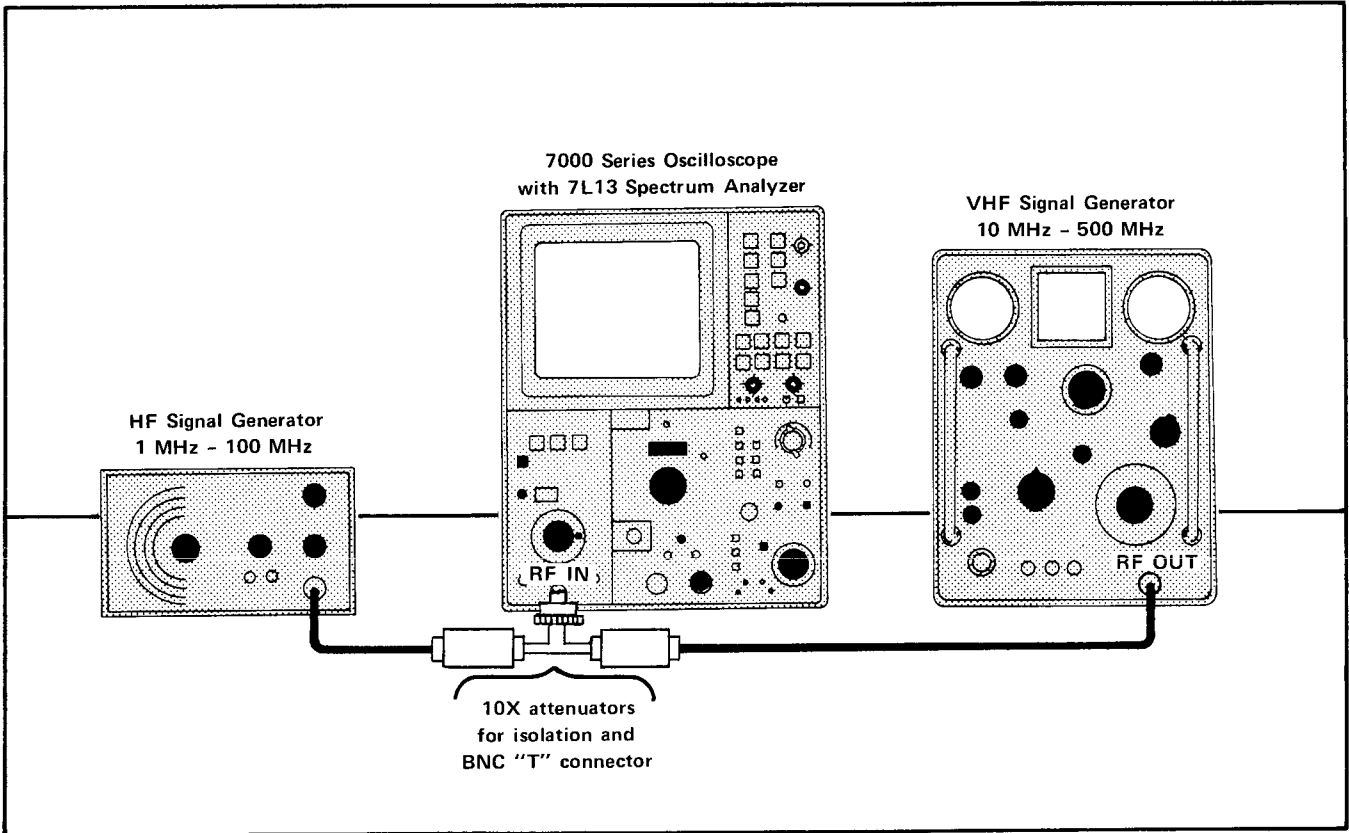


Fig. 3-7. Equipment setup and connections necessary to measure intermodulation distortion.

### NOTE

Refer to step b and have the frequency above 10 MHz.

h. Switch the Gain selector one step cw to shift the  $-40$  dBm signal to the REFERENCE LEVEL. Decrease the FREQ SPAN/DIV to  $.2$  MHz and the RESOLUTION bandwidth to 3 kHz. Change the sweep rate to establish a calibrated display (UNCAL indicator out). The noise amplitude should now equal about 1 division. The dynamic range below the reference is now 70 dB.

i. Check—Second order intermodulation distortion must not exceed 1 division, or 70 dB below the two reference signals (see Fig. 3-7B).

j. Check—Intermodulation products from 1 kHz to 100 kHz, using the above procedures. IM products must not exceed 50 dB below the reference signals.

### 6. Check PULSE STRETCHER Operation

(Pulse Stretcher should increase pulse falltime to at least  $2.5 \mu\text{s}$  per vertical division.)

### CAUTION

Since the pulse stretcher responds only to pulsed spectra, a pulse generator is used to make this check. Use extreme care to ensure that the pulse amplitude, into the RF INput of the 7L13, does not exceed 100 mV (100 mV is approximately  $-3$  dBm).

a. Switch the display mode to LIN and the VIDEO FILTER off. Set the TIME/DIV to 10 ms, the FREQ SPAN/DIV to 2 MHz, and the RESOLUTION bandwidth to 300 kHz. Switch the RF Attenuator to 0 dB and the Gain selector for a REFERENCE LEVEL readout of  $-30$  dBm.

b. Tune the CENTER FREQUENCY to center the 0 Hz response.

c. After ensuring that the pulse generator output is below 1 V, apply its output through a 20 dB (10X)  $50 \Omega$  attenuator, to the RF INput of the 7L13.

d. Set the generator pulse duration to  $.2 \mu\text{s}$  and its period to  $40 \mu\text{s}$ .



e. Adjust the oscilloscope Intensity and the 7L13 BASELINE CLIPPER controls until the pulsed spectrum, about the 0 Hz response, can be observed (see Fig. 3-8). It may be necessary to adjust the output of the pulse generator to approximately 0.1 V; however, do not exceed 1 V peak.

f. Depress the PULSE STRETCHER pushbutton. Note that the intensity of the pulsed spectra increases. Return the pushbutton to its off position.

g. Switch AUTO PHASE LOCKED mode OFF, and tune the 0 Hz response to the left edge of the screen. Decrease the FREQ SPAN/DIV to 0 and switch the TIME/DIV to the 10  $\mu$ s position. Switch the Trigger SOURCE to INT and the Trigger MODE to NORM, then adjust the Trigger LEVEL control for a triggered display of two or more pulses.

#### NOTE

*To increase the display amplitude, tune the CENTER FREQUENCY towards 10 MHz and increase the pulse generator output until the signal amplitude equals 4 divisions.*

h. Depress the PULSE STRETCHER button and note that the pulse falltime increases to approximately 10  $\mu$ s (2.5  $\mu$ s/DIV).

i. Return the TIME/DIV selector to the 0.1 s position, the FREQ SPAN/DIV to 10 MHz, and release the PULSE STRETCHER pushbutton. Disconnect the pulse generator signal to the RF INput connector.

## 7. Check Triggering Operation and Sensitivity

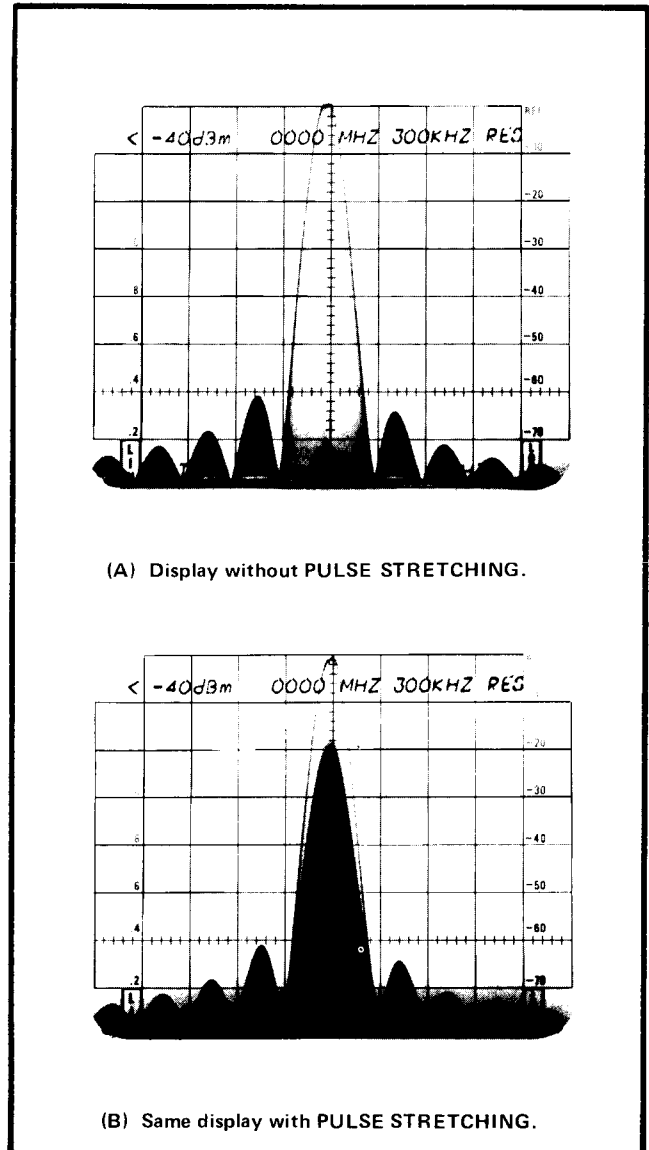
a. Apply a 100 MHz signal from the VHF signal generator to the RF INput of the 7L13 and tune the CENTER FREQUENCY to the signal.

b. Apply a 10 kHz signal from the sine wave signal generator; through a "T" connector, BNC to BNC cable, and BNC to pin-jack cable, to both the EXT IN HORIZ/TRIG jacks on the 7L13 and the External Modulation Input of the VHF signal generator (see Fig. 3-9).

c. Modulate the VHF signal with a 0.5 V peak-to-peak, 10 kHz signal.

#### NOTE

*If the output of the sine wave generator is not calibrated, monitor its output with a test oscilloscope.*



**Fig. 3-8. Displays of a pulsed spectra that illustrate the effect of the PULSE STRETCHER.**

d. With the CENTER FREQUENCY of the 7L13 tuned to the 100 MHz signal from the VHF signal generator, uncouple the FREQ SPAN/DIV and reduce the span to 0, leaving the RESOLUTION at 3 MHz. Switch the display mode to LIN.

e. Adjust the VHF signal generator output for a display amplitude of 1 division. Switch the Triggering to INT (SOURCE) and NORM (MODE). Set the TIME/DIV to .1 ms.

f. Adjust the TRIGGERING LEVEL for a triggered display, then reduce the VHF signal generator output to decrease the display amplitude to 0.5 division and ensure that the 7L13 will still trigger on the 1 kHz modulation.

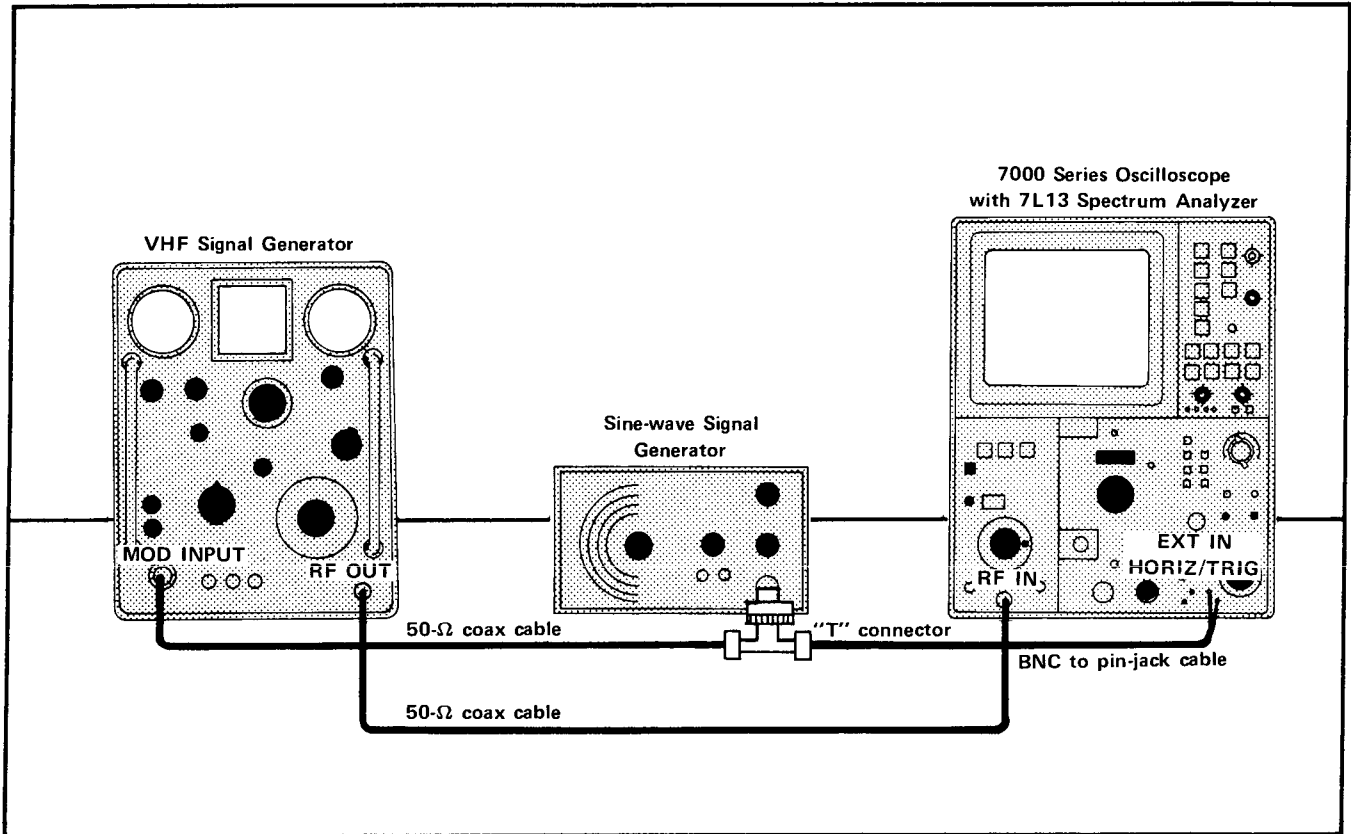


Fig. 3-9. Equipment setup to check triggering operation.

g. Check triggering operation through the frequency range of 15 Hz to 1 MHz, maintaining 0.5 division of display.

h. Switch the TRIGGERING (SOURCE) to EXT. Set the sine wave generator output level for 0.5 V peak-to-peak at 10 kHz.

i. Check triggering through the frequency range of 15 Hz to 1 MHz as described in step g. Ensure that the input level remains at 0.5 V peak-to-peak.

j. Switch the TRIGGERING (SOURCE) to FREE RUN and note that the display will not trigger.

k. Switch the TRIGGERING (SOURCE) to LINE and check that the display triggers at line frequency.

l. Switch the TRIGGERING (MODE) to SGL SWP and the TIME/DIV to 1 s. Check for a single sweep each time the sweep button is pushed.

m. Return the TRIGGERING (SOURCE) to FREE RUN and the (MODE) to NORM.

**8. Check the External Horizontal Input Voltage Requirement.** (0 V to 10 V  $\pm$ 1 V should sweep the analyzer the full span.)

a. Switch the oscilloscope (mainframe) Vert Mode switch off the vertical signal (right for 3-hole mainframes) and the 7L13 TIME/DIV to EXT.

b. With no signal applied to the EXT IN HORIZ/TRIG input jacks, position the crt beam to the left graticule edge to establish 0 V, 0 Hz reference.

c. Apply a variable voltage source, such as a variable power supply, to the EXT IN HORIZ/TRIG pin-jacks and adjust the voltage source so the beam is deflected the full span. Check that the voltage source equals +10 V  $\pm$ 1 V. NOTE: The sine wave generator can be used to check external sweep operation as follows:

- 1) After the beam has been positioned to the 0 V, 0 Hz reference, apply a 10 V peak (positive swing will go to +10 V), 10 Hz sine wave to the EXT IN connectors.

**NOTE**

*The pushbutton should light during sweep time.*

2) The crt beam should sweep to the graticule centerline when the input voltage is 10 V peak  $\pm 1$  V.

d. Disconnect the pin-jacks to the EXT IN connectors; return the TIME/DIV selector to 50 ms and the oscilloscope Vert Mode to Left.

**9. Check the Video Output Level.** (50 mV  $\pm 5\%$  per displayed division about the crt center.)

a. Apply the VIDEO OUT signal to the Input of a vertical amplifier unit in the test oscilloscope. Use the pin-jack to BNC cable adapter. Set the Volts/Div selector of the amplifier to 50 mV.

b. Apply the CAL OUT signal to the RF INput of the 7L13, set the FREQ SPAN/DIV to 2 MHz, and tune the CENTER FREQUENCY to center one of the 50 MHz markers in the display.

c. Adjust the RF Attenuator and the Gain of the 7L13 for a signal amplitude of 4 divisions, then position the display about the vertical center of the crt with the VERTICAL POSITION control. Adjust the REF VARIABLE control for precisely 4 divisions of signal amplitude.

d. Check the video output amplitude on the test oscilloscope. Amplitude should equal 200 mV  $\pm 10$  mV.

**10. Check Frequency Span Accuracy and Linearity.** (Freq Span accuracy within 5%, linearity accuracy within 5% over the center 8 divisions.)

a. Apply the marker and trigger output from the time mark generator through the Harmonic Modulator to the RF INput of the 7L13. Set the 7L13 selectors and controls as follows:

FREQUENCY	800 MHz
Display Mode	10 dB/DIV
RF Attenuator	0 dB
REFERENCE LEVEL	-30 dBm
PHASE LOCKED Mode	ON
FREQ SPAN DIV	100 MHz
RESOLUTION	3 MHz
(Uncoupled)	

b. Check frequency span accuracy and linearity as per Table 3-2.

**NOTE**

*At some settings a better display may be obtained by using the VIDEO FILTER or by tuning the FREQUENCY to a different setting. When the VIDEO FILTER is used, the sweep speed must be decreased to obtain optimum marker amplitude.*

**TABLE 3-2**

FREQ SPAN/DIV	RESOLUTION	Marker	Time Mark Generator		Tolerance (over center 8 div)
			Trigger	Markers/Div	
100 MHz	3 MHz	10 ns	0	1 per div	5%
50 MHz	3 MHz	10 ns	0	1 per 2 div	5%
20 MHz	300 kHz	10 ns	0	1 per 5 div	5%
10 MHz	300 kHz	10 ns	.1 $\mu$ s	1 per div	5%
5 MHz	300 kHz	10 ns	.1 $\mu$ s	1 per 2 div	5%
2 MHz	300 kHz	10 ns	.1 $\mu$ s	1 per 5 div	5%
1 MHz	30 kHz	10 ns	1 $\mu$ s	1 per div	5%
.5 MHz	30 kHz	10 ns	1 $\mu$ s	1 per 2 div	5%
.2 MHz	30 kHz	10 ns	10 $\mu$ s	2 per div	5%
.1 MHz	30 kHz	10 ns	10 $\mu$ s	1 per div	5%
50 kHz	3 kHz	10 ns	10 $\mu$ s	1 per 2 div	5%
20 kHz	3 kHz	10 ns	10 $\mu$ s	1 per 5 div	5%
10 kHz	300 Hz	10 ns	.1 ms	1 per div	5%
5 kHz	300 Hz	10 ns	.1 ms	1 per 2 div	5%
2 kHz	300 Hz	10 ns	.1 ms	1 per 5 div	5%
1 kHz	300 Hz	10 ns	1 ms	1 per div	5%
.5 kHz	300 Hz	10 ns	1 ms	1 per 2 div	5%
200 Hz	30 Hz	10 ns	1 ms	1 per 5 div	5%

**Performance Check—7L13**

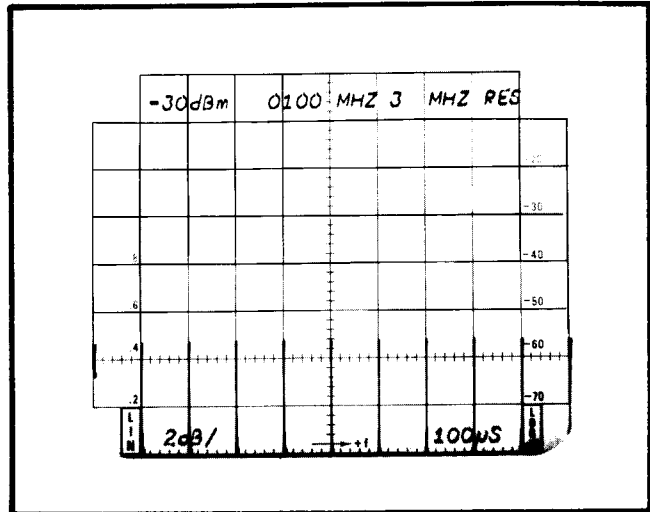
**11. Check the Time/Div Accuracy.** (Accuracy within 2% of the sweep rate selected.)

a. Switch the RF Attenuator to 0 dB and the Gain selector fully ccw for a REFERENCE LEVEL of -30 dB.

b. Apply a 100 MHz, -40 dBm signal from the VHF signal generator to the RF INPUT of the 7L13 and tune the CENTER FREQUENCY to the signal. Apply .1 ms time markers from the Marker Output of the time mark generator to the External Modulation input of the VHF signal generator (see Fig. 3-10) so the signal generator output can be modulated by time markers.

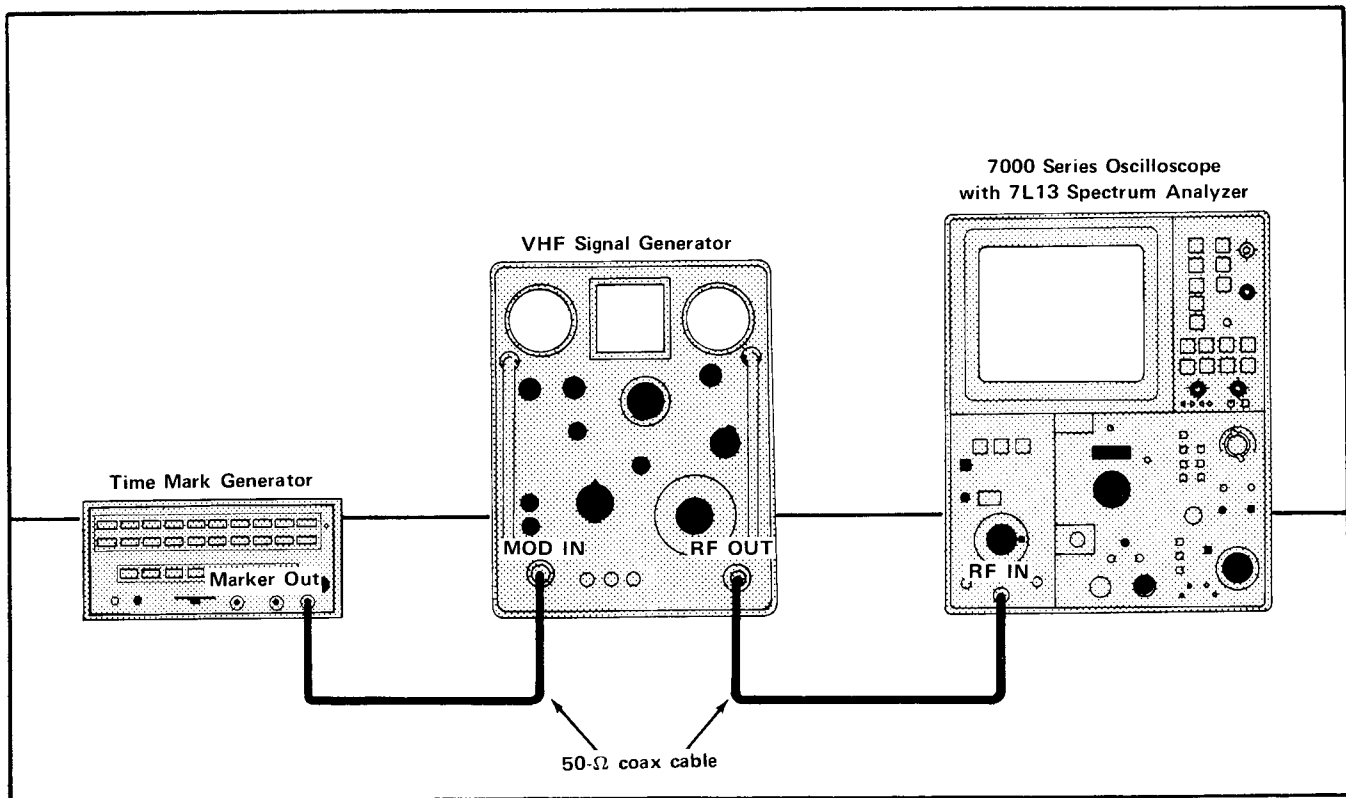
c. With the CENTER FREQUENCY tuned to the 100 MHz signal from the VHF signal generator, uncouple the FREQ SPAN/DIV selector and reduce the span to 0, leaving the RESOLUTION at 3 MHz. Switch the display mode to 2 dB/DIV.

d. Switch the TRIGGERING to INT (SOURCE) and NORM (MODE) and the TIME/DIV to .1 ms. Adjust the VHF signal generator output for a display amplitude of approximately 2 divisions (see Fig. 3-11).



**Fig. 3-11. Display showing time markers for checking TIME/DIV accuracy.**

e. Adjust the TRIGGERING LEVEL for a triggered display, then check the accuracy of the TIME/DIV selections by applying appropriate markers from the time mark generator and noting the displacement error between the graticule marks and the time markers. The error must not exceed  $\pm 2\%$  (0.2 div) over the center 8 divisions of a 10 division display.



**Fig. 3-10. Test equipment setup to check TIME/DIV accuracy.**

**NOTE**

*Use the HORIZ POSITION control to position a marker on the 1st graticule line, then note the error between each marker and its respective graticule line.*

f. Disconnect the signal to the RF INput and return the 7L13 to normal spectrum operation.

This completes the performance check for the 7L13. It will now perform within the specifications described in Section 1.



# CALIBRATION PROCEDURE

This section provides procedural information for internal checks and adjustment. Performing the complete procedure will recalibrate the instrument to its specifications. After calibration, the instrument performance can be verified by performing the Performance Check.

Limits, tolerances, and waveform illustrations in this procedure are guides or aids to calibrate the instrument; they are not intended as instrument specifications. Waveform illustrations are typical.

## Complete or Partial Calibration

The instrument should be cleaned and inspected as outlined in the Maintenance section, before performing a complete calibration. Perform the checks and adjustments in sequence for a complete calibration, then verify the performance by the Performance Check.

Many circuits within this instrument, are very stable, and some require extensive facilities with expensive test equipment to calibrate. It may therefore be desirable, to perform only a partial calibration. Turn to the desired step, prepare the instrument for adjustment by referring to the nearest setup and control instructions, proceeding the step, then adjust or calibrate as directed.

## History Information

The manual and instrument are constantly evaluated and updated. These modifications may require changes in the calibration procedure. History information that is applicable to earlier instruments is included either as a deviation within a step or as a subpart to a step.

## Interaction

Adjustments that interact with other circuits are noted and reference is made to the affected circuit which may require re-adjustment.

## Equipment Required

Equipment for calibration includes the equipment listed for the Performance Check plus the following additional equipment:

DC voltmeter: Checked to within 1% at 15 V, 5 V and 20 V, for example; Triplet Model 630-PL.

Differential Comparator (optional): Common mode signal range  $\pm 10$  V, comparator accuracy 0.1%. Tektronix 7A13 plug-in unit.

Adapter: BNC female to subminiature (SEAELECTRO) female. Tektronix Part No. 175-1162-00, SEAELECTRO Part No. 51-077-6801.

Adapter: SEAELECTRO male to male. Tektronix Part No. 103-0098-00, SEAELECTRO Part No. 51-072-0000.

Shorting Strap or Jumper: Jumper lead approximately 4 inches long with miniature alligator clips.

Plug-in Extenders (three): Tektronix Part No. 067-0616-00.

## SHORT FORM PROCEDURE AND RECORD

The following abridged procedure provides a calibration record and an index to help locate adjustment steps.

7L13 Serial No. \_\_\_\_\_

Calibration Date \_\_\_\_\_

Calibrator \_\_\_\_\_

### TIME BASE SECTION

- |  |          |
|--|----------|
| 1. Adjust Sweep Length, Timing, Offset, and Triggering | Page 4-3 |
|--|----------|

### FUNCTION IF

- |   |          |
|---|----------|
| 2. Adjust LIN Mode Baseline Offset                            | Page 4-6 |
| 3. Adjust Gain Compensation and Calibrate the Reference Level | Page 4-6 |

### 1ST LO PHASE LOCK

- |                                      |          |
|--------------------------------------|----------|
| 4. Error Amplifier Offset Adjustment | Page 4-8 |
|--------------------------------------|----------|

## Calibration Procedure—7L13

### FREQ SPAN AND 1ST LO CALIBRATION

5. Adjust the Frequency Span of the 1st LO and 16-19 MHz Oscillator Page 4-8

6. Calibrate the Center Frequency and Frequency Readout Page 4-10

### PHASE LOCK CALIBRATION ADJUSTMENTS

7. Adjust the Memory Gain Page 4-11

8. Adjust the Error Amplifier Gain Page 4-11

### RESOLUTION

9. Adjust the Bandpass of the 105 MHz IF Amplifier and 300 kHz Filter Page 4-12

10. Adjust the Resolution Gain Leveling Compensation Page 4-14

11. Adjust the Post Resolution Amplifier Gain Page 4-16

12. Minimize Intermodulation Products Page 4-16

### 50 MHz CALIBRATOR

13. Adjust the Calibrator Output Level Page 4-16

## Preliminary Procedure

### NOTE

*Instrument calibration should be performed at a temperature equal to the ambient operating temperature that is normally within +20° C to +30° C after a warmup period (with power on) of at least 30 minutes to allow the instrument to stabilize.*

1. Check the front panel controls and selectors for smooth operation and proper indexing.

2. Remove the 7L13 from the mainframe and reconnect it to the mainframe interface through the flexible plug-in extenders. (Connect the 7L13 into the two vertical and left horizontal compartments of four hole mainframes.)

### NOTE

*The guide pin on the extender cable plug to the RF section of the 7L13 must be removed before it will plug into the interface connector. The guide pin is removed by pulling it out with a pair of pliers.*

3. Turn the power ON and allow the instrument circuits to stabilize before making any adjustments (approximately 20 minutes).



## TIME BASE SECTION

### 1. Adjust Sweep Length, Offset, and Triggering

Set the front panel controls and selectors as follows:

7L13	
TIME/DIV	.5 ms
Triggering SOURCE	FREE RUN
Triggering MODE	NORM
FREQ SPAN/DIV	MAX
RESOLUTION	Coupled to the FREQ SPAN
Display Mode	2 dB/DIV

#### Test Oscilloscope

Time/Div	.1 ms
Volts/div	
(Calibrated)	5 V
Input Coupling	dc

b. Connect the test oscilloscope probe to pin 3 of the TRACK GEN connector (Fig. 4-1A).

c. Adjust the Swp Gain with R1250 (Fig. 4-2) on the sweep board, for a 20 volt ( $\pm 10$  V) sweep ramp (Fig. 4-1B). Adjust R1255 (Fig. 4-2) to center the ramp about 0 volts.

#### NOTE

*This sweep ramp should be an accurate 20 volt ( $\pm 10$  V) ramp. If a differential comparator plug-in unit (e.g., 7A13) is available, use the comparator to measure the amplitude and offset of the sweep ramp.*

*The offset level should be adjusted to 0 volt with R1255 (Swp Offset).*

d. Adjust the sweep length of the 7L13 to 10 divisions, with the front panel SWP CAL, then center the trace within the graticule area. Apply the CAL OUT signal to the RF INput and switch the display mode to 10 dB/DIV.

e. Change the FREQ SPAN/DIV to 10 MHz and tune the center frequency to one of the calibrator markers.

f. Decrease the FREQ SPAN/DIV to .1 MHz, keeping the marker centered with the CENTER FREQUENCY control.

g. Increase the FREQ SPAN/DIV to 100 MHz and adjust the Swp Offset with R1255 to bring the signal to the center of the screen. This will eliminate signal shift as the dispersion is changed.

h. Repeat steps f and g until the signal remains on screen as the frequency span is decreased from 100 MHz/Div to approximately 200 kHz.

#### NOTE

*The hysteresis in the tune control system may shift the center frequency slightly when the frequency span is switched back through its positions.*

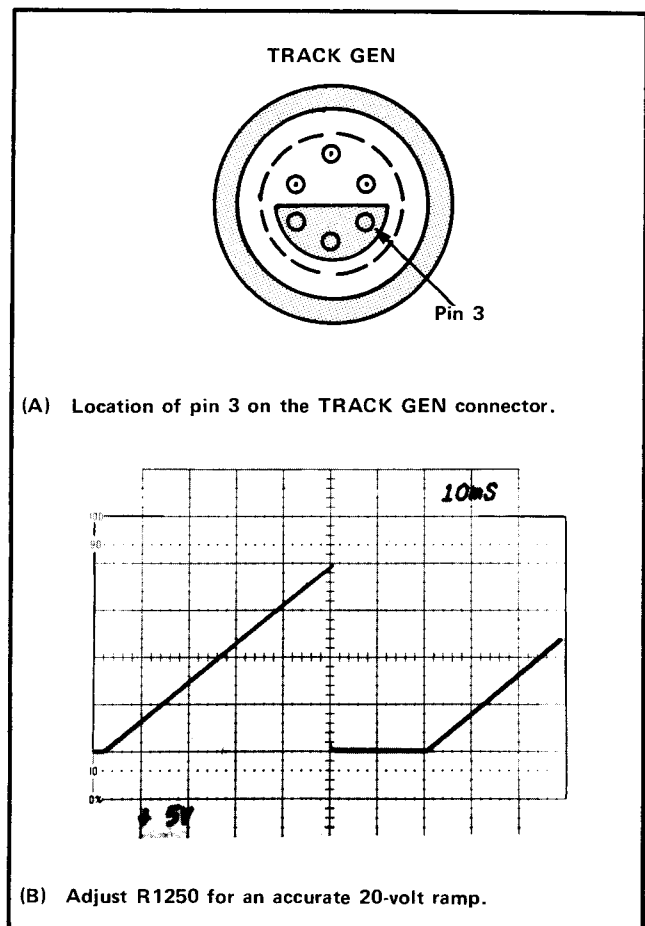


Fig. 4-1. Calibrating the sweep ramp.

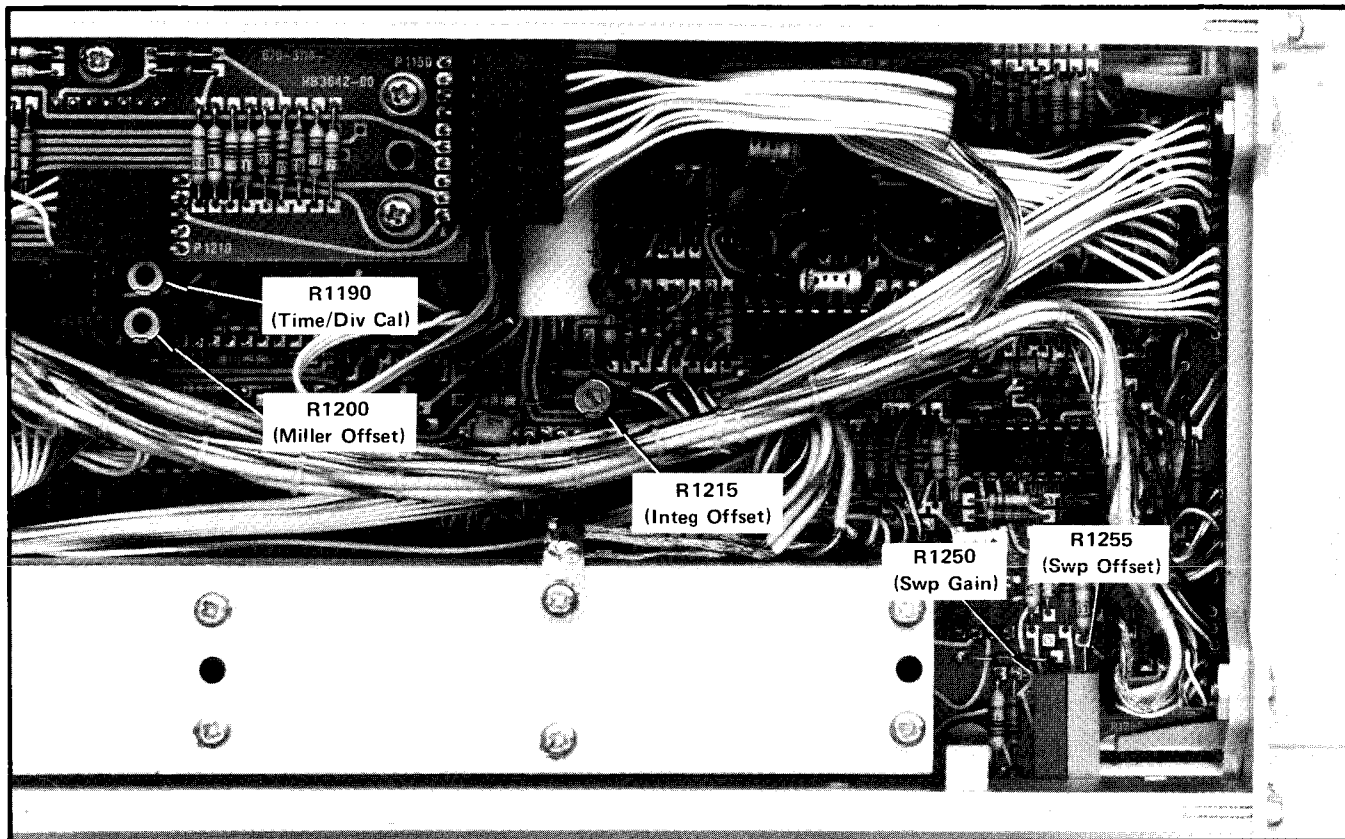


Fig. 4-2. Location of adjustments on the Sweep board.

i. Switch the display mode to 2 dB/DIV. Turn the BASELINE CLIPPER fully ccw. Pull transistor Q1210 (Fig 4-3) and use a screwdriver with a small blade to short between the base and collector terminals. This pulls the collector terminal to ground potential and disables the sweep so a reference near center screen is provided.

j. Position the crt beam at the center line of the graticule with Integrator Offset Adjust R1215 (Fig. 4-2). Replace transistor Q1210.

k. Remove the flexible extender plug from the right vertical compartment of the 7L13 mainframe oscilloscope and install a vertical amplifier unit (e.g., 7A16, 7A18).

l. Switch the mainframe trigger Source to Vert Mode and apply the 40 mV Calibrator signal to the amplifier input. Set the Volts/Div to .1 V.

m. Switch the 7L13 TRIGGERING SOURCE to INT and adjust the LEVEL control for a triggered display.

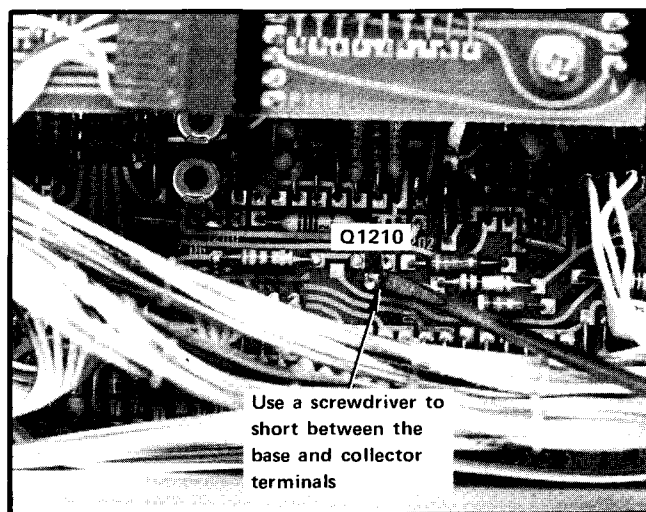


Fig. 4-3. Base to collector terminals for Q1210.

n. Check that the display triggers on either the + or - slope. If the index mark on the LEVEL control is off center, loosen the set screws and reposition the control.

o. Change the TRIGGERING MODE to SGL SWP and the TIME/DIV to .5 s.

p. Check that the sweep runs each time the sweep button is pushed and that the button lights while the sweep is running.

**NOTE**

*The remaining triggering modes of operation can be checked if desired by referring to the Performance Check section of the manual.*

q. Return the TRIGGERING MODE to NORM, the TIME/DIV to 1 ms and remove the signal from the Calibrator to the vertical amplifier plug-in unit. Apply 1 ms markers from a time mark generator (e.g., 2901) through a 50  $\Omega$  feedthrough termination, to the Input of the vertical amplifier unit. Set the Volts1Div to .5 V.

r. Adjust the 7L13 TRIGGERING LEVEL control for a triggered display.

s. Adjust the Time/Div Cal R1190 (Fig. 4-2) for 1 marker/division.

t. Check the timing accuracy for each TIME/DIV selection. Timing accuracy must be within 5%.

u. Change the TIME/DIV to 50  $\mu$ s and apply 50  $\mu$ s markers from the time mark generator.

v. Adjust Miller Offset R1200 (Fig. 4-2) for 1 marker/division.

w. Repeat 1 ms/DIV and 50  $\mu$ s/DIV adjustments to compensate for interaction.

x. Disconnect the signal from the time mark generator, remove the vertical plug-in unit and reconnect the extender from the 7L13 interface to the right vertical interface connector.

## FUNCTION IF ALIGNMENT

### Preliminary

Pull the harmonica (multipin) connector P560, on the Function IF circuit board (Fig. 4-4).

Set the following controls to the positions indicated.

#### 7L13

RF Attenuator	0 dB
Gain Selector	Fully ccw
REF VAR	CAL
Display Mode	LIN
TIME/DIV	20 ms
Triggering	
MODE	NORM
SOURCE	FREE RUN
FREQ SPAN/DIV	50 MHz
RESOLUTION	3 MHz

#### Oscilloscope

Vertical Mode	Right
Horizontal Mode	A (if applicable)

### 2. Adjust the Lin Mode Baseline Offset

a. Position the trace to the lower area of the graticule with the VERTICAL POSITION control.

b. Adjust the Lin Baseline Offset R803 (Fig. 4-4) clockwise, from a fully ccw position to a point where the trace stops moving down. (Do not adjust past this point).

c. Switch between LIN and LOG display modes, checking the baseline shift. Repeat the Offset adjustment if the baseline shifts.

### 3. Adjust the Gain Compensation and Calibrate the Reference Level

a. Switch the display mode to 2 dB/DIV and position the baseline of the display on the bottom graticule line if necessary.

b. Apply a 10 MHz signal at  $-10$  dBm, from a calibrated signal source, through appropriate adapters (BNC female to SEAELECTRO female, SEAELECTRO male to male adapter, and SEAELECTRO female to harmonica connector) to P560. (Fig. 4-4). Part numbers for these adapters are provided under Equipment Required List. If an accurate 10 dB, 50  $\Omega$  step attenuator is available, connect it in series with the signal source.

