

**WARNING**

**THIS MANUAL CONTAINS SERVICING INSTRUCTIONS FOR USE BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO.**

**067-0587-02  
CALIBRATION FIXTURE  
SIGNAL STANDARDIZER**

**SERVICE**

*For Qualified Service Personnel Only.*

**INSTRUCTION MANUAL**

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

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

## WARRANTY

This Tektronix product is warranted against defective materials and workmanship, under normal use, for a period of one year from date of initial shipment. Tektronix will repair or replace, at its option, those products determined to be defective within the warranty period and returned, freight prepaid, to a Tektronix Service Center. There is no implied warranty for fitness of purpose.

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# OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

## TERMS

### In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

### As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

## SYMBOLS

### In This Manual



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

### As Marked on Equipment



DANGER—High voltage.



Protective ground (earth) terminal.



ATTENTION—refer to manual.

### Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

# SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

*Refer also to the preceding Operators Safety Summary.*

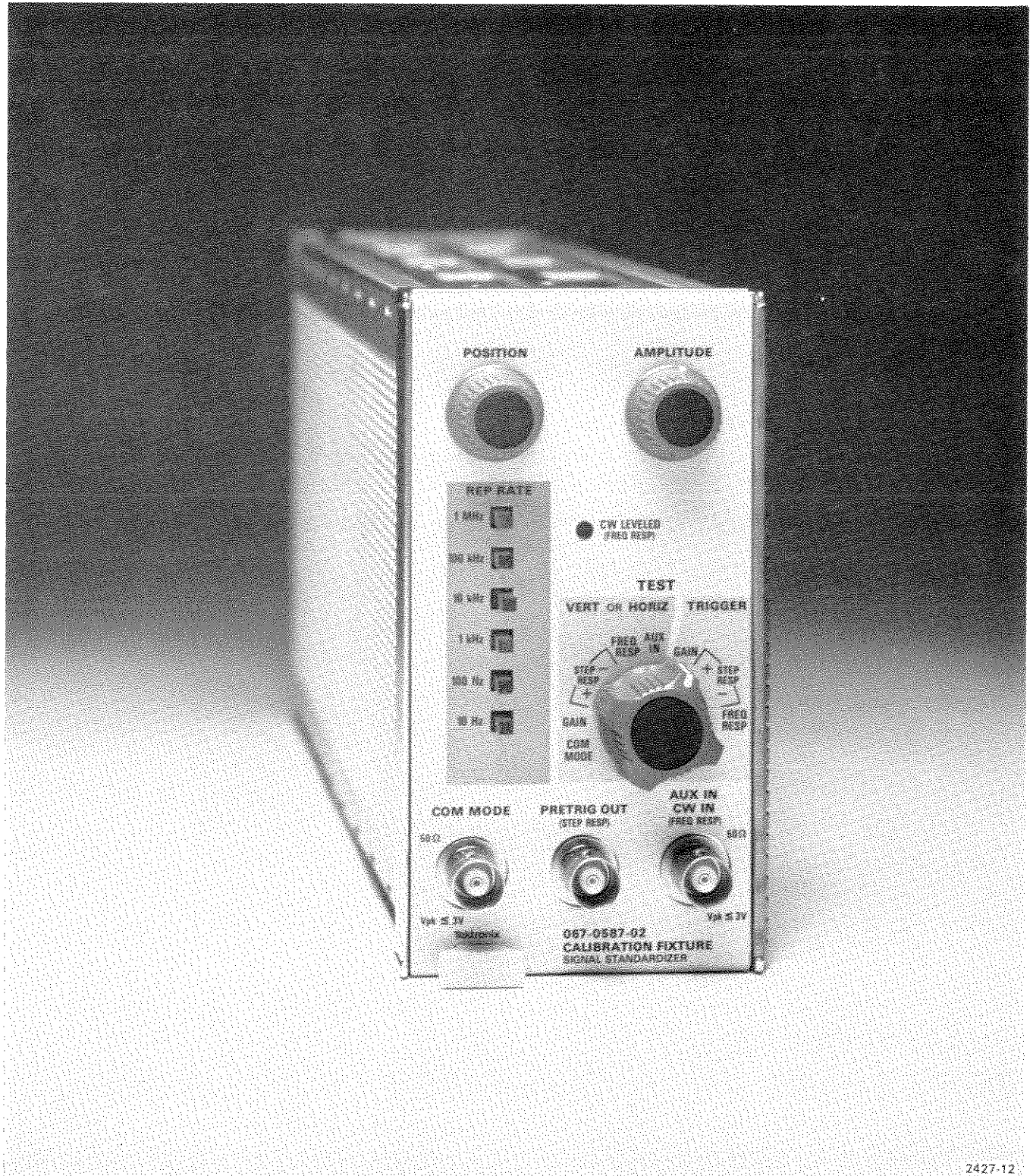
## **Do Not Service Alone**

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

## **Use Care When Servicing With Power On**

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

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



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### SIGNAL STANDARDIZER FEATURES

The Signal Standardizer is a calibration aid for all 7000-series oscilloscope mainframes. It can be used to check the gain, + and - step response, and frequency response of the display and trigger channels of the oscilloscope. It will also permit common-mode rejection checks of the display channels, and has an AUX IN feature that is useful as an aid in checking horizontal timing and linearity of the oscilloscope.



# GENERAL INFORMATION

## INTRODUCTION

The Instruction Manual has eight sections that provide operating and servicing information for the Signal Standardizer, 067-0587-02. Sections 1 and 2 contain information about operating the instrument, and sections 3 through 8 contain servicing information for use by qualified service personnel. Schematic diagrams are located at the rear of the manual and can be unfolded for reference while reading other parts of the manual. The reference designators and symbols used on the schematics are defined on the first page of the Diagrams and Circuit Board Illustrations section. Abbreviations used in the manual, except those in the parts lists and schematics, comply with the American National Standards Institute

Y1.1-1972 publication. The parts lists are computer printouts and use computer-supplied abbreviations.

## DESCRIPTION OF INSTRUMENT

The 067-0587-02 Signal Standardizer is a calibration aid for all 7000-series mainframes. It will standardize all mainframes to all 7-series plug-in units, both vertical and horizontal. Test functions permit calibration of deflection factor, transient response, and gain of trigger channels. Bandwidth measurements of mainframes alone can be made by connecting a frequency standard to the AUX IN-CW IN connector. The gain of the horizontal channel can be calibrated by applying a signal from a time-mark generator to the AUX IN-CW IN connector with the TEST selector set to AUX IN.

# SPECIFICATIONS

The electrical specifications listed in Table 1-1 apply when the following conditions are met: (1) The instrument must have been adjusted in an ambient temperature between +20° and +30°C (+60° and +86°F). (2) The instrument must be operating in an ambient temperature between +20° and +30°C (+68° and +86°F) and (3) The instrument must have been operating for at least 20 minutes.

**TABLE 1-1**  
Electrical Characteristics

Characteristic	Performance Requirement
<b>SIGNAL SOURCES</b>	
<b>GAIN Staircase</b>	
Accuracy	
6 Div (-3 to+3)	±0.3%.
8 Div (-4 to +4)	±0.5%.
Linearity	±0.2% of full range (10 div).
Position Range	±1 div minimum.
Output Impedance	50 Ω ±0.5% per side.
<b>STEP RESPonse Generator</b>	
AMPLITUDE Range	At least 2 to 10 div.
POSITION Range	Flat top can be positioned at least ±5 div from center screen.
Risetime (5 Div step)	150 ps max.
Aberrations (5 Div step)	2% peak.

TABLE 1-1 (CONT.)  
Electrical Characteristics

Characteristic	Performance Requirement
----------------	-------------------------

**SIGNAL SOURCES (CONT.)**

REP RATE	Selectable in decade steps from 10 Hz to 1 MHz (accurate to 0.1%).
Output Impedance	50 Ω per side.
FREQ RESP (CW Leveled)	
Input Impedance (CW IN)	50 Ω ±3% at dc.
Input Range (6 Div Displayed)	0.5 to 1 V p-p.
Amplitude Range	At least 4 to 10 div.
Position Range	At least ±4 div.
Flatness (6 Div Displayed)	±3% (3 MHz to 1 GHz).
Freq Sweep Rate	10 Hz max.
Output Impedance	50 Ω per side.
AUX IN	
Maximum Safe Input	±3 V pk.
Input Impedance (Aux In)	50 Ω ±3% at dc.
Sensitivity (AMPLITUDE Set to Maximum)	50 mV/div ±10%.
Bandwidth (AMPLITUDE Set to Maximum)	5.0 kHz to 1 GHz.
POSITION Range	At least ±4 div.
COMMON MODE	
Input Impedance	50 Ω ±1%.
Input Requirement for Com Mode Test	400 mV p-p.
Output Impedance	50 Ω ±1% per side differentially.

**TRIGGER OUTPUTS**

Internal	
GAIN and STEP RESP Modes	At least 250 mV differential at selected REP RATE.
FREQ RESP and AUX IN Modes	At least 50 V/div differential.
External	
PRETRIG OUT (STEP RESP)	
Impedance	50 Ω ±5%.
Amplitude (Into 50 Ω)	0.5 V ±10%.
Lead Time	Internally variable from less than 55 ns to greater than 95 ns.
Rise Time	Less than 2.5 ns.

**TABLE 1-2**  
Environmental Characteristics

Characteristic	Performance Requirement
Temperature	
Operating	+20° to +30° C mainframe ambient.
Storage	-55° to +75° C.

**TABLE 1-3**  
Physical Characteristics

Characteristic	Performance Requirement
Net Weight	About 0.85 kg (1 lb 14 oz).
Dimensions	See Figure 1-1.

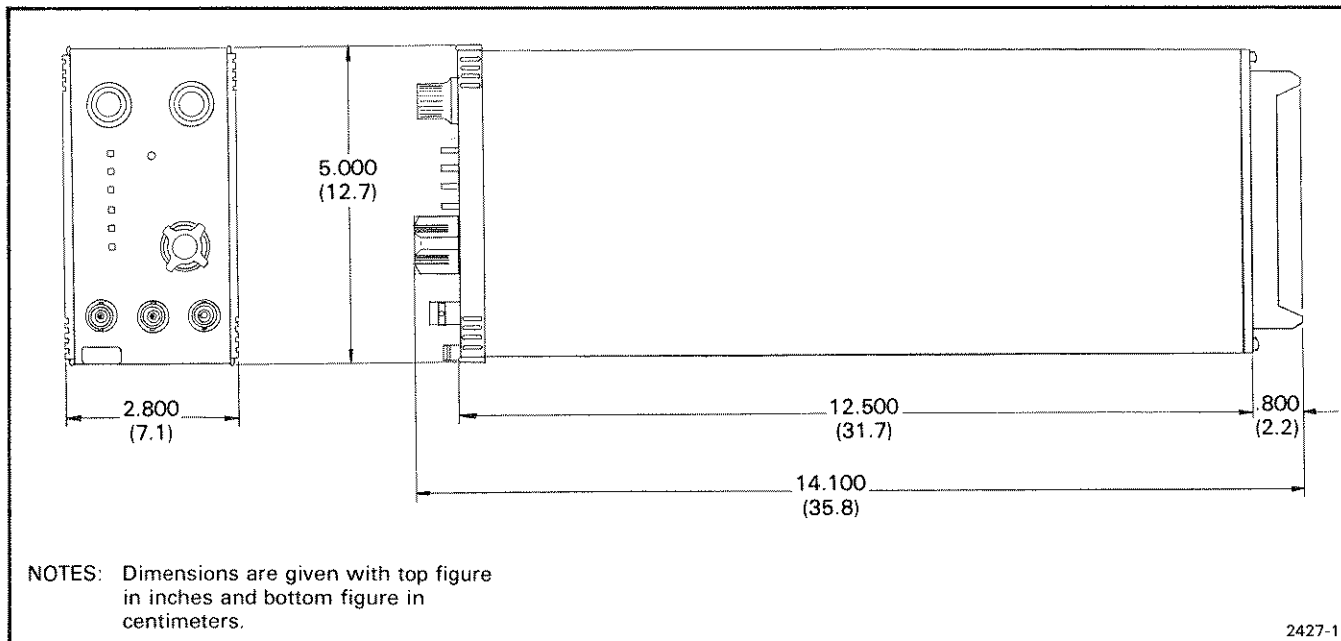


Figure 1-1. Dimensions of Signal Standardizer.

# STANDARD ACCESSORIES

1 ea.....Instruction Manual

# INSTRUMENT PACKAGING

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing the following: Owner (with address) and the name of an individual at your firm who can describe the service required.

Save and re-use the package in which your Signal Standardizer was shipped to you. If the original packaging is unfit for use or is not available, repackage the instrument as follows:

1. Obtain a corrugated-cardboard carton with a 200 pound test strength, and having inside dimensions of

no less than six inches more than the instrument dimensions; this allows for cushioning.

2. Surround the instrument with polyethylene sheeting to protect the finish.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches on all sides.

4. Seal the carton with shipping tape or with an industrial stapler.

# OPERATING INSTRUCTIONS

This section describes the basic functions of the 067-0587-02 Signal Standardizer when operated in a 7000-series oscilloscope. The Signal Standardizer operates in one of the vertical or horizontal plug-in compartments of the oscilloscope. Detailed information for calibrating or testing the oscilloscope appears in its Instruction Manual.

The Signal Standardizer can be used to check the gain, + and - step response, and frequency response of the display and trigger channels of the oscilloscope. It will also permit common-mode rejection checks of the display channels, and has an AUX IN feature that is useful as an aid in checking horizontal timing and linearity of the oscilloscope.

## AMBIENT TEMPERATURE CONSIDERATIONS

For specified accuracy, the Signal Standardizer should operate in mainframes where the ambient air temperature is between +20 ° and +30° C (+68 to +86° F).

The Signal Standardizer can be stored in ambient temperatures between -55° and 75° C (-67 to +167° F). After being stored at temperatures above +30° C, allow the chassis temperature to cool to within the operating limits before applying power. Operating the Signal Standardizer at ambient temperatures either above or below its specified operating limits may result in reduced accuracy.

## CONTROLS AND CONNECTORS

To make full use of the capabilities of the Signal Standardizer, the operator should be familiar with the function and use of each external control and connector. Figure 2-1 shows and describes the front-panel controls, connectors, and indicator.

## DETAILED OPERATING INFORMATION

### TEST EQUIPMENT REQUIRED

The following test equipment was used as a basis to write the Detailed Operating Information. Other test equipment, which meets these requirements, may be substituted. When other equipment is substituted, the control settings or setup may need alteration.

#### 1. Tektronix 7000-Series Oscilloscope

**Description:** Wide-bandwidth, general-purpose oscilloscope.

**Type Used:** TEKTRONIX 7704A Oscilloscope System.

#### 2. Test Oscilloscope (Sampling)

**Description:** Wide-bandwidth, general-purpose oscilloscope.

**Type Used:** TEKTRONIX 7704A Oscilloscope System, with appropriate plug-in units (see below).

#### 3. Dual-Trace Amplifier

**Description:** Tektronix dual-trace plug-in amplifier unit for 7000-series oscilloscopes.

**Type Used:** TEKTRONIX 7A24 Dual Trace Amplifier. (Used with Test Oscilloscope described above.)

#### 4. Time Base for 7000-Series Oscilloscope

**Description:** Horizontal time base for 7000-series oscilloscopes.

**Type Used:** TEKTRONIX 7B80 Time Base.

#### 5. Tektronix Sampling Plug-In Units

**Description:** Bandwidth, dc to 4 GHz Deflection factor, 10 mV/div. Input impedance, 50 Ω. Sweep speed, 10 ps/div to 5 ms/div.

**Type Used:** TEKTRONIX 7S11 Sampling Unit (2 required), TEKTRONIX S-2 Sampling Head (2 required), TEKTRONIX 7T11 Sampling Sweep Unit.

#### 6. Sine-Wave Generator with Leveled Output

**Description:** Frequency range appropriate for the oscilloscope to be tested. Output amplitude; 0.5 V to 4.0 V p-p into 50 Ω.

**Type Used:** TEKTRONIX SG 504 Leveled Sine Wave Generator.

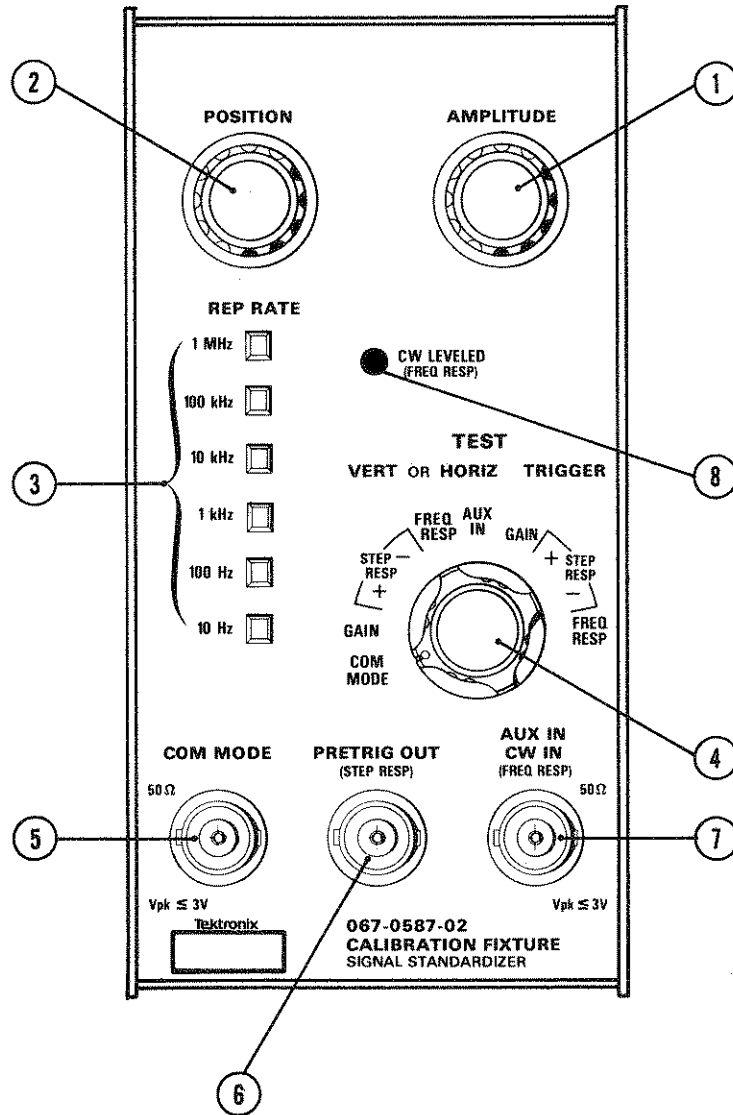


Figure 2-1. Front-panel controls, connectors, and indicator.

- ① **AMPLITUDE Control**  
Adjusts amplitude of the output signal in the AUX IN, STEP RESP and FREQ RESP modes.
- ② **POSITION Control**  
Positions the display vertically when placed in a vertical compartment, or horizontally when placed in a horizontal compartment.
- ③ **REP RATE Pushbuttons**  
Select repetition rate for STEP RESP mode and clocking rate for the GAIN staircase generator, and the trigger signal rate in + and - STEP RESP and GAIN.
- ④ **TEST Selector**  
**VERTICAL OR HORIZONTAL** (Selects a signal source for connection to pins A11 and B11 of the output connector.)
- AUX IN**  
Selects the AUX IN—CW IN connector as signal source.
- FREQ RESP**  
Selects the AUX IN—CW IN connector as signal source for bandwidth check. Sine-wave signal is leveled when the CW LEVELED indicator is lit.
- STEP RESP**  
Selects negative-going pulse from STEP RESP generator for transient-response check.
- +STEP RESP**  
Selects positive-going pulse from STEP RESP generator for transient-response check.
- GAIN**  
Selects staircase-waveform generator for GAIN check.
- COM MODE**  
Selects signal from COM MODE connector for common-mode check.
- TRIGGERing** (Selects a signal source for connection to pins A13 and B13 of the output connector.)
- GAIN**  
Selects staircase-waveform generator for trigger Gain check.
- +STEP RESP**  
Selects positive-going pulse from STEP RESP generator for trigger transient-response check.
- STEP RESP**  
Selects negative-going pulse from STEP RESP generator for trigger transient-response check.
- FREQ RESP**  
Selects the AUX IN—CW IN connector as signal source for trigger bandwidth check. The CW IN signal is leveled when the indicator is lit.
- ⑤ **COM MODE Connector**  
When the TEST selector is in the COM MODE position, signals applied to this connector reach the mainframe as common-mode signals.
- ⑥ **PRETRIG OUT Connector**  
The PRETRIG OUT connector furnishes a signal that precedes, by a preset lead time, the pulse used for checking step response.
- ⑦ **AUX IN—CW IN Connector**  
Input connector for signals used in checking frequency response and checking horizontal timing and linearity.
- ⑧ **CW LEVELED Indicator**  
When lit, indicates that the output of the FREQ RESP signal source is leveled.

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Figure 2-1. Front-panel controls, connectors, and indicator (continued).

7. Time-Mark Generator

**Description:** Provides marker outputs at 1 ns to 5 s intervals. Output impedance 50 Ω. Output amplitude at least 1 V peak into 50 Ω.

**Type Used:** TEKTRONIX SG 501 Time Mark Generator.

8. Plug-In Extender for Tektronix 7000-Series oscilloscopes

**Description:** Provides a means of accessing the oscilloscope's trigger signals.

**Type Used:** Tektronix Part 067-0589-00.

9. Power Module

**Description:** Tektronix TM 500-series power module with one or more plug-in compartments.

**Type Used:** TEKTRONIX TM 501 Power Module (used for the SG 504 Leveled Sine Wave Generator and the TG 501 Time Mark Generator).

10. Cables

**Description:** Coaxial; length, 42 inches, male bnc connectors on each end; impedance, 50 Ω.

**Type Used:** Tektronix Part 012-0057-01.

**HOW TO CHECK THE GAIN OF A DISPLAY CHANNEL**

1. Install the 067-0587-02 Signal Standardizer in a vertical or horizontal plug-in compartment of the oscilloscope.
2. Install a time base in a plug-in compartment of the opposite axis. (e.g., if you put the Signal Standardizer in a vertical plug-in compartment, put a time base in a horizontal plug-in compartment.)
3. Turn on the oscilloscope.
4. Set the TEST selector to the VERT or HORIZ GAIN position.
5. Set the time base to a fast sweep speed (e.g., 1 μs/div), auto trigger, and do not trigger the sweep. In this condition, the staircase waveform from the Signal Standardizer will appear as solid lines across the display.
6. Check the gain of the oscilloscope's deflection amplifier. There should be one line (trace) per major

division of the graticule. (The deflection sensitivities of the vertical and horizontal channels of 7000-series mainframes are the same.)

The lines can also be used to check or set the vertical and horizontal linearity and geometry; the REP RATE is selectable, but the 1 kHz rate is optimum for most applications.

Using REP RATE settings higher than 1 kHz when setting gain will cause errors because the semiconductors in the mainframe amplifier cannot stabilize thermally at those rates.

**HOW TO CHECK THE STEP RESPONSE OF A DISPLAY CHANNEL**

1. Install the Signal Standardizer in a plug-in compartment of the oscilloscope.
2. Install a time base in a plug-in compartment of the opposite axis. (e.g., if you put the Signal Standardizer in a vertical plug-in compartment, put a time base in a horizontal plug-in compartment.)
3. Turn the oscilloscope on.
4. Set the Signal Standardizer TEST selector to the VERT or HORIZ STEP RESP position, + or - polarity. In this mode of operation, a pulser circuit in the Signal Standardizer generates a series of fast-rise pulses for checking the rise time of the selected amplifier in the mainframe.
5. Use the AMPLITUDE control and REP RATE pushbuttons to adjust the size and repetition rate of the test pulses.
6. Observe the step response on the crt display.

