

INSTRUCTION MANUAL

TYPE 7A14 CURRENT PROBE AMPLIFIER

Tektronix, Inc.

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TABLE OF CONTENTS

SECTION 1 SPECIFICATION	Page	SECTION 5 PERFORMANCE CHECK/ CALIBRATION	
Introduction	1-1	Introduction	5-1
Electrical Characteristics	1-1	Test Equipment Required	5-1
Environmental Characteristics	1-1	Short-Form Procedure	5-2
Physical Characteristics	1-1	General	5-3
SECTION 2 OPERATING INSTRUCTIONS		Preliminary Procedure for Complete Calibration	5-4
General	2-1	Adjust DC Balance	5-4
Installation	2-1	Adjust Internal Gain Ratio	5-5
Front Panel Controls and Connectors	2-1	Adjust 5 mA Gain	5-5
First-Time Operation	2-1	Adjust P6022 Current Probe Gain	5-5
General Operating Information	2-3	Check/Adjust Front-Panel GAIN	5-5
Measurement Techniques	2-5	Check Deflection Accuracy	5-6
SECTION 3 CIRCUIT DESCRIPTION		Adjust High-Frequency Compensation	5-7
Introduction	3-1	Check/Adjust Low-Frequency Compensation	5-8
Block Diagram	3-1	Check VAR CURRENT/DIV	5-9
Input Connector	3-1	Check Trigger Out Gain	5-9
Input Attenuators	3-1	Check Trace IDENTIFY	5-9
Input Amplifier	3-1	Check LF —3 dB Point	5-9
Low-Frequency Compensation	3-2	Check 20 MHz Bandwidth	5-10
First Cascode Stage	3-2	Check HF —3 dB Point	5-10
Second Cascode Stage	3-3	Check Overall Noise Level Tangentially	5-12
Third Cascode Stage	3-3		
Output Amplifier	3-4	SECTION 6 ELECTRICAL PARTS LIST	
Trigger Pickoff	3-4	Abbreviations and Symbols	
Readout Block	3-4	Parts Ordering Information	
SECTION 4 MAINTENANCE		Index of Electrical Parts List	
Introduction	4-1	Electrical Parts List	
Preventive Maintenance	4-1	SECTION 7 DIAGRAMS AND MECHANICAL PARTS ILLUSTRATIONS	
Troubleshooting	4-1	Diagrams	
Introduction	4-1	Mechanical Parts Illustrations	
Troubleshooting Aids	4-2	SECTION 8 MECHANICAL PARTS LIST	
Troubleshooting Equipment	4-2	Mechanical Parts List Information	
Troubleshooting Techniques	4-4	Index of Mechanical Parts Illustrations	
Corrective Maintenance	4-5	Mechanical Parts List	
Obtaining Replacement Parts	4-5	Accessories	
Soldering Techniques	4-5		
Component Replacement	4-6		
Recalibration After Repair	4-7		

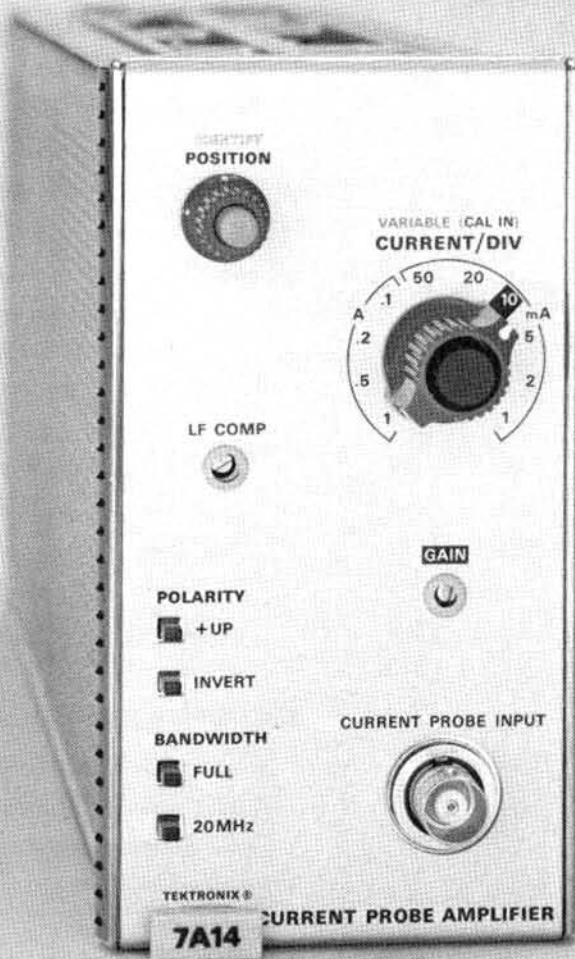


Fig. 1-1. Type 7A14 Current Probe Amplifier.

SECTION 1

SPECIFICATION

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

Introduction

The Type 7A14 Current Amplifier vertical plug-in unit is designed for use with Tektronix P6021 and P6022 Current Probes or at reduced performance with P6019¹ and P6020 Current Probes. The Type 7A14 is part of a Tektronix 7000-series Oscilloscope System. The Type 7A14 provides calibrated deflection factors from 1 mA/DIV to 1 A/DIV. Internal gain and compensation circuits are automatically switched to correspond with the requirements of the current probe being used, when the current probe is connected to the amplifier INPUT connector. A polarity switch permits

inversion of the input current signal within the amplifier. A bandwidth limiting switch allows low-frequency, low-level signals to be viewed with reduced interference from signals above 20 megahertz.

The electrical characteristics described in this section are valid over the stated environmental range for instruments calibrated at an ambient temperature of +20° C to +30° C and after a five minute warmup unless otherwise noted.

¹A special coding ring is required when using the P6019 Current Probe.

ELECTRICAL

Characteristics	Performance	
Deflection Factor Calibrated Ranges	1 mA/Div to 1A/Div in a 1-2-5 sequence	
Gain Ratio Accuracy	Within 2% of GAIN adjusted at 10 mA/div	
Uncalibrated (Variable)	Variable between steps, extends deflection factor to at least 2.5A/div	
Gain Range GAIN (front-panel)	Permits adjustment of deflection factor at 10 mA/div for all indicator oscilloscopes	
Frequency Response Upper -3 dB Bandwidth (system dependent)	With P6021	With P6022
7500-series Indicator Oscilloscope	45 megahertz	75 megahertz
7700-series Indicator Oscilloscope	50 megahertz	105 megahertz
Lower -3 dB Bandwidth	30 hertz or less, 0° to +20°; C 25 hertz or less, +20° C to +75° C	250 hertz or less
Noise (tangentially measured)	0.2 div or less (square wave value) throughout calibrated deflection factor range when amplifier is operated in a 7000-series oscilloscope.	
Maximum CW Current With P6021	15 A P-P to 5 MHz decreasing to 1 A P-P at 100 MHz	
With P6022	6 A P-P to 10 MHz decreasing to 2 A P-P at 150 MHz	

Characteristics	Performance
Maximum Pulse Current With P6021	25 A Peak, not to exceed an amp-second product of 2 A-ms; not to exceed 5.3 A rms
With P6022	25 A Peak, not to exceed an amp-second product of 30 A-μs; not to exceed 2.1 A rms
Maximum Voltage With P6021 or P6022	600 V (DC + Peak AC)
DC Saturation With P6021	0.5 A
With P6022	0.2 A
Insertion Impedance With P6021	0.03 Ω or less at 1 MHz, increasing to 1 Ω or less at 60 MHz
With P6022	0.03 Ω or less at 1 MHz, increasing to 0.7 Ω or less at 175 MHz

ENVIRONMENTAL

Altitude Non-operating	To 50,000 feet and -55° C
Transportation	Qualified under National Safe Transit Committee test procedure 1A, Category II

PHYSICAL

Finish	Front panel is anodized aluminum
Dimensions	14 ¹ / ₄ inches L x 2 ⁵ / ₈ inches W x 5 inches H overall
Weight	≈ 1 ³ / ₄ lbs

SECTION 2

OPERATING INSTRUCTIONS

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

General

The Type 7A14 vertical plug-in unit operates with a Tektronix 7000-series indicator oscilloscope, a 7B-series time base unit, and Tektronix P6021 or P6022 Current Probes to form a complete current measuring system. To effectively use the Type 7A14, the operation and capabilities of the instrument should be known. This section describes the operation of the front-panel controls, gives first-time operation and general operating information, and lists some measurement techniques using the current probes.

Installation

The Type 7A14 is designed to operate in a vertical plug-in compartment of Tektronix 7000-series oscilloscopes. For X-Y operation, the plug-in unit may also be installed in a horizontal plug-in compartment. (Refer to the indicator oscilloscope instruction manual for information concerning X-Y operation.)

To install the Type 7A14 into a plug-in compartment, push it in until it is seated against the front panel of the indicator oscilloscope. To remove, pull the release latch to disengage the plug-in unit from the indicator oscilloscope. Continue to pull the release latch to remove the unit from the oscilloscope.

FRONT-PANEL CONTROLS AND CONNECTORS

All controls and the connector required for operation of the Type 7A14 are located on the front panel of the unit (see Fig. 2-1). A brief description of the function or operation of the front-panel controls and the connector follows. More detailed information is given under General Operating Information.

CURRENT/DIV	Selects vertical deflection factor from 1 mA/Div to 1 AMP/DIV in 1-2-5 sequence (VAR control must be in the calibrated position for indicated deflection factor).
VAR (CAL IN)	Provides variable uncalibrated deflection factors to at least 2.5 times the setting of the CURRENT/DIV switch. Push knob in and release to activate; the knob moves outward from the CURRENT/DIV control when activated.
POSITION	Controls vertical position of trace.
IDENTIFY	Moves trace upward about 0.25 divisions for identification. Also identifies the read-out corresponding to the Type 7A14.
POLARITY	Provides means of inverting the display.

NORM: Conventional current flowing in the direction of the arrow on the probe (see Fig. 2-2) produces a positive deflection on the CRT.

INVERT: Conventional current flowing in the direction of the arrow on the probe produces a negative deflection on the CRT.

BANDWIDTH Provides limiting of upper bandwidth.

FULL: Normal operation with full bandwidth capabilities.

20 MHz: Amplifier bandwidth limited to 20 MHz to provide a reduction in displayed high-frequency noise or interference.

LF COMP Screwdriver adjustment to compensate low-frequency response.

GAIN Screwdriver adjustment to set the gain of the amplifier. The 10 mA position is color shaded to indicate that the GAIN should be adjusted in this position of the switch.

CURRENT PROBE INPUT Signal input connector. Similar to standard BNC connector, but with additional conductor. When the P6021 probe is connected to the input, the additional conductor is shorted to ground by the probe connector, actuating relays in the Type 7A14 to set the gain and peaking circuits to correspond with the P6021 probe.

NOTE

P6021 probes with regular BNC connector must be modified with a special coding ring to be compatible with the 7-series plug-in units. Contact your local Tektronix Field Office or Representative for assistance in procuring the coding ring.

FIRST-TIME OPERATION

General

When shipped from the factory, the Type 7A14 has been calibrated to meet the specifications listed in Section 1 and is ready to be used with an indicator oscilloscope.

The following steps demonstrate the basic operation of the controls and connectors of the Type 7A14. It is recommended that this procedure be followed completely for familiarization with the instrument. Operation of the indicator oscilloscope and time base unit is described in the instruction manuals for those units.

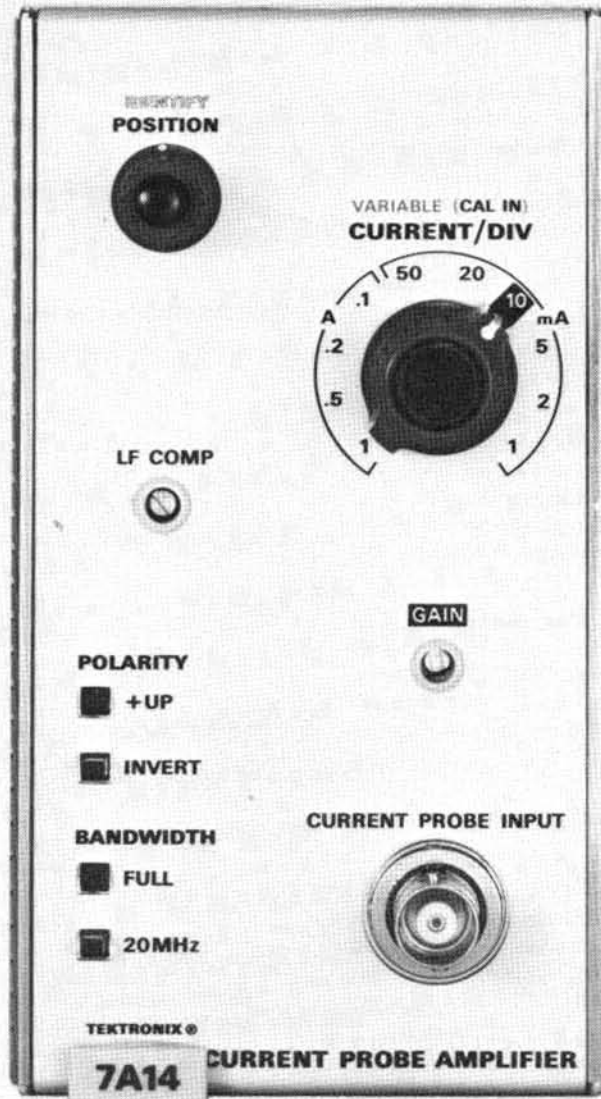


Fig. 2-1. Location of front-panel controls and current probe connector.

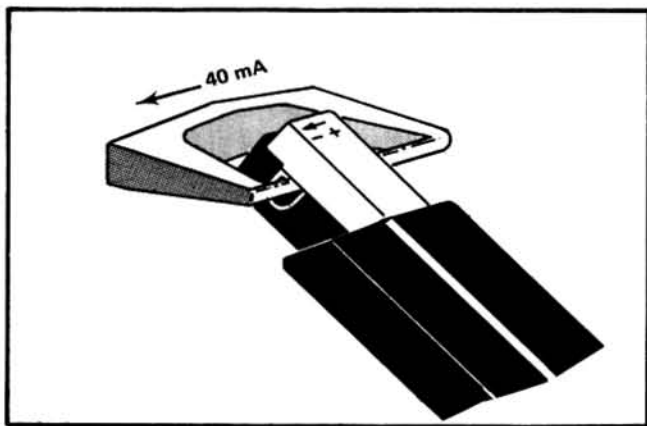


Fig. 2-2. Current flow in a conductor.

Setup Information

1. Insert the Type 7A14 into a vertical plug-in compartment of a 7000-series indicator oscilloscope.
2. Insert a 7B-series time-base unit into a horizontal plug-in compartment.
3. Set the controls as follows:

	Type 7A14
CURRENT/DIV	10 mA
VAR	Calibrated (CAL IN)
POSITION	Midrange
BANDWIDTH	FULL
	Time Base
Time/Div	0.5 msec
Variable Time/Div	Calibrated
MODE	P-P AUTO
Slope	+
Coupling	AC
Source	Int
Position	Midrange
	Indicator Oscilloscope
Calibrator	1 kHz
Intensity	Counterclockwise
Focus	Midrange
Astigmatism	Midrange
Scale Illum	As desired

4. Connect the oscilloscope to a power source which meets the voltage and frequency requirements of the oscilloscope power supply.
5. Turn the oscilloscope power on and allow about five minutes warmup time.
6. Connect either a Tektronix P6021 or P6022 Current Probe to the INPUT connector.
7. Open the probe slider, place the probe around the oscilloscope calibrator 40 mA current loop and lock the slider.

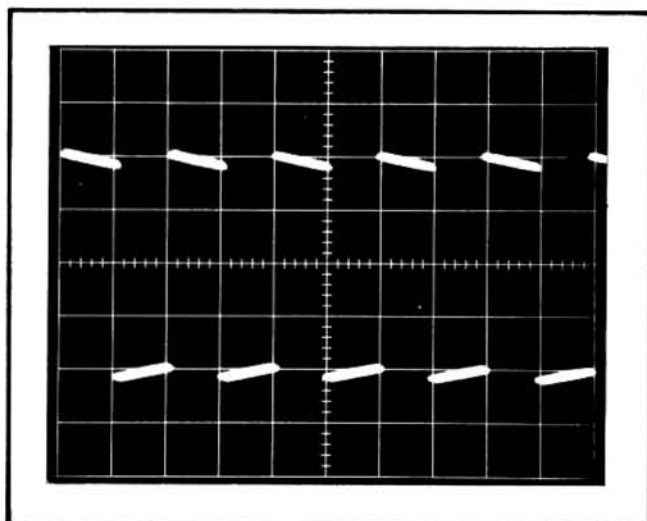


Fig. 2-3. 40 mA Calibrator square-wave.

8. Turn the Intensity control clockwise and adjust triggering controls to obtain a triggered display. (Adjust horizontal and vertical POSITION controls as necessary.)
9. Adjust Focus and Astigmatism controls for an optimum display of the square wave.
10. Check the display for four divisions of vertical deflection (see Fig. 2-3).
11. Press the IDENTIFY button to identify the readout. The Type 7A14 readout will be replaced by the word "IDENTIFY". When the IDENTIFY button is pressed and released, the display moves up and down about 0.25 division. This movement identifies the Type 7A14 waveform when more than one display is on the CRT.
12. Press the INVERT button to display the opposite polarity of the square wave. (When observing a symmetrical waveform, such as the calibrator square wave, inverting the vertical signal makes no apparent change in the display. This is due to the time-base unit triggering on the indicated slope of the displayed waveform.)

This completes the basic operating procedure for the Type 7A14. Instrument operations not explained here, or operations which need further explanation, are discussed under General Operating Information.

GENERAL OPERATING INFORMATION

Current Probe Selection

The two current probes recommended for use with the Type 7A14 are the Tektronix P6021 and P6022. Generally, the P6021 should be used when measuring current waveforms in the low to medium-frequency range, while the P6022 should be used for medium or high-frequency measurements. The P6022 is considerably smaller in size than the P6021.

The P6021 and P6022 probes require different gain and peaking in the amplifier to provide an accurate representation of the current signal. To accomplish these changes automatically, a special BNC connector with a third conductor is used for the INPUT. When the P6021 is connected

Operating Instructions—Type 7A14

to the INPUT, this additional conductor is shorted to ground, relay-switching the necessary internal circuits to correspond with the probe being used. No contact is made to this conductor by the P6022 probe connector.

Signal Connection

The current signal is connected to the amplifier by sliding the thumb-controlled portion of the probe back, placing the probe around the current-carrying conductor, and moving the slider forward, closing the probe transformer core around the conductor.

Signal Polarity

Conventional current (plus to minus) flowing in the direction of the arrow on the probe produces a positive deflection on the CRT when the POLARITY switch + UP button is pressed. When the INVERT button is pressed, conventional current flowing in the direction of the arrow produces a negative deflection on the CRT.

Deflection Factor

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the setting of the CURRENT/DIV switch, and the setting of the VAR CURRENT/DIV control. The calibrated deflection factors indicated by the CURRENT/DIV switch apply only when the VAR control is in the calibrated (pushed in) position.

The VAR CURRENT/DIV control provides uncalibrated vertical deflection factors between the settings of the CURRENT/DIV switch. The VAR control extends the maximum vertical deflection factor of the Type 7A14 to at least 2.5 amperes/division with the CURRENT/DIV switch at 1 A/Div.

Bandwidth Limiter

The bandwidth switch provides a method of reducing interference from unwanted high-frequency signals when viewing low-frequency signals. With the FULL button pressed, the full bandwidth capabilities of the amplifier are available. When the 20 MHz button is pressed, the upper -3 dB bandwidth point of the amplifier is limited to about twenty megahertz. The unwanted high-frequency signals (such as television broadcast radiation interference) are reduced in the displayed waveform. Fig. 2-4 illustrates the use of this feature. The waveform in Fig. 2-4A is the display produced when a low-level, low-frequency signal is viewed in the presence of a strong 50-megahertz radiation (FULL button pressed). Fig. 2-4B shows the resultant CRT display when the high-frequency interference is reduced by pressing the 20 megahertz button.

Low-Frequency Compensation

The low-frequency response of the probe and amplifier varies when changing from one probe to another, even among probes of the same type. Therefore, a low-frequency compensation adjustment is provided on the front panel to match the amplifier response to the response of the probe being used.

To compensate the amplifier, proceed as follows:

1. Connect the P6021 probe from the Type 7A14 to the indicator oscilloscope 40 mA current loop and set the calibrator rate to 1 kHz. Set the TIME/DIV to .2 ms.

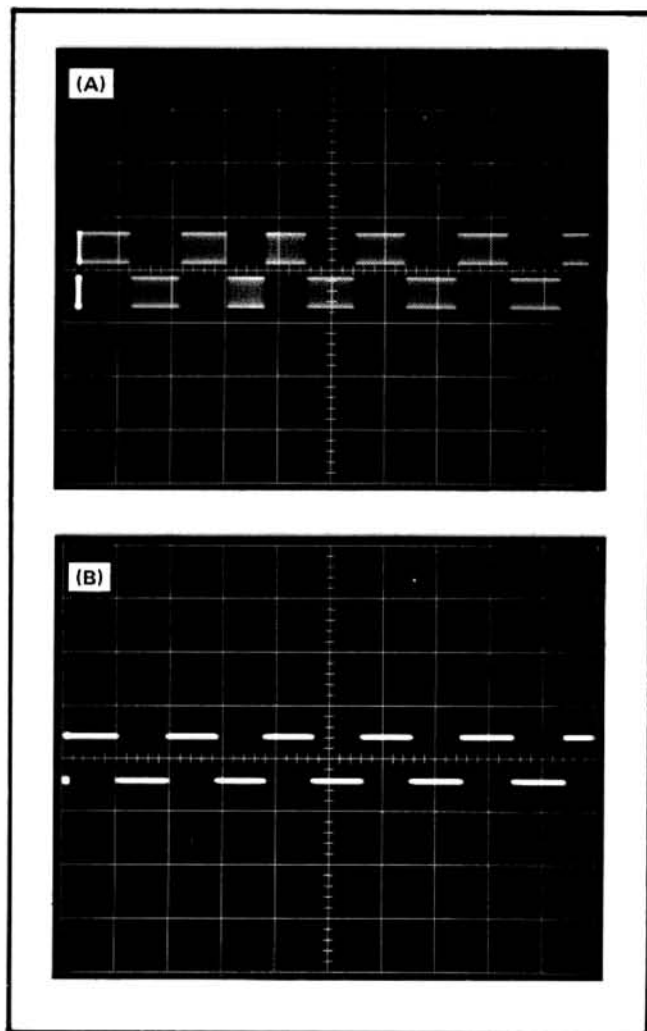


Fig. 2-4. (A) CRT display showing high-frequency interference when attempting to view low-level, low-frequency signal, (B) resultant display when the 20 MHz button is pressed.

2. Set the CURRENT/DIV to 10 mA and the VAR to the CAL IN position. Adjust the triggering controls for a stable display.

3. Adjust the LF COMP (a front-panel adjust) for 0.2 division of tilt in the first 500 μ s of the square-wave. See Fig. 2-5A.

4. Reset the CURRENT/DIV to 5 mA and adjust LF COMP for 0.4 division of tilt in the first 500 μ s. See Fig. 2-5B.

5. Replace the P6021 probe with the P6022 probe. Reset the CURRENT/DIV to 10 mA and the TIME/DIV to .5 ms.

6. Adjust LF COMP for best flat top on waveform (see Fig. 2-5C).

7. Reset the CURRENT/DIV to 5 mA and adjust LF COMP for best flat top.

NOTE

The appropriate steps in the above procedure should be checked each time when changing probes.

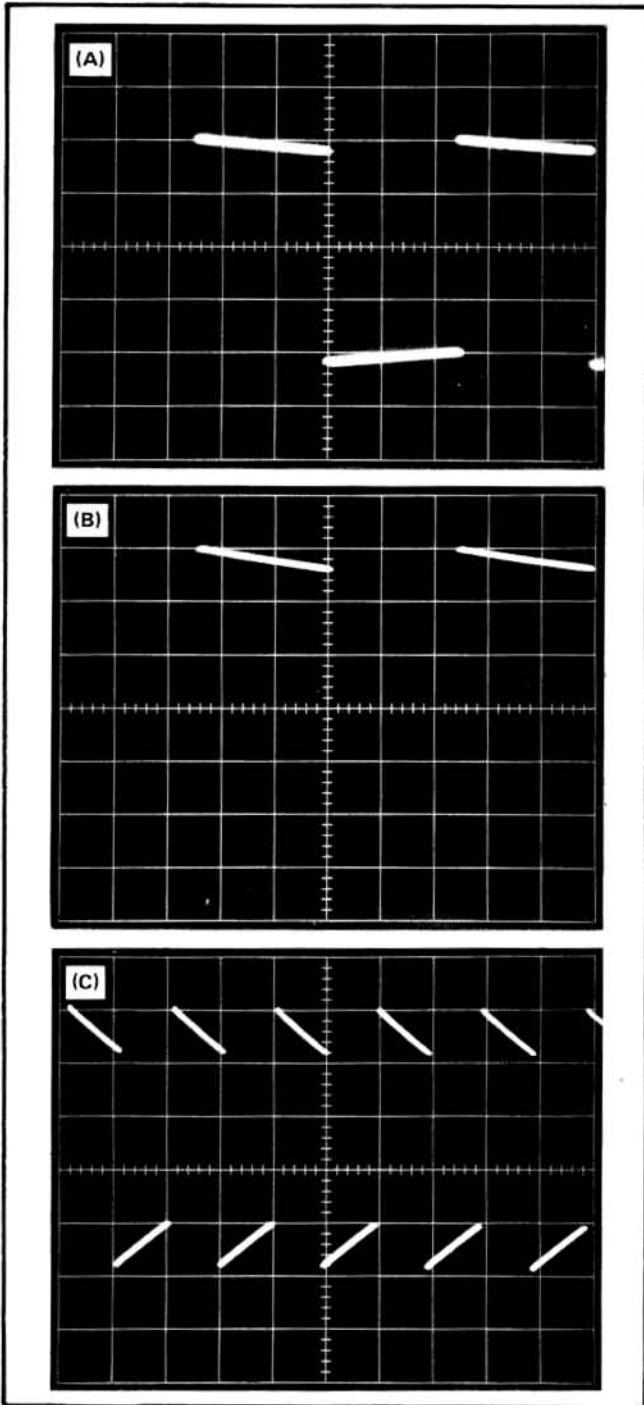


Fig. 2-5. Low frequency Compensation adjustment. A. P6021 at 10 mA/DIV. B. P6021 at 5 mA/DIV. C. P6022 at 10 mA/DIV.

Amplifier Gain

The Type 7A14 amplifier contains two gain-setting adjustments. The GAIN control, a front-panel screwdriver adjustment, affects the gain of the amplifier when using either of the current probes. The P6021/P6022 Gain Ratio adjustment

(R155), located internally affects the gain of the amplifier only when using the P6022 probe.