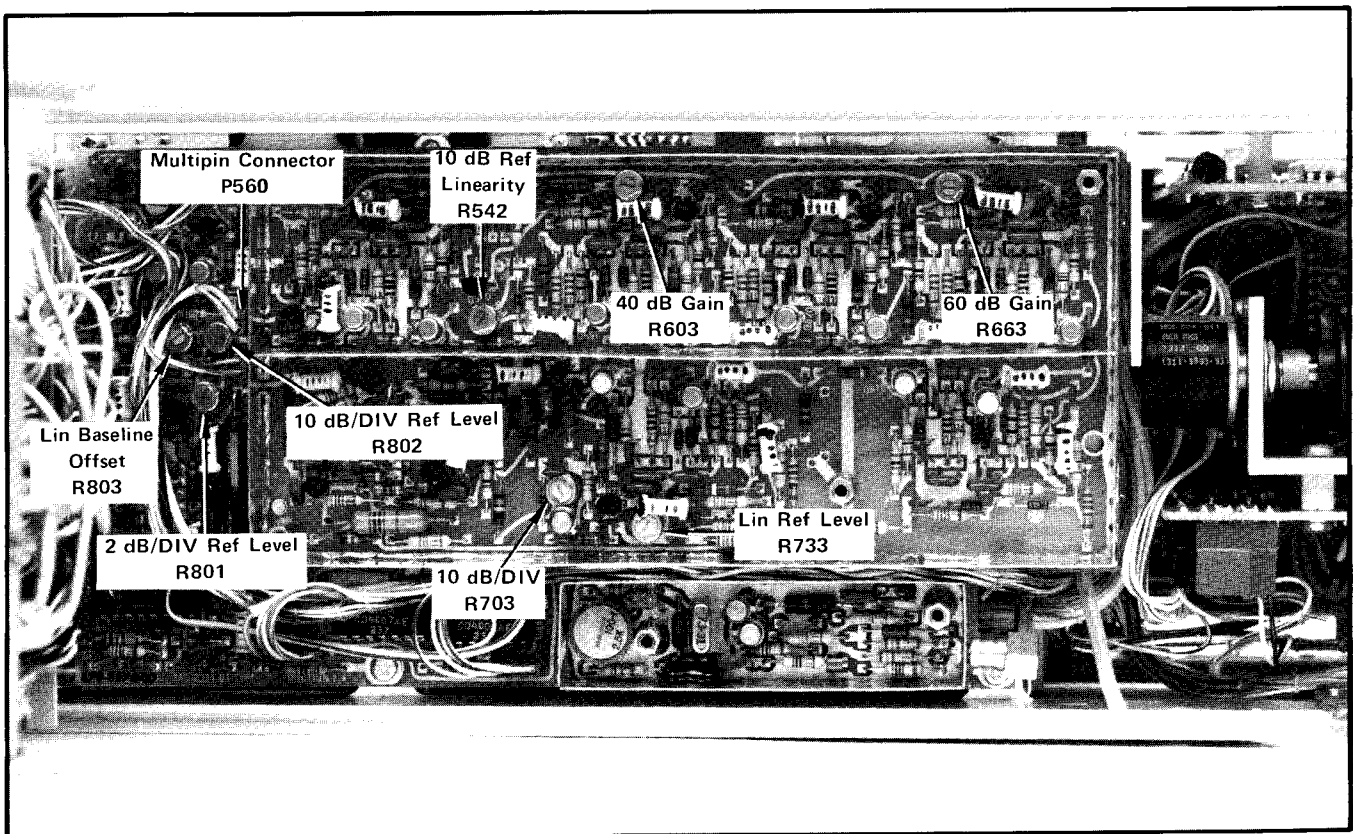


Fig. 4-4. Calibration adjustments and test points on the Function IF board.

c. Adjust the 2 dBm/Div Ref Level R801 (Fig. 4-4) so the trace is at the 5th graticule line down from the top.

d. Increase the signal input level 10 dB. Adjust the front panel LOG CAL for a 5 division increase in signal amplitude, (trace is at the top graticule line).

e. Return the signal level to  $-10$  dBm. Repeat steps c and d to null the interaction between the adjustments.

**NOTE**

*Because of some mainframe drift, it is advisable to periodically remove the signal and check that the display baseline returns to the bottom graticule line.*

f. Switch the display mode to LIN and the signal input level to 0 dBm.

g. Adjust Lin Ref Level R733 (Fig. 4-4) so the trace is at the top graticule line.

h. Switch the display mode to 10 dB/DIV. Decrease the signal input level to  $-70$  dBm.

i. Adjust the 10 dB/DIV Ref Level R802, (Fig. 4-4) so the trace is 7 divisions down from the top graticule line.

j. Increase the signal input level so it is  $-10$  dBm. Adjust the trace so it is 1 division from the top graticule line with 10 dB/DIV R703 (Fig. 4-4).

k. Increase the signal level to 0 dBm, then adjust the 10 dB Ref Linearity R542 (Fig. 4-4) so the trace is at the graticule line.

l. Decrease signal level in 10 dB steps, checking the display calibration for the 10 dB/DIV mode. Trace should shift down  $1 \pm 0.1$  division per each 10 dB step, to a maximum of 1.5 dB over the 70 dB dynamic range. Repeat steps h through k until this accuracy is obtained.

m. Set the signal input level to  $-20$  dBm and switch the display mode to 2 dB/DIV. If necessary, adjust the trace to the bottom graticule line with the VERTICAL POSITION control.

n. Increase the Gain selector setting 50 dB so the REFERENCE LEVEL readout is  $-80$  dBm.

o. Adjust the 40 dB Gain R603 (Fig. 4-4) so the trace is at the reference level or top of the graticule.

p. Decrease the signal level to  $-40$  dBm. If necessary, position the trace on the bottom graticule line with the VERTICAL POSITION control.

q. Increase the Gain selector setting 20 db for a REFERENCE LEVEL readout of  $-100$  dBm.

r. Adjust the 60 dB Gain R663, (Fig. 4-4) so the trace is at the reference level.

s. Remove the signal from the input to the Function IF amplifier and replace the connector P560.

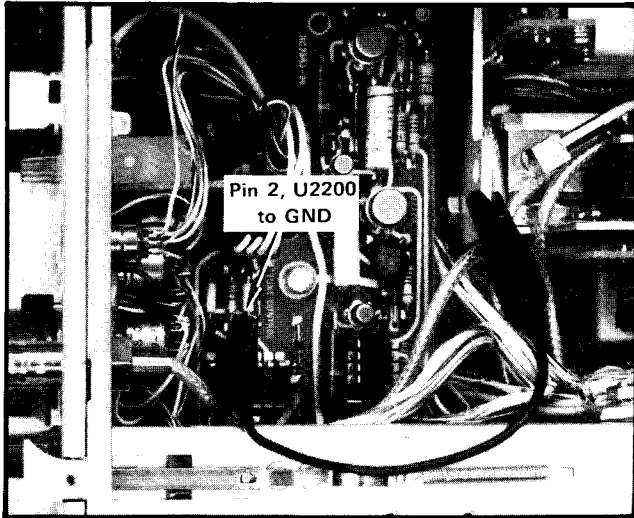


Fig. 4-5. Grounding strap connected to pin 2 of U2200.

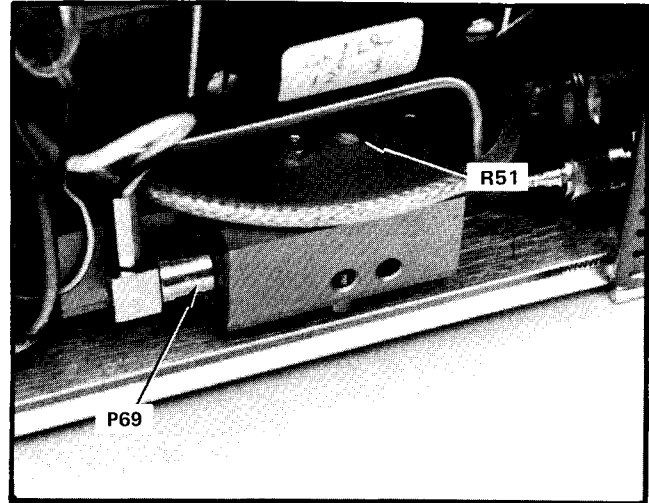


Fig. 4-6. Location of P69 and R51 on Hybrid Assembly A50.

## 1st LO PHASE LOCK LOOP

### 4. Error Amplifier Offset Adjustment

a. Switch the 7L13 into phase locked mode by setting the **FREQ SPAN/DIV** to 50 kHz and switch the **AUTO PHASE LOCKED** switch on. Ground pin 2 of U2200 on the tune control circuit board, with a jumper strap (Fig. 4-5). Remove P69 (Fig. 4-6) from the hybrid assembly A50.

b. Set the test oscilloscope Time/Div to 10 ms and the vertical amplifier deflection sensitivity to 1 V/div. Connect the test oscilloscope probe to J69 and observe the beat signal from the error amplifier.

c. Adjust R51, (Fig. 4-6) so the dc reference level of the error signal is 0 volt.

d. Check for a beat note amplitude that equals or exceeds 4 volts peak-to-peak through the frequency range of the 7L13.

e. Reconnect P69 and remove the grounding strap to pin 2 of U2200.

## FREQUENCY SPAN AND 1st LO CALIBRATION

### 5. Adjust the Frequency Span of the 1st LO and 16-19 MHz Oscillators

**NOTE**

*If the gain and offset adjustments run out of range during this procedure, check the accuracy of the 20 volt ramp as set in step 1.*

a. Set the front panel selectors as follows:

<b>FREQ SPAN/DIV</b>	100 MHz
<b>RESOLUTION (Uncoupled)</b>	3 MHz
<b>TIME/DIV</b>	10 ms
<b>CENTER FREQUENCY</b>	500 MHz
<b>Display Mode</b>	10 dB/DIV
<b>REFERENCE LEVEL</b>	Minimum sensitivity, then increase for full screen display.
<b>VIDEO FILTER</b>	30 kHz
<b>SWP CAL</b>	10 division trace

b. Apply the marker and Trigger output of the time mark generator through the Harmonic Modulator (067-0640-00) to the RF INput of the 7L13. Switch on the 10 ns markers. This provides 100 MHz markers. If this equipment is not available the 50 MHz Calibrator signal can be used.

c. Adjust the YIG oscillator driver gain with R2510 (Fig. 4-7) to calibrate the 100 MHz/div frequency span at 1 marker/division (see Fig. 4-8).

**NOTE**

*Adjusting the driver gain also adjusts the display offset. The gain should be adjusted for the correct marker interval and the offset should be adjusted last. It may be helpful to hold one marker at screen center while adjusting the gain so the markers fall on graticule lines each side of center.*

d. Switch the **FREQ SPAN/DIV** to **MAX** and increase the RF Attenuator setting to 60 dB to attenuate the time markers. Adjust the offset to the YIG oscillator main coil with R2505 (Fig. 4-7) so the 0 Hz marker is at the left edge or start of the display.

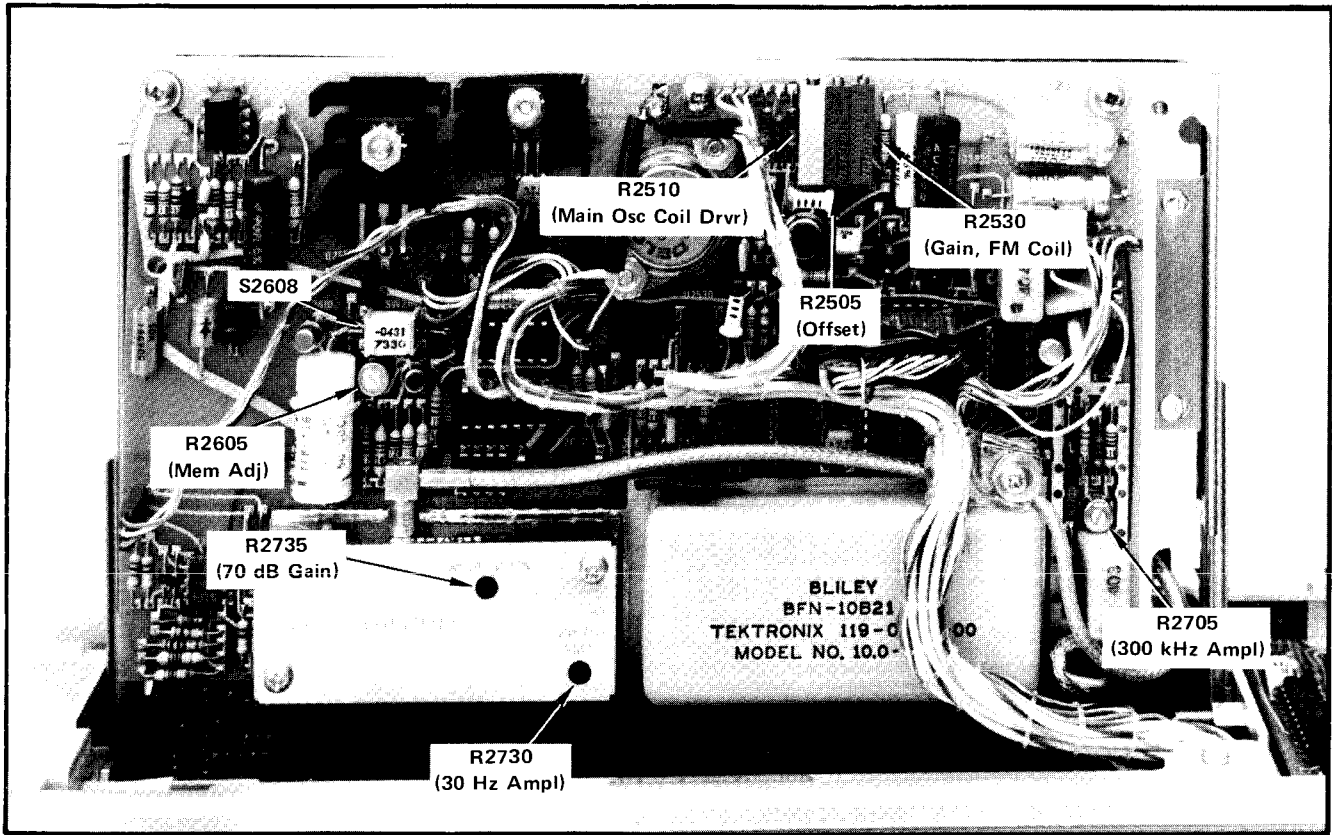


Fig. 4-7. Location of the YIG Driver and Voltage Memory adjustments.

e. Decrease the RF Attenuator setting to 0 dB, FREQ SPAN/DIV to 1 MHz, and the RESOLUTION bandwidth to 30 kHz. Apply 10 ns markers and 1  $\mu$ s trigger signals from the time mark generator.

g. Decrease the FREQ SPAN/DIV to 50 kHz, RESOLUTION bandwidth to 3 kHz, and the TIME/DIV to 20 ms. Apply 10  $\mu$ s trigger signals and 10 ns markers to the Input.

f. Adjust the FM coil driver gain with R2530, (Fig. 4-7) to calibrate the 1 MHz/div frequency span.

h. Adjust the 16-19 MHz sweep gain with R1960, (Fig. 4-9) for 1 marker/2 divisions.

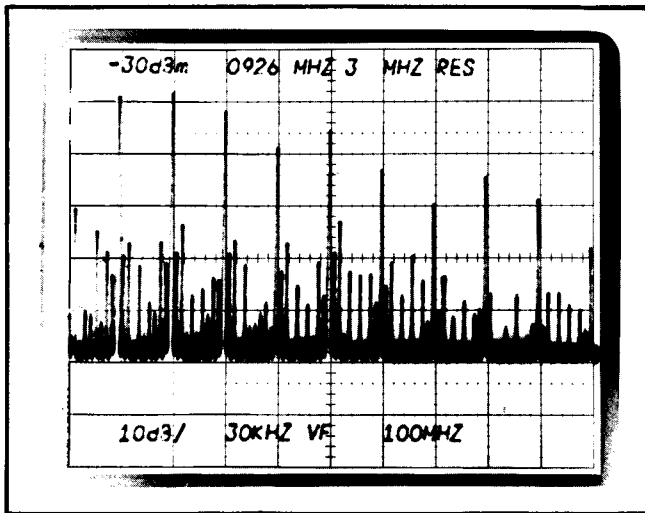


Fig. 4-8. 100 MHz markers on a 100 MHz/DIV frequency span.

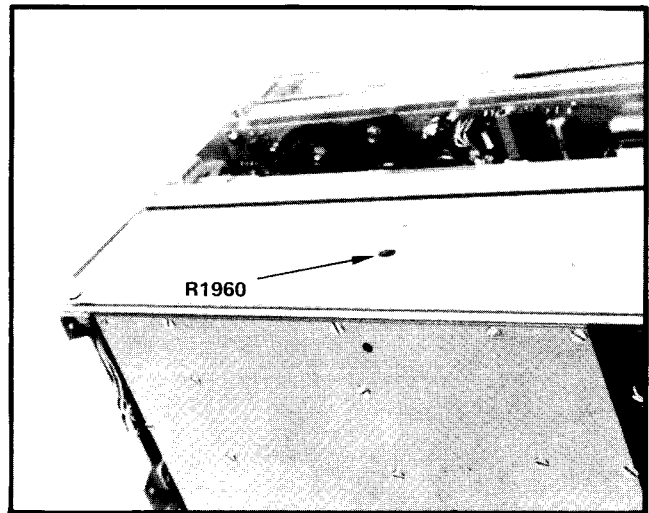


Fig. 4-9. Location of R1069, Sweep Driver adjustment for the 16-19 MHz oscillator.

## Calibration Procedure—7L13

i. Return the FREQ SPAN/DIV to MAX, RESOLUTION to 3 MHz, and the TIME/DIV to 10 ms.

j. Check the frequency span accuracy as per the procedure in the Performance Check Section.

### 6. Calibrate the Center Frequency and Frequency Readout

Couple the FREQ SPAN/DIV and RESOLUTION selectors together and switch the FREQ SPAN/DIV to 100 MHz. Tune the CENTER FREQUENCY for an LED readout of 0888.

b. Adjust the DVM reference current with R2065 (Fig. 4-10) so the mainframe readout matches the 7L13 readout. (This adjustment is not necessary if the 7L13 is operated in a non-readout mainframe.)

c. Apply 10 ns markers from the time mark generator. Couple the FREQ SPAN/DIV to the RESOLUTION selector and switch the FREQ SPAN/DIV to 100 MHz. Tune the CENTER FREQUENCY to center the 900 MHz marker on screen as the FREQ SPAN/DIV is decreased to 1 MHz. (The 900 MHz marker is the 9th marker to the right of the 0 Hz marker.)

d. Adjust the DVM offset with R2135 (Fig. 4-10) so the LED readout is 900 MHz.

e. Return the FREQ SPAN/DIV to 100 MHz and tune the CENTER FREQUENCY to the 100 MHz marker. Reduce the FREQ SPAN/DIV to 1 MHz, so the 100 MHz signal can be accurately tuned to center screen.

f. Adjust the DVM gain with R2110, (Fig. 4-10) so the LED readout is 0100.

g. Repeat the offset and gain adjustments respectively, to compensate for any interaction.

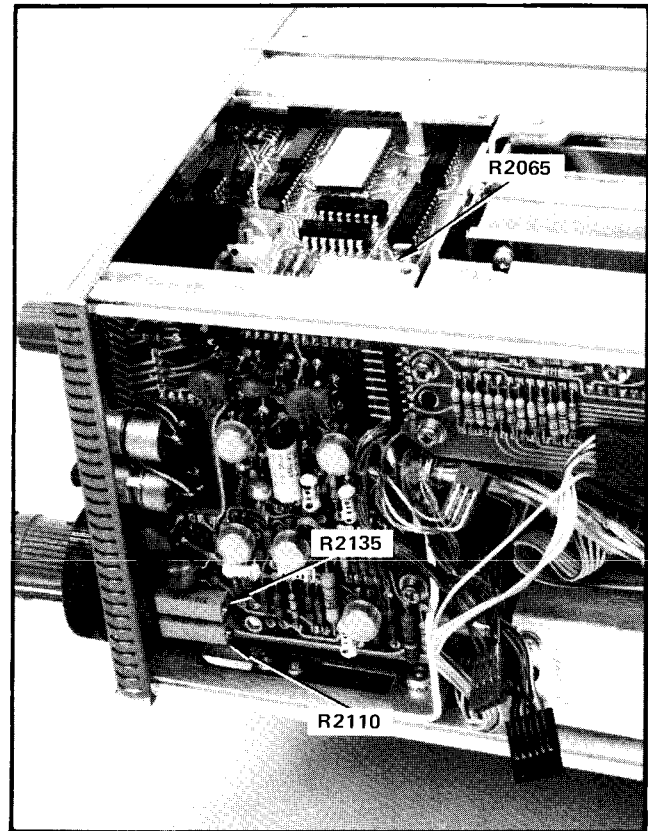


Fig. 4-10. Frequency Readout circuit adjustments.

h. Check the readout tracking accuracy from 0100 to 1800 MHz in 100 MHz increments, approach each check point from the low side. Accuracy must equal  $\pm(5 \text{ MHz} + 10\% \text{ of the Freq Span/Div})$ .

i. Switch the FREQ SPAN/DIV to MAX.

j. Check that the center frequency marker position corresponds to the CENTER FREQUENCY through the tuning range.



## PHASE LOCK CALIBRATION ADJUSTMENTS

### 7. Adjust the Memory Gain

a. Couple the **FREQ SPAN/DIV** and **RESOLUTION** selectors together, then switch the **FREQ SPAN/DIV** and **RESOLUTION** to 10 MHz/300 kHz. Turn the error amplifier loop gain **R1755** (Fig. 4-11B) fully cw. Connect a shorting strap across **S2608** (Fig. 4-11A). Apply the **CAL OUT** signal to **RF IN**put and tune the **CENTER FREQUENCY** to one of the calibrator markers.

b. Switch the front panel **AUTO PHASE LOCKED** switch off, decrease the **FREQ SPAN/DIV** and **RESOLUTION** to 50 kHz/30 kHz, keeping the signal within the display area with the **CENTER FREQUENCY** tuning.

c. Tune the **CENTER FREQUENCY** so the signal is approximately two divisions to the right of center.

d. Switch the **AUTO PHASE LOCKED** switch on and off while adjusting **R2605** (Fig. 4-12) so the signal locks near the same position it was at with phase lock off. If it appears that **R2605** does not have enough range, proceed with step e.

e. Switch the phase lock off and tune the signal two divisions to the left of center.

f. Switch the phase lock on and off and check that the signal locks remain near the same point.

g. Remove the shorting strap across **S2608**. Switch the **AUTO PHASE LOCKED** switch on and center the signal on screen.

### 8. Adjust the Error Amplifier Gain

a. With the signal centered, decrease the **FREQ SPAN/DIV** and **RESOLUTION** to 200 Hz/30 Hz. Switch the display mode to 10 dB/DIV and decrease the sweep rate so the display remains calibrated. Switch the main-frame to Store mode so the full span can be observed.

b. Adjust **R1755** (Fig. 4-11B) to obtain the best signal to noise ratio and still maintain phase lock. If phase lock is lost, turn **R1755** cw and repeat the above procedure.

c. Switch **FREQ SPAN/DIV** to 5 kHz, **RESOLUTION** to 3 kHz. Check that the noise level, 25 kHz from center, is down at least 70 dB from the signal reference level.

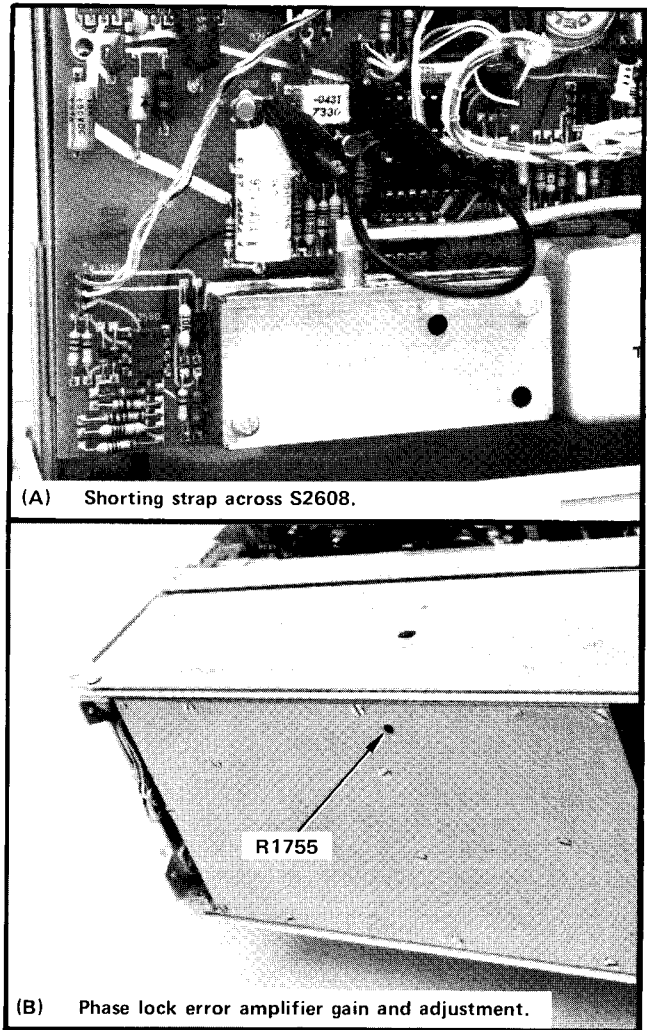


Fig. 4-11. Location of the Phase Lock calibration adjustments.

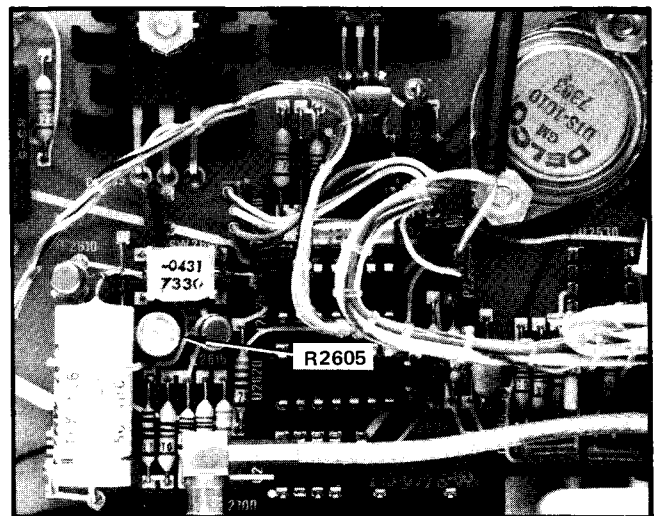


Fig. 4-12. Location of Memory Adjust R2605.

## Calibration Procedure—7L13

### RESOLUTION

#### 9. Adjust the Bandpass of the 105 MHz IF Amplifier and 300 kHz Filter

a. Set the following front panel selectors to the positions indicated.

FREQUENCY	400 MHz
FREQ SPAN/DIV	1 MHz
RESOLUTION	30 kHz (Uncoupled from the FREQ SPAN/DIV selector)
Display Mode	2 dB/DIV
Phase Lock	On
TIME/DIV	10 ms
VIDEO FILTER	OFF

b. Apply either a 400 MHz signal from a signal generator, or the 50 MHz CAL OUT signal from the 7L13 calibrator to the RF Input. Adjust the generator output or the gain from the 7L13, until the 400 MHz signal is displayed on screen. Center the signal on screen with the tuning control.

c. Change the RESOLUTION to 3 MHz and establish a signal amplitude of approximately 7 divisions with the signal generator output control or the 7L13 REF VARIABLE control.

d. Adjust the response of the 105 MHz IF amplifier, and the wide filter bandpass, with C82, the 3 MHz helical resonator. (Fig. 4-13) and C456, in the filter circuit. (Fig. 4-14) so the response is similar to that illustrated in Fig. 4-16.

#### NOTE

*Keep the signal centered as the tuning adjustments are made. Switch back to 30 kHz or 3 kHz RESOLUTION periodically, to ensure that the signal is tuned to the graticule center. This locates the center of the 10 MHz IF. There is no recommended sequence of adjustments, however, the following is applicable for most instruments:*

- 1) Adjust C82 so the response moves slightly to the left of center or the low frequency side of the display.
- 2) Adjust the input and center resonators to shape the display and the output resonator to keep the response centered.
- 3) Adjust C456 (Fig. 4-14) for maximum bandwidth and amplitude.

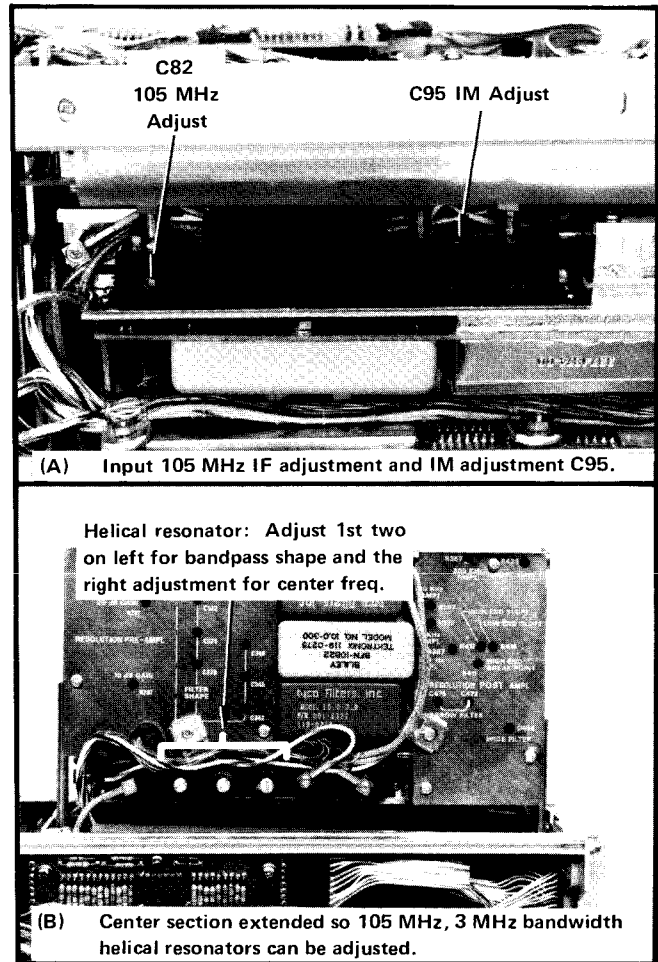


Fig. 4-13. 105 MHz IF and 3 MHz bandwidth adjustments.

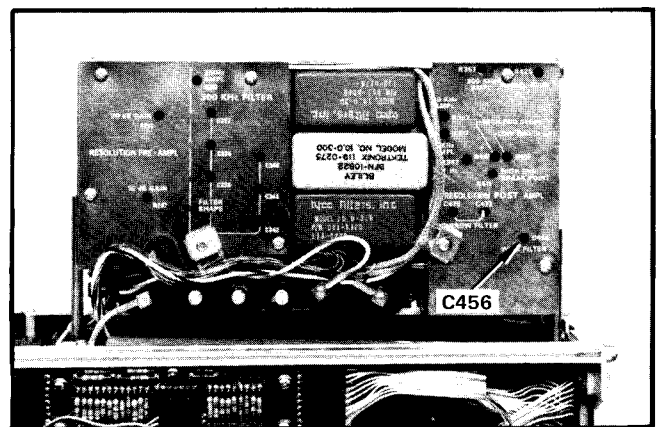


Fig. 4-14. Wide-Band Filter adjust C456.

Bandpass, at the -6 dB down point, should equal 3 MHz  $\pm$ 10%; however, the bandwidth specification is within 20% of the resolution bandwidth selected. The response flatness can vary as much as 2 dB. Fig. 4-15 illustrates this variation with dashed lines. The shape should resemble that of the illustration.

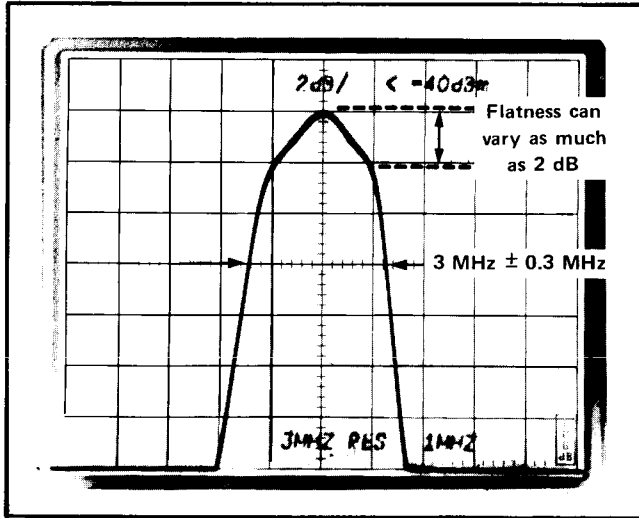


Fig. 4-15. Typical response characteristics for the 105 MHz IF through the Wide Filter.

e. Set the FREQ SPAN/DIV to .1 MHz and the RESOLUTION to 30 kHz. Carefully center the signal with the tuning controls.

**NOTE**

*It is important to calibrate in the phase lock mode.*

Remove the shield cover over the post-resolution amplifier. Remove P304 (jumper for relay K357, see Fig. 4-16A). Remove P301 and P303, of cables W307 and W356. Connect P301 of cable W307 to J303. Ensure that the signal lead, of P303, is connected to pin 1 of J303.

f. Change the RESOLUTION to 3 MHz. Adjust the narrow filter circuits with C472 and C475 (Fig. 4-16A), for a flat-topped response that is similar to that illustrated in Fig. 4-16B. Keep the response centered as these adjustments are made. Do not change the front panel tuning control setting or the frequency of the signal generator. Bandpass at the 6 dB down point, should range between 500 kHz to 600 kHz.

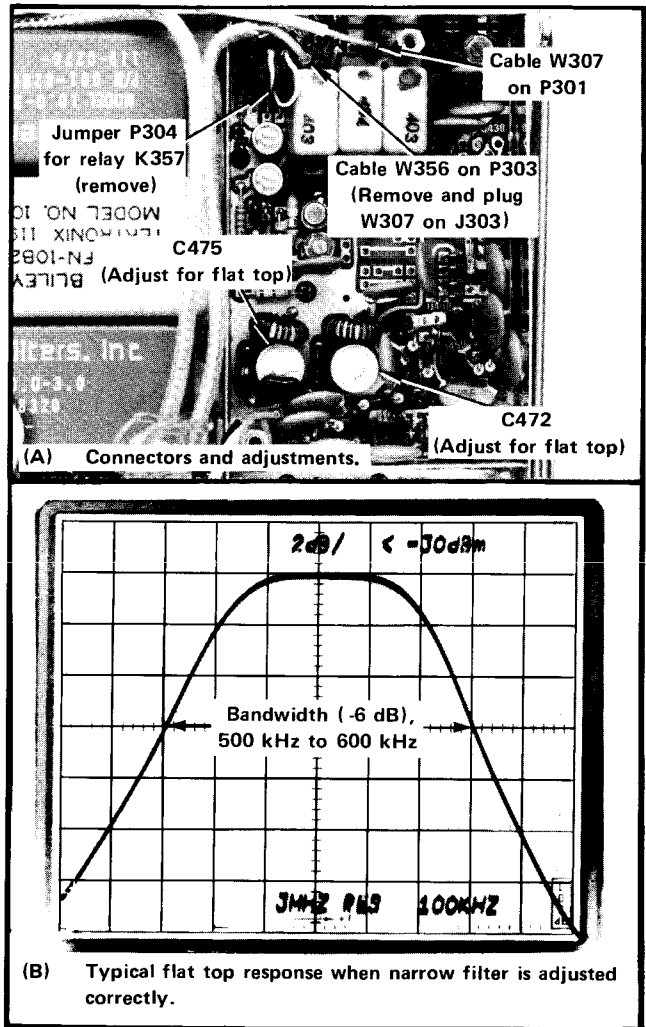


Fig. 4-16. Connections, adjustments, and typical response when adjusting the Narrow Post-Amplifier Filter.

g. Reconnect, the plugs for cables W307 and W356, to their respective pins and replace the jumper plug for relay K357.

h. Switch the RESOLUTION to 30 kHz, FREQ SPAN/DIV to 100 kHz. Ensure that the signal is still centered on screen. If necessary, tune the signal to center then switch the RESOLUTION to 300 kHz.

## Calibration Procedure—7L13

i. Adjust the 300 kHz filter, with C322 through C348 (Fig. 4-17A), for a response that is similar to that shown in Fig. 4-17B.

### NOTE

*If the response is similar to the illustration of Fig. 4-17, try tweaking each capacitor a slight amount. If the response is not centered or is asymmetrical, adjust the capacitors to center and peak the amplitude of the response, then adjust each filter until the response is symmetrical and  $300\text{ kHz} \pm 10\%$  wide. (The input and output resonators usually affect the centering and bandwidth of the display and the center resonators the display slope.)*

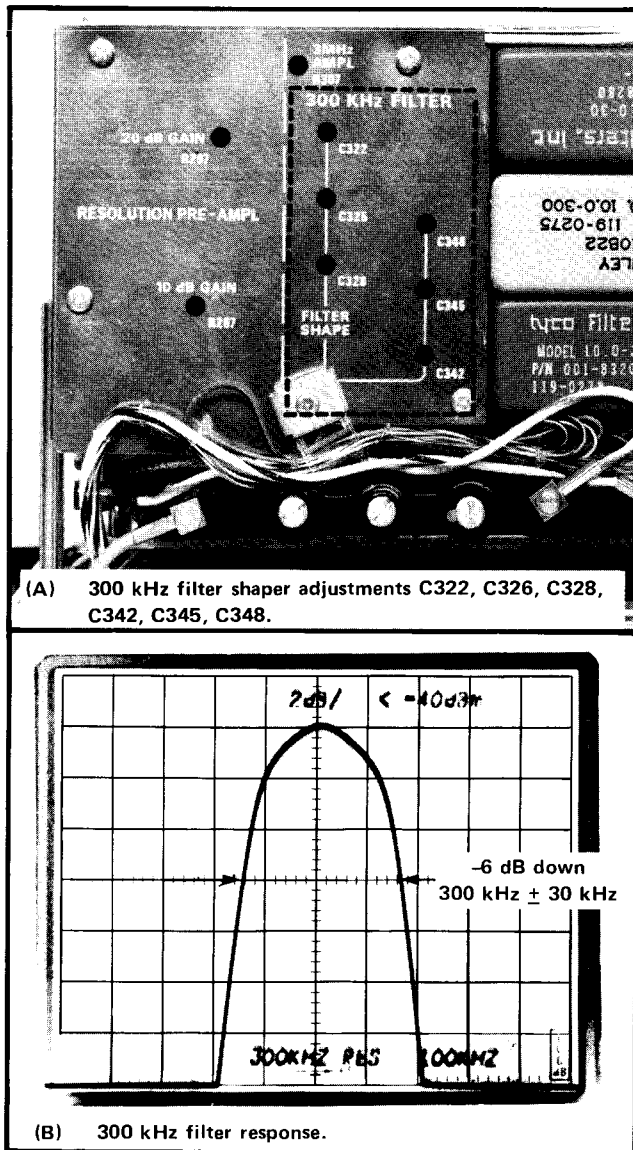


Fig. 4-17. 300 kHz Filter adjustments and typical response characteristics.

## 10. Adjust the Resolution Gain Leveling Compensation.

a. With the signal phase locked, reduce the FREQ SPAN/DIV to 10 kHz and switch the RESOLUTION to 30 kHz. Center the signal on screen with the tuning control and set the signal amplitude to approximately 7 divisions with the REF VARIABLE control.

b. Preset R367 and R377 for maximum amplitude at 3 kHz and 30 kHz resolution.

c. Switch the RESOLUTION between 30 kHz at 10 kHz/Div span and 3 kHz at 1 kHz/Div span. Select the RESOLUTION setting with the lowest signal amplitude and adjust the signal level to 7 divisions with the REF VARIABLE control.

d. Compensate the gain for each RESOLUTION setting, with the amplitude adjustments listed in Table 4-1 and illustrated in Fig. 4-18, so the signal amplitude remains constant through all resolution settings.

### NOTE

*Decrease the sweep speed to maximize the signal amplitude for the 300 Hz RESOLUTION setting.*

TABLE 4-1

RESOLUTION	FREQUENCY SPAN/DIV	ADJUST
3 MHz	1 MHz	R307 (3 MHz Ampl)
.3 MHz	.1 MHz	R2705 (300 kHz Ampl)
30 kHz	10 kHz	R367 (30 kHz Ampl)
3 kHz	1 kHz	R377 (3 kHz Ampl)
300 Hz	.5 kHz	R387 (300 Hz Ampl)
30 Hz	200 Hz	R2730 (30 Hz Ampl)

e. Change the FREQ SPAN/DIV to 1 MHz, RESOLUTION to 3 MHz, RF Attenuator to 0 dB, and turn the Gain selector fully ccw. Position the baseline of the display on the bottom graticule line, then adjust the REF VARIABLE control for a signal level of 7 divisions. If you run out of range on the REF VARIABLE control, tune to a lower frequency signal.

f. Switch the RF Attenuator to 10 dB and increase the Gain setting 10 dB (one position cw from the reference setting).

g. Adjust the 10 dB gain R267 (Fig. 4-18) so the signal amplitude equals the 7 division reference amplitude established in step e.

h. Increase the RF Attenuator setting to 20 dB and the Gain setting an additional 10 dB. Switch in the 300 Hz VIDEO FILTER.

i. Adjust the 20 dB Gain R297, (Fig. 4-18) so the signal amplitude is again 7 divisions.