**HOW TO CHECK THE FREQUENCY RESPONSE OF A DISPLAY CHANNEL**

1. Install the Signal Standardizer in a vertical or horizontal plug-in compartment of the oscilloscope.
2. Install a time base in a plug-in compartment of the opposite axis. (e.g., if you installed the Signal Standardizer in a horizontal plug-in compartment, put a time base in a vertical plug-in compartment.)
3. Preset the time base as follows:

Triggering Mode ..... Auto  
Level ..... Fully cw or ccw  
Time/Div ..... 1 μs or faster



4. Turn on the oscilloscope.
5. Preset the Signal Standardizer as follows:  
 TEST selector ..... VERT or HORIZ FREQ RESP  
 AMPLITUDE control ..... Midrange
6. Connect the output of a leveled sine-wave generator to the AUX IN connector with a 50 Ω coaxial cable.
7. Set the output frequency of the sine-wave generator to the reference frequency specified in the oscilloscope manual.
8. Vary the output level of the sine-wave generator to find the point where the CW LEVELED indicator comes on.
9. Set the AMPLITUDE control to present a 6-division display on the crt.
10. Manually advance the frequency output of the sine-wave generator to the upper limit to be checked. Watch the CW LEVELED indicator while changing the frequency.

a. If the CW LEVELED indicator goes out, increase the output of the sine-wave generator until the indicator comes on again. Then return the sine-wave generator to the reference frequency and check that the display is still 6 divisions in amplitude. Adjust the AMPLITUDE control if necessary.

**NOTE**

*Input signals that are either too great or too small may cause the CW LEVELED indicator to go out. The useful range of inputs is 0.4 to 1.0 V, p-p.*

- b. Verify that the sine-wave generator frequency can be changed from the reference frequency to the upper limit with the CW LEVELED indicator staying on.
11. With the sine-wave generator at the upper frequency limit, check that the display meets the specification of the oscilloscope being tested.

**TESTING COMMON-MODE REJECTION OF A DISPLAY CHANNEL**

When the TEST selector is in the COM MODE position, the Signal Standardizer connects the signal from the COM MODE connector to the + and - signal output lines via 50 Ω resistors.

To test the common-mode rejection of a display channel, proceed as follows:

1. Install the Signal Standardizer in a vertical or horizontal plug-in compartment of the oscilloscope.

2. Install a time base in a plug-in compartment of the opposite axis. (e.g., if you put the Signal Standardizer in a horizontal plug-in compartment, put a time base in a vertical plug-in compartment.)

3. From a leveled sine-wave generator, apply a 400 mV p-p signal of the desired frequency to the COM MODE connector with a 50 Ω coaxial cable.

One convenient way to measure the amplitude of the input signal follows:

- a. Apply sine wave to AUX IN connector.
- b. Set TEST selector to VERT or HORIZ AUX IN.
- c. Turn AMPLITUDE control fully cw.
- d. Vary the output amplitude of the sine-wave generator to cause a display of 8 divisions amplitude (400 mV at 50 mV/div).

You can now apply the 400 mV to the COM MODE connector.

4. For the common-mode rejection specification of the particular oscilloscope, refer to its instruction manual.

**USE OF THE AUX IN FEATURE**

When the TEST Selector is in the AUX IN position, the Signal Standardizer can be used as an aid in checking horizontal timing and linearity of the oscilloscope. The Signal Standardizer should be installed in a vertical plug-in compartment, and a time base installed in a horizontal plug-in compartment of the oscilloscope. Connect a time-mark generator to the AUX IN connector.

**HOW TO CHECK THE GAIN OF A TRIGGER CHANNEL**

Checking the gain of a trigger channel requires a test oscilloscope to permit viewing the trigger signal. Use a plug-in extender to make the trigger signals accessible outside the oscilloscope being tested. To check the gain of a trigger channel, proceed as follows:

1. Install the Signal Standardizer in the desired vertical plug-in compartment of the oscilloscope being tested.
2. Disconnect the two bnc connectors from the jacks marked A-20 and B-20 in the plug-in extender. Be sure the two connectors do not touch the circuit board and cause short circuits.
3. Use two coaxial cables with bnc connectors to connect the A-20 and B-20 female connectors in the plug-in extender to the input connectors of the test oscilloscope. Use 50 Ω terminators only if the test oscilloscope does not have an input impedance of 50 Ω.

4. Install the plug-in extender in a horizontal plug-in compartment.
5. Turn both oscilloscopes on.
6. Set the Signal Standardizer TEST selector to TRIGGER GAIN.
7. Set the test oscilloscope as follows:

Volts/Div, CH1 and CH2 ..... 50 mV  
 Time/Div ..... 1  $\mu$ s or any other "fast" sweep speed  
 Vertical Mode ..... Add

8. Invert one of the channels of the test oscilloscope. The test oscilloscope should display a series of horizontal lines. There should be one line per major division.

**HOW TO CHECK THE STEP RESPONSE OF A TRIGGER CHANNEL**

Checking the step response of a trigger channel requires a test oscilloscope to permit viewing the trigger signal. Because of the speed of the trigger signal, a sampling oscilloscope may be required. Use a Tektronix 7000-series oscilloscope with two 7S11 Sampling Units and a 7T11 Sampling Sweep Unit, or an equivalent system, to view the trigger signal. Use a plug-in extender to make the trigger signals accessible outside the oscilloscope being tested.

To measure the step response of a trigger channel, proceed as follows:

1. Install the Signal Standardizer in the desired vertical plug-in compartment of the oscilloscope being tested.
2. Disconnect the two bnc connectors from the jacks marked A-20 and B-20 in the plug-in extender. Be sure the two plugs do not contact the circuit board and cause short circuits.
3. Use two short, equal-length coaxial cables with bnc connectors to connect the A-20 and B-20 female connectors in the plug-in extender to the S-2 Sampling Heads in the 7S11 Sampling Units (A-20 to the left 7S11). Use GR-to-bnc adapters to connect the cable to the S-2 heads. Connect the PRETRIG OUT signal from the Signal Standardizer to the Trig Input connector of the 7T11 Sampling Unit. Figure 2-2 shows the connections.
4. Install the plug-in extender in a horizontal plug-in compartment.
5. Set the Trigger Source switch on the oscilloscope being tested to select the vertical plug-in compartment that contains the Signal Standardizer.

6. Turn both oscilloscopes on.
7. Set the Signal Standardizer TEST selector to TRIGGER STEP RESP, either polarity.
8. Set the test scope controls as follows:

Horizontal Mode ..... A  
 Vert Mode ..... Add

7S11s, both  
 mVolts/Div ..... 50  
 Variable (Cal In) ..... In  
 Smooth ..... In  
 Invert ..... In on right 7S11  
 + Up ..... In on left 7S11

7T11  
 Time Pos Rng ..... 5  $\mu$ s  
 Time/Div ..... 1 ns  
 Variable (Cal In) ..... In  
 SEQUENTIAL ..... In  
 Scan ..... Fully cw  
 Rep ..... In  
 Trigger Slope ..... +  
 Trig Input  
 Ext 50  $\Omega$  2 V Max ..... In

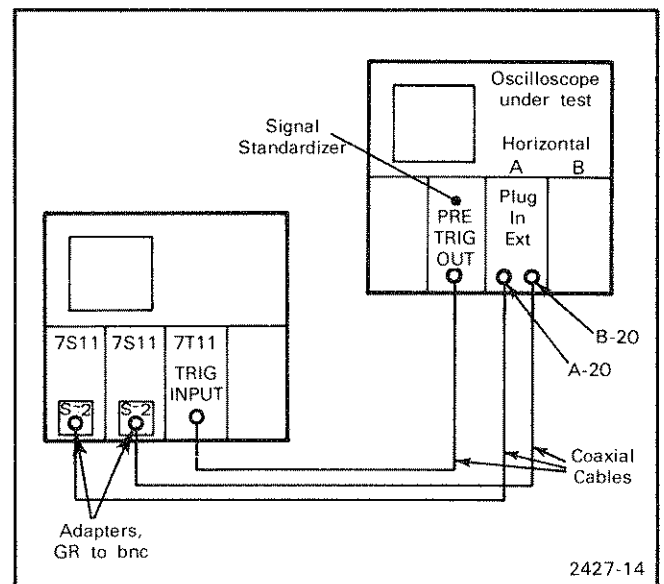


Figure 2-2. Test setup to measure step response of trigger channel.

Set the Trig Level and Stability controls on the 7T11 to present a stable display.

9. Set the REP RATE, POSITION, and AMPLITUDE controls on the Signal Standardizer to present a display of the desired speed and size, positioned in the center of the crt. Usually, the faster sweep speeds and repetition rates will provide sufficient horizontal expansion to facilitate measuring the rise time of the pulse.

10. Center the Delay control on the left 7S11.

11. Adjust the Delay control on the right 7S11 for the fastest displayed rise time.

12. Measure the rise time. Rise time is the time required for the pulse to change from its 10% to 90% amplitude point.

**NOTE**

*Because of high-frequency losses in the coaxial cables, the rise time at the test oscilloscope may be longer than it is at the interface connector in the oscilloscope being tested.*

This procedure can be repeated for all the trigger channels to be tested.

**HOW TO CHECK THE FREQUENCY RESPONSE OF A TRIGGER CHANNEL**

Checking the frequency response of a trigger channel requires another oscilloscope to permit viewing the test signal and its amplitude. Because of the frequencies involved, a sampling oscilloscope may be needed. Use a Tektronix 7000-series oscilloscope with two 7S11 Sampling Units and a 7T11 Sampling Sweep Unit, or an equivalent system, to view the test signal from the trigger channel. Use a leveled sine-wave generator with a frequency range adequate for the oscilloscope being tested, such as the Tektronix SG 504.

To check the frequency response of a trigger channel, proceed as follows:

1. Install the Signal Standardizer in the desired vertical plug-in compartment of the oscilloscope being tested.

2. Disconnect the two plugs from the jacks marked A-20 and B-20 on the plug-in extender. Be sure the two plugs do not contact the circuit board and cause short circuits.

3. Use two short, equal-length coaxial cables to connect the A-20 and B-20 female connectors in the plug-in extender to the S-2 Sampling Heads in the 7S11 Sampling Units. Use GR-to-bnc adapters to connect the cables to the S-2 heads.

**NOTE**

*When using Tektronix 7S11s and a 7T11 in a four-hole oscilloscope, put the 7T11 in the left (A) horizontal plug-in compartment.*

4. Install the plug-in extender in the desired horizontal plug-in compartment of the oscilloscope under test.

5. Turn both oscilloscopes on.

6. Set the Signal Standardizer TEST selector to TRIGGER FREQ RESP.

7. Connect the output of the leveled sine-wave generator to the AUX IN connector on the Signal Standardizer with a 50 Ω coaxial cable. Figure 2-3 shows the connections.

8. Set the Signal Standardizer AMPLITUDE control to mid-range.

9. If you are using a 7S11-7T11 sampling system, preset its controls as follows:

7S11s  
 mVolts/Div ..... 50  
 Variable (Cal In) ..... In  
 Dot Response  
 Smooth ..... In  
 + Up ..... In, on left 7S11  
 Invert.....In, on right 7S11

7T11  
 Slope.....+  
 Time Pos Rng  
 Time/Div .....Set to display 5-20 cycles  
 at the frequency being  
 measured  
 Scan ..... Fully clockwise  
 Rep.....In  
 Sequential ..... In  
 Trig Input  
 Ext 50 Ω 2 V Max ..... In

Mainframe  
 Vertical Mode ..... Add  
 Horizontal Mode..... A

10. Connect the Sig Out connector of the oscilloscope being tested to the Trig Input connector of the 7T11 with a 50 Ω coaxial cable. Figure 2-3 shows this connection.

(Set the Trigger Source switch, on the oscilloscope being tested, to select the vertical plug-in compartment that contains the Signal Standardizer.)

11. Set the Trig Level and Stability controls on the 7T11 to present a stable display.

12. Set the sine-wave generator to the reference frequency specified in the oscilloscope manual.

13. Change the output level of the sine-wave generator to the point where the CW LEVELED indicator comes on.

14. Set the AMPLITUDE control to provide a 6-division (300 mV at 50 mV/div) display on the test oscilloscope.

15. Manually advance the frequency output of the sine-wave generator to the upper limit to be checked. Watch the CW LEVELED indicator while changing the frequency.

a. If the CW LEVELED indicator goes out, increase the output of the sine-wave generator until the indicator comes on again. Then return the sine-wave generator to the reference frequency and check that the display on the test oscilloscope is still 6 divisions in amplitude. Adjust the AMPLITUDE control on the Signal Standardizer if necessary.

**NOTE**

*Input signals that are either too great or too small may cause the CW LEVELED indicator to go out.*

b. Verify that the sine-wave generator frequency can be changed from the reference frequency to the upper limit with the CW LEVELED indicator staying on.

16. With the sine-wave generator at the upper frequency limit, check that the display on the test scope meets the specification of the instrument under test.

**NOTE**

*Because of high-frequency losses in the coaxial cables, the bandwidth at the test oscilloscope may be lower than it is at the interface connector in the oscilloscope being tested.*

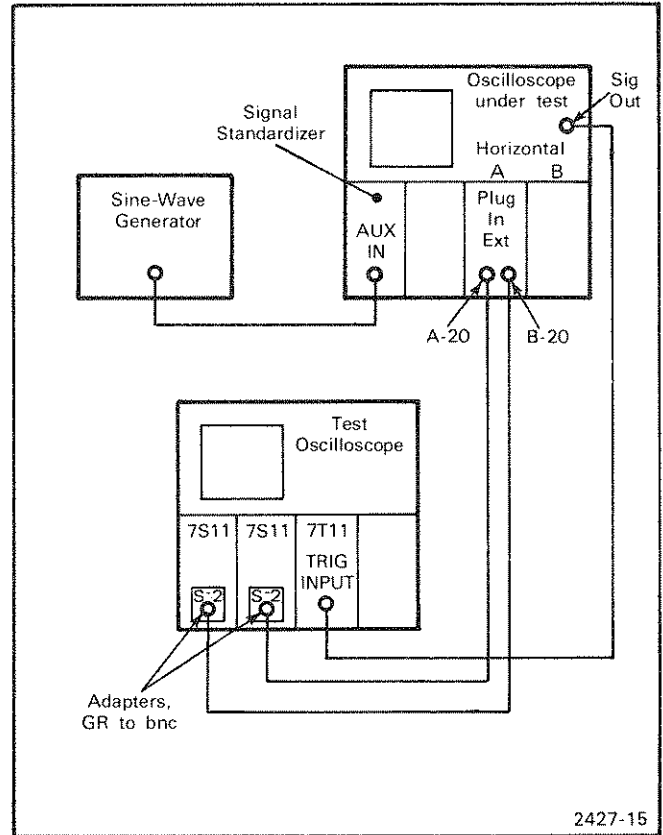


Figure 2-3. Test setup to check frequency response of trigger channel.

# THEORY OF OPERATION

## BLOCK DIAGRAM DESCRIPTION

The Signal Standardizer can furnish three different output signals to the mainframe being tested. First, a staircase waveform for use as an amplitude reference when setting gain; second, a fast-rise pulse for checking transient response; and third, a constant-amplitude sine

wave for checking frequency response. A clock generator is the signal source for the staircase generator and the pulser. An external source must supply the sine wave. The Block Diagram, Figure 3-1, shows the relation of these circuits.

## DETAILED DESCRIPTION

1

### STAIRCASE GENERATOR

#### CLOCK GENERATOR

The Clock Generator, which consists of U115, U121, Q139 and Q140, appears on the top of diagram 1. Crystal Y113 is the frequency-setting element for the oscillator in U115, which operates at 1 MHz. The REP RATE

switch, S105, selects U115's output frequency by controlling its internal frequency division. The output of U115 travels through the six stages of hex-inverter U121 to become the Clock signal for the Pulser of diagram 2. Variable capacitor C152 (Leadtme) on the output of U121C provides an adjustable delay time for the Clock signal. The Clock signal lags the Pretrig Out signal by the delay time introduced by C152 and the A, B, C, and D sections of U121. The output of U121E drives differential pair Q139-Q140, which generates the Pretrig Out signal.

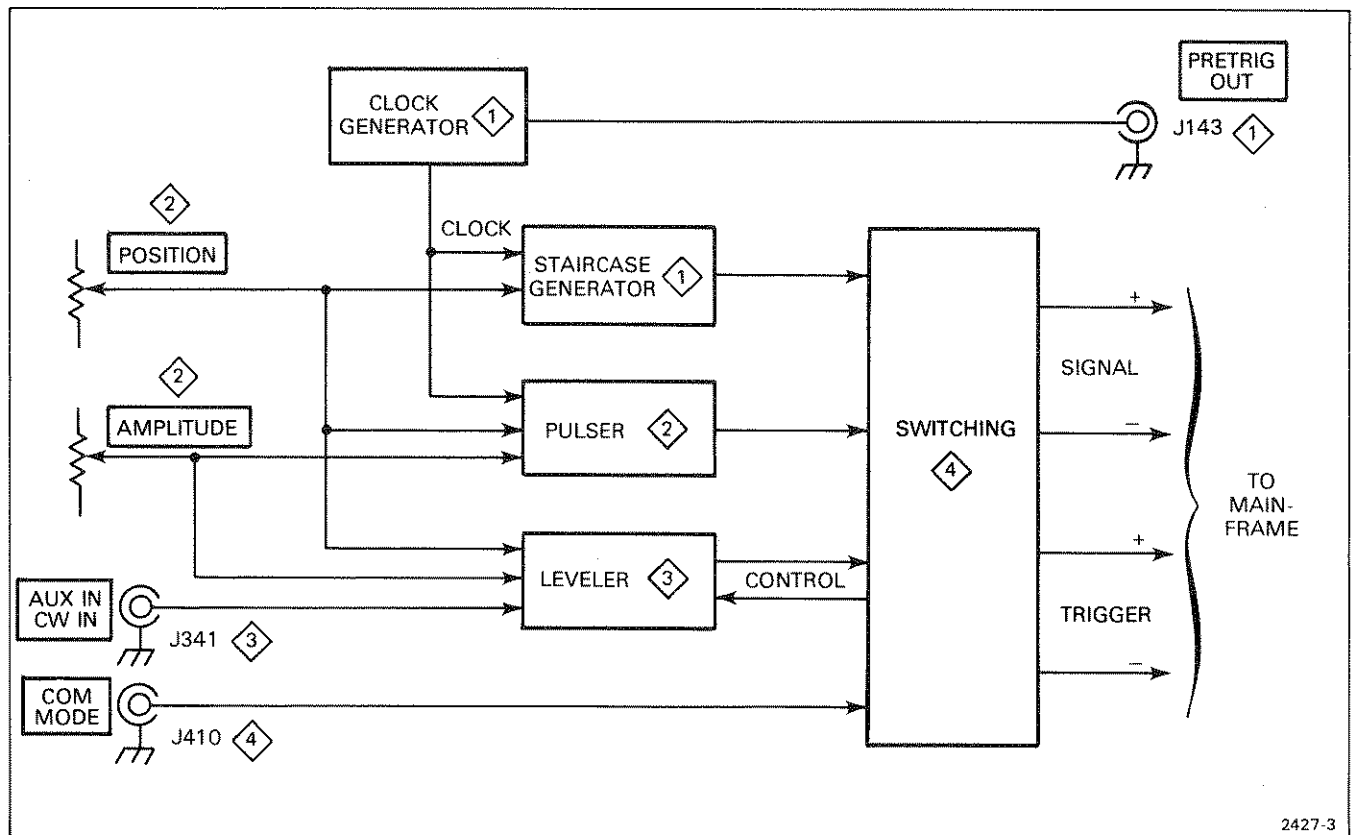


Figure 3-1. Block diagram of Signal Standardizer.

### STAIRCASE GENERATOR

The Staircase Generator consists of U130, U150, U160, U170, U179, and U189. The lower part of diagram 1 shows the Staircase Generator.

Clock pulses increment counter U130, whose four outputs connect to flip-flop (FF) U150 and multiplexer U160. U150 acts as a select control for U160. Starting from a count of zero, U130 increments with each Clock pulse. The eleventh Clock pulse causes logic levels of 1010 (HI, LO, HI, LO) on the Q<sub>A</sub>, Q<sub>B</sub>, Q<sub>C</sub>, and Q<sub>D</sub> outputs of U130, which causes U150 to switch its Q output to a high-logic level. This high-logic level causes multiplexer U160 to connect its B inputs to its output. The B inputs to U160 for Clock pulses 12 through 15 are 0101. This causes D/A converter U170 to produce a constant output at the sixth level of the staircase for a time equal to the duration of five clock intervals. The five-times duration produces a brighter display on the cathode-ray tube (crt) at the center line. Figure 3-2 shows the staircase waveform that appears at the output of U179.

D/A converter U170 converts the digital output of multiplexer U160 to the staircase waveform. The Gain Cal adjustment, R165, sets the voltage reference for D/A converter U170.

A current-to-voltage converter, U179, changes the output of D/A converter U170 to the voltage waveform that goes to the mainframe.

The POSITION control, R205, supplies an offset voltage to U179 via U284B and U272A (diagram 2). The offset voltage, called -Pos, determines the operating level of U179, which sets the position of the display on the crt of the mainframe.

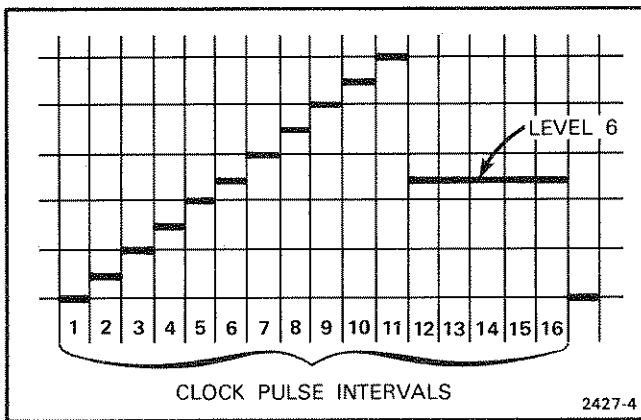


Figure 3-2. Staircase waveform at output of U179 (TP 181).

2

### PULSER

The Pulser circuitry consists of differential pair Q216-Q217, amplifiers U240 and U250, and shaper U280. Transistors Q288, Q289, Q292 and Q293 transmit amplitude information to the shaper. Position information reaches the shaper via U284B, U284A and U272A.

Clock pulses from the Clock Generator activate input transistor Q216. The output of Q216 and Q217 drives U240, which reduces the rise time of the Clock pulse that drives U250. Amplifier U250 increases the slope of the pulse and applies it to shaper U280. Pulse shaper U280 has two pairs of Schottky diodes. (For a simplified diagram of U280, see Fig. 3-3.) In the quiescent condition, the diodes on the right (marked "R" in Fig. 3-3) are conducting current; the top diode conducts Q292's collector current, and the bottom diode conducts Q289's collector current. (The left-hand diodes are reverse-biased.) The AMPLITUDE control establishes a current between about 2 to 10 mA which flows through each R diode, generating voltages between +0.05 and +0.25 volt at the junctions marked "JT" and "JB" in Figure 3-3.