When only one probe type is being used, the gain may be set with the front-panel GAIN control. However, to provide accurate gain when both the P6021 and P6022 probes are being used, proceed as follows:

1. Connect the P6021 probe from the Type 7A14 INPUT to the oscilloscope calibrator 40 mA current loop.
2. With the CURRENT/DIV switch set to 10 mA and the VAR control in the calibrated position, obtain a display on the CRT.
3. Adjust the front-panel GAIN control for four divisions of vertical deflection.
4. Remove the P6021 probe and connect the P6022 probe from the Type 7A14 INPUT to the 40 mA current loop.
5. Check the display for four divisions of vertical deflection. If adjustment is necessary, refer to the Calibration section for P6021/P6022 Gain Ratio adjustment procedure.

MEASUREMENT TECHNIQUES

Increasing the Sensitivity

The current sensitivity of the probe can be increased by increasing the number of turns passing through the core of the probe. For example, if the conductor is looped through the probe two times, a two-turn primary winding is formed, increasing the secondary current by a factor of two. (The ratio of current in a transformer is inversely proportional to the turns ratio.) With the Type 7A14 CURRENT/DIV switch set to 1 mA, the deflection factor would actually be changed by a factor of two to 0.5 mA/division.

Remember, however, that the impedance reflected into the primary (circuit being measured) from the secondary (probe winding) varies as the square of the primary turns. When observing high-frequency current waveforms or fast-rise pulses, the inductance added to the primary circuit by the additional turns may be significant.

Simultaneous Current and Voltage Measurements

Simultaneous current and voltage measurements can be made using the Type 7A14 in one vertical plug-in compartment (of a two-vertical indicator oscilloscope), and a voltage amplifier in the other vertical plug-in compartment.

1. Insert the Type 7A14 into one of the vertical plug-in compartments of the indicator oscilloscope.
2. Connect the current probe to the Type 7A14 INPUT connector.
3. Insert the voltage amplifier unit in the other vertical plug-in compartment.
4. Connect a voltage probe to the voltage amplifier input connector.

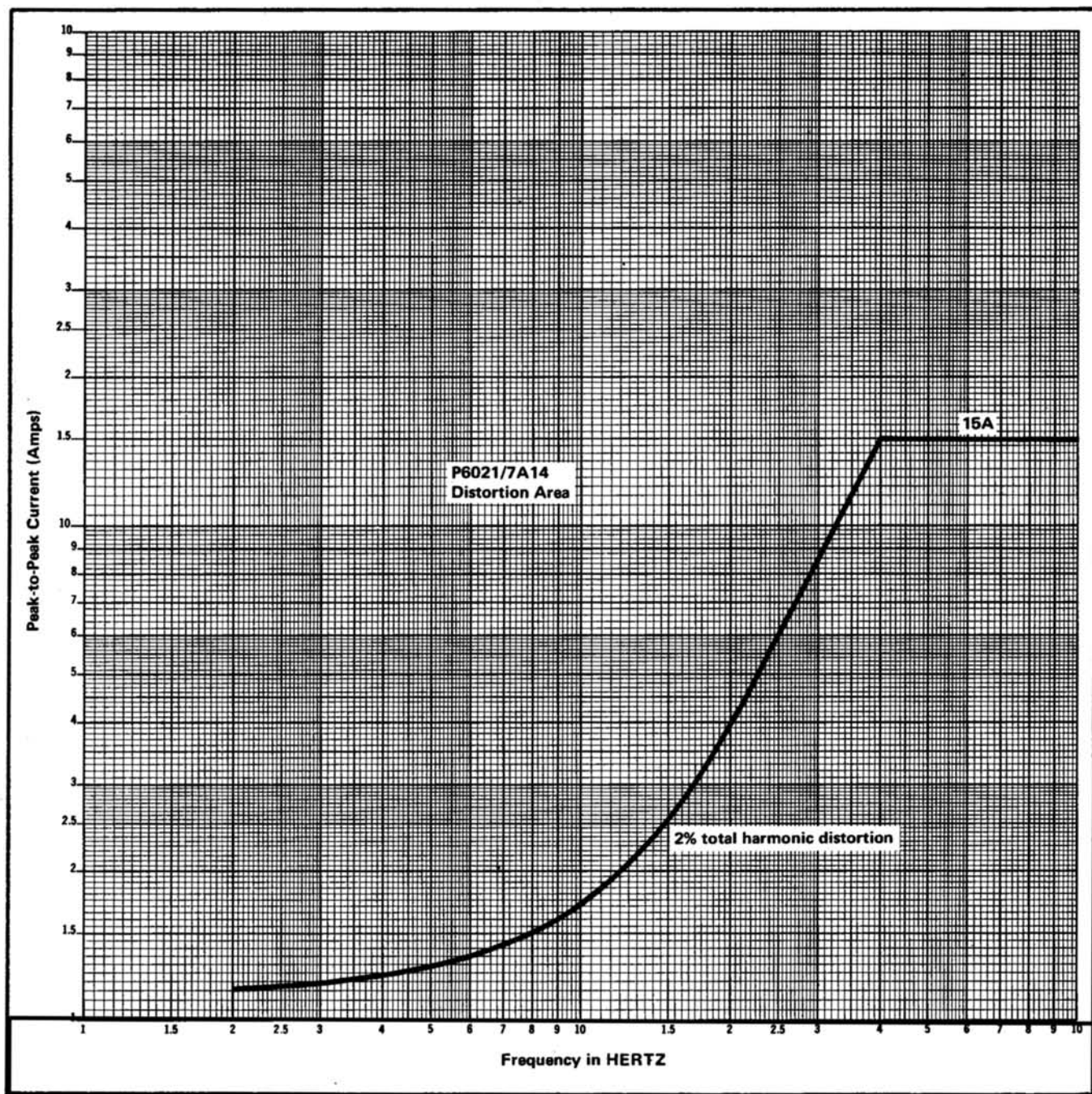


Fig. 2-6. Type P6021/7A14 low frequency response vs. peak-to-peak current. At the lower frequencies, sine wave distortion occurs as a result of core saturation.

5. Connect the current probe around the conductor at the point where the current is to be measured. (Connect the probe ground to the chassis of the instrument under test.)

6. Connect the voltage probe tip to the point where the voltage is to be measured. (Connect the probe ground to the instrument chassis.)

7. Set the appropriate controls on the Type 7A14, the voltage amplifier unit, and the indicator oscilloscope to display both the current and voltage waveforms.

8. The shape and time duration of the two waveforms may now be compared. If desired, the polarity of the current waveform may be inverted for better comparison.

X-Y Operation

In some applications it is desirable to display one signal versus another (X-Y) rather than against time (internal sweep). The Type 7A14 will operate in the horizontal (time-base) compartment.

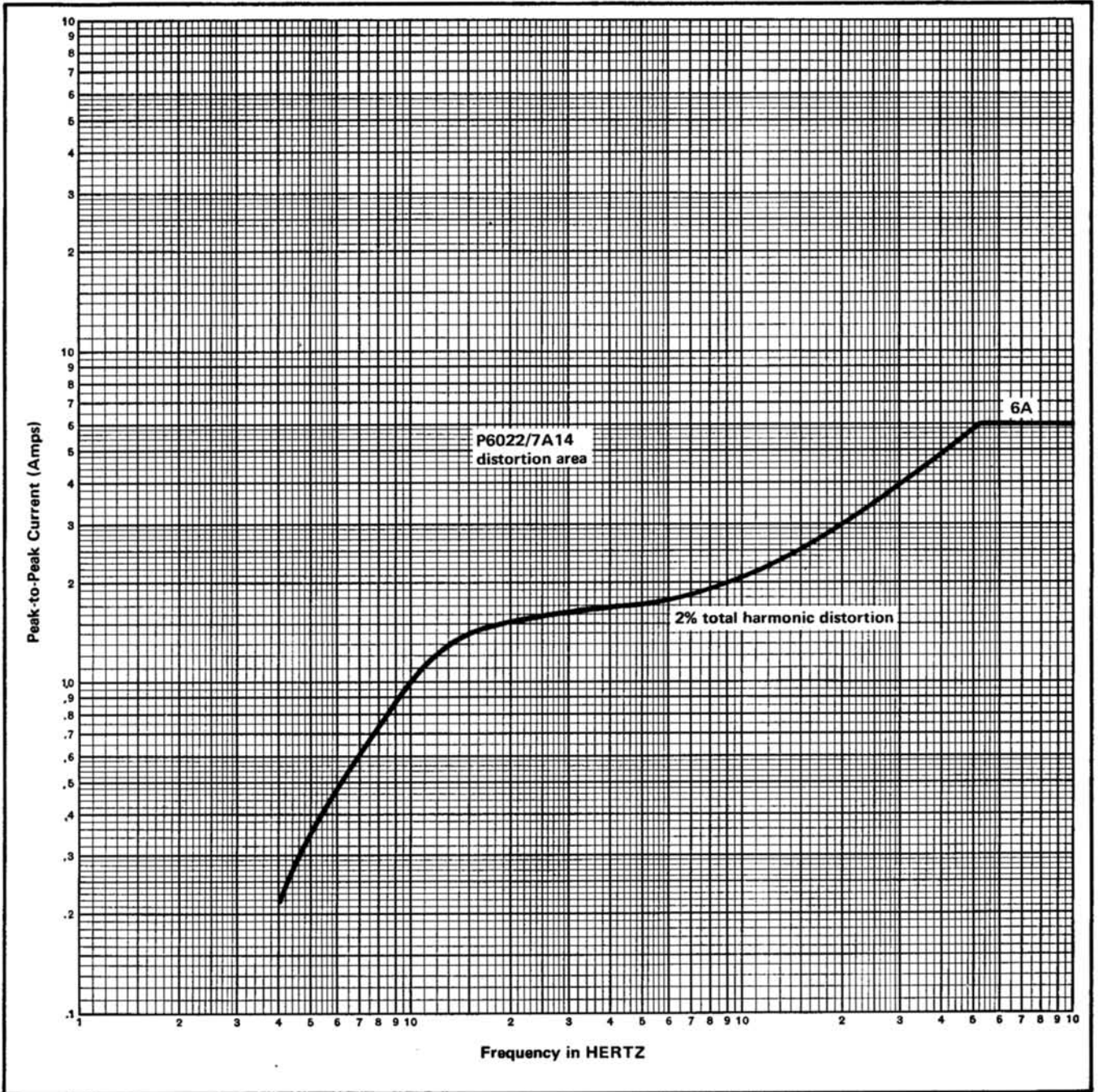


Fig. 2-7. Type P6022/7A14 low frequency response vs. peak-to-peak current. At the lower frequencies, sine wave distortion occurs as a result of core saturation.

To make X-Y measurements, insert the Type 7A14 into the horizontal plug-in compartment. Insert another Type 7A14 (or any other vertical unit) into the vertical plug-in compartment. The calibrated X-axis deflection is indicated by the CURRENT/DIV setting of the Type 7A14 in the horizontal

compartment; the calibrated Y-axis deflection is indicated by the deflection factor set on the vertical compartment plug-in.

Refer to the indicator oscilloscope manual for the various applications of the X-Y mode of operation.

SECTION 3

CIRCUIT DESCRIPTION

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

Introduction

This section of the manual contains a description of the circuitry used in the Type 7A14 amplifier. The description begins with a discussion of the instrument using the block diagram shown in the Diagrams section. Each circuit is then described in detail using the block diagram to show interconnections between the circuits and the relationship of the front-panel controls to the individual stages.

Complete schematics of each circuit are given in the Diagrams section. Refer to these diagrams for electrical values and relationship throughout the following circuit description.

Block Diagram

The following discussion is provided to aid in understanding the overall concept of the Type 7A14 before the individual circuits are discussed in detail. Each block on the block diagram, located in the Diagrams section, represents an individual circuit within the instrument. The number on each block refers to the diagram on which the complete circuit is found.

The signal to be displayed on the CRT is applied to the INPUT connector and directly to the Input Attenuators. The CURRENT/DIV switch provides the appropriate attenuation and applies the signal to the Input Amplifier Stage. Low-Frequency Compensation is included in the collector circuit of the input stage. This compensation is applied to the side of the amplifier which is receiving the input signal. The first cascode stage, Q140-Q240-Q149-Q249, contains the gain-switching relays which, with the input attenuators and the input amplifier, provide the appropriate overall gain for each setting of the CURRENT/DIV switch. This stage also provides gain-switching to correspond with the requirements of the probe being used. C141-C143-C145-C245 provide high-frequency compensation.

The second cascode stage, Q157-Q257-Q168-Q268, contains a peaking network and the VAR CURRENT/DIV control. The AC-coupled outputs are connected through the POLARITY switch to the third cascode stage, Q307-Q407-Q323-Q423. This stage contains another peaking network and the front-panel GAIN control. The output of this stage is connected through the bandwidth limiting circuit to the Output Amplifier where vertical positioning is provided. In the Trigger Pickoff circuit, a portion of the output signal is taken from the emitters of Q345 and Q445 and amplified by Q360 and Q460 to the same level as the output signal.

In addition to the functions of the amplifier just explained, the Type 7A14 also provides knob readout logic for the indicator oscilloscope. Logic identifying the deflection factor, whether calibrated or uncalibrated, and polarity is supplied. When the IDENTIFY button is pressed, this readout is re-

placed by the word "identify". At the same time some additional current is pulled through Q323 to deflect the trace upward approximately 0.25 division.

Input Connector

The input connector is similar to a standard BNC, but has an additional conductor. When the additional conductor, the outside ring on the connector, is grounded by the P6021 probe connector, three relays, K155, K160 and K235, are activated. These three relays switch in the peaking and gain circuits appropriate for the P6021 probe. When a P6022 probe is used instead of a P6021, the outer ring is not grounded, leaving K155, K160 and K235 as shown on the Input Amplifier schematic. The center conductor of the input connector is connected to the CURRENT/DIV switch.

Input Attenuators

The portion of the CURRENT/DIV switch shown on the Input Attenuator Switching diagram provides proper termination and attenuation of the input signal. In the 1 mA, 2 mA, and 5 mA positions of the switch, the signal is connected directly through the switch ($\div 1$), then AC-coupled through C101 to the emitter of Q106. In the seven remaining positions of the CURRENT/DIV switch, the signal is passed through one of six attenuators and DC-coupled to the base of Q206. The positions of the CURRENT/DIV switch and the corresponding attenuators are as follows:

1 mA	$\div 1$	50 mA	$\div 2$
2 mA	$\div 1$.1 AMP	$\div 4$
5 mA	$\div 1$.2 AMP	$\div 8$
10 mA	$\div 1$.5 AMP	$\div 20$
20 mA	$\div 2$	1 AMP	$\div 40$

Input Amplifier

In the 1 mA, 2 mA, and 5 mA positions of the CURRENT/DIV switch, the input signal is applied through C101 and a terminating network to the emitter of Q106, the grounded-base input transistor. At high frequencies the impedance of the terminating network, R100-C100-R101-L101-R102-R103-Q106 is 62.5 ohms. This matches the impedance of the 62.5 ohm probe cable. At low frequencies the input impedance decreases to 10 ohms for improved low-frequency response. A positive signal at the input decreases the conduction of Q106. The AC signal path is through C120 and the low-frequency compensation network. The signal at the base of Q140 is in-phase with the input signal.

In the 10 mA through 1 A positions of the CURRENT/DIV switch, the input signal is applied to the base of Q206. A

positive signal at the input increases the conduction of Q206. The AC signal path is through C220 and the low-frequency compensating network. The signal at the base of Q240 is inverted from the input signal.

R110 is used to DC balance the first cascode stage. R111 sets the quiescent current through this stage and is adjusted for +4.5 volts to ground at TP115 and TP215.

As previously noted under Input Attenuators, there is no attenuation of the signal applied to the emitter of Q106. The sensitivity at the collector of Q106 is approximately 100 millivolt/milliamp at the INPUT connector. In the 10 mA position there is no attenuation, but the signal is applied to Q206, which has a gain one-fifth that of Q106. The sensitivity at the collector of Q206 is approximately 20 millivolts per 1 milliamp at the input connector. R202, with R203-C202-C203, provides a gain adjustment to set this one-to-five ratio between the two input transistors.

In the event that Q106 or Q206 are removed, zener diodes VR107 and VR208 prevent the common-emitter circuit from reaching -50 volts. This provides protection for C101, C207, and C203. The two zener diodes, which appear capacitive to the circuit, are isolated from the input signals by R107 and R207. CR120 and CR220 prevent C120, C220, and the components in the low-frequency compensation circuit from being damaged by the +50-volt supply should the input transistors be removed. C110 and C118 provide additional ripple filtering for the supply voltages.

Low-Frequency Compensation

Because the current probe is an AC-coupled device, low-frequency signals have an exponential decay as the field in the probe transformer collapses. The low-frequency compensation circuit has the effect of connecting a variable capacitor to the junction of R114 and R116 (or R214 and R216, depending upon the side of the amplifier being used). The impedance of the circuit ($\times c$) increases at low frequencies, causing a low-frequency boost of the signal. The apparent value of capacitance is adjusted by the LF COMP, a front-panel adjustment, which sets the gain of the circuit.

With the CURRENT/DIV switch set to 1 mA, 2 mA, or 5 mA, K50 is connected as shown in the schematic. That is, the signal from Q106 is applied through K50A to the base of Q222, which provides high input impedance, to the base

of Q225. At the collector of Q225 the inverted signal is connected through two emitter followers, Q231 and Q233, which provide low output impedance. In the remaining positions of the CURRENT/DIV switch, the signal from Q206 is applied through K50B to the base of Q222. The compensation requirements of the P6021 and P6022 probes differ, therefore, when the P6021 probe is connected, C237 is paralleled with C238 by K235A. The output of the low-frequency compensation amplifier is connected through K50 to the same side of the amplifier as the input signal.

First Cascode Stage

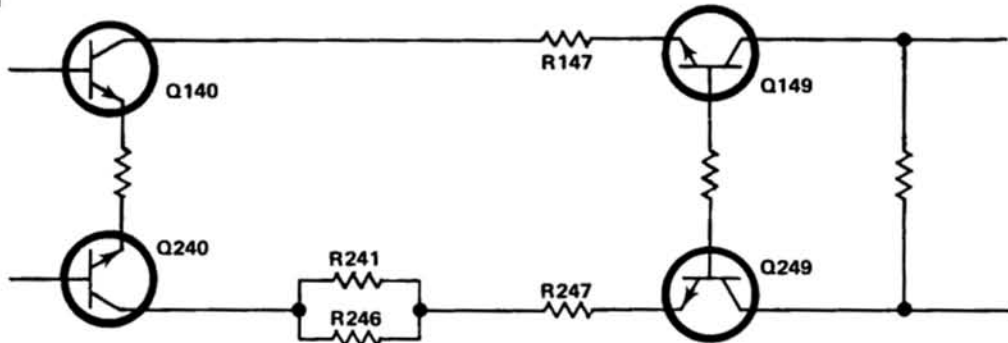
Q140 and Q240 form a paraphase amplifier. When one base is driven with the input signal, the opposite base is at signal ground. The signal divides through R141, producing push-pull signals at the collectors of Q140 and Q240. In all positions of the CURRENT/DIV switch, the signal at the collector of Q140 is inverted from the signal at the INPUT connector. The collector of Q240 is in phase with the input. R143 and C143 with C141 provide peaking for the stage.

The first cascode stage, Q140-Q240-Q149-Q249, contains the gain-switching relays, K51A, K52A, K53A, and K54A. These relays, with the input attenuators and the factor of five difference between the two inputs to the amplifier, combine to provide ten deflection factors of the CURRENT/DIV switch. R245 is a calibration adjustment for the $\div 5$ gain switching. C145-C245 provide high-frequency peaking. Fig. 3-1 illustrates the three configurations of the gain-switching relays. The gain of this stage, with the four gain-switching relays and K155A connected as shown in the schematic, is approximately 1.6 per side or 3.2 push-pull. K155A opens when the P6021 probe is connected to the input and increases the gain by a factor of 2.5 to a maximum of 8 push-pull. The gain ratio of 2.5 to 1 is adjusted by R155. R152 is the DC balance adjustment for the second cascode stage. Table 3-1 shows the input attenuator used for each position of the CURRENT/DIV switch and the sensitivities of the amplifier through the first cascode stage. The third column indicates the voltage at the collector of either Q106 or Q206 per 1 mA at the INPUT connector. The fourth and fifth columns indicate the peak to peak voltage at the collectors of Q149-Q249 per 1 mA at the INPUT connector. The sixth column gives the overall sensitivity of the probe and amplifier from the probe primary (circuit under test) to the collectors of Q149-Q249.

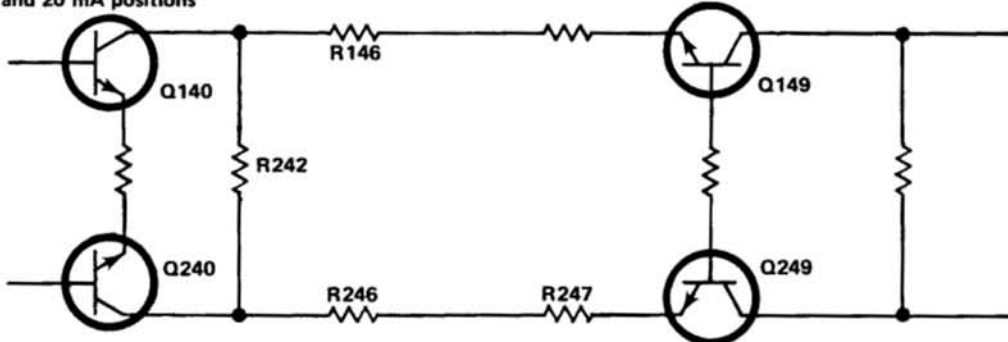
TABLE 3-1

CURRENT/DIV Switch Setting	Input Attenuator	Sensitivity from INPUT to collector of Q106 ¹ or Q206 ²	Sensitivity from INPUT to collectors of Q149-Q249		Sensitivity from probe primary to collectors of Q149-Q249
			P6022 gain circuit	P6021 gain circuit	
1 mA	$\div 1$	100 mV/mA ¹	320 mV/mA	800 mV/mA	6.4 mV/mA
2 mA	$\div 1$	100 mV/mA ¹	160 mV/mA	400 mV/mA	3.2 mV/mA
5 mA	$\div 1$	100 mV/mA ¹	64 mV/mA	160 mV/mA	1.28 mV/mA
10 mA	$\div 1$	20 mV/mA ²	32 mV/mA	80 mV/mA	0.64 mV/mA
20 mA	$\div 2$	10 mV/mA ²	16 mV/mA	40 mV/mA	0.32 mV/mA
50 mA	$\div 2$	10 mV/mA ²	6.4 mV/mA	16 mV/mA	128 μ V/mA
.1 AMP	$\div 4$	5 mV/mA ²	3.2 mV/mA	8 mV/mA	64 μ V/mA
.2 AMP	$\div 8$	2.5 mV/mA ²	1.6 mV/mA	4 mV/mA	32 μ V/mA
.5 AMP	$\div 20$	1 mV/mA ²	0.64 mV/mA	1.6 mV/mA	12.8 μ V/mA
1 AMP	$\div 40$	0.5 mV/mA ²	0.32 mV/mA	0.8 mV/mA	6.4 μ V/mA

(A) 1 mA position



(B) 2 mA, 10 mA, and 20 mA positions



(C) 5 mA, 50 mA, .1 AMP, .5 AMP and 1 AMP positions

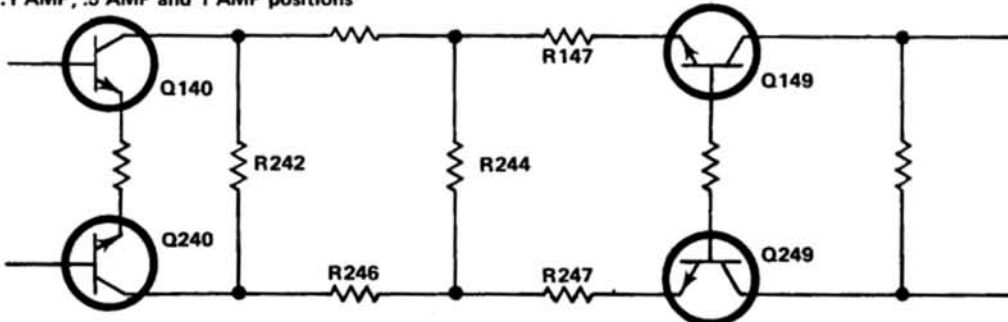


Fig. 3-1. Three configurations of gain-switching relays showing corresponding positions of CURRENT/DIV switch.

Second Cascode Stage

The second cascode stage, Q157-Q257-Q168-Q268, contains peaking circuits and the VAR control. C259 and C170 provide high frequency peaking for both P6021 and P6022 probes, while C160-R160-C161-R161 are relay-switched into the circuit by K160A only when the P6021 probe is connected. C162-R162 and C262-R262 provide thermal compensation. With the VAR control switched off, as shown in the schematic, the gain of the stage is set by R260, R171, R271 for approximately two. With the VARIABLE control in the outward position, K62A closes, reducing the gain of the stage by a factor of up to 2.5, depending upon the position of the VAR control. With the control fully counterclockwise the resistance of R165 is zero, which allows maximum current to flow through R164 and R264. Under this condition, the gain of the stage is minimum, or about 0.8. The DC level at the collectors of Q168 and Q268 is set by voltage divider, VR173-R173 and the load resistors, R171-R271-R172.

The output of the second cascode stage is AC-coupled through C176-C178 and C276-C278 to the following stage. With the POLARITY switch +UP button pressed, K280 is energized and K180 is not energized, connecting the signals to the bases of Q307 and Q407 as shown in the schematic. With the INVERT button pressed, K180 is energized and K280 is not energized, reversing the inputs to Q307 and Q407. This inverts the output signal. Common-mode transformer, T180, attenuates high-frequency common-mode signals.

Third Cascode Stage

The third cascode stage, Q307-Q323 and Q407-Q423, provides a gain of approximately 2.4, adjustable to $\pm 25\%$ by the gain control (R318). The emitter resistor, R310, and the load resistors, R335-R435, with the gain-adjusting network, R317-R318-R417, determine the gain of the stage. With the GAIN control fully counterclockwise the resistance of R318

is zero, which allows maximum current to flow through R317 and R417. Under this condition, the gain of the stage is minimum, or about 1.8.

The DC level at the bases of Q323 and Q423 is set to -10.8 volts by R326 and R327. The current source for the emitters of Q307 and Q407 is through R313, with about 15 mA per side through R312 and R412. C309 and R309, with C310, provide high frequency peaking for the stage. C415-R415-C315-R315 provide thermal compensation. DC Common Mode adjustment R414, adjusts the output DC level at A11 and B11 to zero with no signal in. R321, in the emitter circuit of Q323, is connected to ground when the trace IDENTIFY button is pressed. This adds a small amount to the collector current of Q323 causing the trace to deflect upward about 0.25 division.