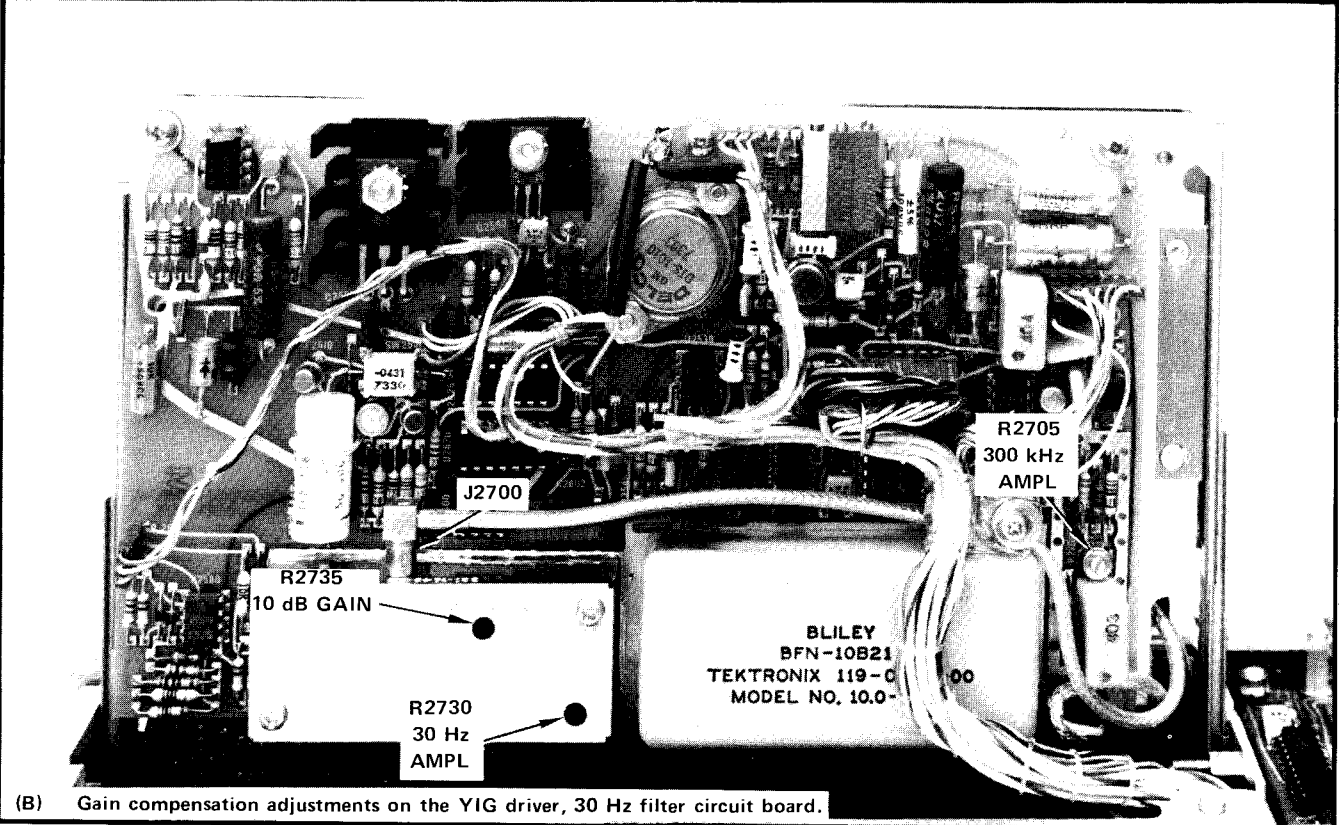
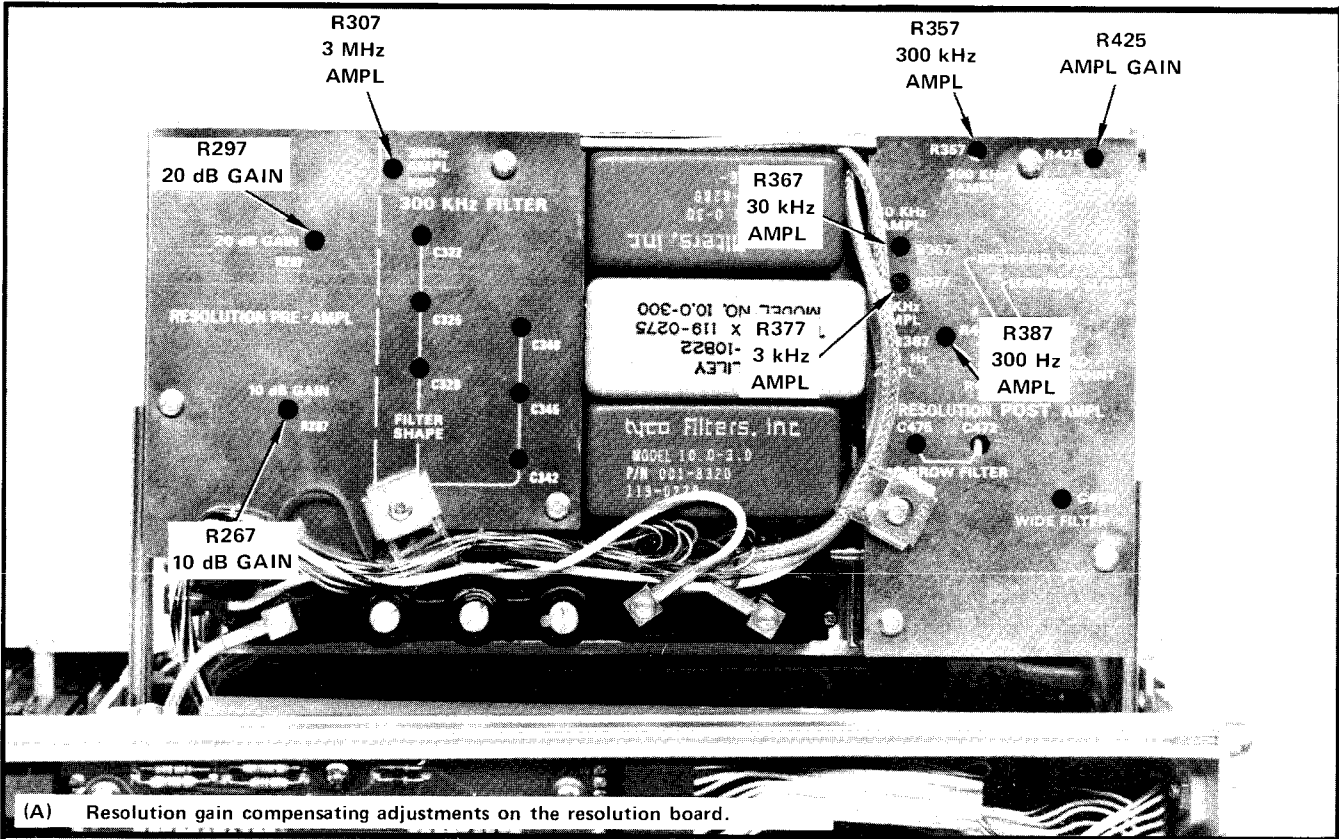


Fig. 4-18. Resolution gain compensating adjustments.

## Calibration Procedure—7L13

j. Switch the RF Attenuator to 30 dB and increase the Gain setting 10 dB. Check that the signal amplitude equals 7 divisions  $\pm 0.5$  divisions. Since there is no adjustment for 30 dB gain, it may be necessary to compromise between the 10 dB gain adjustment and the 20 dB gain adjustment.

k. Apply the CAL OUT signal through a 10 dB step attenuator (such as Hewlett Packard Model 355D) to the RF INput; or apply a 50 MHz signal from a signal generator with a calibrated variable attenuator, such as Hewlett Packard Model 608D, to the 7L13 RF INput.

l. Tune the signal to center screen. Decrease the FREQ SPAN/DIV and RESOLUTION bandwidth to 200 Hz/30 Hz while keeping the signal centered on screen with the tuning control.

m. Switch the 300 Hz VIDEO FILTER on and the display mode to 2 dB/DIV. Increase the signal input attenuation, with the step attenuator or the variable attenuation, while increasing the 7L13 gain until the REFERENCE LEVEL is  $-100$  dBm and the signal attenuation is 80 dB. The signal level is now  $-110$  dBm.

n. Adjust the signal amplitude to some reference point on the graticule, with the REF VARIable control. Increase the signal attenuation 10 dB and switch the 10 dB GAIN button on.

o. Adjust the signal amplitude to the reference established in step n, with R2735 (Fig. 4-18).

p. Disconnect and remove the test equipment cables. Switch the 10 dB GAIN off and return the REFERENCE LEVEL to  $-30$  dBm. Switch out the VIDEO FILTER.

### 11. Adjust the Post Resolution Amplifier Gain

This adjustment sets the gain of the post resolution amplifier so an input of  $-17$  dBm will provide full screen deflection.

a. Switch the FREQ SPAN/DIV to .1 MHz (100 kHz) and the RESOLUTION to .3 MHz (300 kHz). Set the TIME/DIV to 10 ms. Switch the REF VARIable to CAL. Switch the display mode to 2 dB/DIV and position the trace at the bottom graticule line.

b. Apply a 10 MHz signal at  $-17$  dBm, from the signal generator, through a BNC to subminiature (SEALLECTRO) adapter, to J2700 (Fig. 4-18b).

c. Adjust the post resolution amplifier gain with R425 (Fig. 4-18a) for a display reference level of 8 divisions.

d. Remove the cable from the signal generator to J2700 and replace P2700.

### 12. Minimize Intermodulation Products

a. Set the following front panel controls as indicated:

FREQ SPAN/DIV	.5 MHz
RESOLUTION	30 kHz
Display Mode	10 dB/DIV
RF Attenuator	0 dB
Gain	Fully ccw
REFERENCE LEVEL	$-30$ dBm

b. Apply two signals, separated by 1 MHz, from two  $50 \Omega$  signal generators, through 10X attenuators (for isolation) then through a BNC "T" connector to the RF INput. (Fig. 4-19).

c. Tune the 7L13 CENTER FREQUENCY midway between the two signals and adjust the output of the generators so the amplitude of both signals is at least full screen, or until sidebands can be observed on the display.

d. Adjust IM Adj C95 (Fig. 4-20) to minimize the amplitude of the sidebands.

e. Remove the signal generator hookup to the RF INput.

## 50 MHz CALIBRATOR

### 13. Adjust the Calibrator Output ( $-30$ dBm $\pm 0.3$ dB)

Since the output of the 7L13 Calibrator contains harmonics, direct power measurement is not possible. The following are suggested methods and procedures:

#### Vector Voltmeter Method (Hewlett Packard Model 8405A Vector Voltmeter)

1) Terminate the "A" probe, with a BNC  $50 \Omega$  feedthrough termination and connect the probe through the termination, to the CAL OUT connector on the 7L13.

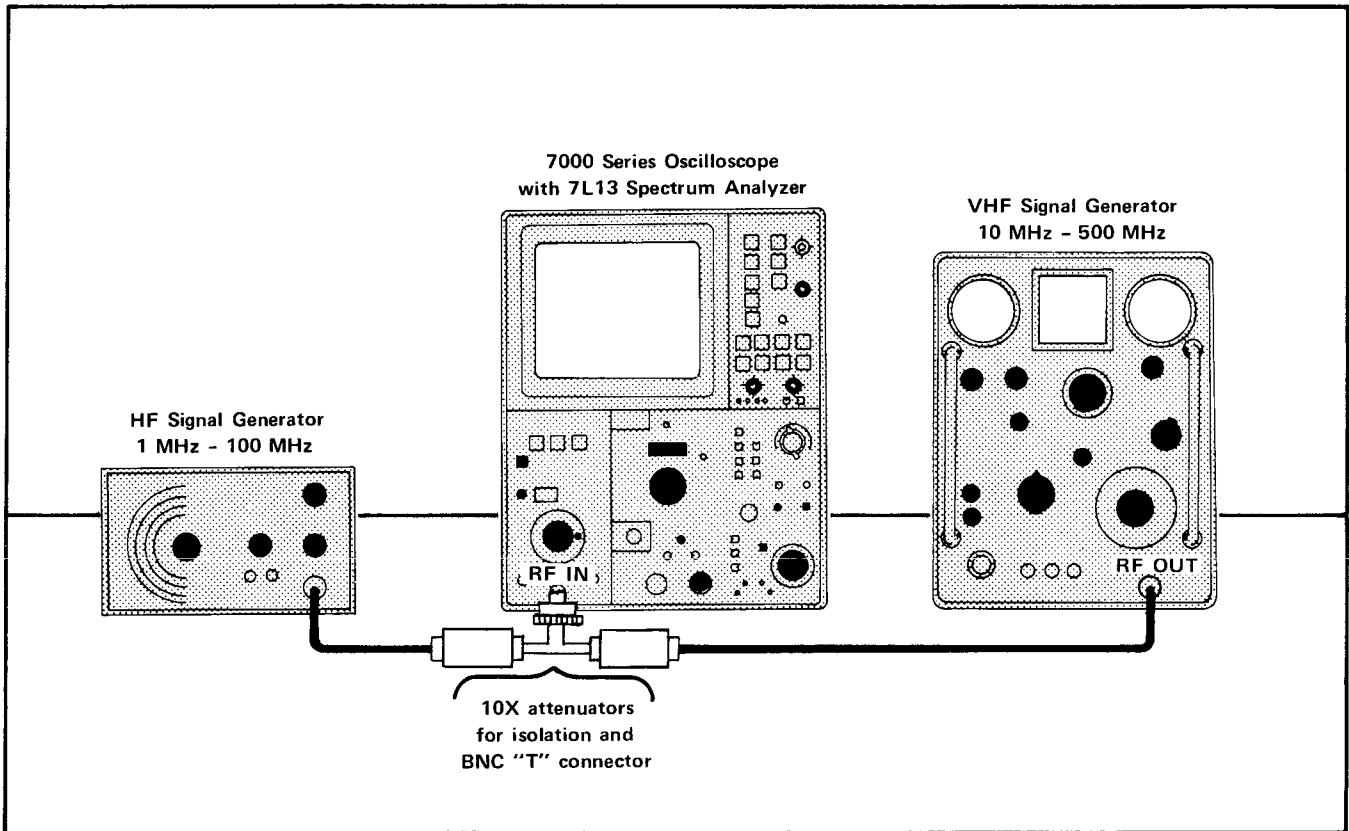


Fig. 4-19. Equipment setup to measure IM distortion.

- 2) Switch the Vector Voltmeter frequency to 50 MHz.
- 3) Check that the RMS reading is between 6.85 mV and 7.3 mV ( $-30$  dBm is 7.07 mV RMS, into  $50 \Omega$ ).
- 4) The calibrator output level can be adjusted by, removing the left vertical plug-in unit and the oscilloscope left side panel to gain access to the 7L13 calibrator. Adjust R956 (Fig. 4-21) for an output level of  $-30$  dBm (7.07 mV RMS).

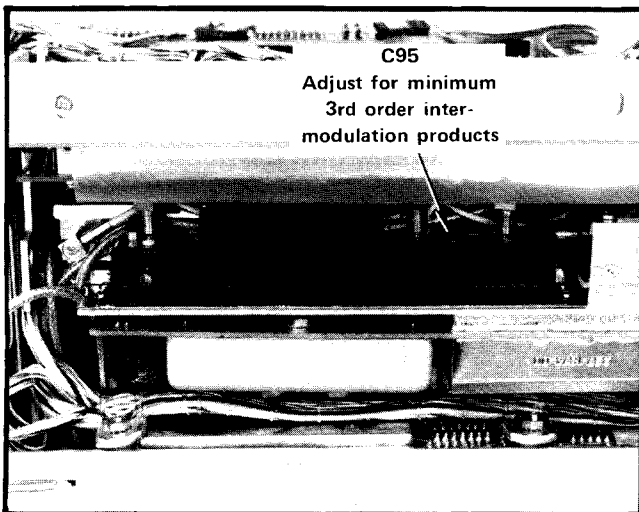


Fig. 4-20. Location of C95 in 3rd Mixer Assembly.

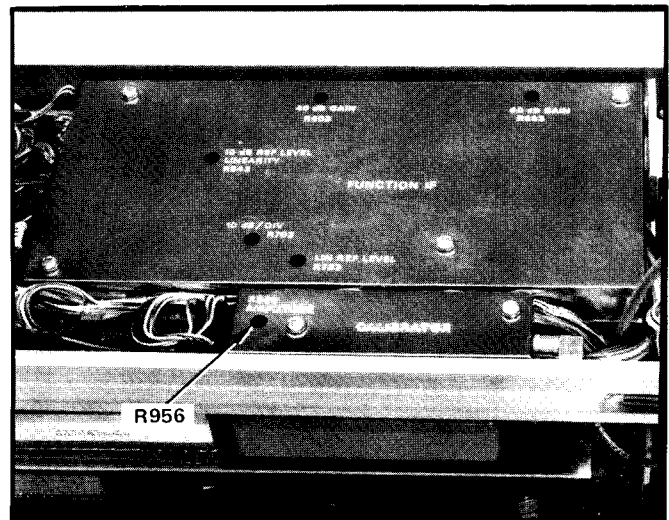


Fig. 4-21. Location of R956, Calibrator Output Level adjustment.

## Calibration Procedure—7L13

**Using a Power Meter (within 0.1 dB) and 50 MHz Low Pass Filter, with 40 dB or more rolloff at 100 MHz through 2.0 GHz; (General Microwave Power Meter Model 454A, or Hewlett Packard Model 432A Power Meter)**

### NOTE

*The insertion loss of the filter and cables, must be accounted for to an accuracy of 0.1 dB.*

1) Connect the power meter through the filter to the CAL OUT connector and measure the output level.

2) If necessary, adjust the 7L13 calibrator output as described in the Vector Voltmeter method (step 4).

**Accurate –30 dBm Signal Source (Signal substitution method)**

### NOTE

*The power meters that were recommended for the preceding method, can be used to verify the signal source output level.*

1) Set the FREQ SPAN/DIV to .5 MHz and the RESOLUTION to .3 MHz. Switch the RF attenuator to 10 dB and the Gain selector fully ccw. Push in the 2 dB/DIV, LOG display button.

2) Apply a calibrated –30 dBm 50 MHz signal to the RF INput of the 7L13 and tune the frequency to center the signal in the graticule window. Adjust the VARIABLE Gain control to position the top of the signal to a reference line (2nd or 3rd from the top).

3) Disconnect the –30 dBm reference signal, then apply the 7L13 CAL OUT signal to the RF INput connector.

4) Adjust R956 so the output of the 7L13 Calibrator is –30 dBm.

This completes the calibration of the 7L13. The Performance Check will verify that the instrument meets specifications.



# CIRCUIT DESCRIPTION

This section describes the functions of the major circuits in the 7L13 and their relationship in the overall operation of the instrument. The description is general and intended as an aid for the technician and operator to help service or operate the instrument at maximum efficiency. A general description of circuit concepts, common to spectrum analyzers, is provided in Tektronix Concept Booklet, "Spectrum Analyzer Circuit," Part No. 062-1055-00.

The section begins with a functional block diagram description, followed with more detailed analysis of the major circuits. Positive logic is used for digital circuits. The diagrams contain typical waveform and voltage data that should be helpful to understand circuit functions and aid in troubleshooting the instrument.

## BLOCK DIAGRAM

The 7L13 is a swept front end spectrum analyzer that covers the frequency range from 1 kHz to 1.8 GHz and provides a frequency span of 1.8 GHz. A detailed block diagram in the Diagrams section, illustrates signal paths and function of the major circuits. Refer to this diagram while reading the description.

The input signal path to the 1st mixer consists of a 0 to 60 dB step attenuator, a 1.8 GHz low-pass filter, and a 3 dB isolation pad. The stop band for the filter begins at 2.095 GHz. The filter attenuates frequencies of 2.095 GHz (1st IF) and higher, that may exist between the 1st mixer and the RF INput. This reduces susceptibility to image responses, IF direct feed-through from the RF INput, and keeps the 1st LO output from reaching the RF INput connector.

The 1st mixer is a double-balanced type mixer, with its input and output isolated by a 3 dB pad and a traveling wave directional filter, respectively. The 3 dB pad reduces VSWR interaction and improves the response flatness. The traveling wave directional filter reduces intermodulation distortion and provides a termination for image responses from the 1st mixer.

The frequency of the 1st LO is swept, when the frequency span is 100 kHz/Div or more, through some portion or all of the frequency range from 2.095 GHz to 3.895 GHz. The center frequency of the oscillator can also be tuned through the selected frequency span. When the frequency span is 50 kHz/Div or less, the 1st LO frequency is fixed and the 2nd LO is swept through the selected span.

The output of the 1st mixer (1st IF) is centered at 2.095 GHz. A bandpass filter 10 MHz wide (with a center frequency of 2.095 GHz) attenuates the upper sideband, and a 2.2 GHz low-pass filter ensures the outband integrity of the bandpass filter. The 1st IF is converted to 105 MHz (2nd IF) in the 2nd mixer by mixing the 2nd LO frequency of 2.2 GHz with the 1st IF of 2.095 GHz.

The 2nd IF signal is amplified by a Pre-Resolution amplifier, then reduced in bandwidth to 3 MHz by a three-cavity helical resonator filter. The 105 MHz IF is converted down to 10 MHz in the 3rd mixer by the 3rd LO frequency off 95 MHz mixing with the 2nd IF of 105 MHz. Amplification and bandwidth of the 10 MHz 3rd IF, are controlled in the resolution and function IF amplifier stages. Amplification is controlled by switching in amplifier stages. Bandwidth is controlled, in decade steps from 3.0 MHz to 30 Hz, by switching bandpass filters into the signal path. IF gain can be selected in 10 dB steps from 0 to 70 dB. Gain stages are in the Pre-Resolution amplifier and the Function IF amplifier, with an additional 10 dB of gain in the 30 Hz filter. The additional 10 dB of gain may be added only when the resolution bandwidth is 30 Hz and the display mode is 2 dB/DIV or LIN. Variable gain between the 10 dB steps, is provided by a variable gain stage in the Post-Resolution amplifier.

The Function IF amplifier contains circuits for logarithmic, linear, and vertical deflection factor. The log displays are 2 dB/Div and 10 dB/Div. The amplifier also compensates for the gain variation when the resolution bandwidth and display modes are changed, so the reference level remains constant through all combinations of resolution and display modes.

The detected signal from the Function IF amplifier is amplified and summed with voltage levels for vertical positioning, then applied through push-pull amplifiers to the oscilloscope mainframe interface. Three auxiliary circuits can be switched into the video signal path. These circuits provide; video filtering (30 kHz, 300 Hz, and 10 Hz), pulsed video signal processing or pulse stretching, and baseline suppression.

The sweep circuits provide the frequency base or time base for the display. In the frequency domain, the output from the sweep generator is applied through the horizontal amplifier to the mainframe interface, for the horizontal deflection, and through the frequency span attenuator to the 1st or 2nd local oscillator, for frequency sweeping. The frequency span of the display is therefore a function of how much the 1st LO or the 2nd LO is swept.

## Circuit Description—7L13

The sweep ramp from the sweep generator, is attenuated in calibrated increments by the **FREQ SPAN/DIV** attenuator, then applied through switch contacts to either the 1st LO (YIG) driver circuits or the voltage controlled 16-19 MHz oscillator in the 2nd LO phase lock loop.

A current ramp through the main tuning coil, sweeps the 1st LO for frequency spans from 100 MHz/Div through 5 MHz/Div, the current ramp is then applied to the FM coil of the YIG oscillator for spans of 2 MHz/Div through 0.1 MHz/Div. When the frequency span is decreased to 50 kHz/Div or less, the 1st LO may be phase locked and the sweep ramp is applied through switch contacts to a voltage controlled 16-19 MHz oscillator in the 2nd LO phase lock loop. The 2nd LO phase lock loop is a servo system which transmits changes of the 16-19 MHz oscillator frequency to the 2nd LO.

The marker (or ditch) that is displayed when the **FREQ SPAN/DIV** selector is in **MAX** position, is produced by the marker generator. The marker position is relative to the setting of the **TUNE** control so it indicates to the operator the portion of the span that will be display center, when the frequency span is reduced. The marker, is summed with the video at the amplifier that drives the vertical output stage.

This completes the signal path flow and the function of the frequency span circuits.

## DETAILED CIRCUIT DESCRIPTION

The following is more detailed than the block diagram description and should assist in servicing and operating the instrument.

### RF or Microwave Circuits

The RF section consists of sealed microwave assemblies that contain hybrid circuits on ceramic substrates, or circuit boards mounted in a metal substrate. The cover of the assembly is then sealed with a conductive sealant. This seal should not be broken, nor repair attempted. Components in the RF microwave assemblies are identified with a circuit number when they are referred to in the calibration procedure (e.g., C15, C16, and C17 in A10). The circuitry within the block is simplified to illustrate the function of the hybrid assembly.

As previously described in the block diagram description, input signals to the unit can be attenuated in 10 dB increments up to 60 dB, by AT1. These signals then pass through a 1.8 GHz low-pass filter (FL2) with a stop band that begins at 2.095 GHz. Signals in the frequency band from 0 to 1.8 GHz, then pass through a 3 dB isolation pad to the 1st mixer.

The 1st mixer, a double balanced type, converts the incoming broad spectrum of signals to a 2.095 GHz IF, by mixing these incoming signal frequencies with the output of the 1st LO (A12). The 1st LO may be swept and tuned within the 2.095 GHz to 3.895 GHz band.

The output of the 1st mixer (A4) is isolated by a traveling wave directional coupler that couples the 2.095 GHz IF signal to a 2.2 GHz LP filter, 2.095 GHz band pass filter, and into the 2nd mixer in assembly A11. As previously described this isolation improves the performance of the 1st mixer and reduces spurious signals.

The 2nd mixer in assembly A11, mixes the output of the 2.2 GHz 2nd LO (in A20) to convert 2.095 GHz down to 105 MHz IF.

The bandpass and center frequency of the 2.095 GHz IF is adjusted by the capacitors C15, C16, and C17 (in A10) and the coupling of the 2nd mixer, in assembly A11. These adjustments are performed to obtain a bandpass of 10 MHz that is centered at 2.095 GHz with optimum skirt shape. The mixer is oriented in the chamber to one of two balance points to provide the best rejection of spurious products generated by the 1st LO and 2nd LO.

Band reject filters, consisting of 1/4 wavelength stubs that are separated 1/4 wavelength, are distributed along the output transmission lines of the 2nd mixer to the 105 MHz IF. These suppress 2.3 GHz and 4.6 GHz.

The active component for the 2nd LO (in A20) is transistor Q20. Its collector load is a stripline resonator. The center frequency of this oscillator and the frequency span are controlled by an error voltage from the 2nd LO frequency servo system. The oscillator output is coupled through a directional coupler to the 2nd mixer and through a low pass filter to another directional coupler which is part of the 2nd LO frequency servo system.

The phase lock loop for the 2nd LO (in A20) contains a 99.2045 MHz oscillator which is multiplied by a factor of 22. This frequency of 2.1825 GHz is then passed through a bandpass filter (A40) and mixed in A41 with the output of the 2nd LO to produce an IF between 16 to 19 MHz. Bandpass characteristics and center frequency response of A40 are adjusted by the same procedure that is used to adjust the bandpass characteristics of assemblies A10 and A11.

The 16-19 MHz IF output from assembly A41, is also passed through a 2.3 GHz and 4.3 GHz filter that is identical to the filter in assembly A20.

The 1st LO (in A12) is a YIG (yttrium-iron-garnet) tuned oscillator. YIG is a material that changes its resonant frequency when it is subjected to a changing magnetic field. The intensity of this field is controlled by current through the tuning coil. When the oscillator is swept, a current ramp from the YIG driver amplifier stage is applied to this tuning coil. The amplitude of this current depends on the setting of the FREQ SPAN/DIV selector. With FREQ SPAN/DIV setting of 50 kHz/Div or less, the normal state of the 1st LO is to operate in a phase locked mode at a frequency which depends on the setting of the TUNING control and some multiple of a 2.19 MHz reference oscillator.

The front panel 1st LO and 2nd LO OUT jacks (J30 and J36) provide access to the two oscillator outputs. These outputs are used by tracking generators. The two ports must be terminated at all times to prevent reflections back into the system. Termination plugs P30 and P36 provide this termination when the ports are not used.

### Phase Lock and Frequency Stabilization



Frequency stabilization is increased and incidental FM'ing reduced to 10 Hz or less, by a phase lock system that automatically locks the 1st LO at frequency spans of 50 kHz/Div or less unless the front panel PHASE LOCK

switch is in the OFF position. The 2nd LO is always phase locked by a translation phase lock system which is described below.

The 1st LO phase lock loop contains a reference oscillator, a pulse generator and sampler, a phase detector, an error amplifier, and a compensating amplifier that drives the frequency determining element of the oscillator. A narrow rectangular pulse from the sampler driver, at one-half the reference oscillator period, and the output of the 1st LO are applied to a diode detector. The detector output charges to the voltage of the pulse plus the amplitude (at the instant) of the coupled oscillator signal. The summation of these signals is proportional to the phase difference between the 1st LO and the reference oscillator. This voltage is amplified by the error amplifier and drives the compensating amplifier. The output of the compensating amplifier maintains a constant phase difference between the 1st LO and some multiple of the reference oscillator. While a phase difference may exist, there is no frequency error. When locked, the long term frequency stability of the locked oscillator is that of some multiple of the reference oscillator.

To achieve the required stability, the 2nd LO is controlled by a translation phase lock oscillator system. The phase lock loop consists of the circuitry shown in Fig. 5-1. The 2nd LO output is applied through a direc-

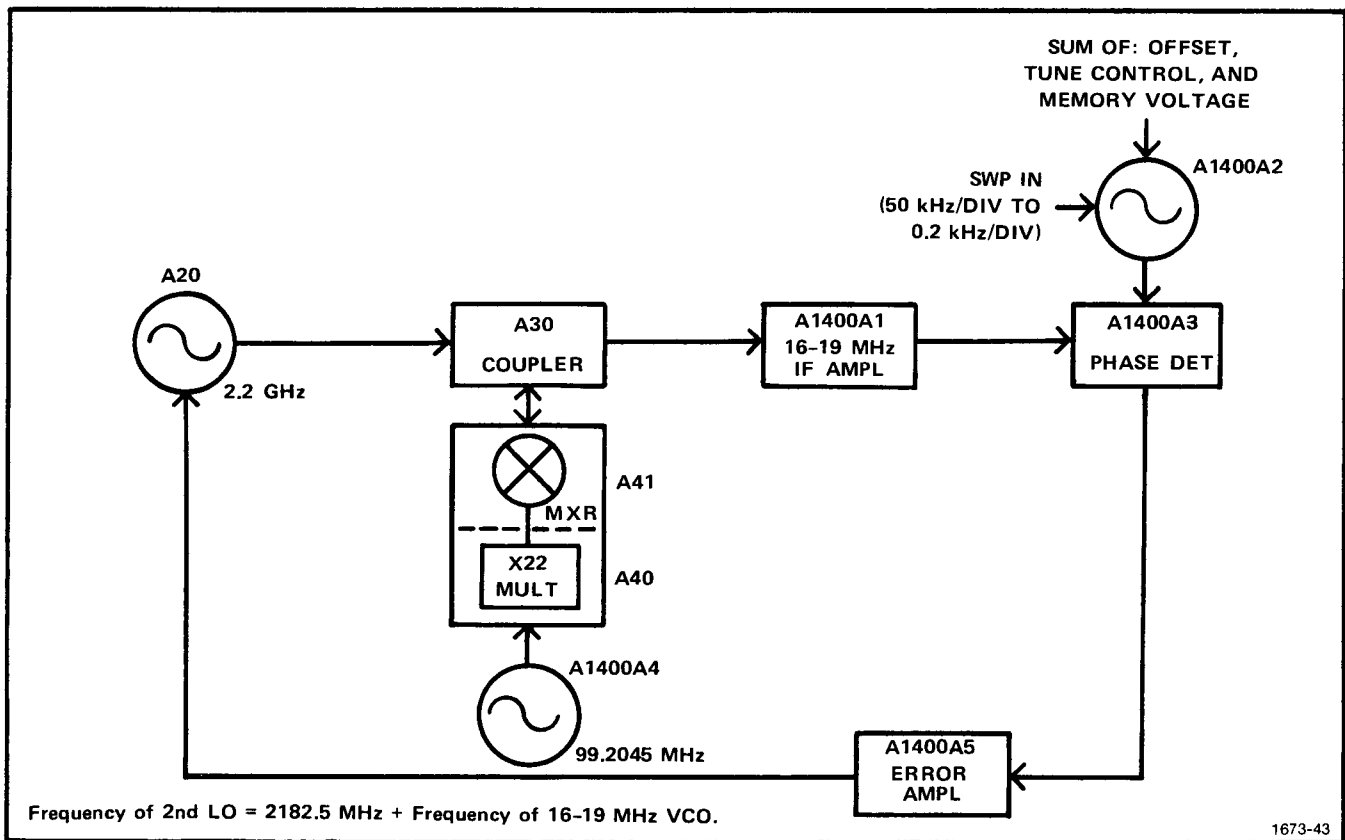


Fig. 5-1. Functional block diagram of 2nd LO phase lock circuit or frequency servo system.

## Circuit Description—7L13

tional coupler to the phase lock loop mixer A41. It mixes with the 22nd multiple of a 99.2045 reference oscillator in A1400A4, and generates an IF signal between 16 to 19 MHz. The 16 to 19 MHz IF signal is amplified and applied to a phase detector (A1400A3) where it is compared with the signal from a 16 to 19 MHz oscillator (A1400A2). The phase difference is detected, amplified by the error amplifier (A1400A5), and applied as a control voltage to the 2nd LO.

When the 1st LO switches from a swept oscillator to phase locked mode, it may shift in frequency. This shift in frequency is coupled through to the VCO for the 2nd LO frequency servo system and pulls the frequency of the 2nd LO in a direction to offset the frequency shift of the 1st LO. The center frequency on the display therefore remains stable. This offset information is provided by the memory offset digital circuit.

The memory looks at the offset voltage of the 1st LO before and after phase lock is set, then generates an offset voltage to apply through a summing amplifier to the 2nd LO frequency servo system.

The 16 to 19 MHz oscillator consists of an emitter coupled logic (ECL) IC with a high Q resonant circuit, that is tuned by a hyperabrupt tuning diode CR1564. The frequency of this voltage controlled oscillator (VCO) is affected by the voltage it receives from the TUNE control memory circuit, offset voltage, and at spans 50 kHz/Div or less, the sweep voltage. The control voltages are applied to both ends of the diode. The summed combination of offset, tune control, and memory voltage is applied through pin F to one side of the tuned circuit and the sweep voltage is applied through pin G, a 30:1 divider (R1560, R1562) to the anode of CR1564.

The sweep voltage comes through the 5 volt regulator circuit board, where its amplitude is adjusted by the Swp Gain adjustment R1960. Additional filtering with C1960, C1962, is switched in at the slower sweep rates to reduce the amount of residual line related noise that may be riding on the sweep line.

The summing amplifier for the tune control, memory, and offset voltage, is U1735. The memory voltage is applied through pin AC and the tune control voltage through pin AN, to the input of the amplifier. The offset voltage that establishes the center frequency of tuning, is supplied by VR1720 and a selectable resistor R1725. Select resistor R1735 sets the gain of U1735 and the response of the 16 to 19 MHz oscillator to the tune and memory voltage.

The output of the phase detector (A1400A3) is amplified by the error amplifier U1715, Q1715, on A1400A5. The amplifier output drives the collector of the 2.2 GHz oscillator to control its frequency.

The sampling generator and driver (A1400A6) are part of the 1st LO phase lock loop. The output from a 2.1944 MHz crystal controlled oscillator is applied through Q1820 and Q1825 to a divide-by-two counter U1825. The 1.0972 MHz output, from the counter, triggers avalanche diode CR1832 to generate strobe pulses for the sampling gate in A50.

The error voltage from the phase detector is applied through J1900 and pin S to the input of U1755, which is the active component for a double-bounded conditionally stable search amplifier. The double bounding of this amplifier is achieved with diodes CR1748 and CR1749 (low leakage, temperature stable diodes) which limit the search amplitude; and CR1742, CR1744, CR1745, and CR1746 which limit the holding range of the loop within the stable gain response range of the phase detector.

The 5 volt regulator board contains; a 5 volt regulated supply, phase lock enable relay K1955, sweep gain adjustment for the 16-19 MHz oscillator, and additional filtering for the sweep voltage line when the resolution is 30 Hz. The phase lock enable relay K1955 switches the 1st LO FM coil from the sweep voltage source to the output of compensating amplifier U1755 (in the phase lock circuit) when phase lock is set. Relay K1965 is energized when the resolution bandwidth is reduced to 30 Hz and adds additional filtering to the sweep line. Gain adjustment R1960 calibrates the 5 kHz/Div and less, frequency spans.

## YIG Driver, Voltage Memory, and Phase Lock Logic

The YIG driver consists of a main coil driver and an FM coil driver. The main coil driver contains an operational amplifier U2510, and a Darlington transistor Q2520. The FM coil driver contains amplifier U2530, driving transistors Q2540 and Q2545. Operation of these drivers is described under Frequency Tuning and Readout that follows this title.

The sequence of events required to phase lock the 1st local oscillator are performed by the phase lock logic circuit. When phase lock mode is set, the sequence of events is as follows: 1) The 2nd LO tune control is engaged and the 1st LO tune control is disengaged. At the same time the sampling generator for the 1st LO phase lock loop is enable. 2) At the end of a delay period, the phase lock enable relay is energized and the search cycle of the loop begins. 3) At the end of another delay period, the memory is activated and it looks at the shift the 1st LO made to reach a lock point. 4) The memory stores this data, which is later applied to the 2nd LO and summed with other controlling voltages to shift the 2nd LO frequency an equivalent amount so it compensates for the shift of the 1st LO frequency when it locked.

Pin 1 of P2550 (input to U2560E) is grounded through the FREQ SPAN/DIV selector when the frequency span is 50 kHz/Div or less. The output of a set-reset flip-flop (U2565A, U2565C) is low when the PHASE LOCK switch S125 is ON. The two high inputs at U2565B produce a low-to-enable signal out, which is inverted by U2560A and applied through pin 4 of P2550 to switch the tuning logic from the 1st LO tuning potentiometer to the 2nd LO tuning potentiometer R20. This high is also applied through U2575A, Q2570, and Q2575 to enable the sampling generator for the 1st LO phase lock loop.

The low-to-enable signal out of the NAND gate U2565B, also triggers a mono-stable multivibrator, U2570. At the end of some delay period, the output of U2570 goes high. This is compared by NAND gate U2565D, to the high at the output of U2560A.

The delayed low, out of U2565D, is applied through buffer amplifier U2575D and energizes phase lock enable relay K1955, on the 5 V regulator board. The delayed low signal is also inverted by U2560B and applied through buffer amplifier U2575B, as a high for the TRACK GEN connector J70, and through a second buffer, U2575C, to another delay circuit in the voltage memory.

At this time, the phase lock loop is closed and starts its search mode. Before one cycle is complete, the 1st LO should acquire lock. To provide the time necessary for the loop to lock, a second delay is inserted in the sequence path by a one shot mono-stable multivibrator U2620 and NAND gate U2625B. At the end of this delay, the output of U2625B goes high which is inverted by U2625A and energizes L2608 to close S2608.

The closing of S2608 contacts allows the capacitor C2610 to charge to the input error voltage at pin 2 of P2600. This error voltage is indicative of the direction and amount the 1st LO traveled to reach a lock point. The contacts of S2608 open and the output of Q2610 and Q2615 goes to the voltage that was stored across C2610. Memory now sends this compensation voltage to the 2nd LO and the center frequency on the display remains stationary.

## Frequency Tuning Control and Readout



Three modes of operation are used to tune the center frequency: 1) Tune control voltage is summed with the sweep voltage at the driver input for the main coil of the YIG oscillator, over frequency spans of 100 MHz/div through 5 MHz/div. 2) The sweep voltage is removed from the main coil driver and applied to the FM coil driver for frequency spans of 2 MHz/div to 0.1 MHz/div. The tune control voltage is still applied to the main coil driver. 3) The sweep and tune control voltages are removed from

the YIG oscillator driver circuits and applied to the 2nd LO driver, for frequency spans of 50 kHz/div or less. The 1st LO is phase locked, providing the front panel PHASE LOCK switch is on.

## Tuning Control 5

The input to P2230-3 (U2200F, U2200D, U2200E) is high when the phase lock is set (PHASE LOCK switch S125 on and FREQ SPAN/DIV selector 50 kHz or less). This condition energizes MP22, which engages the drive clutch to the tuning potentiometer R20 for the 2nd LO. MP20 engages when the input to P2230-3 is low, which is its state for frequency spans of .1 MHz/div (100 kHz/div) and higher. This drives the tuning potentiometer R22 for the 1st LO.

The voltage source for the tuning potentiometers is the outputs of operational amplifiers U2210, Q2215, and U2220, Q2225. Zener diode VR2212 sets the inverting input of U2210 at 9.0 volts, which establishes approximately  $-9.2$  volts at the emitter of Q2215 and  $+9.2$  volts at the emitter of Q2225.

The output of U2225 is proportional to the position of the tuning potentiometer. This voltage is summed with the sweep voltage at the input to the search marker generator, then applied through cam 33 (100 MHz/Div or less) to the YIG driver. The center arm potential of the tuning potentiometer R20, is applied to the summing point at U1735, which drives the frequency determining circuits for the 2nd LO oscillator.

## YIG Driver 4

The dc level, out of the center frequency tuning potentiometer R22, is summed with the sweep voltage at the inverting input to U2510. U2510 is an operational amplifier with a Darlington transistor Q2520 as the negative supply source. Increasing the voltage input to the amplifier increases the current demand from the negative supply. This forward biases Q2520 and increases the current output so the current through the YIG main coil increases until the voltage output of R22 balances the input voltage change to U2510. As the current increases through the YIG main coil, the frequency of the oscillator increases.

When the FREQ SPAN/DIV is reduced to 2 MHz or less, the sweep voltage is removed from the input to U2510 and applied to the FM coil driver (U2530, Q2545 and Q2540). Current through the main coil is now dependent on the dc level from the tune potentiometer R22, which sets the center frequency of the YIG oscillator. K2526 is energized to shunt the main coil with a filter network consisting of R2525, C2524 and C2526.

## Circuit Description—7L13

The FM coil driver is similar to the main coil driver, with the addition of Q2540 supplying positive current to the FM coil.

R2505 adjusts an offset voltage into the summing point of U2510 so the center frequency of the YIG oscillator can be calibrated. R2510 and R2530 set the gain of the operational amplifiers so the frequency span of the YIG oscillator is calibrated for spans of 100 kHz/div and higher.

### Frequency Span

The sweep ramp from either the sweep generator (U1170), the external sweep source, or the manual control circuit, is applied through R1254 to the inverting input of operational amplifier U1250A. This is a voltage ramp from 0 to about 9 volts, which is summed with a dc offset voltage set by R1255. The output sweep amplitude of U1250A, is set by R1250 (Swp Gain) so the ramp is a calibrated 20 volts centered about 0 V. This voltage ramp drives both the search marker generator (U2580A and U2580B) and the frequency span attenuator circuit.

U1250B is the active component of an operational amplifier whose gain is a function of the input-to-feedback resistance ratio. This ratio is selected by the **FREQ SPAN/DIV** selector S108B. The output voltage ramp of U1250B is applied to the YIG oscillator main tuning coil driver U2510, for frequency spans of 5 MHz/Div or more and to the FM coil for spans of 0.1 MHz/Div and 2 MHz/Div. When the **FREQ SPAN/DIV** is 50 kHz or less, this sweep is applied to the phase lock loop for the 2nd LO.

### Marker Generator

Switching the **FREQ SPAN/DIV** selector to **MAX SPAN**, closes cam 34 and opens cams 33 and 32. This routes the tune control dc voltage and sweep voltage output from U1250A to the input of amplifier U2580A. The YIG oscillator is now swept its full frequency span and a marker is generated that is commensurate to the dc potential out of the 1st LO tune control (R22).

The output of U2580A causes diodes CR2590 and CR2592 to switch as the sweep ramp crosses through the dc level setting of the tune control circuit, developing a negative ditch or marker at the output of U2580B. This marker is applied to the vertical output circuit to provide the center frequency marker on the display.

### 105 MHz IF Amplifier, 3rd Mixer and Oscillator

Signals within the 10 MHz bandwidth of the 105 MHz IF, are amplified by Q85. The output load for Q85, is a three sectional helical resonator that is tuned so the bandwidth

is reduced to 3 MHz. The 3rd mixer converts the 105 MHz IF to 10 MHz IF, by mixing 105 MHz with the output of a crystal controlled 95 MHz oscillator.

Aperture coupling is used between each section of the helical resonator. The 3rd mixer is a balanced mixer. L85, and C95 are tuned to the sum of the two input frequencies (about 200 MHz). This reflects the upper sideband back into the mixer and reduces IM signals. C87, R87, L89, and R241 provide a constant impedance matching circuit to the input of the 10 MHz IF amplifier.

### 10 MHz IF Pre-resolution Amplifier and Resolution Filter Circuits

Three circuit blocks comprise the resolution circuit; the 10 MHz preamplifier, five selectable resolution filters, and a post-resolution amplifier. As the resolution bandwidth is selected, gain compensation is provided to maintain a constant signal level input to the Function IF amplifier. The Function IF amplifier is then adjusted so a constant signal reference level is maintained on the display for changes of resolution or display modes.

The signal path through the Resolution Preamplifier depends on the position of relay K281. This relay is energized in all positions of the Gain selector except the first two (0 dB and 10 dB). When energized, the signal path is through Q280 and Q290, which has a gain of 20 dB. Gain of the operational amplifier, containing Q250 and Q260, is increased by 10 dB when the base of Q270 is grounded through the gain selector. This occurs every odd 10 dB step of the selector.

With the gain selector fully ccw (0 db), the 10 MHz input signal to T240 is amplified by the IF amplifier Q240 and the operational amplifier that contains Q250 and Q260. The front panel **AMPL (CAL)** adjustment R80, sets the gain of Q240 so a -30 dBm 50 MHz signal, at the RF INput provides full-screen signal amplitude.

Switching the Gain selector one position cw, grounds the base of Q270, turning the transistor on, and bypasses some of the feedback current of the operational amplifier Q250. The closed loop gain of the stage is therefore increased 10 dB. Gain is accurately calibrated by the 10 dB gain adjustment R267.

Increasing the Gain selector position an additional 10 dB, opens the base of Q270 and energizes relay K281. The output of T264 is now switched through Op Amp Q280-Q290, for 20 dB of additional gain.

Increasing the Gain position to 30 dB grounds the base of Q270, increasing the gain of the preamplifier an

additional 10 dB for a total gain increase through the preamplifier of 30 dB. As previously described, the relay K281 remains energized through the remaining four positions of the Gain selector (total range of the selector is 70 dB, the additional gain variation is provided by the Function IF).