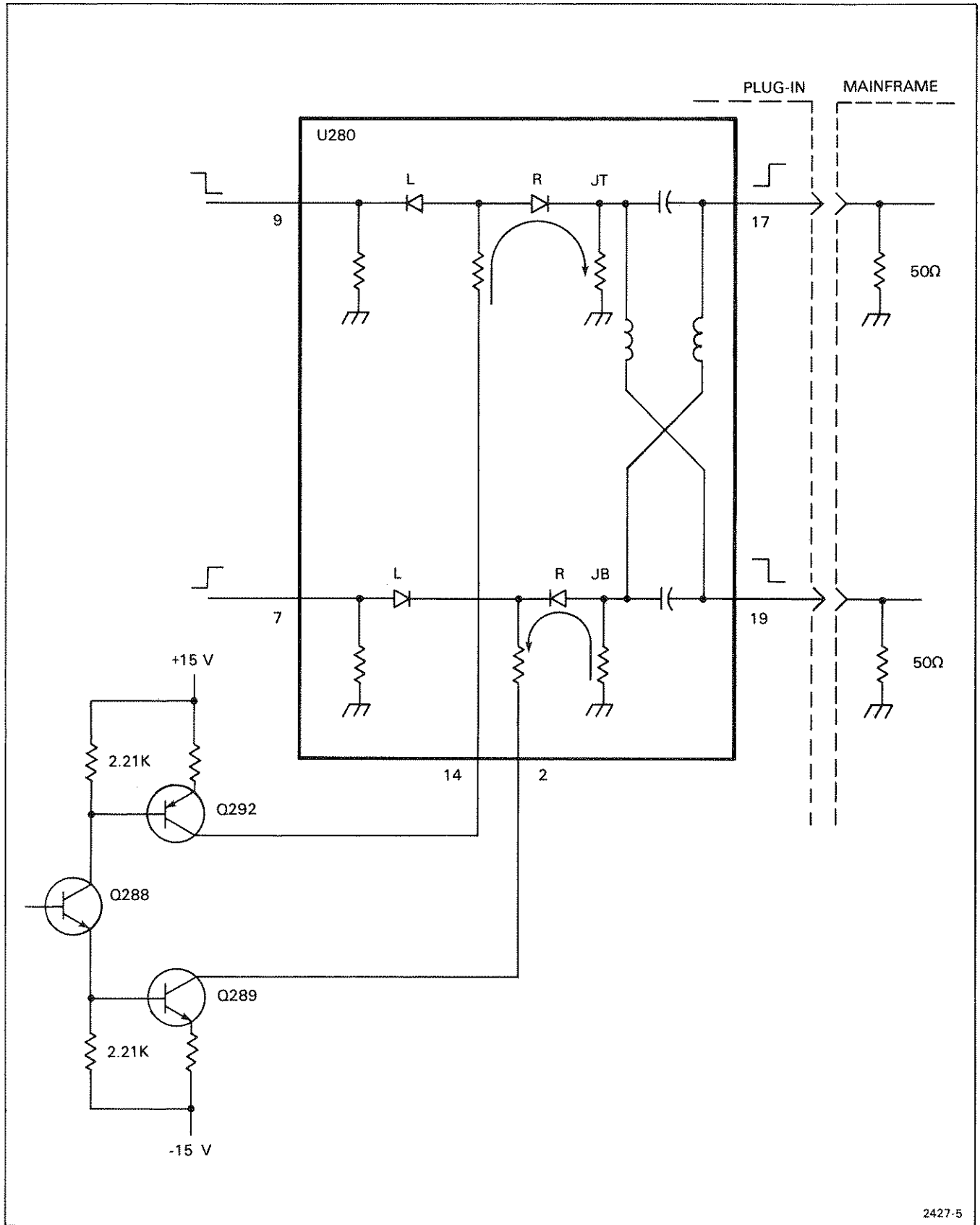
A pulse from U250 causes a negative transition at U280's pin 9 input and a positive transition at its pin 7 input. The steep slopes of the input transitions switch the Schottky diodes in U280, turning on the left diodes and turning off the right diodes. The fast switching action of the Schottky diodes produces a fast-rise output pulse. When the right diodes cease conducting, the voltages at the JT and JB points (Fig. 3-3) decrease to zero, creating a flat output pulse. The pulse from JT reaches output pin 19 of U280 via the inductor, and the pulse from JB reaches output pin 17 via the other inductor.

The AMPLITUDE control varies the gain of differential pair Q216-Q217, amplifier U250, and shaper U280. Distributing gain changes among stages helps optimize the transient response.

To control the position of the display, the output of the front-panel POSITION control (R205) biases the pin 1 and pin 15 inputs of shaper U280 via amplifiers U284B, U272A, and U284A. When the front-panel TEST switch, S430A, is in the -STEP RESP, FREQ RESP or AUX IN position, S430A grounds the pin 5 input of U284B and causes U284B to invert. When pin 5 is not grounded, U284B is a non-inverting amplifier and ensures that the display always goes upward when the POSITION control is rotated clockwise.

The Step Resp Symmetry adjustment, R285, enables the pulses at pins 17 and 19 of U280 to be set for symmetrical response.

The Trans Resp adjustment, R235, adjusts the transient response of the Pulser.



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Figure 3-3. Simplified diagram of shaper U280.

  
**LEVELER**

Diagram 3 shows the circuitry of the Leveler, which consists of amplifier U350, detector U390, amplifiers U312A and B, and lamp-driver Q329-Q332.

The Leveler is used in an automatic gain control (agc) mode in the FREQ RESP positions of the TEST selector and as an adjustable gain amplifier in the AUX IN position.

Signals from J341, the AUX IN-CW IN connector, enter U350. With the TEST selector in the AUX IN position, R210, the AMPLITUDE potentiometer, controls the gain of U350 via Q293 (diagram 2) and Q306. The gain can be changed from about 0.1 to 2.0; a range of 20. This range permits setting time marks to an amplitude suitable for timing and geometry adjustments.

When the TEST selector is in either FREQ RESP position the AMPLITUDE control does not directly control the gain of U350. Instead, amplifier U312B controls U350's gain by comparing the output of a detector in U390 with a reference voltage from U312A. U312A generates the reference voltage by summing the voltage from the

AMPLITUDE control and the voltage from a temperature-compensated reference diode in U390. After being amplified by U312A, the temperature variation in the voltage from U390's reference diode compensates for the temperature variations in the detector diodes in U390.

Transistors Q329 and Q332 monitor the output voltage of U312B. When U312B's output voltage is between +2.2 and +7.0 volt, Q332 turns on DS335 (CW LEVELED indicator).

The pin 2 and pin 4 outputs of U350 drive amplifiers Q361 and Q362, which furnish the +Aux/Cw Trig and -Aux/Cw Trig signals to the TEST selector switch.

Potentiometer R390, Freq Resp, supplies a variable voltage to varactor diodes in U390. Varying R390 changes the high-frequency response of U390. Lowering the input voltage from R390 increases U390's high-frequency response.

Diodes CR319 and VR319 limit the output swing of U312B when it is out of its limiting range. Diode CR319 prevents U312B pin 7 from going more than 1 volt below ground, and VR319 limits the positive excursion to about 10 volts. Limiting the travel of U312B's output in this manner minimizes its recovery time.



# MAINTENANCE

This section of the manual contains information for performing preventive maintenance, troubleshooting, and corrective maintenance for the Signal Standardizer.

## PREVENTIVE MAINTENANCE

Preventive maintenance, performed regularly, can prevent instrument breakdown and may improve the reliability of the instrument. The severity of the environment to which the instrument is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is preceding electrical adjustment of the instrument.

### CLEANING

The Signal Standardizer should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dust on components acts as an insulating blanket which prevents efficient heat dissipation, and also provides an electrical conduction path which may result in instrument failure. Cabinet panels provide some protection against dust in the interior of the instrument.

#### CAUTION

*Circuit boards and components must be dry before applying power to the instrument to prevent damage from electrical arcing.*

#### CAUTION

*Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Use a nonresidue type of cleaner, preferably isopropyl alcohol, total denatured ethyl alcohol, or a fluorinated solvent (i.e., trichloroethylene) such as Freon TF or Spray-On #2002. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

### VISUAL INSPECTION

Inspect the Signal Standardizer occasionally for such defects as broken connections, improperly seated semiconductors, damaged or improperly installed circuit boards, and heat-damaged parts. The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged parts are found. Overheating usually indicates other trouble in the instrument; therefore, the cause of overheating must be corrected to prevent recurrence of the damage.

### SEMICONDUCTOR CHECKS

Periodic checks of semiconductors are not recommended. The best check of semiconductor performance is actual operation in the instrument. More details on semiconductors appear under Troubleshooting later in this section.

### EXTERIOR

Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small brush. The brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

### INTERIOR

Cleaning the interior of the instrument should only be occasionally necessary. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (about 5 lb/in<sup>2</sup>). Remove any dirt which remains with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces, or for cleaning more delicate circuit components.

### ELECTRICAL ADJUSTMENT

To ensure accurate measurements, check the electrical adjustment of this instrument after each 1000 hours of operation, or every six months if used infrequently. In addition, replacement of components may necessitate adjustment of the affected circuits. Complete adjustment instructions are given in Section 5, Calibration. This procedure can be helpful in localizing certain troubles in the instrument, and in some cases, may correct them.

# TROUBLESHOOTING

The following information is provided to facilitate troubleshooting the Signal Standardizer. Information in other sections of this manual should be used in conjunction with the following data to aid in locating a defective component. An understanding of the circuit operation is helpful in locating troubles. See Section 3, Theory of Operation, for this information.

## TROUBLESHOOTING AIDS

### DIAGRAMS

Complete schematic diagrams appear on the foldout pages in Section 7, Diagrams and Circuit Board Illustrations. The component number and electrical value of each component in this instrument are shown on these diagrams. (See the first page of the Diagrams and Circuit Board Illustrations section for definitions of the reference designators and symbols used to identify components in this instrument.) Important voltages and numbered waveform test points are also shown on the diagrams. Important waveforms, and the numbered test points where they were obtained, are located adjacent to each diagram. Each schematic diagram is divided into functional blocks, indicated by wide shaded lines. These functional blocks are described in detail in Section 3, Theory of Operation.

### CIRCUIT-BOARD ILLUSTRATIONS

An illustration of the circuit board appears on the back of the foldout page facing the schematic diagram. This illustration shows the location of the components and waveform test points that appear on the schematic diagram. The circuit-board illustration is arranged in a grid locator with an index to facilitate rapid location of parts shown on the schematic diagrams.

### TEST POINT AND ADJUSTMENT LOCATIONS

To aid in locating test points and adjustable components called out in the Performance Check and Adjustment procedures, a Test Point and Adjustment Locations foldout page is provided in Section 7, Diagrams and Circuit Board Illustrations.

### COMPONENT COLOR CODING

This instrument contains composition resistors, metal-film resistors, carbon-film resistors and wire-wound resistors. The resistance values of wire-wound resistors are usually printed on the component body. The resistance values of composition resistors and metal-film resistors are color coded on the components using the EIA color code (some metal-film resistors may have the value printed on the body). The color code is read starting with the stripe nearer the end of the resistor. Carbon film and composition resistors have four stripes, which consist of two significant figures, a multiplier, and a tolerance value (see Fig. 4-1). Metal-film resistors have five stripes consisting of three significant figures, a multiplier, and a tolerance value.

The values of common disc capacitors and small electrolytics are marked on the side of the component body. The white ceramic and epoxy-coated tantalum capacitors used in the instrument are color coded using a modified EIA code (see Fig. 4-1). Axial capacitors either have the value printed on the body or use the modified EIA code.

The cathode end of glass-encased diodes is indicated by a stripe, a series of stripes, or a dot. The cathode and anode ends of metal-encased diodes can be identified by the diode symbol marked on the body.

### SEMICONDUCTOR LEAD CONFIGURATIONS

Figure 4-2 shows the lead configurations of semiconductors used in the Signal Standardizer.

### MULTI-CONNECTOR HOLDERS

The multi-connector holders are keyed with two triangles, one on the holder and one on the circuit board. When a connection is made perpendicular to a circuit board surface, the orientation of the triangle on the end-lead multi-pin connector holder is determined by the placement of the multi-pin connector index (see Fig. 4-3).

### TROUBLESHOOTING EQUIPMENT

The following equipment, in addition to that listed in the Performance Check and Adjustment section, is useful for troubleshooting the Signal Standardizer.

#### Semiconductor Tester

**Description:** Dynamic-type tester.

**Purpose:** To test the semiconductors used in this instrument.

**Recommended Type:** TEKTRONIX Type 576 Curve Tracer or equivalent.

#### Multimeter

**Description:** Ten-megohm input impedance and 0 to 300 volts range, ac and dc; ohmmeter, 0 to 50 megohms; accuracy, within 3%. Test probes must be insulated to prevent accidental shorting.

**COLOR CODE**

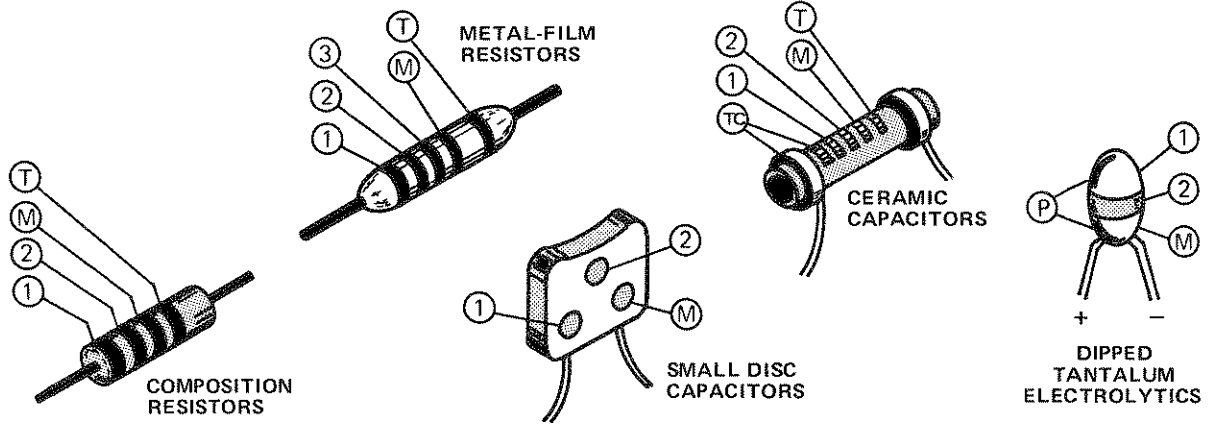
① ② AND ③ - 1st, 2nd, AND 3rd SIGNIFICANT FIGS.

Ⓣ AND/OR ⓉⓈ COLOR CODE MAY NOT BE PRESENT ON SOME CAPACITORS;

Ⓜ - MULTIPLIER; Ⓣ - TOLERANCE;

Ⓟ - POSITIVE (+) POLARITY AND VOLTAGE RATING.

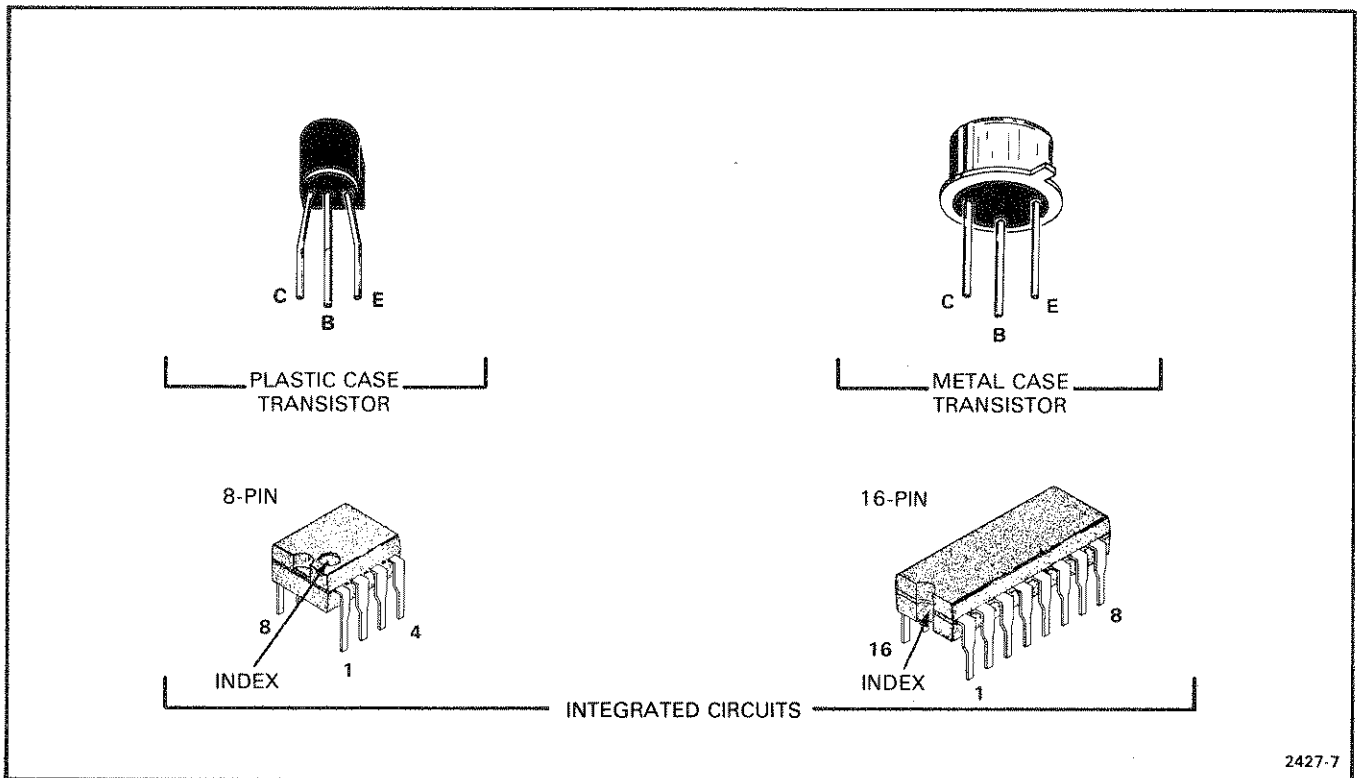
ⓉⓈ - TEMPERATURE COEFFICIENT.



COLOR	SIGNIFICANT FIGURES	RESISTORS		CAPACITORS			DIPPED TANTALUM VOLTAGE RATING
		MULTIPLIER (OHMS)	TOLERANCE	MULTIPLIER (pF)	TOLERANCE		
					OVER 10pF	UNDER 10pF	
BLACK	0	1	---	1	±20%	± 2pF	4VDC
BROWN	1	10	±1%	10	±1%	±0.1pF	6VDC
RED	2	10 <sup>2</sup> or 100	±2%	10 <sup>2</sup> or 100	±2%	---	10VDC
ORANGE	3	10 <sup>3</sup> or 1 K	±3%	10 <sup>3</sup> or 1000	±3%	---	15VDC
YELLOW	4	10 <sup>4</sup> or 10K	±4%	10 <sup>4</sup> or 10,000	+100% -0%	---	20VDC
GREEN	5	10 <sup>5</sup> or 100 K	±1/2%	10 <sup>5</sup> or 100,000	±5%	±0.5pF	25VDC
BLUE	6	10 <sup>6</sup> or 1 M	±1/4%	10 <sup>6</sup> or 1,000,000	---	---	35VDC
VIOLET	7	---	±1/10%	10 <sup>7</sup> or 10,000,000	---	---	50VDC
GRAY	8	---	---	10 <sup>-2</sup> or 0.01	+80% -20%	±0.25pF	---
WHITE	9	---	---	10 <sup>-1</sup> or 0.1	±10%	±1pF	3VDC
GOLD	---	10 <sup>-1</sup> or 0.1	±5%	---	---	---	---
SILVER	---	10 <sup>-2</sup> or 0.01	±10%	---	---	---	---
NONE	---	---	±20%	---	±10%	±1pF	---

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Figure 4-1. Color codes for resistors and capacitors.



2427-7

Figure 4-2. Semiconductor lead configurations.

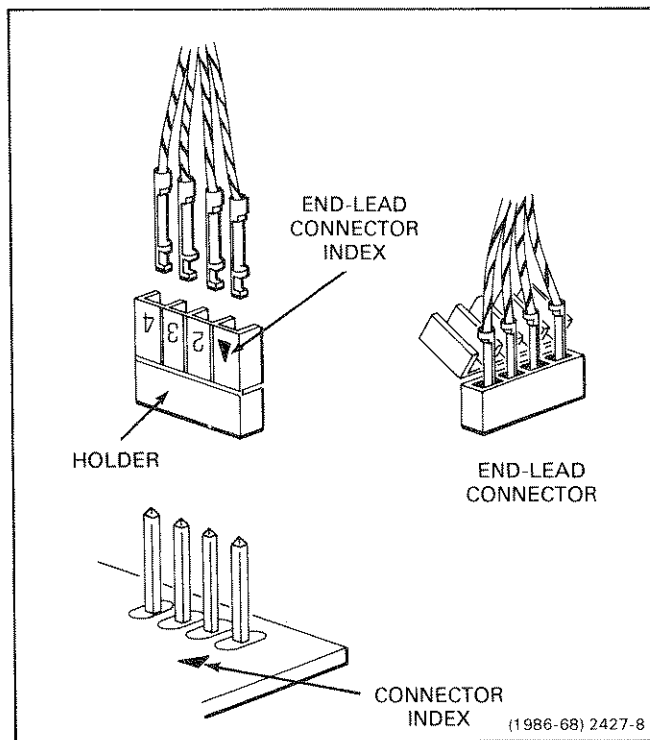


Figure 4-3. Orientation of multi-connector holders.

Test Oscilloscope

**Description:** Frequency response, 0 to 50 MHz; deflection factor, one millivolt/division to five volts/division. Use a 10X, ten-megohm voltage probe to reduce circuit loading for voltage measurements.

**Purpose:** To check operating waveforms.

**TROUBLESHOOTING TECHNIQUES**

This troubleshooting procedure is arranged in an order that checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and adjustment. If the trouble is located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, replace it using the replacement procedure given under Component Replacement in this section.

**1. CHECK CONTROL SETTINGS**

Incorrect control settings can indicate a trouble that does not exist. If there is any question about the correct function or operation of any control on the Signal Standardizer, refer to Section 2, Operating Instructions.

## 2. CHECK ASSOCIATED EQUIPMENT

Before proceeding with troubleshooting, check that the equipment used with this instrument is operating correctly. Also, check that the input signals are properly connected and that the interconnecting cables are not defective. Check the power source voltages.

## 3. VISUAL CHECK

Visually check that portion of the instrument where the trouble is located. Many troubles can be found by visible indications, such as unsoldered connections, broken wires, damaged circuit boards and damaged components.

## 4. CHECK INSTRUMENT ADJUSTMENT

Check the electrical adjustment of this instrument, or of the affected circuit if the trouble appears in one circuit. The apparent trouble may be a result of misadjustment. Complete adjustment instructions are given in Section 5, Calibration.

## 5. ISOLATE TROUBLE TO A CIRCUIT

To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit where the trouble is located. When trouble symptoms appear in more than one circuit, check the affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supplies. Check first for the correct output voltage of the individual supplies. A defective component elsewhere in the instrument can appear as a power-supply trouble and may also affect the operation of other circuits. Refer to the manual for the mainframe in use for its particular voltage ranges and ripple values. These voltages are measured between the power-supply test points and ground (see the Test Point and Adjustment Locations foldout page in Section 7, Diagrams and Circuit Board Illustrations, for test-point locations). If the power-supply voltages and ripple are within the listed ranges, the supply can be assumed to be working correctly. If they are outside the range, the supply may be misadjusted or operating incorrectly. To adjust the power supplies, use the procedure given in the Performance Check and Adjustment section of the mainframe manual.

## 6. CHECK VOLTAGES AND WAVEFORMS

Often the defective component can be located by checking for the correct voltages or waveforms in the circuit. Typical voltages and waveforms are given in Section 7, Diagrams and Circuit Board Illustrations.

### NOTE

*Voltages and waveforms given in Section 7, Diagrams and Circuit Board Illustrations, are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to make these readings, see the list of set-up conditions.*

## 7. CHECK INDIVIDUAL COMPONENTS

The following procedures describe methods of checking individual components in the Signal Standardizer. Components which are soldered in place are best checked by first disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

### WARNING

*To avoid electric shock, always unplug the Signal Standardizer from the mainframe before replacing components.*

### Transistors

A good check of transistor operation is actual performance under operating conditions. A transistor can most effectively be checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended because they do not check operation under simulated operating conditions.

### Integrated Circuits

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit operation is essential when troubleshooting circuits that contain integrated circuits. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. A convenient means of clipping a test probe to the in-line multi-pin integrated circuits is with an integrated-circuit test clip. This device also doubles as an integrated-circuit extraction tool.

### Diodes

A diode can be checked for an open or shorted condition by measuring the resistance between terminals with an ohmmeter set on a scale having a low internal source current, such as the R X 1K scale. The resistance should be very high in one direction and very low in the other direction.

### CAUTION

*When checking diodes, do not use an ohmmeter scale that has a high internal current because high currents may damage the diodes under test.*

### Resistors

Check resistors with an ohmmeter. Resistor tolerance is given in Section 6, Replaceable Electrical Parts. Normally, resistors need not be replaced unless the measured value varies widely from the specified value.

### Capacitors

A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking if the capacitor passes ac signals.

### 8. REPAIR AND READJUST THE CIRCUIT

If any defective parts are located, follow the replacement procedures given under Removing and Replacing Parts in this section. Check the performance of any circuit that has been repaired or that has had any electrical components replaced. Adjustment of the circuit may be necessary.

## CORRECTIVE MAINTENANCE

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in the Signal Standardizer are given here.

### OBTAINING REPLACEMENT PARTS

Most electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc. please check the electrical parts list for proper value, tolerance, rating, and description.

#### NOTE

*When selecting replacement parts, remember that the physical size and shape of a component may affect its performance in the instrument. All replacement parts should be direct replacements unless you know that a different component will not adversely affect instrument performance.*

### SPECIAL PARTS

Some components of the Signal Standardizer are manufactured or selected by Tektronix, Inc. to meet specific performance requirements. Most of the mechanical parts used in this instrument were manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

### ORDERING PARTS

When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument serial number.
3. A description of the part (if electrical, include the circuit number).
4. Tektronix part number.