With the BANDWIDTH switch FULL button pressed, the output of the third cascode stage is connected directly through K330 to the output amplifier. In the 20 MHz position, the bandwidth limiting circuit, C331-L331-L330-L430-C333, is switched in by K330. This low-pass filter limits the upper frequency limit of the amplifier to approximately 20 MHz. Common-mode transformer (T344) attenuates high-frequency common-mode signals.

Output Amplifier

Under quiescent conditions, and with the POSITION control set to midrange, the current through the third cascode stage sets the DC level at the bases of Q345 and Q445 to -7.5 volts. The center taps of R342 also being -7.5 volts, there is no current through R340 and R440. With the POSITION control set to midrange, the Position Bal adjustment (R338) balances the two sides of the amplifier. The output DC levels are set to zero volts by R345 and R445. A clockwise rotation of the POSITION control moves the base of Q345 more negative and the base of Q445 toward ground. This raises the level at B11 and lowers the level at A11, moving the display upward.

The collectors of Q345 and Q445 are terminated in 50 ohms in the indicator unit. The gain of the output stage, determined by the 50 ohms and the emitter load, is approximately 1.6. The deflection factor at the output is 0.5 mA (through the

50 ohms) per division or 25 mV (per side) per division. R346-C346 and R446-C446 provide thermal compensation. C347 and R347 provide peaking for the output amplifier.

Trigger Pickoff

The divider network in the emitter circuit of Q345 and Q445, R350-R354-R450-R454-R353, isolates the trigger pickoff circuit from the output amplifier to avoid loading. The + and - signals from the divider network are amplified by Q360 and Q460 to the same level as the output signals. The + and - trigger signals are terminated in 50 ohms in the indicator unit. R360 and R460 set the output DC levels to zero volts. The Trigger Bal adjustment (R368) balances the levels between the two trigger outputs. R361-C361 and R461-C461 provide thermal compensation. C363 and R363 provide peaking, bringing the risetime of the trigger pickoff circuit to about 3.5 nanoseconds.

Readout Block

An analog coding system is used in the Type 7A14 to convey information from the plug-in to the indicator oscilloscope readout section. Each symbol used by the Type 7A14 requires two currents to define it. This readout information is encoded on two output lines, interface connectors A37 and B37, by the resistors between output lines and interface connectors A30, A32, A33, B29, B32, B33.

The resistor combinations and switch closures used for each symbol are as follows: The symbol "A", for ampere, is selected by R77 and R78; the prefix to the unit of measurement "m", for milli, is selected by R70 and R67 when readout switch contact 7 is closed; the numeral 1, 2, or 5 is selected, in the above order, by R59 for 1, by R59/R58 and switch contact 3 for 2, and by R59/R60 and switch contact 4 for 5; the uncalibrated symbol ">", is selected by R75, R62-CR62 when the VAR CURRENT/DIV knob is in the out position; the invert symbol " ", is selected by R73, R72 when the POLARITY switch is in the INVERT position; the number of zeros, if any, following the numeral 1, 2, or 5 is selected by R69, R64, R65 and switch contacts 5 and 6.

Refer to the indicator oscilloscope Manual for a complete discussion on the readout system operation.

SECTION 4

MAINTENANCE

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

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance and troubleshooting of the Type 7A14.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of cleaning, visual inspection, lubrication, etc. Preventative maintenance performed on a regular basis may prevent instrument breakdown and will improve reliability of this instrument. The severity of the environment to which the Type 7A14 is subjected determines the frequency of maintenance. A convenient time to perform preventative maintenance is preceding recalibration of the instrument.

Cleaning

The Type 7A14 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path.

The covers of the indicator oscilloscope minimize the amount of dust which reaches the interior of the Type 7A14. Operation of the system without the indicator oscilloscope covers in place necessitates more frequent cleaning. When the Type 7A14 is not in use, it should be stored in a protected location such as a dust-tight cabinet.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

Exterior. Loose dust accumulated on the outside of the Type 7A14 can be removed with a soft cloth or small paint brush. The paint 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. Abrasive cleaners should not be used.

Interior. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air.

Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipper applicator is useful for cleaning in narrow spaces.

Visual Inspection

The Type 7A14 should be inspected occasionally for such defects as broken connections, broken or damaged circuit boards, improperly seated transistors or relays, and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent a recurrence of the damage.

Transistor Checks

Periodic checks of the transistors in the Type 7A14 are not recommended. The best check of transistor performance is its actual operation in the instrument. More details on checking transistor operation is given under Troubleshooting.

Recalibration

To ensure accurate measurements, check the calibration of this instrument after each 1000 hours of operation or every six months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuits. Complete calibration instructions are given in Section 5.

The Performance Check/Calibration Procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by calibration.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the Type 7A14. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An understanding of the circuit operation is very helpful in locating troubles. See the Circuit Description section for complete information.

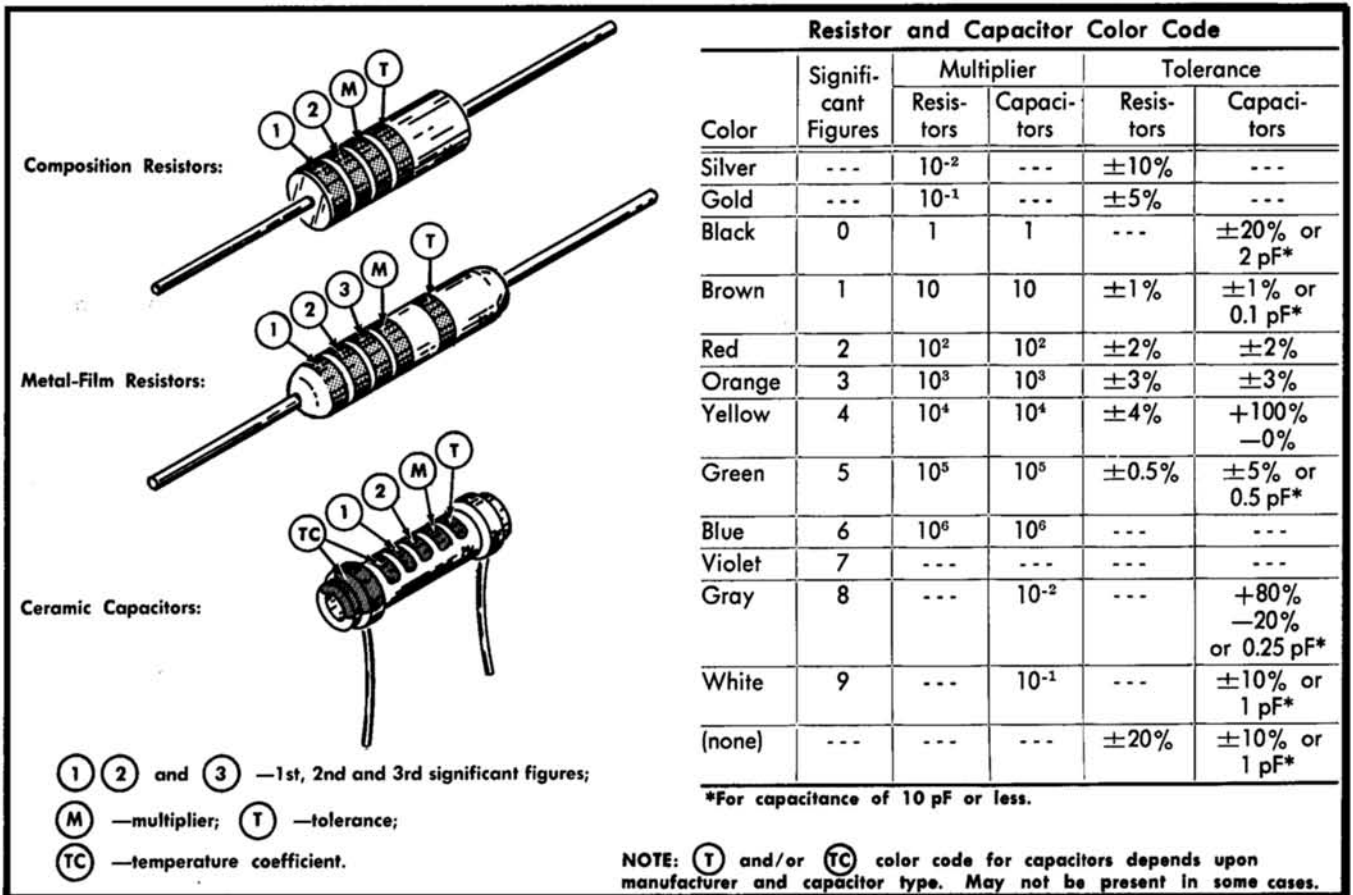


Fig. 4-1. Color-code for resistors and ceramic capacitors.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 8. The component number and electrical value of each component in this instrument are shown on the diagrams. Important voltages and waveforms are also shown on the diagrams.

Switch Cam Identification. Switch cam numbers shown on the diagrams indicate the position of the cam in the complete switch assembly. The cams are numbered from the front, or mounting end of the switch, toward the rear.

Resistor Color-Code. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in the Type 7A14. The resistance values of wire-wound resistors are printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components (some metal-film resistors may have the value printed on the body) with EIA color-code. The color-code is read starting with the stripe nearest the end of the resistor. 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.

Capacitor Marking. The capacitance values of common disc capacitors and small electrolytics are marked in micro-

farads on the side of the component body. The white ceramic capacitors used in the Type 7A14 are color coded in picofarads using a modified EIA code (see Fig. 4-1).

Diode Color Code. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes or a dot. For most silicon or germanium diodes with a series of stripes, the color-code also indicates the type of diode or identifies the Tektronix Part Number using the resistor color-code system (e.g., a diode color-coded blue or pink-brown-gray-green indicates Tektronix Part Number 152-0185-00). The cathode and anode end of metal-encased diodes can be identified by the diode symbol marked on the body.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the Type 7A14.

1. Transistor Tester

Description: Tektronix Type 576 Transistor-Curve Tracer or equivalent.

Purpose: To test the semiconductors used in this instrument.

2. Volt-ohmmeter

Description: 20,000 ohms/volt. 0-500 volts DC. Accurate within 3%. Test probes must be well insulated.

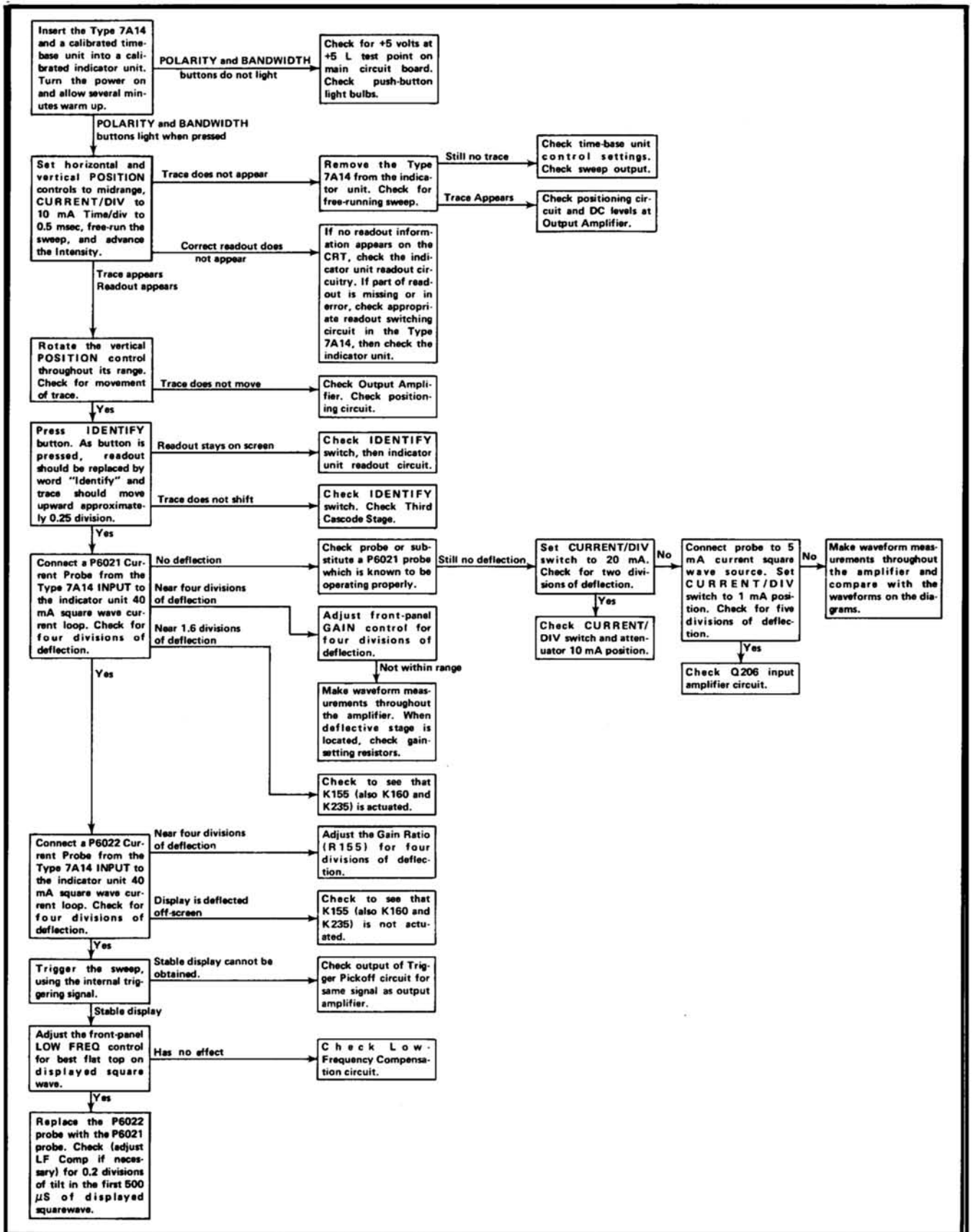


Fig. 4-2. Troubleshooting chart for Type 7A14.

Maintenance—Type 7A14

Purpose: To measure voltages and resistances.

3. Test Oscilloscope

Description: DC to 50 MHz frequency response, 5 millivolts to 5 volts/division deflection factor. Use a $10\times$ probe.

Purpose: To check waveforms in the instrument.

4. Plug-in Extension

Description: Calibration fixture.

Purpose: Permits operation of the unit outside the plug-in compartment for better accessibility during troubleshooting.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given under Corrective Maintenance.

1. Check Control Setting. 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, see the Operating Instructions section of this manual.

2. Check Associated Equipment. Before proceeding with troubleshooting of the Type 7A14, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the probe cable is not defective. The indicator oscilloscope and time-base plug-in unit can be checked for proper operation by substituting another vertical unit which is known to be operating properly (preferably another Type 7A14 or similar unit). If the trouble persists after substitution, the indicator oscilloscope and/or time-base plug-in unit is defective.

3. Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the Calibration section of this manual.

4. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged components, etc.

5. Isolate Trouble to a Circuit. To isolate a trouble to a circuit, note the trouble symptom. The symptom often indicates the circuit in which the trouble is located. For example, erroneous deflection in only the 1 mA, 2 mA and 5 mA position indicates that the Q106 input circuit rather than the Q206 circuit is probably at fault. If the LOW FREQ adjustment has little or no effect on the displayed waveform, the Low-Frequency Compensation circuit is probably not functioning properly. When trouble symptoms appear in more than one circuit, check all affected circuits by taking voltage and waveform readings. If the signal is correct, the circuit is working correctly up to that point.

Fig. 4-2 provides a guide to aid in locating a defective circuit. This chart does not include checks for all possible

defects; use steps 6 and 7 for further troubleshooting. Start from the top of the chart and perform the given checks on the left side of the page until a step is found which is not correct. Further checks and/or the circuit in which the trouble is probably located are listed to the right of this step.

After the defective circuit has been located, proceed with steps 6 and 7 to locate the defective component(s).

6. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the first diagram page.

7. Check Individual Components. The following procedures describe methods of checking individual components in the Type 7A14. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

A. RELAYS. There are two types of relays in the Type 7A14. They are the eight-pin DPDT relay, Tektronix Part No. 148-0034-00, and the five-pin SPDT relay, Tektronix Part No. 148-0035-00. These relays, which are plugged into the circuit board, may be removed and checked. Fig. 4-3 shows the internal configuration of the two relays. Using an ohmmeter, check for the indicated DC resistances. The relay may be

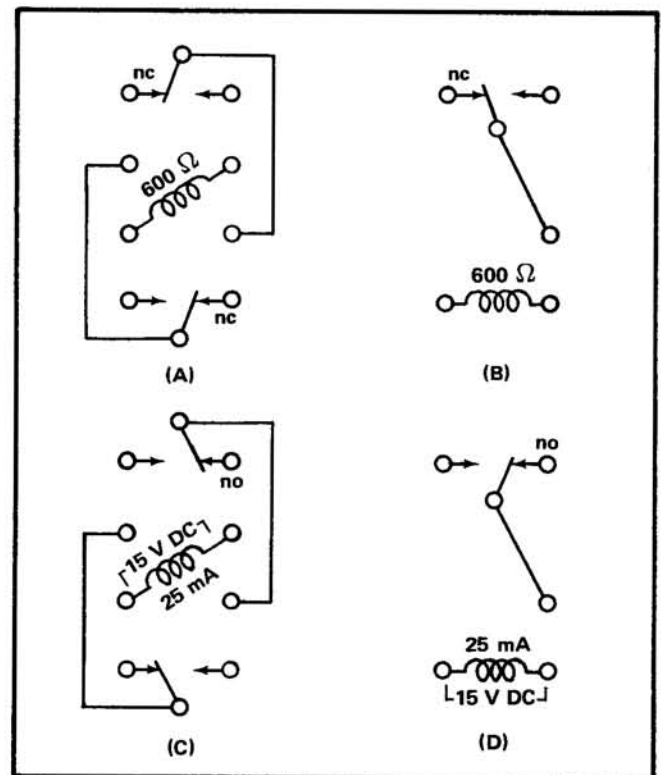


Fig. 4-3. Internal configuration of relays, showing (A) DPDT relay not energized, (B) SPDT relay not energized, (C) DPDT relay energized, and (D) SPDT relay energized.

actuated by applying fifteen volts to the coil, as shown in Fig. 4-3. With the relay actuated, check the normally open contacts for continuity. When returning the relays to the circuit board, place the five-pin SPDT relays in the five-pin sockets. The eight-pin DPDT relays are symmetrical, hence may be placed in their sockets facing either direction.

B. TRANSISTORS. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can be checked by substituting a new component 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 (such as Tektronix Type 576).

C. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode.

D. RESISTORS. Resistors can be checked with an ohmmeter. Check the Electrical Parts List for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

E. INDUCTORS. Check for open inductors by checking continuity with an ohmmeter. Shorted or partially shorted inductors can usually be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response.

F. CAPACITORS. A leaky or shorted capacitor can best be detected by checking the 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 whether the capacitor passes AC signals.

8. Repair and Readjust the Circuit. If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

CORRECTIVE MAINTENANCE

General

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

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the Type 7A14 can be obtained through your

local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may effect the performance in the instrument, particularly at high frequencies. All replacements parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special parts are used in the Type 7A14. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been 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 circuit number).
4. Tektronix Part Number.

Soldering Techniques

WARNING

Disconnect the instrument from the power source before soldering.

Circuit Boards. The components mounted on the circuit boards in the amplifier can be replaced using normal circuit board soldering techniques. Keep the following points in mind when soldering on the circuit boards.

1. Use a pencil-type soldering iron with a power rating from 15 to 50 watts.
2. Apply heat from the soldering iron to the junction between the component and the circuit board.
3. Heat-shunt the lead to the component by means of a pair of long-nosed pliers.
4. Avoid excessive heating of the junction with the circuit board, as this could separate the circuit board wiring from the laminate.
5. Use electronic grade 60-40 tin-lead solder.
6. Clip off any excess lead length extending beyond the circuit board and clean off any residual flux with a flux-removing solvent. Be careful that the solvent does not remove any printing from the circuit board.

Maintenance—Type 7A14

Metal Terminals. When soldering metal terminals (e.g., switch terminals, potentiometers, etc.), use 60-40 tin-lead solder and a 15 to 50 watt soldering iron. Observe the following precautions when soldering metal terminals:

1. Apply only enough heat to make the solder flow freely.
2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.
3. If a wire extends beyond the solder joint, clip off the excess.
4. Clean the flux from the solder joint with a flux-removing solvent.

Component Replacement

WARNING

Disconnect the equipment from the power source before replacing components.

Relay Replacement. The relays in the Type 7A14 are manufactured by Tektronix, Inc. If a relay fails, a replacement may be ordered from your local Tektronix Field Office or representative. The five-pin relay sockets on the circuit board will accept only the five-pin SPDT relay. It is possible, however to place a five-pin SPDT relay in an eight-pin socket intended for use with the eight-pin DPDT relay. This would not damage the instrument or the relay, but would cause a malfunction of the instrument. The eight-pin DPDT relays may be placed in their sockets facing either direction, as these relays are symmetrical.

Transistor Replacement. Transistors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors may

affect the calibration of this instrument. When transistors are replaced, check the operation of that part of the instrument which may be affected.

Replacement transistors should be of the original type or a direct replacement. Remount the transistors in the same manner as the original. Fig. 4-4 shows the lead configurations of the transistors used in this instrument. This view is as seen from the bottom of the transistor. When replacing transistors, check the manufacture's basing diagram for correct basing.

Light-Bulb Replacement. The POLARITY and BANDWIDTH switches each contain one incandescent light bulb common to the two push-buttons of the switch. This light bulb may be replaced without removal of the switch as follows:

1. Remove the screw and cover from the back of the switch, exposing the light bulb.
2. While holding one lead of the bulb with a pair of long-nosed pliers, touch a 15-watt pencil-type soldering iron to the connection on the other side of the circuit board. Remove the lead from the circuit board. Unsolder the remaining lead and remove the bulb.
3. Cut the leads of the replacement bulb to the same length as those of the old bulb. Place the insulating tubes over the leads.
4. Grasp one lead of the replacement bulb with the long-nosed pliers and position in the appropriate holes in the circuit board. Touch the soldering iron to the connection on the other side of the circuit board and push the lead into place. Repeat with the remaining lead.
5. Position the bulb so that it does not fall in line with the bottom push-button. Replace the cover.

POLARITY or BANDWIDTH Switch Replacement. Should either the POLARITY switch or the BANDWIDTH switch fail, the front panel must be removed to gain access to the switch mounting screws. Proceed as follows:

1. Remove the four control knobs from their shafts. The IDENTIFY button pulls off; use a $\frac{1}{16}$ -inch hex-head wrench to remove the POSITION, CURRENT/DIV, and VAR control knobs.
2. Remove the nut from the POSITION control, using a $\frac{5}{16}$ -inch hex-socket wrench. Remove the washer.
3. Remove the nut from the CURRENT/DIV control, using a $\frac{7}{16}$ -inch hex-socket wrench. Remove the washer.
4. Remove the bushings from the LOW FREQ and GAIN controls.
5. Remove the front panel to gain access to the switch mounting screws. Remove the screw holding the faulty switch assembly.
6. Install the replacement switch by reversing the above procedure. Match the arrow on the plug to the arrow on the jack when replacing pin connectors.

CURRENT/DIV Switch Removal. The CURRENT/DIV cam switch consists of two circuit boards, on which are mounted the switch contacts, positioned adjacent to the cam or rotating portion of the switch. For inspection, cleaning, repair, or replacement, the switch should be disassembled as follows:

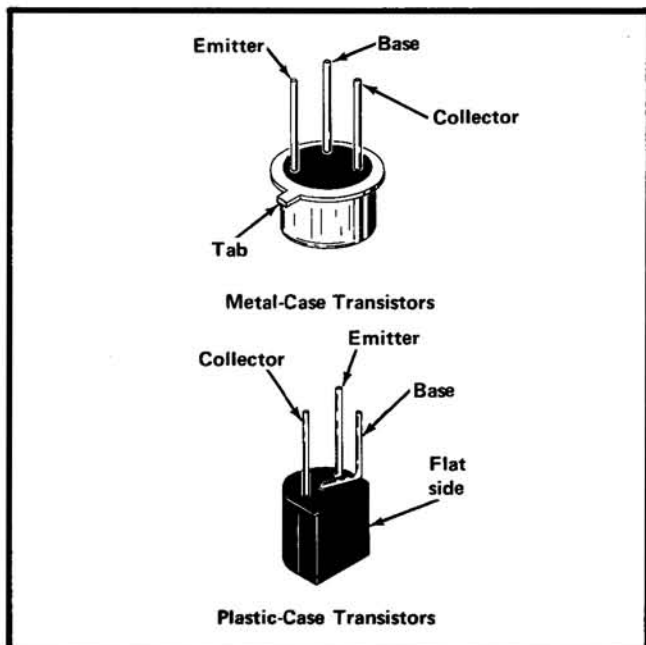


Fig. 4-4. Electrode configuration for transistors in this instrument.

1. Remove the two screws which secure the smaller of the two cam switch circuit boards to the right side of the switch. Unsolder the ground strap.

2. Lift the circuit board up slightly at the rear and remove it from the switch. The circuit board may be removed completely by disconnecting the pin connections.

CAUTION

Do not bend the circuit board switch contacts. A change in position or tension may cause a malfunction of the switch.

3. Remove the cross-brace from the instrument. It is secured by two counter-sunk phillips-head screws, one top and one bottom, and two $\frac{5}{16}$ -inch nuts near the back of the cam switch.

4. Unsolder the two straps running from the back of the remaining cam switch circuit board to the main circuit board.

5. Unsolder the center conductor and ground connection from the INPUT connector.

6. Remove the CURRENT/DIV and VAR control knobs, using a $\frac{1}{16}$ -inch hex-head wrench.

7. Remove the nut and washer from the front of the CURRENT/DIV switch, using a $\frac{7}{16}$ -inch hex-socket wrench.

8. Disconnect the VAR control shaft from the slide switch and potentiometer.

9. Remove the remainder of the switch assembly from the instrument.

10. Remove the two screws holding the attenuator shield onto the cam switch circuit board.

11. Remove the four screws holding the circuit board to the cam portion of the switch and separate the two.

12. Remove the small screw from the cam assembly and separate the front and back sections of the stator.

13. Remove the 'C' ring from the front of the shaft and slide the cam out of the stator. Do not lose the small detent roller.

14. Reassemble the CURRENT/DIV switch assembly by reversing the above procedure. Match the arrow on the plug to the arrow on the jack when replacing pin connectors.

Main Circuit Board Replacement. If the main amplifier circuit board requires replacement, a complete wired board is available from Tektronix, Inc. To replace the circuit board, proceed as follows:

1. The GAIN potentiometer is located near the back of the instrument, and is driven from the front panel by a control shaft. Using a .05-inch hex-head wrench, loosen the two setscrews on the front portion of the coupling and remove the shaft.