The resolution section contains four crystal filters (for 30 Hz to 30 kHz resolution) and a 300 kHz coupled-resonator filter. The 300 kHz filter consists of six resonant sections and an amplifier. Signal path through or around the filters, is directed and controlled by relays K300, K353, K354, K355, K356, and K357. (The 30 Hz filter is located on YIG Driver Voltage Memory and 30 Hz filter board, Diagram 8). These relays are energized as the RESOLUTION cam switch S108A is switched to positions that connect the relay armature to the -15 V power source.

Amplitude adjustments for each filter section establish a signal output level as the resolution is changed, so the signal reference level on screen remains constant through the RESOLUTION range. It is important when aligning the filters, that their center frequency is centered on the others. This is done by switching in one of the crystal filters periodically to re-establish the center of the band-pass for the 300 kHz and 3 MHz filters.

The resolution output amplifier provides approximately 15 dB of gain. The gain compensates for loss in sensitivity through the microwave circuits. The response across the 1.8 GHz span remains relatively flat (within +1 dB, -2 dB).

The 10 MHz IF signal is routed (by K357) through either a wide filter (3 MHz) or a narrow filter, for additional shaping and noise reduction. Bandpass of the narrow filter is between 500 kHz and 600 kHz. K357 is de-energized when the RESOLUTION is switched from 3 MHz to 0.3 MHz.

### YIG Oscillator Power Supply

#### SN B070294 and below

This supply furnishes a regulated +20 volt and -5 volt to the YIG oscillator. The +20 volt supply uses +50 volt supply from the mainframe. R2550 and R2554 set the reference to the non-inverting input of U2555. U2555 drives the output transistor Q2555. Q2565 is a current limiter for the supply.

Reference level for the -5 volt supply is set by R2583 and R2584 at the non-inverting input to U2585. U2585 drives the output transistor Q2580.

#### SN B070295 and up

This supply furnishes a regulated +15 volt to the YIG oscillator. The +15 volt supply uses +50 volt supply from the mainframe. R2550 and R2554 set the reference to the non-inverting input of U2555. U2555 drives the output transistor Q2555. Q2565 is a current limiter for the supply.

### 30 Hz Filter

This filter contains an amplifier, crystal filter, and a 10 dB gain boost circuit. The 10 MHz IF is routed through the filter when K354 is de-energized, and K2710 is energized. Q2710 and Q2715 are emitter coupled amplifiers. Gain of the amplifier is set by adjusting the amount of feedback from the output of T2714 to the base of Q2715. This adjustment is R2730.

An additional 10 dB of gain is provided when the 30 Hz filter is in the signal path and S27 (10 dB Gain) is closed. This turns Q2735 on and decreases the negative feedback for the amplifier. Gain is calibrated by adjusting R2735.

### 50 MHz Calibrator

The calibrator is a crystal controlled oscillator configured with the crystal in the feedback loop of a multivibrator. Output of the oscillator is calibrated to a -30 dBm with adjustment R956. Output impedance is 50  $\Omega$ .

### Function IF Amplifier

The Function IF consists of six cascode amplifier cells or blocks connected in cascade. Each cell operates as a linear or logarithmic amplifier depending on the display mode selected to provide the gain characteristics required for the three display modes of the 7L13. The gain of each cell is a function of the emitter resistance of the input transistor. In the Log mode, diodes in the emitter circuit of the amplifier reduce the gain at a logarithmic rate from 10 k $\Omega$  to 0 dB as the signal level increases.

When the operator depresses the 10 dB/DIV display button, +15 V is applied through S130A, pin 1 of P135 and pin 2 of P520 to the anodes of the log diodes; CR511-CR512, CR514-CR515, CR517-CR518, CR521-CR522, CR524-CR525, and CR531-CR532. These diodes are forward biased (with no signal input) and the amplifier cell operates at full gain. As the signal input level increases, the emitter voltage approaches the bias of the diodes to turn the diodes off. The amplifier gain therefore decreases to 0 dB.

The gain decreases to 0 dB progressively as the signal level increases, starting with Q720-Q710 and progresses towards the front end.

In the 2 dB/DIV mode, +15 V is applied to diodes CR527-CR528 and CR534-CR535 in the emitters of Q680 and Q720 and +15 V is removed from the anode of the 10 dB log diodes so they are now back biased.

## Circuit Description—7L13

CR534-CR535, in the emitter of Q720, and CR527-CR528 in the emitter of Q680, provide approximately 4 dB of log gain per amplifier cell. This provides two break points, at about 4 dB and 8 dB of the gain curve over the dynamic window. These two break points change the curve slope sufficiently to shape the curve for 2 dB/DIV. R737 and R697 set the slope of the curve after the break point.

The 10 dB and 2 dB/Div Ref Level adjustments R802 and R801, position the linear portion of the log gain curve (see Fig. 5-2) within the 8 division graticule window.

The 2 dB/DIV and LIN mode displays require at least 70 dB of gain through the analyzer's IF; therefore, additional stages are switched in to increase the Function IF gain. S130A is disengaged when the 2 dB/DIV or LIN mode buttons are pressed. The base of transistors Q570 and Q600 now have a return path to ground, through S83 and pin 4 of P84, in the 40 dB or 50 dB positions of the gain selector. Grounding the base of the transistors, turn them on and boost the gain through these amplifier cells an additional 10 dB per cell. Transistors Q630 and Q660 are turned on when S83 is switched to the 60 or 70 dB positions.

Gain of the Function IF amplifier, in the LIN and 2 dB modes, is calibrated at the 40 dB and 60 dB steps by adjusting R603 and R664. Q730 is turned on when the LIN mode is selected and R733 (LIN Ref Lvl) sets the reference level of the display to the top line of the graticule.

The output signal of Q700 is coupled to a linear detector. The linear detector consists of Q740 driving the

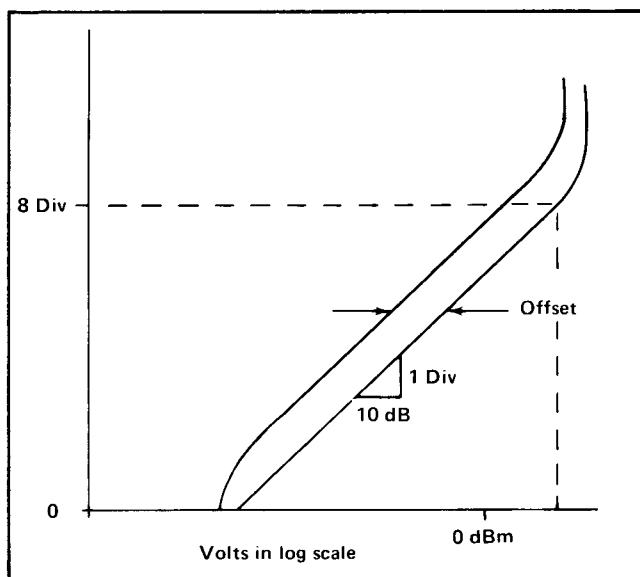


Fig. 5-2. Log converter curve.

common emitter amplifier Q750-Q760 with feedback through C766, the detector diodes CR772-CR771, resistors R775-R776, and C776 to the input of the amplifier.

During the positive and negative excursion of the IF signal, feedback current is supplied through CR772 and CR771. This produces a circulating current through the diodes proportional to the average signal input level. The negative video output signal is developed across R772-R819 and R771. The video is then applied through a filter network to the vertical output stages.

Linear Baseline Offset adjustment R803, compensates for baseline shift when the display mode is switched from LOG to LIN.

### Video Filter, Pulse Stretcher, Baseline Clipper and Vertical Output 10

Video signals from the detector, are amplified by operational amplifier U820B. Its feedback resistance, R826, is shunted by baseline clamping diodes and fast or slow video filter circuits that are switched in by U830 and U840.

Clamping diodes CR825 and CR826 maintain the video baseline reference by clamping the amplifier input and output signal levels. CR825 clamps the input of the amplifier from shifting positive and CR826 clamps the output at P820-2 so this point cannot shift negative.

The three sections of U840 are connected so they operate as OR gates to connect C840 in the feedback loop for U820B. Pulling pin 2 or 3 of P830 low, or closing the front panel 30 kHz switch S90C, turns one section of U840 on, to connect C840 in the feedback loop. Pin 2 of P830 is pulled low when the front panel RESOLUTION selector is switched to the 30 kHz position and pin 3 of P830 is pulled low when the RESOLUTION is switched to 3 kHz or 300 Hz position.

The three sections of U830 and one section of U840 are connected to operate as an AND-OR gate. When 300 Hz (S90A) switch is closed, one section of U830 is turned on to connect C830 in the feedback loop. Closing both S90A and S90C (300 Hz and 30 kHz) turns two sections of U830 and one section of U840 on. This connects C830, C832, and C840 in the feedback loop. The following logic describes the three filter combinations:

30 kHz = (30 kHz RESOLUTION) OR (3 KHz to 300 Hz RESOLUTION) OR (C90C closed).

300 Hz = (S90A closed).

10 Hz = (S90A) AND (S90C closed).



The output of U820B is isolated from summing amplifier U820C by Op Amp U820D. U820C sums the video signal with the dc level set by the vertical position control plus the search marker, when present. The output of U820C drives the positive output for the oscilloscope interface, the inverting amplifier U820A (which drives the negative output to the oscilloscope interface) and the Baseline Clipper circuit.

Closing the PULSE STRETCHER switch S90B, turns Q880 on. Current through an emitter follower output transistor, of amplifier U820D, provides a fast charge path for C880 on the positive excursion of pulsed video signals and a long discharge time-constant to stretch the decay time.

The Baseline Clipper circuit consists of a common emitter current switch (Q887-Q890) and a logic circuit (Q895-Q898) that modulates the Z Axis switching circuit. The Z Axis switching circuit consists of a current switch (Q2320-Q2330) that is controlled by an exclusive OR gate (Q2335 and CR2336). The output of the current switch drives the Z axis common (pin B17) and the Aux Z axis (pin A17).

Q2335 with CR2336, operate as an exclusive OR, to gate the state of either interface pin B7 (channel switch) or A16 (mode info) to the base transistor Q2330. When this

state is high, Q2320 is switched on and positive current through the interface pin A17 (High) reduces or clips the crt beam intensity.

The amount of current through Q2320 or Q2330 is a function of the Baseline Clipper logic circuit. The common emitter current switch Q887-Q890, switches transistor Q898 off when Q887 is on. Composite video from U820C will cause the circuit to switch at some level set by the BASELINE CLIPPER control R96. When Q890 switches on, Q898 is switched on increasing the current through Q2320 to increase the crt beam intensity.

The BASELINE CLIPPER control range is about 50% of the display amplitude. The CONTRAST control sets the quiescent current through CR898 which establishes the contrast between the clipped and unclipped portions of the display.

### Frequency Readout 12 13

The frequency readout system looks at the frequency tune control voltage and outputs both a standard readout signal for the mainframe and a LED readout for the frequency indicator on the 7L13. The system consists of a digital voltmeter, drivers for multiplexing the LED readout, and an A to D converter to drive the mainframe readout circuits. Fig. 5-3 is a basic functional block diagram.

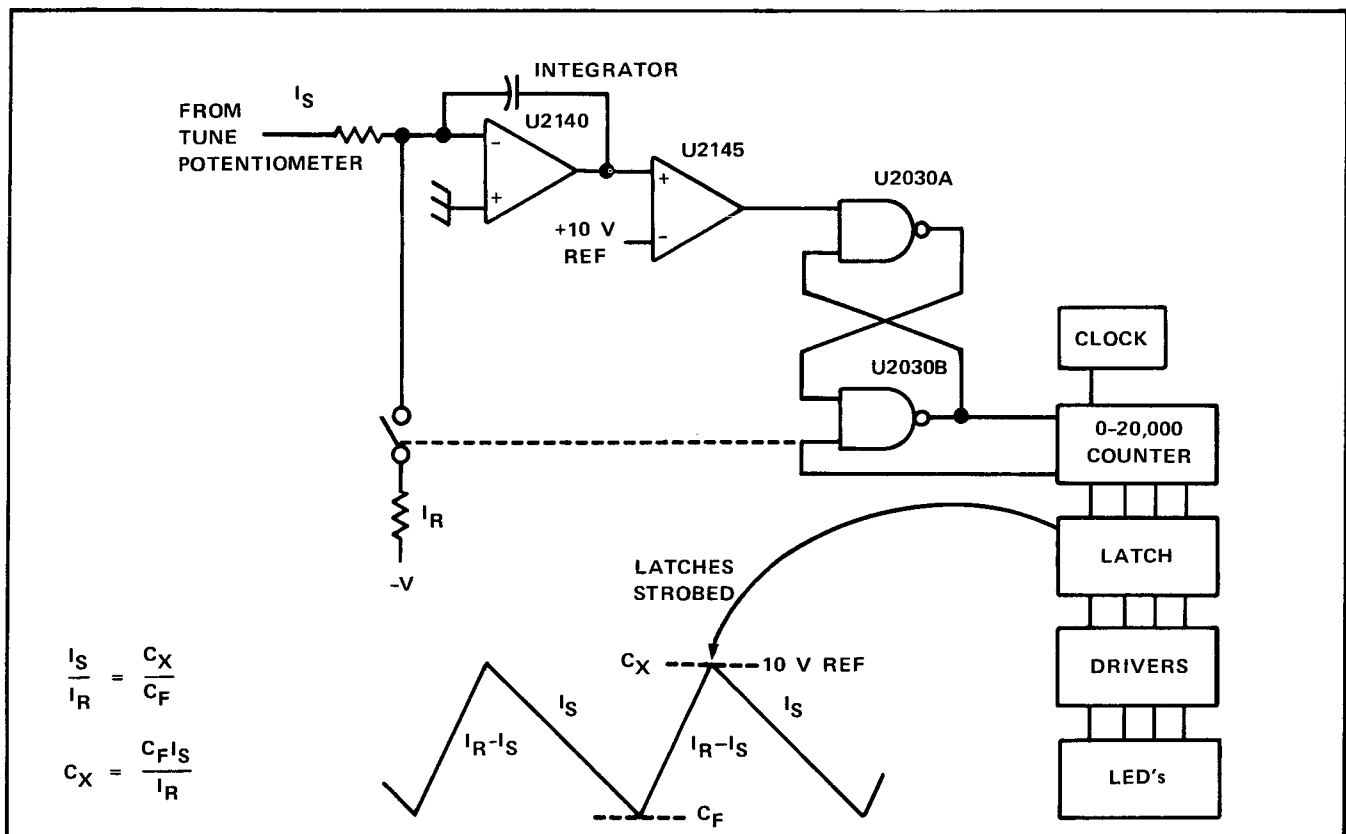


Fig. 5-3. Functional block diagram of the Frequency Readout circuit.

## Circuit Description—7L13

The DVM is a precision oscillator. An integrator is ramped up and down by switching its input currents. These input currents are switched by commands from a digital counter and an analog comparator. During one transition, the count is loaded into latches. This number is then displayed during the next transition.

The integrator generates an output ramp with a timing sequence proportional to the dc level set by the tuning potentiometer for the 1st LO. The comparator generates a step signal output when the ramp signal crosses a reference voltage which triggers the multivibrator.

The counter counts towards 20,000 during the run-up time of the ramp. When the output of the comparator steps positive, it triggers the flip-flop which loads the count into the latch and also shifts its number into decoders and drivers for the LED readout. The new state of the flip-flop also switches the reference current off and the output voltage of the integrator ramps down towards 0 volts.

Referring to the schematic diagram 12; the voltage output of the amplifier U2110 is proportional to the input voltages at pins 2 and 3. The voltage at pin 3 is from the tuning potentiometer, and ranges from about -9 volt to +9 volt. An offset voltage can be summed in with this tuning voltage, for calibration, by adjustment R2135.

Reference current for the integrator U2140, is supplied by a buffered operational amplifier U2120 and Q2120. An input reference voltage of 11.7 volts to U2120 is set by Zener diode VR2115. This sets the current output of Q2120 to a value that is independent of the signal voltages. The current from this source is steered either to the input of the integrator or to the power supply by diodes CR2130, CR2132, and CR2134.

The voltage state of pin F is set by the multivibrator U2030A, U2030B in the digital section of the DVM. When the state is low, CR2132 and CR2134 are off and reference current is steered through CR2130 to the input of the integrator. When the state is high, the diodes are turned on to steer the reference current through R2147 to the power supply.

As indicated in Fig. 5-3, the reference current is larger than the signal current so the output of the integrator is a positive-going ramp when it is summed with the signal current. When the reference current is switched off, the output of the integrator is a negative-going ramp.

The reference voltage source for the comparator U2115, is the output of operational amplifier U2130. The 11.7 volt Zener diode VR2115 sets this output at a very

stable 11.7 volts. This source provides the reference for the offset current through R2135 and the reference for the negative input of the comparator U2145.

As the positive-going ramp from U2110 crosses the reference voltage, the output of the comparator steps high. This triggers the multivibrator U2030A, U2030B and the voltage at pin F goes high to turn diodes CR2132 and CR2134 on. The output of the integrator swings past the reference voltage a slight amount before it starts negative. When it again crosses the reference potential, the output of the comparator switches low.

U2015, in the digital section of the DVM, is a 0 to 20,000 counter and latch. When it counts to 20,000 or 0, pin 18 goes high. This high is fed back through two inverters U2000B and U2000C to reset the flip-flop. The resultant low on pin F turns diodes CR2132 and CR2134 off. The reference current is again summed with the signal current and the cycle repeats. The slope of the positive-going ramp determines the time required for the voltage to reach the reference that determines the count of the counter.

The clock input to the counter U2015 is generated by oscillator Q2005-Q2010. The output of the oscillator is applied through emitter follower Q2015, to pin 1 of U2015. The digit output on pins 4, 5, 6, and 10 is in binary format. The count in the latch of U2015 is transferred, when the latch is strobed, to a BCD-to-7 segment decoder (U2020) and through inverter drivers (U2000A, U2000D, U2000E, and U2000F) to a digital-to-analog converter U2065. The converter sums the digital current input and provides column sense data (at pin 19) for the readout circuits of the mainframe.

The digits are displayed sequentially. The seven digit code for the LED's is applied from decoder U2070; however, only one digit lights at a time. The command to light each digit is sent out on pins 8, 7, 17, and 22 of U2015, to LED DS2075. The clock pulse that strobos the display command from one digit to the next is applied to pin 11 of U2015 from NAND gate U2030D. When a time slot goes low, the clock continues to strobe the counter from one digit to the next (1, 10, 100, 1000) until the corresponding digit display command is gated through AND-NOR gate U2040. At this time the clock signal through the NAND gate U2030D is blocked and the column sense signal current is sent from pin 19 of the D to A converter U2065, to the mainframe readout.

One unit of current differential exists between the LED readout and the mainframe. Resistors R2020, R2026, R2133, and R2137 are connected between the respective time slot line and the sense line to add an additional unit of current for the mainframe readout circuit.

**Uncal Circuit** 17

Reference level calibration of the display depends on the combination of frequency span, resolution bandwidth, sweep rate, and video filter bandwidth. It was determined from the amplitude loss factor equation<sup>1</sup>;

$$\alpha = \left[ 1 + 0.195 \left( \frac{D}{tB^2} \right)^2 \right]^{-1/4}$$

that the display is calibrated when the combination of the above parameters cause the equations;

$$\frac{\text{Freq Span}}{0.5 (\text{min } B, V) (B) (t)}$$

to equal or exceed 1, where

min B, V = minimum bandwidth of either the resolution or video filter

B = Resolution bandwidth

t = Sweep time

The multiplication and division of quantities in this equation can be done by summing the logarithm of the various parameters. The equation becomes:

$$\log (\text{freq span}) - \log (0.5) - \log (\text{min } B, V) - \log (t) \geq 1$$

By normalizing these parameters so each term is equals or is greater than zero, the equation becomes:

$$- \log \left( \frac{200 \times 10^6}{\text{Freq Span}} \right) + \log \left[ \max \left( \frac{10^6}{B} \text{ or } \frac{10^6}{V} \right) \right] +$$

$$\log \left( \frac{10^6}{B} \right) - \log \left( \frac{t}{5 \times 10^{-3}} \right) - 1.097 \geq 0$$

The logarithmic summation of these parameters is performed by an analog circuit and compared against ground or zero. The resultant indicates if the display is uncalibrated or calibrated. Fig. 5-4 illustrates the basic uncal circuit.

<sup>1</sup>Morris Engelson, "Spectrum Analyzer Measurements (Theory and Practice)". Tektronix Concept Booklet No 062-1334-00.

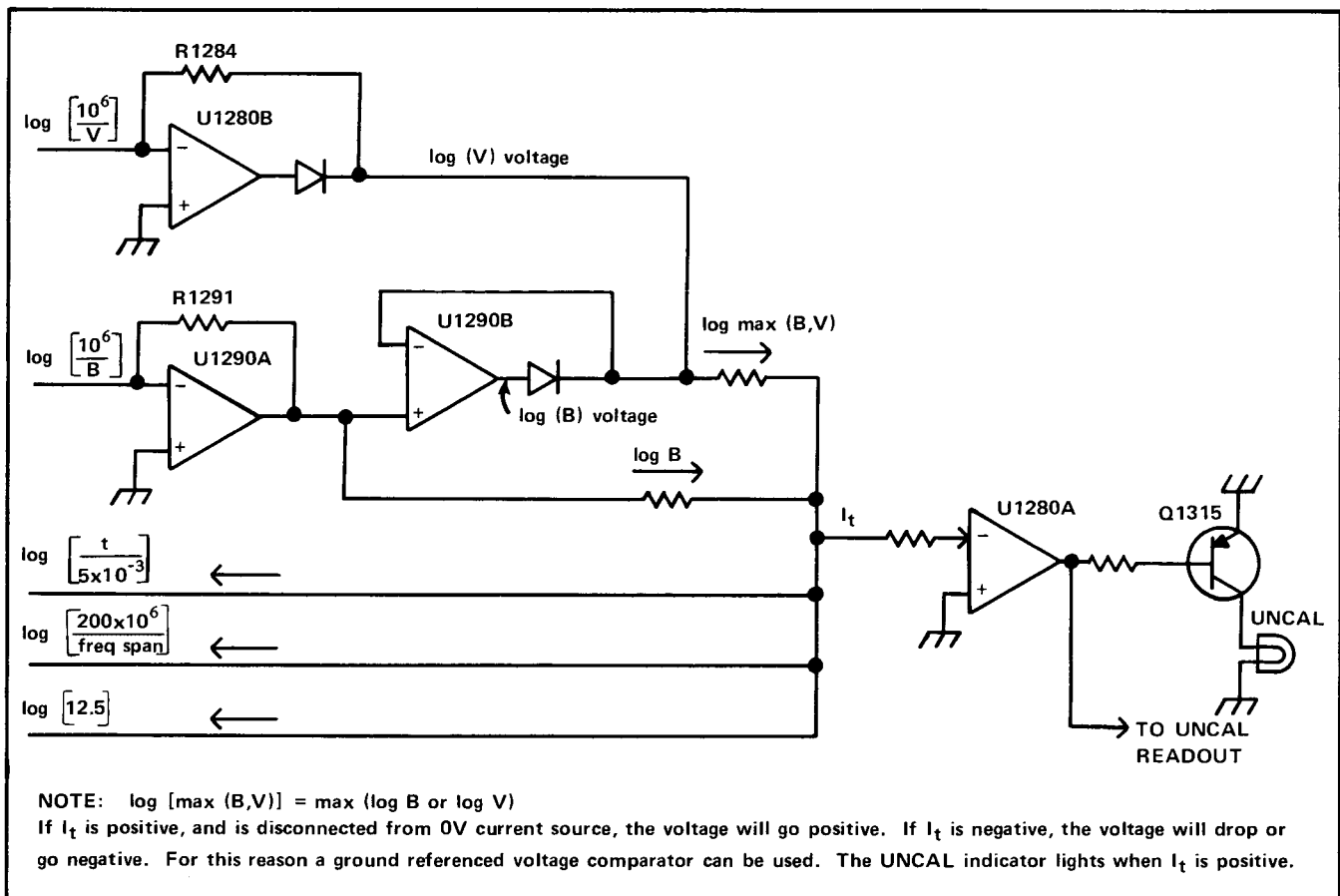


Fig. 5-4. Basic functional diagram of the Uncal circuit.

## Circuit Description—7L13

### Sweep Triggering, Sweep Generator and Horizontal Amplifiers

The sweep ramp is generated by U1170 when it is gated on by a positive gate signal from U1180. U1180 can be triggered, or it will automatically recycle after an RC time interval (set at pin 12) to provide a constant baseline.

Triggering for the sweep generator circuit is supplied from one of three sources which are selected by S101. The selected trigger signal is applied to the input of an operational amplifier U1010B. The output of U1010B is summed with the dc level set by the LEVEL control R100. When the triggering signal amplitude exceeds this dc level, CR1038 is switched on to generate a positive trigger signal for the trigger input to U1180. The following occurs as each source is selected: 1) EXT connects the EXT IN HORIZ/TRIG connector to the input of operational amplifier U1010B. 2) INT selects the output of a differential amplifier U1010A, which receives its trigger signal from the mainframe interface. 3) LINE selects a sample of the line voltage from the mainframe interface and applies it to the input of U1010B. FREE RUN (a triggering mode) grounds the input of U1010B, which sets the output of U1010C to approximately 0 volt and the input to pin 4 of U1180 low (approximately -0.7 volt). The gate generator free runs when pin 4 is low.

The positive gate out of U1180 provides the signal for the sweep generator U1170. The negative gate is amplified and inverted by Q1230 to provide the unblanking gate for the crt. Pin 15 goes high at the end of the sweep gate and gates a holdoff pulse through U1160A, U1160B and Q1160 to the mainframe interface.

Current for the SWP indicator light DS1152, is supplied by transistor Q1150. During gate time, in the SGL SWP mode, the lamp drive from U1180 goes low. This gates a

low out of U1160B to turn transistor Q1150 on. In the SGL SWP mode, pin 6 of U1180 is grounded so the gate generator will not run until it has been reset by pushing the Start button and gating a signal through the NAND gate U1160C to trigger Q1120. This pulls pin 7 of U1180 high and resets the gate generator so it recycles.

U1170 generates a sweep ramp of 10 volts, with a duration that depends on the timing current into the summing point at pin 9. The timing current for the capacitors C1173, C1174, and C1175 is supplied through timing resistors R1220, R1221, R1222, and R1224 by operational amplifier U1120A. Timing combinations are switched into the circuit by the TIME/DIV selector S104.

The dc level at the input to U1120A is adjusted by R1200 to compensate for offset of the IC U1170. The jumper across P1200 permits a step compensation when U1170 is replaced and the offset is outside the range of R1200.

Pin 6 of P1160 is an input from a Tracking Generator. When this input is high, Q1215 and Q1216 are turned on. Q1216 shunts the integrating current for U1170 from U1120A to ground. Q1215 sets the sweep output line to a dc level that represents center sweep. R1215 adjusts or calibrates this offset dc level of the sweep integrator in U1170 so the crt beam is centered during the input signal period from the tracking generator.

The sweep output of U1170 is connected through cam 29 of S104, to the output amplifier U1050A. U1050A drives U1040D and both amplifiers supply approximately 0.5 volt of push-pull drive to the mainframe deflection circuit. Gain of U1050A is set by SWP CAL adjustment R107. U1050C provides a sweep to the mainframe for sweep logic, which provides the + Sawtooth Output at the front panel of the 7000-Series oscilloscope.

# MAINTENANCE INSTRUCTIONS

## Introduction

This section describes the procedure for reducing or preventing instrument malfunction, plus troubleshooting, and corrective maintenance. Preventive maintenance improves instrument reliability. Should the instrument fail to function properly, corrective measures should be taken immediately; otherwise, additional problems may develop within the instrument.

## PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning, visual inspection, performance check, and if needed, a recalibration. The preventive maintenance schedule that is established for the instrument should be based on the environment in which the instrument is operated and the amount of use. Under average conditions (laboratory situation) a preventive maintenance check should be performed every 1000 hours of instrument operation.

### Cleaning

Clean the instrument often enough to prevent dust or dirt from accumulating in or on it. Dirt acts as a thermal insulating blanket and prevents efficient heat dissipation. It also provides high resistance electrical leakage paths between conductors or components in a humid environment.

**Exterior.** Clean the dust from the outside of the instrument by wiping or brushing the surface with a soft cloth or small brush. The brush will remove dust from around the front panel selector buttons. Hardened dirt may be removed with a cloth dampened in water that contains a mild detergent. Abrasive cleaners should not be used.

**Interior.** Normally the interior of the instrument will not require cleaning unless it has been left out of the oscilloscope plug-in compartment and uncovered for an extended period of time. Clean the interior by loosening accumulated dust with a dry soft brush, then remove the loosened dirt with low pressure air to blow the dust clear. (High velocity air can damage some components.) Hardened dirt or grease may be removed with a cotton tipped applicator dampened with a solution of mild detergent in water. Do not leave detergent on critical memory components. Abrasive cleaners should not be used. If the circuit board assemblies need cleaning, remove the circuit board by referring to the instructions under Corrective Maintenance in this section.

After cleaning, allow the interior to thoroughly dry before applying power to the instrument.

### CAUTION

*Do not allow water to get inside any enclosed assembly or components such as the cam switches, hybrid assemblies, differential RF Attenuator assembly, potentiometers, etc. Instructions for removing these assemblies are provided in the Corrective Maintenance section. Do not clean any plastic materials with organic cleaning solvents such as benzene, toluene, xylene, acetone or similar compounds because they may damage the plastic.*

### Lubrication

No components in this instrument require lubrication. The cam switches are self-lubricating.

### Visual Inspection

After cleaning, carefully check the instrument for such defects as defective connections, damaged parts, and improperly seated transistors and integrated circuits. The remedy for most visible defects is obvious; however, if heat-damaged parts are discovered, try to determine the cause of overheating before the damaged part is replaced; otherwise the damage may be repeated.

### Transistor and Integrated Circuit Checks

Periodic checks of the transistors and integrated circuits are not recommended. The best measure of performance is the actual operation of the component in the circuit. Performance of these components is thoroughly checked during the performance check or recalibration, and any substandard transistors or integrated circuits will usually be detected at that time.

When handling MOS FET's, keep the shorting strap in place until the transistor is in its socket.

### Performance Checks and Recalibration

The instrument performance should be checked after each 1000 hours of operation or every six months if the instrument is used intermittently to ensure maximum performance and assist in locating defects that may not be apparent during regular operation. Instructions for conducting a performance check are provided in the Performance Check section.

## TROUBLESHOOTING

The following are a few aids and suggestions that may assist in locating a problem. After the defective assembly or component has been located, refer to the Corrective Maintenance part of this section for removal and replacement instructions.

### Troubleshooting Aids

**Diagrams.** Block and circuit diagrams, on foldout pages in the diagrams section contain significant waveform and voltage information. The condition and instrument control settings used to obtain these waveforms are described at the beginning of the diagram section and on the waveform illustration. Refer to the Electrical Part List section for a description of all assemblies and components.

#### NOTE

*Corrections and modifications to the manual and instrument are described on inserts bound into the rear of the manual. Check this section for changes and corrections to the manual or the instrument.*

**Circuit Board Illustrations.** Electrical components, connectors and test points are identified on circuit board illustrations located on the inside fold of the corresponding circuit diagram or the back of the preceding diagram. This allows the troubleshooter to trace and check the operation of each circuit, and physically locate circuit components.

**Wiring Color Code.** Color coded wires are used to aid circuit tracing. Power supply dc voltage leads, have either a white background for positive voltage or a violet background for negative voltage. Signal wires and coaxial cables use an identifying one-band or two-band color code.

**Multiple Terminal (Harmonica) Connector Holders.** Most intercircuit connections are made through pin connectors that may be mounted in a harmonica type holder. The terminals in the holder are identified by numbers that appear on the holder and the circuit diagrams. Connector orientation to the circuit board is keyed by triangles on the holder and the circuit board (see Fig. 6-1). Some connectors contain more than one section. All connectors are identified on the schematic and board with "P" numbers.

**Resistor Color Code.** Brown composition resistors, metal-film resistors (identifiable by their gray body color) and some wire-wound resistors (usually light blue or gray-green) are used in the 7L13. The resistance value of a wire-

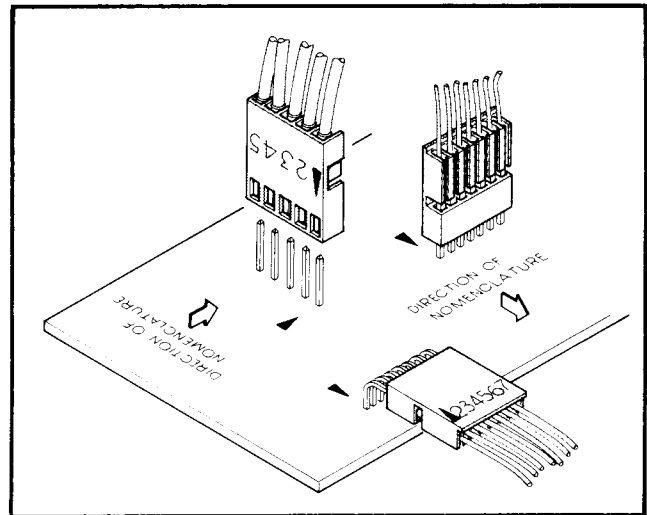


Fig. 6-1. Multipin (harmonica) circuit board connectors.

wound resistor is printed on the body of the component. The resistance value of a composition resistor or metal-film resistor is color-coded on the component with EIA color-code (some metal-film resistors may have the value printed on the body).

**Capacitor Marking.** The capacitance value of common disc capacitors or small electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors are color coded in picofarads.

**Diode Color Code.** The cathode of each glass encased diode is indicated by a stripe, a series of stripes, or a dot. Some diodes have a diode symbol printed on one side. Fig. 6-2 illustrates diode types and polarity markings that are used in this instrument.

**Transistor and Integrated Circuit Electrode Configuration.** Lead identification for the transistors and MOS FETs is shown in Fig. 6-3. IC pin out diagrams are shown on the back of the adjoining pullout schematic diagram.

Semiconductor failures account for the majority of electronic equipment failures. Most semiconductor devices (transistors and IC's) are socket-mounted. Substitution is often the most practical means for checking their performance. The following guide lines should be followed when substituting these components:

- a. First determine that circuit voltages are safe for the substituted component, so the replacement will not be damaged.
- b. Use only good components for substitution.

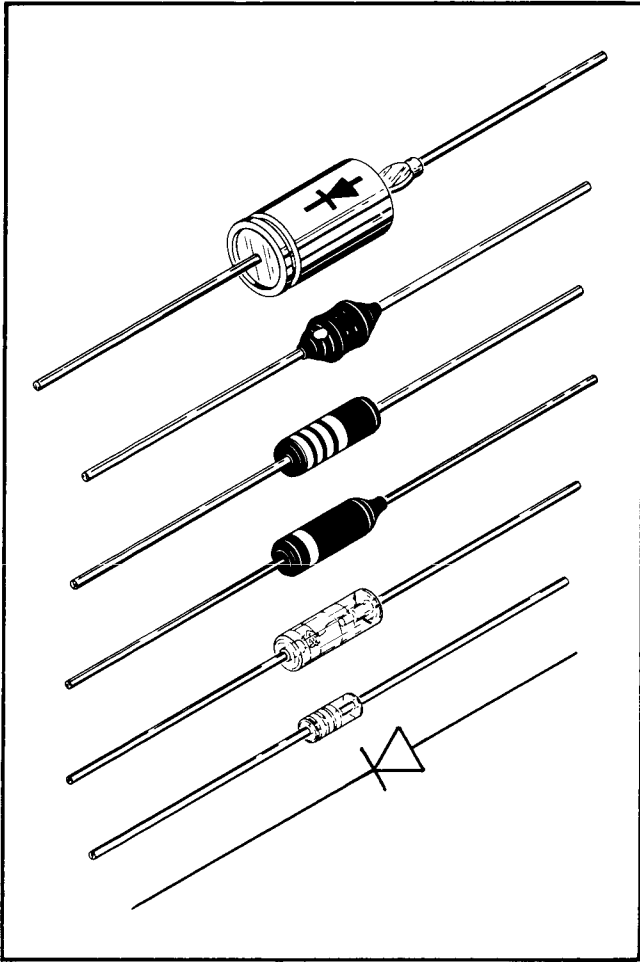


Fig. 6-2. Diode polarity markings.

c. Turn the power off before a component is substituted.

d. Be sure the component (transistor or IC) is inserted properly in the socket (see Fig. 6-3 or the manufacturer's data sheet).

e. After the operational check, return the good components to their original sockets to reduce calibration time and run-in period.

#### NOTE

*If a substitute is not available, check the transistor or MOS FET with a dynamic tester such as the Tektronix Type 576 Curve Tracer. Static type testers, such as an ohmmeter, can be used to check the resistance ratio across some semiconductor junction if no other method is available. (Do not measure resistance across MOS FET's because they are very*

*susceptible to static charges.) Use the high resistance ranges ( $R \times 1 k$  or higher) so the external test current is limited to less than 6 mA. If uncertain, measure the external test current with an ammeter. Resistance ratios across base-to-emitter or base-to-collector junctions usually run 100:1 or higher. The ratio is measured by connecting the meter leads across the terminals, noting the reading, then reversing the leads and noting the second reading.*

**Diode Checks.** Most diodes can be checked in the circuit by taking measurements across the diode and comparing these with voltages listed on the diagram. Forward-to-back resistance ratios can usually be taken by referring to the schematic and pulling appropriate transistors and pin connectors to remove low resistance loops around the diode.

#### CAUTION

*Do not use an ohmmeter scale with a high external current to check the diode junction. Do not check the forward-to-back resistance ratios of tunnel diodes or mixer diodes.*

**Integrated Circuit (IC) Checks.** Integrated circuits are most easily checked by direct replacement. When substitution is impossible, check input and output signal states as described in the circuit description and on the diagram. Lead configuration and data for the IC's used in this instrument are provided on the inside fold of the schematic or the back of the previous schematic.

Check calibration and performance after a faulty component has been replaced.

If the above procedure fails to locate the trouble, a more detailed analysis must be performed. The Circuit Description section describes the operational theory of each circuit and may aid to further evaluate the problem.

### General Troubleshooting Technique

The following procedure is recommended to isolate a problem and expedite repairs.

1. Ensure that the malfunction exists in the instrument. Check the operation of associated equipment and the operating procedure of the 7L13 (see Operating Instructions).

2. Determine and evaluate all trouble symptoms. Try to isolate the problem to a circuit or assembly. For example: Absence of a frequency marker notch in MAX position,

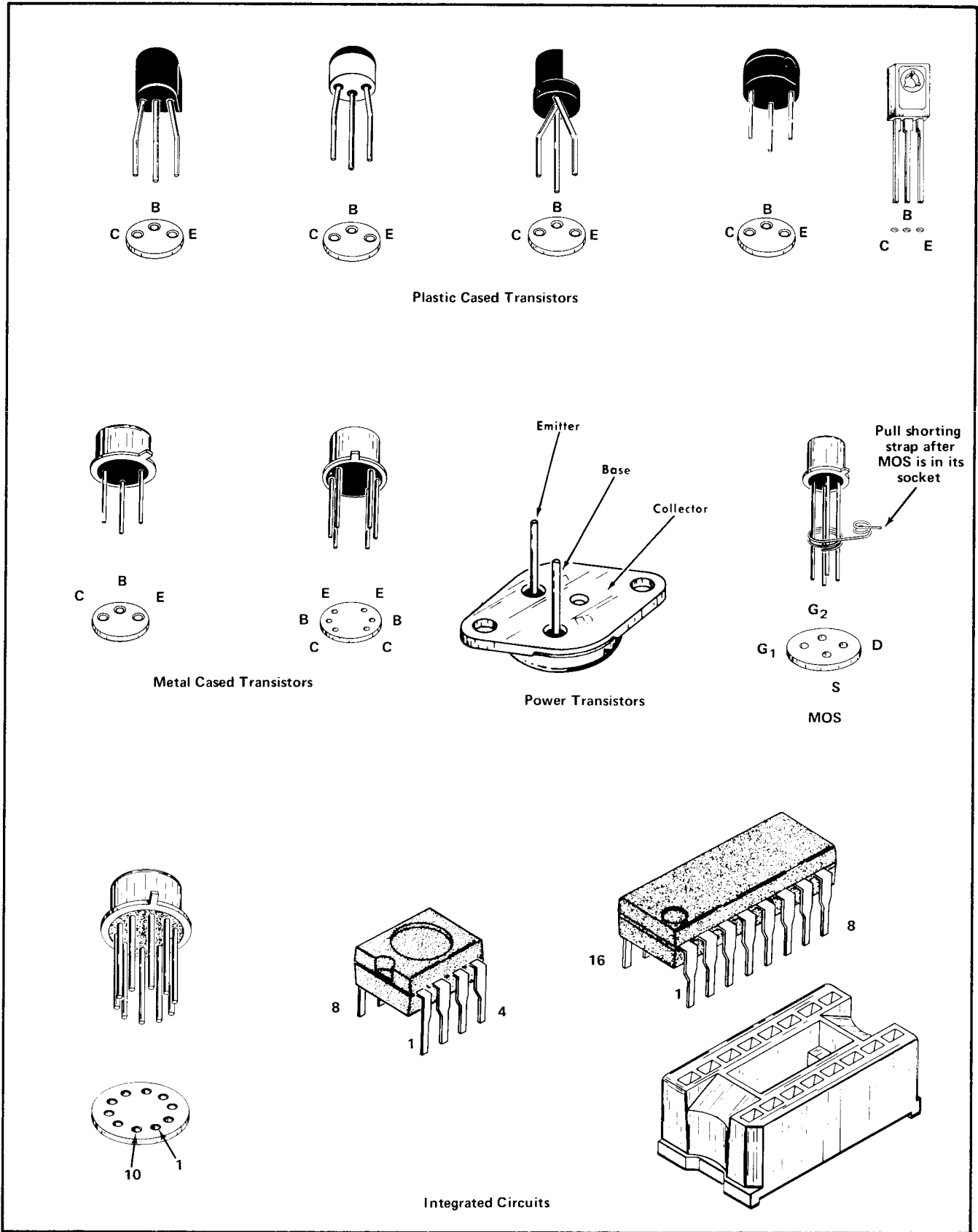


Fig. 6-3. Electrode configuration for socket mounted transistors, MOS's and IC's.



could indicate a malfunction in the video summing stage, the marker generator, or the switching circuitry. A test oscilloscope will check the input to the video summing stage and isolate the problem to one or the other of the two circuits. The block diagram in the diagrams section can aid in signal tracing and circuit isolation. It also shows the required signal level at different points to produce full screen deflection.

**CAUTION**

*When measuring voltages and waveforms, use extreme care in placing meter leads or probes. Because of high component density and limited access within the instrument, an inadvertent movement of the leads or probe could cause a short circuit. This may produce transient voltages which can destroy many components. The 1st LO (YIG oscillator) case is floating above chassis potential. Do not use its case as a ground reference point when measuring voltages. The power supply for the oscillator is short proof; however, it should not be shorted to chassis ground over extended periods.*

3. Make an educated guess as to the nature of the problem such as component failure or calibration, and the functional area most likely at fault.

4. Visually inspect the area or the assembly for such defects as broken or loose connections, improperly seated components, overheated or burned components, chafed insulation, etc. Repair or replace all obvious defects. In the case of overheated components, try to determine the cause of the overheated condition and correct before applying power.

5. By successive electrical checks, locate the problem. At this time an oscilloscope is a valuable test item for evaluating circuit performance. If applicable, check the calibration adjustments. Before changing an adjustment, note its position so it can be returned to the original setting. This will facilitate recalibration after the trouble has been located and repaired.

6. Determine the extent of the repair needed; if complex, we recommend contacting your local Tektronix Field Office or representative. If minor, such as a component replacement, see the Parts List for replacement information. Removal and replacement procedure of the assemblies and sub-assemblies is described under Corrective Maintenance.

## CORRECTIVE MAINTENANCE

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

### Obtaining Replacement Parts

All electrical and mechanical parts are available through your local Tektronix Field Office or representative. The Parts List section contains information on how to order these replacement parts. Many standard electronic components can be obtained locally in less time than that required to order from Tektronix, Inc. It is best to duplicate the original component as closely as possible. Parts orientation and lead dress should be duplicated because some components are oriented to reduce interaction or control circuit characteristics.