### SOLDERING TECHNIQUES

#### WARNING

*To avoid electric shock, unplug the Signal Standardizer from the mainframe before soldering.*

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 resin-core, electronic-grade solder. The choice of soldering iron is determined by the repair to be made. When soldering on circuit boards or small wiring, use only a 15-watt, pencil-type soldering iron. A higher-wattage soldering iron can cause the etched circuit wiring to separate from the base material and melt the insulation from small wiring. Always keep the soldering-iron tip properly tinned to ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat-sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder-removing wick to remove excessive solder from connections or to clean circuit board pads.

The following technique should be used to replace a component on any of the circuit boards in this instrument. Most components can be replaced without removing the board(s) from the instrument.

1. Touch the soldering iron to the lead at the solder connection. Never place the iron directly on the board.
2. Melt a small amount of solder onto the component lead connection. This replaces the flux, which may have been removed during instrument cleaning, and facilitates removal of the component.

3. Grip the component lead with a pair of long-nose pliers. When the solder begins to flow, gently pull the component lead from the board. If unable to separate the lead from the board, try removing the other end of the component.

#### NOTE

*Some components are difficult to remove from the circuit board due to a bend placed in each lead during machine insertion of the component. (The bent leads hold the component in position during a flow-solder manufacturing process which solders all components at once.) To make removal of machine-inserted components easier, straighten the leads of the component on the back of the circuit board using a small screwdriver or pliers, while heating the soldered connection.*

4. Bend the leads of the replacement component to fit the holes in the circuit board. If the component is replaced while the board is mounted in the instrument, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so that the component is firmly seated against the board, or as originally positioned.

5. Touch the iron to the connection and apply enough solder to make a firm solder joint.

6. Cut off any excess lead protruding through the board (if not clipped in step 4).

7. Clean the area around the solder connection with a flux-removing solvent. Be careful not to remove information printed on the circuit board. Do not allow any solvent to get in the HYPCON connectors on the elastomer switch. Tilt the instrument so that solvent does not flow toward the HYPCON connectors or the elastomer switch.

## REMOVING AND REPLACING PARTS

### WARNING

*To avoid electric shock, always unplug the Signal Standardizer from the mainframe before replacing components.*

The exploded-view drawings associated with the Replaceable Mechanical Parts list (located at the rear of this manual) may be helpful in the removal or disassembly of individual components or sub-assemblies.

## CIRCUIT BOARDS

If a circuit board is damaged beyond repair, the entire assembly, including all soldered-on components, can be

replaced. The part number for the complete board assembly appears in Section 6, Replaceable Electrical Parts.

#### NOTE

*The circuit board is made of fluorglas, which is softer than conventional circuit-board material. To avoid damage, be particularly careful of the board-edge connector when the instrument is not plugged in to the mainframe or when the board's edge is otherwise exposed.*

## How to Remove the Circuit Board

1. Set the TEST selector to the VERT or HORIZ GAIN position to access the shaft-retaining setscrews in the coupler on the cam switch.

2. Use a hex-key (Allen) wrench to loosen the set screws that hold the knob shaft.

3. Remove the TEST knob and shaft as an assembly.

4. Unplug P342, P142, and P411 from the back of the board.

5. Unplug P203 and P532 from the front of the board.

6. Remove the four screws that hold the gray-plastic rear panel to the frame.

7. Remove the six screws that hold the circuit board to the brackets on the frame.

8. Remove the circuit board through the back of the instrument.

## How to Replace the Circuit Board

1. Install the board through the rear of the plug-in frame.

2. Guide the six pushbuttons into their holes in the front panel.

3. Install the four screws that secure the rear panel to the instrument frame.

4. Install the six screws that hold the circuit board to the frame brackets.

5. Plug the orange six-pin connector to the pins marked P203, and the red four-pin connector to the pins marked P532.

6. Connect the coaxial connectors P342, P142, and P411 to their respective connectors on the back of the circuit board. The connectors are identified by J-number on the opposite side of the board (the component side).

7. Insert the TEST knob-shaft assembly through the hole in the front panel, and guide the shaft into the coupler on the cam switch.

8. Set the TEST knob to the VERT or HORIZ GAIN position; locate the knob about 1/32" from the front panel, and tighten the setscrews that retain the shaft to the switch coupler.

9. Rotate the TEST switch to the extremes of its travel to verify that you've indexed the knob properly.

### HYPCON CONNECTORS AND HYBRID CIRCUITS

HYPCON connectors are precision-made connectors designed to provide low-loss electrical and thermally-efficient connections between the circuit board and the

hybrid integrated circuit. Figure 4-4 shows an exploded view of the HYPCON connector and gives removal and replacement instructions. When replacing the hybrid ICs, be careful not to touch the gold-plated contacts in the elastomer with your fingers. Do not use a cleaner which will degrade the contact reliability. The HYPCON connector and hybrid IC should be removed if it becomes necessary to use a cleaning solvent near the connector when replacing adjacent (within 1/2 inch) circuit-board components.

**IMPORTANT:** Remove all traces of solder flux or foreign material from the circuit-board contact area before replacing the connector. Contamination usually occurs during the soldering and cleaning processes. Even when soldering carefully, flux, oil, or other contaminants can be carried under the connector during the cleaning

#### DISASSEMBLY AND REMOVAL

- ① Note indexes on circuit board (arrow) and HYPCON plastic frame (pointed mounting ear).
- ② Unscrew and remove the four screw-washer assemblies.
- ③ Lift HYPCON connector from board.
- ④ Note index location of hybrid and remove from board with tweezers.
- ⑤ Note index location of elastomer contact holder and remove by grasping a corner of the contact holder with tweezers and lifting up. Do not touch the gold-plated contacts with your skin.

#### REASSEMBLY AND REPLACEMENT

Grasp corner of elastomer contact holder with tweezers and place in plastic frame slot. Match the flat on the contact holder with the flat on the frame corner. Place a clean plastic envelope over finger and press with finger to seat contact holder into the frame. The contact holder must be evenly seated on all four sides.

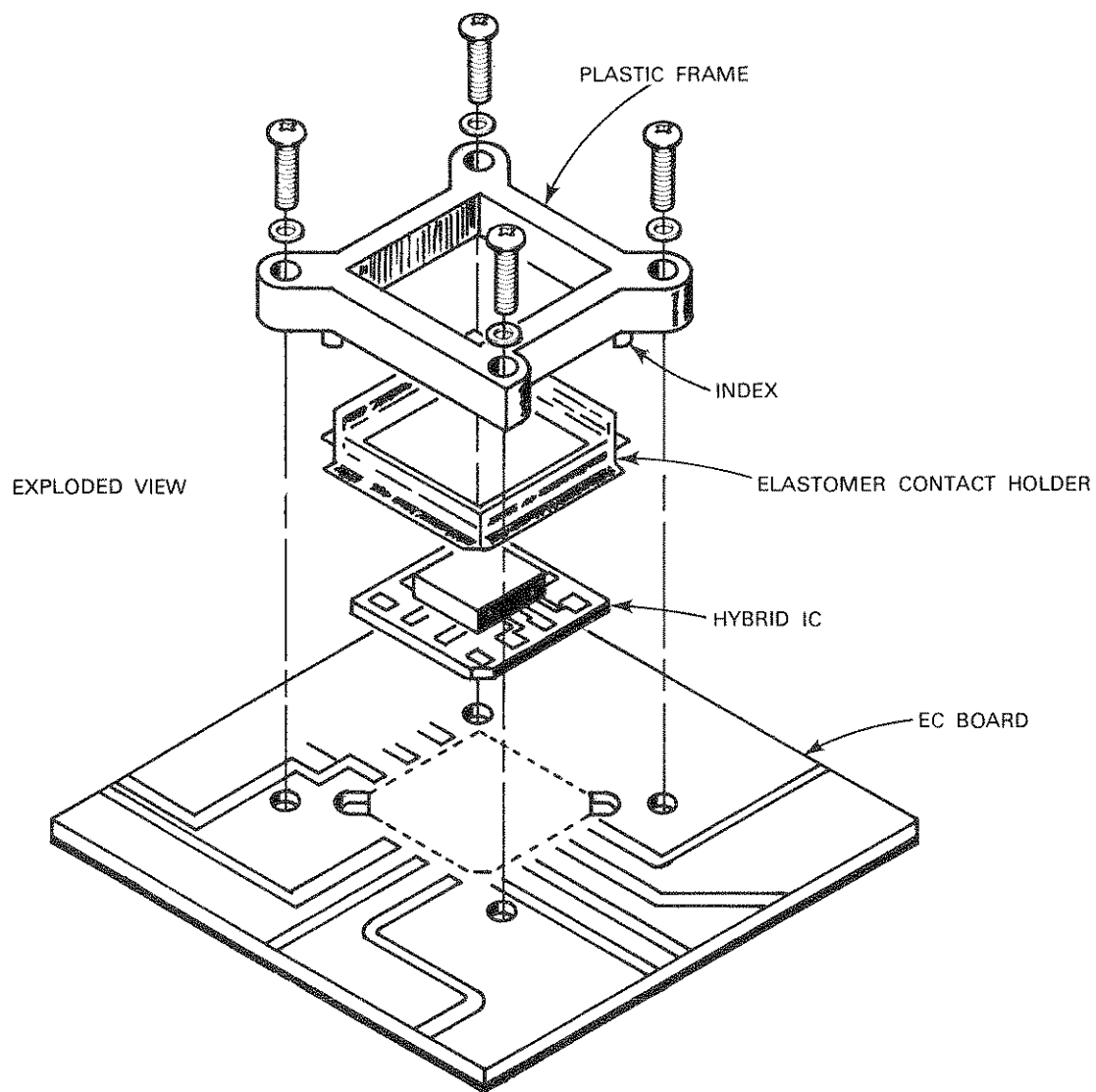
Using tweezers, match the hybrid-corner index with the elastomer contact-holder index and insert between the registration pins. Turn the assembly over, grasp the hybrid "hat" with the tweezers, and guide the registration pins into the board holes. Match the plastic frame's pointed mounting ear with the circuit board arrow.

Install the retaining screws, and apply 2 inch-pounds of torque to secure the connector assembly.

2427-9A

Figure 4-4A. Details of HYPCON connectors.





2427-9B

Figure 4-4B (Cont.). Details of HYPCON connectors.

operation. When the cleaning solvent evaporates, nonconductive contaminants may remain on or near the contact interfaces.

Hand cleaning with solvent or machine cleaning in an automatic detergent wash is not recommended for boards containing HYPCON connectors.

If a component near a HYPCON connector must be replaced, proceed as follows.

1. Before soldering or cleaning, remove the hybrid IC and HYPCON connector (see Disassembly and Removal instructions) and store it in a clean covered container. When several hybrids and HYPCON connectors are to be removed, keep their parts in sets. Do not interchange parts.

2. Hand soldering

- a. Use small-diameter solder (0.030" to 0.040").
- b. Use a low-wattage soldering iron (15-20 watts).
- c. Use care with solder amount and placement.

3. Remove solder flux and contact contamination with isopropyl alcohol, denatured alcohol, or a fluorinated solvent (i.e., trifluorotrchloroethane) such as Freon TF or Spray-On #2002.

4. Flush the hybrid IC and HYPCON connector mounting area with isopropyl alcohol. Tilt the instrument so that solvent flows away from other HYPCON connectors and elastomer switch. Do not scrub with a cotton-tipped applicator, because cotton fibers will adhere to edges and surfaces of contact area and cause open or intermittent connections. Examine the elastomer in a bright light for dust, hair, or other contaminants before reinstalling it. If the circuit-board surfaces need further cleaning, scrub with a rubber eraser (the Pink Pearl brand is ideal for this) and blow or vacuum the area clean while dusting the surface with a small brush.

5. If the hybrid IC and elastomer contact holder are contaminated, clean the contact holder and the hybrid by flushing or spraying with alcohol and oven dry at 50° C. Do not scrub with a cotton-tipped applicator or similar swab. If the contact holder is excessively contaminated, replace it with a new one.



*Because of the close tolerances involved, be particularly careful to index the IC to the HYPCON parts during reassembly. Failure to do so can result in a cracked hybrid substrate. See Figure 4-4B for index locations.*

**ELASTOMER SWITCH**

The TEST switch in the Signal Standardizer is a cam-operated elastomer switch. The cam and the elastomer switch attach to opposite sides of the circuit board.

The elastomer switch can be cleaned or replaced by service personnel. It can be repaired only at the factory because the delicate elastomer contacts require a highly-accurate fixture for reassembly.

To clean or replace the elastomer switch, proceed as follows:

**NOTE**

*Do not clean the elastomer switch while it is assembled to the circuit board.*

1. Check for obvious damage or malfunctioning of visible parts, such as the cam, flex coupler, spring fingers, etc.
2. Set the TEST selector to VERT or HORIZ GAIN position.
3. Hold the elastomer housing against the circuit board while removing the four 4-40 screws that hold the switch to the circuit board. Figure 4-5 shows the retaining screws. Do not loosen the other screws.
4. Remove the elastomer switch by lifting it perpendicularly away from the board.
5. Loosen the two set screws that hold the shaft in the flex coupling on the cam assembly.
6. Remove the cam assembly.

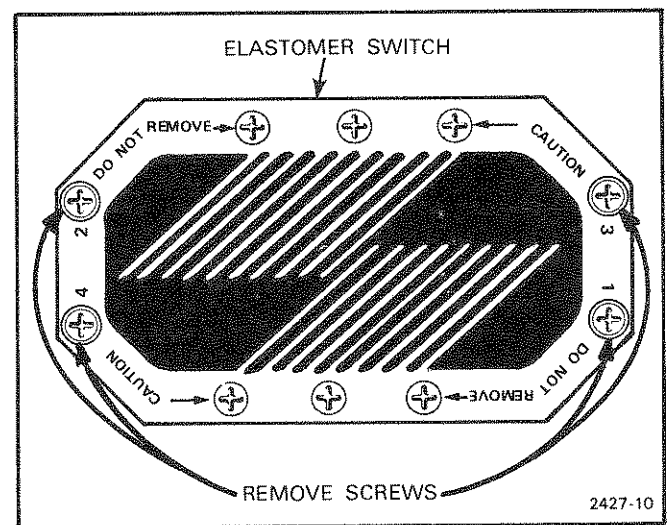


Figure 4-5. Retaining screws for elastomer switch.

7. Inspect the switch pads on the circuit board and clean them with a solution of 5% Kelite Spray White, 5% nonsoapy, nonsudsing ammonia, and water. Then rinse with isopropyl alcohol. Tilt the instrument so that the alcohol flows away from the other contact surfaces and the HYPCON connectors. Let set for 60 seconds, then blow off with compressed air; oven dry if required. Do not lubricate the contact pads; they are designed to operate dry.

Do not scrub or wipe the contact pads with anything, such as a cotton swab, that could leave fibers caught on the edge of the stripline.

Check the soldered crossover line for continuity and shorting to the line beneath it.

8. Inspect the gold-plated contacts and elastomer parts in the switch housing. If there are any damaged parts, the assembly should be replaced with another assembly (Tektronix Part 263-0032-00) because of the assembly fixturing required.

9. Clean the elastomer contacts, if necessary, by washing them very lightly and carefully with a small brush and isopropyl alcohol. Do not use anything that could leave fibers or other material on the contacts. Carefully blow off the excess alcohol and allow to dry. Be very careful not to dislodge the elastomer strips from their proper positions by unseating the elastomer force columns from the sockets in the inner and outer actuators. Figure 4-6 shows details of the elastomer switch.

10. To reassemble, orient the switch so that the numbers 2 and 4 on the end of the spring plate are toward the front of the instrument. As another proof of correct orientation, verify that the two groups of actuator posts (there are groups of eight and 10 posts) go into the two groups of holes of the same numbers. (The switch cannot be installed backward.) Be careful not to touch or abrade the elastomer contacts. Bring the switch housing to the board as perpendicular as possible. If necessary, use a probe from the other side of the board to guide the actuator posts through the holes in the board. Be careful not to damage the elastomers or the actuator posts with the probe.

11. While holding the elastomer switch against the circuit board, position the cam over the locating holes and actuator posts. Push the cam perpendicularly down onto the circuit board. Install the four 4-40 retaining screws and washers and tighten them evenly while holding the switch to the board. Torque each 4-40 retaining screw to three inch-pounds in the sequence given by the numbers on the metal spring plate.

12. Set the TEST knob to the VERT or HORIZ GAIN position, locate the knob about 1/32" from the front panel, and tighten the setscrews that retain the shaft to the switch coupler.

13. Rotate the TEST switch to the extremes of its travel to verify that you've properly indexed the knob.

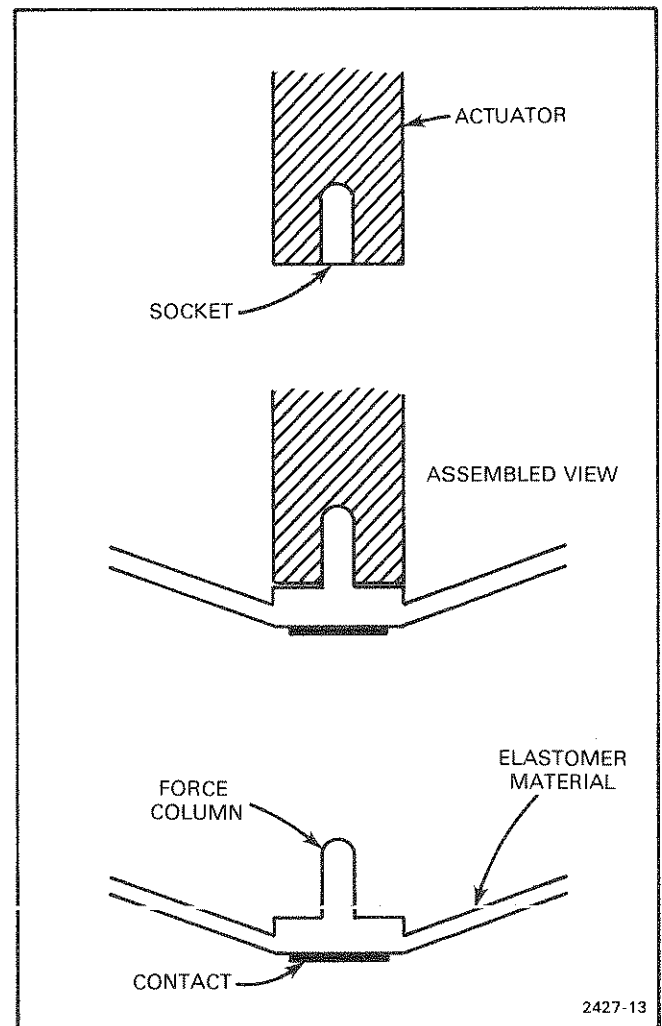


Figure 4-6. Details of elastomer switch.

## SEMICONDUCTORS

Semiconductors should be replaced only when defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of semiconductors may affect the accuracy of the instrument. When semiconductors are replaced, check the operation of circuits which may be affected.

### WARNING

*To avoid electrical-shock hazard, always unplug the Signal Standardizer from the mainframe before replacing components.*

Replacement semiconductors should be of the original type or a direct replacement. Lead configurations of the semiconductors used in this instrument are shown in Figure 4-2. Some plastic-cased transistors have lead configurations different from those shown. If a

replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. All transistor sockets in the Signal Standardizer are wired for the standard basing as used for metal-cased transistors.

### CIRCUIT-BOARD PIN REPLACEMENT

A circuit-board pin replacement kit, including necessary tools, instructions, and replacement pins with attached spare ferrules, is available from Tektronix, Inc. Order Tektronix Part 040-0542-00.

To replace a damaged pin, first disconnect any pin connectors. Then unsolder (see Soldering Techniques) the damaged pin and pull it from the board with a pair of pliers, leaving the ferrule (see Fig. 4-7) in the hole if possible. If the ferrule remains in the circuit board, remove the spare ferrule from the replacement pin and press the new pin into the hole in the circuit board. If the ferrule is removed with the damaged pin, clean out the hole using a solder-removing wick and a scribe. Then press the replacement pin, with attached spare ferrule, into the hole. Position the replacement pin in the same manner as the original pin was positioned. Solder the pin to the circuit board on each side of the circuit board. If the original pin was bent at an angle to mate with a connector, carefully bend the new pin to the same angle. Replace the pin connector.

### END-LEAD PIN CONNECTORS

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the associated leads. To remove or replace damaged end-lead pin connectors, remove the old pin connector from the end of the lead and clamp the replacement connector to the lead.

Some of the pin connectors are grouped and mounted in a plastic holder; these connectors are removed and installed as multi-pin connectors (see Troubleshooting Aids). If the individual end-lead pin connectors are removed from their plastic holder, note the order of the individual wires for correct replacement in the holder.

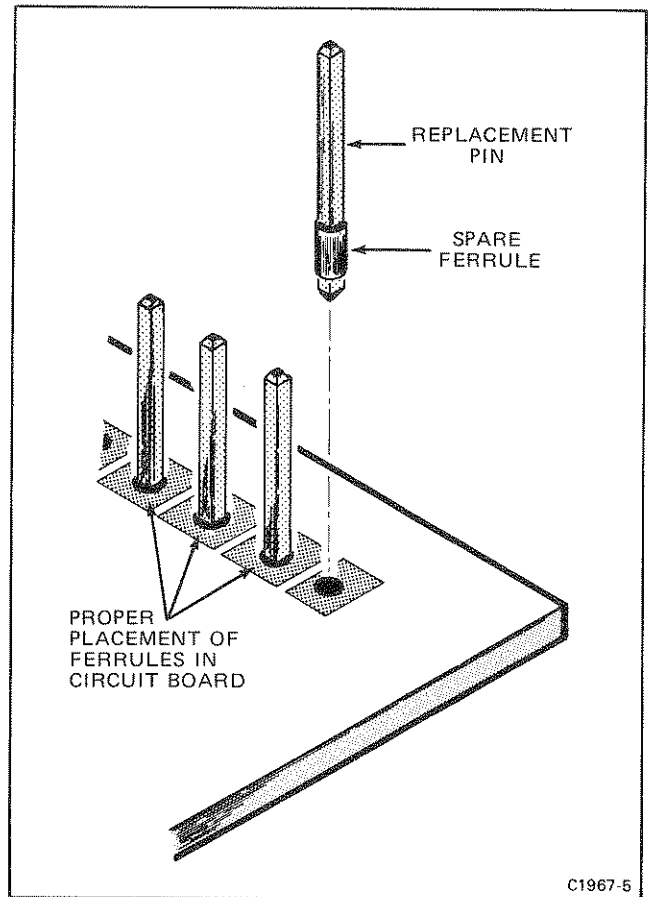


Figure 4-7. Exploded view of circuit-board pin and ferrule.

# CALIBRATION

This section provides procedures for calibrating this instrument. These procedures are designed to compare the performance of this instrument with other measurement instruments of known accuracy to detect, correlate, or eliminate by adjustment, any variation from the electrical specifications. These procedures also verify that the controls function properly.

This section is divided into two parts: Part I—Performance Check is provided for those who wish to verify that this instrument meets the applicable electrical specifications in section 1 without making internal adjustments. Part II—Adjustment and Performance Check provides a complete calibration procedure that includes adjustments and performance checks in addition to verifying that the controls function properly. The procedures in Part I and Part II are written so that the entire instrument or any major circuit or part of a circuit can be checked or adjusted.

Table 5-1, Calibration Procedure Electives, lists the choices available and instructions for performing complete or partial calibration procedures. Also refer to page 5-2, Using These Procedures, for more detailed information.

**TABLE 5-1**  
**Calibration Procedure Electives**

Electives	Procedure
Functional Check	Perform Power-Up Sequence in Part II—Adjustment and Performance check. Then proceed sequentially through subsections (A, B, C, etc.) to end. If a functional check only is desired, perform the Detailed Operating Information procedures in section 2.
Performance Check Only	Perform Power-Up Sequence in Part I—Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end.
Complete Calibration (Part II—Adjustment and Performance Check)	Perform Power-Up Sequence in Part II—Adjustment and Performance Check. Then proceed sequentially through subsections (A, B, C, etc.) to end.
Partial Part I—Performance Check or Part II—Adjustment and Performance Check by Subsection (A, B, C, etc.)	Perform Power-Up Sequence for Part I—Performance Check or Part II—Adjustment and Performance Check. Perform Before You Begin and Preliminary Control Setting instructions for the desired subsection. Then proceed sequentially through the procedures in the desired subsection.
Partial Part I—Performance Check or Part II—Adjustment and Performance Check by Step (A1, A2, B1, B2, etc.) Within a Subsection (A, B, C, etc.)	Perform Power-Up Sequence for Part I—Performance Check or Part II—Adjustment and Performance Check. Perform Before You Begin and Preliminary Control Settings instructions for subsection (A, B, C, etc.) containing the desired step (A1, A2, B1, B2, etc.). Then proceed through the instructions (a, b, c, etc.) in the desired step. <p style="text-align: center;"><b>NOTE</b></p> <p style="text-align: center;"><i>Although a partial adjustment procedure may be done, we recommend that the entire subsection procedure be performed if any adjustments are made.</i></p>

**USING THESE PROCEDURES**

**NOTE**

*In this procedure, capital letters within the body of the text identify front-panel controls, indicators and connectors on the Signal Standardizer (e.g., REP RATE). Initial capitalizing identifies controls, indicators, and connectors (e.g. Position) on associated test equipment (used in this procedure) and adjustments internal to the Signal Standardizer (e.g., Step Resp Symmetry).*

These procedures are divided into subsections by major functional circuits (e.g., A. Rep Rate, B. Gain, etc.). The order in which the subsections and procedures appear is the recommended sequence for a complete performance check or calibration of the instrument.