2. Disconnect the VAR control shaft from the slide switch and potentiometer.

3. Remove the cross-brace from the instrument. It is secured by two counter-sunk phillips-head screws, one on top and one on the bottom, and two $\frac{5}{16}$ -inch nuts near the back of the CURRENT/DIV circuit board.

4. Unsolder the two straps running from the back of the cam switch circuit board to the main circuit board.

5. Unsolder the center connection (B) to the VAR (CAL/UNCAL) switch circuit board.

6. From the left side of the instrument, partially remove the two screws which secure the main circuit board to the cam switch circuit board. Loosen the screws until they clear the cam switch circuit board.

7. Remove all the pin connections from both sides of the main circuit board. See Fig. 4-5 for wiring color code.

8. Remove the six screws that secure the main circuit board to the positioning blocks.

9. Remove the four screws which secure the rear casting to the top and bottom frame.

10. Remove the circuit board assembly from the instrument.

11. Unsolder the potentiometer connections and remove the mounting brackets from the circuit board.

12. Install the replacement circuit board by reversing the above procedure.

Recalibration After Repair

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. The Performance Check procedure in Section 5 provides a quick and convenient means of checking instrument operation.

Repackaging Information

If the 7A14 is to be shipped for long distances by commercial means of transportation, it is recommended that the instrument be repackaged in the original manner for maximum protection. The original shipping carton can be saved and used for this purpose. Repackaging information and/or new shipping cartons can be obtained from Tektronix, Inc. Contact your local Tektronix Field Office or representative.

NOTE

The plug-ins should not be shipped installed in an oscilloscope. The oscilloscope packaging material is not designed to protect the plug-ins.

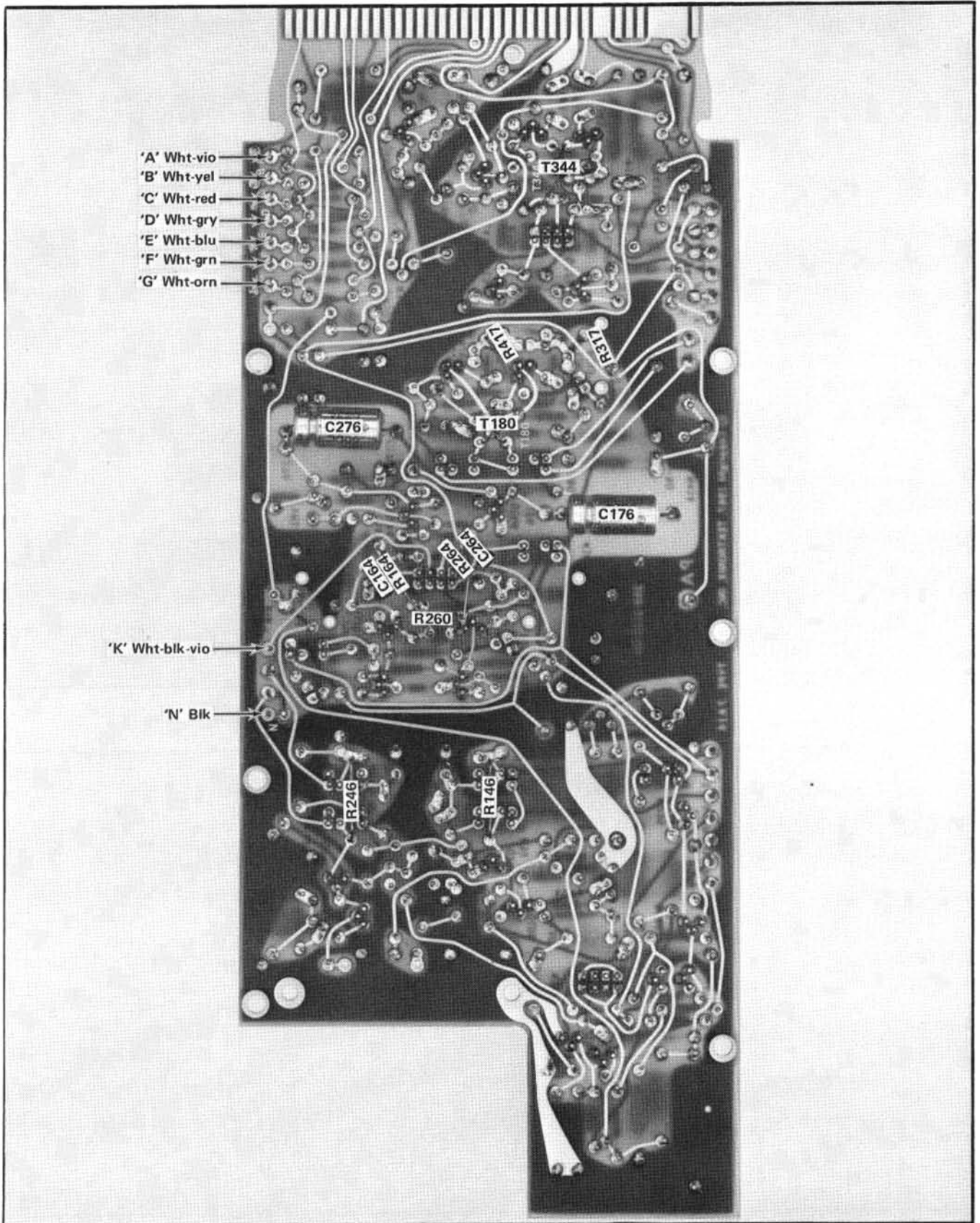


Fig. 4-6. Main Circuit Board (rear view).

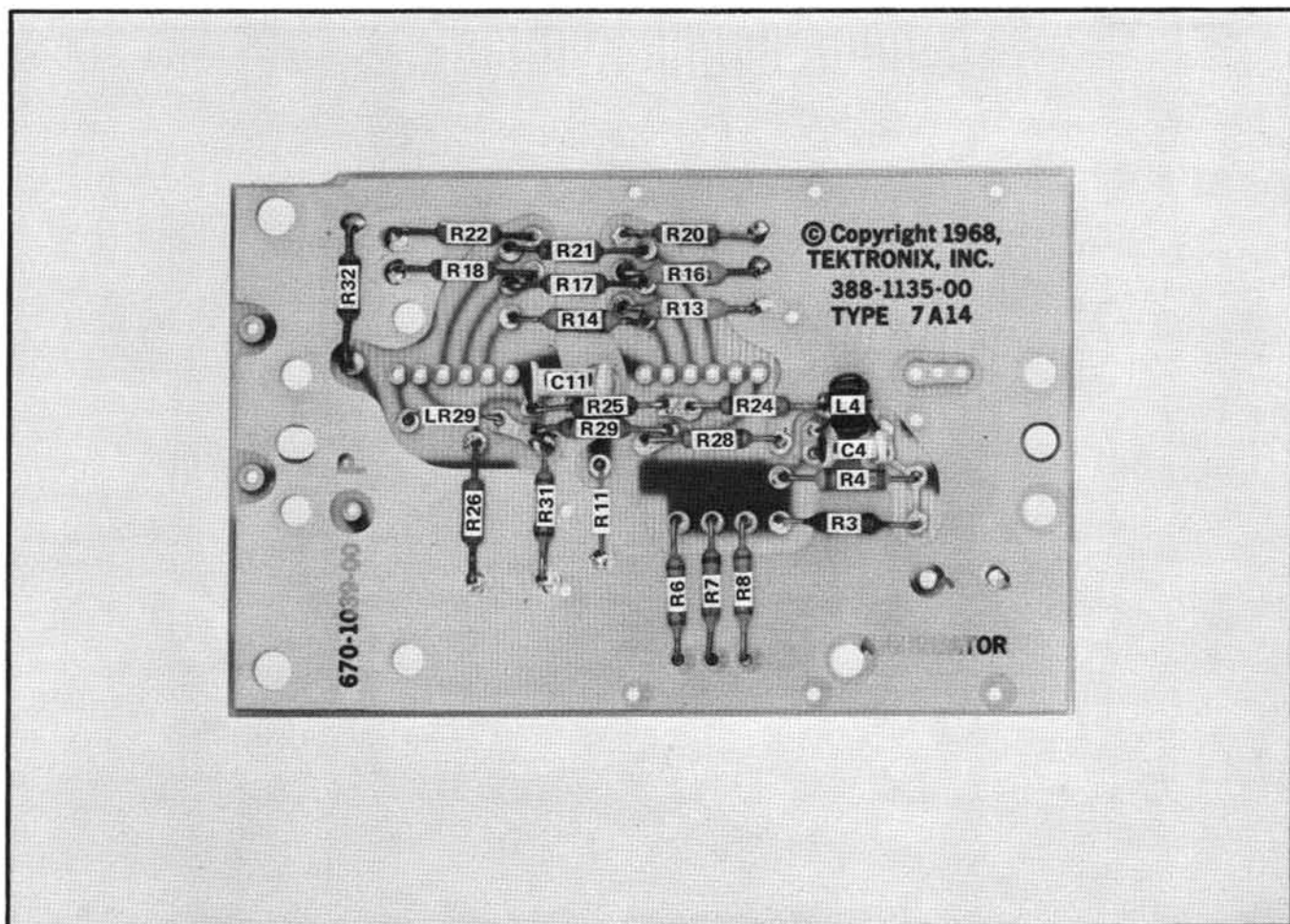


Fig. 4-7. Attenuator Board.

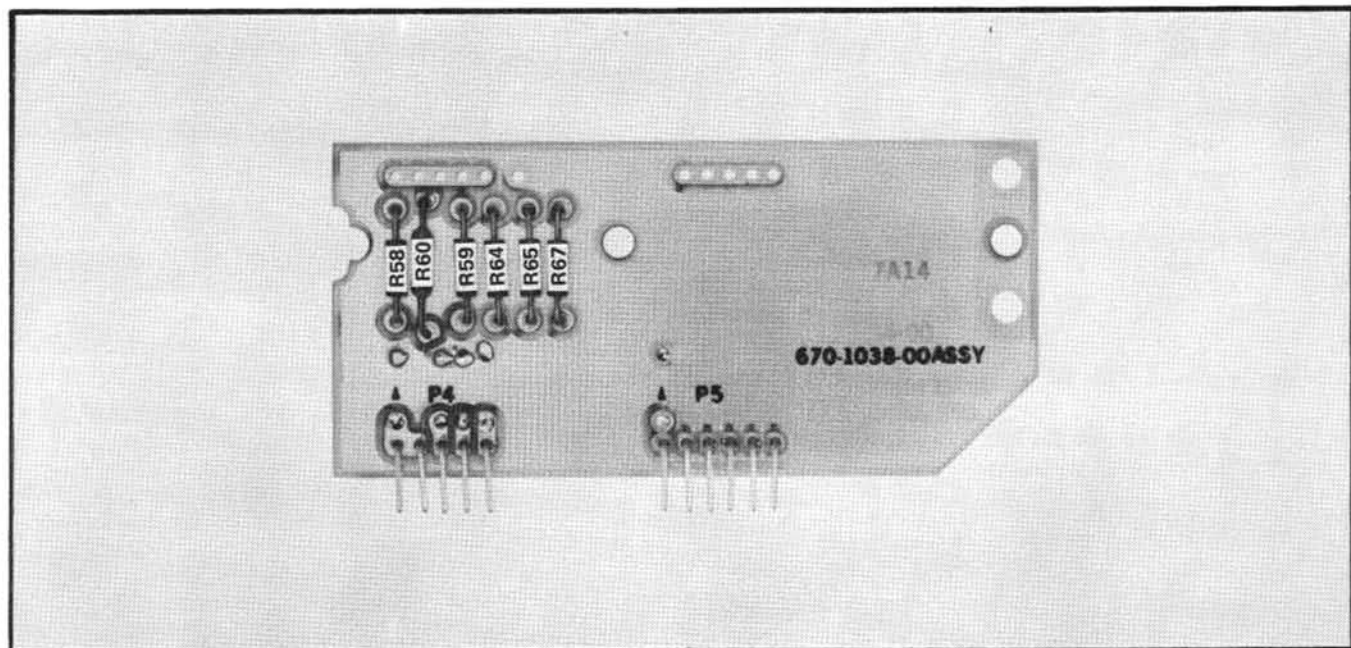


Fig. 4-8. Logic Board.

SECTION 5

PERFORMANCE CHECK / CALIBRATION

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

Introduction

To assure instrument accuracy, check the calibration of the Type 7A14 every 1000 hours or every six months if used infrequently. Before calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance Section.

The complete Performance Check/Calibration Procedure can be used to check instrument performance without removing side covers or making internal adjustments by performing all portions except the ADJUST part of the steps. (The ADJUST instructions are printed in red.) Screw-driver adjustments which are accessible without removing the covers are adjusted as part of the performance check procedure. A note titled PERFORMANCE CHECK ONLY gives instructions which are applicable only to the performance check procedure.

Completion of each step in the complete Performance Check/Calibration Procedure insures that this instrument meets the electrical specifications given in Section 1. For best overall instrument performance, when performing a complete calibration procedure, make each adjustment to the exact setting even if the CHECK is within the allowable tolerance.

A Short-Form Procedure is given prior to the complete procedure. To facilitate instrument calibration, for the experienced calibrator, the Short-Form Procedure lists the calibration adjustment necessary for each step and the applicable tolerances. This procedure also includes the step number and title as listed in the complete Performance Check/Calibration Procedure and the page number on which each step begins. Therefore, the Short-Form Procedure can be used as an index to locate a step in the complete procedure. Another feature of the Short-Form Procedure is the spaces provided to record performance data or to check off steps as they are completed. This procedure may be reproduced and used as a permanent record of instrument calibration.

NOTE

All waveforms shown in this procedure were taken with a Tektronix Oscilloscope Camera System. Limits, tolerances and waveforms in this procedure are given as calibration guides and should not be interpreted as instrument specifications except as specified in Section 1.

A partial calibration is often desirable after replacing a component or to touch up an adjustment of a portion of the instrument between major recalibrations. For partial calibration, set the controls as given under Preliminary Control Setting and start with the nearest test equipment pic-

ture preceding the desired check or checks. If any controls need to be changed from the preliminary settings for this portion of the calibration procedure, they are listed under the heading Partial Procedure following the equipment required picture. To prevent unnecessary recalibration of other parts of the instrument, readjust only if the tolerance given in the CHECK part of the step is not met. If readjustment is necessary, also check the calibration of any steps listed in the INTERACTION part of the step.

An Alternate Calibration Procedure is given for steps 7 (7A) and 14 (14A) for those desiring to calibrate the Type 7A14 in a specific Indicator Oscilloscope, or if a Sampling Oscilloscope System is not available. This procedure will insure that the Type 7A14 will meet the System Specifications for the particular Indicator Oscilloscope being used. However, if this Alternate Procedure is used, the Type 7A14 must be recalibrated each time it is operated in a different Indicator Oscilloscope (even one of the same Type). The remainder of the calibration steps apply equally to both procedures.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or its equivalent, are required for complete calibration of the Type 7A14. Specifications given are the minimum necessary for accurate calibration. Therefore, some of the recommended equipment may have specifications which exceed those given. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

Special Tektronix calibration fixtures are used in this procedure only where they facilitate calibration. These special calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Test Equipment

1. 7000 series Indicator Oscilloscope. Type 7504 used in these checks.
2. 7B—series Time-Base. Type 7B51 used in these checks.
3. Test Oscilloscope. Storage and Sampling capabilities; Bandwidth, at least 200 megahertz; minimum deflection factor, 10 millivolts/div. Tektronix Type 564B with 3S1/3T2 plug-in units recommended.

Performance Check/Calibration—Type 7A14

4. Pulse Generator. Risettime, 0.25 nanosecond; amplitude, 0 to 50 volts into 50 ohms. Tektronix Type 109 recommended.

5. Delay Line. Characteristic impedance, 50 ohms; 60 nanoseconds delay. Tektronix Type 113 Delay Cable recommended.

6. Constant Amplitude Sine-Wave Generator. Reference frequency, 50 kHz; frequency range, below 15 megahertz to above 60 megahertz; output amplitude, variable from 0.5 to 5 volts peak to peak; amplitude accuracy, within 3% of 50 kHz reference as output frequency changes. Tektronix Type 191 Constant Amplitude Signal Generator recommended.

7. Constant Amplitude Sine-Wave Generator. Reference frequency, 1 kHz; frequency range, 20 hertz to above 1 kilohertz; output amplitude, variable from 0.5 to 5 volts peak to peak; amplitude accuracy, output amplitude constant within 3% of 1 kHz reference frequency as output frequency changes. For example, General Radio Model 1310-A Oscillator.

8. DC Voltmeter. 20,000 ohms/volt minimum sensitivity; range, 0 to 50 volts; accuracy, checked to within 1% at the voltages to be measured. For example, Triplet Model 630-NA.

9. Calibration Fixture, Constant Amplitude Signal Generator. Reference frequency, 3 megahertz; frequency range, 65 megahertz to above 175 megahertz; output amplitude, 0.5 to 5 volts peak to peak into 50 ohms; amplitude accuracy, output amplitude constant within 1% of 3 megahertz reference as output frequency changes. Tektronix Part Number 067-0532-00.

10. Calibration Fixture, Plug-In Extender, Tektronix Part Number 067-0589-00.

11. Calibration Fixture. 50-ohm terminating current loop; GR connector. Tektronix Part Number 067-0559-00.

Accessories

12. Cable (two). Impedance, 50 ohms; electrical length, 2 nanoseconds; connectors, GR. Tektronix Part Number 017-0505-00.

13. Adapter (two). GR to BNC female. Tektronix Part Number 017-0063-00.

14. Adapter. GR to BNC male. Tektronix Part Number 017-0064-00.

15. Adapter (two). GR elbow. Tektronix Part Number 017-0070-00.

16. Termination. Impedance, 50 ohms; endline; connector, GR. Tektronix Part Number 017-0081-00.

17. Attenuator. Impedance 50 ohms; attenuation, 2X; connectors, GR. Tektronix Part Number 017-0080-00.

18. Attenuator. Impedance, 50 ohms; attenuation, 5X; connectors, GR. Tektronix Part Number 017-0079-00.

19. Attenuator. Impedance, 50 ohms; attenuation 10X; connectors, GR. Tektronix Part Number 017-0078-00.

20. CT-3, Signal Pickoff. Tektronix Part Number 017-0061-00.

21. Coaxial Cable. Impedance, 50 ohms; length, 18 inch. Connectors, BNC. Tektronix Part Number 012-0076-00.

22. P6021 Current Probe. Tektronix Part Number 010-0237-00.

23. P6022 Current Probe. Tektronix Part Number 010-0238-00.

24. Variable Attenuator. A variable attenuator which has the end terminals of a 100-ohm potentiometer connected from input to ground and the potentiometer divider arm connected to the attenuator output. Tektronix Calibration Fixture 067-0511-00 recommended.

25. Alignment Tool Kit. Tektronix Part Number 003-0007-00.

SHORT-FORM PROCEDURE

Type 7A14

Calibration Date _____

Calibrated By _____

1. Adjust DC Balance (R110-R111-R152-R313-
Position-R338-R414-R368) Page 5-4

Requirement: Correct balance; see complete procedure.
Performance: Correct ; incorrect .

2. Adjust Internal Gain Ratio (R202) Page 5-5

Requirement: With CURRENT/DIV at 1 mA, signal in through 2X, 5X, and 10X attenuators adjusted for 5 divisions; reset CURRENT/DIV to 10 mA and remove the 10X attenuator. Check for 5 divisions of display.

Performance: Correct ; incorrect .

3. Adjust 5 mA Gain (R245) Page 5-5

Requirement: With CURRENT/DIV at 1 mA, signal in through 2X, 5X, and 10X attenuators adjusted for 5 divisions; reset CURRENT/DIV to 5 mA and remove the 5X attenuator. Check for 5 divisions of display.

Performance: Correct ; incorrect .

4. Adjust P6022 Probe Gain (R155) Page 5-5

Requirement: With CURRENT/DIV at 5 mA, signal in through P6021 Probe adjusted for 5 divisions; replace the P6021 probe with the P6022. Check for 5 divisions of display.

Performance: Correct ; incorrect .

5. Check/Adjust Front-Panel Gain (R318) Page 5-5

Requirement: With Current Probe connected to Indicator Oscilloscope 40 mA current loop and CURRENT/DIV set to 10 mA. Check for 4 divisions of display.

Performance: Correct ; incorrect .

6. Check Deflection Accuracy Page 5-6

Requirement: Vertical deflection factor, for all positions of the CURRENT/DIV switch, within 3% of gain set at 10 mA/Div.

Performance: Correct ; incorrect (list exceptions).

7. Adjust High-Frequency Compensation (R143- Page 5-7
C143-C141-C170-C259-R309-C309-C310-R347-C347-C145-
C245-R103-C100-C160-C154-C363)
Requirement: Optimum square leading corner and flat
top. See complete procedure.
Performance: Correct ; incorrect .
- 7A. Adjust High-Frequency Compensation (Al- Page 5-8
ternate Procedure) adjustments and requirements are the
same as Step 7.
8. Check/Adjust Low-Frequency Compensation Page 5-8
(R128)
Requirement: 0.2 division tilt in the first 500 μ s of a 1 kilo-
hertz square-wave.
Performance: Correct ; incorrect .
9. Check Variable Current/Div Control Range Page 5-9
Requirement: Continuously variable between the cali-
brated settings of the CURRENT/DIV switch.
Performance: Correct ; incorrect .
10. Check Trigger Out Gain Page 5-9
Requirement: Trigger out gain is approximately the same
as the vertical out gain.
Performance: Correct ; incorrect .
11. Check Trace IDENTIFY Page 5-9
Requirement: Trace moves about 0.25 division and (if
applicable) the displayed readout is replaced by the word
IDENTIFY.
Performance: Correct ; incorrect .
12. Check Low-Frequency —3 dB Point Page 5-9
Requirement: Gain is not more than —3 dB at 25 hertz
with the P6021 probe (250 hertz with the P6022 probe).
Performance: P6021 probe: hertz.
P6022 probe: hertz.
13. Check 20 Megahertz Bandwidth Page 5-10
Requirement: 3 dB attenuation of a 20 megahertz sine-
wave input, within 3 megahertz.
Performance: 3 dB down at megahertz.
14. Check High-Frequency —3 dB Point Page 5-10
Requirement: Not more than —3 dB at 175 megahertz
using P6022 probe (60 megahertz with the P6021 probe).
Performance: P6022 megahertz.
P6021 megahertz.
- 14A. Check High-Frequency —3 dB Point Page 5-11
(Alternate Procedure)
Requirement: With a 7500 series Indicator Oscilloscope:
not more than —3 dB at 75 megahertz using P6022
probe (45 megahertz with the P6021 probe). With a
7700 series Indicator Oscilloscope: not more than —3 dB
at 105 megahertz using P6022 probe (50 megahertz with
the P6021 probe).
Performance: Type 7500 with P6021 megahertz.
P6022 megahertz.
Performance: Type 7700 with P6021 megahertz.
P6022 megahertz.
15. Check Overall Noise Level Tangentially Page 5-12
Requirement: Not more than 0.2 division noise.
Performance: division.

General

The following procedure is arranged so the Type 7A14 can be calibrated with the least interaction of adjustments and reconnection of equipment. A picture of the test equipment required for each group of steps is given to aid in identification of the necessary equipment. The control settings and test equipment setup throughout this procedure continue from the preceding step(s) unless noted otherwise. The control settings can be checked at any "test equipment required" picture by setting the controls as given at the start of the procedure under the heading Preliminary Control Settings. Then make any changes listed following the "test equipment required" picture, under the heading Partial Procedure (also applies to partial calibration procedure).

The following procedure uses the equipment listed under Test Equipment Required. If other equipment is substituted, control settings or calibration setup may need to be altered to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is required.

NOTE

This instrument should be calibrated at an ambient temperature of 20°C to 30°C for best overall accuracy. The performance of this instrument can be checked at any temperature within the 0°C to +40°C range. If the temperature is outside the given range, see Section 1 for the applicable tolerances.

Preliminary Procedure for Complete Calibration

1. Connect the Type 7A14 to the Plug-in Extender and plug the Extender into the Indicator Oscilloscope Left Vertical compartment.

2. Connect the Indicator Oscilloscope to a suitable power source. Set the Power switch to ON (turn Intensity control fully CCW) and allow 20 minutes warm-up.

Preliminary Control Settings

TYPE 7A14

CURRENT/DIV	10 mA
POLARITY	+ UP
BANDWIDTH	FULL
POSITION	Midrange

A TIME-BASE

TRIGGERING CONTROLS

MODE	AUTO
COUPLING	AC
SOURCE	INT
LEVEL/SLOPE	0/+
HORIZ MAG	×1
POSITION	Midrange
TIME/DIV	.05 μs
VAR TIME/DIV	CAL IN

INDICATOR OSCILLOSCOPE

FOCUS	Optimum
INTENSITY	Optimum
CALIBRATOR RATE	1 kHz

Test Oscilloscope

Focus	Optimum
Intensity	Optimum

Type 3T2

Time Position (Fine and Coarse)	Fully CW
Horiz Position	Midrange
Range	100 ns
Start Point	With Trigger
Time Magnifier	×1
Display Mode	Normal
Polarity	+
Source	Int

Type 3S1

Position (A and B)	Midrange
Dual Trace	A + B
mVOLTS/Div (both)	50
CH 1 Invert/Norm	Norm
CH 2 Invert/Norm	Invert
Internal Trigger	A

NOTE

Refer to Fig. 5-1 for location of test points.

1. Adjust DC Balance



- a. TP146 and TP246.
 - (1) Set the DC Voltmeter to the +12 volt scale.
 - (2) Connect the voltmeter between TP146 and TP246.
 - (3) ADJUST—R110 for a null (zero) reading on voltmeter. Shift the voltmeter to progressively lower scales as null is approached.
- b. TP115 and TP215.
 - (1) Reset the voltmeter to the 12 volt scale.
 - (2) Connect the voltmeter between TP115 and ground.
 - (3) ADJUST—R111 for +4.5 volts from TP115 to ground.
 - (4) CHECK—for +4.5 volts from TP215 to ground.
- c. TP176 and TP276.
 - (1) Connect the voltmeter between TP176 and TP276.
 - (2) ADJUST—R152 for a null (zero) reading on voltmeter. Shift the voltmeter to the lowest scale for the final adjustment.
- d. TP316 and TP416.
 - (1) Reset the voltmeter to the 12 volt scale.
 - (2) Connect the voltmeter between TP316 and TP416.
 - (3) ADJUST—R313 for a null (zero) reading on voltmeter. Shift the voltmeter to the lowest scale for the final adjustment.
- e. TP340 and TP440.
 - (1) Reset the voltmeter to the 12 volt scale.
 - (2) Connect the voltmeter between TP340 and TP440.
 - (3) ADJUST—POSITION control for a null (zero) reading on voltmeter. Shift the voltmeter to the lowest scale for the final adjustment.
- f. A11 and B11.
 - (1) Reset the voltmeter to the 12 volt scale.
 - (2) Connect the voltmeter between A11 and B11 (the rearward end of R345 and R445. See Fig. 5-1).
 - (3) ADJUST—R338 for a null (zero) reading on the voltmeter. Shift to the lowest scale for the final adjustment.
- g. DC Common Mode Balance
 - (1) Reset the voltmeter to the 12 volt scale.
 - (2) Connect the voltmeter between A11 (the rearward end of R345) and ground.