If a part you have ordered has been replaced with a new or improved part, your local Field Office or representative will contact you concerning any change in the part number. After repair, the circuits may need recalibration.

### Parts Repair and Exchange Program

Assemblies containing hybrid circuits or substrates in a semi-sealed module, complex assemblies such as the differential attenuator, and the YIG oscillator, can be exchanged under the Tektronix exchange program. Contact your local Field Office for exchange rates.

Tektronix repair centers provide replacement or repair service on major assemblies as well as the unit. Return the instrument or assembly to your local Field Office for this service.

### Soldering Technique

**CAUTION**

*Disconnect the instrument from its power source before replacing or soldering components.*

Some of the circuit boards in this instrument are multilayer; therefore, extreme caution must be used when a soldered component is removed or replaced. Excess heat from the soldering iron and bent component leads may pull the plating out of the hole. We suggest clipping the old component free, leaving enough lead length to solder the new component leads to. If you desire to remove the component leads; use a 15 watt pencil type iron, straighten the leads on the back side of the board, then when the solder melts gently pull the soldered lead through the hole. A desoldering tool should be used to remove the old solder.

## Maintenance—7L13

### Replacing the Square Pin for the Multi-pin Connectors

It is important not to damage or disturb the ferrule when removing the old stub of a broken pin. The ferrule is pressed into the circuit board and provides a base for soldering the pin connector.

If the broken stub is long enough, grasp it with a pair of needle nose pliers, apply heat with a small soldering iron to the pin base of the ferrule and pull the old pin out. (The pin is pressed into the ferrule so a firm pull is required to pull it out.)

If the broken stub is too short to grasp with pliers, use a small dowel (0.028 inch in diameter) clamped in a vise to push the pin out of the ferrule after the solder has been heated.

The old ferrule can be cleaned by reheating the solder and placing a sharp object such as a toothpick or small dowel into the hole. A 0.031 drill mounted in a pin vise may also be used to ream the solder out of the old ferrule.

Use a pair of diagonal cutters to remove the ferrule from the new pin, then insert the pin into the old ferrule and solder the pin to both sides of the ferrule.

If it is necessary to bend the new pin, grasp the base of the pin with needle nose pliers and bend against the pressure of the pliers to avoid breaking the board around the ferrule.

## REPLACING ASSEMBLIES

Most assemblies or sub-assemblies in this instrument can be easily removed and replaced. Some components and assemblies mounted between the front panel and the circuit board chassis require a detailed and sequential procedure. The procedures are described with illustrations and a step-by-step procedure.

### Front Panel Controls and Selectors

Front panel potentiometers are screwed into bushings swaged to the front sub-panel. A lock washer between the bushing and the potentiometer shoulder, prevents the potentiometer from turning after it has been tightened.

Remove the knob, unsolder the leads, then use pliers (with tape over the jaws to prevent marring the surface) to unscrew the potentiometer out of the bushing.

When the potentiometer is replaced, screw it into the bushing so it locks in position, resolder the leads to their respective terminals (remember the terminals may not be orientated the same as the old) and replace the knobs. Ensure the knob is properly indexed to the markings on the front panel.

### Removing and Installing the Front Panel FREQ SPAN/RESOLUTION Knobs and Skirts

#### NOTE

*Turn all selectors to their full clockwise position. Position the other knobs that have no stop to some reference point.*

1. After switching the RESOLUTION and FREQ SPAN selectors fully cw, loosen the setscrews and remove the FREQ SPAN and RESOLUTION knobs.

2. With the RESOLUTION and FREQ SPAN cam switches turned fully clockwise, install the RESOLUTION knob and FREQ SPAN skirt so the forks seat firmly in the two holes at the top of the RESOLUTION knob skirt ring (see exploded Mechanical Drawing Fig. 1 in the Mechanical Parts section).

3. Turn the RESOLUTION knob clockwise, until the last "3M" position marker is centered in the resolution readout window, then move the RESOLUTION knob away from the panel for clearance, without removing the RESOLUTION knob skirt. Tighten the RESOLUTION knob setscrews.

4. With the PULL TO UNLOCK insert knob pushed in to its detent position, slide the FREQ SPAN knob onto the switch shaft until the spring loaded pin engages the slot on the hub of the RESOLUTION knob. The white index mark on the FREQ SPAN knob should be aligned with MAX SPAN on the RESOLUTION skirt ring. Tighten both setscrews firmly, after centering the knob pin in the slot and allowing for knob clearance (use a piece of paper between the knobs).

5. Unlock the RESOLUTION from the FREQ SPAN selector by pulling out the PULL TO UNLOCK sleeve. Rotate each selector through its 19 positions to ensure you have full range of the selector and that they are indexing properly with the readout on the skirt.

6. Push in the PULL TO UNLOCK sleeve to recouple the two selectors. Now rotate both selectors through their range. Ensure that they detent positively and simultaneously. If the switching action seems rough or double detents exist, loosen the RESOLUTION knob setscrews and allow the outer shaft to slip into its detent position.

## Replacing or Repairing the Cam Switches



*The alignment and spring tension of the cam switch contacts are critical and must be maintained for proper operation; therefore, replacing or repairing these switches should be performed only by experienced personnel. A repair kit that includes replacement contacts, alignment tools, and instructions for replacing the switch contacts, can be ordered from Tektronix, Inc. Order Part No. 040-0541-00. If assistance is desired, contact your local Tektronix Field Office or representative.*

**Preliminary.** We recommend replacing the complete actuator assembly if any part of the actuator is defective. The following procedures describe how to replace the complete actuator for the **FREQ SPAN/RESOLUTION** selector and the **TIME/DIV** selector. Precise alignment and complex procedures are required to replace any section of these actuators.

Before the cam switch can be removed for repair or replacement, the Sweep Circuit board assembly must be removed. This procedure is described under Replacing Major Circuit Board Assemblies, which follows this description.

### FREQ SPAN/RESOLUTION Selector Replacement.

1. Turn the circuit board over and remove the eight (8) 4-40 screws that mount the actuator assembly to the board.
2. Lift the actuator assembly from the board to expose its related contacts.
3. Clean and replace any contacts if necessary, as per the instructions with the repair kit.

### TIME/DIV Selector Replacement.

1. Unsolder the connections to the **MANUAL SCAN** potentiometer switch assembly.
2. Turn the board over and remove four (4) 4-40 screws that mount the actuator assembly to the circuit board.
3. Lift the actuator assembly from the board to expose the related contacts for cleaning and repair, if necessary.

4. Replace the **MANUAL SCAN** potentiometer switch assembly as follows:

- a) Remove two (2) 2-56 screws and lock washers from the mounting plate located at the rear of the actuator assembly.
- b) Pull the potentiometer switch assembly, including the coupler and shaft, clear of the actuator assembly.

### Replacing the Cam Actuator and Potentiometer Switch Assemblies.

To re-assemble these assemblies, reverse the above removal procedure.

### Removing the Front Panel Pushbutton Switches

#### NOTE

*Before removing any of the switchable selectors, such as the **FREQ SPAN/DIV**, preset the selector either fully cw or ccw. This establishes a reference so the knobs can be correctly oriented when they are replaced.*

### Display Mode LOG/LIN Switches

1. Disconnect the semi-rigid cable W30 from J31, of the Coupler and Band Reject Filter (A30). Loosen and remove the mounting screws for assembly A40 (No. 1 in Fig. 6-4). Remove the mounting screws and nut holding the switch mounting bracket (No. 2 in Fig. 6-4).

#### NOTE

*On earlier models, disconnect the semi-rigid cables from the filter assembly A25 to A20 (J29 and A30 (J31)).*

2. Gently lift the filter assembly out and down, so it does not obstruct the switch circuit board. NOTE: There are two spacer washers between the assembly and the top plate.

3. Unplug the harmonica connectors to the switch assembly. Remove the two mounting stud nuts that hold the switch assembly on the front panel and slide the switch assembly back and out of the instrument.

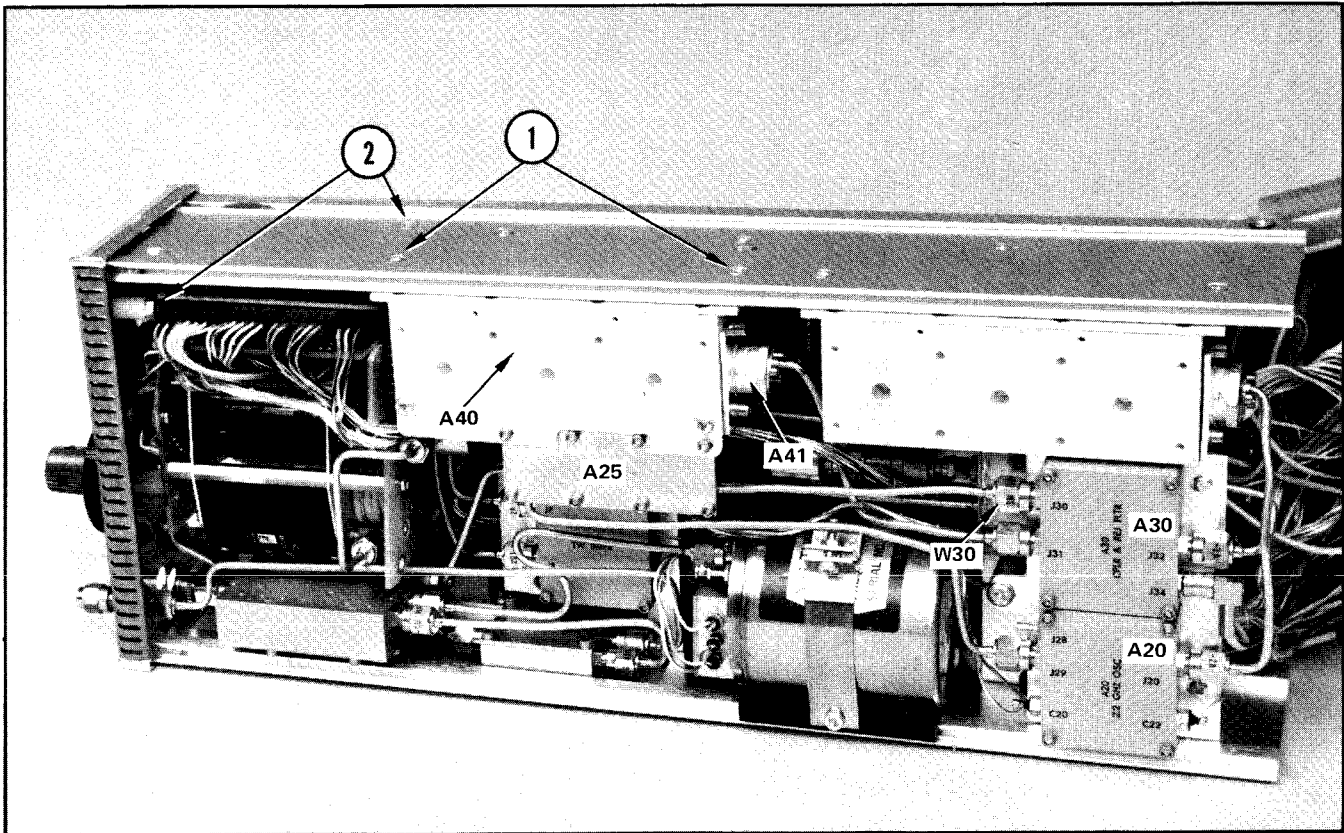


Fig. 6-4. Location of screws and assemblies that are referenced in the procedure to remove the display mode push button circuit board.

**Triggering Switches.**

1. Remove the knobs and front panel.
  
2. Loosen the screws that hold the switches to the sub-panel. Now loosen the screws that hold the sub-panel to the side rails and carefully pull the sub-panel forward until the switches can be removed.

**Video Filter and Pulse Stretcher Switches.**

1. Remove the knobs and front panel.
  
2. Loosen the screws that hold the switches to the sub-panel and slide the switch assembly out of the instrument.

**Replacing the Circuit Board Assemblies**

**Removing the DVM Logic and Readout Circuit Board.**

1. Remove the mounting screws for the DVM (Analog) and DVM Logic Readout circuit boards (Fig. 6-5A).
  
2. Unplug the MARKER light from its holder by pulling on the base off the holder, then unplug the five harmonica plugs as shown in Fig. 6-5A.

3. Unplug the interconnect between the two boards. Move the Logic and Readout circuit board back and to the left, tipping the board so the right front corner clears the rail extrusion (Fig. 6-5B).

4. Move the board to the left until the right edge clears the mounting extrusion, then slip the board to the right and out the top of the instrument (Fig. 6-5B).

**Replacing the Sweep Circuit Board.**

1. Position the FREQ SPAN/DIV and RESOLUTION selectors fully cw. Set the TIME/DIV selector in the OFF position. Loosen the knob locking screws with a 1/16 Allen wrench and remove the knobs.

2. Disconnect all harmonica (multipin) connectors to the sweep board.

3. Pull the center drawer (Resolution, YIG driver, Voltage Memory and 30 Hz Filter) assembly up. Uncouple the back rail assembly from the center drawer by pushing in on the spring clip and pulling up on the assembly, as shown in Fig. 6-6A.

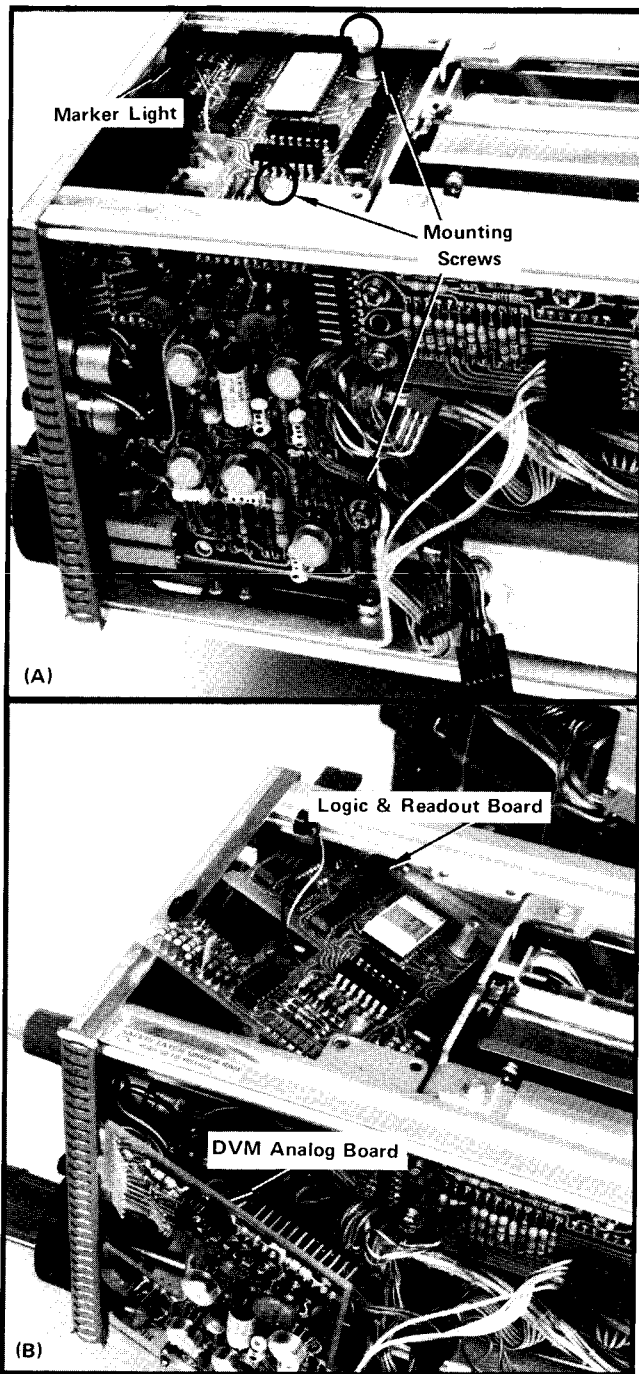


Fig. 6-5. Removing the Frequency Readout boards.

**CAUTION**

*Do not pull the center drawer to far up or let it fall free, because the forward rail may be bent or damaged.*

4. Loosen and remove the back panel screws shown in Fig. 6-6B. Pull the back panel and the plastic circuit board holder free from the sweep circuit board.

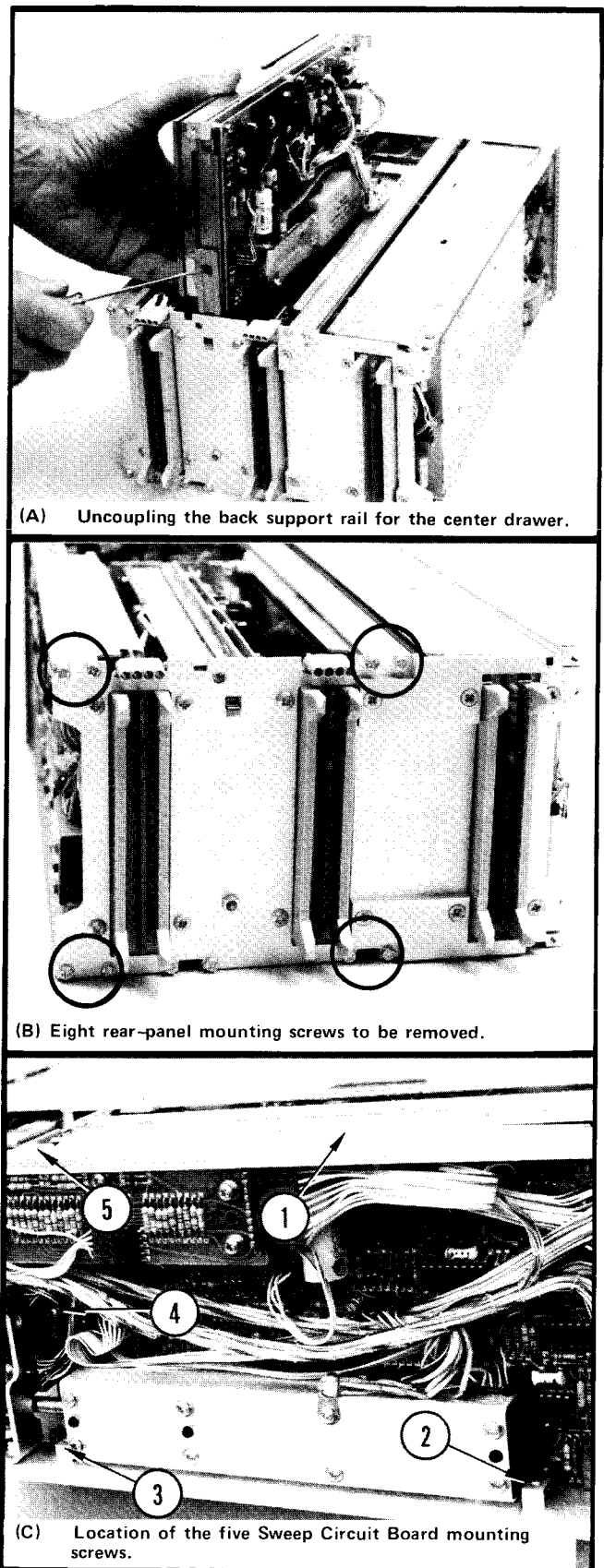


Fig. 6-6. Illustrations to show the procedure for removing the Sweep board.

## Maintenance—7L13

5. Loosen and remove the five (5) sweep board mounting screws as shown in Fig. 6-6C and pull the board assembly back and out of the instrument.

### NOTE

*Refer to Cam Switch Replacement procedure if the cam switches are to be replaced.*

6. Replace the circuit board assembly, by reversing the removal procedure. Remember to use the same knob reference point before tightening the setscrews, and check that the selectors index properly through their range.

**Replacing the Function IF Circuit Board.** Remove or unplug the harmonica connectors and P900 (output of the calibrator) from the interface board. Remove the two mounting screws and lift the board assembly out of the instrument.

**Replacing the Resolution Circuit Board Assembly.** Unscrew and remove the eight (8) mounting posts that hold the board to the chassis (see Fig. 6-7). Lift the circuit board assembly off of its chassis.

**Replacing Circuit Boards in the Phase Lock Circuit (Honeycomb) Assembly.** Remove the screws holding the shield cover on the honeycomb and remove the cover. Loosen and remove the respective Allen-head screws that hold the board and remove the boards.

**Replacing the 5 Volt Regulator Board.** This board is mounted behind the honeycomb assembly. Remove the four screws that go through the top and bottom plate to hold the honeycomb assembly in place. Slide the honeycomb assembly out and disconnect the required connectors to gain access to the mother board or the 5-volt regulator board.

### Replacing Microwave Assemblies

Maintenance Tools: Open-end offset wrenches are required to loosen the nuts for the semi-rigid coax cable connectors. Fig. 6-8 shows the two 15/64 wrenches and a 5/16 inch wrench ground so it will fit into limited access spaces. The special 5/16 wrench may be ordered from Tektronix, Inc. (Part No. 003-0703-00) if desired.

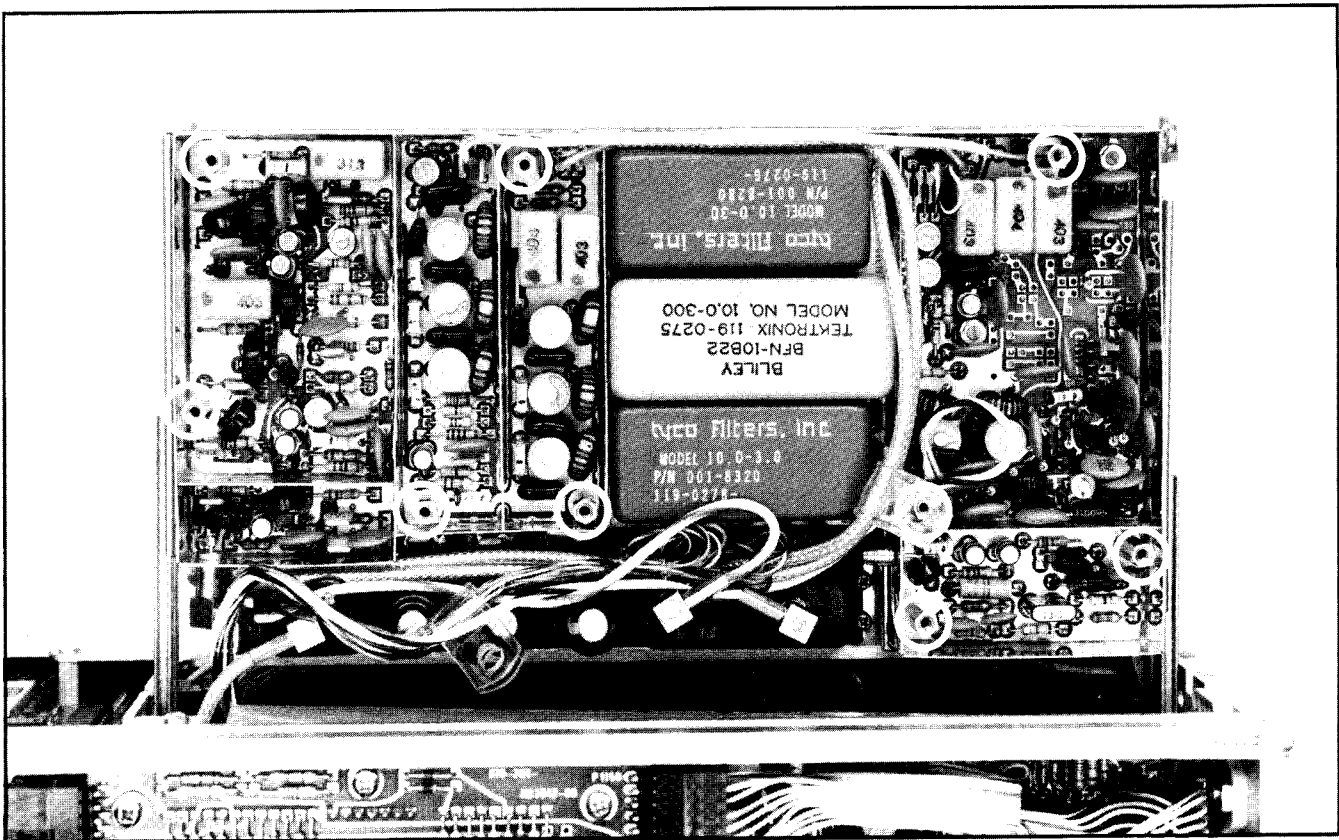


Fig. 6-7. Remove the mounting post screws indicated by a circle outline, to free the Resolution board.

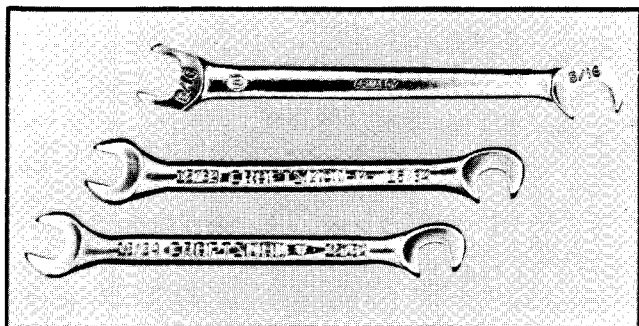


Fig. 6-8. Wrenches required to loosen and remove the semi-rigid cable connectors.

#### Replacing the 2.095 GHz Filter Assembly A10, or the Multiplier, Bandpass Filter Assembly A40.

1. Loosen the semi-rigid coaxial lead connectors.
2. Loosen the set screws that clamp the mixer in position and remove the mixer assembly from its cavity.
3. Loosen and remove the filter mounting screws then slide the assembly out of the unit.
4. Replace the assembly by reversing this procedure.
5. Calibrate as per the procedure under Replacing the 2nd Mixer or the 2.18 GHz Bandpass Filter, and 16-19 MHz Mixer Assembly.

#### CAUTION

*The nuts that tighten the connectors for the semi-rigid cable plugs should be tightened so they are slightly more than finger tight. If slight torque does not loosen the nut, a second wrench should be used to hold the rigid portion of the connector while loosening the nut.*

When the cables are replaced, torque these connector nuts so the fit is snug or the cable assembly just starts to twist.

**Replacing the 2nd Mixer Assembly.** The coupling of the 2nd mixer affects the response of the 2.095 GHz bandpass filter and mixer assemblies; therefore, replacement of either assembly requires re-adjustment of the filter tuning and mixer coupling. This adjustment requires the following equipment:

1. A 50  $\Omega$  crystal detector with a frequency range to 105 MHz; such as Hewlett Packard Model 8471A.

2. A narrow bandpass (1 kHz or less) high gain (0.2 mV/Div) vertical amplifier; such as Tektronix 7A22 Differential Amplifier Plug-In unit or 7A13 Differential Comparator Amplifier.

3. (Optional) A low pass filter (flat to approximately 110 MHz). This filter prevents the output of the 2nd LO (2.2 GHz) from developing some dc output level from the crystal detector. This could drive a dc coupled signal to the vertical amplifier, outside the display window area. If the vertical amplifier is a 7A22, with an adjustable low frequency cutoff of approximately 0.1 Hz, no external filter is required.

The 2nd mixer orientation (rotation) affects the mixer balance and reduces spurious response that are generated by products from the 1st LO and 1st mixer and products from the 2nd LO and 2nd mixer. Two positions, 180° from each other, will balance the mixer, usually one of these positions provides the best balance.

The following describes how to replace the assembly and the alignment procedure.

#### Adjust the response of the filter and mixer assemblies.

1. Set the following front panel controls as indicated:

FREQUENCY	50 MHz
FREQ SPAN/DIV	50 MHz
RESOLUTION	300 kHz
Display Mode	10 dB/DIV
RF Atten	0 dB
Gain	Fully ccw

2. Apply a -30 dBm, 52.5 MHz signal from a signal generator to the RF INput. Tune the center frequency so the applied signal is centered on screen. It may be necessary to increase the signal generator output level to obtain a signal if the bandpass filter is detuned.

3. Remove the signal generator signal from the RF INput and look for a spurious signal near 52.5 MHz. Open up the display by decreasing the FREQ SPAN after the spur is located. Adjust the sweep rate to obtain maximum signal amplitude.

4. Loosen the mixer assembly locking screws (Fig. 6-9), then rotate the assembly to minimize the spurious signal amplitude. Tighten the locking screw, ensuring that the assembly position does not shift.

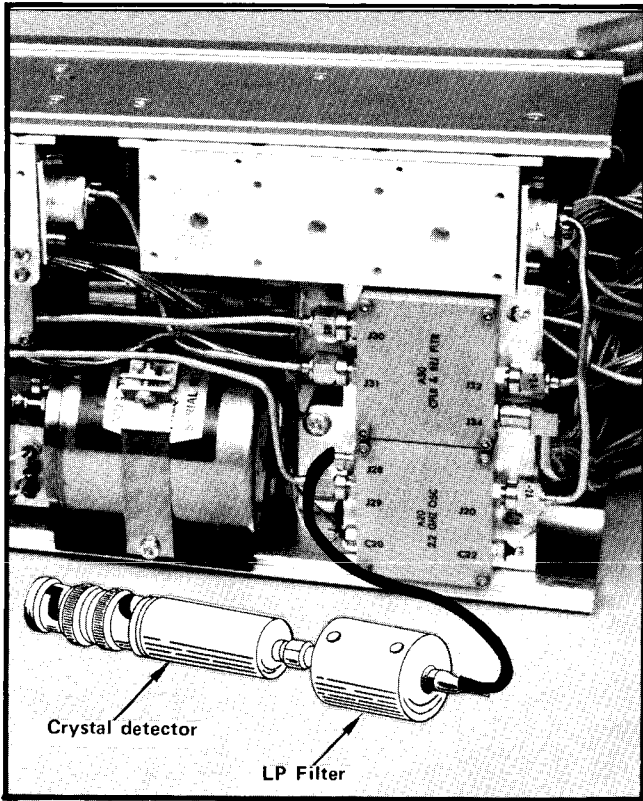


Fig. 6-9. Connecting a crystal detector and LF filter to the 105 MHz output of the Hybrid Assembly.

5. Set the TIME/DIV to 5 ms, FREQ SPAN/DIV to 5 MHz, RESOLUTION to 300 kHz and Display Mode to 2 dB/DIV.

6. Re-apply the 50 MHz signal from the signal generator to the RF INput and carefully tune the signal to the center of the graticule.

7. Remove P28 from the 105 MHz output of the hybrid and connect a 105 MHz crystal detector (through appropriate adapters) between the 105 MHz IF output (J28) and the Input to the narrow band (1 kHz) high gain amplifier. (See Fig. 6-9). Switch the oscilloscope Vertical Mode to Right or Chop, so the amplifier output can be observed. Switch the input coupling of the amplifier to dc. If the amplifier has selectable bandwidth, set the HF point to 1 kHz and the LF point to 0.1 Hz.

NOTE

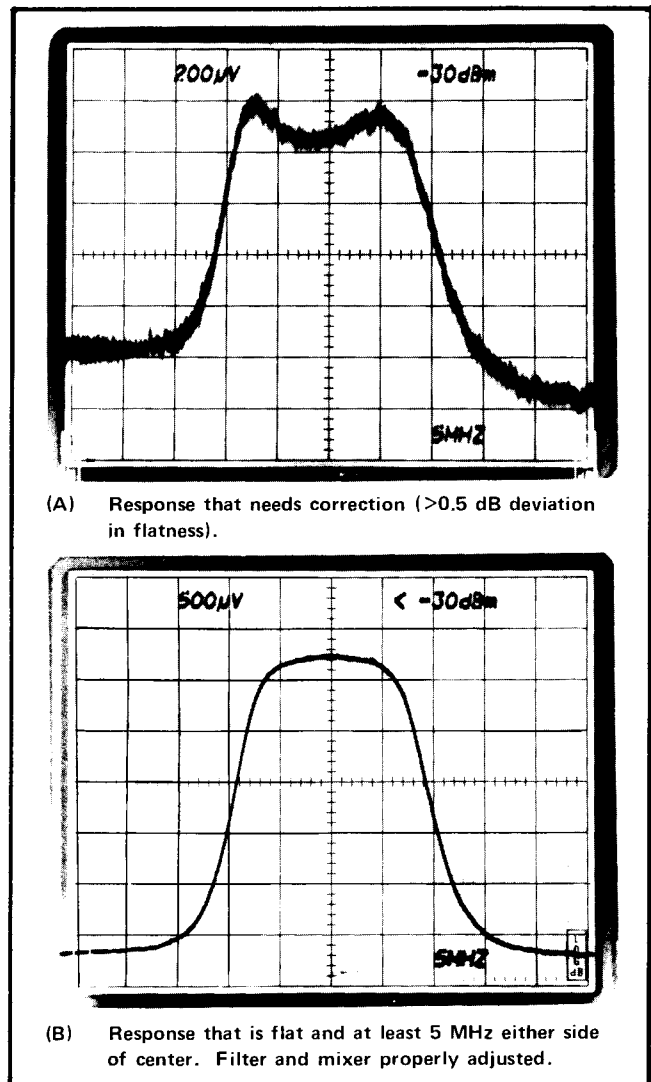
If the amplifier does not have selectable bandwidth, use a LP filter between the 105 MHz output and the detector. If the bandpass filter alignment is nearly correct, a signal level of approximately 0 dBm, with a Volts/Div deflection factor of 0.5 mV, will provide a display amplitude that is adequate for adjusting the filter and mixer coupling.

8. Adjust the signal generator output for a display amplitude of approximately 5 divisions (see Fig. 6-10). Check the response flatness by using the Variable attenuator control of the signal generator to measure the amplitude variations in dB across the top of the display. Flatness should measure within  $\pm 0.5$  dB, bandpass should equal or exceed 5 MHz either side of center. If flatness or bandpass are not correct, proceed with step 9.

9. Adjust C15, C16, C17, and the coupling of the mixer for a flat topped display that is centered about the graticule center.

**CAUTION**

Do not rotate the mixer, because this will introduce a 52.5 MHz spur that was minimized in the first part of this procedure.



(A) Response that needs correction (>0.5 dB deviation in flatness).

(B) Response that is flat and at least 5 MHz either side of center. Filter and mixer properly adjusted.

Fig. 6-10. Illustrations showing both an unsatisfactory and good response through the 2.095 GHz Filter and 2nd Mixer Assembly.



A treatise of coupled resonators and this type of filter is given in Tektronix Circuit Concept Booklet 062-1055-00. Fig. 6-10 illustrates both a satisfactory and unsatisfactory response for the filter-mixer combination.

10. Reconnect P28 to the 105 MHz output of the hybrid circuit. Recheck the signal location to ensure it is still centered. Decrease the FREQ SPAN/DIV to 1 MHz then tune the FINE frequency control through its range while checking the response flatness across the 2 MHz band. Signal level must remain within 0.5 dB of average level.

11. Remove signal from the RF INput and re-check amplitude of the 52.5 MHz spur to ensure that the mixer assembly orientation was not changed.

**Replacing the Multiplier, 2.18 GHz Bandpass Filter and 16-19 MHz Mixer Circuit Board Assembly.** If replacement is necessary, we recommend returning the 7L13 to a factory repair center. The following test fixtures and equipment are required to replace these assemblies, if the instrument is to meet or exceed specifications. 1) A spectrum analyzer with a frequency range to 2.5 GHz and a dynamic range of 70 dB, such as the 7L12 Mod 139T. 2) A second spectrum analyzer that covers the frequency spectrum to 60 MHz, such as the 7L12 or 7L13. 3) A 26 dB, 50  $\Omega$  tap as shown in Fig. 6-11. 4) A subminiature (SEALLECTRO) "T" connector to connect the low frequency spectrum analyzer into the output of the coupler.

If the test equipment is available, use the following procedure to calibrate the assemblies.

1. Connect the test equipment as shown in Fig. 6-11.
2. While observing the 17.5 MHz spectrum analyzer display, adjust the bandpass filter with C20, C22, and C24 and the mixer coupling for maximum response to 17.5 MHz.
3. While observing the display of the 2.2 GHz spectrum analyzer, adjust the mixer orientation for minimum sideband amplitude of the 17.5 MHz IF, maintaining maximum amplitude of the 17.5 MHz signal on the low frequency spectrum analyzer display. Sideband amplitude must be down 60 dB or more from the 2.2 GHz signal.
4. Change the output level of the 99.2045 MHz oscillator by changing the value of select resistor R1620, so

the 17.5 MHz IF amplitude is between  $-26$  dBm and  $-30$  dBm at the 26 dB divider tap.

#### Replacing the 1st LO (YIG) Oscillator Assembly.

1. Disconnect the semi-rigid cable W37.
2. Loosen and remove the bolt holding the mounting strap in place and remove the mounting strap.
3. Lift the assembly out of its cradle. Unsolder the wires.
4. Replace by reversing the procedure. Refer to Frequency Span and 1st LO Calibration adjustments in the Calibration section, to calibrate the new oscillator.

#### Replacing the Differential Attenuator Assembly.

1. Loosen and disconnect the input and output semi-rigid cables to the attenuator and the semi-rigid cables to the front panel 1st LO and 2nd LO output connectors.



*Do not use pliers to loosen or tighten these connectors. If the nut on the plug does not loosen readily, use a second wrench to hold the rigid portion of the connector so the cable does not bend or the connector at the jack does not twist.*

2. Turn the gain and RF Attenuator selectors fully cw, then remove the knobs. Remove the nut and plate against the front panel.
3. Remove the front panel from the sub-panel.
4. Remove the screws holding the sub-panel to the top and bottom plates and remove the sub-panel, then remove the attenuator assembly.
5. Replacement procedure is the reverse of the removal. When the knobs are replaced, ensure that they index correctly. Remember that the knobs were positioned fully cw before removal. Torque the nuts for the semi-rigid connectors until snug to eliminate RF leaks.

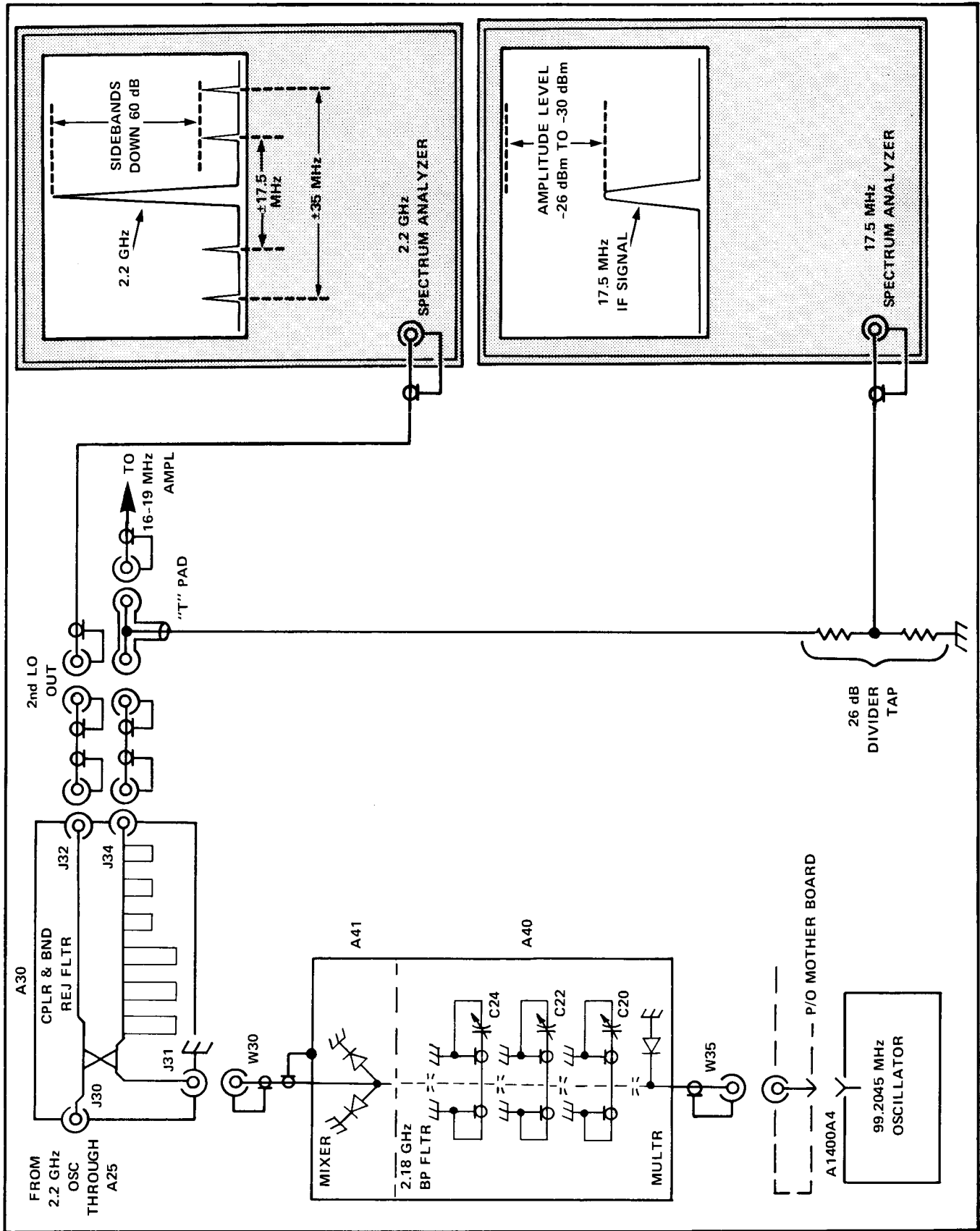


Fig. 6-11. Test equipment setup and illustrations to show the response when calibrating the Multiplier, 2.18 GHz BP Filter, and Mixer Assembly for the 2nd LO frequency servo system.

# OPTION INFORMATION

Your instrument may be equipped with one or more options. This section describes those options, or directs the reader to where the option is documented.