Each step contains the Setup Conditions which, if applicable, include control settings for this instrument, a test setup illustration, and test equipment control settings. The Setup Conditions are written so that, if desired, each subsection (A, B, C, etc.) or step (A1, A2, B1, B2, etc.) can be performed separately.

A heading system is provided to readily identify the steps (A1, A2, B1, B2, etc.) that contain performance check and/or adjustment instructions. For example, if CHECK is the first word in the title of a step, an electrical specification is checked. If ADJUST is the first word in the title, the step concerns one or more internal adjustments. And if CHECK/ADJUST appears in the title, the step involves electrical specification checks and related adjustments. If EXAMINE is the first word in the step title, the step concerns measurement limits that indicate whether the instrument is operating properly; these limits are not to be interpreted as electrical specifications.

The alphabetical instructions under each step (a, b, c, etc.) may contain CHECK, EXAMINE, ADJUST, or INTERACTION as the first word of the instruction. These terms are defined as follows:

1. **CHECK**—indicates the instruction accomplishes an electrical specification check. Each electrical specification checked is listed in Table 5-2, Performance Check Summary (see Performance Check Summary discussion for more information).

2. **EXAMINE**—usually precedes an ADJUST instruction and indicates that the instruction determines whether adjustment is necessary. If no ADJUST instruction appears in the same step, the EXAMINE instruction concerns measurement limits that do not have a related adjustment. Measurement limits following the word EXAMINE are not to be interpreted as electrical specifications. They are provided as indicators of a properly functioning instrument and to aid in the adjustment process.

3. **ADJUST**—describes which adjustment to make and the desired result. We recommend that the adjustments not be made if a previous CHECK or EXAMINE instruction indicates that no adjustment is necessary.

4. **INTERACTION**—indicates that the adjustment described in the preceding instruction interacts with other circuits. The nature of the interaction is described and reference is made to the step(s) affected.

**PERFORMANCE CHECK SUMMARY**

Table 5-2, Performance Check Summary, lists the electrical specifications that are checked in Part I and Part II of this section. Table 5-2 is intended to provide a convenient means for locating the procedures in Part I and Part II that check and/or adjust the instrument to meet the applicable electrical specifications. For example: If the A1 Main Interface board had been repaired or replaced, use Table 5-2 to locate the electrical specifications affected by the repair or replacement. Then, note the title of the procedure in Part I or Part II in which those specifications are checked and/or adjusted. Use the index provided at the front of Part I and Part II to determine the page number of the desired procedures.

**TABLE 5-2**  
**Performance Check Summary**

Characteristic	Performance Requirement	Part I, Performance Check, Procedure Title	Part II, Adjustment and Performance Check, Procedure Title
Repetition Rate of Step Response Pulse	±0.1%.	A1. Check Rep Rate of STEP RESP Pulse.	A1. Check Rep Rate of STEP RESP Pulse.
Gain	0.3000 V ±3% between + and - values.	B1. Check Reference Voltages for Gain Staircase.	B1. Check/Adjust Reference Voltages for Gain Staircase.
Gain Staircase	±0.5% of full range.	B2. Check Linearity of Gain Staircase.	B2. Check Linearity of Gain Staircase.
Lead Time of PRETRIG OUT pulse	< 20 ns to > 65 ns.	C1. Check Lead Time Between PRETRIG OUT and Pulse Out.	C1. Check/Adjust Lead Time Between PRETRIG OUT and Pulse Out.

**TABLE 5-2 (CONT.)**  
**Performance Check Summary**

Characteristic	Performance Requirement	Part I, Performance Check, Procedure Title	Part II, Adjustment and Performance Check, Procedure Title
CW LEVELED Operation	0.4 to 1 V p-p.	D1. Check Input Range of CW LEVELED Operation.	D1. Check Input Range of CW LEVELED Operation.
Symmetry		E1. Examine Symmetry of Output Pulses.	E1. Examine/Adjust Symmetry of Output Pulses.
Transient Response	125 to 150 ps.	E2. Check Transient Response of STEP RESP Pulse.	E2. Check/Adjust Transient Response of STEP RESP Pulse.

**NOTE**

*For optimum adjustment of the frequency response of the Signal Standardizer, the adjustment should be performed at the factory because Tektronix has the necessary test equipment, traceable to the National Bureau of Standards. However, if you desire, you can adjust the frequency response characteristics of your own instrument by using the procedure described in step E3.*

Frequency Response	3 MHz to 1 GHz $\pm 3\%$ .	E3. Check Frequency Response.	E3. Check/Adjust Frequency Response.
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**ADJUSTMENT INTERVAL**

To maintain instrument accuracy, check performance every 1000 hours of operation, or every 6 months if used infrequently. Before complete adjustment, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

**TEKTRONIX FIELD SERVICE**

Tektronix Field Service Centers and the Factory Service Center provide instrument repair and adjustment services. Contact your Tektronix Field Office or representative for further information.

**TEST EQUIPMENT REQUIRED**

The test equipment listed in Table 5-3, Test Equipment, is required for a complete Adjustment and Performance Check of the instrument. If only Part I—Performance Check is to be performed, the items required for Part II—Adjustment and Performance Check are not required and are indicated by footnote 1. The remaining test equipment is common to both procedures.

The specifications for test equipment, given in Table 5-3 are the minimum required to meet the performance requirements. Detailed operating instructions for test equipment are omitted in these procedures. Refer to the test equipment instruction manual if more information is needed.

**SPECIAL FIXTURES**

Special fixtures are used only where they facilitate instrument adjustment. These fixtures are available from Tektronix, Inc. Order by part number from Tektronix Field Offices or representatives.

**TEST EQUIPMENT ALTERNATIVES**

All of the listed test equipment is required to completely calibrate this instrument. However, complete checking or adjusting may not always be necessary or desirable. You may be satisfied with checking only selected characteristics, thereby reducing the amount of test equipment actually required.

The calibration procedures in Part I and Part II are based on the first item of equipment given as an example. When other equipment is substituted, control settings or setups may need to be altered. If the exact item of equipment given as an example in Table 5-3 is not available, first check the Minimum Specifications column carefully to see if any other equipment might suffice. Then check the Purpose column to see what this item is used for. If used for a performance check or adjustment that is of little or no importance for your measurement requirements, the item and corresponding step(s) can be deleted.

**TABLE 5-3**  
**Test Equipment**

Description	Minimum Specifications	Purpose	Examples of Suitable Test Equipment
1. Oscilloscope Mainframe	Tektronix 7000-series; dc to 500 MHz.	Operate Signal Standardizer.	a. TEKTRONIX 7904 Oscilloscope.
2. Counter/Timer	10 Hz to 1 MHz; 0.01% accuracy.	Check REP RATE of STEP RESP pulse.	a. TEKTRONIX 7D15 225 MHz Universal Counter/Timer.  b. Hewlett-Packard 5327A Universal Timer/Counter.
3. Time Base	1 s/div to 10 ns/div, 2.5% accuracy.	Provide sweep display on oscilloscope.	a. TEKTRONIX 7B80 Time Base.  b. TEKTRONIX 7B85 Time Base.
4. Digital Multimeter	Accuracy, 0.1%; 4 1/2-digit display.	Set gain.	a. TEKTRONIX DM501 Digital Multimeter. (Operates in TM 500-series power module.)  b. Fluke 8040A Digital Multimeter.
5. Amplifier	Dc to 200 MHz; sensitivity, 0.2 V/div.	Measure lead time of PRETRIG OUT.	a. TEKTRONIX 7A16A Amplifier.  b. TEKTRONIX 7A11 Amplifier.
6. Sampling Unit (Uses Item 7, Sampling Head,) 2 required	Dc to 4.6 GHz, 50 $\Omega$ input impedance.	Measure symmetry and transient response.	a. TEKTRONIX 7S11 Sampling Unit.
7. Sampling Head (used in item 6, Sampling Unit,) 2 required		Use with 7S11.	a. TEKTRONIX Type S-2 Sampling Head.
8. Sampling Sweep	50 ps/div, 3% accuracy.	Measure symmetry and transient response.	a. TEKTRONIX 7T11 Sampling Sweep Unit.
9. Leveled Sine-Wave Generator	3 MHz to 1000 MHz. Accuracy: Frequency $\pm 2\%$ Amplitude $\pm 3\%$ .	Test operation of CW LEVELED mode.	a. TEKTRONIX SG 504 Leveled Sine Wave Generator (operates in TM 500-series power module).
10. Attenuator, 5X	Impedance 50 $\Omega$ Power capacity 2W Connectors bnc.	Test operation of CW LEVELED mode.	a. Tektronix Part 011-0060-02.
11. Flexible Plug-In Extender	Tektronix 7000-series plug-in extender.	Permit operating Signal Standardizer at a distance from the oscilloscope.	a. Tektronix 067-0616-00 Calibration Fixture.
12. Signal Pickoff Adapter	Tektronix 7000-series signal pickoff adapter.	Makes the + and - output signals accessible via coaxial cables.	a. Tektronix 067-0655-00 Calibration Fixture.



TABLE 5-3 (CONT.)  
Test Equipment

Description	Minimum Specification	Purpose	Examples of Suitable Test Equipment
13. Adapter (2 required)	Peltola to GR.	Connect output of pickoff adapter to 7S11 inputs.	a. Tektronix Part 017-0093-00.
14. Adapter (2 required)	Bnc to GR female.	Connect output of precision 50 $\Omega$ terminator to probe in gain staircase check.	a. Tektronix Part 017-0063-00.
15. Terminator (2 required)	Impedance, 50 $\Omega$ , within 0.1%.	Check gain staircase.	a. Tektronix 067-0515-00 Calibration Fixture.
16. Probe	Dc to 34 MHz. Attenuation, X1.	Connects outputs of precision terminators to DMM in gain staircase check.	a. Tektronix P6101.
17. Test Clip	For 16-pin DIP integrated circuits.	Connect switch to staircase generator.	a. Model TC-16 made by AP Products. Tektronix 003-0709-00.
18. Switch	SPST, normally open, momentary, pushbutton	Advance gain staircase manually.	
19. Coaxial Cable (3 required)	Impedance, 50 $\Omega$ ; connectors, bnc; length, two 42", one 18".	Symmetry, check/adjust	a. Tektronix Parts: 012-0057-01, 42" cable, 012-0076-00, 18" cable.
20. Coupler, Dual-Input	Impedance, 50 $\Omega$ ; Connectors one bnc female two bnc male.	Check operation of CW LEVELED.	a. Tektronix 067-0525-00 Calibration Fixture.
21. Adapter	Bnc to female to test point.	Connect probe tip to 50 $\Omega$ terminators in GAIN check.	a. Tektronix Part 012-0092-00.
22. Adapter	Bnc female to dual banana.	Connect probe of digital multimeter.	a. Tektronix Part 103-0090-00.
23. Sweep Generator <sup>1</sup>	3 MHz to 1000 MHz.	Check/adjust frequency response.	a. Wiltron 610D.
24. Adapter <sup>1</sup>	GR to SMA male.	Connect X2 attenuator to input from signal pickoff adapter.	a. Tektronix Part 015-1007-00.
25. Attenuator <sup>1</sup> (2 required)	Attenuation, X2 Impedance, 50 $\Omega$ Connectors, SMA.	Reduce signal level to desired amplitude for crystal detectors.	a. Tektronix Part 015-1001-00.
26. Crystal Detector <sup>2</sup> (2 required)	Impedance, 50 $\Omega$ . Characterized traceable to National Bureau of Standards.	Detect high frequencies for input to summing fixture.	a. Hewlett-Packard HP 8472B.
27. Summing Fixture <sup>1</sup>	Dual input, single output.	Sum outputs of detectors and provide an input for oscilloscope.	a. Tektronix Part 015-0338-00.
28. Amplifier, <sup>1</sup> Differential	Dc to 1 MHz, sensitivity, 0.5 mV/div.	Check/adjust frequency response.	a. TEKTRONIX 7A22 Differential Amplifier.

<sup>1</sup> Equipment needed for frequency response check/adjustment only.

<sup>2</sup> Frequency range, 10 MHz to 18 GHz; Flatness,  $\pm 2$  dB, 10 MHz to 8 GHz; VSWR, 1.2, 10 MHz to 4 GHz; Sensitivity, 0.5 mV/ $\mu$ W; Impedance, 50  $\Omega$ .

# PART I—PERFORMANCE CHECK

The following procedure (Part I—Performance Check) verifies electrical specifications without removing the instrument covers or making internal adjustments. All tolerances given are as specified in the Specification tables (section 1) in this manual.

Part II—Adjustment and Performance Check, provides the information necessary to: (1) verify that the instrument meets the electrical specifications, (2) verify that the controls function properly, and (3) perform all internal adjustments.

See Table 5-1, Calibration Procedure Electives, at the beginning of this section, for information on performing a partial Part I—Performance Check procedure.

## INDEX TO THE PERFORMANCE CHECK PROCEDURE

- A. REP RATE
  - 1. Check Rep Rate of STEP RESP Pulse..... 5-7
- B. GAIN
  - 1. Check Reference Voltages for Gain Staircase ..... 5-8
  - 2. Check Linearity of Gain Staircase ..... 5-9
- C. LEAD TIME OF PRETRIG OUT PULSE
  - 1. Check Lead Time Between PRETRIG OUT and Pulse Out..... 5-11
- D. CW LEVELED OPERATION
  - 1. Check Input Range of CW LEVELED Operation ..... 5-12
- E. RESPONSE CHARACTERISTICS
  - 1. Examine Symmetry of Output Pulses ..... 5-13
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  - 3. Check Frequency Response ..... 5-14

## PERFORMANCE CHECK POWER-UP SEQUENCE

### NOTE

*The performance of this instrument can be checked at any ambient temperature from +20° to +30° C unless otherwise indicated.*

- 1. Install the Signal Standardizer in the right vertical plug-in compartment of the oscilloscope mainframe.
- 2. Turn on the mainframe and allow at least 20 minutes warmup before beginning the procedure.

## A. REP RATE

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |                           |              |
|---------------------------|--------------|
| 1. Oscilloscope Mainframe | 3. Time Base |
| 2. Counter/Timer          |              |

### BEFORE YOU BEGIN:

Perform the Performance Check Power-Up Sequence.

a. **CHECK**—The periods of the output pulses at all REP RATE settings against the tolerances listed in Table 5-4.

### A1. CHECK REP RATE OF STEP RESP PULSE

**TABLE 5-4**  
Readout of REP RATE Period

REP RATE	TIME AVERG	CLOCK	Oscilloscope Readout
1 MHz	X1000	10 ns	999.00-1001.00 ns
100 kHz	X1000	100 ns	9.9900-10.0100 $\mu$ s
10 kHz	X1000	1 $\mu$ s	99.900-100.100 $\mu$ s
1 kHz	X100	1 $\mu$ s	999.00-1001.00 $\mu$ s
100 Hz	X100	10 $\mu$ s	9.9900-10.0100 ms
10 Hz	X10	10 $\mu$ s	99.900-100.100 ms

**A1. SETUP CONDITIONS**

Signal Standardizer Controls

TEST ..... VERT or HORIZ + STEP RESP  
 POSITION ..... Set pulse to screen center  
 AMPLITUDE ..... Set for 5-division display  
 REP RATE ..... 1 MHz

Oscilloscope Mainframe

Vertical Mode ..... Right  
 Horizontal Mode ..... B  
 A Trigger Source ..... Vert Mode  
 B Trigger Source ..... Vert Mode

Counter/Time (7D15)

Gate ..... Norm  
 Display Time ..... 0.1 s  
 Mode ..... Period A  
 Time Averg ..... 10 s, X1000  
 Clock ..... 10 ns

Trigger A

Level ..... Preset  
 Slope + ..... + (In)  
 Coupl AC ..... AC (In)  
 Source ..... Input B (In)  
 P-P Sens ..... Trig Source

Time Base (7B80)

Triggering ..... P-P Auto, AC, Int  
 Time/Div ..... Any convenient speed

## B. GAIN

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |   |   |
|---|---|
| 1. Oscilloscope Mainframe                 | 16. Probe                                     |
| 4. Digital Multimeter (DMM)               | 17. Test Clip                                 |
| 11. Flexible Plug-In Extender             | 18. Switch                                    |
| 12. Signal Pickoff Adapter                | 21. Adapter (bnc to test point, two required) |
| 13. Adapter (Peltola to GR, two required) | 22. Adapter (bnc to dual banana)              |
| 14. Adapter (bnc to GR, two required)     |   |
| 15. Terminator (two required)             |   |

### BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) See the **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page Section 7, Diagrams and Circuit Board Illustrations.

### B1. CHECK/ADJUST REFERENCE VOLTAGES FOR GAIN STAIRCASE

### GAIN PRELIMINARY CONTROL SETTINGS:

Signal Standardizer  
TEST ..... VERT or HORIZ GAIN  
Staircase Mode switch, S129 ..... -3 Div

Digital Multimeter  
DC Volts ..... 2 V

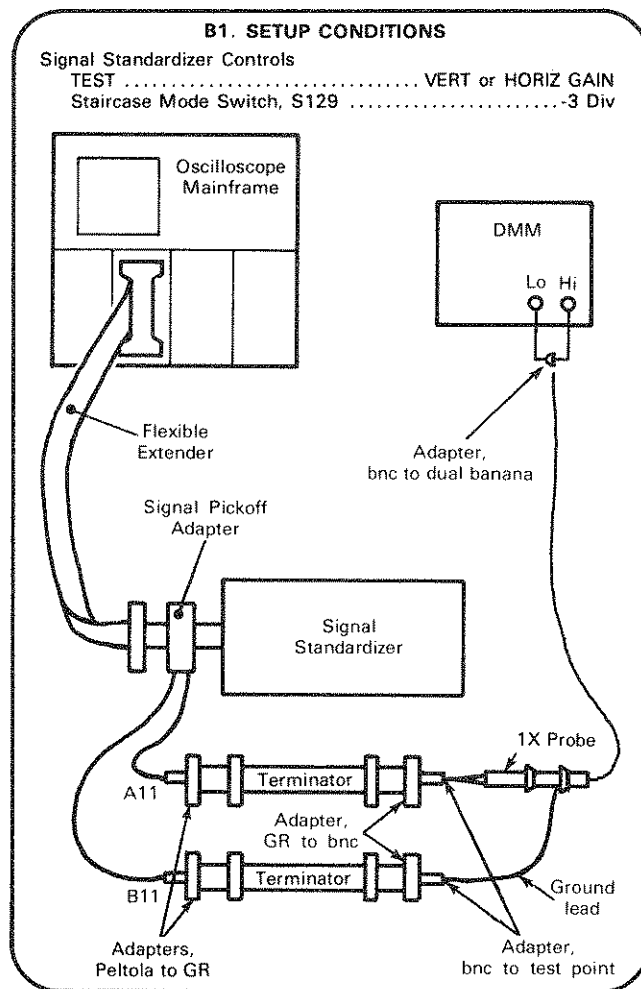




TABLE 5-5  
 Staircase Voltages

Step Number	Voltage Level	Desired Voltage	Specified Voltage Range
1	1	-0.2500	-0.2490 to -0.2510
2	2	-0.2000	-0.1990 to -0.2010
3	3	-0.1500	-0.1490 to -0.1510
4	4	-0.100	-0.0990 to -0.1010
5	5	-0.050	-0.0490 to -0.0510
6	6	0.000	None-set it "right on"
7	7	+0.50	+0.0490 to +0.0510
8	8	+0.1000	+0.0990 to +0.1010
9	9	+0.1500	+0.1490 to +0.1510
10	10	+0.2000	+0.1990 to +0.2010
11	11	+0.2500	+0.2490 to +0.2510
12	6	0.0000	Same as step 6
13	6	0.0000	
14	6	0.0000	
15	6	0.0000	
16	6	0.0000	

e. Disconnect the Signal Standardizer from the extender, remove the test clip from U121, and replace U115.

## C. LEAD TIME OF PRETRIG OUT PULSE

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |                           |                             |
|---------------------------|-----------------------------|
| 1. Oscilloscope Mainframe | 19. Coaxial Cable (18-inch) |
| 3. Time Base              |                             |
| 5. Amplifier              |                             |

### BEFORE YOU BEGIN:

Perform the Performance Check Power-Up Sequence.

### C1. CHECK/ADJUST LEAD TIME BETWEEN PRETRIG OUT AND PULSE OUT

a. Set the 7B80 Triggering Level control for a stable display.

b. Use the POSITION control on the Signal Standardizer to position the two waveforms so their tops are at the same level.

c. Use the AMPLITUDE control on the Signal Standardizer to set the bottom of the output pulse at the same level as the bottom of the PRETRIG OUT pulse.

d. With the 7B80 Position control, set the 50% level of the PRETRIG OUT pulse at the second vertical graticule line (10 ns from the start of the sweep).

e. **CHECK**—that the PRETRIG OUT pulse precedes the pulse out by 65 to 80 ns.

**C1. SETUP CONDITIONS**

Signal Standardizer Controls

REP RATE ..... 1 MHz  
TEST ..... VERT or HORIZ STEP RESP  
POSITION ..... As needed  
AMPLITUDE ..... As needed

Oscilloscope Mainframe

Vertical Mode ..... Alt  
Horizontal Mode ..... B  
B Trigger Source ..... Left Vert

Time Base (7B80)

Time/Div ..... 10 ns  
Triggering ..... P-P Auto, AC, Int, +

Amplifier (7A16A)

Volts/Div ..... 0.2  
Coupling ..... DC  
Polarity ..... + Up  
Bandwidth ..... Full

## D. CW LEVELED OPERATION

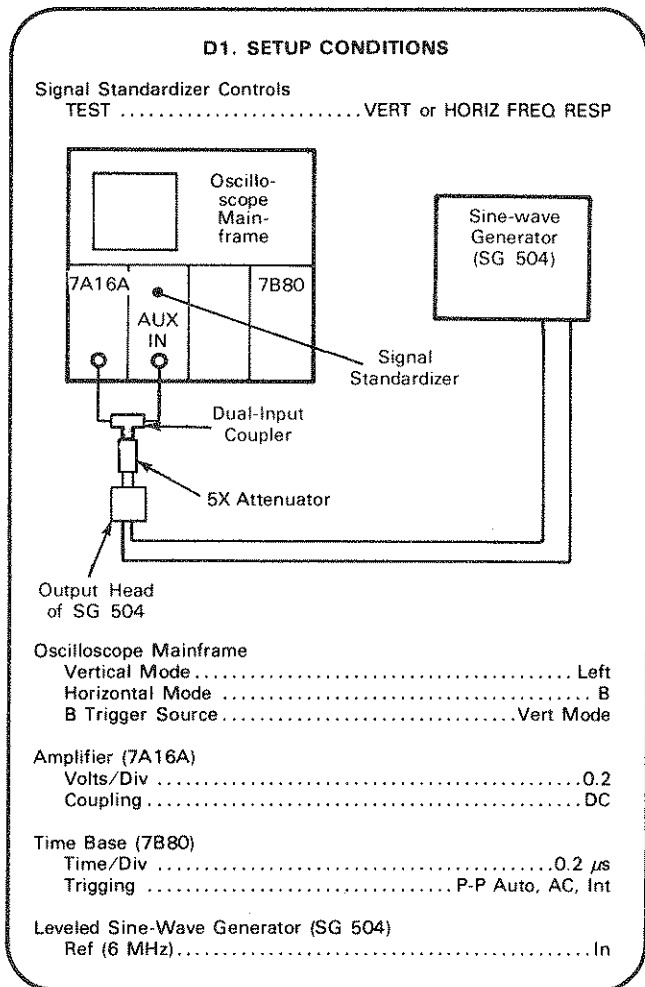
**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |                                |                         |
|--------------------------------|-------------------------|
| 1. Oscilloscope Mainframe      | 10. Attenuator, 5X      |
| 3. Time Base                   | 20. Coupler, Dual-Input |
| 5. Amplifier                   |                         |
| 9. Leveled Sine-Wave Generator |                         |

### BEFORE YOU BEGIN:

Perform the Performance Check Power-Up Sequence.

