

TEKTRONIX®

**7A24
DUAL TRACE
AMPLIFIER**

INSTRUCTION MANUAL

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

Serial Number _____



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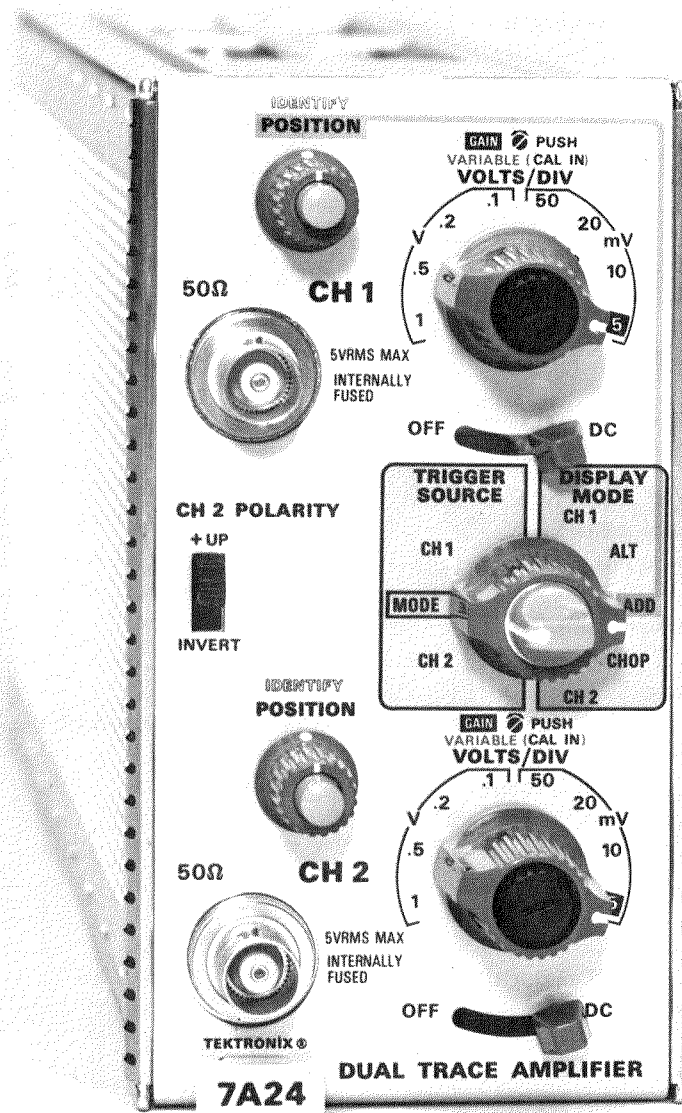
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7A24 FEATURES

The 7A24 is a dual-channel, wide-bandwidth amplifier plug-in unit designed for use with Tektronix 7000-series Oscilloscopes. Each channel has an input impedance of 50 ohms and is internally fused. Internal attenuators and gain circuits are switched to correspond to the settings of the VOLTS/DIV switches. Channel 2 can be inverted and added to channel 1 for differential measurements.

Fig. 1-1. 7A24 Dual-Trace Amplifier.

OPERATING INSTRUCTIONS

PRELIMINARY INFORMATION

Installation

The 7A24 is calibrated and ready for use as received. It can be installed in any compartment of Tektronix 7000-series oscilloscopes, but is principally used in vertical plug-in compartments. To install, align the upper and lower rails of the 7A24 with the oscilloscope tracks and fully insert it. The front is flush with the front of the oscilloscope when the 7A24 is fully inserted, and the latch at the bottom-left corner of the 7A24 will be in place against the front panel. See Fig. 1-2.

To remove the 7A24, pull on the latch (which is inscribed with the unit identification "7A24") and the 7A24 will unlatch. Continue pulling on the latch to slide the 7A24 out of the oscilloscope.

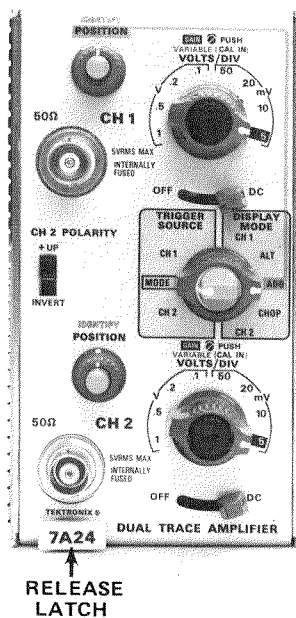


Fig. 1-2. Release Latch.