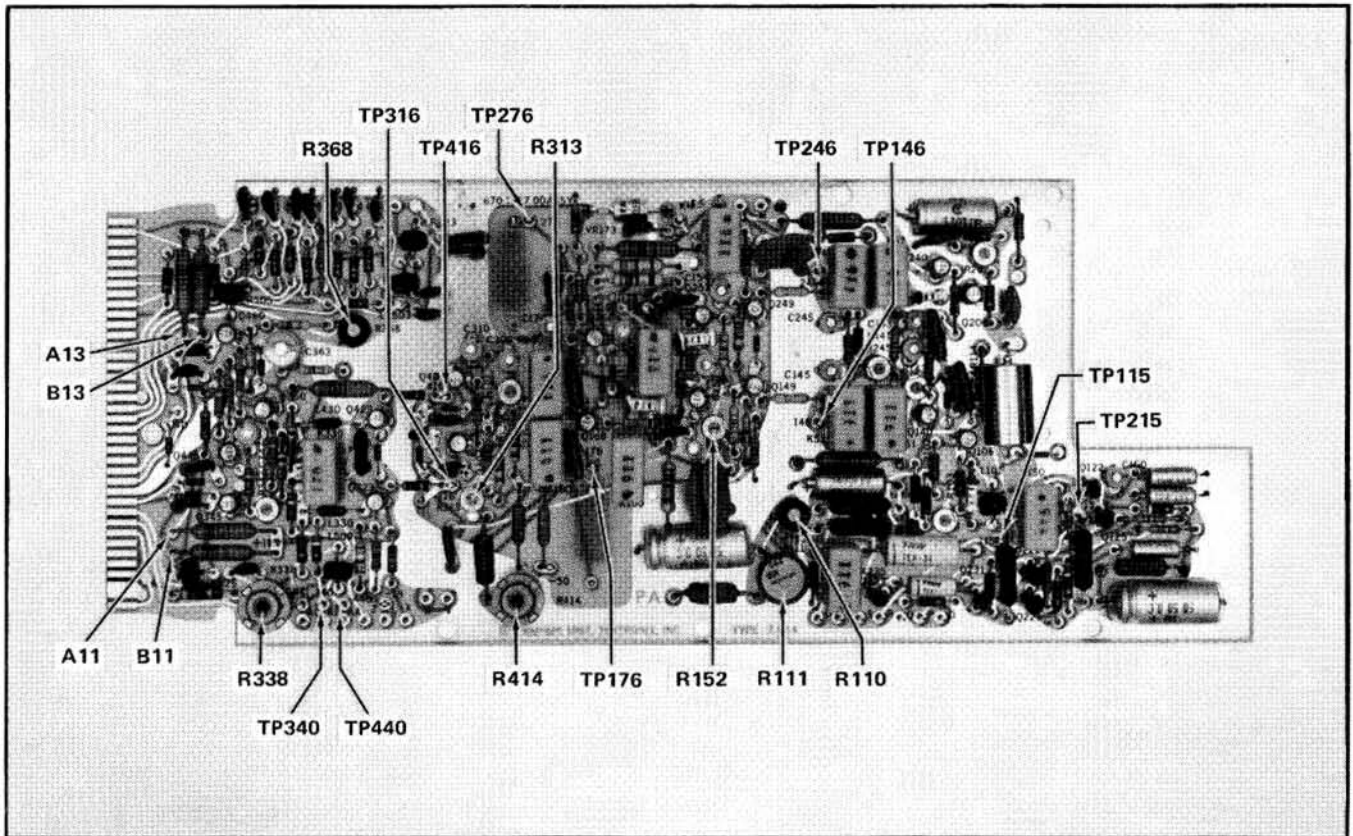


Fig. 5-1. Location of adjustment and test points for DC Balance checks.

(3) ADJUST—R414 for zero volts between A11 and ground.

(4) CHECK—B11 to ground for zero volts.

INTERACTION: Recheck Step f.

h. Trigger Balance

(1) Connect the voltmeter between A13 and B13 (the bottom end of R360 and R460).

(2) ADJUST—R368 for a null (zero) reading on the voltmeter. Shift the voltmeter to the lowest scale for the final adjustment.

(3) CHECK—A13 and B13 to ground for a voltmeter reading of approximately zero volts.

2. Adjust Internal Gain Ratio ①

a. Test equipment setup is shown in Fig. 5-2; Reset the Type 7A14 CURRENT/DIV to 1 mA.

b. Connect a 50 ohm termination to one of the Type 109 charge lines, connect the remaining charge line through two GR elbows to the Type 113; connect the 10×, 5×, and 2× GR Attenuators to the Output connector of the Type 109; connect the Calibration Fixture to the Attenuators; connect the P6021 Current Probe from the Type 7A14 CURRENT PROBE INPUT to the Calibration Fixture.

c. Adjust the Type 109 for 5 divisions of displayed amplitude (disregard the first 50 ns of the pulse).

d. Reset the Type 7A14 CURRENT/DIV to 10 mA and remove the 10× Attenuator.

e. ADJUST—R202 for 5 divisions of displayed amplitude.

3. Adjust 5 mA Gain ①

a. Replace the 5× Attenuator with the 10× Attenuator and reset the Type 7A14 CURRENT/DIV to 5 mA.

b. ADJUST—R245 for 5 divisions of displayed amplitude.

4. Adjust P6022 Current Probe Gain

a. Replace the P6021 Current Probe with the P6022 Current Probe.

b. ADJUST—R155 for 5 divisions of displayed amplitude.

5. Check/Adjust Front-Panel GAIN

a. Reset the Type 7A14 CURRENT/DIV to 10 mA and connect the P6022 Current Probe to the Indicator Oscilloscope 40 mA Current Loop. Reset the Time-Base TIME/DIV to .2 ms.

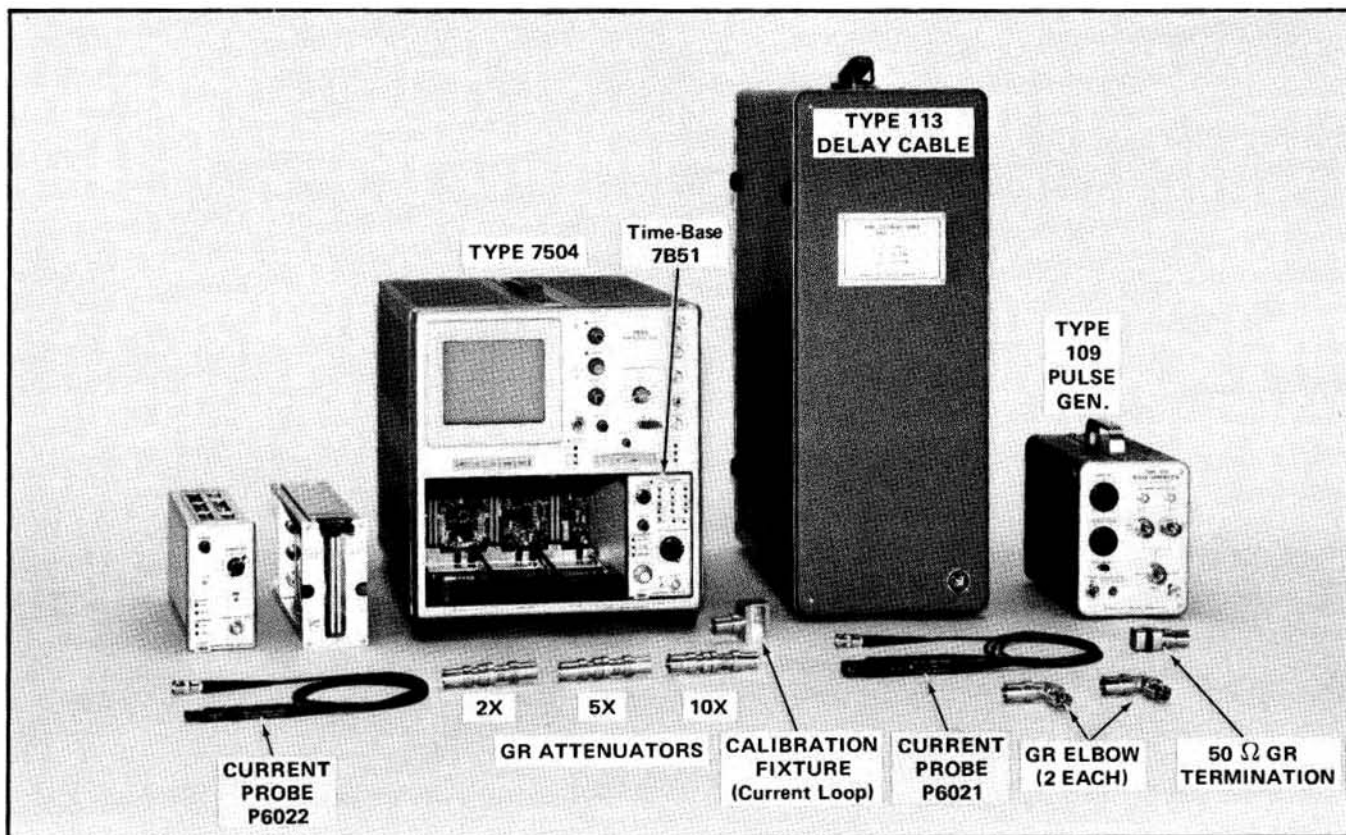


Fig. 5-2. Test equipment required for Steps 2 through 6.

- b. CHECK—For 4 divisions of displayed amplitude. PERFORMANCE CHECK—Front-Panel adjustment; may be adjusted as part of performance check.
- c. ADJUST—GAIN control, R318, for 4 divisions of displayed amplitude. See Fig. 5-3.

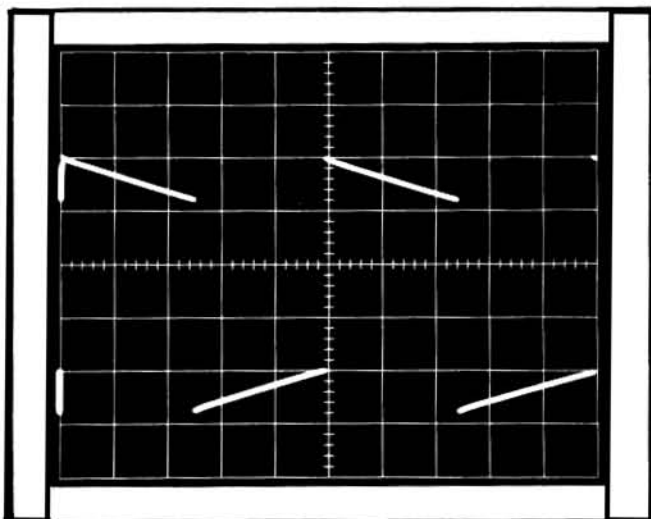


Fig. 5-3. 40 mA Calibrator square-wave. Front-panel GAIN adjusted for 4 divisions.

6. Check Deflection Accuracy

- a. Reset the Time-Base TIME/DIV to $.05 \mu s$.
- b. Connect the P6022 Current Probe through the Calibration Fixture, 10X, and 2X Attenuators to the Type 109 Output.
- c. Adjust the Type 109 for 4 divisions of displayed amplitude.
- d. CHECK—The remaining positions of the Type 7A14 CURRENT/DIV switch using Table 5-1 as a guide.

TABLE 5-1

CURRENT /DIV Sw. setting	Vertical Deflection (divisions)	Maximum Error for 3% accuracy (divisions)	Attenuators used
20 mA	4	.12	5X, 2X
50 mA	3.2	.1	5X
.1 A	4	.12	2X
.2 A	4	.12	none
.5 A	1.6	.05	none
1 A	.8	.025	none

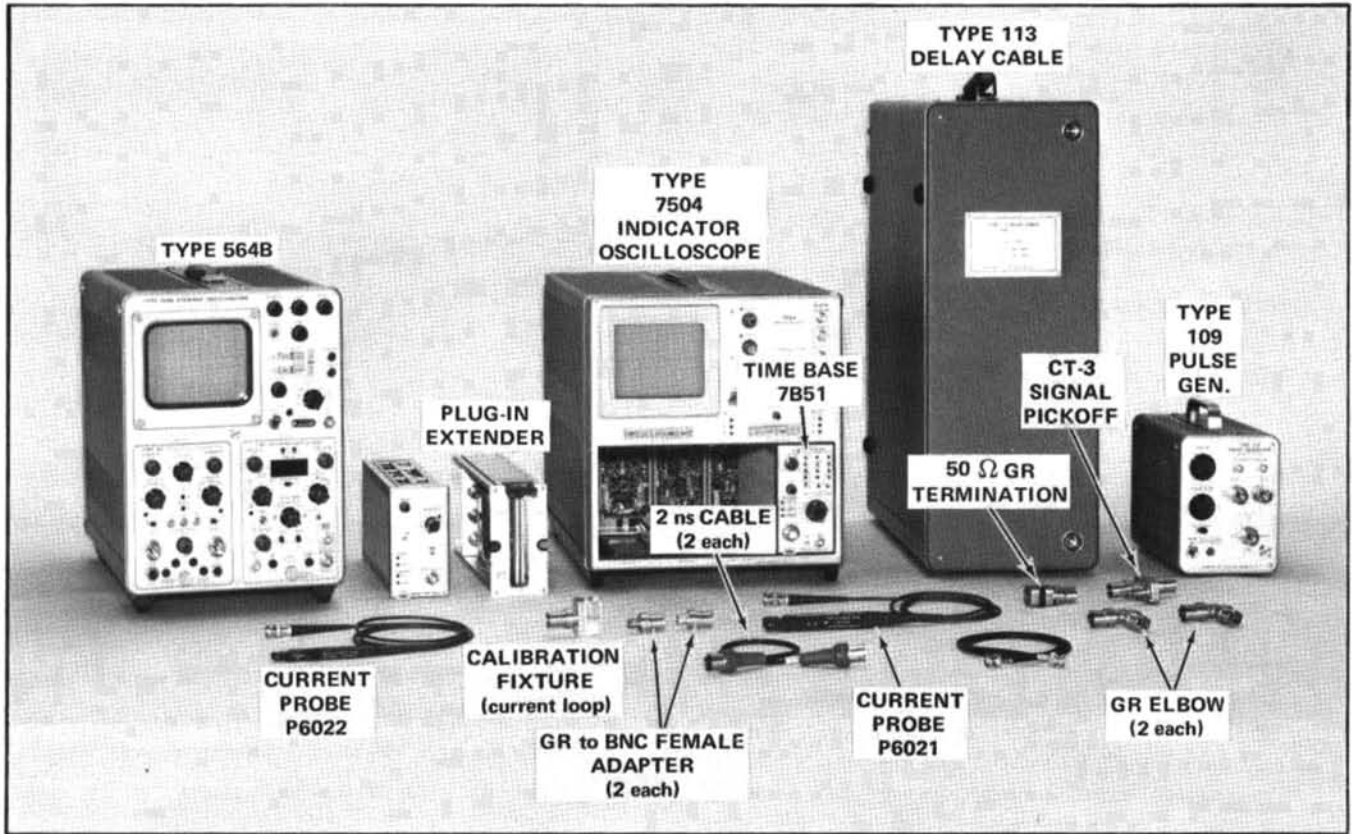


Fig. 5-4. Test equipment setup for step 7.

Partial Procedure

If beginning a partial procedure with this step, set the controls as given under Preliminary Control Settings except as follows:

CURRENT/DIV 20 mA

7. Adjust High-Frequency Compensation

- Test equipment setup is shown in Fig. 5-4.
- Using two GR elbows, connect the Type 109 Charge Line to the Type 113 Delay Cable, terminate the other Charge Line into a 50 Ω Termination; connect the CT-3 Signal Pickoff and the Calibration Fixture to the Type 109 Output; using the 2 ns cables, connect the two vertical signal cables of the Extender to the Type 3S1 A and B inputs; Connect the P6022 Current Probe from the Type 7A14 to the Calibration Fixture.
- Adjust the Type 109 for a pulse amplitude of 5 divisions on the Test Oscilloscope.

NOTE

The Type 3T2 Time Position control range may not be sufficient to observe the leading edge of

the pulse. In this case, externally trigger the Type 3T2 using a BNC cable from the CT-3 BNC connector to the Type 3T2 50 Ω Trigger Input connector.

d. ADJUST—C143 for minimum level difference, R143 for minimum ringing and C141 for best corner. Reset the Type 3T2 Time Magnifier to X5 and adjust the following for best response:

C170	best level
C259	best corner
R309	least ringing
C309	best level
C310	best corner
R347	least ringing
C347	best corner

e. Reset the Type 7A14 CURRENT/DIV to 50 mA and re-adjust the Type 109 for 5 divisions of displayed amplitude.

f. ADJUST—C145 and C245 for best corner.

g. Reset the Type 7A14 CURRENT/DIV to 5 mA and re-adjust the Type 109 for a 5 division display.

Performance Check/Calibration—Type 7A14

- h. ADJUST—C100-R103 for best front corner and no level difference in first 20 ns. Reset the Type 3T2 Time Magnifier to X1.
- i. Check for aberrations not to exceed the values given:

NOTE

These values are given as an aid to calibration and are not instrument specifications.

- | | |
|-----------------------|---------|
| 1 mA/Div to 50 mA/Div | 5% P-P |
| .1 A/Div | 6% P-P |
| .2 A/Div | 10% P-P |
| .5 A and 1 A/Div | 6% P-P |
- j. Replace the P6022 Current Probe with the P6021 Current Probe. Reset the Type 7A14 CURRENT/DIV to 20 mA and adjust the Type 109 for a 5-division display.
 - k. ADJUST—C160-C154 for optimum square leading corner.
 - l. CHECK—The remaining positions of the CURRENT/DIV switch, adjusting the Current Probe High-Frequency Compensation adjust for optimum response. Replace the P6021 Current Probe with the P6022 Current Probe.
 - m. Replace the Extender Vertical Out cables and connect the Extender Trigger Out cables through the 2 ns cables to the Type 3S1 A and B inputs. Reset the Type 7A14 CURRENT/DIV to 20 mA and adjust the Type 109 for 5 divisions of display.
 - n. ADJUST—C363 for optimum square leading corner.
 - o. Replace the Trigger Out cables on their correct jacks.

NOTE

If steps 7A and 14A are used, the Type 7A14 must be recalibrated when used with another Indicator Oscilloscope.

7A. Adjust High-Frequency Compensation (alternate procedure) ①

- a. Reset the Type 7A14 CURRENT/DIV to 20 mA.
- b. Using two GR elbows, connect the Type 109 Charge Line to the Type 113 Delay Cable, terminate the other Charge Line into a 50 Ω Termination; connect the CT-3 Signal Pickoff and the Calibration Fixture to the Type 109 Output; connect the P6022 Current Probe from the Type 7A14 to the Calibration Fixture.
- c. Adjust the Type 109 for a pulse amplitude of 5 divisions.
- d. ADJUST—The following, in the order given, for the best square leading corner and no level difference in the first 20 ns; R143-C143-C141-C170-C259-R309-C309-C310-R347-C347. Repeat the adjustments if necessary for optimum results.
- e. Reset the Type 7A14 CURRENT/DIV to 50 mA and re-adjust the Type 109 for 5 divisions of displayed amplitude.

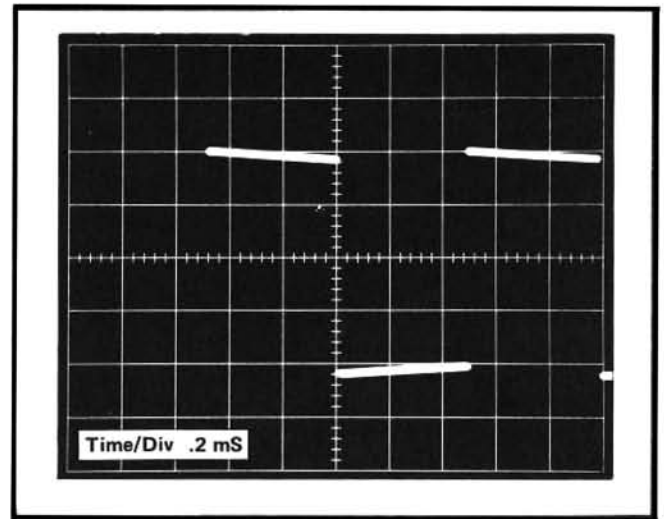


Fig. 5-5. LF Comp correctly adjusted using P6021 probe for 1 minor division of tilt in the first 500 μ s.

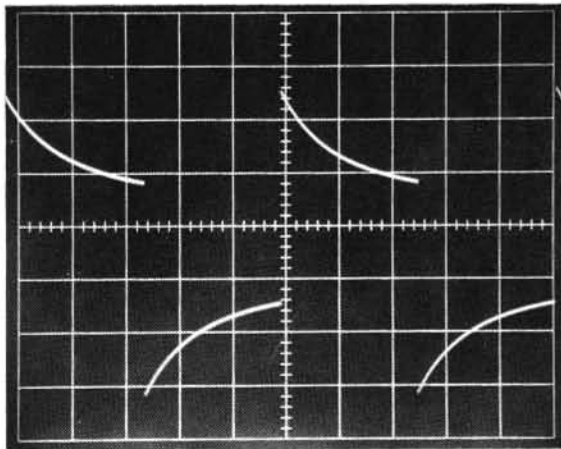
- f. ADJUST—C145-C245 for best square leading corner.
 - g. Reset the Type 7A14 CURRENT/DIV to 5 mA and re-adjust the Type 109 for a 5-division display.
 - h. ADJUST—C100-R103 for best square leading corner and no level difference in the first 20 ns.
 - i. CHECK—The remaining positions of the Type 7A14 CURRENT/DIV switch (use the Type 109 Amplitude control as necessary) for optimum response. Use the Current Probe High Frequency Compensation adjust to obtain optimum response.
 - j. Replace the P6022 Current Probe with the P6021 Current Probe. Reset the Type 7A14 CURRENT/DIV to 20 mA and adjust the Type 109 for a 5-division display.
 - k. ADJUST—C160-C154 for optimum square leading corner.
 - l. CHECK—The remaining positions of the CURRENT/DIV switch, adjusting the Current Probe High-Frequency Compensation adjust, for optimum response. Replace the P6021 Current Probe with the P6022 Current Probe.
 - m. In the Extender, switch the Vertical Out cables to the Trigger Jacks and the Trigger Out cables to the Vertical Jacks. Reset the Type 7A14 CURRENT/DIV to 20 mA and adjust the Type 109 for a 5-division display.
 - n. ADJUST—C363 for optimum square leading corner.
 - o. Return the Vertical Out and Trigger Out cables to their correct Jacks.
- ## 8. Check/Adjust Low Frequency Compensation ①
- a. Reset the CURRENT/DIV to 10 mA and the TIME/DIV to .2 ms; Connect the P6021 Current Probe from the Type 7A14 to the Indicator Oscilloscope 40 mA current loop.
 - b. CHECK—For 0.2 division of tilt in the first 500 μ s of the square wave. See Fig. 5-5.

NOTE

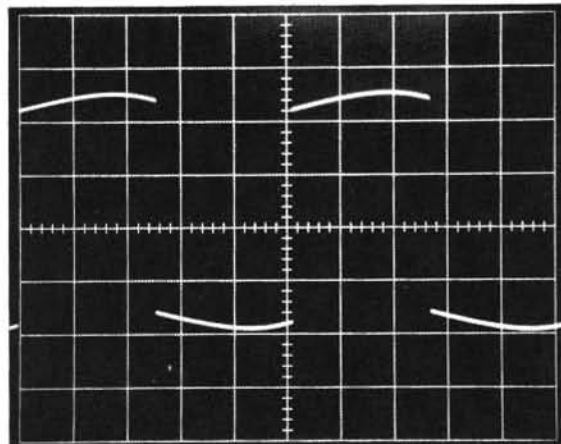
This tolerance is provided as a guide to correct instrument operation and is not an instrument specification.

PERFORMANCE CHECK—Front-Panel adjustment; may be adjusted as part of performance check.

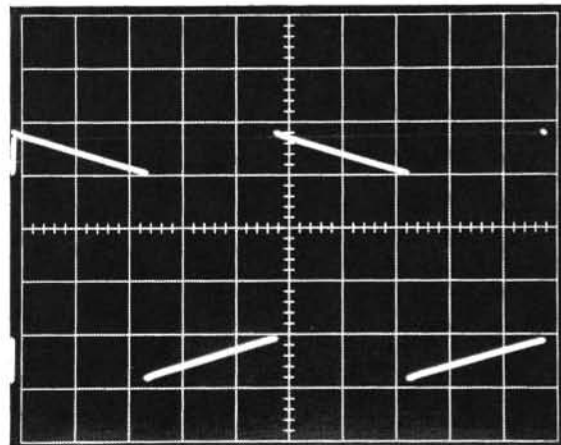
- c. ADJUST—LF COMP (front-panel adjust) for 0.2 division of tilt in the first 500 μ s of the square wave.
- d. Reset the CURRENT/DIV to 5 mA and repeat (b) and (c) for 0.4 division of tilt in the first 500 μ s.
- e. Replace the P6021 Current Probe with the P6022 Current Probe.
- f. ADJUST—LF COMP for best flat top (see Fig. 5-6). This adjustment should be made each time when changing from one probe to another, even with probes of the same type.



(A) Undercompensated



(B) Overcompensated



(C) Correctly Compensated

Fig. 5-6. LF COMP using the P6022 probe connected to the 40 mA current loop. (a) under compensated (b) overcompensated (c) correctly adjusted.

9. Check VAR CURRENT/DIV

- a. Reset the CURRENT/DIV to 10 mA and check for a four-division display.
- b. CHECK—With the VAR CURRENT/DIV in the out (un-calibrated) position and rotated fully counterclockwise, check for 1.6 divisions or less of displayed amplitude.

10. Check Trigger Out Gain

- a. Set the VAR CURRENT/DIV to the CAL IN position. Check for a four-division display.
- b. Switch the Vertical Out cables to the Trigger jacks and the Trigger Out cables to the Vertical jacks in the Extender.
- c. CHECK—For approximately four divisions of displayed amplitude. Return the Vertical and Trigger cables to their proper jacks.

11. Check Trace IDENTIFY

- a. CHECK—Press the trace IDENTIFY button and observe that the display moves upward about 0.25 division. If the Indicator Oscilloscope has knob readout, observe that the readout disappears and the word IDENTIFY appears when the IDENTIFY button is pressed.

12. Check LF —3 dB Point

- a. Test equipment is shown in Fig. 5-7.
- b. Connect the Calibration Fixture to the low-frequency Sine-Wave Generator. Connect the P6021 Current Probe from the Calibration Fixture to the Type 7A14.
- c. Set the Sine-Wave Generator to 1 kHz and adjust the amplitude for a four-division display. Use the Time-Base TIME/DIV control as necessary for optimum viewing.