### D1. CHECK INPUT RANGE OF CW LEVELED OPERATION



- a. Set the Amplitude control on the SG 504 to produce a 0.4 V p-p display on the oscilloscope.
- b. Set the oscilloscope Vertical Mode switch to Right.
- c. Set the AMPLITUDE control on the Signal Standardizer for a 6-division display.
- d. **CHECK**—That the CW LEVELED indicator on the Signal Standardizer is on.
- e. Rotate the SG 504 Amplitude control counterclockwise until the CW LEVELED indicator on the Signal Standardizer goes out.
- f. Set the oscilloscope Vertical Mode switch to Left.
- g. **CHECK**—That the input to the Signal Standardizer is less than 0.4 V (2 divisions).
- h. Remove the 5X attenuator from the input of the dual-input coupler.
- i. Connect the SG 504 output head directly to the dual-input coupler.
- j. Set the oscilloscope Vertical Mode to Right.
- k. Rotate the SG 504 Amplitude control clockwise until the CW LEVELED indicator on the Signal Standardizer goes out. (The waveform will start to distort after the light goes out.)
- l. Set the oscilloscope Vertical Mode to Left.
- m. Set the 7A16A Volts/Div control to 0.5.
- n. **CHECK**—That the input to the Signal Standardizer is 3 divisions or more.



## E. RESPONSE CHARACTERISTICS

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |   |                                       |
|---|---------------------------------------|
| 1. Oscilloscope Mainframe                 | 19. Coaxial Cable (two required)      |
| 5. Amplifier                              | 23. Sweep Generator                   |
| 6. Sampling Unit (two required)           | 24. Adapter (GR to SMA, two required) |
| 7. Sampling Head (two required)           | 25. Attenuator (2X, two required)     |
| 8. Sampling Sweep                         | 26. Crystal Detector (two required)   |
| 11. Flexible Plug-In Extender             | 27. Summing Fixture                   |
| 12. Signal Pickoff Adapter                | 28. Differential Amplifier            |
| 13. Adapter (Peltola to GR, two required) |                                       |

### BEFORE YOU BEGIN:

Perform the Performance Check Power-Up Sequence

### RESPONSE CHARACTERISTICS PRELIMINARY CONTROL SETTINGS:

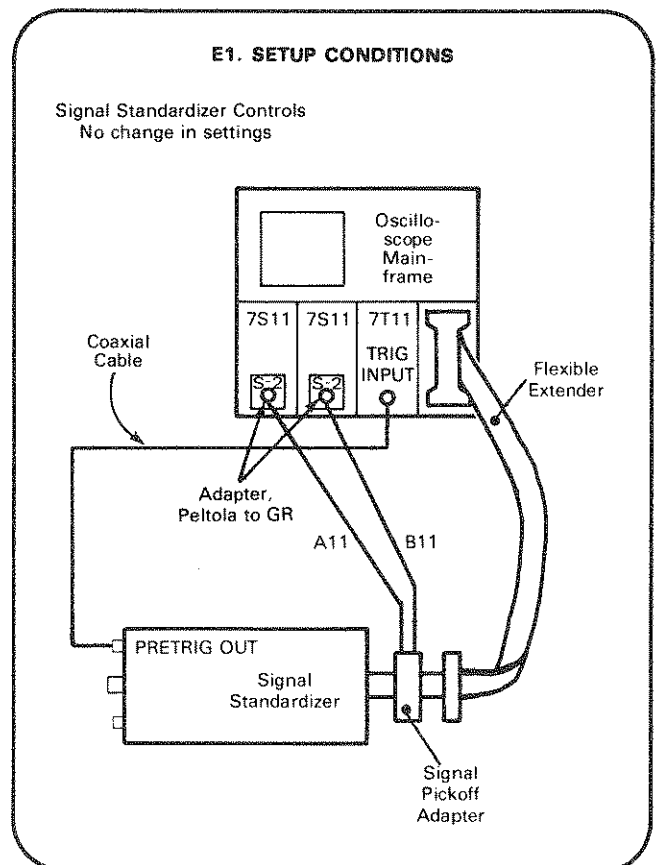
Signal Standardizer  
TEST ..... +STEP RESP  
RESP RATE ..... 1 MHz

Oscilloscope Mainframe  
Vertical Mode ..... Chop  
Horizontal Mode ..... A

Sampling Units (both 7S11 units)	Left	Right
mV/Div	50	50
Variable (Cal In)	In	In
Polarity		
+Up	In	
Invert		In
DC Offset	As Needed	As Needed
Dot Response	As Needed	As Needed
Smooth	In	In

Sampling Sweep (7T11)  
Sweep Range ..... 50 ns  
Time/Div ..... 2 ns  
Variable (Cal In) ..... In  
Trig Level ..... As Needed  
Stability ..... As Needed  
Slope  
+ ..... In  
Sequential ..... In  
Trig Amp  
X1 ..... In  
Ext Trig Input  
50  $\Omega$  2 V Max ..... In  
Scan  
Rep ..... In

### E1. EXAMINE SYMMETRY OF OUTPUT PULSES



**Calibration Part I—067-0587-02  
Performance Check**

- a. Set the 7T11 Stability, Level and Time Position controls for a stable display of the normal and inverted + pulse.
- b. **EXAMINE**—The preshoot at the bottoms of the two waveforms for similar shapes.

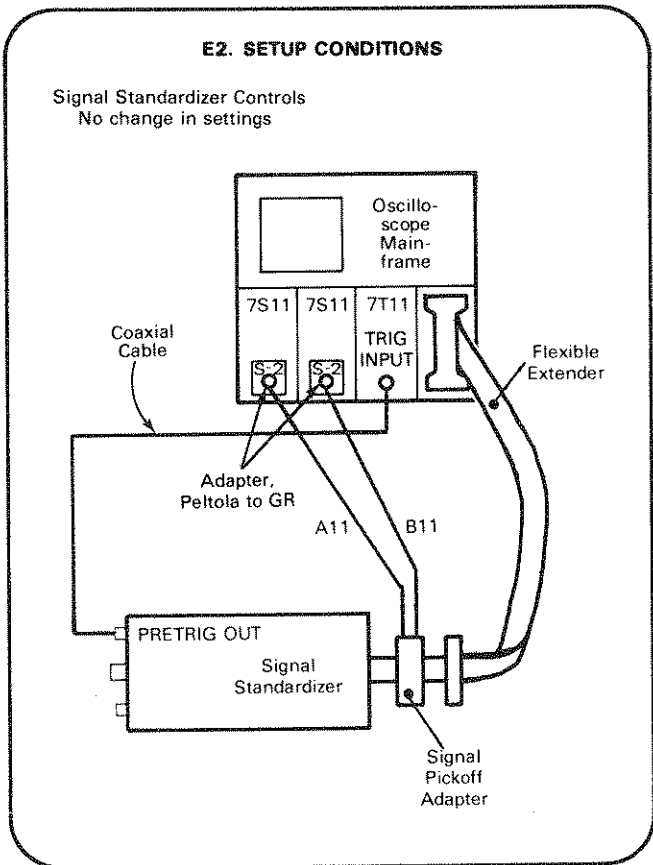
**E2. CHECK TRANSIENT RESPONSE OF STEP RESP PULSE**

**NOTE**

*The transient response of the Signal Standardizer should be checked at the factory, because the S-2 Sampling Heads used for the check must be characterized with a pulse traceable to the National Bureau of Standards. However, if you desire, you can check the transient-response characteristics of your own instrument by using the following equipment and procedure, making allowances for the limitations of your test equipment.*

**NOTE**

*If the preceding step was not performed, first refer to the Response Characteristics Preliminary Control Settings, then proceed with the following instructions.*



- a. Set the 7T11 Stability and Level controls for a stable display.
- b. Use the DC Offset control on one 7S11 to vertically superimpose the two waveforms.
- c. Press in the + Up control on the right 7S11.
- d. Set the oscilloscope Vertical Mode control to Add.
- e. Use the Delay controls on both 7S11s to cancel the displayed pulse. (This horizontally superimposes the two waveforms by matching their delays.)
- f. Press in the Invert control on the right 7S11.
- g. Use the Signal Standardizer AMPLITUDE and POSITION controls to set the displayed waveform to 5 divisions amplitude, centered on the screen.
- h. Set the 7T11 Time/Div to 50 ps.
- i. Use the 7T11 Time Position control to bring the transition to screen center.
- j. **CHECK**—That the rise time of the pulse is 125 to 150 ps.

**E3. CHECK FREQUENCY RESPONSE**

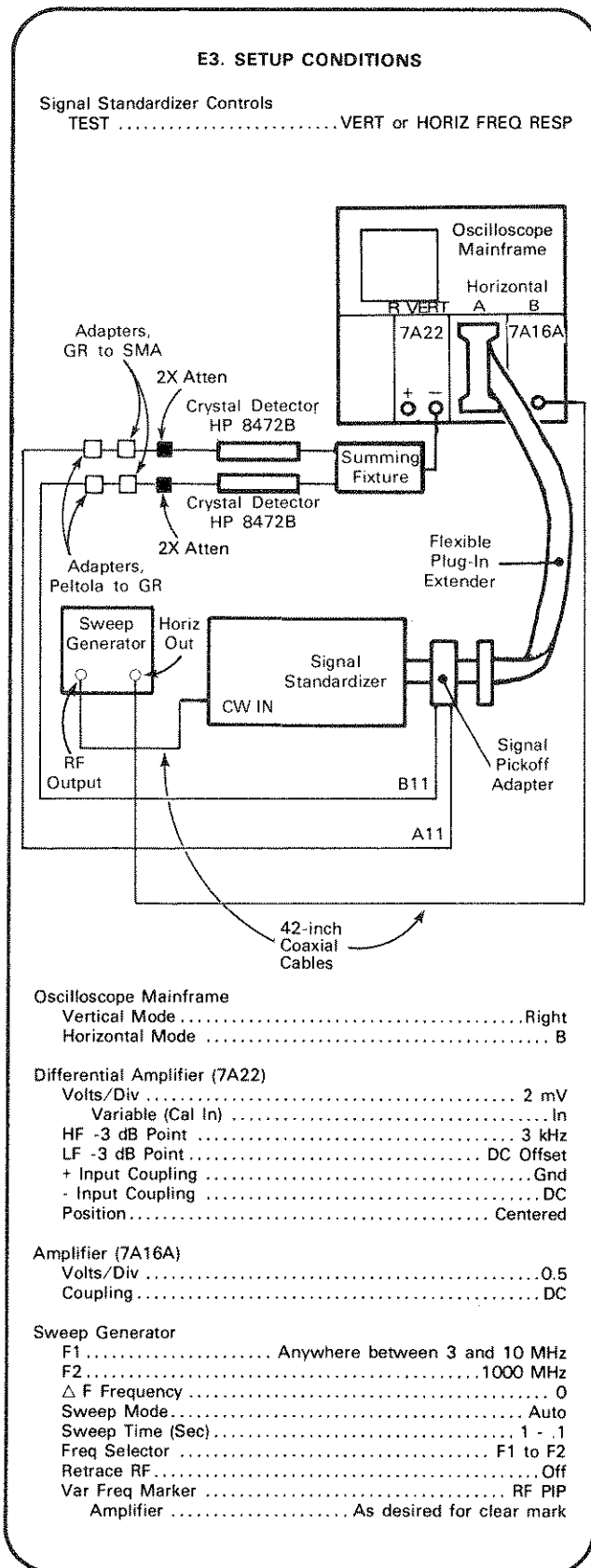
**NOTE**

*For optimum measurement of the frequency response of the Signal Standardizer, the measurement should be performed at the factory because Tektronix has the necessary test equipment, traceable to the National Bureau of Standards.*

*However, if you desire, you can measure the frequency-response characteristics of your own instrument by using the following equipment and procedure, making allowances for the limitations of your test equipment.*

**NOTE**

*If the preceding step was not performed, first refer to the Response Characteristics Preliminary Control Settings, then proceed with the following instructions.*



a. Vary the 7A22 Coarse and Fine Offset controls to bring the display on the crt. Set the retrace line to the lower graticule line.

b. Verify that the sweep generator Unleveled indicator stays off during its sweeps. If the Unleveled indicator comes on, increase the level of the output signal with the Vernier and Vernier Cal controls.

c. Set the Signal Standardizer AMPLITUDE control to position the response curve 5 divisions above the retrace line at the reference frequency. To accomplish this, set the reference frequency on the sweep generator to the reference frequency you are using, and observe the bright dot on the response curve. Then set the AMPLITUDE control on the Signal Standardizer so that the marker is 5 divisions above the retrace line.

With the 7A22 vertical sensitivity set at 2 mV/Div, the display now shows 10 mV amplitude at the reference frequency. Figure 5-2 shows this display.

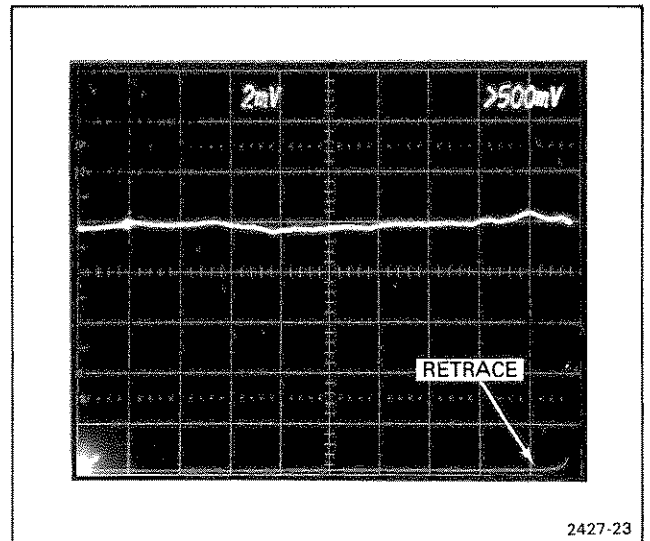


Figure 5-2. Initial display of frequency-response curve and retrace.

d. Check that the Signal Standardizer CW LEVELED indicator is on during the sweep.

e. Calibrate the horizontal axis to 100 MHz/div as follows:

1. Set the sweep generator Var Freq Mkr to 100 MHz.
2. With the Position control on the 7A16A, move the display horizontally so that the bright dot on the frequency-response curve is at the second vertical graticule line.

**Calibration Part I—067-0587-02  
Performance Check**

3. Use the Var Freq Mkr control on the sweep generator to move the market dot to 900 MHz.
4. With the Variable (Cal In) control on the 7A16A, move the display horizontally so that the bright dot is at the tenth vertical graticule line.
5. Repeat steps 1 through 4 twice to eliminate interaction of the two settings.

The display is now calibrated from 0 to 1000 MHz at 100 MHz per horizontal division.

- f. Set the sweep generator Var Freq Mkr to the reference frequency.
- g. Change the 7A22 Volts/Div switch to 0.5 mV.
- h. Use the 7A22 Offset controls to position the frequency-response curve to the center of the display. Set the reference frequency marker to the center horizontal graticule line. Figure 5-3 shows this display.

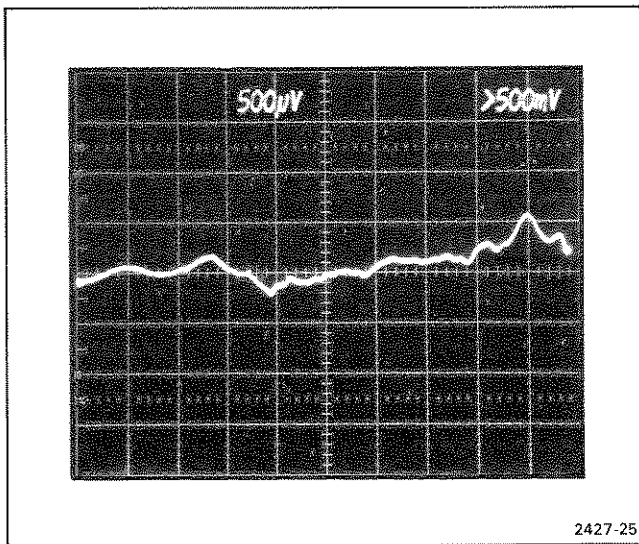


Figure 5-3. Display of frequency-response curve at 0.5 mV/Div.

- i. Each vertical division now represents 2.5% deviation from flat response, as expressed by the equation

$$\text{Deviation in \%} = \frac{\text{Sensitivity of 7A22}}{\text{(Reference voltage) (2)}}$$

$$\text{Deviation} = \frac{0.5 \text{ mV}}{(10 \text{ mV reference) (2)}} = \frac{0.5}{20} = 2.5\%$$

(The 10 mV reference voltage was established in step e.)

**NOTE**

*This equation is a linear approximation centered at the zero-error point of the exact equation. It will suffice for measurements within ±5%.*

- j. Make two curves representing the instrument's specification modified by the normalized voltage-frequency response of the crystal detectors you are using. To construct curves for your combination of detectors, proceed as follows:

1. Calculate the values for the + and - limits by adding +3% and -3% to the variation figures from the detector's normalized voltage-frequency chart. The +3 and -3 numbers are the specified maximum variations.
2. Superimpose the values from the +3 and -3 columns of the table you calculated in step 1 on your graticule with a grease pencil or other erasable marker.

The detectors used in this example had a normalized sum output that varied from flat as Table 5-6 describes.

**TABLE 5-6**

Calculations for Upper and Lower Frequency Limits

Frequency (MHz)	Normalized Detector Output (%) (Column A)	Region of Acceptable Response (Column A ±3%)	
		-3%	+3%
3	0	-3.0	3.0
10	-0.1	-3.1	2.9
30	0	-3.0	3.0
50	0.2	-2.8	3.2
100	1.0	-2.0	4.0
150	1.5	-1.5	4.5
200	2.0	-1.0	5.0
250	2.2	-0.8	5.2
300	2.5	-0.5	5.5
400	2.3	-0.7	5.3
500	2.5	-0.5	5.5
600	2.5	-0.5	5.5
700	2.2	-0.8	5.2
800	2.4	-0.6	5.4
900	2.0	-1.0	5.0
1000	1.7	-1.3	4.7

- k. **CHECK**—That the frequency response curve displayed on your oscilloscope mainframe falls within the limits for your set of detectors.

This concludes the Performance Check of the Signal Standardizer.

# PART II—ADJUSTMENT AND PERFORMANCE CHECK

The following procedure (Part II—Adjustment and Performance Check) provides the information necessary to: (1) verify that the instrument meets the electrical specifications; (2) verify that the controls function properly, and (3) perform all internal adjustments.

Part I—Performance Check verifies electrical specifications without removing the instrument covers or making internal adjustments. All tolerances given are as specified in the Specification tables (section 1) in this manual.

See Table 5-1, Calibration Procedure Electives, at the beginning of this section, for further information.

## INDEX TO THE ADJUSTMENT AND PERFORMANCE CHECK PROCEDURE

- A. REP RATE
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- B. GAIN
  - 1. Check/Adjust Reference Voltages for Gain Staircase ..... 5-19
  - 2. Check Linearity of Gain Staircase ..... 5-20
- C. LEAD TIME OF PRETRIG OUT PULSE
  - 1. Check/Adjust Lead Time Between PRETRIG OUT and Pulse Out..... 5-22
- D. CW LEVELED OPERATION
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  - 1. Examine/Adjust Symmetry of Output Pulses..... 5-25
  - 2. Check/Adjust Transient Response of STEP RESP Pulse ..... 5-25
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## PERFORMANCE CHECK POWER-UP SEQUENCE

### NOTE

*The performance of this instrument can be checked at any ambient temperature from +20° to +30° C unless otherwise indicated.*

- 1. Install the Signal Standardizer in the right vertical plug-in compartment of the oscilloscope mainframe.
- 2. Turn on the mainframe and allow at least 20 minutes warmup before beginning the procedure.

## A. REP RATE

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |                           |              |
|---------------------------|--------------|
| 1. Oscilloscope Mainframe | 3. Time Base |
| 2. Counter/Timer          |              |

### BEFORE YOU BEGIN:

1. Perform the Performance Check Power-Up Sequence.

(2) See the **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page Section 7, Diagrams and Circuit Board Illustrations.

a. **CHECK**—The periods of the output pulses at all REP RATE settings against the tolerances listed in Table 5-7.

### A1. CHECK REP RATE OF STEP RESP PULSE

TABLE 5-7  
Readout of REP RATE Period

REP RATE	TIME AVERG	CLOCK	Oscilloscope Readout
1MHz	X1000	10 ns	999.00-1001.00 ns
100 kHz	X1000	100 ns	9.9900-10.0100 $\mu$ s
10 kHz	X1000	1 $\mu$ s	99.900-100.100 $\mu$ s
1 kHz	X100	1 $\mu$ s	999.00-1001.00 $\mu$ s
100 Hz	X100	10 $\mu$ s	9.9900-10.0100 ms
10 Hz	X10	10 $\mu$ s	99.900-100.100 ms

**A1. SETUP CONDITIONS**

Signal Standardizer Controls

TEST ..... VERT or HORIZ + STEP RESP  
POSITION ..... Set pulse to screen center  
AMPLITUDE ..... Set for 5-division display  
REP RATE ..... 1 MHz

Oscilloscope Mainframe

Vertical Mode ..... Right  
Horizontal Mode ..... B  
A Trigger Source ..... Vert Mode  
B Trigger Source ..... Vert Mode

Counter/Time (7D15)

Gate ..... Norm  
Display Time ..... 0.1 s  
Mode ..... Period A  
Time Averg ..... 10 s, X1000  
Clock ..... 10 ns  
Trigger A

Level ..... Preset  
Slope + ..... + (In)  
Coupl AC ..... AC (In)  
Source ..... Input B (In)  
P-P Sens ..... Trig Source

Time Base (7B80)

Triggering ..... P-P Auto, AC, Int  
Time/Div ..... Any convenient speed

## B. GAIN

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |   |   |
|---|---|
| 1. Oscilloscope Mainframe                 | 16. Probe                                     |
| 4. Digital Multimeter                     | 17. Test Clip                                 |
| 11. Flexible Plug-In Extender             | 18. Switch                                    |
| 12. Signal Pickoff Adapter                | 21. Adapter (bnc to test point, two required) |
| 13. Adapter (Peltola to GR, two required) | 22. Adapter (bnc to dual banana)              |
| 14. Adapter (bnc to GR, two required)     |   |
| 15. Terminator (two required)             |   |

### BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) See the **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page Section 7, Diagrams and Circuit Board Illustrations.