# REPLACEABLE ELECTRICAL PARTS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

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

## SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

## ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

## ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

## CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
0000A	LEMO USA	2015 2ND ST.	BERKLEY, CA 94710
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P. O. BOX 128	PICKENS, SC 29671
01002	GENERAL ELECTRIC CO., INDUSTRIAL AND POWER CAPACITOR PRODUCTS DEPT.	JOHN ST.	HUDSON FALLS, NY 12839
01121	ALLEN-BRADLEY CO.	1201 2ND ST. SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P. O. BOX 5012	DALLAS, TX 75222
02111	SPECTROL ELECTRONICS CORP.	17070 EAST GALE AVE.	CITY OF INDUSTRY, CA 91745
02735	RCA CORP., SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
04713	MOTOROLA, INC., SEMICONDUCTOR PRODUCTS DIV.	5005 E. MCDOWELL RD.	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS ST.	MOUNTAIN VIEW, CA 94042
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPT.	NELA PK.	CLEVELAND, OH 44112
10389	CHICAGO SWITCH, INC.	2035 WABANSIA AVE.	CHICAGO, IL 60647
11237	CTS KEENE, INC.		PASO ROBLES, CA 93446
12040	NATIONAL SEMICONDUCTOR CORP.	COMMERCE DRIVE	DANBURY, CT 06810
12637	FLEET PRODUCTS CO., INC.	1920 E POMONA ST.	SANTA ANA, CA 92705
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON ST.	DOVER, NH 03820
12969	UNITRODE CORP.	580 PLEASANT ST.	WATERTOWN, MA 02172
13571	ELECTRONIC RESEARCH CO.	P. O. BOX 913	SHAWNEE MISSION, KS 66201
13715	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	4300 REDWOOD HWY.	SAN RAFAEL, CA 94903
14298	AMERICAN COMPONENTS, INC., SUB OF INSILCO	8TH AVE. AT HARRY ST.	CONSHOHOCKEN, PA 19428
14752	ELECTRO CUBE INC.	1710 S. DEL MAR AVE.	SAN GABRIEL, CA 91776
14936	GENERAL INSTRUMENT CORP., SEMICONDUCTOR PRODUCTS GROUP	600 W. JOHN ST.	HICKSVILLE, NY 11802
15818	TELEDYNE SEMICONDUCTOR	1300 TERRA BELLA AVE.	MOUNTAIN VIEW, CA 94040
16179	OMNI SPECTRA, INC.	24600 HALLWOOD CT.	FARMINGTON, MI 48024
16758	DELCO ELECTRONICS, DIV. OF GENERAL MOTORS CORP.	700 E. FIRMIN ST.	KOKOMO, IN 46901
18203	ENGELMANN MICROWAVE CO.	SKYLINE DRIVE	MONTVILLE, NJ 07045
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
19701	ELECTRA-MIDLAND CORP., ELECTRA DIV.	P. O. BOX 760	MINERAL WELLS, TX 76067
21847	AERTECH	825 STEWART DR.	SUNNYVALE, CA 94086
24211	GRIGSBY-BARTON INC.	3800 INDUSTRIAL DRIVE	ROLLING MEADOWS, IL 60008
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SAN YSIDRO WAY	SANTA CLARA, CA 95051
28480	HEWLETT-PACKARD CO., CORPORATE HQ.	1501 PAGE MILL RD.	PALO ALTO, CA 94304
32159	WEST-CAP ARIZONA	2201 E. ELVIRA ROAD	TUCSON, AZ 85706
34553	AMPEREX ELECTRONIC CORP., COMPONENT DIV.	35 HOFFMAN AVE.	HAPPAUGE, NY 11787
34630	TYCO FILTERS DIV., INC.	3940 W. MONTECITO	PHOENIX, AZ 85019
50579	LITRONIX INC.	19000 HOMESTEAD RD.	CUPERTINO, CA 95014
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
63743	WARD LEONARD ELECTRIC CO., INC.	31 SOUTH ST.	MOUNT VERNON, NY 10550
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	5757 N. GREEN BAY AVE.	MILWAUKEE, WI 53201
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74868	BUNKER RAMO CORP., THE AMPHENOL RF DIV.	33 E. FRANKLIN ST.	DANBURY, CT 06810
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE.	COMPTON, CA 90224
78488	STACKPOLE CARBON CO.		ST. MARYS, PA 15857
80009	TEKTRONIX, INC.	P. O. BOX 500	BEAVERTON, OR 97077
80294	BOURNS, INC., INSTRUMENT DIV.	6135 MAGNOLIA AVE.	RIVERSIDE, CA 92506
80740	BECKMAN INSTRUMENTS, INC.	2500 HARBOR BLVD.	FULLERTON, CA 92634
81483	INTERNATIONAL RECTIFIER CORP.	9220 SUNSET BLVD.	LOS ANGELES, CA 90069
84411	TRW ELECTRONIC COMPONENTS, TRW CAPACITORS	112 W. FIRST ST.	OGALLALA, NB 69153
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY CO., INC.	3029 E. WASHINGTON ST.	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NB 68601
98291	SEALECTRO CORP.	225 HOYT	MAMARONECK, NY 10544

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	119-0331-02			ATT/GAIN DIFF:	80009	119-0331-02
A1A1	670-1760-00	B010100	B080399	CKT BOARD ASSY:REF LVL RDOUT	80009	670-1760-00
A1A1	670-1760-01	B080400		CKT BOARD ASSY:REF LVL RDOUT	80009	670-1760-01
A4	119-0462-00			MIXER UNIT,DBL:1ST MIXER	80009	119-0462-00
A5	119-0507-00			HYB CKT ENCL:DIR CPLR AND ATT	80009	119-0507-00
A6	119-0512-00			HYB CKT ENCL:TW DIR FLTR AND BP FLTR	80009	119-0512-00
A10	119-0513-00			HYB CKT ASSY:2.2 GHZ LP FLTR AND BP FLTR	80009	119-0513-00
A11	119-0306-01			MIXER UNIT,SGL:2ND MIXER	80009	119-0306-01
A12	119-0289-00	B010100	B069999	OSC ASSY:2-4 GHZ	80009	119-0289-00
A12	119-0676-00	B070000		OSC ASSY:2-4 GHZ	80009	119-0676-00
A20	119-0511-00			HYB CKT ASSY:2ND LO,DIR CPLR AND BS FLTR	80009	119-0511-00
A25	119-0501-00	XB010108		LP FILTER ASSY:	80009	119-0501-00
A30	119-0509-00			HYB CKT ASSY:DIR CPLR AND BS FLTR	80009	119-0509-00
A40	119-0508-00			HYB CKT ASSY:MULTR AND 2.183 GHZ BP FLTR	80009	119-0508-00
A41	119-0306-02			MIXER UNIT,SGL:MIXER FOR 2ND LO PHASE LOCK	80009	119-0306-02
A50	119-0510-00			HYB CKT ASSY:DIR CPLR AND PHASE DET WITH ER	80009	119-0510-00
A60	670-3106-00			CKT BOARD ASSY:10 DB GAIN SEL	80009	670-3106-00
A80	119-0334-01			IF MODULE ASSY:105 MHZ	80009	119-0334-01
A80A1	670-1745-01			CKT BOARD ASSY:105 MHZ IF	80009	670-1745-01
A80A2	205-0152-01			SHELL,TUNED CAV:2/TUNING SCREWS AND CAP	80009	205-0152-01
A90	670-3111-00			CKT BOARD ASSY:VID FLTR AND PLS STRETCHED	80009	670-3111-00
A100	670-3110-00			CKT BOARD ASSY:TRIGGER SOURCE SWITCH	80009	670-3110-00
A102	670-3109-00			CKT BOARD ASSY:TRIGGER MODE SEL	80009	670-3109-00
A130	672-0429-00			DSPL MODE ASSY:	80009	672-0429-00
A130A1	670-3112-00			CKT BOARD ASSY:DSPL MODE SWITCH CONNECTOR	80009	670-3112-00
A130A2	670-3113-00			CKT BOARD ASSY:DSPL MODE RESISTOR	80009	670-3113-00
A200	670-3373-00			CKT BOARD ASSY:RESOLUTION	80009	670-3373-00
A500	670-3374-00	B010100	B039999	CKT BOARD ASSY:FUNCTION IF	80009	670-3374-00
A500	670-3374-01	B040000		CKT BOARD ASSY:FUNCTION IF	80009	670-3374-01
A1000	672-0421-00			SWEEP ASSEMBLY:	80009	672-0421-00
A1000A1	670-3107-00	B010100	B080364	CKT BOARD ASSY:SWEEP,SPAN,UNCAL SENSE	80009	670-3107-00
A1000A1	670-3107-01	B080365		CKT BOARD ASSY:SWEEP,SPAN,UNCAL SENSE	80009	670-3107-01
A1000A2	670-3114-00			CKT BOARD ASSY:SWP AND VID FLTR RDOUT	80009	670-3114-00
A1400	644-0444-00			PHASE LOCK ASSY:	80009	644-0444-00
A1400A1	670-3098-00			CKT BOARD ASSY:16-19 MHZ AMPL	80009	670-3098-00
A1400A2	670-3099-00			CKT BOARD ASSY:16-19 MHZ V CONTROLLED OSC	80009	670-3099-00
A1400A3	670-3100-00			CKT BOARD ASSY:PHASE DETECTOR	80009	670-3100-00
A1400A4	670-3102-00			CKT BOARD ASSY:99.2045 MHZ CRYSTAL OSC	80009	670-3102-00
A1400A5	670-3103-00			CKT BOARD ASSY:SUM AMPL AND 2ND LO ERROR AM	80009	670-3103-00
A1400A6	670-3108-00	B010100	B049999	CKT BOARD ASSY:SAMPLING GEN AND DRIVER	80009	670-3108-00
A1400A6	670-3108-01	B050000		CKT BOARD ASSY:SAMPLING GEN AND DRIVER	80009	670-3108-01
A1400A7	670-3105-00	B010100	B069999	CKT BOARD ASSY:MOTHER BOARD	80009	670-3105-00
A1400A7	670-3105-01	B070000		CKT BOARD ASSY:MOTHER BOARD	80009	670-3105-01
A1400A8	670-3289-00	B010100	B039999	CKT BOARD ASSY:+5 VOLT REGULATED PWR SUP	80009	670-3289-00
A1400A8	670-3289-01	B040000		CKT BOARD ASSY:+5 VOLT REGULATED PWR SUP	80009	670-3289-01
A2000	670-3101-00			CKT BOARD ASSY:DVM,LOGIC AND RDOUT	80009	670-3101-00
A2100	670-3116-00	B010100	B080364	CKT BOARD ASSY:DVM,ANALOG SECT	80009	670-3116-00
A2100	670-3116-01	B080365		CKT BOARD ASSY:DVM,ANALOG SECT	80009	670-3116-01
A2200	119-0478-00			FREQ TUNING ASSY:	80009	119-0478-00
A2200A1	670-3115-00			CKT BOARD ASSY:TUNE CONTROL	80009	670-3115-00
A2300	670-3117-00			CKT BOARD ASSY:CENTER INTERFACE	80009	670-3117-00
A2350	670-3118-00			CKT BOARD ASSY:LEFT INTERFACE	80009	670-3118-00

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Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont			
A2500	670-3104-00	B010100	B019999	CKT BOARD ASSY:YIG DRIVER,V MEM 30 HZ FLTR	80009	670-3104-00
A2500	670-3104-01	B020000	B039999	CKT BOARD ASSY:YIG DRIVER,V MEM 30 HZ FLTR	80009	670-3104-01
A2500	670-3104-02	B040000	B069999	CKT BOARD ASSY:YIG DRIVER,V MEM 30 HZ FLTR	80009	670-3104-02
A2500	670-3104-03	B070000		CKT BOARD ASSY:YIG DRIVER,V MEM 30 HZ FLTR	80009	670-3104-03
AT3	119-0479-00			ATTENUATOR,FXD:3DB,DC,6GHZ,5 OHM	18203	A799S
C80	281-0709-00			CAP.,FXD,CER DI:7FF,+/-0.1PF,500V	72982	374-000COG0709B
C82	281-0139-00			CAP.,VAR,CER DI:2.5-9PF,100V	72982	518-002A2.5-9
C83	283-0238-00			CAP.,FXD,CER DI:0.01UF,10%,50V	72982	8121N071WR5103K
C84	281-0697-00			CAP.,FXD,CER DI:5000PF,+100-0%,100V	72982	2425-003W5W502A
C85	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208E102Z
C86	283-0156-00			CAP.,FXD,CER DI:1000PF,+100-0%,200V	72982	8111A208E102Z
C87	281-0524-00			CAP.,FXD,CER DI:150PF,+/-30PF,500V	72982	301-000X5U0151M
C95	281-0122-00			CAP.,VAR,CER DI:2.5-9PF,100V	72982	518-000A2.5-9
C201	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	56289	19C611
C204	283-0642-00			CAP.,FXD,MICA D:33PF,+/-0.5PF,300V	00853	D10-3E330G0
C207	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	56289	19C611
C211	283-0080-00			CAP.,FXD,CER DI:0.022UF,+80-20%,25V	56289	19C611
C212	281-0616-00			CAP.,FXD,CER DI:6.8PF,+/-0.5PF,200V	72982	374-001COH0689D
C230	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C231	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C232	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C241	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C242	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C244	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C248	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C250	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C253	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C258	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C260	281-0562-00			CAP.,FXD,CER DI:39PF,10%,500V	72982	301-000U2J0390K
C261	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C267	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C270	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C272	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C280	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C281	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C283	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C288	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C290	281-0562-00			CAP.,FXD,CER DI:39PF,10%,500V	72982	301-000U2J0390K
C292	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C294	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C296	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	72982	855-547E103Z
C300	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C320	283-0642-00			CAP.,FXD,MICA D:33PF,+/-0.5PF,300V	00853	D10-3E330G0
C321	283-0603-00			CAP.,FXD,MICA D:113PF,2%,300V	00853	D153F1130G0
C322	281-0092-00			CAP.,VAR,CER DI:9-35PF	72982	538-011E2P094R
C323	281-0615-00			CAP.,FXD,CER DI:3.9PF,+/-0.5PF,200V	72982	374-001COJ0399D
C324	283-0644-00			CAP.,FXD,MICA D:150PF,1%,500V	00853	D151E151F0
C325	281-0092-00			CAP.,VAR,CER DI:9-35PF	72982	538-011E2P094R
C326	281-0615-00			CAP.,FXD,CER DI:3.9PF,+/-0.5PF,200V	72982	374-001COJ0399D
C327	283-0618-00			CAP.,FXD,MICA D:130PF,2%,300V	00853	D155E131G0
C328	281-0092-00			CAP.,VAR,CER DI:9-35PF	72982	538-011E2P094R
C329	281-0727-00			CAP.,FXD,CER DI:12.8PF,1%,500V	72982	374-000COG1289F



Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont			
C333	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C338	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C340	281-0727-00			CAP., FXD, CER DI:12.8PF, 1%, 500V	72982	374-000C0G1289F
C341	283-0618-00			CAP., FXD, MICA D:130PF, 2%, 300V	00853	D155E131G0
C342	281-0092-00			CAP., VAR, CER DI:9-35PF	72982	538-011E2P094R
C343	281-0615-00			CAP., FXD, CER DI:3.9PF, +/-0.5PF, 200V	72982	374-001C0J0399D
C344	283-0644-00			CAP., FXD, MICA D:150PF, 1%, 500V	00853	D151E151F0
C345	281-0092-00			CAP., VAR, CER DI:9-35PF	72982	538-011E2P094R
C346	281-0615-00			CAP., FXD, CER DI:3.9PF, +/-0.5PF, 200V	72982	374-001C0J0399D
C347	283-0603-00			CAP., FXD, MICA D:113PF, 2%, 300V	00853	D153F1130G0
C348	281-0092-00			CAP., VAR, CER DI:9-35PF	72982	538-011E2P094R
C349	283-0642-00			CAP., FXD, MICA D:33PF, +/-0.5PF, 300V	00853	D10-3E330G0
C353	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C354	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C383	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C385	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C388	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C390	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C391	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C392	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C422	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C424	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C428	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C440	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C442	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C444	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C445	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C448	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C450	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C452	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C455	283-0665-00			CAP., FXD, MICA D:190PF, 1%, 100V	00853	D151F191F0
C456	281-0123-00			CAP., VAR, CER DI:5-25PF, 100V	72982	518-000A5-25
C457	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C458	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C462	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C468	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C470	281-0716-00			CAP., FXD, CER DI:13.8PF, 1%, 500V	72982	374-005C0G1389F
C471	283-0618-00			CAP., FXD, MICA D:130PF, 2%, 300V	00853	D155E131G0
C472	281-0092-00			CAP., VAR, CER DI:9-35PF	72982	538-011E2P094R
C473	281-0612-00			CAP., FXD, CER DI:5.6PF, +/-0.5PF, 500V	72982	374-001C0H0569D
C474	283-0603-00			CAP., FXD, MICA D:113PF, 2%, 300V	00853	D153F1130G0
C475	281-0092-00			CAP., VAR, CER DI:9-35PF	72982	538-011E2P094R
C476	283-0600-00			CAP., FXD, MICA D:43PF, 5%, 500V	00853	D105E430J0
C477	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C479	283-0003-00			CAP., FXD, CER DI:0.01UF, +80-20%, 150V	72982	855-547E103Z
C500	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C501	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C502	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C511	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C514	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C517	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C521	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C523	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscnt	Name & Description	Mfr	
					Code	Mfr Part Number
C524	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C527	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C531	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C534	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C538	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C546	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C547	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C551	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C554	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C560	281-0504-00			CAP., FXD, CER DI:10PF, +/-1PF, 500V	72982	301-000C0G0100F
C562	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C566	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C567	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C571	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C572	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C574	281-0620-00			CAP., FXD, CER DI:21PF, 1%, 500V	72982	301-000C0G0210F
C581	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C584	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C596	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C597	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C601	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C602	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C604	281-0620-00			CAP., FXD, CER DI:21PF, 1%, 500V	72982	301-000C0G0210F
C611	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C614	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C626	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C627	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C631	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C632	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C634	281-0620-00			CAP., FXD, CER DI:21PF, 1%, 500V	72982	301-000C0G0210F
C641	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C644	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C656	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C657	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C661	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C662	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C664	281-0620-00			CAP., FXD, CER DI:21PF, 1%, 500V	72982	301-000C0G0210F
C671	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C674	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C685	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C686	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C687	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C697	281-0576-00			CAP., FXD, CER DI:11PF, 5%, 500V	72982	301-050C0G0110J
C701	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C704	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C711	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C714	281-0580-00			CAP., FXD, CER DI:470PF, 10%, 500V	72982	301-000Z5D0471K
C725	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C726	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C727	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C731	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C732	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C734	281-0577-00			CAP., FXD, CER DI:14PF, 5%, 500V	72982	301-050C0G0140J

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C737	281-0576-00			CAP., FXD, CER DI:11PF, 5%, 500V	72982	301-050C0G0110J
C741	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C744	281-0511-00	B010100	B039999	CAP., FXD, CER DI:22PF, +/-2.2PF, 500V	72982	301-000C0G0220K
C744	281-0629-00	B040000		CAP., FXD, CER DI:33PF, 5%, 600V	72982	308-000C0G0330G
C748	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C751	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C757	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C766	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C767	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C776	283-0167-00			CAP., FXD, CER DI:0.1UF, 10%, 100V	72982	8131N147W5R104K
C811	281-0550-00			CAP., FXD, CER DI:120PF, 10%, 500V	72982	301-000X5P0121K
C813	281-0504-00			CAP., FXD, CER DI:10PF, +/-1PF, 500V	72982	301-000C0G0100F
C814	283-0641-00			CAP., FXD, MICA D:180PF, 1%, 100V	00853	D151E181FO
C816	283-0639-00			CAP., FXD, MICA D:56PF, 1%, 100V	00853	D151E560FO
C817	283-0599-00			CAP., FXD, MICA D:98PF, 5%, 500V	00853	D105E980JO
C820	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C823	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C826	281-0504-00			CAP., FXD, CER DI:10PF, +/-1PF, 500V	72982	301-000C0G0100F
C830	285-0808-00			CAP., FXD, PLSTC:0.1UF, 10%, 50V	56289	LP66A1A104K00A
C832	290-0573-00			CAP., FXD, ELCTLT:2.7UF, 20%, 50V	56289	196D275X0050JA1
C840	285-0659-00			CAP., FXD, PLSTC:0.001UF, 10%, 100V	84411	TEK24-10291
C850	281-0578-00			CAP., FXD, CER DI:18PF, 5%, 500V	72982	301-000C0G0180J
C852	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C857	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C858	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C880	283-0010-00			CAP., FXD, CER DI:0.05UF, +100-20%, 50V	56289	273C20
C890	281-0509-00			CAP., FXD, CER DI:15PF, +/-1.5PF, 500V	72982	301-000C0G0150K
C893	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C898	281-0518-00			CAP., FXD, CER DI:47PF, +/-9.4PF, 500V	72982	301-000U2J0470M
C950	283-0598-00			CAP., FXD, MICA D:253PF, 5%, 300V	00853	D153E2530JO
C951	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C952	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C953	283-0005-00			CAP., FXD, CER DI:0.01UF, +100-0%, 250V	72982	8131-250651103P
C954	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C962	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C1004	283-0004-00			CAP., FXD, CER DI:0.02UF, +80-20%, 150V	72982	855-547E203Z
C1020	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1028	281-0592-00			CAP., FXD, CER DI:4.7PF, +/-0.5PF, 500V	72982	301-023COH0479D
C1048	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1049	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1050	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1051	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1053	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1060	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C1088	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C1100	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1105	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1112	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1125	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1126	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1128	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1138	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C1152	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C1164	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1167	281-0513-00			CAP., FXD, CER DI:27PF, +/-5.4PF, 500V	72982	301-000P2G0270M
C1168	283-0114-00			CAP., FXD, CER DI:0.0015UF, 5%, 200V	72982	805-509B152J
C1172	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1173 } C1174 } C1175 }	295-0171-00			CAP., SET MTCHD:510PF, 0.05UF, 5UF	80009	295-0171-00
C1176	281-0509-00			CAP., FXD, CER DI:15PF, +/-1.5PF, 500V	72982	301-000COG0150K
C1178	283-0668-00			CAP., FXD, MICA D:184PF, 1%, 500V	00853	D155F1840F0
C1186	290-0536-00			CAP., FXD, ELCTLT:10UF, 20%, 25V	90201	TDC106M025NLF
C1188	290-0527-00			CAP., FXD, ELCTLT:15UF, 20%, 20V	90201	TDC156M020NLF
C1210	283-0644-00			CAP., FXD, MICA D:150PF, 1%, 500V	00853	D151E151F0
C1230	290-0525-00			CAP., FXD, ELCTLT:4.7UF, 20%, 50V	56289	196D475X0050KA1
C1235	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1238	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1297	283-0203-00			CAP., FXD, CER DI:0.47UF, 20%, 50V	72982	8131N075651474M
C1400	283-0256-00			CAP., FXD, CER DI:130PF, 5%, 100V	72982	8121B145P3K131J
C1402	283-0256-00			CAP., FXD, CER DI:130PF, 5%, 100V	72982	8121B145P3K131J
C1405	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C1406	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C1408	283-0256-00			CAP., FXD, CER DI:130PF, 5%, 100V	72982	8121B145P3K131J
C1401	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C1414	283-0256-00			CAP., FXD, CER DI:130PF, 5%, 100V	72982	8121B145P3K131J
C1500	283-0156-00			CAP., FXD, CER DI:1000PF, +100-0%, 200V	72982	8111A208E102Z
C1505	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C1510	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N058651103M
C1512	283-0156-00			CAP., FXD, CER DI:1000PF, +100-0%, 200V	72982	8111A208E102Z
C1520	283-0156-00			CAP., FXD, CER DI:1000PF, +100-0%, 200V	72982	8111A208E102Z
C1530	283-0156-00			CAP., FXD, CER DI:1000PF, +100-0%, 200V	72982	8111A208E102Z
C1535	283-0197-00	B010100	B010108	CAP., FXD, CER DI:470PF, 5%, 100V	72982	8121N064C0G471J
C1535	283-0330-00	B010109		CAP., FXD, CER DI:100PF, 5%, 50V	72982	8111M100C0G0A101
C1536	283-0156-00			CAP., FXD, CER DI:1000PF, +100-0%, 200V	72982	8111A208E102Z
C1539	283-0197-00	B010100	B010108	CAP., FXD, CER DI:470PF, 5%, 100V	72982	8121N064C0G471J
C1539	283-0330-00	B010109		CAP., FXD, CER DI:100PF, 5%, 50V	72982	8111M100C0G0A101
C1550	290-0441-00			CAP., FXD, ELCTLT:10UF, 10%, 50V	56289	109D206X9010C2
C1552	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C1554	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C1556	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N058651103M
C1562	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C1563	281-0161-00	B010100	B010116X	CAP., VAR, CER DI:5-15PF, 350V	72982	518-000A5-15
C1564	283-0249-00			CAP., FXD, CER DI:0.068UF, 10%, 50V	72982	8131N075WR5683K
C1573	290-0513-00			CAP., FXD, ELCTLT:510UF, +75-10%, 25V	01002	69F2336G7
C1574	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N058651103M
C1576	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C1600	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C1602	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C1607	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C1610	283-0191-00			CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C1612	281-0536-00			CAP., FXD, CER DI:1000PF, 10%, 500V	72982	301-055X5P0102K
C1614	281-0616-00			CAP., FXD, CER DI:6.8PF, +/-0.5PF, 200V	72982	374-001COH0689D
C1615	281-0629-00			CAP., FXD, CER DI:33PF, 5%, 600V	72982	308-000COG0330G
C1617	283-0000-00			CAP., FXD, CER DI:0.001UF, +100-0%, 500V	72982	831-516E102P
C1712	285-0901-00			CAP., FXD, PLSTC:0.47UF, 5%, 50V	56289	LP88A1A473J

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C1717	285-0901-00			CAP.,FXD,PLSTC:0.47UF,5%,50V	56289	LP88A1A473J
C1730	285-0913-00			CAP.,FXD,PLSTC:3UF,5%,50V	56289	LP66A 1A305J
C1732	285-0905-00			CAP.,FXD,PLSTC:0.33UF,5%,50V	56289	LP66A1A334J002
C1735	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C1736	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C1737	281-0536-00			CAP.,FXD,CER DI:1000PF,10%,500V	72982	301-055X5P0102K
C1740	285-0808-00			CAP.,FXD,PLSTC:0.1UF,10%,50V	56289	LP66A1A104K004
C1742	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C1754	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C1755	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C1756	285-1056-00			CAP.,FXD,PLSTC:1UF,2%,50V	14752	650B1A105G
C1757	285-1056-00			CAP.,FXD,PLSTC:1UF,2%,50V	14752	650B1A105G
C1800	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039651105Z
C1802	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039651105Z
C1804	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C1806	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8131N075651104M
C1808	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	72982	8131N039651105Z
C1810	281-0513-00			CAP.,FXD,CER DI:27PF,+/-5.4PF,500V	72982	301-000P2G0270M
C1812	283-0204-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N058651103M
C1820	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C1822	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C1830	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C1832	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C1834	281-0523-00			CAP.,FXD,CER DI:100PF,+/-20PF,350V	72982	301-000U2M0101M
C1836	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C1838	283-0346-00			CAP.,FXD,CER DI:0.47UF,+80-20%,100V	72982	8131-M100651474Z
C1900	290-0513-00			CAP.,FXD,ELCTLT:510UF,+75-10%,25V	01002	69F2336G7
C1902	290-0513-00			CAP.,FXD,ELCTLT:510UF,+75-10%,25V	01002	69F2336G7
C1904	290-0340-00			CAP.,FXD,ELCTLT:10UF,10%,50V	56289	109D106X9050C2
C1906	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1908	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1912	285-1069-00			CAP.,FXD,PLSTC:0.047UF,200V	14752	C2319
C1914	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1916	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1920	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1922	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1924	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1926	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1928	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1930	281-0752-00			CAP.,FXD,CER DI:1750PF	80009	281-0752-00
C1941	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020NLF
C1960	290-0441-00	B010100	B010116	CAP.,FXD,ELCTLT:10UF,10%,50V	56289	109D206X9010C2
C1960	290-0134-00	B010117		CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C1962	290-0441-00	B010100	B010116	CAP.,FXD,ELCTLT:10UF,10%,50V	56289	109D206X9010C2
C1962	290-0134-00	B010117		CAP.,FXD,ELCTLT:22UF,20%,15V	56289	150D226X0015B2
C1966	283-0116-00			CAP.,FXD,CER DI:820PF,5%,500V	72982	801-547B821J
C1967	283-0178-00			CAP.,FXD,CER DI:0.1UF,+80-20%,100V	72982	8131N145651104Z
C1968	290-0340-00			CAP.,FXD,ELCTLT:10UF,10%,50V	56289	109D106X9050C2
C2000	290-0530-00			CAP.,FXD,ELCTLT:68UF,20%,6V	90201	TDC686M006NLF
C2005	283-0666-00			CAP.,FXD,MICA D:890PF,2%,100V	00853	D151F891G0
C2010	290-0527-00			CAP.,FXD,ELCTLT:15UF,20%,20V	90201	TDC156M020NLF
C2012	283-0198-00			CAP.,FXD,CER DI:0.22UF,20%,50V	72982	8131N075651224M
C2060	283-0005-00			CAP.,FXD,CER DI:0.01UF,+100-0%,250V	72982	8131-250651103P

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C2110	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C2114	290-0528-00			CAP., FXD, ELCTLT:15UF, 20%, 50V	90201	TDC156M050WLC
C2120	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C2130	281-0523-00			CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C2132	281-0505-00	B010100	B080634X	CAP., FXD, CER DI:12PF, +/-1.2PF, 500V	72982	301-002COG0120K
C2138	283-0103-00	XB080635		CAP., FXD, CER DI:180PF, 5%, 500V	56289	40C638
C2140	283-0670-00			CAP., FXD, MICA D:375PF, 1%, 500V	00853	D155F3750F0
C2142	281-0523-00	B010100	B080634	CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C2142	283-0047-00	B080635		CAP., FXD, CER DI:270PF, 5%, 500V	72982	861-518B271J
C2144	285-0809-00			CAP., FXD, PLSTC:1UF, 10%, 50V	56289	LP66A1A105K
C2146	290-0525-00			CAP., FXD, ELCTLT:4.7UF, 20%, 50V	56289	196D475X0050KA1
C2148	283-0080-00	XB080635		CAP., FXD, CER DI:0.022UF, +80-20%, 25V	56289	19C611
C2150	290-0529-00			CAP., FXD, ELCTLT:47UF, 20%, 20V	56289	196D476X0020LA3
C2152	290-0530-00			CAP., FXD, ELCTLT:68UF, 20%, 6V	90201	TDC686M006NLF
C2154	290-0529-00			CAP., FXD, ELCTLT:47UF, 20%, 20V	56289	196D476X0020LA3
C2156	290-0529-00			CAP., FXD, ELCTLT:47UF, 20%, 20V	56289	196D476X0020LA3
C2200	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2201	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2202	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2206	283-0059-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8141N038651105Z
C2214	283-0115-00			CAP., FXD, CER DI:47PF, 5%, 200V	72982	805-509C0G470J
C2216	283-0629-00			CAP., FXD, MICA D:62PF, 1%, 500V	00853	D105E620F0
C2224	283-0115-00			CAP., FXD, CER DI:47PF, 5%, 200V	72982	805-509C0G470J
C2228	283-0629-00			CAP., FXD, MICA D:62PF, 1%, 500V	00853	D105E620F0
C2302	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2304	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2306	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2308	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2500	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C2502	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C2510	281-0653-00			CAP., FXD, CER DI:3.3PF, 30%, 200V	72982	374-001C0K0109C
C2512	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C2514	285-0683-00			CAP., FXD, PLSTC:0.022UF, 5%, 100V	56289	410P22351
C2516	281-0523-00	B010100	B019999X	CAP., FXD, CER DI:100PF, +/-20PF, 350V	72982	301-000U2M0101M
C2520	281-0536-00			CAP., FXD, CER DI:1000PF, 10%, 500V	72982	301-055X5P0102K
C2522	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8131N075651224M
C2524	290-0650-00			CAP., FXD, ELCTLT:1000UF, 20%, 10V	56289	109D108X0010T2
C2526	290-0650-00			CAP., FXD, ELCTLT:1000UF, 20%, 10V	56289	109D108X0010T2
C2538	281-0504-00			CAP., FXD, CER DI:10PF, +/-1PF, 500V	72982	301-000COG0100F
C2550	290-0340-00			CAP., FXD, ELCTLT:10UF, 10%, 50V	56289	109D106X9050C2
C2554	283-0178-00			CAP., FXD, CER DI:0.1UF, +80-20%, 100V	72982	8131N145651104Z
C2556	283-0178-00			CAP., FXD, CER DI:0.1UF, +80-20%, 100V	72982	8131N145651104Z
C2558	283-0204-00			CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N058651103M
C2559	283-0051-00			CAP., FXD, CER DI:0.0033UF, 5%, 100V	72982	8131N145COG332J
C2562	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2568	290-0536-00			CAP., FXD, ELCTLT:10UF, 20%, 25V	90201	TDC106M025NLF
C2569	283-0204-00	B010100	B069999X	CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N058651103M
C2578	283-0129-00			CAP., FXD, CER DI:0.56UF, 20%, 100V	56289	275C7
C2579	283-0129-00			CAP., FXD, CER DI:0.56UF, 20%, 100V	56289	275C7
C2582	290-0340-00	B010100	B069999X	CAP., FXD, ELCTLT:10UF, 10%, 50V	56289	109D106X9050C2
C2583	283-0177-00	B010100	B069999X	CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C2584	283-0177-00	B010100	B069999X	CAP., FXD, CER DI:1UF, +80-20%, 25V	72982	8131N039651105Z
C2586	283-0268-00	B010100	B069999X	CAP., FXD, CER DI:0.015UF, 10%, 50V	72982	8131N075W5R153K

Ckt No.	Tektronix		Serial/Model No.		Name & Description	Mfr	
	Part No.	Eff	Dscont	Code		Mfr Part Number	
C2610	285-1031-00				CAP., FXD, PLSTC:0.56UF, 10%, 50V	84411	TEK116-5649R5
C2620	290-0536-00	B010100	B039999		CAP., FXD, ELCTLT:10UF, 20%, 25V	90201	TDC106M025NLF
C2620	290-0512-00	B040000			CAP., FXD, ELCTLT:22UF, 20%, 15V	56289	196D226X0015KA1
C2700	283-0111-00				CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2710	283-0111-00				CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2714	283-0111-00				CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2716	283-0111-00				CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8131N075651104M
C2724	283-0191-00				CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
C2738	283-0191-00				CAP., FXD, CER DI:0.022UF, 20%, 50V	72982	8121N063651223M
CR91	153-0044-00				SEMICOND, DEVICE:SILICON, 15V, MATCHED	80009	153-0044-00
CR92							
CR93							
CR94							
CR242	152-0524-00				SEMICOND DEVICE:100V, 100MA	21847	A5S138
CR280	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR355	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR356	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR357	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR444	152-0524-00				SEMICOND DEVICE:100V, 100MA	21847	A5S138
CR457	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR478	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR511	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR512	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR514	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR515	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR517	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR518	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR521	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR522	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR524	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR525	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR527	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR528	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR531	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR532	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR534	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR535	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR540	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR546	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR547	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR701	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR771	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR772	152-0322-00				SEMICOND DEVICE:SILICON, 15V	28480	5082-2672
CR801	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR802	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR825	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR826	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR854	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR887	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR888	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR895	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR898	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152
CR1038	152-0141-02				SEMICOND DEVICE:SILICON, 30V, 150MA	07910	1N4152

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR1040	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1237	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1283	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1284	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1295	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1315	152-0075-00			SEMICON DEVICE:GE,25V,40MA	14936	GD238
CR1331	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1332	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1372	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1374	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR1530	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR1564	152-0578-00			SEMICON DEVICE:VARACTOR,200PF	80009	152-0578-00
CR1730	152-0246-00			SEMICON DEVICE:SILICON,400P IV,200MA	07910	CD12676
CR1742	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR1744	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR1745	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR1746	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR1748	152-0246-00			SEMICON DEVICE:SILICON,400P IV,200MA	07910	CD12676
CR1749	152-0246-00			SEMICON DEVICE:SILICON,400P IV,200MA	07910	CD12676
CR1820	152-0322-00			SEMICON DEVICE:SILICON,15V	28480	5082-2672
CR1822	152-0322-00			SEMICON DEVICE:SILICON,15V	28480	5082-2672
CR1830	152-0322-00			SEMICON DEVICE:SILICON,15V	28480	5082-2672
CR1832	152-0322-00			SEMICON DEVICE:SILICON,15V	28480	5082-2672
CR1955	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR1965	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR2060	152-0322-00			SEMICON DEVICE:SILICON,15V	28480	5082-2672
CR2130	152-0246-00			SEMICON DEVICE:SILICON,400P IV,200MA	07910	CD12676
CR2132	152-0246-00			SEMICON DEVICE:SILICON,400P IV,200MA	07910	CD12676
CR2134	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2142	152-0246-00			SEMICON DEVICE:SILICON,400P IV,200MA	07910	CD12676
CR2202	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2206	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2332	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2336	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2342	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2525	152-0400-00			SEMICON DEVICE:SILICON,400V,1A	80009	152-0400-00
CR2526	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2590	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2592	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2602	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR2608	152-0242-00			SEMICON DEVICE:SILICON,225V,200MA	12969	NDP341
CR2710	152-0141-02			SEMICON DEVICE:SILICON,30V,150MA	07910	1N4152
CR2720	152-0153-00			SEMICON DEVICE:SILICON,15V,50MA	13715	FD7003
CR2722	152-0153-00			SEMICON DEVICE:SILICON,15V,50MA	13715	FD7003
CR2724	152-0153-00	XB040000		SEMICON DEVICE:SILICON,15V,50MA	13715	FD7003
CR2726	152-0153-00	XB040000		SEMICON DEVICE:SILICON,15V,50MA	13715	FD7003
DS27 <sup>1</sup>						
DS92 <sup>2</sup>						
DS94 <sup>2</sup>						
DS96 <sup>2</sup>						
DS101 <sup>3</sup>						
DS130	150-0048-00			LAMP, INCAND:5V,60MA	08806	683

<sup>1</sup>Furnished as a unit with 670-3106-00.

<sup>2</sup>Furnished as a unit with 670-3111-00.

<sup>3</sup>Furnished as a unit with 670-3110-00.



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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
DS1152 <sup>1</sup>						
DS1156 <sup>1</sup>						
DS2075	150-1012-00			NUM DISPLAY:4 DIGITS,7 SEG LED,RED	50579	DATA-LIT 34
FL2	119-0472-00	B010100	B029999	FILTER,LOW PASS:1800 MHZ	80009	119-0472-00
FL2	119-0472-01	B030000		FILTER,LOW PASS:1800 MHZ	80009	119-0472-01
FL360	119-0276-00			FILTER BAND PAS:10MHZ	34630	10.0-30
FL370	119-0278-00			FILTER BAND PAS:10MHZ	34630	10.0-3.0
FL380	119-0275-00			FILTER,BAND PAS:CRYSTAL,10 MHZ	34630	10.0-300
FL2730	119-0449-00	B010100	B049999	FILTER,BAND PAS:10 MHZ	80009	119-0449-00
FL2730 <sup>2</sup>	119-0449-01	B050000		FILTER BAND PAS:10 MHZ	80009	119-0449-01
J70	131-1471-00			CONN,RCPT,ELEC:	0000A	RA1306
J80	131-0156-00			CONNECTOR,RCPT,:COAXIAL	74868	27-3
J87	136-0387-00			JACK,TIP:GRAY	71279	4352-1-0318
J88	136-0387-00			JACK,TIP:GRAY	71279	4352-1-0318
J92	131-0156-00			CONNECTOR,RCPT,:COAXIAL	74868	27-3
J95	131-0156-00			CONNECTOR,RCPT,:COAXIAL	74868	27-3
J97	136-0387-00			JACK,TIP:GRAY	71279	4352-1-0318
J98	136-0387-00			JACK,TIP:GRAY	71279	4352-1-0318
J211	131-0391-01			CONNECTOR,RCPT,:50 OHM,COAX,SNAP-ON MALE	98291	51-051-0119
J240	131-0391-01			CONNECTOR,RCPT,:50 OHM,COAX,SNAP-ON MALE	98291	51-051-0119
J900	131-0391-01			CONNECTOR,RCPT,:50 OHM,COAX,SNAP-ON MALE	98291	51-051-0119
J2700	131-0391-01			CONNECTOR,RCPT,:50 OHM,COAX,SNAP-ON MALE	98291	51-051-0119
K281	148-0088-00			RELAY,ARMATURE:DPDT,12OMW	80009	148-0088-00
K300	148-0087-00			RELAY,ARMATURE:SPDT,90MW	80009	148-0087-00
K353	148-0087-00			RELAY,ARMATURE:SPDT,90MW	80009	148-0087-00
K354	148-0088-00			RELAY,ARMATURE:DPDT,12OMW	80009	148-0088-00
K355	148-0088-00			RELAY,ARMATURE:DPDT,12OMW	80009	148-0088-00
K356	148-0087-00			RELAY,ARMATURE:SPDT,90MW	80009	148-0087-00
K357	148-0088-00			RELAY,ARMATURE:DPDT,12OMW	80009	148-0088-00
K1955	148-0086-00			RELAY,REED:SPDT,COIL 5V,150 OHM	24211	GB835C-1
K1965	148-0076-00			RELAY,REED:	24211	GB831A-22
K2526	148-0087-00			RELAY,ARMATURE:SPDT,90MW	80009	148-0087-00
K2602	148-0076-00			RELAY,REED:	24211	GB831A-22
K2700	148-0088-00			RELAY,ARMATURE:DPDT,12OMW	80009	148-0088-00
K2710	148-0088-00			RELAY,ARMATURE:DPDT,12OMW	80009	148-0088-00
L80	108-0215-00			COIL,RF:1.1UH	80009	108-0215-00
L82	108-0706-00			COIL,RF:146NH	80009	108-0706-00
L85	108-0433-00			COIL,RF:0.09UH	80009	108-0433-00
L86	108-0703-00			TRANSFORMER,RF:3UH	80009	108-0703-00
L87	108-0704-00			COIL,RF:3.27UH	80009	108-0704-00
L88	108-0758-00			TRANSFORMER,RF:3.34UH	80009	108-0758-00
L89	108-0182-00			COIL,RF:0.3UH	80009	108-0182-00
L202	108-0315-00			COIL,RF:0.22UH	32159	72203M
L204	108-0062-00			COIL,RF:0.45UH	80009	108-0062-00
L230	108-0395-00			COIL,RF:64UH	80009	108-0395-00
L231	108-0395-00			COIL,RF:64UH	80009	108-0395-00
L232	108-0395-00			COIL,RF:64UH	80009	108-0395-00
L254	108-0406-00			COIL,RF:80UH,TOROIDAL	80009	108-0406-00
L284	108-0406-00			COIL,RF:80UH,TOROIDAL	80009	108-0406-00
L292	108-0406-00			COIL,RF:80UH,TOROIDAL	80009	108-0406-00
L321	108-0701-00			COIL,RF:1.3UH	80009	108-0701-00

<sup>1</sup>Furnished as a unit with 670-3109-00.

<sup>2</sup>See Mechanical Parts List.