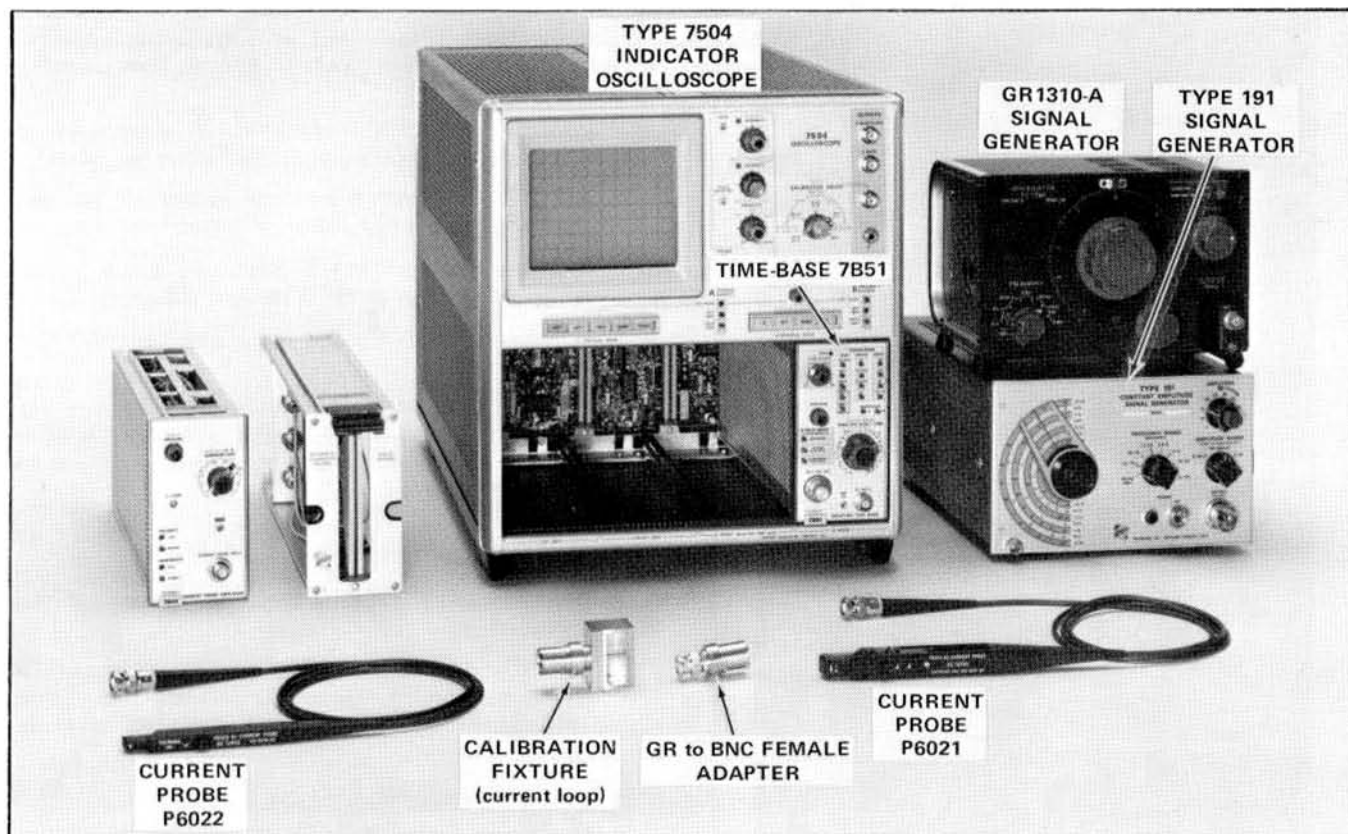


Fig. 5-7. Test equipment required for STEPS 12 and 13.

- d. Reduce the Sine-Wave Generator frequency to 25 Hz.
- e. CHECK—The displayed amplitude must be 2.8 divisions or greater.
- f. Replace the P6021 Current Probe with the P6022 Current Probe. Reset the Sine-Wave Generator to 5 kHz and adjust the amplitude for a four-division display.
- g. Reduce the Sine-Wave Generator frequency to 250 Hz.
- h. CHECK—The displayed amplitude must be 2.8 divisions or greater.

13. Check 20 MHz Bandwidth

- a. Connect the Calibration Fixture to the Type 191 Constant Amplitude Signal Generator; connect the P6022 Current Probe from the Type 7A14 to the Calibration Fixture.
- b. Reset the Time-Base TIME/DIV to .1 ms; set the Type 191 Frequency Range to 50 kHz and adjust the Amplitude controls to obtain a six-division display on the Indicator Oscilloscope.

- c. Reset the Type 191 Frequency Range to the 18-42 megahertz position. Set the tuning dial to 18.
- d. CHECK—While slowly increasing the frequency, observe when the Indicator Oscilloscope display amplitude decreases to 4.2 divisions. The frequency, read from the tuning dial, must be 20 MHz within 3 MHz.

14. Check HF —3 dB Point

- a. Test equipment setup is shown in Fig. 5-8.
- b. Connect the Extender Vertical Out cables through 2 ns cables to the Type 3S1 A and B inputs; connect the Type 7A14 through the P6022 Current Probe and Calibration Fixture to the output connector of the constant Amplitude Signal Generator (067-0532-00).
- c. Set the Type 3S1 to the settings given under Preliminary Control Settings; reset the Type 3T2 TIME/DIV controls to give 100 ns/Div on the Type 3T2 readout display.
- d. Set the Constant Amplitude Signal Generator Frequency Range to 3 MHz and the Amplitude to 2.5. Adjust the VAR Amplitude control for a six-division display on the Test Oscilloscope.

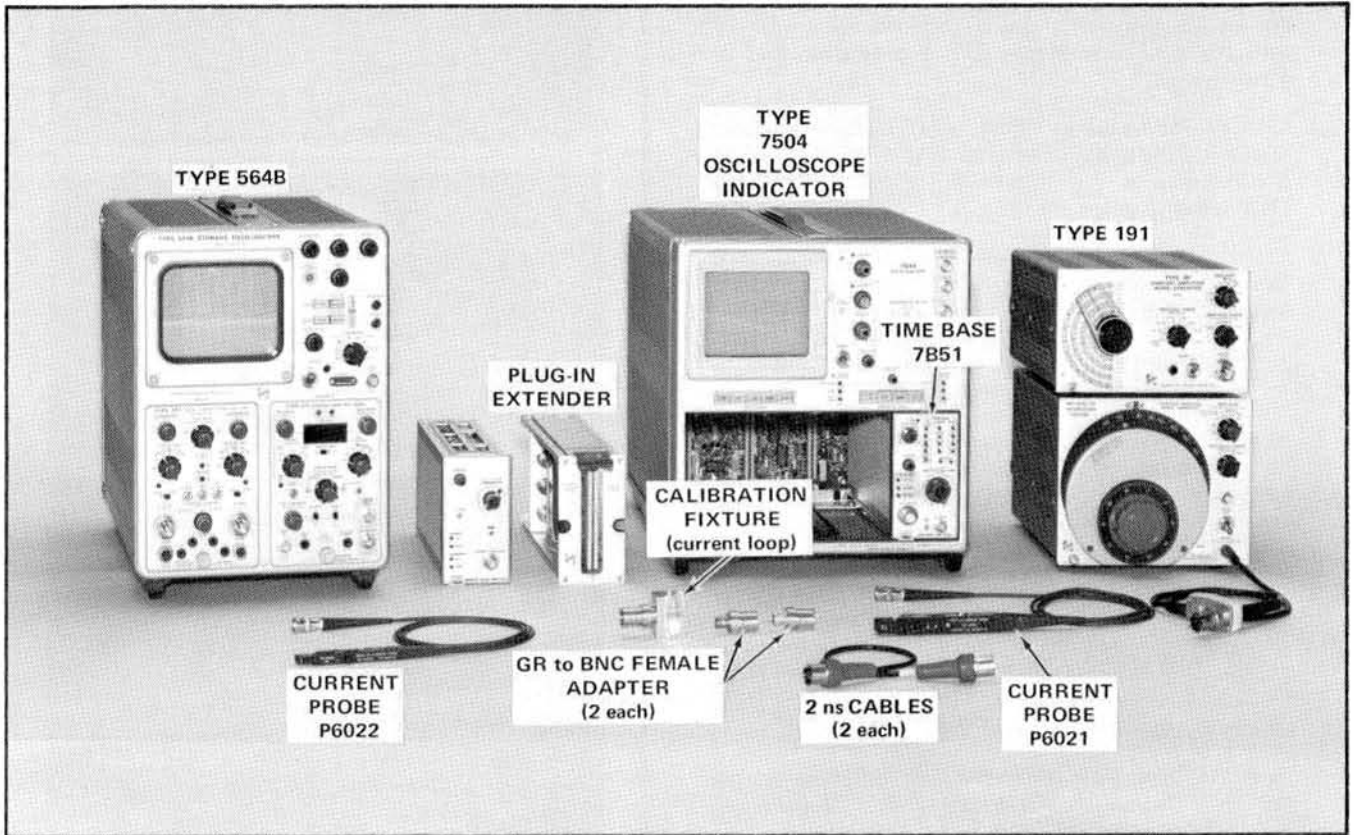


Fig. 5-8. Test equipment required for Step 14 and 14a.

- e. Reset the Constant Amplitude Signal Generator Frequency Range to 65-500 megahertz (use the Type 3T2 TIME/DIV controls as necessary for optimum viewing of the display). Starting at 65 megahertz on the Tuning Dial, slowly increase the frequency until the amplitude of the CRT display decreases to 4.2 divisions.
- f. CHECK—The frequency of the Constant Amplitude Signal Generator is 175 megahertz or greater.

NOTE

This tolerance is provided as a guide to correct instrument operation and is not an instrument specification.

- g. Remove the Calibration Fixture from the 067-0532-00 Signal Generator and connect it to the Type 191 Output connector. Replace the P6022 Current Probe with the P6021 Current Probe.
- h. Set the Type 191 Frequency Range to 50 kHz and adjust the Amplitude controls for a six-division display on the Test Oscilloscope.
- i. Reset the Type 191 Frequency Range to 40-100 megahertz. Starting at 42 megahertz slowly increase the frequency until the Test Oscilloscope display decreases to 4.2 divisions.

- j. CHECK—The frequency of the Type 191 is 60 megahertz or greater.

NOTE

This tolerance is provided as a guide to correct instrument operation and is not an instrument specification.

- k. Replace the Extender Vertical Out cables to their correct Jacks on the Extender.

NOTE

If steps 7A and 14A are used, the Type 7A14 must be recalibrated when used with another Indicator Oscilloscope.

14A. Check HF —3 dB Point (alternate procedure)

- a. Connect the Type 7A14 through the P6022 Current Probe and Calibration Fixture to the output connector of the 067-0532-00 Signal Generator.
- b. Set the Frequency Range to 3 MHz and adjust the Amplitude controls for a six-division display on the CRT. (Use the Time-Base TIME/DIV control as necessary for optimum viewing).

Performance Check/Calibration—Type 7A14

- c. Reset the Frequency Range to 65-500 megahertz. Starting at 65 megahertz, slowly increase the frequency until the amplitude of the CRT display decreases to 4.2 divisions.
- d. CHECK—The frequency of the 067-0532-00 Signal Generator is 75 megahertz or greater with the 7500 series Oscilloscope, or 105 megahertz or greater with the 7700 series Oscilloscope.
- e. Remove the Calibration Fixture from the 067-0532-00 Signal Generator and connect it to the output connector of the Type 191 Signal Generator. Replace the P6022 Current Probe with the P6021 Current Probe. Set the Type 191 to 50 kHz and adjust the amplitude for a six-division display on the CRT.
- f. Reset the Type 191 Frequency Range to 42-100 megahertz. Starting at 42 megahertz slowly increase the frequency until the amplitude of the CRT display decreases to 4.2 divisions.
- g. CHECK—The frequency of the Type 191 is 45 megahertz or greater with the 7500 series Oscilloscope, or 50 megahertz or greater with the 7700 series Oscilloscope.

15. Check Overall Noise Level Tangentially

- a. Reset the Type 7A14 CURRENT/DIV to 1 mA; set the Indicator Oscilloscope Calibrator Volts to 4 volts and the Calibrator Rate to 1 kHz; set the Time-Base TIME/DIV to 10 μ s and the Triggering MODE to AUTO.
- b. Connect the Type 7A14 through the P6021 Current Probe, the Calibration Fixture, a Variable Attenuator, a $\times 10$ Attenuator, and a GR to BNC Adapter to the Calibrator Volts Output connector.
- c. Turn the Variable Attenuator fully clockwise (minimum resistance) and adjust the Time-Base LEVEL/SLOPE to obtain a free-running trace. Observe two noise bands displayed on the CRT (noise and free-running square-wave). See Fig. 5-9.
- d. Reduce the input to the Type 7A14 by slowly turning the Variable Attenuator counterclockwise until the two noise bands merge to the point where the darker band between the two noise bands just disappears. See Fig. 5-9.

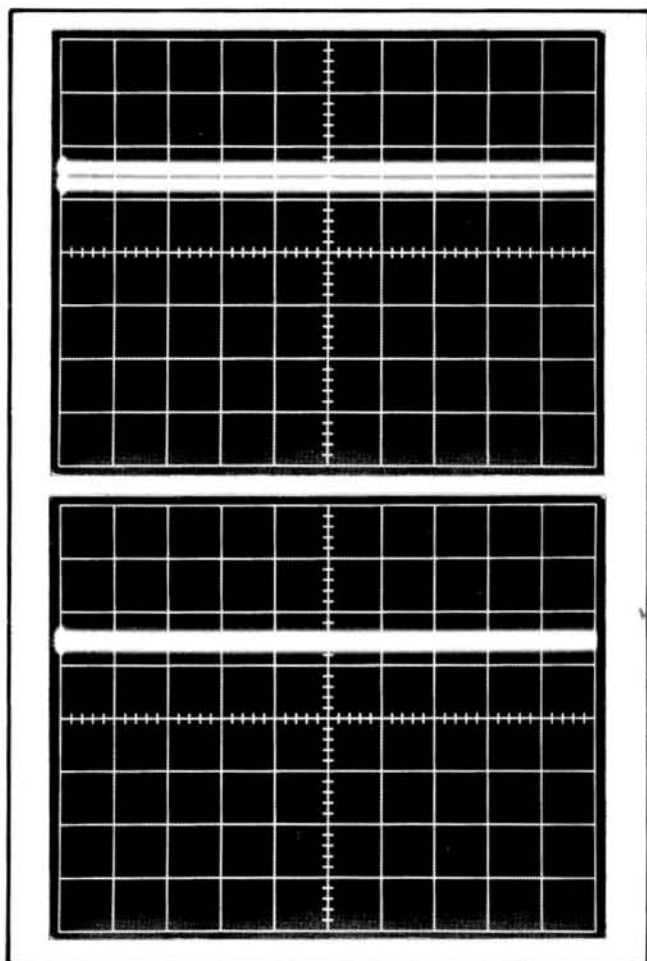


Fig. 5-9. (a) Display showing two noise bands when checking overall noise level, tangentially. (b) Two noise bands merged.

- e. Remove the $\times 10$ Attenuator and connect the Variable Attenuator to the GR to BNC Adapter.
- f. Reset the Type 7A14 CURRENT/DIV to 10 mA and the Time-Base TIME/DIV to .5 ms.
- g. CHECK—The square-wave amplitude should not exceed 0.2 division.
- h. This completes the calibration procedure for the Type 7A14. Disconnect all test equipment.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

INDEX OF ELECTRICAL PARTS LIST

Title	Page No.
CHASSIS	6-1
MAIN Circuit Board Assembly	6-1
LOGIC Circuit Board Assembly	6-8
ATTENUATOR Circuit Board Assembly	6-8
CAL-UNCAL Circuit Board Assembly	6-9
POLARITY Circuit Board Assembly	6-10
BANDWIDTH Circuit Board Assembly	6-10

SECTION 6

ELECTRICAL PARTS LIST

Values are fixed, unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
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CHASSIS

Connector

J1	131-0679-00			BNC, receptacle electrical
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Inductor

L1¹

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R128	311-0949-00			2 k Ω , Var
R165	311-0828-00			5 k Ω , Var
R342 ²	311-0652-00	B010100	B029999	2 x 5 k Ω , Var
R342 ²	311-0652-01	B030000		2 x 5 k Ω , Var

Switches

Wired or Unwired

S40 ³	*672-0004-00			Cam	CURRENT/DIV
S342 ⁴	311-0652-00	B010100	B029999		IDENTIFY
S342 ²	311-0652-01	B030000			IDENTIFY

MAIN Circuit Board Assembly

*670-1037-00	B010100	B039999	Complete Board
*670-1037-01	B040000		Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C62	283-0065-00	0.001 μ F	Cer	100 V	5%
C71	283-0065-00	0.001 μ F	Cer	100 V	5%
C72	283-0065-00	0.001 μ F	Cer	100 V	5%
C73	283-0065-00	0.001 μ F	Cer	100 V	5%
C74	283-0065-00	0.001 μ F	Cer	100 V	5%

¹Furnished as a unit with Main Chassis Cable.

²Furnished as a unit with S342.

³See Mechanical Parts List for replacement parts.

⁴Furnished as a unit with R342.

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Capacitors (cont)						
C80	283-0065-00			0.001 μ F	Cer	100 V 5%
C81	283-0065-00			0.001 μ F	Cer	100 V 5%
C100	281-0122-00			2.5-9 pF, Var	Cer	
C101	290-0326-00			820 μ F	Elect.	6 V 10%
C102	281-0611-00			2.7 pF	Cer	200 V ± 0.25 pF
C110	290-0117-00			50 μ F	Elect.	50 V
C118	290-0117-00			50 μ F	Elect.	50 V
C120	283-0190-00			0.47 μ F	Cer	50 V 5%
C121	290-0167-00			10 μ F	Elect.	15 V
C123	290-0167-00			10 μ F	Elect.	15 V
C140	283-0081-00			0.1 μ F	Cer	25 V +80% -20%
C141	281-0122-00			2.5-9 pF, Var	Cer	
C142	281-0617-00			15 pF	Cer	200 V
C143	281-0123-00			5-25 pF, Var	Cer	
C145	281-0122-00			2.5-9 pF, Var	Cer	
C154	281-0122-00			2.5-9 pF, Var	Cer	
C160	281-0123-00			5-25 pF, Var	Cer	
C161	281-0511-00	B010100	B039999	22 pF	Cer	500 V 10%
C161	281-0517-00	B040000		39 pF	Cer	500 V 10%
C162	283-0065-00			0.001 μ F	Cer	100 V 5%
C164	281-0534-00			3.3 pF	Cer	500 V ± 0.25 pF
C170	281-0123-00			5-25 pF, Var	Cer	
C171	283-0095-00			56 pF	Cer	200 V 10%
C176	290-0273-00			68 μ F	Elect.	60 V 10%
C178	283-0129-00			0.56 μ F	Cer	100 V
C202	283-0026-00			0.2 μ F	Cer	25 V
C203	290-0138-00			330 μ F	Elect.	6 V
C207	290-0139-00			180 μ F	Elect.	6 V
C208	283-0080-00			0.022 μ F	Cer	25 V +80% -20%
C220	283-0190-00			0.47 μ F	Cer	50 V 5%
C231	290-0301-00			10 μ F	Elect.	20 V 10%
C237	285-0808-00			0.1 μ F	PTM	50 V 10%
C238	285-0809-00			1 μ F	PTM	50 V 10%
C240	283-0081-00			0.1 μ F	Cer	25 V +80% -20%
C245	281-0122-00			2.5-9 pF, Var	Cer	
C248	283-0081-00			0.1 μ F	Cer	25 V +80% -20%
C259	281-0122-00			2.5-9 pF, Var	Cer	
C261	281-0549-00			68 pF	Cer	500 V 10%
C262	283-0065-00			0.001 μ F	Cer	100 V 5%
C264	281-0534-00			3.3 pF	Cer	500 V ± 0.25 pF
C276	290-0273-00			68 μ F	Elect.	60 V
C278	283-0129-00			0.56 μ F	Cer	100 V
C309	281-0123-00			5-25 pF, Var	Cer	
C310	281-0122-00			2.5-9 pF, Var	Cer	

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
Capacitors (cont)				
C315	283-0065-00		0.001 μ F	Cer 100 V 5%
C316	281-0634-00		10 pF	Cer 500 V ± 0.25 pF
C331	283-0634-00		65 pF	Mica 100 V 1%
C333	281-0616-00		6.8 pF	Cer 200 V
C346	283-0065-00		0.001 μ F	Cer 100 V 5%
C347	281-0123-00		5-25 pF, Var	Cer
C361	283-0065-00		0.001 μ F	Cer 100 V 5%
C363	281-0092-00		9-35 pF, Var	Cer
C415	283-0065-00		0.001 μ F	Cer 100 V 5%
C446	283-0065-00		0.001 μ F	Cer 100 V 5%
C461	283-0065-00		0.001 μ F	Cer 100 V 5%
C502	283-0065-00		0.001 μ F	Cer 100 V 5%
C503	283-0111-00		0.1 μ F	Cer 50 V
C505	283-0059-00		1 μ F	Cer 25 V +80%—20%
C522	283-0065-00		0.001 μ F	Cer 100 V 5%
C523	283-0111-00		0.1 μ F	Cer 50 V
C525	283-0059-00		1 μ F	Cer 25 V +80%—20%
C526	283-0065-00		0.001 μ F	Cer 100 V 5%

Semiconductor Device, Diodes

CR62	*152-0185-00		Silicon	Replaceable by 1N4152
CR80	*152-0185-00		Silicon	Replaceable by 1N4152
VR107	152-0226-00		Zener	1N751A 400 mW, 5.1 V, 5%
CR120	*152-0185-00		Silicon	Replaceable by 1N4152
VR173	152-0291-00		Zener	1N3027B 1 W, 20 V, 5%
VR208	152-0226-00		Zener	1N751A 400 mW, 5.1 V, 5%
CR220	*152-0185-00		Silicon	Replaceable by 1N4152

Relays

K50	*148-0034-00		Armature, 15 V DC,	dpdt
K51	*148-0035-00		Armature, 15 V DC,	spdt
K52	*148-0035-00		Armature, 15 V DC,	spdt
K53	*148-0035-00		Armature, 15 V DC,	spdt
K54	*148-0035-00		Armature, 15 V DC,	spdt
K62	*148-0034-00		Armature, 15 V DC,	dpdt
K155	*148-0035-00		Armature, 15 V DC,	spdt
K160	*148-0035-00		Armature, 15 V DC,	spdt
K180	*148-0035-00		Armature, 15 V DC,	spdt
K235	*148-0035-00		Armature, 15 V DC,	spdt
K280	*148-0035-00		Armature, 15 V DC,	spdt
K330	*148-0034-00		Armature, 15 V DC,	dpdt

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description
Inductors				
L101	*108-0551-00			Toroid, 14 μ H
L140	276-0507-00			Core, ferramic suppressor
L162	276-0507-00			Core, ferramic suppressor
L240	276-0507-00			Core, ferramic suppressor
L248	276-0507-00			Core, ferramic suppressor
L262	276-0507-00			Core, ferramic suppressor
L315	276-0507-00			Core, ferramic suppressor
L330	*108-0262-01	B010100	B019999	0.6 μ H
L330	*108-0262-00	B020000		0.6 μ H
L331	276-0543-00			Core, ferrite
L415	276-0507-00			Core, ferramic suppressor
L430	*108-0262-01	B010100	B019999	0.6 μ H
L430	*108-0262-00	B020000		0.6 μ H
L503	276-0507-00			Core, ferramic suppressor
L505	276-0507-00			Core, ferramic suppressor
L509	*120-0382-00			Toroid, 14 turns, single
L523	276-0507-00			Core, ferramic suppressor
L525	276-0507-00			Core, ferramic suppressor
LR114	*108-0540-00			20 nH (wound on a 22 Ω , $\frac{1}{8}$ W, 5% resistor)
LR503	*108-0542-00			200 μ H (wound on a 100 Ω , $\frac{1}{8}$ W, 5% resistor)
LR505	*108-0542-00			200 μ H (wound on a 100 Ω , $\frac{1}{8}$ W, 5% resistor)
LR523	*108-0542-00			200 μ H (wound on a 100 Ω , $\frac{1}{8}$ W, 5% resistor)
LR525	*108-0542-00			200 μ H (wound on a 100 Ω , $\frac{1}{8}$ W, 5% resistor)
Transistors				
Q105	*151-0300-00			Silicon Tek Spec
Q122	*151-0216-00			Silicon Replaceable by MPS 6523
Q125	*151-0216-00			Silicon Replaceable by MPS 6523
Q140	*151-0300-00			Silicon Tek Spec
Q149	*151-0212-00			Silicon Tek Spec
Q157	*151-0212-00			Silicon Tek Spec
Q168	*151-0212-00			Silicon Tek Spec
Q206	*151-0300-00			Silicon Tek Spec
Q222	*151-0216-00			Silicon Replaceable by MPS 6523
Q225	*151-0216-00			Silicon Replaceable by MPS 6523
Q231	*151-0216-00			Silicon Replaceable by MPS 6523
Q233	*151-0216-00			Silicon Replaceable by MPS 6523
Q240	*151-0300-00			Silicon Tek Spec
Q249	*151-0212-00			Silicon Tek Spec
Q257	*151-0212-00			Silicon Tek Spec
Q268	*151-0212-00			Silicon Tek Spec
Q307	*151-0212-00			Silicon Tek Spec
Q323	*151-0212-00			Silicon Tek Spec
Q345	*151-0212-00			Silicon Tek Spec
Q360	*151-0212-00			Silicon Tek Spec