### GAIN PRELIMINARY CONTROL SETTINGS:

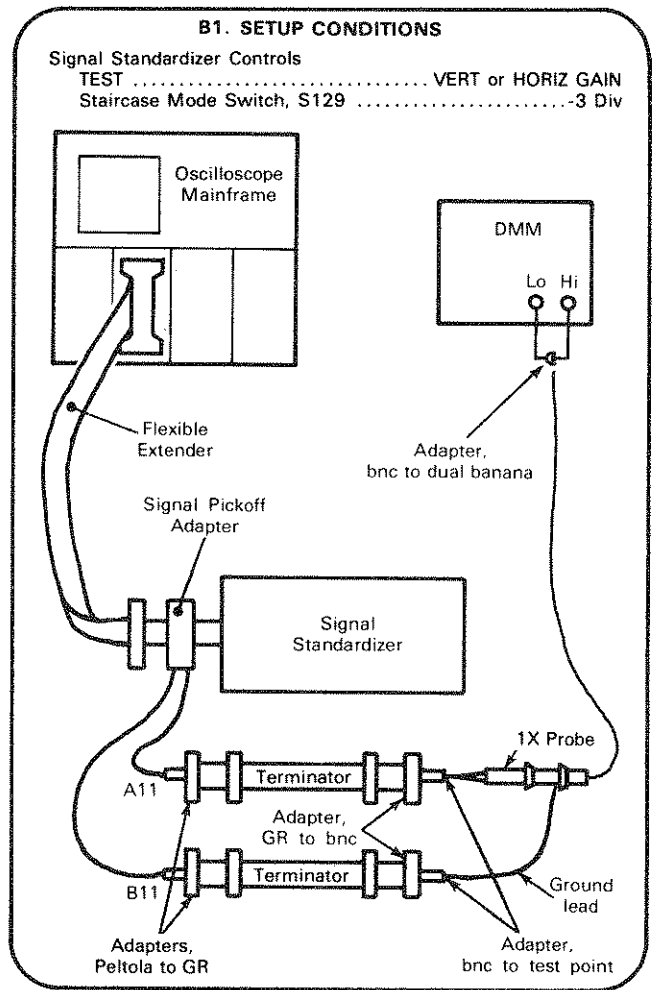
Signal Standardizer

TEST ..... VERT or HORIZ GAIN  
Staircase Mode Switch, S129 ..... -3 Div  
(See Test Point and Adjustment Locations diagram)

Digital Multimeter

DC Volts ..... 2 V

### B1. CHECK/ADJUST REFERENCE VOLTAGES FOR GAIN STAIRCASE



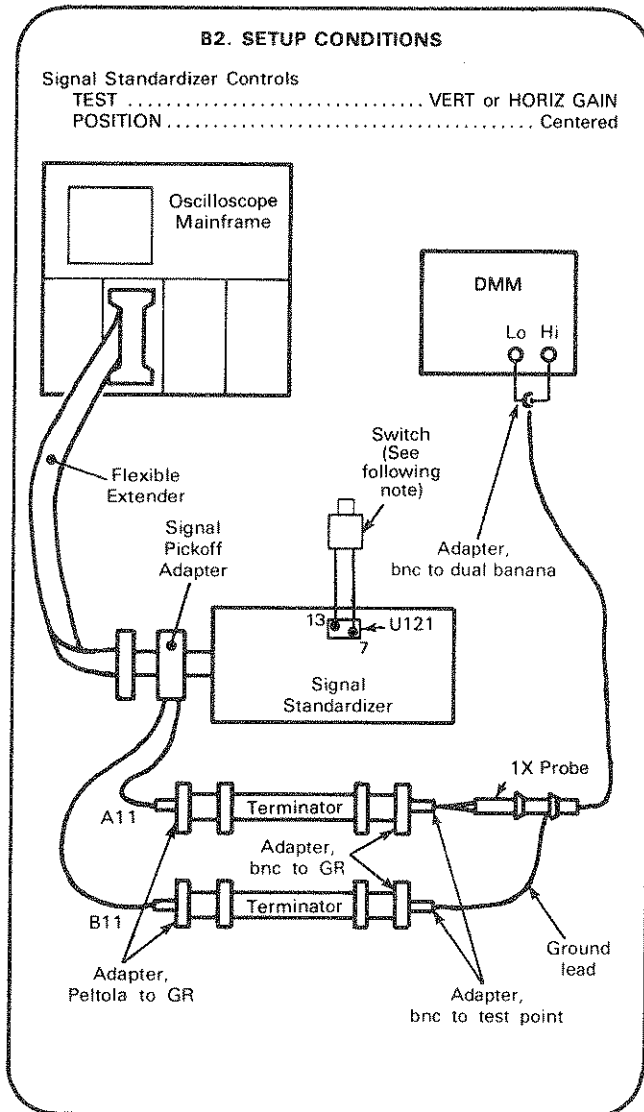
**Calibration Part II—067-0587-02  
Adjustment and Performance Check**

- a. Set the Signal Standardizer POSITION control for a voltage reading of  $-0.1500\text{ V}$  on the Digital Multimeter.
- b. Set S129 to +3 Div.
- c. **CHECK**—For a reading of  $+0.1500 \pm 0.3\%$  ( $+0.1496$  to  $+0.1504\text{ V}$ ).
- d. **ADJUST**—R165, Gain Cal, for a voltmeter reading of  $+0.1500\text{ V}$ .
- e. **INTERACTION**—Because the Gain Cal and POSITION controls interact, repeat steps a through d until both + and - voltages are within specifications. The difference between the readings at the -3 Div and +3 Div settings must be  $0.3000\text{ V} \pm 0.3\%$  (or more than  $0.2991\text{ V}$  and less than  $0.3009\text{ V}$ ).
- f. Return S129 to the CLK position.

**B2. CHECK LINEARITY OF GAIN STAIRCASE**

**NOTE**

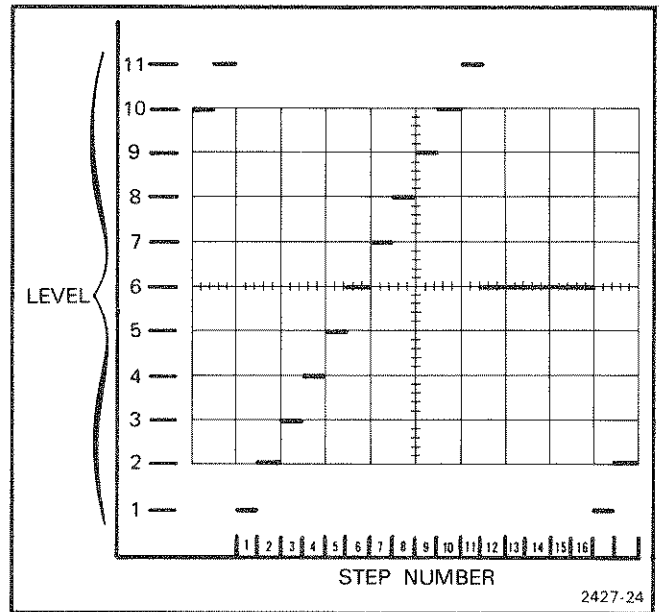
*If the preceding step was not performed, first refer to the Gain Preliminary Control Settings, then proceed with the following instructions.*



**NOTE**

- 1. Turn off power to oscilloscope.
- 2. Remove U115 from Signal Standardizer.
- 3. Attach test clip (item 17) to U121.
- 4. Connect terminals of switch to pins 13 and 7 of test clip on U121.
- 5. Turn oscilloscope power switch on.

- a. Actuate the switch repeatedly until the output reaches level six. (This advances the staircase generator through the staircase waveform.) With the Signal Standardizer's POSITION control centered, the level six voltage is close to zero volts. It will remain at level six during steps (switch closures) 12 through 16. See Figure 5-4.



**Figure 5-4. Staircase waveform.**

- b. Keep the output at level six, and vary the POSITION control until the voltmeter is  $.0000\text{ V}$ .
- c. Press the pushbutton switch repeatedly until the voltmeter reads  $-.2500\text{ V}$ . The staircase generator is now at its bottom step, level one.
- d. **CHECK**—The voltages at each of the steps against the voltages listed in Table 5-8.



TABLE 5-8  
Staircase Voltages

Step Number	Voltage Level	Desired Voltage	Specified Voltage Range
1	1	-0.2500	-0.2490 to -0.2510
2	2	-0.2000	-0.1990 to -0.2010
3	3	-0.1500	-0.1490 to -0.1510
4	4	-0.1000	-0.0990 to -0.1010
5	5	-0.0500	-0.0490 to -0.0510
6	6	0.0000	None-set it "right on"
7	7	+0.5000	+0.0490 to +0.5100
8	8	+0.1000	+0.0990 to +0.1010
9	9	+0.1500	+0.1490 to +0.1510
10	10	+0.2000	+0.1990 to +0.2010
11	11	+0.2500	+0.2490 to +0.2510
12	6	0.0000	Same as step 6
13	6	0.0000	
14	6	0.0000	
15	6	0.0000	
16	6	0.0000	

e. Disconnect the Signal Standardizer from the extender, remove the test clip from U121, and replace U115.

## C. LEAD TIME OF PRETRIG OUT PULSE

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |                           |  |
|---------------------------|--|
| 1. Oscilloscope Mainframe | 19. Coaxial Cable (42-inch two required) |
| 3. Time Base              |  |
| 5. Amplifier              |  |

### BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) See the **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page Section 7, Diagrams and Circuit Board Illustrations.

### C1. CHECK/ADJUST LEAD TIME BETWEEN PRETRIG OUT AND PULSE OUT

**C1. SETUP CONDITIONS**

Signal Standardizer Controls

REP RATE .....	1 MHz
TEST .....	VERT or HORIZ STEP RESP
POSITION .....	As needed
AMPLITUDE .....	As needed

Oscilloscope Mainframe

Vertical Mode .....	Alt
Horizontal Mode .....	B
B Trigger Source .....	Left Vert

Time Base (7B80)

Time/Div .....	10 ns
Triggering .....	P-P Auto, AC, Int, +

Amplifier (7A16A)

Volts/Div .....	0.2
Coupling .....	DC
Polarity .....	+ Up
Bandwidth .....	Full

a. Set the 7B80 Triggering Level control for a stable display.

b. Use the POSITION control on the Signal Standardizer to position the two waveforms so their tops are at the same level.

c. Use the AMPLITUDE control on the Signal Standardizer to set the bottom of the output pulse at the same level as the bottom of the PRETRIG OUT pulse.

d. With the 7B80 Position control, set the 50% level of the PRETRIG OUT pulse at the second vertical graticule line (10 ns from the start of the sweep).

e. Set the B Trigger Source on the mainframe to Right Vert.

f. **CHECK**—that the PRETRIG OUT pulse precedes the pulse out by 65 to 80 ns.

g. Remove the left cover of the oscilloscope.

h. **ADJUST**—C152, Lead Time, so that the leading edge of the output pulse crosses the reference line 72 ns after the leading edge of the PRETRIG OUT pulse crosses the reference line.

i. Replace the left oscilloscope cover.

## D. CW LEVELED OPERATION

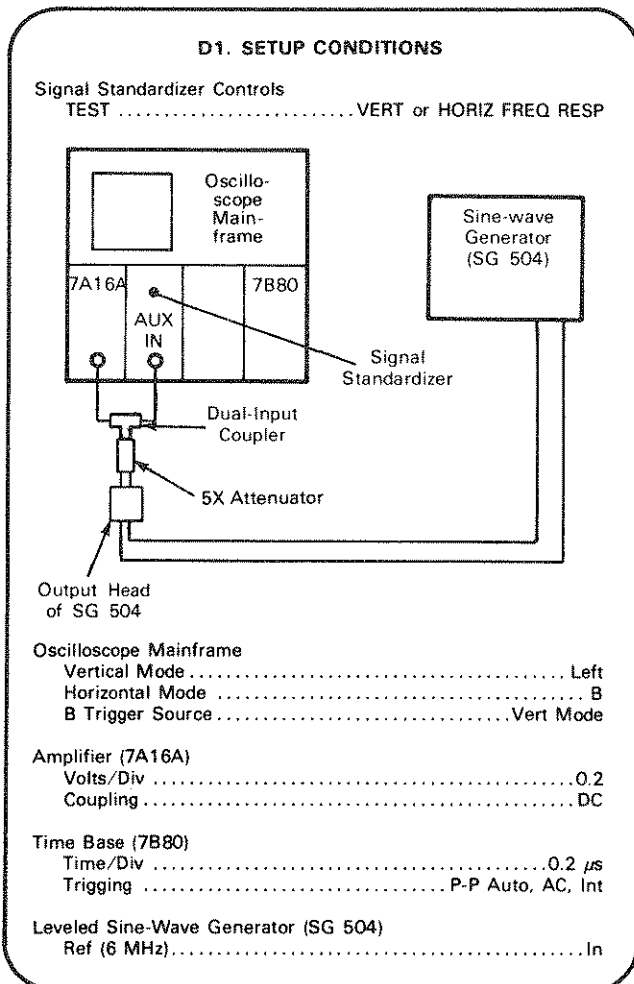
**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |                                |                         |
|--------------------------------|-------------------------|
| 1. Oscilloscope Mainframe      | 10. Attenuator, 5X      |
| 3. Time Base                   | 20. Coupler, Dual-Input |
| 5. Amplifier                   |                         |
| 9. Leveled Sine-Wave Generator |                         |

### BEFORE YOU BEGIN:

- (1) Perform the Performance Check Power-Up Sequence.
- (2) See the **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page Section 7, Diagrams and Circuit Board Illustrations.

### D1. CHECK INPUT RANGE OF CW LEVELED OPERATION



- a. Set the Amplitude control on the SG 504 to produce a 0.4 V p-p display on the oscilloscope.
- b. Set the oscilloscope Vertical Mode switch to Right.
- c. Set the AMPLITUDE control on the Signal Standardizer for a 6-division display.
- d. **CHECK**—That the CW LEVELED indicator on the Signal Standardizer is on.
- e. Rotate the SG 504 Amplitude control counterclockwise until the CW LEVELED indicator on the Signal Standardizer goes out.
- f. Set the oscilloscope Vertical Mode switch to Left.
- g. **CHECK**—That the input to the Signal Standardizer is less than 0.4 V (2 divisions).
- h. Remove the 5X attenuator from the input of the dual-input coupler.
- i. Connect the SG504 output head directly to the dual-input coupler.
- j. Set the oscilloscope Vertical Mode to Right.
- k. Rotate the SG 504 Amplitude control clockwise until the CW LEVELED indicator on the Signal Standardizer goes out. (The waveform will start to distort after the light goes out.)
- l. Set the oscilloscope Vertical Mode to Left.
- m. Set the 7A16A Volts/Div control to 0.5.
- n. **CHECK**—That the input to the Signal Standardizer is 3 divisions or more.

## E. RESPONSE CHARACTERISTICS

**Equipment Required:** (Numbers correspond to those listed in Table 5-3, Test Equipment.)

- |   |                                       |
|---|---------------------------------------|
| 1. Oscilloscope Mainframe                 | 19. Coaxial Cable (four required)     |
| 5. Amplifier                              | 23. Sweep Generator                   |
| 6. Sampling Unit (two required)           | 24. Adapter (GR to SMA, two required) |
| 7. Sampling Head (two required)           | 25. Attenuator (2X, two required)     |
| 8. Sampling Sweep                         | 26. Crystal Detector (two required)   |
| 11. Flexible Plug-In Extender             | 27. Summing Fixture                   |
| 12. Signal Pickoff Adapter                | 28. Differential Amplifier            |
| 13. Adapter (Peltola to GR, two required) |                                       |

### BEFORE YOU BEGIN:

(1) Perform the Performance Check Power-Up Sequence.

(2) See the **TEST POINT AND ADJUSTMENT LOCATIONS** foldout page Section 7, Diagrams and Circuit Board Illustrations.

Sampling Units (both 7S11 units)

	Left	Right
mV/Div	50	50
Variable (Cal In)	In	In
Polarity		
+Up	In	
Invert		In
DC Offset	As Needed	As Needed
Dot Response	As Needed	As Needed
Smooth	In	In

### RESPONSE CHARACTERISTICS PRELIMINARY CONTROL SETTINGS:

Signal Standardizer

TEST ..... +STEP RESP  
 RESP RATE ..... 1 MHz

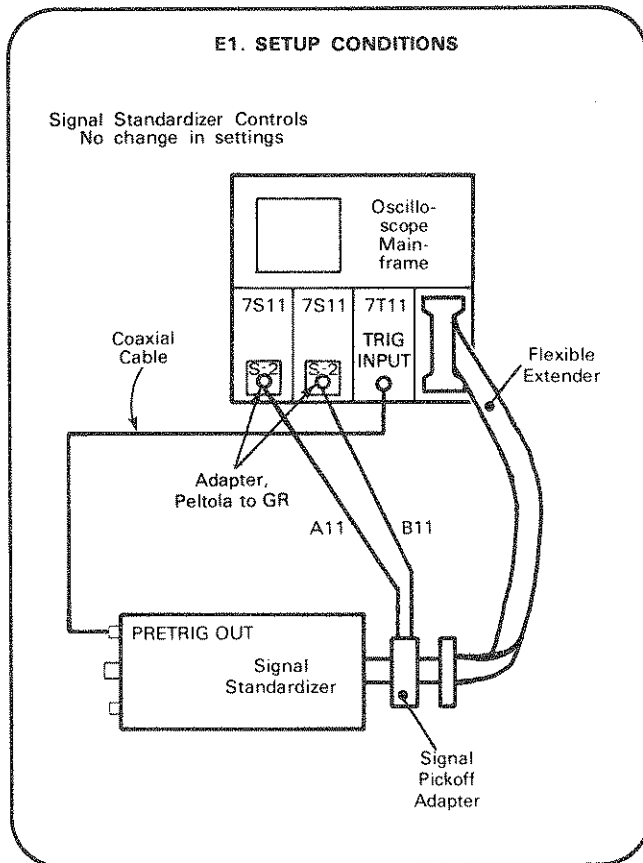
Oscilloscope Mainframe

Vertical Mode ..... Chop  
 Horizontal Mode ..... A

Sampling Sweep (7T11)

Sweep Range .....	50 ns
Time/Div .....	2 ns
Variable (Cal In) .....	In
Trig Level .....	As Needed
Stability .....	As Needed
Slope	
+ .....	In
Sequential .....	In
Trig Amp	
X1 .....	In
Ext Trig Input	
50 Ω 2 V Max .....	In
Scan	
Rep .....	In

## E1. EXAMINE/ADJUST SYMMETRY OF OUTPUT PULSES



a. Set the 7T11 Stability, Level, and Time Position controls for a stable display of the normal and inverted + pulse.

b. **EXAMINE**—The preshoot at the bottoms of the two waveforms for similar shapes.

c. **ADJUST**—R285, Symmetry, so that the preshoot at the bottoms of the two waveforms are as similar as possible.

## E2. CHECK/ADJUST TRANSIENT RESPONSE OF STEP RESP PULSE

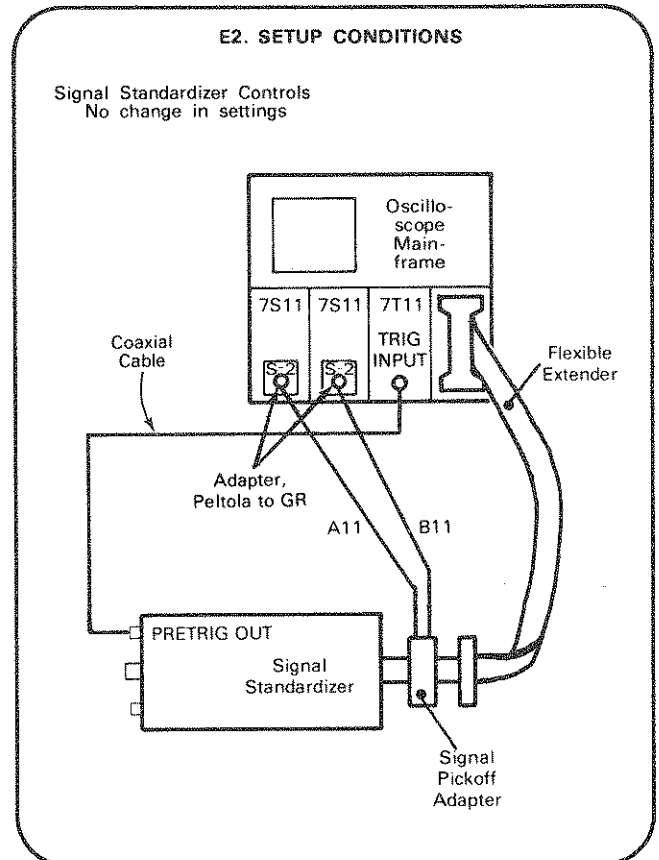
### NOTE

*For optimum adjustment of transient response of the Signal Standardizer, the adjustment should be performed at the factory because the S-2 Sampling Heads used for the check must be characterized with a pulse traceable to the National Bureau of Standards.*

*However, if you desire, you can check the transient-response characteristics of your own instrument by using the following equipment and procedure, making allowances for the limitations of your test equipment.*

### NOTE

*If the preceding step was not performed, first refer to the Response Characteristics Preliminary Control Settings, then proceed with the following instructions.*



a. Set the 7T11 Stability and Level controls for a stable display.

b. Use the DC Offset control on one 7S11 to vertically superimpose the two waveforms.

c. Press in the + Up control on the right 7S11.

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Adjustment and Performance Check**

- d. Set the oscilloscope Vertical Mode control to Add.
- e. Adjust the Delay controls on both 7S11s so that they cancel the displayed pulse. (This horizontally superimposes the two waveforms by matching their delays.)
- f. Press in the Invert control on the right 7S11.
- g. Adjust the Signal Standardizer's Amplitude and Position controls for a centered five-division display.
- h. Switch the 7T11 Time/Div to 50 ps.
- i. Use the 7T11 Time Position control to bring the transition to the center of the screen.
- j. **CHECK**—That the rise time of the pulse is 125 to 150 ps.
- k. **ADJUST**—R235, Trans Resp, for a displayed risetime of exactly 140 ps.

**I. INTERACTION**—Check the symmetry of the two waveforms by setting the oscilloscope Vertical Mode to Chop, the 7T11 Time/Div to 2 ns, and offsetting one of the waveforms with the DC Offset control on one 7S11. If necessary, repeat step E1, then check the transient response again.

**E3. CHECK/ADJUST FREQUENCY RESPONSE**

**NOTE**

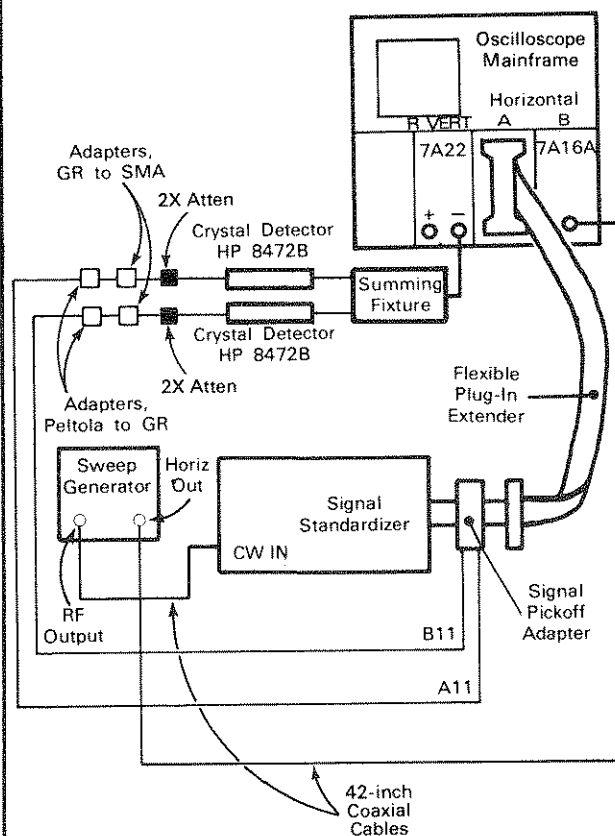
*For optimum adjustment of the frequency response of the Signal Standardizer, the adjustment should be performed at the factory because Tektronix has the necessary test equipment, traceable to the National Bureau of Standards. However, if you desire, you can adjust the frequency-response characteristics of your own instrument by using the following equipment and procedure.*

**NOTE**

*If the preceding step was not performed, first refer to the Response Characteristics Preliminary Control Settings, then proceed with the following instructions.*

**E3. SETUP CONDITIONS**

Signal Standardizer Controls  
TEST ..... VERT or HORIZ FREQ RESP



- Oscilloscope Mainframe  
Vertical Mode ..... Right  
Horizontal Mode ..... B
- Differential Amplifier (7A22)  
Volts/Div ..... 2 mV  
Variable (Cal In) ..... In  
HF -3 dB Point ..... 3 kHz  
LF -3 dB Point ..... DC Offset  
+ Input Coupling ..... Gnd  
- Input Coupling ..... DC  
Position ..... Centered
- Amplifier (7A16A)  
Volts/Div ..... 0.5  
Coupling ..... DC
- Sweep Generator  
F1 ..... Anywhere between 3 and 10 MHz  
F2 ..... 1000 MHz  
Δ F Frequency ..... 0  
Sweep Mode ..... Auto  
Sweep Time (Sec) ..... 1 - .1  
Freq Selector ..... F1 to F2  
Retrace RF ..... Off  
Var Freq Marker ..... RF PIP  
Amplifier ..... As desired for clear mark

- a. Vary the 7A22 Coarse and Fine Offset controls to bring the display on the crt. Set the retrace line to the lower graticule line.
- b. Verify that the sweep generator Unleveled indicator stays off during its sweeps. If the Unleveled indicator comes on, increase the level of the output signal with the Vernier and Vernier Cal controls.
- c. Set the Signal Standardizer AMPLITUDE control to position the response curve 5 divisions above the retrace line at the reference frequency. To accomplish this, set the reference frequency on the sweep generator to the reference frequency you are using, and observe the bright dot on the response curve. Then set the AMPLITUDE control on the Signal Standardizer so that the marker is 5 divisions above the retrace line.

With the 7A22 vertical sensitivity set at 2 mV/Div, the display now shows 10 mV amplitude at the reference frequency. Figure 5-5 shows this display.