# Electrical Parts List—7L13

Ckt No.	Tektronix		Serial/Model No.		Name & Description	Mfr	
	Part No.	Eff	Dscont			Code	Mfr Part Number
L324	108-0701-00				COIL, RF: 1.3UH	80009	108-0701-00
L327	108-0701-00				COIL, RF: 1.3UH	80009	108-0701-00
L341	108-0701-00				COIL, RF: 1.3UH	80009	108-0701-00
L344	108-0701-00				COIL, RF: 1.3UH	80009	108-0701-00
L347	108-0701-00				COIL, RF: 1.3UH	80009	108-0701-00
L382	276-0528-00				SHIELDING BEAD, :0.1UH	80009	276-0528-00
L390	108-0395-00				COIL, RF: 64UH	80009	108-0395-00
L391	108-0395-00				COIL, RF: 64UH	80009	108-0395-00
L392	108-0395-00				COIL, RF: 64UH	80009	108-0395-00
L455	108-0095-00				COIL, RF: 1.4UH	80009	108-0095-00
L471	108-0701-00				COIL, RF: 1.3UH	80009	108-0701-00
L474	108-0701-00				COIL, RF: 1.3UH	80009	108-0701-00
L533	108-0240-00				COIL, RF: 820UH	76493	108-0240-00
L548	108-0443-00				COIL, RF: 25UH	80009	108-0443-00
L813	108-0702-00				COIL, RF: 36UH	80009	108-0702-00
L816	108-0443-00				COIL, RF: 25UH	80009	108-0443-00
L950	108-0538-00				COIL, RF: 2.7UH	76493	70F276A1
L951	108-0666-00				COIL, RF: 900NH	80009	108-0666-00
L954	276-0507-00				SHIELDING BEAD, :0.6UH	78488	57-0180-7D
L958	276-0507-00				SHIELDING BEAD, :0.6UH	78488	57-0180-7D
L1400	108-0062-00				COIL, RF: 0.45UH	80009	108-0062-00
L1408	108-0062-00				COIL, RF: 0.45UH	80009	108-0062-00
L1505	108-0551-00				COIL, RF: 14UH	80009	108-0551-00
L1512	108-0440-00				COIL, RF: 8UH, TOROIDAL INDUCTOR	80009	108-0440-00
L1530	108-0440-00				COIL, RF: 8UH, TOROIDAL INDUCTOR	80009	108-0440-00
L1536	108-0440-00				COIL, RF: 8UH, TOROIDAL INDUCTOR	80009	108-0440-00
L1552	108-0551-00				COIL, RF: 14UH	80009	108-0551-00
L1562	108-0551-00				COIL, RF: 14UH	80009	108-0551-00
L1564	108-0474-00				COIL, RF: 2UH	80009	108-0474-00
L1602	108-0315-00				COIL, RF: 0.22UH	32159	72203M
L1800	108-0551-00				COIL, RF: 14UH	80009	108-0551-00
L1814	276-0507-00				SHIELDING BEAD, :0.6UH	78488	57-0180-7D
L1832	108-0395-00				COIL, RF: 64UH	80009	108-0395-00
L1835	108-0395-00				COIL, RF: 64UH	80009	108-0395-00
L2000	108-0598-00				COIL, RF: 200UH	80009	108-0598-00
L2150	108-0537-00				COIL, RF: 200UH	80009	108-0537-00
L2152	108-0597-00				COIL, RF: TOROIDAL, 425UH	80009	108-0597-00
L2154	108-0537-00				COIL, RF: 200UH	80009	108-0537-00
L2608	108-0431-00				COIL, REED SW: REED DRIVE	80009	108-0431-00
L2710	108-0395-00				COIL, RF: 64UH	80009	108-0395-00
L2712	276-0528-00	XB020000			SHIELDING BEAD, :0.1UH	80009	276-0528-00
L2718	108-0395-00				COIL, RF: 64UH	80009	108-0395-00
P30	131-1470-00				CONNECTOR, RCPT, :DOUBLE MALE FEEDTHROUGH	16179	OSM-209A
P36	131-1470-00				CONNECTOR, RCPT, :DOUBLE MALE FEEDTHROUGH	16179	OSM-209A
Q85	151-1055-00				TRANSISTOR: SILICON, JFE, N-CHANNEL	02735	62460
Q204	151-0442-00				TRANSISTOR: SILICON, NPN	80009	151-0442-00
Q211	151-0442-00				TRANSISTOR: SILICON, NPN	80009	151-0442-00
Q240	151-0442-00				TRANSISTOR: SILICON, NPN	80009	151-0442-00
Q250	151-0442-00				TRANSISTOR: SILICON, NPN	80009	151-0442-00
Q260	151-0442-00				TRANSISTOR: SILICON, NPN	80009	151-0442-00
Q270	151-0220-00				TRANSISTOR: SILICON, PNP	80009	151-0220-00
Q280	151-0442-00				TRANSISTOR: SILICON, NPN	80009	151-0442-00

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Ckt No.	Tektronix	Serial/Model No.		Name & Description	Mfr	
	Part No.	Eff	Dscont		Code	Mfr Part Number
Q290	151-0442-00			TRANSISTOR:SILICON,NPN	80009	151-0442-00
Q330	151-0442-00			TRANSISTOR:SILICON,NPN	80009	151-0442-00
Q380	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q420	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q440	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q450	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q460	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q540	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q550	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q560	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q570	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q580	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q590	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q600	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q610	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q620	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q630	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q640	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q650	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q660	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q670	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q680	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q700	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q710	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q720	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q730	151-0220-00			TRANSISTOR:SILICON,PNP	80009	151-0220-00
Q740	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q750	151-0221-00			TRANSISTOR:SILICON,PNP	80009	151-0221-00
Q760	151-0221-00			TRANSISTOR:SILICON,PNP	80009	151-0221-00
Q880	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q887	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q890	151-0195-00			TRANSISTOR:SILICON,NPN	80009	151-0195-00
Q895	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q898	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q950	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q960	151-0441-00			TRANSISTOR:SILICON,NPN	80009	151-0441-00
Q1110	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1120	151-0503-00			TRANSISTOR:SCR,30V,0.8A	04713	2N5060
Q1150	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q1160	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1210	151-0216-00			TRANSISTOR:SILICON,PNP	04713	MPS6523
Q1215	151-1078-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1078-00
Q1216	151-1078-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	80009	151-1078-00
Q1230	151-0333-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS918	80009	151-0333-00
Q1315	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q1402	151-0402-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	80009
Q1605	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q1615	151-0367-00			TRANSISTOR:SILICON,NPN,SEL FROM 3571TP	80009	151-0367-00
Q1715	151-0169-00			TRANSISTOR:SILICON,NPN	02735	2N3439
Q1810	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q1815	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q1820	151-0327-00			TRANSISTOR:SILICON,PNP	80009	151-0327-00
Q1825	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q1830	151-0327-00			TRANSISTOR:SILICON,PNP	80009	151-0327-00
Q1835	151-0288-00			TRANSISTOR:SILICON,NPN	80009	151-0288-00
Q9165	151-0334-00			TRANSISTOR:SILICON,NPN	80009	151-0334-00
Q2005	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2010	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2015	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q2120	151-1005-00			TRANSISTOR:SILICON,JFE,N-CHANNEL	15818	U1490
Q2140	151-0190-00	XB080365		TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2215	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q2225	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q2320	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q2330	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
Q2335	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2340	151-0190-00			TRANSISTOR:SILICON,NPN	80009	151-0190-00
Q2345	151-1039-00			TRANSISTOR:SILICON,JFE,P-CHAN	04713	2N5462
Q2520	151-0454-00			TRANSISTOR:SILICON,NPN	16758	DTS1010
Q2540	151-0335-00			TRANSISTOR:SILICON,PNP	80009	151-0335-00
Q2545	151-0334-00			TRANSISTOR:SILICON,NPN	80009	151-0334-00
Q2555	151-0415-00			TRANSISTOR:SILICON,NPN	04713	MJE1102
Q2565	151-0302-00			TRANSISTOR:SILICON,NPN	04713	2N2222A
Q2570	151-0228-00			TRANSISTOR:SILICON,PNP,SEL FROM 2N4888	07263	S21862
Q2575	151-0250-00			TRANSISTOR:SILICON,NPN	07263	S36744
Q2580	151-0335-00	B010100	B069999X	TRANSISTOR:SILICON,PNP	80009	151-0335-00
Q2610	151-1002-00			TRANSISTOR:SILICON,FE,N-CHANNEL MOS	04713	SS3598
Q2615	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q2710	151-0288-00			TRANSISTOR:SILICON,NPN	80009	151-0288-00
Q2715	151-0288-00			TRANSISTOR:SILICON,NPN	80009	151-0288-00
Q2735	151-0188-00			TRANSISTOR:SILICON,PNP	04713	2N3906
R20	311-1683-00			RES.,VAR,WW:2K OHM,5%	80294	3540S-512-202
R22	311-1673-00			RES.,VAR,WW:10K OHM,10%	73138	7266-373-0
R27	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R80	311-0328-00			RES.,VAR,NONWIR:1K OHM,20%	01121	W7365
R81	317-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.125W	01121	BB7525
R82 <sup>1</sup>	311-0771-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	71590	BA162-005
R84	315-0114-00			RES.,FXD,CMPSN:110K OHM,5%,0.25W	01121	CB1145
R85	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R86	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R87	317-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.125W	01121	BB4705
R95	311-0328-00			RES.,VAR,NONWIR:1K OHM,20%	01121	W7365
R96	311-1095-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	11237	300SF-3P1631
R97	311-0326-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	01121	W7683
R98	311-1095-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	11237	300SF-3P1631
R100 <sup>2</sup>	311-1192-00			RES.,VAR,NONWIR:10K OHM,20%,1W	12637	381-CM39695
R102	311-1099-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	01121	WA1G032S104AA
R107	311-0387-00			RES.,VAR,NONWIR:5K OHM,20%	11237	41027
R110	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R111	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R112	321-0199-00			RES.,FXD,FILM:1.15K OHM,1%,0.125W	75042	CEATO-1151F
R115	311-0329-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	01121	W7356
R130	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R131	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R132	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R133	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F

<sup>1</sup>Furnished as a unit with S82.

<sup>2</sup>Furnished as a unit with S100.

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R134	321-0335-00		RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R135	321-0327-00		RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R136	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R137	321-0327-00		RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R138	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R139	321-0356-00		RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R140	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R141	321-0321-00		RES.,FXD,FILM:21.5K OHM,1%,0.125W	75042	CEATO-2152F
R142	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R143	321-0321-00		RES.,FXD,FILM:21.5K OHM,1%,0.125W	75042	CEATO-2152F
R144	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R145	321-0373-00		RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R146	321-0335-00		RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R147	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R148	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R149	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R150	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R160	321-0373-00		RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R161	321-0306-00		RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R162	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R163	321-0327-00		RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R164	321-0321-00		RES.,FXD,FILM:21.5K OHM,1%,0.125W	75042	CEATO-2152F
R165	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R166	321-0373-00		RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R167	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R168	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R169	321-0356-00		RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R170	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R180	321-0344-00		RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R181	321-0356-00		RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R182	321-0373-00		RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R183	321-0335-00		RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R184	321-0327-00		RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R185	321-0321-00		RES.,FXD,FILM:21.5K OHM,1%,0.125W	75042	CEATO-2152F
R186	321-0315-00		RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R187	321-0310-00		RES.,FXD,FILM:16.5K OHM,1%,0.125W	75042	CEATO-1652C
R188	321-0300-00		RES.,FXD,FILM:13K OHM,1%,0.125W	75042	CEATO-1302F
R189	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R190	321-0335-00		RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R191	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R192	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R193	321-0327-00		RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R194	321-0373-00		RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R195	321-0327-00		RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R196	321-0402-00		RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R201	315-0242-00		RES.,FXD,CMPNS:2.4K OHM,5%,0.25W	01121	CB2425
R202	315-0221-00		RES.,FXD,CMPNS:220 OHM,5%,0.25W	01121	CB2215
R205	315-0272-00		RES.,FXD,CMPNS:2.7K OHM,5%,0.25W	01121	CB2725
R207	315-0470-00		RES.,FXD,CMPNS:47 OHM,5%,0.25W	01121	CB4705
R210	315-0510-00		RES.,FXD,CMPNS:51 OHM,5%,0.25W	01121	CB5105
R211	315-0470-00		RES.,FXD,CMPNS:47 OHM,5%,0.25W	01121	CB4705
R214	315-0181-00		RES.,FXD,CMPNS:180 OHM,5%,0.25W	01121	CB1815
R215	315-0622-00		RES.,FXD,CMPNS:6.2K OHM,5%,0.25W	01121	CB6225

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R240	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205
R241	315-0620-00		RES.,FXD,CMPNS:62 OHM,5%,0.25W	01121	CB6205
R242	315-0472-00		RES.,FXD,CMPNS:4.7K OHM,5%,0.25W	01121	CB4725
R244	315-0510-00		RES.,FXD,CMPNS:51 OHM,5%,0.25W	01121	CB5105
R245	315-0301-00		RES.,FXD,CMPNS:300 OHM,5%,0.25W	01121	CB3015
R247	315-0301-00		RES.,FXD,CMPNS:300 OHM,5%,0.25W	01121	CB3015
R248	315-0222-00		RES.,FXD,CMPNS:2.2K OHM,5%,0.25W	01121	CB2225
R250	321-0277-00		RES.,FXD,FILM:7.5K OHM,1%,0.125W	75042	CEATO-7501F
R251	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205
R253	315-0430-00		RES.,FXD,CMPNS:43 OHM,5%,0.25W	01121	CB4305
R254	321-0143-00		RES.,FXD,FILM:301 OHM,1%,0.125W	75042	CEATO-3010F
R255	315-0100-00		RES.,FXD,CMPNS:10 OHM,5%,0.25W	01121	CB1005
R257	321-0202-00		RES.,FXD,FILM:1.24K OHM,1%,0.125W	75042	CEATO-1241F
R258	321-0158-00		RES.,FXD,FILM:432 OHM,1%,0.125W	75042	CEATO-4320F
R260	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205
R261	315-0331-00		RES.,FXD,CMPNS:330 OHM,5%,0.25W	01121	CB3315
R264	321-0072-00		RES.,FXD,FILM:54.9 OHM,1%,0.125W	75042	CEATO-54R90F
R265	311-0622-00		RES.,VAR,NONWIR:100 OHM,10%,0.50W	80740	62-53-5
R266	315-0100-00		RES.,FXD,CMPNS:10 OHM,5%,0.25W	01121	CB1005
R267	315-0203-00		RES.,FXD,CMPNS:20K OHM,5%,0.25W	01121	CB2035
R268	315-0391-00		RES.,FXD,CMPNS:390 OHM,5%,0.25W	01121	CB3915
R270	315-0202-00		RES.,FXD,CMPNS:2K OHM,5%,0.25W	01121	CB2025
R272	315-0511-00		RES.,FXD,CMPNS:510 OHM,5%,0.25W	01121	CB5115
R275	315-0390-00		RES.,FXD,CMPNS:39 OHM,5%,0.25W	01121	CB3905
R280	315-0105-00		RES.,FXD,CMPNS:1M OHM,5%,0.25W	01121	CB1055
R281	321-0277-00		RES.,FXD,FILM:7.5K OHM,1%,0.125W	75042	CEATO-7501F
R282	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205
R283	315-0430-00		RES.,FXD,CMPNS:43 OHM,5%,0.25W	01121	CB4305
R284	321-0143-00		RES.,FXD,FILM:301 OHM,1%,0.125W	75042	CEATO-3010F
R285	315-0100-00		RES.,FXD,CMPNS:10 OHM,5%,0.25W	01121	CB1005
R287	321-0202-00		RES.,FXD,FILM:1.24K OHM,1%,0.125W	75042	CEATO-1241F
R288	321-0158-00		RES.,FXD,FILM:432 OHM,1%,0.125W	75042	CEATO-4320F
R290	315-0431-00		RES.,FXD,CMPNS:430 OHM,5%,0.25W	01121	CB4315
R291	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205
R292	315-0331-00		RES.,FXD,CMPNS:330 OHM,5%,0.25W	01121	CB3315
R293	315-0105-00		RES.,FXD,CMPNS:1M OHM,5%,0.25W	01121	CB1055
R294	321-0072-00		RES.,FXD,FILM:54.9 OHM,1%,0.125W	75042	CEATO-54R90F
R295	315-0100-00		RES.,FXD,CMPNS:10 OHM,5%,0.25W	01121	CB1005
R296	315-0680-00		RES.,FXD,CMPNS:68 OHM,5%,0.25W	01121	CB6805
R297	311-0605-00		RES.,VAR,NONWIR:200 OHM,10%,0.50W	80740	62-54-3
R298	315-0391-00		RES.,FXD,CMPNS:390 OHM,5%,0.25W	01121	CB3915
R300	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205
R306	321-0092-00		RES.,FXD,FILM:88.7 OHM,1%,0.125W	75042	CEATO-88R70F
R307	311-0622-00		RES.,VAR,NONWIR:100 OHM,10%,0.50W	80740	62-53-5
R308	315-0121-00		RES.,FXD,CMPNS:120 OHM,5%,0.25W	01121	CB1215
R330	321-0165-00		RES.,FXD,FILM:511 OHM,1%,0.125W	75042	CEATO-5110F
R331	315-0470-00		RES.,FXD,CMPNS:47 OHM,5%,0.25W	01121	CB4705
R333	315-0470-00		RES.,FXD,CMPNS:47 OHM,5%,0.25W	01121	CB4705
R334	321-0172-00		RES.,FXD,FILM:604 OHM,1%,0.125W	75042	CEATO-6040F
R337	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R338	315-0911-00		RES.,FXD,CMPNS:910 OHM,5%,0.25W	01121	CB9115
R353	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205
R354	315-0220-00		RES.,FXD,CMPNS:22 OHM,5%,0.25W	01121	CB2205

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R366	321-0092-00		RES.,FXD,FILM:88.7 OHM,1%,0.125W	75042	CEATO-88R70F
R367	311-0622-00		RES.,VAR,NONWIR:100 OHM,10%,0.50W	80740	62-53-5
R368	315-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R376	321-0092-00		RES.,FXD,FILM:88.7 OHM,1%,0.125W	75042	CEATO-88R70F
R377	311-0622-00		RES.,VAR,NONWIR:100 OHM,10%,0.50W	80740	62-53-5
R378	315-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R380	321-0068-00		RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R383	315-0112-00		RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R384	321-0136-00		RES.,FXD,FILM:255 OHM,1%,0.125W	75042	CEATO-2550F
R385	315-0104-00		RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R386	315-0510-00		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R387	311-0605-00		RES.,VAR,NONWIR:200 OHM,10%,0.50W	80740	62-54-3
R388	315-0242-00		RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R422	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R423	315-0151-00		RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R424	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R425	311-0605-00		RES.,VAR,NONWIR:200 OHM,10%,0.50W	80740	62-54-3
R427	315-0621-00		RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R428	315-0821-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R440	315-0133-00		RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R442	315-0301-00		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R443	315-0301-00		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R445	315-0242-00		RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R447	315-0621-00		RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R448	315-0821-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R450	315-0133-00		RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R451	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R452	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R453	315-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R455	315-0471-00		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R456	315-0220-00		RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R457	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R458	315-0821-00		RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R460	315-0133-00		RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R461	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R462	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R463	315-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
R467	315-0511-00		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R468	315-0301-00		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R477	315-0391-00		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R478	315-0621-00		RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R479	315-0511-00		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R511	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R512	321-0315-00		RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R514	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R515	321-0315-00		RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R517	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R518	321-0315-00		RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R521	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R522	321-0315-00		RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R524	321-0097-00		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R525	321-0315-00		RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R527	321-0205-00		RES.,FXD,FILM:1.33K OHM,1%,0.125W	75042	CEATO-1331F

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R528	321-0261-00			RES., FXD, FILM:5.11K OHM, 1%, 0.125W	75042	CEATO-5111F
R531	321-0097-00			RES., FXD, FILM:100 OHM, 1%, 0.125W	75042	CEATO-1000F
R532	321-0315-00			RES., FXD, FILM:18.7K OHM, 1%, 0.125W	75042	CEATO-1872F
R534	321-0205-00			RES., FXD, FILM:1.33K OHM, 1%, 0.125W	75042	CEATO-1331F
R535	321-0261-00			RES., FXD, FILM:5.11K OHM, 1%, 0.125W	75042	CEATO-5111F
R537	316-0104-00			RES., FXD, CMPSN:100K OHM, 10%, 0.25W	01121	CB1041
R539	316-0103-00			RES., FXD, CMPSN:10K OHM, 10%, 0.25W	01121	CB1031
R540	315-0153-00			RES., FXD, CMPSN:15K OHM, 5%, 0.25W	01121	CB1535
R542	311-0633-00			RES., VAR, NONWIR:5K OHM, 10%, 0.50W	80740	62-58-3
R543	315-0102-00			RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
R544	321-0120-00			RES., FXD, FILM:174 OHM, 1%, 0.125W	75042	CEATO-1740F
R546	321-0120-00			RES., FXD, FILM:174 OHM, 1%, 0.125W	75042	CEATO-1740F
R547	315-0105-00			RES., FXD, CMPSN:1M OHM, 5%, 0.25W	01121	CB1055
R550	316-0101-00			RES., FXD, CMPSN:100 OHM, 10%, 0.25W	01121	CB1011
R551	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R552	321-0190-00			RES., FXD, FILM:931 OHM, 1%, 0.125W	75042	CEATO-9310F
R554	316-0101-00			RES., FXD, CMPSN:100 OHM, 10%, 0.25W	01121	CB1011
R556	315-0620-00			RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
R560	321-0178-00			RES., FXD, FILM:698 OHM, 1%, 0.125W	75042	CEATO-6980F
R562	321-0297-00			RES., FXD, FILM:12.1K OHM, 1%, 0.125W	75042	CEATO-1212F
R563	321-0350-00			RES., FXD, FILM:43.2K OHM, 1%, 0.125W	75042	CEATO-4322F
R564	316-0101-00			RES., FXD, CMPSN:100 OHM, 10%, 0.25W	01121	CB1011
R566	321-0184-00			RES., FXD, FILM:806 OHM, 1%, 0.125W	75042	CEATO-8060F
R567	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R571	315-0202-00			RES., FXD, CMPSN:2K OHM, 5%, 0.25W	01121	CB2025
R572	315-0511-00			RES., FXD, CMPSN:510 OHM, 5%, 0.25W	01121	CB5115
R574	321-0148-00			RES., FXD, FILM:340 OHM, 1%, 0.125W	75042	CEATO-3400F
R576	321-0337-00			RES., FXD, FILM:31.6K OHM, 1%, 0.125W	75042	CEATO-3162F
R580	316-0101-00			RES., FXD, CMPSN:100 OHM, 10%, 0.25W	01121	CB1011
R581	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R582	321-0190-00			RES., FXD, FILM:931 OHM, 1%, 0.125W	75042	CEATO-9310F
R584	316-0101-00			RES., FXD, CMPSN:100 OHM, 10%, 0.25W	01121	CB1011
R586	315-0620-00			RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
R590	321-0297-00			RES., FXD, FILM:12.1K OHM, 1%, 0.125W	75042	CEATO-1212F
R591	321-0350-00			RES., FXD, FILM:43.2K OHM, 1%, 0.125W	75042	CEATO-4322F
R596	281-0184-00			CAP., VAR, PLSTC:2-18PF, 500VDC	34553	2222-809-05003
R597	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R600	316-0104-00			RES., FXD, CMPSN:100K OHM, 10%, 0.25W	01121	CB1041
R601	315-0202-00			RES., FXD, CMPSN:2K OHM, 5%, 0.25W	01121	CB2025
R602	315-0511-00			RES., FXD, CMPSN:510 OHM, 5%, 0.25W	01121	CB5115
R603	311-0605-00			RES., VAR, NONWIR:200 OHM, 10%, 0.50W	80740	62-54-3
R604	321-0134-00			RES., FXD, FILM:243 OHM, 1%, 0.125W	75042	CEATO-2430F
R606	321-0337-00			RES., FXD, FILM:31.6K OHM, 1%, 0.125W	75042	CEATO-3162F
R610	316-0101-00			RES., FXD, CMPSN:100 OHM, 10%, 0.25W	01121	CB1011
R611	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R612	321-0190-00			RES., FXD, FILM:931 OHM, 1%, 0.125W	75042	CEATO-9310F
R614	316-0101-00			RES., FXD, CMPSN:100 OHM, 10%, 0.25W	01121	CB1011
R616	315-0620-00			RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
R620	321-0297-00			RES., FXD, FILM:12.1K OHM, 1%, 0.125W	75042	CEATO-1212F
R621	321-0350-00			RES., FXD, FILM:43.2K OHM, 1%, 0.125W	75042	CEATO-4322F
R626	321-0184-00			RES., FXD, FILM:806 OHM, 1%, 0.125W	75042	CEATO-8060F
R627	315-0201-00			RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
R631	315-0202-00			RES., FXD, CMPSN:2K OHM, 5%, 0.25W	01121	CB2025



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Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr	
		Eff	Dscont		Code	Mfr Part Number
R632	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R634	321-0148-00			RES.,FXD,FILM:340 OHM,1%,0.125W	75042	CEATO-3400F
R636	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	75042	CEATO-3162F
R640	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R641	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R642	321-0190-00			RES.,FXD,FILM:931 OHM,1%,0.125W	75042	CEATO-9310F
R644	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R646	315-0620-00			RES.,FXD,CMPSN:62 OHM,5%,0.25W	01121	CB6205
R650	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEATO-1212F
R651	321-0350-00			RES.,FXD,FILM:43.2K OHM,1%,0.125W	75042	CEATO-4322F
R656	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	75042	CEATO-8060F
R657	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R660	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R661	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R662	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R663	311-0605-00			RES.,VAR,NONWIR:200 OHM,10%,0.50W	80740	62-54-3
R664	321-0134-00			RES.,FXD,FILM:243 OHM,1%,0.125W	75042	CEATO-2430F
R666	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	75042	CEATO-3162F
R670	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R671	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R672	321-0190-00			RES.,FXD,FILM:931 OHM,1%,0.125W	75042	CEATO-9310F
R674	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R676	315-0620-00			RES.,FXD,CMPSN:62 OHM,5%,0.25W	01121	CB6205
R680	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEATO-1212F
R681	321-0350-00			RES.,FXD,FILM:43.2K OHM,1%,0.125W	75042	CEATO-4322F
R686	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	75042	CEATO-8060F
R687	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R696	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	75042	CEATO-3162F
R697	321-0152-00			RES.,FXD,FILM:374 OHM,1%,0.125W	75042	CEATO-3740F
R698	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEATO-1212F
R701	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R702	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R703	311-0609-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	80740	62-57-3
R704	315-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R710	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R711	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R712	321-0132-00			RES.,FXD,FILM:232 OHM,1%,0.125W	75042	CEATO-2320F
R714	321-0120-00			RES.,FXD,FILM:174 OHM,1%,0.125W	75042	CEATO-1740F
R716	315-0620-00			RES.,FXD,CMPSN:62 OHM,5%,0.25W	01121	CB6205
R720	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEATO-1212F
R721	321-0350-00			RES.,FXD,FILM:43.2K OHM,1%,0.125W	75042	CEATO-4322F
R726	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	75042	CEATO-8060F
R727	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R731	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R732	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R733	311-0634-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	80740	62-55-3
R734	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R736	321-0337-00			RES.,FXD,FILM:31.6K OHM,1%,0.125W	75042	CEATO-3162F
R737	321-0152-00			RES.,FXD,FILM:374 OHM,1%,0.125W	75042	CEATO-3740F
R738	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	75042	CEATO-1212F
R741	315-0910-00			RES.,FXD,CMPSN:91 OHM,5%,0.25W	01121	CB9105
R742	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R744	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R745	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R746	315-0510-00	XB040000		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R747	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R748	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	75042	CEATO-6041F
R750	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R751	321-0041-00			RES.,FXD,FILM:26.1 OHM,1%,0.125W	75042	CEATO-26R10F
R752	323-0126-00			RES.,FXD,FILM:200 OHM,1%,0.50W	75042	CECTO-2000F
R755	321-0235-00			RES.,FXD,FILM:2.74K OHM,1%,0.125W	75042	CEATO-2741F
R756	321-0223-00			RES.,FXD,FILM:2.05K OHM,1%,0.125W	75042	CEATO-2051F
R757	315-0300-00			RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R762	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R766	301-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.50W	01121	EB1025
R767	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R771	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R772	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	75042	CEATO-4990F
R775	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	75042	CEATO-2000F
R776	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	75042	CEATO-2000F
R801	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	80740	62-63-3
R802	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	80740	62-63-3
R803	311-0613-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	80740	62-63-3
R806	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R807	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R808	315-0275-00			RES.,FXD,CMPSN:2.7M OHM,5%,0.25W	01121	CB2755
R819	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	75042	CEATO-4990F
R820	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R821	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R822	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R823	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R824	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R825	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R826	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	75042	CEATO-5111F
R829	321-0181-00			RES.,FXD,FILM:750 OHM,1%,0.125W	75042	CEATO-7500F
R830	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R833	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R840	316-0104-00			RES.,FXD,CMPSN:100K OHM,10%,0.25W	01121	CB1041
R852	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R854	315-0134-00			RES.,FXD,CMPSN:130K OHM,5%,0.25W	01121	CB1345
R855	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R856	315-0433-00			RES.,FXD,CMPSN:43K OHM,5%,0.25W	01121	CB4335
R857	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R858	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R859	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R860	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R861	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R862	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R864	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R865	321-0195-00			RES.,FXD,FILM:1.05K OHM,1%,0.125W	75042	CEATO-1051F
R866	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R867	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R868	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R880	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R881	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R882	321-0274-00			RES.,FXD,FILM:6.98K OHM,1%,0.125W	75042	CEATO-6981F

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R883	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	75042	CEATO-6040F
R884	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	75042	CEATO-7501F
R886	316-0101-00			RES.,FXD,CMPSN:100 OHM,10%,0.25W	01121	CB1011
R887	321-0259-00			RES.,FXD,FILM:4.87K OHM,1%,0.125W	12697	MFF1816G48700F
R889	321-0198-00			RES.,FXD,FILM:1.13K OHM,1%,0.125W	75042	CEATO-1131F
R890	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R891	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R892	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R894	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R895	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R896	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R898	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R951	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R952	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	75042	CEATO-3091F
R954	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEATO-10R00F
R955	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R956	311-0540-00			RES.,VAR,WW:2.5K OHM,5%	75042	100-1000-252
R958	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R959	321-0066-00			RES.,FXD,FILM:47.5 OHM,1%,0.125W	75042	CEATO-47R50F
R960	321-0240-00			RES.,FXD,FILM:3.09K OHM,1%,0.125W	75042	CEATO-3091F
R962	321-0066-00			RES.,FXD,FILM:47.5 OHM,1%,0.125W	75042	CEATO-47R50F
R964	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	75042	CEATO-3920F
R966	321-0073-00			RES.,FXD,FILM:56.2 OHM,1%,0.125W	75042	CEATO-56R20F
R967	321-0073-00			RES.,FXD,FILM:56.2 OHM,1%,0.125W	75042	CEATO-56R20F
R1000	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R1001	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R1002	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	75042	CEATO-3571F
R1003	321-0246-00			RES.,FXD,FILM:3.57K OHM,1%,0.125W	75042	CEATO-3571F
R1006	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R1008	321-0070-00			RES.,FXD,FILM:52.3 OHM,1%,0.125W	75042	CEATO-52R30F
R1010	321-0191-00			RES.,FXD,FILM:953 OHM,1%,0.125W	75042	CEATO-9530F
R1012	321-0191-00			RES.,FXD,FILM:953 OHM,1%,0.125W	75042	CEATO-9530F
R1014	321-0275-00			RES.,FXD,FILM:7.15K OHM,1%,0.125W	75042	CEATO-7151F
R1016	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R1018	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R1020	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R1022	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	75042	CEATO-1003F
R1024	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R1026	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R1028	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R1030	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R1032	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R1034	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R1036	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R1038	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1040	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R1042	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1044	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R1046	321-0253-00			RES.,FXD,FILM:4.22K OHM,1%,0.125W	75042	CEATO-4221F
R1048	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1049	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1050	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1051	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005

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Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont			
R1052	315-0473-00			RES.,FXD,CMPASN:47K OHM,5%,0.25W	01121	CB4735
R1053	315-0100-00			RES.,FXD,CMPASN:10 OHM,5%,0.25W	01121	CB1005
R1054	315-0473-00			RES.,FXD,CMPASN:47K OHM,5%,0.25W	01121	CB4735
R1060	321-0380-00			RES.,FXD,FILM:88.7K OHM,1%,0.125W	75042	CEATO-8872F
R1062	321-0335-00	B010100	B080364	RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R1062	321-0333-00	B080365		RES.,FXD,FILM:28.7K OHM,1%,0.125W	75042	CEATO-2872F
R1064	321-0384-00			RES.,FXD,FILM:97.6K OHM,1%,0.125W	75042	CEATO-9762F
R1066	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R1068	315-0911-00			RES.,FXD,CMPASN:910 OHM,5%,0.25W	01121	CB9115
R1070	315-0302-00			RES.,FXD,CMPASN:3K OHM,5%,0.25W	01121	CB3025
R1072	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R1074	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R1076	315-0911-00			RES.,FXD,CMPASN:910 OHM,5%,0.25W	01121	CB9115
R1078	315-0302-00			RES.,FXD,CMPASN:3K OHM,5%,0.25W	01121	CB3025
R1080	321-0271-00			RES.,FXD,FILM:6.49K OHM,1%,0.125W	75042	CEATO-6491F
R1082	321-0286-00			RES.,FXD,FILM:9.31K OHM,1%,0.125W	75042	CEATO-9311F
R1084	321-0313-00			RES.,FXD,FILM:17.8K OHM,1%,0.125W	75042	CEATO-1782F
R1086	321-0286-00			RES.,FXD,FILM:9.31K OHM,1%,0.125W	75042	CEATO-9311F
R1088	315-0821-00			RES.,FXD,CMPASN:820 OHM,5%,0.25W	01121	CB8215
R1090	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R1092	321-0209-00			RES.,FXD,FILM:1.47K OHM,1%,0.125W	75042	CEATO-1471F
R1100	315-0100-00			RES.,FXD,CMPASN:10 OHM,5%,0.25W	01121	CB1005
R1105	315-0100-00			RES.,FXD,CMPASN:10 OHM,5%,0.25W	01121	CB1005
R1110	315-0100-00			RES.,FXD,CMPASN:10 OHM,5%,0.25W	01121	CB1005
R1112	315-0471-00			RES.,FXD,CMPASN:470 OHM,5%,0.25W	01121	CB4715
R1114	315-0132-00			RES.,FXD,CMPASN:1.3K OHM,5%,0.25W	01121	CB1325
R1116	315-0472-00			RES.,FXD,CMPASN:4.7K OHM,5%,0.25W	01121	CB4725
R1118	315-0132-00			RES.,FXD,CMPASN:1.3K OHM,5%,0.25W	01121	CB1325
R1120	315-0122-00			RES.,FXD,CMPASN:1.2K OHM,5%,0.25W	01121	CB1225
R1122	315-0101-00			RES.,FXD,CMPASN:100 OHM,5%,0.25W	01121	CB1015
R1124	315-0302-00			RES.,FXD,CMPASN:3K OHM,5%,0.25W	01121	CB3025
R1125	315-0200-00			RES.,FXD,CMPASN:20 OHM,5%,0.25W	01121	CB2005
R1126	315-0513-00			RES.,FXD,CMPASN:51K OHM,5%,0.25W	01121	CB5135
R1127	315-0101-00			RES.,FXD,CMPASN:100 OHM,5%,0.25W	01121	CB1015
R1128	315-0200-00			RES.,FXD,CMPASN:20 OHM,5%,0.25W	01121	CB2005
R1129	315-0102-00			RES.,FXD,CMPASN:1K OHM,5%,0.25W	01121	CB1025
R1130	321-0038-00			RES.,FXD,FILM:24.3 OHM,1%,0.125W	75042	CEATO-24R20F
R1131	315-0472-00			RES.,FXD,CMPASN:4.7K OHM,5%,0.25W	01121	CB4725
R1132	315-0472-00			RES.,FXD,CMPASN:4.7K OHM,5%,0.25W	01121	CB4725
R1134	315-0102-00			RES.,FXD,CMPASN:1K OHM,5%,0.25W	01121	CB1025
R1136	321-0038-00			RES.,FXD,FILM:24.3 OHM,1%,0.125W	75042	CEATO-24R20F
R1138	315-0102-00			RES.,FXD,CMPASN:1K OHM,5%,0.25W	01121	CB1025
R1140	311-0959-00			RES.,VAR,WVLOK OHM,5%,1.5W	71590	BA165-007
R1142	321-0347-00			RES.,FXD,FILM:40.2K OHM,1%,0.125W	75042	CEATO-4022F
R1144	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R1145	321-0443-00			RES.,FXD,FILM:402K OHM,1%,0.125W	91637	MFF1816G40202F
R1146	321-0339-00			RES.,FXD,FILM:33.2K OHM,1%,0.125W	75042	CEATO-3322F
R1150	315-0512-00			RES.,FXD,CMPASN:5.1K OHM,5%,0.25W	01121	CB5125
R1154	315-0911-00			RES.,FXD,CMPASN:910 OHM,5%,0.25W	01121	CB9115
R1160	315-0103-00			RES.,FXD,CMPASN:10K OHM,5%,0.25W	01121	CB1035
R1162	315-0242-00			RES.,FXD,CMPASN:2.4K OHM,5%,0.25W	01121	CB2425
R1164	315-0100-00			RES.,FXD,CMPASN:10 OHM,5%,0.25W	01121	CB1005
R1166	315-0682-00			RES.,FXD,CMPASN:6.8K OHM,5%,0.25W	01121	CB6825

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1167	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R1170	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R1171	321-0445-00			RES.,FXD,FILM:422K OHM,1%,0.125W	75042	CEATO-4223F
R1172	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R1178	315-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.25W	01121	CB1315
R1180	321-0268-00			RES.,FXD,FILM:6.04K OHM,1%,0.125W	75042	CEATO-6041F
R1182	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	75042	CEATO-9091F
R1184	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1186	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R1188	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R1190	311-1265-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	80294	3329P-L58-202
R1192 <sup>1</sup>	321-0753-06			RES.,FXD,FILM:9K OHM,0.25%,0.125W	91637	MFF1816C90000C
R1194	321-0318-02			RES.,FXD,FILM:20K OHM,0.5%,0.125W	75042	CEAT2-2002D
R1196 <sup>1</sup>	321-0720-02			RES.,FXD,FILM:60K OHM,0.5%,0.125W	91637	MFF1816D60001D
R1199 <sup>1</sup>	321-0318-03			RES.,FXD,FILM:20K OHM,0.5%,0.125W	91637	MFF1816D20001C
R1200	311-1272-00			RES.,VAR,NONWIR:100K OHM,10%,0.50W	73138	62PT-355-0
R1202	321-0452-00			RES.,FXD,FILM:499K OHM,1%,0.125W	75042	CEATO-4993F
R1203	321-0510-00			RES.,FXD,FILM:2M OHM,1%,0.125W	75042	CEATO-2004F
R1204	321-0285-00			RES.,FXD,FILM:9.09K OHM,1%,0.125W	75042	CEATO-9091F
R1208 <sup>1</sup>	321-1618-02			RES.,FXD,FILM:6.5K OHM,0.5%,0.125W	91637	MFF1816D65000D
R1210	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R1212	315-0433-00			RES.,FXD,CMPSN:43K OHM,5%,0.25W	01121	CB4335
R1214	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R1215	311-1265-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	80294	3329P-L58-202
R1216	315-0913-00			RES.,FXD,CMPSN:91K OHM,5%,0.25W	01121	CB9135
R1217	321-0303-00			RES.,FXD,FILM:14K OHM,1%,0.125W	75042	CEATO-1402F
R1218	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R1219	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	75042	CEATO-4531F
R1220 <sup>1</sup>	321-1628-02			RES.,FXD,FILM:1.644M OHM,0.5%,0.125W	91637	MFF1816D16440D
R1221 <sup>1</sup>	321-0502-02			RES.,FXD,FILM:1.65M OHM,0.5%,0.125W	91637	MFF1816D165003D
R1222 <sup>1</sup>	321-1626-02			RES.,FXD,FILM:175.4K OHM,0.5%,0.125W	91637	MFF1816D17540D
R1224 <sup>1</sup>	321-0736-02			RES.,FXD,FILM:10.06K OHM,0.5%,0.125W	91637	MFF1816D10061D
R1226	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R1230	321-0315-00			RES.,FXD,FILM:18.7K OHM,1%,0.125W	75042	CEATO-1872F
R1232	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R1235	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R1236	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R1237	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R1238	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R1250	311-1319-00			RES.,VAR,NONWIR:10K OHM,10%,0.75W	01121	4SP103
R1252	321-0290-00			RES.,FXD,FILM:10.2K OHM,1%,0.125W	75042	CEATO-1022F
R1254 <sup>1</sup>	321-1313-08			RES.,FXD,FILM:18K OHM,1%,0.125W	91637	MFF1816D18000F
R1255	311-1338-00			RES.,VAR,NONWIR:20K OHM,10%,0.50W	02111	43P203
R1256	321-0756-03			RES.,FXD,FILM:50K OHM,0.25%,0.125W	75042	CEAT2-5002C
R1258 <sup>1</sup>	321-0341-00			RES.,FXD,FILM:34.8K OHM,1%,0.125W	75042	CEATO-3482F
R1260 <sup>1</sup>	321-0648-02			RES.,FXD,FILM:500K OHM,0.5%,0.125W	91637	MFF1816D50002D
R1262 <sup>1</sup>	321-1623-02			RES.,FXD,FILM:55.5K OHM,0.5%,0.125W	19701	MF5C
R1264 <sup>1</sup>	321-1615-02			RES.,FXD,FILM:5.55K OHM,0.5%,0.125W	91637	MFF1816D55J00D
R1266	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R1270 <sup>1</sup>	321-0928-02			RES.,FXD,FILM:250 OHM,0.5%,0.125W	91637	MFF1816D250R0D
R1272 <sup>1</sup>	321-0181-02			RES.,FXD,FILM:750 OHM,0.5%,0.125W	91637	MFF1816D750R0D
R1274 <sup>1</sup>	321-1613-02			RES.,FXD,FILM:1.75K OHM,0.5%,0.125W	91637	MFF1816D17500D
R1276 <sup>1</sup>	321-1616-02			RES.,FXD,FILM:2.25K OHM,0.5%,0.125W	91637	MFF1816D22500D

<sup>1</sup>Instruments with S/N B010100 through B010150 have selected components, which were selected at the factory to supplement a shortage at the initial build. They are all replaceable with the listed component part number.

# Electrical Parts List—7L13

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscnt	Name & Description	Mfr Code	Mfr Part Number
R1278 <sup>1</sup>	321-0928-02		RES., FXD, FILM:250 OHM, 0.5%, 0.125W	91637	MFF1816D250ROD
R1279	315-0622-00		RES., FXD, CMPSN:6.2K OHM, 5%, 0.25W	01121	CB6225
R1280 <sup>1</sup>	321-1330-03		RES., FXD, FILM:27.1K OHM, 0.25%, 0.125W	91637	MFF1816D27100C
R1282 <sup>1</sup>	321-1631-07		RES., FXD, FILM:12.11K OHM, 0.1%, 0.125W	91637	MFF1816C12111B
R1283	315-0514-00		RES., FXD, CMPSN:510K OHM, 5%, 0.25W	01121	CB5145
R1284	321-0256-07		RES., FXD, FILM:4.53K OHM, 0.1%, 0.125W	75042	CEAT9-4531D
R1286	315-0104-00		RES., FXD, CMPSN:100K OHM, 5%, 0.25W	01121	CB1045
R1288 <sup>1</sup>	321-1614-07		RES., FXD, FILM:2.056K OHM, 0.1%, 0.125W	91637	MFF1816C20560B
R1290 <sup>1</sup>	321-1619-07		RES., FXD, FILM:8.334K OHM, 0.1%, 0.125W	91637	MFF1816C83340B
R1291	321-0256-07		RES., FXD, FILM:4.53K OHM, 0.1%, 0.125W	75042	CEAT9-4531D
R1292 <sup>1</sup>	321-0622-00		RES., FXD, FILM:37.96K OHM, 0.25%, 0.125W	91637	MFF1816D37961C
R1294	321-0318-02		RES., FXD, FILM:20K OHM, 0.5%, 0.125W	75042	CEAT2-2002D
R1296	321-0256-07		RES., FXD, FILM:4.53K OHM, 0.1%, 0.125W	75042	CEAT9-4531D
R1297	321-0256-07		RES., FXD, FILM:4.53K OHM, 0.1%, 0.125W	75042	CEAT9-4531D
R1298 <sup>1</sup>	321-0318-03		RES., FXD, FILM:20K OHM, 0.5%, 0.125W	91637	MFF1816D20001C
R1299	321-0924-02		RES., FXD, FILM:40K OHM, 0.5%, 0.125W	75042	CEAT2-4002D
R1300	321-0368-00		RES., FXD, FILM:66.5K OHM, 1%, 0.125W	75042	CEATO-6652F
R1302	321-0397-00		RES., FXD, FILM:133K OHM, 1%, 0.125W	75042	CEATO-1333F
R1303	315-0153-00		RES., FXD, CMPSN:15K OHM, 5%, 0.25W	01121	CB1535
R1304	315-0103-00		RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
R1305	321-0289-07		RES., FXD, FILM:10K OHM, 0.1%, 0.125W	75042	CEAT9-1002B
R1306 <sup>1</sup>	321-0318-03		RES., FXD, FILM:20K OHM, 0.5%, 0.125W	91637	MFF1816D20001C
R1308	321-0924-02		RES., FXD, FILM:40K OHM, 0.5%, 0.125W	75042	CEAT2-4002D
R1310	321-0368-00		RES., FXD, FILM:66.5K OHM, 1%, 0.125W	75042	CEATO-6652F
R1312	321-0397-00		RES., FXD, FILM:133K OHM, 1%, 0.125W	75042	CEATO-1333F
R1314 <sup>1</sup>	321-1621-03		RES., FXD, FILM:36.47K OHM, 0.25%, 0.125W	91637	MFF1816D36470C
R1315	315-0432-00		RES., FXD, CMPSN:4.3K OHM, 5%, 0.25W	01121	CB4325
R1316	315-0513-00		RES., FXD, CMPSN:51K OHM, 5%, 0.25W	01121	CB5135
R1320	321-0402-00		RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R1321	321-0402-00		RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R1322	321-0373-00		RES., FXD, FILM:75K OHM, 1%, 0.125W	75042	CEATO-7502F
R1323	321-0356-00		RES., FXD, FILM:49.9K OHM, 1%, 0.125W	75042	CEATO-4992F
R1324	321-0327-00		RES., FXD, FILM:24.9K OHM, 1%, 0.125W	75042	CEATO-2492F
R1325	321-0327-00		RES., FXD, FILM:24.9K OHM, 1%, 0.125W	75042	CEATO-2492F
R1326	321-0321-00		RES., FXD, FILM:21.5K OHM, 1%, 0.125W	75042	CEATO-2152F
R1327	321-0373-00		RES., FXD, FILM:75K OHM, 1%, 0.125W	75042	CEATO-7502F
R1330	321-0355-00		RES., FXD, FILM:48.7K OHM, 1%, 0.125W	75042	CEATO-4872F
R1331	321-0343-00		RES., FXD, FILM:36.5K OHM, 1%, 0.125W	75042	CEATO-3652F
R1332	321-0402-00		RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R1333	321-0373-00		RES., FXD, FILM:75K OHM, 1%, 0.125W	75042	CEATO-7502F
R1335	321-0373-00		RES., FXD, FILM:75K OHM, 1%, 0.125W	75042	CEATO-7502F
R1336	321-0356-00		RES., FXD, FILM:49.9K OHM, 1%, 0.125W	75042	CEATO-4992F
R1337	321-0344-00		RES., FXD, FILM:37.4K OHM, 1%, 0.125W	75042	CEATO-3742F
R1338	321-0356-00		RES., FXD, FILM:49.9K OHM, 1%, 0.125W	75042	CEATO-4992F
R1340	321-0344-00		RES., FXD, FILM:37.4K OHM, 1%, 0.125W	75042	CEATO-3742F
R1341	321-0402-00		RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R1342	321-0402-00		RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R1343	321-0327-00		RES., FXD, FILM:24.9K OHM, 1%, 0.125W	75042	CEATO-2492F
R1344	321-0321-00		RES., FXD, FILM:21.5K OHM, 1%, 0.125W	75042	CEATO-2152F
R1345	321-0356-00		RES., FXD, FILM:49.9K OHM, 1%, 0.125W	75042	CEATO-4992F
R1346	321-0335-00		RES., FXD, FILM:30.1K OHM, 1%, 0.125W	75042	CEATO-3012F
R1347	321-0344-00		RES., FXD, FILM:37.4K OHM, 1%, 0.125W	75042	CEATO-3742F
R1348	321-0310-00		RES., FXD, FILM:16.5K OHM, 1%, 0.125W	75042	CEATO-1652C

<sup>1</sup>Instruments with S/N B010100 through B010150 have selected components, which were selected at the factory to supplement a shortage at the initial build. They are all replaceable with the listed component part number.