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Transistors (cont)						
Q407	*151-0212-00			Silicon		Tek Spec
Q423	*151-0212-00			Silicon		Tek Spec
Q445	*151-0212-00			Silicon		Tek Spec
Q460	*151-0212-00			Silicon		Tek Spec
Resistors						
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.						
R62	315-0133-00			13 k Ω	1/4 W	5%
R69	315-0753-00			75 k Ω	1/4 W	5%
R70	315-0513-00			51 k Ω	1/4 W	5%
R72	315-0154-00			150 k Ω	1/4 W	5%
R73	315-0154-00			150 k Ω	1/4 W	5%
R75	315-0154-00			150 k Ω	1/4 W	5%
R77	321-0344-00			37.4 k Ω	1/8 W	Prec 1%
R78	315-0513-00			51 k Ω	1/4 W	5%
R80	315-0133-00			13 k Ω	1/4 W	5%
R100	317-0181-00	B010100	B039999	180 Ω	1/8 W	5%
R100	315-0181-00	B040000		180 Ω	1/4 W	5%
R101	321-0070-00			52.3 Ω	1/8 W	Prec 1%
R102	315-0130-00			13 Ω	1/4 W	5%
R103	311-0643-00			50 Ω , Var		
R105	317-0510-00	B010100	B039999	51 Ω	1/8 W	5%
R105	315-0510-00	B040000		51 Ω	1/4 W	5%
R107	315-0181-00			180 Ω	1/4 W	5%
R108	308-0508-00			2 k Ω	3 W	WW 1%
R110	311-0839-00			50 Ω , Var		
R111	311-0515-00			250 Ω , Var		
R112	308-0553-00			680 Ω	3 W	WW 1%
R114	321-0097-00			100 Ω	1/8 W	Prec 1%
R116	308-0508-00			2 k Ω	3 W	WW 1%
R118	308-0552-00			750 Ω	3 W	WW 1%
R122	315-0912-00			9.1 k Ω	1/4 W	5%
R126	321-0350-00			43.2 k Ω	1/8 W	Prec 1%
R140	323-0203-00			1.27 k Ω	1/2 W	Prec 1%
R141	321-0067-00			48.7 Ω	1/8 W	Prec 1%
R143	311-0605-00			200 Ω , Var		
R146	321-0804-02			60 Ω	1/8 W	Prec 1/2%
R147	321-0802-02			56.8 Ω	1/8 W	Prec 1/2%
R149	317-0510-00	B010100	B039999	51 Ω	1/8 W	5%
R149	315-0510-00	B040000		51 Ω	1/4 W	5%
R151	321-0124-00			191 Ω	1/8 W	Prec 1%
R152	311-0643-00			50 Ω , Var		
R154	321-0103-00			115 Ω	1/8 W	Prec 1%
R155	311-0622-00			100 Ω , Var		
R158	322-0181-00			750 Ω	1/4 W	Prec 1%

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R160	317-0360-00	B010100	B039999	36 Ω	1/8 W	5%
R160	315-0360-00	B040000		36 Ω	1/4 W	5%
R161	317-0271-00	B010100	B039999	270 Ω	1/8 W	5%
R161	315-0271-00	B040000		270 Ω	1/4 W	5%
R162	317-0301-00	B010100	B039999	300 Ω	1/8 W	5%
R162	315-0301-00	B040000		300 Ω	1/4 W	5%
R164	315-0360-00			36 Ω	1/4 W	5%
R167	321-0073-00			56.2 Ω	1/8 W	Prec 1%
R169	317-0510-00	B010100	B039999	51 Ω	1/8 W	5%
R169	315-0510-00	B040000		51 Ω	1/4 W	5%
R171	321-0097-00			100 Ω	1/8 W	Prec 1%
R172	321-0095-01			95.3 Ω	1/8 W	Prec 1/2%
R173	315-0303-00			30 kΩ	1/4 W	5%
R202	311-0634-00			500 Ω, Var		
R203	315-0820-00			82 Ω	1/4 W	5%
R205	321-0193-00			1 kΩ	1/8 W	Prec 1%
R207	315-0181-00			180 Ω	1/4 W	5%
R208	308-0508-00			2 kΩ	3 W	WW 1%
R214	321-0097-00			100 Ω	1/8 W	Prec 1%
R216	308-0508-00			2 kΩ	3 W	WW 1%
R222	315-0912-00			9.1 kΩ	1/4 W	5%
R226	321-0350-00			43.2 kΩ	1/8 W	Prec 1%
R228	315-0151-00			150 Ω	1/4 W	5%
R230	321-0280-00			8.06 kΩ	1/8 W	Prec 1%
R231	315-0102-00			1 kΩ	1/4 W	5%
R232	315-0512-00			5.1 kΩ	1/4 W	5%
R234	315-0681-00			680 Ω	1/4 W	5%
R240	323-0203-00			1.27 kΩ	1/2 W	Prec 1%
R241	315-0360-00			36 Ω	1/4 W	5%
R242	321-1133-02			240 Ω	1/8 W	Prec 1/2%
R243	315-0201-00			200 Ω	1/4 W	5%
R244	321-0083-00			71.5 Ω	1/8 W	Prec 1%
R245	311-0635-00			1 kΩ, Var		
R246	321-0804-02			60 Ω	1/8 W	Prec 1/2%
R247	321-0802-02			56.8 Ω	1/8 W	Prec 1/2%
R248	321-0181-00			750 Ω	1/8 W	Prec 1%
R249	321-0197-00			1.1 kΩ	1/8 W	Prec 1%
R251	321-0124-00			191 Ω	1/8 W	Prec 1%
R254	321-0103-00			115 Ω	1/8 W	Prec 1%
R258	322-0181-00			750 Ω	1/4 W	Prec 1%
R260	321-0070-00			52.3 Ω	1/8 W	Prec 1%
R261	321-0221-00			1.96 kΩ	1/8 W	Prec 1%
R262	317-0301-00	B010100	B039999	300 Ω	1/8 W	5%
R262	315-0301-00	B040000		300 Ω	1/4 W	5%
R264	315-0360-00			36 Ω	1/4 W	5%
R267	321-0073-00			56.2 Ω	1/8 W	Prec 1%
R268	323-0236-00			2.8 kΩ	1/2 W	Prec 1%
R269	322-0229-00			2.37 kΩ	1/4 W	Prec 1%
R270	321-0269-00			6.19 kΩ	1/8 W	Prec 1%
R271	321-0097-00			100 Ω	1/8 W	Prec 1%

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R302	321-0155-00			402 Ω	$\frac{1}{8}$ W	Prec 1%
R304	322-0237-00			2.87 k Ω	$\frac{1}{4}$ W	Prec 1%
R305	322-0257-00			4.64 k Ω	$\frac{1}{4}$ W	Prec 1%
R309	311-0605-00			200 Ω , Var		
R310	321-0073-00			56.2 Ω	$\frac{1}{8}$ W	Prec 1%
R312	321-0143-00			301 Ω	$\frac{1}{8}$ W	Prec 1%
R313	311-0605-00			200 Ω , Var		5%
R315	317-0271-00	B010100	B039999	270 Ω	$\frac{1}{8}$ W	5%
R315	315-0271-00	B040000		270 Ω	$\frac{1}{4}$ W	5%
R316	317-0202-00	B010100	B039999	2 k Ω	$\frac{1}{8}$ W	5%
R316	315-0202-00	B040000		2 k Ω	$\frac{1}{4}$ W	5%
R317	315-0750-00			75 Ω	$\frac{1}{4}$ W	5%
R318	311-0816-00			2.5 k Ω , Var		
R320	315-0470-00			47 Ω	$\frac{1}{4}$ W	5%
R321	315-0134-00			130 k Ω	$\frac{1}{4}$ W	5%
R324	317-0510-00	B010100	B039999	51 Ω	$\frac{1}{8}$ W	5%
R324	315-0510-00	B040000		51 Ω	$\frac{1}{4}$ W	5%
R326	321-0207-00			1.4 k Ω	$\frac{1}{8}$ W	Prec 1%
R327	321-0168-00			549 Ω	$\frac{1}{8}$ W	Prec 1%
R335	321-0093-01			90.9 Ω	$\frac{1}{8}$ W	Prec $\frac{1}{2}$ %
R336	323-0129-00			215 Ω	$\frac{1}{2}$ W	Prec 1%
R338	311-0463-00			5 k Ω , Var		
R339	315-0512-00			5.1 k Ω	$\frac{1}{4}$ W	5%
R340	315-0392-00			3.9 k Ω	$\frac{1}{4}$ W	5%
R345	323-0194-00			1.02 k Ω	$\frac{1}{2}$ W	Prec 1%
R346	317-0271-00	B010100	B039999	270 Ω	$\frac{1}{8}$ W	5%
R346	315-0271-00	B040000		270 Ω	$\frac{1}{4}$ W	5%
R347	311-0643-00			50 Ω , Var		
R348	321-0075-00			59 Ω	$\frac{1}{8}$ W	Prec 1%
R350	321-0058-00			39.2 Ω	$\frac{1}{8}$ W	Prec 1%
R353	321-0127-00			205 Ω	$\frac{1}{8}$ W	Prec 1%
R354	321-0157-00			422 Ω	$\frac{1}{8}$ W	Prec 1%
R360	323-0194-00			1.02 k Ω	$\frac{1}{2}$ W	Prec 1%
R361	317-0331-00	B010100	B039999	330 Ω	$\frac{1}{8}$ W	5%
R361	315-0331-00	B040000		330 Ω	$\frac{1}{4}$ W	5%
R363	317-0200-00	B010100	B039999	20 Ω	$\frac{1}{8}$ W	5%
R363	315-0200-00	B040000		20 Ω	$\frac{1}{4}$ W	5%
R365	321-0042-00			26.7 Ω	$\frac{1}{8}$ W	Prec 1%
R367	321-0147-00			332 Ω	$\frac{1}{8}$ W	Prec 1%
R368	311-0839-00			50 Ω , Var		
R402	321-0155-00			402 Ω	$\frac{1}{8}$ W	Prec 1%
R412	321-0143-00			301 Ω	$\frac{1}{8}$ W	Prec 1%
R413	308-0553-00			680 Ω	3 W	WW 1%
R414	311-0442-00			250 Ω , Var		
R415	317-0271-00	B010100	B039999	270 Ω	$\frac{1}{8}$ W	5%
R415	315-0271-00	B040000		270 Ω	$\frac{1}{4}$ W	5%
R417	315-0750-00			75 Ω	$\frac{1}{4}$ W	5%
R420	315-0470-00			47 Ω	$\frac{1}{4}$ W	5%
R435	321-0093-01			90.9 Ω	$\frac{1}{8}$ W	Prec $\frac{1}{2}$ %
R440	315-0392-00			3.9 k Ω	$\frac{1}{4}$ W	5%
R445	323-0194-00			1.02 k Ω	$\frac{1}{2}$ W	Prec 1%
R446	317-0271-00	B010100	B039999	270 Ω	$\frac{1}{8}$ W	5%
R446	315-0271-00	B040000		270 Ω	$\frac{1}{4}$ W	5%

MAIN Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Resistors (cont)						
R450	321-0058-00			39.2 Ω	$\frac{1}{8}$ W	Prec 1%
R454	321-0157-00			422 Ω	$\frac{1}{8}$ W	Prec 1%
R460	323-0194-00			1.02 k Ω	$\frac{1}{2}$ W	Prec 1%
R461	317-0331-00	B010100	B039999	330 Ω	$\frac{1}{8}$ W	5%
R461	315-0331-00	B040000		330 Ω	$\frac{1}{4}$ W	5%
R467	321-0147-00			332 Ω	$\frac{1}{8}$ W	Prec 1%
R501	315-0510-00			51 Ω	$\frac{1}{4}$ W	5%
R507	317-0036-00	B010100	B039999	3.6 Ω	$\frac{1}{8}$ W	5%
R507	307-0111-00	B040000		3.6 Ω	$\frac{1}{4}$ W	5%
R509	301-0470-00			47 Ω	$\frac{1}{2}$ W	5%
R521	315-0510-00			51 Ω	$\frac{1}{4}$ W	5%

Transformers

T180	*120-0269-00			Toroid, 4 turns, bifilar		
T344	*120-0269-00			Toroid, 4 turns, bifilar		

LOGIC Circuit Board Assembly

*670-1038-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C56	283-0065-00			0.001 μ F	Cer	100 V	5%
C58	283-0065-00			0.001 μ F	Cer	100 V	5%
C63	283-0065-00			0.001 μ F	Cer	100 V	5%
C64	283-0065-00			0.001 μ F	Cer	100 V	5%
C67	283-0065-00			0.001 μ F	Cer	100 V	5%

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R58	315-0154-00			150 k Ω	$\frac{1}{4}$ W		5%
R59	315-0753-00			75 k Ω	$\frac{1}{4}$ W		5%
R60	321-0344-00			37.4 k Ω	$\frac{1}{8}$ W	Prec	1%
R64	315-0154-00			150 k Ω	$\frac{1}{4}$ W		5%
R65	315-0753-00			75 k Ω	$\frac{1}{4}$ W		5%
R67	315-0154-00			150 k Ω	$\frac{1}{4}$ W		5%

ATTENUATOR Circuit Board Assembly

*670-1039-00

Complete Board

ATTENUATOR Circuit Board Assembly (cont)

Kct. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description		
Capacitors						
Tolerance $\pm 20\%$ unless otherwise indicated.						
C2	281-0619-00			1.2 pF	Cer	200 V
C4	281-0611-00			2.7 pF	Cer	200 V
C11	281-0540-00			51 pF	Cer	500 V
						± 0.25 pF 5%

Inductors						
L4	*108-0539-00			Toroid, 18 μ H		
LR29	*108-0541-00			70 nH (wound on a 43 Ω , 1/8 W, 5% resistor)		

Resistors						
Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.						
R3	321-0101-00			110 Ω	1/8 W	Prec 1%
R4	321-0103-00			115 Ω	1/8 W	Prec 1%
R6	321-0806-06			34.5 Ω	1/8 W	Prec 1/4%
R7	321-0806-06			34.5 Ω	1/8 W	Prec 1/4%
R8	321-0806-06			34.5 Ω	1/8 W	Prec 1/4%
R11	317-0300-00	B010100	B039999	30 Ω	1/8 W	5%
R11	315-0300-00	B040000		30 Ω	1/4 W	5%
R13	321-0800-02			184.6 Ω	1/8 W	Prec 1/2%
R14	321-0803-02			88.2 Ω	1/8 W	Prec 1/2%
R16	321-0799-02			146.8 Ω	1/8 W	Prec 1/2%
R17	321-0801-07			178.2 Ω	1/8 W	Prec 1/10%
R18	321-0122-07			182 Ω	1/8 W	Prec 1/10%
R20	321-0104-00			118 Ω	1/8 W	Prec 1%
R21	321-0814-07			335.6 Ω	1/8 W	Prec 1/10%
R22	321-0797-02			105.3 Ω	1/8 W	Prec 1/2%
R24	321-0098-01			102 Ω	1/8 W	Prec 1/2%
R25	321-0817-07			949.2 Ω	1/8 W	Prec 1/10%
R26	321-0798-02			114.9 Ω	1/8 W	Prec 1/2%
R28	321-0097-00			100 Ω	1/8 W	Prec 1%
R29	321-0805-02			974.8 Ω	1/8 W	Prec 1/2%
R31	321-0053-02			34.8 Ω	1/8 W	Prec 1/2%
R32	321-0097-07			100 Ω	1/8 W	Prec 1/10%

CAL-UNCAL Circuit Board Assembly

*670-1074-00

Complete Board

Inductor						
L62	*120-0382-00			Toroid, 14 turns, single		

Switch						
S62 ⁵	*670-1074-00			Push-Push		CAL IN VAR

⁵See Mechanical Parts List for replacement parts.

POLARITY Circuit Board Assembly

Ckt. No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Description	
	*670-1122-00	B010100	B039999	Complete Board	
	*670-1122-01	B040000		Complete Board	
Bulb					
DS510	*150-0057-01	B010100	B039999	Incandescent 7153AS15, selected	
DS510	*150-0048-01	B040000		Incandescent #683, selected	
Switch					
Wired or Unwired					
S72 A, B ⁶	*670-1122-00	B010100	B039999	Pushbutton	POLARITY
S72 A, B ⁶	*670-1122-01	B040000		Pushbutton	POLARITY

BANDWIDTH Circuit Board Assembly

	*670-1123-00	B010100	B039999	Complete Board	
	*670-1123-01	B040000		Complete Board	
Bulb					
DS512	*150-0057-01	B010100	B039999	Incandescent 7153AS15, selected	
DS512	*150-0048-01	B040000		Incandescent #683, selected	
Switch					
Wired or Unwired					
S330 A, B ⁶	*670-1123-00	B010100	B039999	Pushbutton	BANDWIDTH
S330 A, B ⁶	*670-1123-01	B040000		Pushbutton	BANDWIDTH

⁶See Mechanical Parts List for replacement parts.

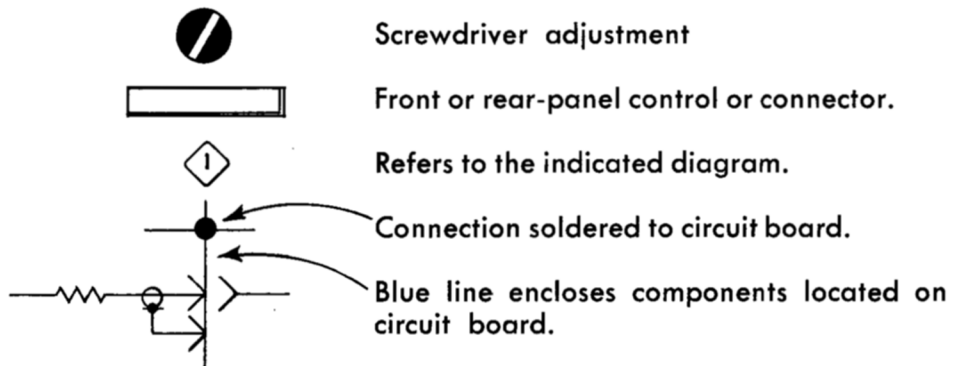
SECTION 7

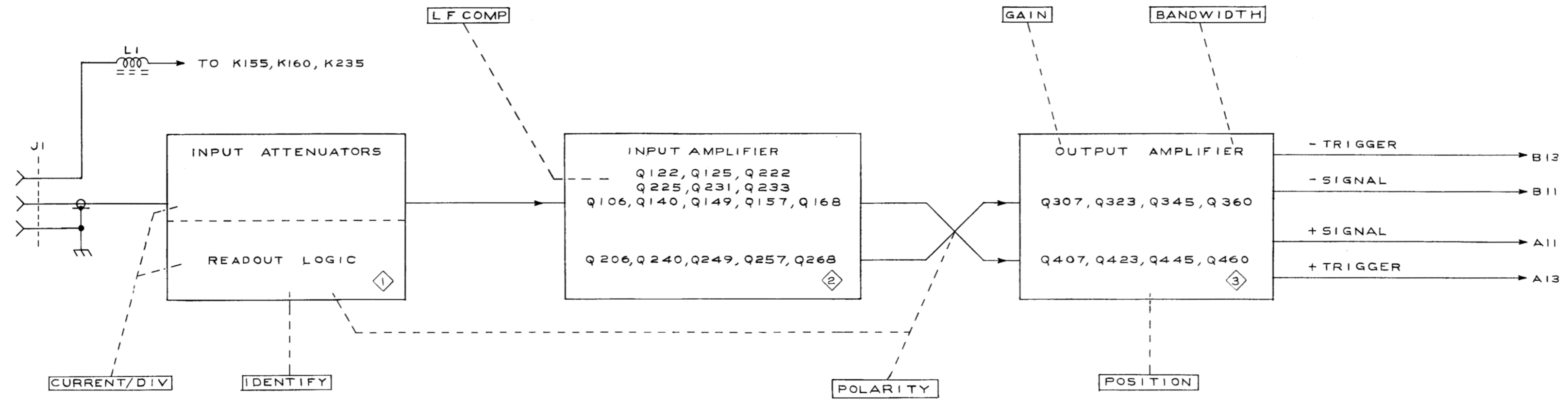
DIAGRAMS

and

MECHANICAL PARTS ILLUSTRATIONS

The following special symbols are used on the diagrams:





REFERENCE DIAGRAMS

- ① CURRENT/DIV SWITCH
- ② INPUT AMPLIFIER
- ③ OUTPUT AMPLIFIER

TYPE 7A14

Ⓐ

BLOCK DIAGRAM

VOLTAGE AND WAVEFORM TEST CONDITIONS

Typical voltage measurements and waveform photographs were obtained under the following conditions unless noted otherwise on the individual diagrams:

Type 7504 Indicator Oscilloscope

Calibrator

Rate 1 kHz

Volts 4 V

Vertical Mode LEFT

Horizontal Mode A

Left Vertical Compartment

Type 7A22 Controls (with X1 Probe)

HF -3 dB Point 1 mHz

LF -3 dB Point DC

Volts/Div As shown on waveforms

Right Vertical Compartment

Type 7A14 Controls

CURRENT/DIV 10 mA

POLARITY + UP

BANDWIDTH FULL

Signal applied

P6021 current probe connected to 40 mA current loop of indicator oscilloscope

A Horizontal Compartment

Type 7B51 Controls

Level/Slope 0/+

Triggering

Mode P-P Auto

Coupling AC

Source EXT

Magnifier X1

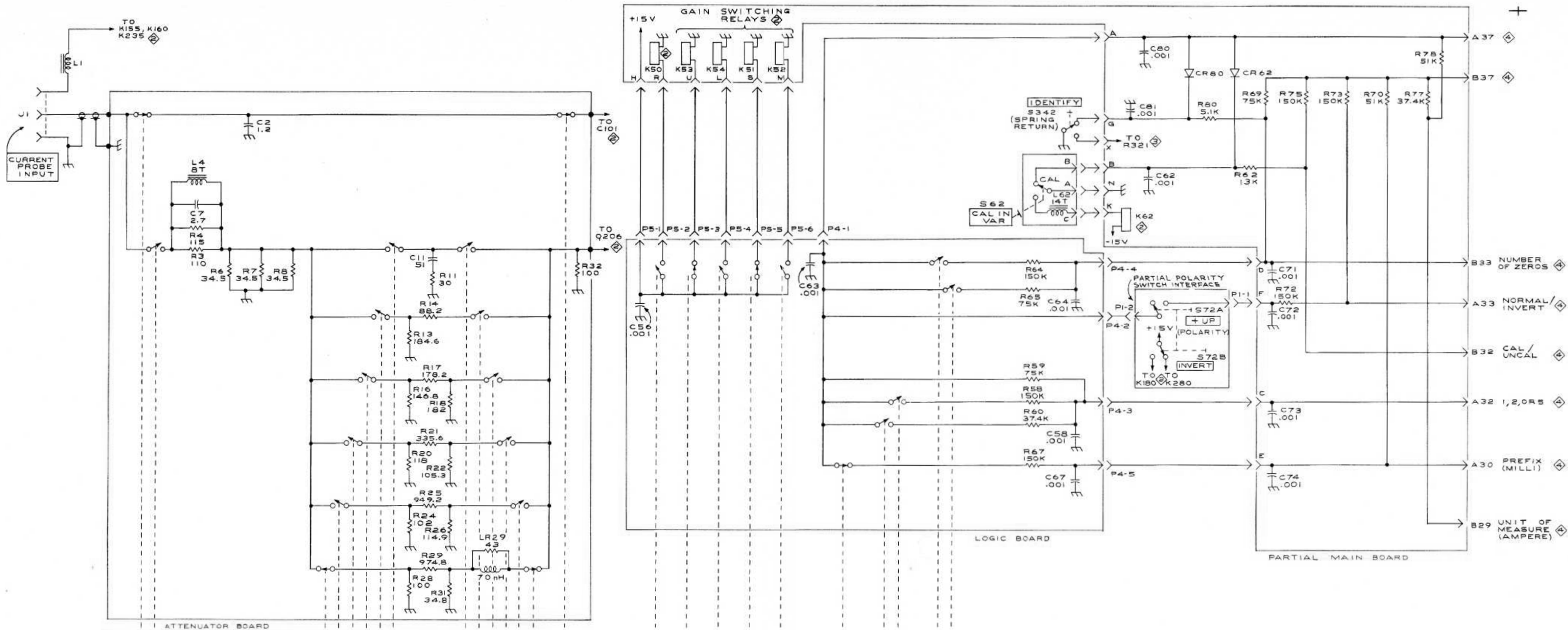
Time/Div .5 ms

Variable CAL IN

Ext. trigger applied

Calibrator output applied to Ext Trig In connector

All voltages given on the diagrams are in volts. Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System. Voltages and waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of differing component tolerances, internal calibration or front-panel controls settings.