GENERAL OPERATING INFORMATION

Introduction

For single-trace operation, either of the two identical amplifier channels can be used independently by setting the DISPLAY MODE and TRIGGER SOURCE switches to

CH 1 or CH 2 and connecting the signal to be observed to the appropriate input. In the discussions to follow, single-trace operations using CH 1 only apply equally to CH 2 only.

Signal Connections

The 50-ohm input impedance of the 7A24 is ideally suited for making waveform measurements on 50-ohm systems, in that 50-ohm coaxial cables can be connected directly to the input of the 7A24. The 7A24, however, should not be connected directly to a power supply, power line, or other voltage source that would exceed the input voltage limits of the 7A24 (see Specification section, Table 2-1). Probes recommended for use with the 7A24 are the P6056 (10X) and P6057 (100X). Both probes are compatible with 50-ohm systems, and will allow optimum frequency response. These probes also contain trace IDENTIFY and readout encoding functions. A one-megohm input impedance may be achieved by using the P6051 FET Probe.

Vertical Gain Check and Adjustment

To check the gain of either channel, set the VOLTS/DIV switch to 5 mV and connect a 40-millivolt, one-kilohertz signal (20-millivolts when terminated by 50-ohms) from the oscilloscope calibrator to the input connector of the channel being checked. The vertical deflection should be exactly four divisions. If not, adjust the front-panel GAIN for exactly four divisions of deflection. The GAIN adjustment is engaged by pressing in the GAIN control knob and turning the knob with a narrow-blade screwdriver (see Fig. 1-3, Front-Panel Controls and Connectors). Turn the knob clockwise, then counterclockwise, until the GAIN control is engaged. When the GAIN control is engaged, the vertical deflection will change as the knob is turned. Turn the GAIN control knob with the screwdriver until the deflection is set to exactly four divisions, then remove the screwdriver.

Input Coupling

The Channel 1 and Channel 2 Input (OFF-DC) switches select the signal input coupling mode.

DC. The DC position couples both ac and dc components of the signal into the input amplifier. A 50-ohm impedance is presented to the signal source.