## Electrical Parts List—7L13

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1350	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R1352	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R1354	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R1355	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R1356	321-0306-00			RES.,FXD,FILM:15K OHM,1%,0.125W	75042	CEATO-1502F
R1357	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R1358	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1359	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R1360	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1362	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1364	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1366	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R1368	321-0372-00			RES.,FXD,FILM:73.2K OHM,1%,0.125W	75042	CEATO-7322F
R1370	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1372	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R1374	321-0401-00			RES.,FXD,FILM:147K OHM,1%,0.125W	75042	CEATO-1473F
R1376	321-0327-00			RES.,FXD,FILM:24.9K OHM,1%,0.125W	75042	CEATO-2492F
R1377	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R1378	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1379	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R1382	321-0321-00			RES.,FXD,FILM:21.5K OHM,1%,0.125W	75042	CEATO-2152F
R1383	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R1384	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R1386	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R1387	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1389	321-0373-00			RES.,FXD,FILM:75K OHM,1%,0.125W	75042	CEATO-7502F
R1392	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R1393	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R1394	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	75042	CEATO-1652C
R1396	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R1397	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEATO-3742F
R1398	321-0356-00			RES.,FXD,FILM:49.9K OHM,1%,0.125W	75042	CEATO-4992F
R1399	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R1402	315-0201-00			RES.,FXD,CMPNS:200 OHM,5%,0.25W	01121	CB2015
R1405	315-0101-00			RES.,FXD,CMPNS:100 OHM,5%,0.25W	01121	CB1015
R1408	315-0201-00			RES.,FXD,CMPNS:200 OHM,5%,0.25W	01121	CB2015
R1410	307-0113-00			RES.,FXD,CMPNS:5.1 OHM,5%,0.25W	01121	CB51G5
R1412	301-0392-00			RES.,FXD,CMPNS:3.9K OHM,5%,0.50W	01121	EB3925
R1510	315-0510-00			RES.,FXD,CMPNS:51 OHM,5%,0.25W	01121	CB5105
R1535	315-0821-00			RES.,FXD,CMPNS:820 OHM,5%,0.25W	01121	CB8215
R1537	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R1538	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R1539	315-0821-00			RES.,FXD,CMPNS:820 OHM,5%,0.25W	01121	CB8215
R1550	307-0103-00			RES.,FXD,CMPNS:2.7 OHM,5%,0.25W	01121	CB27G5
R1554	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R1556	315-0510-00			RES.,FXD,CMPNS:51 OHM,5%,0.25W	01121	CB5105
R1560 <sup>1</sup>	321-0666-08			RES.,FXD,FILM:3.04K OHM,1%,0.125W	91637	MFF1816D30400D
R1562 <sup>1</sup>	321-0097-09			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816C100ROF
R1570 <sup>1</sup>	321-0097-09			RES.,FXD,FILM:100 OHM,1%,0.125W	91637	MFF1816C100ROF
R1572	321-0001-00			RES.,FXD,FILM:10 OHM,1%,0.125W	75042	CEATO-10ROOF
R1600	321-0229-00			RES.,FXD,FILM:2.37K OHM,1%,0.125W	75042	CEATO-2371F
R1602	321-0130-00			RES.,FXD,FILM:221 OHM,1%,0.125W	75042	CEATO-2210F
R1605	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F

<sup>1</sup>Instruments with S/N B010100 through B010150 have selected components, which were selected at the factory to supplement a shortage at the initial build. They are all replaceable with the listed component part number.

# Electrical Parts List—7L13

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R1607	321-0234-00			RES., FXD, FILM:2.67K OHM, 1%, 0.125W	75042	CEATO-2671F
R1610	321-0001-00			RES., FXD, FILM:10 OHM, 1%, 0.125W	75042	CEATO-10R00F
R1616	321-0121-00			RES., FXD, FILM:178 OHM, 1%, 0.125W	75042	CEATO-1780F
R1617	321-0269-00			RES., FXD, FILM:6.19K OHM, 1%, 0.125W	75042	CEATO-6191F
R1618	321-0001-00			RES., FXD, FILM:10 OHM, 1%, 0.125W	75042	CEATO-10R00F
R1619	321-0612-00			RES., FXD, FILM:500 OHM, 1%, 0.125W	91637	MFF1816D5000F
R1700	315-0392-00			RES., FXD, CMPSN:3.9K OHM, 5%, 0.25W	01121	CB3925
R1705	315-0152-00			RES., FXD, CMPSN:1.5K OHM, 5%, 0.25W	01121	CB1525
R1710	321-0285-00			RES., FXD, FILM:9.09K OHM, 1%, 0.125W	75042	CEATO-9091F
R1712	321-0162-00	B010100	B010108	RES., FXD, FILM:475 OHM, 1%, 0.125W	75042	CEATO-4750F
R1712	321-0228-00	B010109		RES., FXD, FILM:2.32K OHM, 1%, 0.125W	75042	CEATO-2321F
R1714	321-0285-00			RES., FXD, FILM:9.09K OHM, 1%, 0.125W	75042	CEATO-9091F
R1716	315-0181-00			RES., FXD, CMPSN:180 OHM, 5%, 0.25W	01121	CB1815
R1717	321-0162-00	B010100	B010108	RES., FXD, FILM:475 OHM, 1%, 0.125W	75042	CEATO-4750F
R1717	321-0228-00	B010109		RES., FXD, FILM:2.32K OHM, 1%, 0.125W	75042	CEATO-2321F
R1719	315-0100-00			RES., FXD, CMPSN:10 OHM, 5%, 0.25W	01121	CB1005
R1724	321-0199-00			RES., FXD, FILM:1.15K OHM, 1%, 0.125W	75042	CEATO-1151F
R1725	321-0269-00			RES., FXD, FILM:6.19K OHM, 1%, 0.125W	75042	CEATO-6191F
R1726 <sup>1</sup>	321-0338-09			RES., FXD, FILM:32.4K OHM, 1%, 0.125W	91637	MFF1816C32401F
R1727 <sup>1</sup>	321-0376-09			RES., FXD, FILM:80.6K OHM, 1%, 0.125W	91637	MFF1816C80601F
R1728 <sup>1</sup>	321-0347-09			RES., FXD, FILM:40.2K OHM, 1%, 0.125W	91637	MFF1816C40201F
R1729 <sup>1</sup>	321-0402-09			RES., FXD, FILM:150K OHM, 1%, 0.125W	91637	MFF1816C15002F
R1730 <sup>1</sup>	321-0347-09			RES., FXD, FILM:40.2K OHM, 1%, 0.125W	91637	MFF1816C40201F
R1732 <sup>1</sup>	321-0376-09			RES., FXD, FILM:80.6K OHM, 1%, 0.125W	91637	MFF1816C80601F
R1735	321-0373-00			RES., FXD, FILM:75K OHM, 1%, 0.125W	75042	CEATO-7502F
R1737	321-0311-00			RES., FXD, FILM:16.9K OHM, 1%, 0.125W	75042	CEATO-1692F
R1742	321-0323-00			RES., FXD, FILM:22.6K OHM, 1%, 0.125W	75042	CEATO-2262F
R1750	321-0097-00			RES., FXD, FILM:100 OHM, 1%, 0.125W	75042	CEATO-1000F
R1752	321-0362-00			RES., FXD, FILM:57.6K OHM, 1%, 0.125W	75042	CEATO-5762F
R1754	321-0264-00			RES., FXD, FILM:5.49K OHM, 1%, 0.125W	75042	CEATO-5491F
R1755	311-1266-00			RES., VAR, NONWIR:2.5K OHM, 10%, 0.50W	73138	62PT-349-0
R1756	321-0264-00			RES., FXD, FILM:5.49K OHM, 1%, 0.125W	75042	CEATO-5491F
R1757	321-0097-00	B010100	B010108	RES., FXD, FILM:100 OHM, 1%, 0.125W	75042	CEATO-1000F
R1757	321-0114-00	B010109		RES., FXD, FILM:150 OHM, 1%, 0.125W	75042	CEATO-1500F
R1758	321-0335-00			RES., FXD, FILM:30.1K OHM, 1%, 0.125W	75042	CEATO-3012F
R1800	315-0470-00			RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
R1804	321-0001-00			RES., FXD, FILM:10 OHM, 1%, 0.125W	75042	CEATO-10R00F
R1808	315-0200-00			RES., FXD, CMPSN:20 OHM, 5%, 0.25W	01121	CB2005
R1810	321-0234-00			RES., FXD, FILM:2.67K OHM, 1%, 0.125W	75042	CEATO-2671F
R1812	321-0250-00			RES., FXD, FILM:3.92K OHM, 1%, 0.125W	75042	CEATO-3921F
R1814	321-0193-00			RES., FXD, FILM:1K OHM, 1%, 0.125W	75042	CEATO-1001F
R1815	321-0234-00			RES., FXD, FILM:2.67K OHM, 1%, 0.125W	75042	CEATO-2671F
R1817	321-0250-00			RES., FXD, FILM:3.92K OHM, 1%, 0.125W	75042	CEATO-3921F
R1820	321-0247-00			RES., FXD, FILM:3.65K OHM, 1%, 0.125W	75042	CEATO-3651F
R1832	321-0231-00			RES., FXD, FILM:2.49K OHM, 1%, 0.125W	75042	CEATO-2491F
R1834	308-0393-00			RES., FXD, WW:1.6K OHM, 5%, 3W	63743	34300
R1835	308-0298-00			RES., FXD, WW:560 OHM, 5%, 3W	91637	RS2B-B560R0J
R1900	301-0100-00			RES., FXD, CMPSN:10 OHM, 5%, 0.50W	01121	EB1005
R1902	301-0390-00			RES., FXD, CMPSN:39 OHM, 5%, 0.50W	01121	EB3905
R1904	321-0145-00			RES., FXD, FILM:316 OHM, 1%, 0.125W	75042	CEATO-3160F
R1906	321-0139-00			RES., FXD, FILM:274 OHM, 1%, 0.125W	75042	CEATO-2740F
R1912	305-0821-00			RES., FXD, CMPSN:820 OHM, 5%, 2W	01121	HB8215
R1924	321-0155-00	B010100	B069999	RES., FXD, FILM:402 OHM, 1%, 0.125W	75042	CEATO-4020F

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Electrical Parts List—7L13

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R1924	321-0167-00	B070000	RES., FXD, FILM:536 OHM, 1%, 0.125W	75042	CEATO-5360F
R1941	307-0106-00		RES., FXD, CMPSN:4.7 OHM, 5%, 0.25W	01121	CB47G5
R1960	311-1339-00		RES., VAR, NONWIR:5K OHM, 10%, 0.50W	02111	43P502
R1962	321-0289-00		RES., FXD, FILM:10K OHM, 1%, 0.125W	75042	CEATO-1002F
R1964	321-0349-00		RES., FXD, FILM:42.2K OHM, 1%, 0.125W	75042	CEATO-4222F
R1965	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
R1966	321-0199-00		RES., FXD, FILM:1.15K OHM, 1%, 0.125W	75042	CEATO-1151F
R1967	308-0223-00		RES., FXD, WW:35 OHM, 5%, 3W	91637	RS2B-K35R00J
R1968	321-0280-00		RES., FXD, FILM:8.06K OHM, 1%, 0.125W	75042	CEATO-8061F
R1969	315-0471-00		RES., FXD, CMPSN:470 OHM, 5%, 0.25W	01121	CB4715
R2002	321-0289-00		RES., FXD, FILM:10K OHM, 1%, 0.125W	75042	CEATO-1002F
R2004	321-0289-00		RES., FXD, FILM:10K OHM, 1%, 0.125W	75042	CEATO-1002F
R2005	321-0236-00		RES., FXD, FILM:2.8K OHM, 1%, 0.125W	75042	CEATO-2801F
R2006	321-0271-00		RES., FXD, FILM:6.49K OHM, 1%, 0.125W	75042	CEATO-6491F
R2008	321-0342-00		RES., FXD, FILM:35.7K OHM, 1%, 0.125W	75042	CEATO-3572F
R2010	315-0182-00		RES., FXD, CMPSN:1.8K OHM, 5%, 0.25W	01121	CB1825
R2012	315-0103-00		RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
R2014	321-0271-00		RES., FXD, FILM:6.49K OHM, 1%, 0.125W	75042	CEATO-6491F
R2016	315-0202-00		RES., FXD, CMPSN:2K OHM, 5%, 0.25W	01121	CB2025
R2018	315-0432-00		RES., FXD, CMPSN:4.3K OHM, 5%, 0.25W	01121	CB4325
R2020	321-0402-00		RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R2022	315-0682-00		RES., FXD, CMPSN:6.8K OHM, 5%, 0.25W	01121	CB6825
R2024	315-0243-00		RES., FXD, CMPSN:24K OHM, 5%, 0.25W	01121	CB2435
R2026	321-0402-00		RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R2028	315-0682-00		RES., FXD, CMPSN:6.8K OHM, 5%, 0.25W	01121	CB6825
R2030	315-0243-00		RES., FXD, CMPSN:24K OHM, 5%, 0.25W	01121	CB2435
R2032	315-0472-00		RES., FXD, CMPSN:4.7K OHM, 5%, 0.25W	01121	CB4725
R2034	315-0682-00		RES., FXD, CMPSN:6.8K OHM, 5%, 0.25W	01121	CB6825
R2036	315-0243-00		RES., FXD, CMPSN:24K OHM, 5%, 0.25W	01121	CB2435
R2038	315-0472-00		RES., FXD, CMPSN:4.7K OHM, 5%, 0.25W	01121	CB4725
R2040	315-0682-00		RES., FXD, CMPSN:6.8K OHM, 5%, 0.25W	01121	CB6825
R2042	315-0243-00		RES., FXD, CMPSN:24K OHM, 5%, 0.25W	01121	CB2435
R2044	315-0362-00		RES., FXD, CMPSN:3.6K OHM, 5%, 0.25W	01121	CB3625
R2046	315-0273-00		RES., FXD, CMPSN:27K OHM, 5%, 0.25W	01121	CB2735
R2060	321-0341-00		RES., FXD, FILM:34.8K OHM, 1%, 0.125W	75042	CEATO-3482F
R2062	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
R2064	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
R2065	311-1267-00		RES., VAR, NONWIR:5K OHM, 10%, 0.50W	73138	62PT-3500-502K
R2066	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
R2068	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
R2070	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
R2072	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
R2074	315-0301-00		RES., FXD, CMPSN:300 OHM, 5%, 0.25W	01121	CB3015
R2102 <sup>1</sup>	321-0753-06		RES., FXD, FILM:9K OHM, 0.25%, 0.125W	91637	MFF1816C90000C
R2104 <sup>1</sup>	321-0753-06		RES., FXD, FILM:9K OHM, 0.25%, 0.125W	91637	MFF1816C90000C
R2106 <sup>1</sup>	321-0289-06		RES., FXD, FILM:10K OHM, 0.25%, 0.125W	91637	MFF1816C10001C
R2108 <sup>1</sup>	321-0289-06		RES., FXD, FILM:10K OHM, 0.25%, 0.125W	91637	MFF1816C10001C
R2109	323-0760-00		RES., FXD, FILM:7.2M OHM, 1%, 0.50W	75042	CECTO-7204F
R2110	311-1337-00		RES., VAR, NONWIR:25K OHM, 10%, 0.50W	02111	43P253
R2111 <sup>1</sup>	321-1622-06		RES., FXD, FILM:61.73K OHM, 0.25%, 0.125W	91637	MFF1816C61730C
R2112 <sup>1</sup>	321-1625-06		RES., FXD, FILM:277.8K OHM, 0.25%, 0.125W	91637	MFF1816C27780C
R2113	323-0230-00		RES., FXD, FILM:2.43K OHM, 1%, 0.50W	75042	CEBTO-2431F
R2118	321-0264-00		RES., FXD, FILM:5.49K OHM, 1%, 0.125W	75042	CEATO-5491F

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R2122 <sup>1</sup>	321-1617-06			RES.,FXD,FILM:5.85K OHM,0.25%,0.125W	91637	MFF1816C58500C
R2126	321-0332-07			RES.,FXD,FILM:28K OHM,0.1%,0.125W	75042	CEAT9-2802B
R2128	321-0332-07			RES.,FXD,FILM:28K OHM,0.1%,0.125W	75042	CEAT9-2802B
R2130	321-0332-07			RES.,FXD,FILM:28K OHM,0.1%,0.125W	75042	CEAT9-2802B
R2131	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R2132	321-0332-07			RES.,FXD,FILM:28K OHM,0.1%,0.125W	75042	CEAT9-2802B
R2133	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R2134 <sup>1</sup>	321-1627-06			RES.,FXD,FILM:731.3K OHM,0.25%,0.125W	91637	MFF1816C73130C
R2135	311-1337-00			RES.,VAR, NONWIR:25K OHM,10%,0.50W	02111	43P253
R2136 <sup>1</sup>	321-1624-06			RES.,FXD,FILM:45.2K OHM,0.25%,0.125W	91637	MFF1816C45200C
R2137	321-0402-00			RES.,FXD,FILM:150K OHM,1%,0.125W	75042	CEATO-1503F
R2138	321-0332-07			RES.,FXD,FILM:28K OHM,0.1%,0.125W	75042	CEAT9-2802B
R2139	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R2140 <sup>1</sup>	321-0728-06			RES.,FXD,FILM:136K OHM,0.25%,0.125W	91637	MFF1816C13602C
R2141	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R2142	321-0193-00	B010100	B080364	RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R2142	321-0612-00	B080365		RES.,FXD,FILM:500 OHM,1%,0.125W	91637	MFF1816D5000F
R2144	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R2146	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	75042	CEATO-1003F
R2147	321-0261-00			RES.,FXD,FILM:5.11K OHM,1%,0.125W	75042	CEATO-5111F
R2148	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R2149	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R2151	321-0193-00	XB080365		RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R2153	315-0331-00	XB080365		RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R2154	315-0200-00			RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
R2156	315-0622-00	XB080365		RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R2158	321-0612-00	XB080365		RES.,FXD,FILM:500 OHM,1%,0.125W	91637	MFF1816D5000F
R2200	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R2206	315-0300-00	B010100	B010108	RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R2206	315-0100-00	B010109		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R2208	315-0300-00	B010100	B010108	RES.,FXD,CMPSN:30 OHM,5%,0.25W	01121	CB3005
R2208	315-0100-00	B010109		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R2210	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R2211	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R2212	322-0184-00			RES.,FXD,FILM:806 OHM,1%,0.25W	75042	CEBTO-8060F
R2214 <sup>1</sup>	321-0286-09			RES.,FXD,FILM:9.31K OHM,1%,0.125W	91637	MFF1816C93100F
R2215	303-0151-00			RES.,FXD,CMPSN:150 OHM,5%,1W	01121	GB1515
R2216	321-0289-09			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816C10001F
R2220	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R2222	321-0289-09			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816C10001F
R2224	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R2226	303-0151-00			RES.,FXD,CMPSN:150 OHM,5%,1W	01121	GB1515
R2228	321-0289-09			RES.,FXD,FILM:10K OHM,1%,0.125W	91637	MFF1816C10001F
R2229	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R2310	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R2312	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R2314	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R2316	321-0068-00			RES.,FXD,FILM:49.9 OHM,1%,0.125W	75042	CEATO-49R90F
R2317	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R2318	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R2319	321-0305-00			RES.,FXD,FILM:14.7K OHM,1%,0.125W	75042	CEATO-1472F
R2320	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R2322	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Model No. Dscont	Name & Description	Mfr Code	Mfr Part Number
R2324	315-0202-00			RES., FXD, CMPSN:2K OHM, 5%, 0.25W	01121	CB2025
R2330	315-0432-00			RES., FXD, CMPSN:4.3K OHM, 5%, 0.25W	01121	CB4325
R2332	315-0432-00			RES., FXD, CMPSN:4.3K OHM, 5%, 0.25W	01121	CB4325
R2336	315-0823-00			RES., FXD, CMPSN:82K OHM, 5%, 0.25W	01121	CB8235
R2337	315-0623-00			RES., FXD, CMPSN:62K OHM, 5%, 0.25W	01121	CB6235
R2338	315-0823-00			RES., FXD, CMPSN:82K OHM, 5%, 0.25W	01121	CB8235
R2341	321-0344-00			RES., FXD, FILM:37.4K OHM, 1%, 0.125W	75042	CEATO-3742F
R2342	321-0335-00			RES., FXD, FILM:30.1K OHM, 1%, 0.125W	75042	CEATO-3012F
R2343	321-0321-00			RES., FXD, FILM:21.5K OHM, 1%, 0.125W	75042	CEATO-2152F
R2344	321-0335-00			RES., FXD, FILM:30.1K OHM, 1%, 0.125W	75042	CEATO-3012F
R2346	321-0344-00			RES., FXD, FILM:37.4K OHM, 1%, 0.125W	75042	CEATO-3742F
R2347	321-0356-00			RES., FXD, FILM:49.9K OHM, 1%, 0.125W	75042	CEATO-4992F
R2348	321-0310-00			RES., FXD, FILM:16.5K OHM, 1%, 0.125W	75042	CEATO-1652C
R2349	321-0402-00			RES., FXD, FILM:150K OHM, 1%, 0.125W	75042	CEATO-1503F
R2505	311-1340-00			RES., VAR, NONWIR:1K OHM, 10%, 0.50W	02111	43P102
R2506 <sup>1</sup>	321-0267-09			RES., FXD, FILM:5.9K OHM, 1%, 0.125W	91637	MFF1816C93100F
R2507 <sup>1</sup>	321-0318-06			RES., FXD, FILM:20K OHM, 0.25%, 0.125W	91637	MFF1816C20001C
R2508 <sup>1</sup>	321-0318-06			RES., FXD, FILM:20K OHM, 0.25%, 0.125W	91637	MFF1816C20001C
R2509	321-0260-00			RES., FXD, FILM:4.99K OHM, 1%, 0.125W	75042	CEATO-4991F
R2510 <sup>1</sup>	311-1680-00			RES., VAR, NONWIR:250 OHM, 10%, 0.75W	80294	3006P.250K
R2512 <sup>1</sup>	321-1211-09	B010100	B069999	RES., FXD, FILM:1560 OHM, 1%, 0.125W	91637	MFF1816D15600F
R2512	321-0219-00	B070000		RES., FXD, FILM:1.87K OHM, 1%, 0.125W	75042	CEATO-1871F
R2514	315-0155-00			RES., FXD, CMPSN:1.5M OHM, 5%, 0.25W	01121	CB1555
R2516	321-0194-00			RES., FXD, FILM:1.02K OHM, 1%, 0.125W	75042	CEATO-1021F
R2518	321-0066-00			RES., FXD, FILM:47.5 OHM, 1%, 0.125W	75042	CEATO-47R50F
R2519	308-0584-00			RES., FXD, WW:20 OHM, 0.5%, 5W	91637	RS520ROD
R2520	321-0150-00			RES., FXD, FILM:357 OHM, 1%, 0.125W	75042	CEATO-3570F
R2521	307-0105-00	XB020000		RES., FXD, CMPSN:3.9 OHM, 5%, 0.25W	01121	CB39G5
R2522	321-0169-00			RES., FXD, FILM:562 OHM, 1%, 0.125W	75042	CEATO-5620F
R2525	321-0017-00	B010100	B069999	RES., FXD, FILM:14.7 OHM, 1%, 0.125W	75042	CEATO-14R70F
R2525	321-0001-00	B070000		RES., FXD, FILM:10 OHM, 1%, 0.125W	75042	CEATO-10R00F
R2530	311-1339-00			RES., VAR, NONWIR:5K OHM, 10%, 0.50W	02111	43P502
R2532	321-0267-00			RES., FXD, FILM:5.9K OHM, 1%, 0.125W	75042	CEATO-5901F
R2534	321-0256-00			RES., FXD, FILM:4.53K OHM, 1%, 0.125W	75042	CEATO-4531F
R2536	321-0097-00			RES., FXD, FILM:100 OHM, 1%, 0.125W	75042	CEATO-1000F
R2538	321-0289-00			RES., FXD, FILM:10K OHM, 1%, 0.125W	75042	CEATO-1002F
R2540	321-0001-00			RES., FXD, FILM:10 OHM, 1%, 0.125W	75042	CEATO-10R00F
R2544	308-0243-00	B010100	B069999	RES., FXD, WW:240 OHM, 5%, 3W	91637	RS2B-B240ROJ
R2544	308-0443-00	B070000		RES., FXD, WW:330 OHM (NOM VALUE), SEL		
R2546	321-0001-00			RES., FXD, FILM:10 OHM, 1%, 0.125W	75042	CEATO-10R00F
R2548	321-0097-00			RES., FXD, FILM:100 OHM, 1%, 0.125W	75042	CEATO-1000F
R2550	321-0289-00			RES., FXD, FILM:10K OHM, 1%, 0.125W	75042	CEATO-1002F
R2552	321-0324-00			RES., FXD, FILM:23.2K OHM, 1%, 0.125W	75042	CEATO-2322F
R2554	301-0272-00			RES., FXD, CMPSN:2.7K OHM, 5%, 0.50W	01121	EB2725
R2556	308-0078-00			RES., FXD, WW:70 OHM, 5%, 5W	63743	7686
R2558	321-0222-00			RES., FXD, FILM:2K OHM, 1%, 0.125W	75042	CEATO-2001F
R2560	315-0101-00			RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
R2561	321-0114-00			RES., FXD, FILM:150 OHM, 1%, 0.125W	75042	CEATO-1500F
R2562	315-0101-00			RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
R2563	321-0214-00			RES., FXD, FILM:1.65K OHM, 1%, 0.125W	75042	CEATO-1651F
R2565	321-0013-00			RES., FXD, FILM:13.3 OHM, 1%, 0.125W	75042	CEATO-13R30F
R2566	315-0102-00			RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
R2567	321-0306-00			RES., FXD, FILM:15K OHM, 1%, 0.125W	75042	CEATO-1502F

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Model No. Dscont	Name & Description	Mfr Code	Mfr Part Number
R2568	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R2569	321-0260-00	B010100	B069999X	RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R2572	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R2574	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R2576	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
R2578	315-0273-00			RES.,FXD,CMPSN:27K OHM,5%,0.25W	01121	CB2735
R2579	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R2580	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R2581	321-0258-00	B010100	B069999X	RES.,FXD,FILM:4.75K OHM,1%,0.125W	75042	CEATO-4751F
R2582	321-0289-00			RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R2583	321-0260-00	B010100	B069999X	RES.,FXD,FILM:4.99K OHM,1%,0.125W	75042	CEATO-4991F
R2584	321-0289-00	B010100	B069999X	RES.,FXD,FILM:10K OHM,1%,0.125W	75042	CEATO-1002F
R2585	321-0193-00	B010100	B069999X	RES.,FXD,FILM:1K OHM,1%,0.125W	75042	CEATO-1001F
R2586 <sup>1</sup>	321-0289-02			RES.,FXD,FILM:10K OHM,0.5%,0.125W	91637	MFF1816D10001D
R2587	308-0460-00	B010100	B069999X	RES.,FXD,WW:56 OHM,5%,3W	56289	242E5605
R2588 <sup>1</sup>	321-1293-02			RES.,FXD,FILM:11.1K OHM,0.5%,0.125W	91637	MFF1816D11100D
R2589	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R2590	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R2592	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R2594	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R2596	321-0097-00			RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R2597	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R2598	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R2600	321-0364-00			RES.,FXD,FILM:60.4K OHM,1%,0.125W	75042	CEATO-6042F
R2602	321-0323-00			RES.,FXD,FILM:22.6K OHM,1%,0.125W	75042	CEATO-2262F
R2604	321-0335-00			RES.,FXD,FILM:30.1K OHM,1%,0.125W	75042	CEATO-3012F
R2605	311-1271-00			RES.,VAR,NONWIR:50K OHM,10%,0.50W	73138	62PT-354-0
R2606	321-0367-00			RES.,FXD,FILM:64.9K OHM,1%,0.125W	75042	CEATO-6492F
R2610	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R2612	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	75042	CEATO-2002F
R2614	321-0807-00			RES.,FXD,FILM:900K OHM,1%,0.125W	14298	CE1-4C1-9003F
R2616	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	75042	CEATO-1003F
R2618	321-0369-00			RES.,FXD,FILM:68.1K OHM,1%,0.125W	75042	CEATO-6812F
R2620	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R2702	315-0220-00			RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R2704	321-0092-00			RES.,FXD,FILM:88.7 OHM,1%,0.125W	75042	CEATO-88R70F
R2705	311-1259-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	80294	3329P-L58-101
R2706	321-0105-00			RES.,FXD,FILM:121 OHM,1%,0.125W	75042	CEATO-1210F
R2712	321-0131-00			RES.,FXD,FILM:226 OHM,1%,0.125W	75042	CEATO-2260F
R2714	303-0561-00			RES.,FXD,CMPSN:560 OHM,5%,1W	01121	GB5615
R2716	303-0561-00			RES.,FXD,CMPSN:560 OHM,5%,1W	01121	GB5615
R2720	321-0067-00			RES.,FXD,FILM:48.7 OHM,1%,0.125W	75042	CEATO-48R70F
R2722	321-0155-00			RES.,FXD,FILM:402 OHM,1%,0.125W	75042	CEATO-4020F
R2724	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R2728	321-0069-00			RES.,FXD,FILM:51.1 OHM,1%,0.125W	75042	CEATO-51R10F
R2730	311-1260-00	B010100	B010108	RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-345-0
R2730	311-1262-00	B010109		RES.,VAR,NONWIR:750 OHM,10%,0.50W	73138	62PT-3620-751K
R2732	321-0124-00	B010100	B010108	RES.,FXD,FILM:191 OHM,1%,0.125W	75042	CEATO-1910F
R2732	321-0097-00	B010109		RES.,FXD,FILM:100 OHM,1%,0.125W	75042	CEATO-1000F
R2735	311-1259-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	80294	3329P-L58-101
R2736	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R2738	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325

<sup>1</sup>Instruments with S/N B010100 through B010150 have selected components, which were selected at the factory to supplement a shortage at the initial build. They are all replaceable with the listed component part number.

Ckt No.	Tektronix		Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
	Part No.	Eff	Dscont				
S27 <sup>1</sup>	670-3106-00				SWITCH,PUSH:10DB GAIN	80009	670-3106-00
S82 <sup>2</sup>	-----				SWITCH,PUSH:CAL		
S83 <sup>3</sup>	-----				SWITCH,PUSH:IF GAIN (REFERENCE LEVEL)		
S90A <sup>1</sup>	670-3111-00				SWITCH,PUSH:300HZ	80009	670-3111-00
S90B <sup>1</sup>	670-3111-00				SWITCH,PUSH:PULSE STRETCHER	80009	670-3111-00
S90C <sup>1</sup>	670-3111-00				SWITCH,PUSH:30KHZ	80009	670-3111-00
S100 <sup>4</sup>	-----				SWITCH,PUSH:SLOPE		
S101A,B <sup>1</sup>	670-3110-00				SWITCH,PUSH:EXT/INT	80009	670-3110-00
S101C,D <sup>1</sup>	-----				SWITCH,PUSH:LINE/FREE RUN		
S102 <sup>1</sup>	670-3109-00				SWITCH,PUSH:TRIGGER MODE SELECTOR	80009	670-3109-00
S104	263-1029-00				DRUM ASSY,CAM S:TIME/DIV	80009	263-1029-00
S108A,B	263-1030-00				ACTR ASSY,CAM S:RESOLUTION HZ/FREQ SPAN/DIV	80009	263-1030-00
S125	260-0960-00				SWITCH,SLIDE:2A AT 120VAC	10389	23-021-006
S130A,B	260-1360-01				SWITCH,PUSH:10DB/DIV/2DB/DIV	80009	260-1360-01
S130C	-----				SWITCH,PUSH:LIN		
S2608	260-1237-00				SWITCH,REED:SPST	80009	260-1237-00
T90	120-0871-00				XFMR,TOROID:4 TURNS,TRIFILAR	80009	120-0871-00
T92	120-0871-00				XFMR,TOROID:4 TURNS,TRIFILAR	80009	120-0871-00
T211	120-0779-00				XFMR,TOROID:(2) 4 TURN WINDINGS	80009	120-0779-00
T240	120-0774-00				XFMR,TOROID:2 WINDINGS	80009	120-0774-00
T245	120-0774-00				XFMR,TOROID:2 WINDINGS	80009	120-0774-00
T264	120-0775-00				XFMR,TOROID:2 WINDINGS	80009	120-0775-00
T280	120-0772-00				XFMR,TOROID:2 WINDINGS	80009	120-0772-00
T294	120-0775-00				XFMR,TOROID:2 WINDINGS	80009	120-0775-00
T380	120-0773-00				XFMR,TOROID:2 WINDINGS	80009	120-0773-00
T420	120-0773-00				XFMR,TOROID:2 WINDINGS	80009	120-0773-00
T457	120-0774-00				XFMR,TOROID:2 WINDINGS	80009	120-0774-00
T560	120-0780-00				XFMR,TOROID:2 WINDINGS	80009	120-0780-00
T1405	120-0904-00				XFMR,TOROID:2 WINDINGS,BIFILAR	80009	120-0904-00
T1564	120-0901-00				XFMR,TOROID:2 WINDINGS	80009	120-0901-00
T1612	120-0779-00				XFMR,TOROID:(2) 4 TURN WINDINGS	80009	120-0779-00
T2712	120-0902-00				XFMR,TOROID:5 TURNS,BIFILAR	80009	120-0902-00
T2714	120-0903-00				XFMR,TOROID:3 WINDINGS,TRIFILAR	80009	120-0903-00
U820	155-0035-00				MICROCIRCUIT,LI:QUAD OPERATIONAL AMPL	80009	155-0035-00
U830	156-0352-00				MICROCIRCUIT,DI:DUAL COMPL PAIR PLUS INVERT	02735	CD4007AE
U840	156-0352-00				MICROCIRCUIT,DI:DUAL COMPL PAIR PLUS INVERT	02735	CD4007AE
U1010	155-0035-00				MICROCIRCUIT,LI:QUAD OPERATIONAL AMPL	80009	155-0035-00
U1050	155-0035-00				MICROCIRCUIT,LI:QUAD OPERATIONAL AMPL	80009	155-0035-00
U1120	156-0158-00				MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U1160	156-0030-00				MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U1170	155-0042-02				MICROCIRCUIT,DI:MILLER INTEGRATOR	80009	155-0042-02
U1180	155-0056-00				MICROCIRCUIT,DI:SWEEP CONTROL	80009	155-0056-00
U1250	156-0158-00				MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U1280	156-0158-00				MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U1290	156-0158-00				MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U1510	156-0457-00				MICROCIRCUIT,LI:DUAL SCHMITT TRIG	04713	MC1035P
U1530	156-0230-00				MICROCIRCUIT,DI:DUAL D MA-SLAVE FLIP-FLOP	04713	MC10131L
U1535	156-0025-00				MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	04713	MC1010L
U1555	156-0266-00				MICROCIRCUIT,LI:EMITTER COUPLED OSCILLATOR	04713	MC1648P
U1715	156-0067-00				MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U1735	156-0223-00				MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U1755	156-0067-00				MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00

<sup>1</sup>See Mechanical Parts List for replacement parts.

<sup>2</sup>Furnished as a unit with R82.

<sup>3</sup>Furnished as a unit with A1.

<sup>4</sup>Furnished as a unit with R100.

# Electrical Parts List—7L13

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U1825	156-0038-00			MICROCIRCUIT,DI:J-K MASTER SLAVE FLIP-FLOP	01295	SN7472N
U1965	156-0105-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM301AN
U2000	156-0292-00			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LO4N
U2010	156-0292-00			MICROCIRCUIT,DI:HEX INVERTER	01295	SN74LO4N
U2015	156-0306-00			MICROCIRCUIT,DI:4.5 DECADE COUNTER	07263	A7R381R19X
U2020	156-0411-00			MICROCIRCUIT,DI:QUAD COMP,SINGLE SUPPLY	04713	MC3302P
U2030	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U2040	156-0452-00			MICROCIRCUIT,DI:2 INPUT AND-OR-INVERT GATE	01295	SN74LS54N
U2050	156-0094-00			MICROCIRCUIT,DI:DUAL PERIPHERAL DRIVER	01295	SN75451P
U2060	156-0094-00			MICROCIRCUIT,DI:DUAL PERIPHERAL DRIVER	01295	SN75451P
U2065	155-0088-00			MICROCIRCUIT,DI:ML,LEGEND GENERATOR "C2"	80009	155-0088-00
U2070	156-0379-00			MICROCIRCUIT,DI:BCD TO 7-SEGMENT DCDR/DRV	18324	N8T06B
U2110	156-0223-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U2120	156-0223-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U2130	156-0223-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U2140	156-0223-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U2145	156-0096-00			MICROCIRCUIT,LI:VOLTAGE COMPARATOR	27014	LM311H
U2200	156-0093-00			MICROCIRCUIT,DI:HEX. INVERTER	01295	SN7416N
U2210	156-0223-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U2220	156-0223-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U2225	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U2510	156-0223-00	B010100	B019999	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	12040	LM308H
U2510	156-0049-00	B020000		MICROCIRCUIT,LI:OPERATING AMPLIFIER	07263	U5B7741393
U2530	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U2555	156-0105-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM301AN
U2560	156-0093-00			MICROCIRCUIT,DI:HEX. INVERTER	01295	SN7416N
U2565	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
U2570	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	27014	DM74121N
U2575	156-0140-00			MICROCIRCUIT,DI:HEX BFR,15V,TTL	01295	SN7417N
U2580	156-0158-00			MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U2585	156-0105-00	B010100	B069999X	MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	27014	LM301AN
U2600	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U2620	156-0072-00			MICROCIRCUIT,DI:MONOSTABLE MV,TTL	27014	DM74121N
U2625	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NAND GATE	01295	SN7400N
VR1700	152-0147-00			SEMICONV DEVICE:ZENER,0.4W,27V,5%	81483	1N971B
VR1705	152-0127-00			SEMICONV DEVICE:ZENER,0.4W,7.5V,5%	04713	1N755A
VR1720	152-0456-00			SEMICONV DEVICE:ZENER,0.4W,6.2V,5%	04713	1N827
VR1960	152-0456-00			SEMICONV DEVICE:ZENER,0.4W,6.2V,5%	04713	1N827
VR2014	152-0278-00			SEMICONV DEVICE:ZENER,0.4W,3V,5%	07910	1N4372A
VR2115	152-0171-00			SEMICONV DEVICE:ZENER,0.5W,11.7V,5%	04713	SZ13464
VR2212	152-0212-00			SEMICONV DEVICE:ZENER,0.5W,9V,5%	04713	SZ50646
VR2525	152-0087-00			SEMICONV DEVICE:ZENER,1W,100V,5%	04713	1N3044B
VR2554	152-0293-00			SEMICONV DEVICE:ZENER,1W,33V,5%	04713	1N3032B
W1	175-1448-00			CABLE ASSEMBLY:INPUT BNC TO ATEN	80009	175-1448-00
W2	175-1440-00			CABLE ASSEMBLY:ATEN TO LARK FILTER	80009	175-1440-00
W6	175-1449-00			CABLE ASSEMBLY:MIXER TO DAMPER	80009	175-1449-00
W7	175-1442-00			CABLE ASSEMBLY:DAMPER TO LOW PASS FILTER	80009	175-1442-00
W20	175-1446-00			CABLE ASSEMBLY:BAL FILTER TO COUPLER	80009	175-1446-00
W25	175-1431-00			CABLE ASSEMBLY:POWER DIVIDER TO MIXER	80009	175-1431-00
W29	175-1441-00	B010100	B010107X	CABLE ASSEMBLY:2ND LO TO MIXER COUPLER	80009	175-1441-00
W30	175-1450-00			CABLE ASSEMBLY:MULT MIXER TO MIXER COUPLER	80009	175-1450-00
W31	175-1504-00			CABLE ASSEMBLY:RF	80009	175-1504-00
W32	175-1445-00			CABLE ASSEMBLY:MIXER CPLR TO 2ND LO OUT	80009	175-1445-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
W35	175-1457-00		CABLE ASSEMBLY:	80009	175-1457-00
W37	175-1443-00		CABLE ASSEMBLY:YIG OSC TO O GATES	80009	175-1443-00
W38	175-1447-00		CABLE ASSEMBLY:PHASE GATE TO PWR DIVIDER	80009	175-1447-00
W39	175-1444-00		CABLE ASSEMBLY:PWR DIV TO 1ST,LO OUTPUT	80009	175-1444-00
W40	175-1502-00		CABLE ASSEMBLY:RF	80009	175-1502-00
W69	175-1503-00		CABLE ASSEMBLY:RF	80009	175-1503-00
W92	175-1374-00		CABLE ASSEMBLY:RF	80009	175-1374-00
W95	175-1372-00		CABLE ASSEMBLY:RF	80009	175-1372-00
W302	175-1505-00		CABLE ASSEMBLY:RF	80009	175-1505-00
W303	175-1501-00		CABLE ASSEMBLY:INTERCONNECTING	80009	175-1501-00
W307	175-1352-00		CABLE ASSEMBLY:RF	80009	175-1352-00
W900	175-1370-00		CABLE ASSEMBLY:RF	80009	175-1370-00
Y204	158-0074-00		XTAL UNIT,QTZ:95MHZ	13571	ER-1238
Y950	158-0068-00		XTAL UNIT,QTZ:50MHZ	13571	ER-1234
Y1605	158-0091-00		XTAL UNIT,QTZ:99.2045MHZ	80009	158-0091-00
Y1815	158-0092-00		XTAL UNIT,QTZ:2.210MHZ	80009	158-0092-00