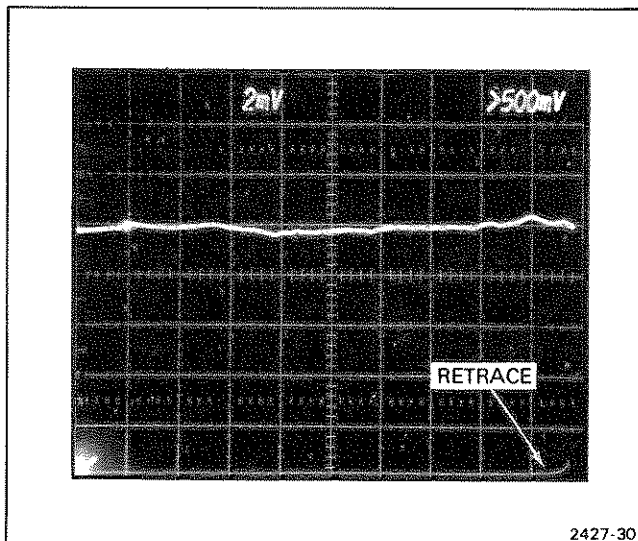


Figure 5-5. Initial display of frequency-response curve and retrace.

- d. Check that the Signal Standardizer CW LEVELED indicator is on during the sweep.

e. Calibrate the horizontal axis to 100 MHz/div as follows:

1. Set the sweep generator Var Freq Mkr to 100 MHz.
2. With the Position control on the 7A16A, move the display horizontally so that the bright dot on the frequency-response curve is at the second vertical graticule line.
3. Use the Var Freq Mkr control on the sweep generator to move the marker dot to 900 MHz.

4. With the Variable (Cal In) control on the 7A16A, move the display horizontally so that the bright dot is at the tenth vertical graticule line.

5. Repeat steps 1 through 4 twice to eliminate interaction of the two settings.

The display is now calibrated from 0 to 1000 MHz at 100 MHz per horizontal division.

- f. Set the sweep generator Var Freq Mkr to the reference frequency.

- g. Change the 7A22 Volts/Div switch to 0.5 mV.

- h. Use the 7A22 Offset controls to position the frequency-response curve to the center of the display. Set the reference frequency marker to the center horizontal graticule line. Figure 5-6 shows this display.

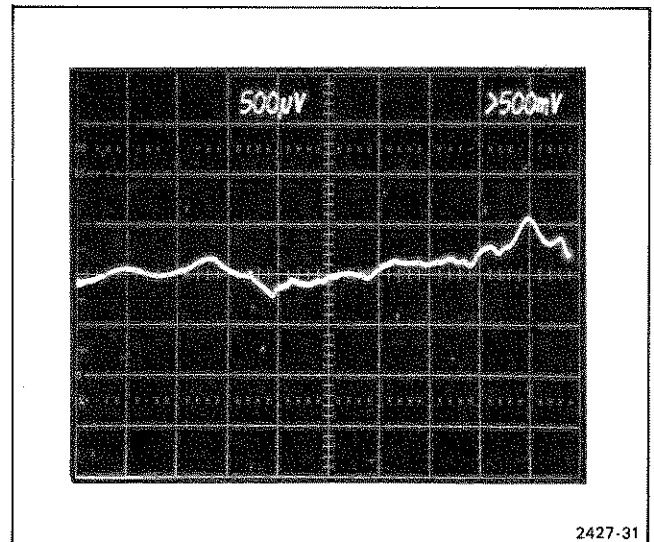


Figure 5-6. Display of frequency-response curve at 0.5 mV/Div.

- i. Each vertical division now represents 2.5% deviation from flat response, as expressed by the equation

$$\text{Deviation in \%} = \frac{\text{Sensitivity of 7A22}}{(\text{Reference voltage}) (2)}$$

$$\text{Deviation} = \frac{0.5 \text{ mV}}{(10 \text{ mV reference}) (2)} = \frac{0.5}{20} = 2.5\%$$

(The 10 mV reference voltage was established in step e.)

**NOTE**

*This equation is a linear approximation centered at the zero-error point of the exact equation. It will suffice for measurements within ±5%.*

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Adjustment and Performance Check**

j. Make two curves representing the instrument's specification modified by the normalized voltage-frequency response of the crystal detectors you are using. To construct curves for your combination of detectors, proceed as follows:

1. Calculate the values for the + and - limits by adding +3% and -3% to the variation figures from the detector's normalized voltage-frequency chart. The +3 and -3 numbers are the specified maximum variations.
2. Superimpose the values from the +3 and -3 columns of the table you calculated in step 1 on your graticule with a grease pencil or other erasable marker.

The detectors used in this example had a normalized sum output that varied from flat as Table 5-9 describes.

k. **CHECK**—That the frequency response curve displayed on your test oscilloscope falls within the limits for your set of detectors.

l. **ADJUST**—R390, Freq Resp, so that the response curve lies within the response limits marked on the graticule.

This concludes the Performance Check of the Signal Standardizer.

**TABLE 5-9**

Calculations for Upper and Lower Frequency Limits

Frequency (MHz)	Normalized Detector Output (%) (Column A)	Region of Acceptable Response (Column A $\pm$ 3%)	
		-3%	+3%
3	0	-3.0	3.0
10	-0.1	-3.1	2.9
30	0	-3.0	3.0
50	0.2	-2.8	3.2
100	1.0	-2.0	4.0
150	1.5	-1.5	4.5
200	2.0	-1.0	5.0
250	2.2	-0.8	5.2
300	2.5	-0.5	5.5
400	2.3	-0.7	5.3
500	2.5	-0.5	5.5
600	2.5	-0.5	5.5
700	2.2	-0.8	5.2
800	2.4	-0.6	5.4
900	2.0	-1.0	5.0
1000	1.7	-1.3	4.7



# 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
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
02114	FERROXCUBE CORPORATION	PO BOX 359, MARION ROAD	SAUGERTIES, NY 12477
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
07716	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, BURLINGTON DIV.	2850 MT. PLEASANT	BURLINGTON, IA 52601
07910	TELEDYNE SEMICONDUCTOR	12515 CHADRON AVE.	HAWTHORNE, CA 90250
08806	GENERAL ELECTRIC CO., MINIATURE LAMP PRODUCTS DEPARTMENT	NELA PARK	CLEVELAND, OH 44112
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50088	MOSTEK CORP.	1400 UPFIELD DR.	CARROLLTON, TX 75006
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	CHICAGO, IL 60645
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
75378	CTS KNIGHTS, INC.	400 REIMANN AVE.	SANDWICH, IL 60548
78488	STACKPOLE CARBON CO.		ST. MARYS, PA 15857
79727	C-W INDUSTRIES	550 DAVISVILLE RD., P O BOX 96	WARMINISTER, PA 18974
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
91293	JOHANSON MFG. COMPANY	P O BOX 329	BOONTON, NJ 07005
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-5167-00			CKT BOARD ASSY:MAIN INTERFACE	80009	670-5167-00
C113	281-0792-00			CAP., FXD, CER DI:82PF, 10%, 100V	72982	8035D2AADCG0820K
C114	281-0763-00			CAP., FXD, CER DI:47PF, 10%, 100V	72982	8035D9AADC1G470K
C130	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C151	281-0509-00			CAP., FXD, CER DI:15PF, +/-1.5PF, 500V	72982	301-000C0G0150K
C152	281-0205-00			CAP., VAR, PLSTC:4-65PF, 100V	80031	2810C5R565QJ02F0
C153	290-0746-00			CAP., FXD, ELCTLT:47UF, +50-10%, 16V	56289	502D226
C173	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C236	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C263	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C271	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C361	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C383	283-0408-00			CAP., FXD, CER DI:0.68UF, +100-0%, 12V	91293	120S41Z684PP
C393	283-0408-00			CAP., FXD, CER DI:0.68UF, +100-0%, 12V	91293	120S41Z684PP
C516	290-0804-00			CAP., FXD, ELCTLT:10UF, +50-10%, 25V	55680	503D106G025AS
C517	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C526	290-0804-00			CAP., FXD, ELCTLT:10UF, +50-10%, 25V	55680	503D106G025AS
C527	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C552	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C566	290-0804-00			CAP., FXD, ELCTLT:10UF, +50-10%, 25V	55680	503D106G025AS
C567	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
CR319	152-0141-02			SEMICONV DEVICE:SILICON, 30V, 150MA	80009	152-0141-02
CR320	152-0141-02			SEMICONV DEVICE:SILICON, 30V, 150MA	80009	152-0141-02
CR349	152-0141-02			SEMICONV DEVICE:SILICON, 30V, 150MA	80009	152-0141-02
CR391	152-0141-02			SEMICONV DEVICE:SILICON, 30V, 150MA	80009	152-0141-02
DS335	150-0048-01			LAMP, INCAND: 5V, 0.06A, SEL	08806	683AS15
DS532	150-0048-01			LAMP, INCAND: 5V, 0.06A, SEL	08806	683AS15
DS533	150-0048-01			LAMP, INCAND: 5V, 0.06A, SEL	08806	683AS15
E261	276-0532-00			SHIELDING BEAD, :	02114	56-590-65/4A6
E342	276-0576-00			CORE, EM: TPROID, FERRITE	78488	59-0047
E342	276-0614-00			CORE, EM: TOROID, FERRITE	78488	57-1656
LR298	108-0215-00			COIL, RF: 1.1UH	80009	108-0215-00
LR299	108-0215-00			COIL, RF: 1.1UH	80009	108-0215-00
LR396	108-0733-00			COIL, RF: 113NH	80009	108-0733-00
LR398	108-0733-00			COIL, RF: 113NH	80009	108-0733-00
LR516	108-0543-00			COIL, RF: FIXED, 1.1UH	80009	108-0543-00
LR526	108-0543-00			COIL, RF: FIXED, 1.1UH	80009	108-0543-00
LR551	108-0543-00			COIL, RF: FIXED, 1.1UH	80009	108-0543-00
LR566	108-0537-00			COIL, RF: 200UH	80009	108-0537-00
Q139	151-0221-00			TRANSISTOR: SILICON, PNP	80009	151-0221-00
Q140	151-0221-00			TRANSISTOR: SILICON, PNP	80009	151-0221-00
Q216	151-0221-00			TRANSISTOR: SILICON, PNP	80009	151-0221-00
Q217	151-0221-00			TRANSISTOR: SILICON, PNP	80009	151-0221-00
Q261	151-0367-00			TRANSISTOR: SILICON, NPN, SEL FROM 3571TP	80009	151-0367-00
Q262	151-0367-00			TRANSISTOR: SILICON, NPN, SEL FROM 3571TP	80009	151-0367-00
Q282	151-0302-00			TRANSISTOR: SILICON, NPN	80009	151-0302-00
Q288	151-0192-00			TRANSISTOR: SILICON, NPN, SEL FROM MPS6521	80009	151-0192-00
Q289	151-0192-00			TRANSISTOR: SILICON, NPN, SEL FROM MPS6521	80009	151-0192-00
Q292	151-0216-00			TRANSISTOR: SILICON, PNP	80009	151-0216-00
Q293	151-0216-00			TRANSISTOR: SILICON, PNP	80009	151-0216-00
Q306	151-0301-00			TRANSISTOR: SILICON, PNP	04713	2N2907A

Replaceable Electrical Parts—067-0587-02

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q329	151-0192-00			TRANSISTOR:SILICON,NPN,SEL FROM MPS6521	80009	151-0192-00
Q332	151-0302-00			TRANSISTOR:SILICON,NPN	80009	151-0302-00
Q361	151-0212-00			TRANSISTOR:SILICON,NPN	80009	151-0212-00
Q362	151-0212-00			TRANSISTOR:SILICON,NPN	80009	151-0212-00
R106	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R107	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R108	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R111	315-0914-00			RES.,FXD,CMPSN:910K OHM,5%,0.25W	01121	CB9145
R112	315-0624-00			RES.,FXD,CMPSN:620K OHM,5%,0.25W	01121	CB6245
R114	315-0243-00			RES.,FXD,CMPSN:24K OHM,5%,0.25W	01121	CB2435
R121	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R122	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R123	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R126	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R127	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R129	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R136	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R137	315-0221-00			RES.,FXD,CMPSN:220 OHM,5%,0.25W	01121	CB2215
R138	301-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.50W	01121	EB5615
R139	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R140	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R141	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R142	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R151	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R153	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R154	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R156	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R157	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R163	321-0190-00			RES.,FXD,FILM:931 OHM,1%,0.125W	91637	MFF1816G931R0F
R164	325-0275-00			RES.,FXD,FILM:1.54K OHM,0.1%,0.1W	07716	OBD
R165	311-1223-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	32997	3386F-T04-251
R166	325-0275-00			RES.,FXD,FILM:1.54K OHM,0.14,0.1W	07716	OBD
R167	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R169	325-0275-00			RES.,FAC,FILM:1.54K OHM,0.1%,0.1W	07716	OBD
R172	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R173	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R174	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R179	325-0277-00			RES.,FXD,FILM:200 OHM,0.1%,0.1W	07716	OBD
R182	325-0276-00			RES.,FXD,FILM:50 OHM,0.1%,0.1W	07716	OBD
R187	325-0277-00			RES.,FXD,FILM:200 OHM,0.4%,0.1W	07716	OBD
R189	325-0277-00			RES.,FXD,FILM:200 OHM,0.1%,0.1W	07716	OBD
R192	325-0276-00			RES.,FXD,FILM:50 OHM,0.1%,0.1W	07716	OBD
R205	311-0310-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	01121	W-7350A
R206	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R207	321-0310-00			RES.,FXD,FILM:16.5K OHM,1%,0.125W	91637	MFF1816G16501F
R208	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
R209	321-0277-00			RES.,FXD,FILM:7.5K OHM,1%,0.125W	91637	MFF1816G75000F
R210	311-0310-00			RES.,VAR,NONWIR:5K OHM,20%,0.50W	01121	W-7350A
R212	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R213	315-0511-00			RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
R214	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R216	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R217	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R218	315-0241-00			RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
R222	315-0560-00			RES., FXD, CMPSN: 56 OHM, 5%, 0.25W	01121	CB5605
R223	315-0560-00			RES., FXD, CMPSN: 56 OHM, 5%, 0.25W	01121	CB5605
R224	321-0169-00			RES., FXD, FILM: 562 OHM, 1%, 0.125W	91637	MFF1816G562ROF
R228	315-0201-00			RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R229	315-0151-00			RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
R231	315-0151-00			RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
R232	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R233	315-0151-00			RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
R235	311-1224-00			RES., VAR, NONWIR: 500 OHM, 20%, 0.50W	32997	3386F-T04-501
R236	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R246	321-0236-00			RES., FXD, FILM: 2.8K OHM, 1%, 0.125W	91637	MFF1816G28000F
R247	321-0306-00			RES., FXD, FILM: 15K OHM, 1%, 0.125W	91637	MFF1816G15001F
R249	321-0118-00			RES., FXD, FILM: 165 OHM, 1%, 0.125W	91637	MFF1816G165ROF
R251	321-0162-00			RES., FXD, FILM: 475 OHM, 1%, 0.125W	91637	MFF1816G475ROF
R252	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R253	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R254	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R256	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R257	321-0264-00			RES., FXD, FILM: 5.49K OHM, 1%, 0.125W	91637	MFF1816G54900F
R259	303-0680-00			RES., FXD, CMPSN: 68 OHM, 5%, 1W	01121	GB6805
R261	321-0260-00			RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R262	321-0260-00			RES., FXD, FILM: 4.99K OHM, 1%, 0.125W	91637	MFF1816G49900F
R263	321-0189-00			RES., FXD, FILM: 909 OHM, 1%, 0.125W	91637	MFF1816G909ROF
R266	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R267	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R271	307-0106-00			RES., FXD, CMPSN: 4.7 OHM, 5%, 0.25W	01121	CB47G5
R272	321-0318-00			RES., FXD, FILM: 20K OHM, 1%, 0.125W	91637	MFF1816G20001F
R273	321-0318-00			RES., FXD, FILM: 20K OHM, 1%, 0.125W	91637	MFF1816G20001F
R274	321-0164-00			RES., FXD, FILM: 499 OHM, 1%, 0.125W	91637	MFF1816G499ROF
R279	317-0470-00			RES., FXD, CMPSN: 47 OHM, 5%, 0.125W	01121	BB4705
R280	317-0470-00			RES., FXD, CMPSN: 47 OHM, 5%, 0.125W	01121	BB4705
R281	301-0750-00			RES., FXD, CMPSN: 75 OHM, 5%, 0.50W	01121	EB7505
R282	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R283	315-0513-00			RES., FXD, CMPSN: 51K OHM, 5%, 0.25W	01121	CB5135
R284	321-0357-00			RES., FXD, FILM: 51.1K OHM, 1%, 0.125W	91637	MFF1816G51101F
R285	311-1556-00			RES., VAR, NONWIR: 50K OHM, 20%, 0.50W	73138	91A R50K
R286	321-0385-00			RES., FXD, FILM: 100K OHM, 1%, 0.125W	91637	MFF1816G10002F
R287	321-0327-00			RES., FXD, FILM: 24.9K OHM, 1%, 0.125W	91637	MFF1816G24901F
R288	321-0226-00			RES., FXD, FILM: 2.21K OHM, 1%, 0.125W	91637	MFF1816G22100F
R289	321-0226-00			RES., FXD, FILM: 2.21K OHM, 1%, 0.125W	91637	MFF1816G22100F
R291	321-0181-00			RES., FXD, FILM: 750 OHM, 1%, 0.125W	91637	MFF1816G750ROF
R292	321-0181-00			RES., FXD, FILM: 750 OHM, 1%, 0.125W	91637	MFF1816G750ROF
R293	321-0211-00			RES., FXD, FILM: 1.54K OHM, 1%, 0.125W	91637	MFF1816G15400F
R294	315-0100-00			RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R299	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R306	315-0182-00			RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W	01121	CB1825
R309	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R310	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
R312	315-0303-00			RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R313	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R314	315-0624-00			RES., FXD, CMPSN: 620K OHM, 5%, 0.25W	01121	CB6245
R317	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035

Replaceable Electrical Parts—067-0587-02

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Discont	Name & Description	Mfr Code	Mfr Part Number
R320	315-0473-00			RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R321	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R327	321-0274-00			RES., FXD, FILM: 6.98K OHM, 1%, 0.125W	91637	MFF1816G69800F
R328	321-0308-00			RES., FXD, FILM: 15.8K OHM, 1%, 0.125W	91637	MFF1816G15801F
R329	315-0222-00			RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R331	315-0303-00			RES., FXD, CMPSN: 30K OHM, 5%, 0.25W	01121	CB3035
R332	315-0100-00			RES., FXD, CMPSN: 10 OHM, 5%, 0.25W	01121	CB1005
R343	321-0106-00			RES., FXD, FILM: 124 OHM, 1%, 0.125W	91637	MFF1816G124R0F
R344	315-0391-00			RES., FXD, CMPSN: 390 OHM, 5%, 0.25W	01121	CB3915
R348	315-0201-00			RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R349	315-0301-00			RES., FXD, CMPSN: 300 OHM, 5%, 0.25W	01121	CB3015
R351	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R352	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R361	321-0231-00			RES., FXD, FILM: 2.49K OHM, 1%, 0.125W	91637	MFF1816G24900F
R362	321-0231-00			RES., FXD, FILM: 2.49K OHM, 1%, 0.125W	91637	MFF1816G24900F
R363	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R364	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R366	321-0225-00			RES., FXD, FILM: 2.15K OHM, 1%, 0.125W	91637	MFF1816G21500F
R367	321-0225-00			RES., FXD, FILM: 2.15K OHM, 1%, 0.125W	91637	MFF1816G21500F
R368	321-0211-00			RES., FXD, FILM: 1.54K OHM, 1%, 0.125W	91637	MFF1816G15400F
R372	308-0218-00			RES., FXD, WW: 150 OHM, 5%, 3W	91637	RS2B-B150R0J
R373	321-0069-00			RES., FXD, FILM: 51.1 OHM, 1%, 0.125W	91637	MFF1816G51R10F
R374	321-0069-00			RES., FXD, FILM: 51.1 OHM, 1%, 0.125W	91637	MFF1816G51R10F
R379	315-0912-00			RES., FXD, CMPSN: 9.1K OHM, 5%, 0.25W	01121	CB9125
R382	315-0155-00			RES., FXD, CMPSN: 1.5M OHM, 5%, 0.25W	01121	CB1555
R383	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R384	317-0470-00			RES., FXD, CMPSN: 47 OHM, 5%, 0.125W	01121	BB4705
R387	308-0075-00			RES., FXD, WW: 100 OHM, 5%, 3W	91637	RS2B-B100R0J
R389	315-0473-00			RES., FXD, CMPSN: 47K OHM, 5%, 0.25W	01121	CB4735
R390	311-1234-00			RES., VAR, NONWLR: 50K OHM, 20%, 0.50W	32997	3386F-T06-503
R391	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R393	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R394	317-0470-00			RES., FXD, CMPSN: 47 OHM, 5%, 0.125W	01121	BB4705
R397	321-0169-00			RES., FXD, FILM: 562 OHM, 1%, 0.125W	91637	MFF1816G562R0F
R416	321-0751-06			RES., FXD, FILM: 50 OHM, 0.25%, 0.125W	91637	MFF1816C50R00C
R417	321-0751-06			RES., FXD, FILM: 50 OHM, 0.25%, 0.125W	91637	MFF1816C50R00C
R430	315-0470-00			RES., FXD, CMPSN: 47 OHM, 5%, 0.25W	01121	CB4705
R511	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R521	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
S105	263-0029-01			SWITCH, PB ASSY: 6 LATCH, 7.5MM, 7 CONTACTS	80009	263-0029-01
S129	260-0984-00			SWITCH, SLIDE: DP 3 POSN, 0.5A, 125VAC-DC	79727	G-128-S-0012
S430	263-0032-00			SWITCH ACTR AS: ELASTOMETER	80009	263-0032-00
T220	120-0444-00			XFMR, TOROID: 5 TURNS, BIFILAR	80009	120-0444-00
U115	156-0410-00			MICROCIRCUIT, DI: COUNTER TIME BASE	50088	MK5009P
U121	156-0403-00			MICROCIRCUIT, DI: HEX. INV W/OPEN COLL OUTPS	01295	SN74S05N
U130	156-0741-00			MICROCIRCUIT, DI: 4-BIT BINARY COUNTER	80009	156-0741-00
U150	156-0280-00			MICROCIRCUIT, DI: T-K MASTER SLAVE F-F	01295	SN74L2N
U160	156-0125-00			MICROCIRCUIT, DI: QUAD 2-INPUT POS NAND BFR	80009	156-0125-00
U170	156-0927-00			MICROCIRCUIT, LI: DIGITAL TO ANALOG CONVERTER	80009	156-0927-00
U179	156-1149-00			MICROCIRCUIT, LI: OPERATIONAL AMP, JFET INPUT	80009	156-1149-00
U189	156-1149-00			MICROCIRCUIT, LI: OPERATIONAL AMP, JFET INPUT	80009	156-1149-00
U240	155-0160-00			MICROCIRCUIT, LI: TRIGGER AMPL/CHANNEL SW	80009	155-0160-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
U250	155-0175-00			MICROCIRCUIT, LI: TRIGGER AMPLIFIER	80009	155-0175-00
U272	156-0158-00			MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U280	155-0182-00			MICROCIRCUIT, LI: DIODE SHAPER	80009	155-0182-00
U284	156-0158-00			MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U312	156-0158-00			MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U350	155-0175-00			MICROCIRCUIT, LI: TRIGGER AMPLIFIER	80009	155-0175-00
U390	155-0183-00			MICROCIRCUIT, LI: DIODE PEAK DETECTOR	80009	155-0183-00
VR114	152-0278-00			SEMICOND DEVICE: ZENER, 0.4W, 3V, 5%	07910	1N4372A
VR163	152-0486-00			SEMICOND DEVICE: ZENER, 0.25W, 6.2V, 5%	80009	152-0486-00
VR227	152-0217-00			SEMICOND DEVICE: ZENER, 0.4W, 8.2V, 5%	80009	152-0217-00
VR241	152-0279-00			SEMICOND DEVICE: ZENER, 0.4W, 5.1V, 5%	80009	152-0279-00
VR286	152-0168-00			SEMICOND DEVICE: ZENER, 0.4W, 12V, 5%	04713	1N963B
VR319	152-0149-00			SEMICOND DEVICE: ZENER, 0.4W, 10V, 5%	80009	152-0149-00
Y113	158-0014-00			XTAL UNIT, QTZ: 1 MHZ, +/-0.005	75378	TX-004