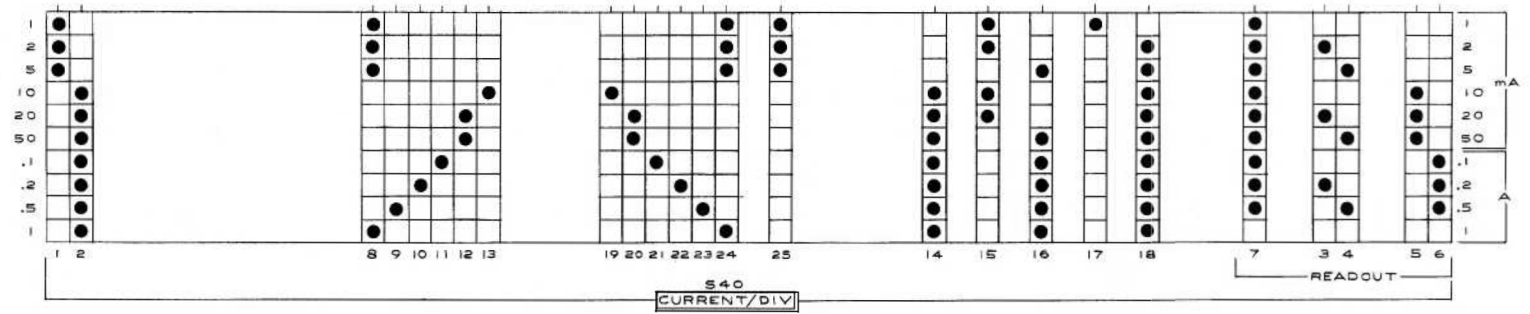


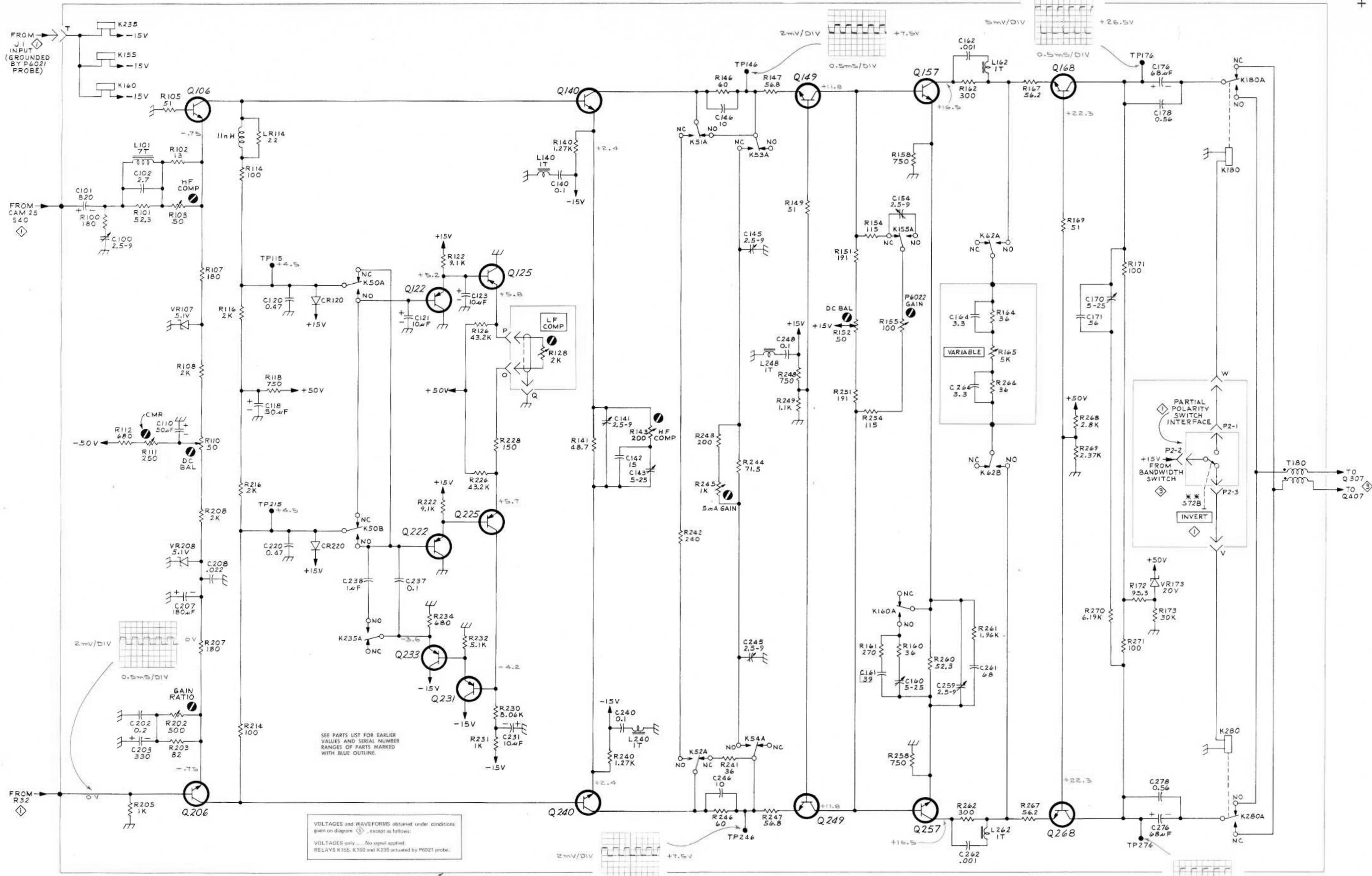
VOLTAGE & WAVEFORM CONDITIONS

- REFERENCE DIAGRAMS
- ⊗ INPUT AMPLIFIER
 - ⊕ OUTPUT AMPLIFIER
 - ⊠ PLUG-IN CONNECTOR

NOTE:

1. CAM SWITCHES ARE SHOWN IN CW POSITION. ⊠ INDICATES CAM OPERATED SWITCH CLOSURE.
2. *SELF CANCELING WITH SW72A ⊠
3. SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

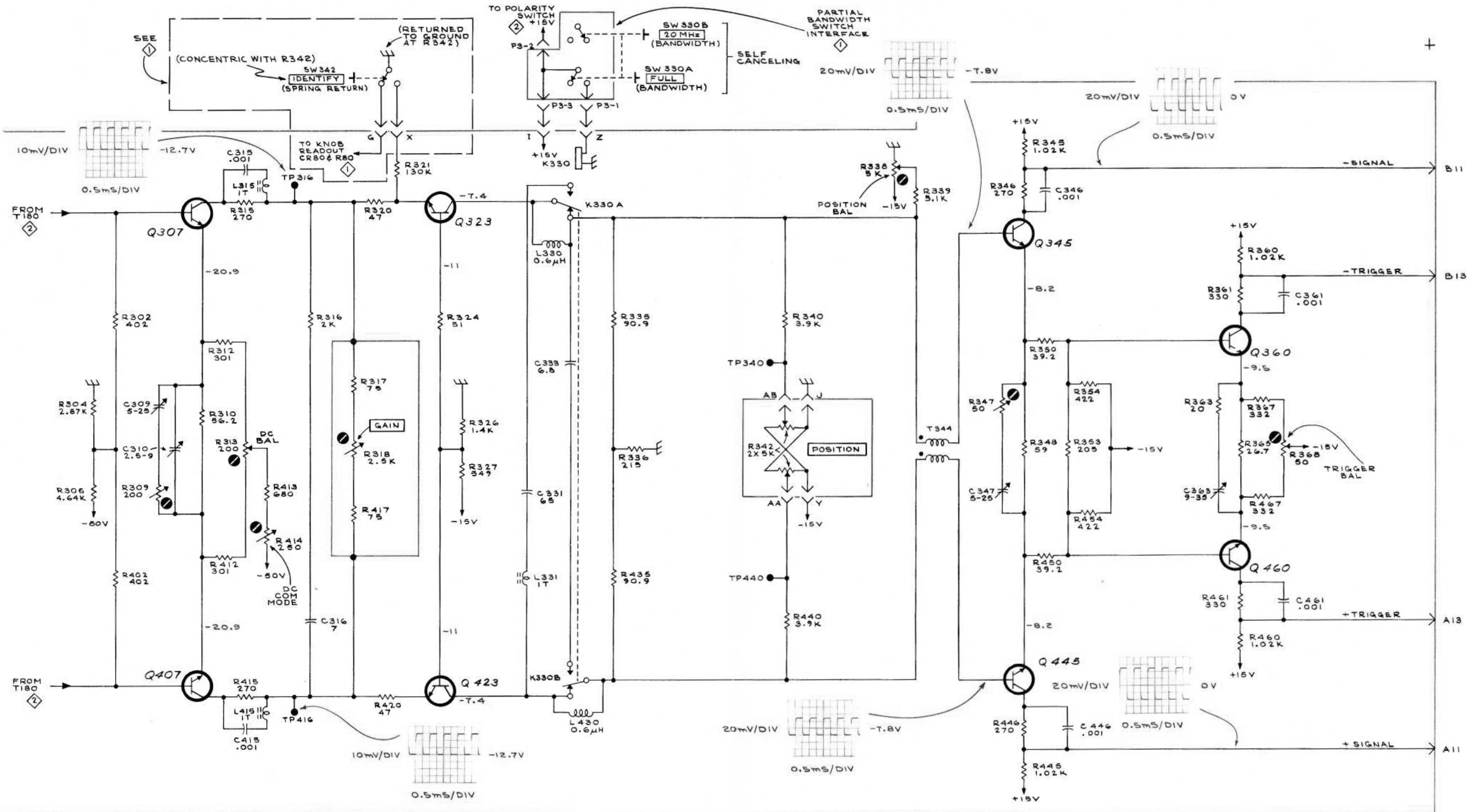




VOLTAGES and WAVEFORMS obtained under conditions given on diagram, except as follows:
 VOLTAGES only.....No signal applied.
 RELAYS K155, K160 and K235 actuated by P6021 probe.

- NOTES:
- 572A & 572B ARE SELF CANCELING.
 - IT COILS ARE FERRITE BEADS.
 - SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

- REFERENCE DIAGRAMS
- ① CURRENT/DIV SWITCH
 - ② OUTPUT AMPLIFIER

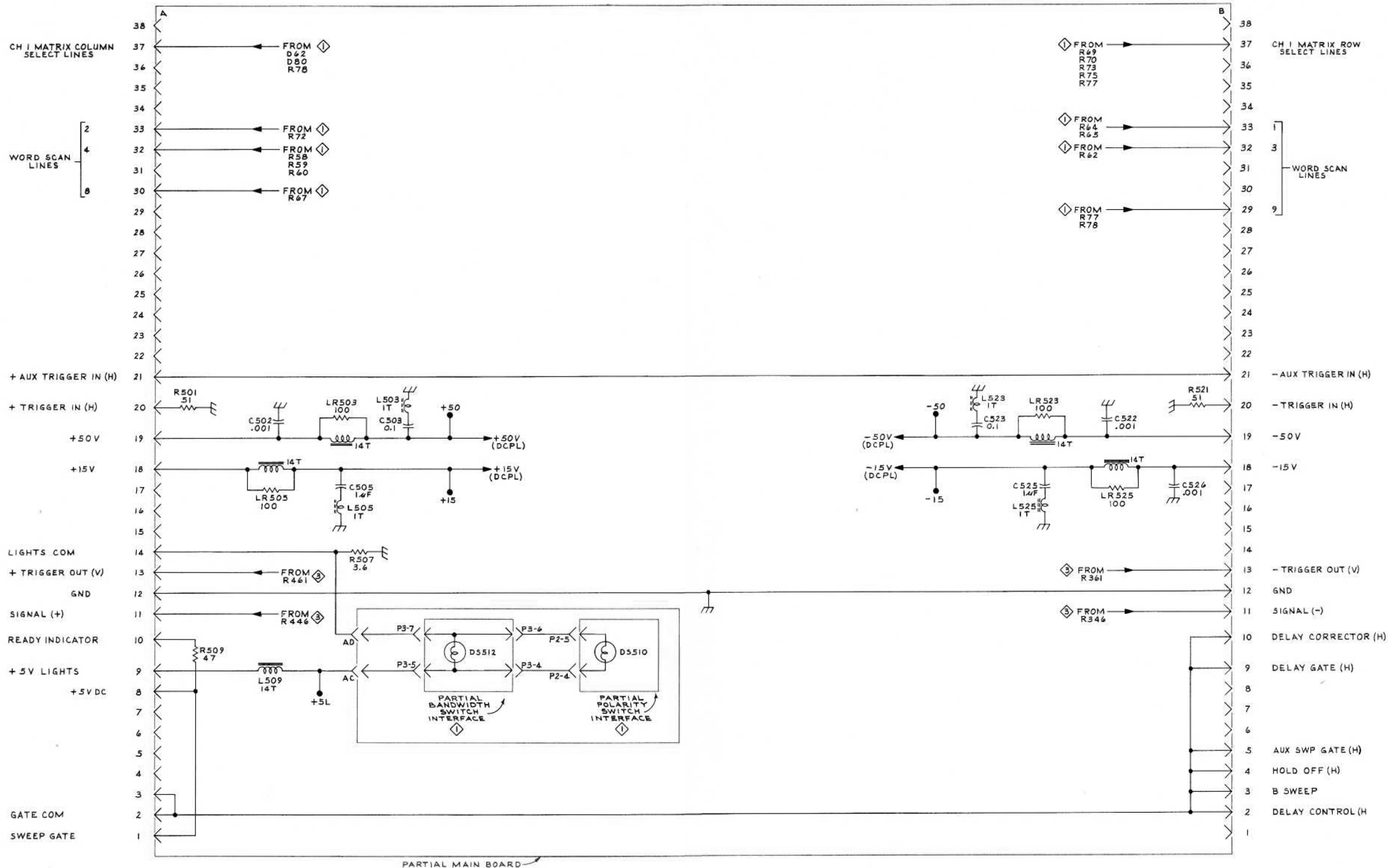


PARTIAL MAIN BOARD

VOLTAGES and WAVEFORMS obtained under conditions given on diagram \diamond , except as follows:
 VOLTAGES only.....No signal applied.

REFERENCE DIAGRAM
 \diamond 1 CURRENT/DIV SWITCH
 \diamond 2 INPUT AMPLIFIER

NOTE:
 1. IT COILS ARE FERRITE BEADS
 2. SEE PARTS LIST FOR SEMICONDUCTOR TYPES



PARTIAL MAIN BOARD

NOTE:
 1. IT COILS ARE FERRITE BEADS.

REFERENCE DIAGRAMS
 ① CURRENT/DIV SWITCH
 ③ OUTPUT AMPLIFIER

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

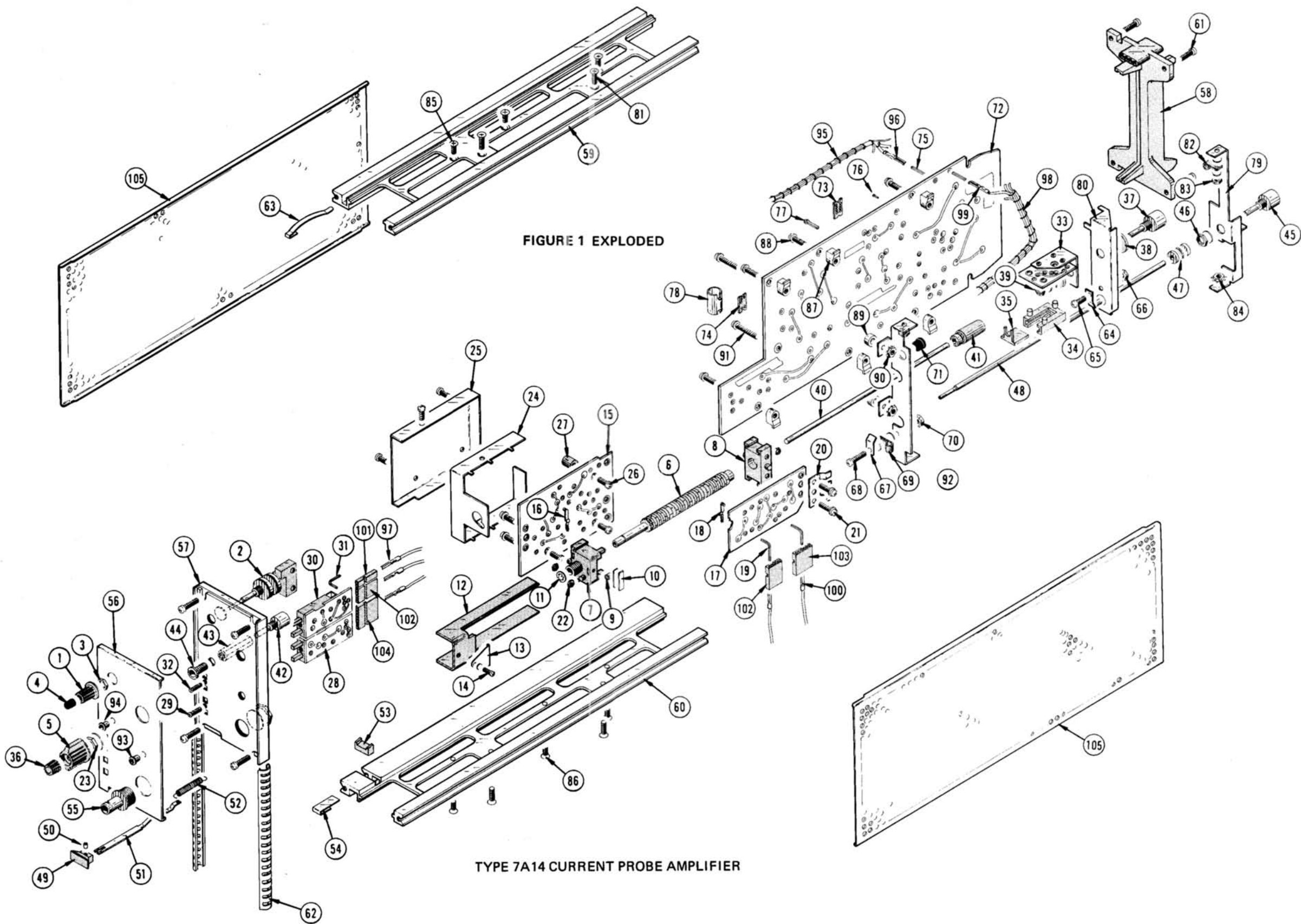
Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS ILLUSTRATIONS

Title	Location (reverse side of)
Figure 1. Exploded	Plug-In Connector Diagram



SECTION 8

MECHANICAL PARTS LIST

FIGURE 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q † Y	Description
		Eff	Disc		
1-1	366-1077-00			1	KNOB, gray—POSITION
	- - - - -			-	knob includes:
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-2	- - - - -			1	RESISTOR, variable, w/switch
	- - - - -			-	mounting hardware: (not included w/resistor)
	210-1027-00			1	WASHER, flat, 0.252 ID x 0.405 inch OD
	210-0046-00			1	WASHER, lock, internal, 0.261 ID x 0.400 inch OD
-3	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch
-4	366-1059-00			1	KNOB, push button, gray—IDENTIFY
-5	366-1057-00			1	KNOB, gray—CURRENT/DIV
	- - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
	672-0004-00			1	ASSEMBLY, circuit board—CURRENT/DIV
	- - - - -			-	assembly includes:
-6	105-0182-00			1	DRUM, cam switch
-7	401-0053-01			1	BEARING, front
-8	401-0052-00			1	BEARING, rear
-9	214-1127-00			1	ROLLER, detent
-10	214-1126-00 ¹			-	SPRING, flat, gold
	214-1126-01 ¹			-	SPRING, flat, green
	214-1126-02 ¹			-	SPRING, flat, red
-11	354-0219-00			1	RING, retaining
-12	200-0924-00			1	COVER, cam switch
-13	386-1701-00			1	PLATE, backing spring
	- - - - -			-	mounting hardware: (not included w/plate)
-14	211-0001-00			1	SCREW, 2-56 x 0.250 inch, PHS
	210-0001-00			1	LOCKWASHER, internal, #2
	210-0405-00			1	NUT, hex., 2-56 x 3/16 inch
-15	670-1039-00			1	ASSEMBLY, circuit board—ATTENUATOR
	- - - - -			-	assembly includes:
	388-1135-00			1	BOARD, circuit
-16	131-0604-00			15	CONTACT-POST ASSEMBLY
-17	670-1038-00			1	ASSEMBLY, circuit board—LOGIC
	- - - - -			-	assembly includes:
	388-1134-00			1	BOARD, circuit
-18	131-0604-00			10	CONTACT-POST ASSEMBLY
-19	131-0589-00			11	TERMINAL, pin
-20	131-0783-00			1	CONTACT, electrical grounding
-21	211-0116-00			6	SCREW, sems, 4-40 x 5/16 inch, PHB
-22	210-0591-00			6	NUT, hex., 4-40 x 5/16 inch
	- - - - -			-	mounting hardware: (not included w/assembly)
-23	210-0012-00			1	WASHER, lock, internal, 3/8 ID x 1/2 inch OD
	210-0590-00			1	NUT, hex., 3/8-32 x 7/16 inch
-24	337-1037-00			1	SHIELD, electrical
-25	337-1038-00			1	SHIELD, electrical, attenuator cover
	- - - - -			-	mounting hardware: (not included w/shield)
-26	211-0005-00			4	SCREW, 4-40 x 1/8 inch, PHS
	211-0116-00			3	SCREW, sems, 4-40 x 5/16 inch, PHB
-27	129-0182-00			3	POST, metallic

¹Replace only with part bearing same color as the original part in your instrument.

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Q † y	Description	1 2 3 4 5				
						1	2	3	4	5
1-28	670-1123-00	B010100	B039999	1	ASSEMBLY, push-button switch—BANDWIDTH					
	670-1123-01	B040000		1	ASSEMBLY, push-button switch—BANDWIDTH					
	- - - - -			-	assembly includes:					
	380-0153-01			1	HOUSING, bulb					
	- - - - -			-	mounting hardware: (not included w/housing)					
	213-0187-00			1	SCREW, thread forming, #2 x 0.375 inch, PHS					
	131-0589-00			6	TERMINAL, pin					
	- - - - -			-	mounting hardware: (not included w/assembly)					
-29	211-0156-00			1	SCREW, 1-72 x 0.250 inch, FHS					
-30	670-1122-00	B010100	B039999	1	ASSEMBLY, push-button switch—POLARITY					
	670-1122-01	B040000		1	ASSEMBLY, push-button switch—POLARITY					
	- - - - -			-	assembly includes:					
	380-0153-01			1	HOUSING, bulb					
	- - - - -			-	mounting hardware: (not included w/housing)					
	213-0181-00			1	SCREW, thread forming, #2 x 0.375 inch, PHS					
-31	131-0589-00			7	TERMINAL, pin					
	- - - - -			-	mounting hardware: (not included w/assembly)					
-32	211-0156-00			1	SCREW, 1-72 x 0.250 inch, FHS					
-33	670-1074-00			1	ASSEMBLY, circuit board—VARIABLE (CAL IN)					
	- - - - -			-	assembly includes:					
-34	351-0180-00			1	GUIDE, actuator					
-35	214-1136-00			1	SLIDE, actuator					
	131-0604-00			2	CONTACT-POST ASSEMBLY					
-36	366-1166-00			1	KNOB, red—VARIABLE (CAL IN)					
	- - - - -			-	knob includes:					
	213-0153-00			1	SCREW, set, 5.40 x 0.125 inch, HSS					
-37	- - - - -			1	RESISTOR, variable					
	- - - - -			-	mounting hardware: (not included w/resistor)					
-38	342-0006-00			1	INSULATOR, bushing					
	342-0005-00			1	INSULATOR, washer					
	210-0046-00			1	WASHER, lock, internal, 0.261 ID x 0.400 inch OD					
	210-1027-00			1	WASHER, flat, 0.252 ID x 0.406 inch OD					
-39	210-0583-00			1	NUT, hex., 1/4-32 x 5/16 inch					
-40	384-0457-00			1	SHAFT, extension, plastic					
-41	214-1190-00			1	EXTENDER-RETRACTOR, knob					
	- - - - -			-	extender-retractor includes:					
	213-0225-00			1	SETSCREW, 2-56 x 0.0625 inch, HSS					
-42	- - - - -			1	RESISTOR, variable					
	- - - - -			-	mounting hardware: (not included w/resistor)					
-43	210-0471-00			1	NUT, hex., 1/4-32 x 19/32 inch long					
	210-0046-00			2	WASHER, lock, internal, 0.261 ID x 0.400 inch OD					
-44	358-0409-00			1	BUSHING					

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Q					Description	
				t	y	1	2	3		4
1-45	- - - - -			1						RESISTOR, variable
	- - - - -			-						mounting hardware: (not included w/resistor)
	210-0046-00			1						WASHER, lock, internal, 0.261 ID x 0.400 inch OD
-46	210-0583-00			1						NUT, hex., 1/4-32 x 5/16 inch
-47	376-0050-00	B010100	B039999	1						COUPLING, flexible
	376-0051-00	B040000		1						COUPLING, flexible
	- - - - -			-						coupling includes:
	213-0022-00			4						SCREW, set, 4-40 x 1/8 inch, HSS
-48	384-0458-00			1						SHAFT, extension
-49	366-1058-01			1						KNOB—latch
	- - - - -			-						mounting hardware: (not included w/knob)
-50	214-1095-00			1						PIN, split
-51	105-0076-00			1						RELEASE BAR, latch
-52	214-1280-00			1						SPRING, helical
-53	105-0075-00			1						BOLT, latch
-54	214-1054-00			1						SPRING, flat
-55	131-0679-00			1						CONNECTOR, coaxial, 1 contact BNC, w/hardware
-56	333-1089-00			1						PANEL, front
-57	386-1447-01			1						SUBPANEL, front
-58	386-1402-00			1						PANEL, rear
-59	426-0499-02			1						FRAME SECTION, top
-60	426-0505-02			1						FRAME SECTION, bottom
	361-0326-00			1						SPACER, sleeve (not shown)
-61	213-0192-00			8						SCREW, 6-32 x 1/2 inch, Fil HS.
-62	348-0157-00	B010100	B010110	2						SHIELDING GASKET
	348-0235-00	B010111		2						SHIELDING GASKET
-63	214-1061-00			1						SPRING, flat grounding
-64	131-0664-00			1						CONTACT, electrical
	- - - - -			-						mounting hardware: (not included w/contact)
-65	211-0007-00			1						SCREW, 4-40 x 3/16 inch, PHS
-66	210-0586-00			1						NUT, keps, 4-40 x 1/4 inch
-67	131-0664-00			1						CONTACT, electrical
	- - - - -			-						mounting hardware: (not included w/contact)
-68	211-0097-00			1						SCREW, 4-40 x 5/16 inch, PHS
-69	343-0144-00			1						CLAMP, loop, 0.125 inch ID
	210-0994-00			2						WASHER, flat, 0.125 ID x 0.250 inch OD
-70	210-0586-00			1						NUT, keps, 4-40 x 1/4 inch
-71	348-0067-00			1						GROMMET, plastic, 5/16 inch diameter
-72	670-1037-00	B010100	B039999	1						ASSEMBLY, circuit board—main
	670-1037-01	B040000		1						ASSEMBLY, circuit board—main
	- - - - -			-						assembly includes:
	388-1133-00			1						BOARD, circuit
-73	136-0337-00			3						SOCKET, relay, 8 pin
-74	136-0336-00			9						SOCKET, relay, 5 pin
-75	131-0589-00			30						TERMINAL, pin
-76	136-0252-01			72						SOCKET, pin connector
-77	214-0579-00			15						PIN, test point
-78	337-1182-00			1						SHIELD, capacitor
-79	407-0489-00			1						BRACKET, variable resistor
-80	407-0488-00			1						BRACKET
	346-0081-00	XB030000		2						STRAP, grounding

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Q t Y	Description
		Eff	Disc		
1-	- - - - -			-	mounting hardware: (not included w/assembly)
-81	211-0114-00			1	SCREW, 4-40 x 7/16 inch, FHS
-82	343-0144-00			1	CLAMP, loop, 0.125 inch ID
	210-0994-00			2	WASHER, flat, 0.125 ID x 0.250 inch OD
-83	210-0406-00			1	NUT, hex., 4-40 x 3/16 inch
-84	210-0586-00			2	NUT, hex., 4-40 x 1/4 inch
-85	211-0101-00			3	SCREW, 4-40 x 1/4 inch, FHS, 100° csk
-86	211-0105-00			6	SCREW, 4-40 x 3/16 inch, FHS, 100° csk
-87	220-0547-01			6	NUT, block
-88	211-0116-00			6	SCREW, sems, 4-40 x 5/16 inch, PHS
	386-1845-00	XB030000		1	SUPPORT, circuit board
-89	361-0225-00	B010100	B030000X	2	SPACER
-90	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-91	211-0154-00			2	SCREW, sems, 4-40 x 0.562 inch, PHB
-92	131-0638-00	B010100	B030000X	1	LINK, terminal connector
-93	358-0378-00			1	BUSHING, plastic
-94	358-0301-02			1	BUSHING, plastic
-95	179-1428-00			1	WIRING HARNESS, chassis
	136-0623-00			-	wiring harness includes:
				2	CONNECTOR, terminal
-96	131-0621-00	B010100	B02039	19	CONNECTOR, terminal
	131-0621-00	B020310		1	CONNECTOR, terminal
	131-0792-00	B020310		1	CONNECTOR, terminal
-97	131-0707-00			18	CONNECTOR, terminal
-98	179-1429-00			1	WIRING HARNESS, connecting
				-	wiring harness includes:
-99	131-0621-00			7	CONNECTOR, terminal
-100	131-0707-00			7	CONNECTOR, terminal
-101	352-0169-00			1	HOLDER, terminal connector, 2 terminal
-102	352-0163-00			1	HOLDER, terminal connector, 5 terminal
-103	352-0164-00			1	HOLDER, terminal connector, 6 terminal
-104	352-0165-00			1	HOLDER, terminal connector, 7 terminal
-105	337-1064-00			2	SHIELD, side

STANDARD ACCESSORIES

070-0979-00	1	MANUAL, instruction (not shown)
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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.