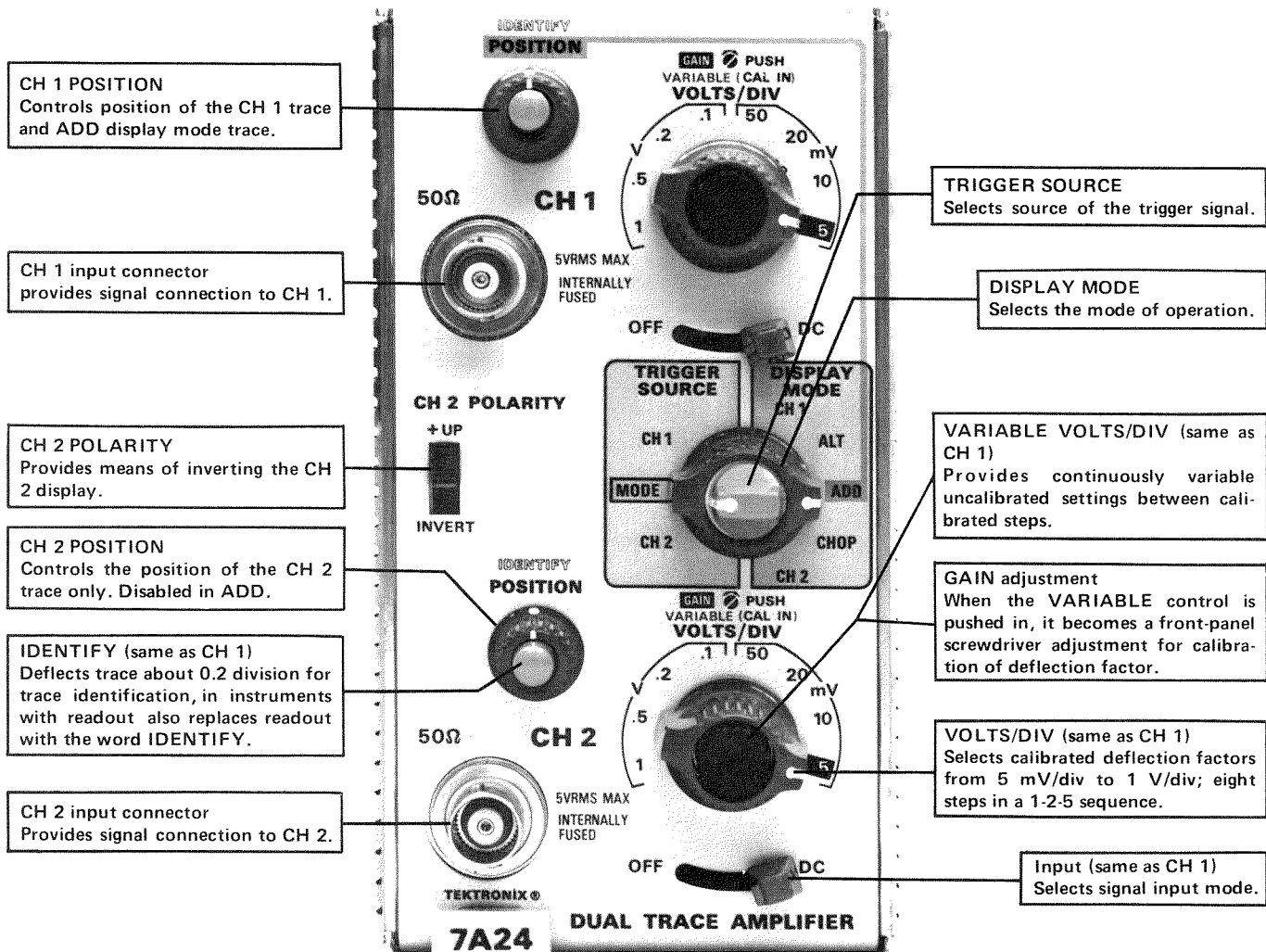


Fig. 1-3. 7A24 Front-Panel Controls and Connectors.

OFF. The OFF position disconnects the signal source from the amplifier and connects it to a resistive 50-ohm termination.

Input Protection Fuse

A fuse in the input of each channel protects the 7A24 from damage due to excessive signal voltages. If this fuse is open, no display can be obtained. If no waveform can be displayed, but the POSITION control will move the trace on the crt, check the condition of the fuse.

The thick film, ceramic fuse is located on the front of the Attenuator circuit board. A spare fuse is stored on the rear of the board. (See the Maintenance section of this manual for fuse replacement instructions.) If fuse replacement is necessary, order a new fuse to replace the spare.

VOLTS/DIV and VARIABLE Controls

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the attenuation factor of the probe, the setting of the VOLTS/DIV switch, and the setting of the VARIABLE control. Calibrated deflection factors indicated by the settings of the VOLTS/DIV switch apply only when the VARIABLE control is in the calibrated (CAL IN) position.

The VARIABLE control provides variable, uncalibrated settings between the calibrated steps of the VOLTS/DIV switch. With the VARIABLE control fully counter-clockwise and the VOLTS/DIV switch set to 1 volt/division the uncalibrated vertical deflection factor is extended to at least 2.5 volts/division. By applying a calibrated voltage source to the input connector, any specific deflection factor can be set within the range of the VARIABLE control.

CH 2 POLARITY Switch

The CH 2 POLARITY switch may be used to invert the displayed waveform of the signal applied to the CH 2 input. This is particularly useful in added operation of the 7A24 when differential measurements are to be made. The CH 2 POLARITY switch has two positions, +UP and INVERT. In the +UP position, the displayed waveform will have the same polarity as the applied signal and a positive dc voltage will move the crt trace up. In the INVERT position, a waveform at the CH 2 input will be displayed on the crt in inverted form and a positive dc voltage will move the trace down.

DISPLAY MODE Switch

For single-trace operation, apply the signal either to the CH 1 input or the CH 2 input and set the DISPLAY MODE switch to the corresponding position: CH 1 or CH 2.

To display a signal in one channel independently when a signal is also applied to the other channel, simply select the desired channel by setting the DISPLAY MODE switch to the appropriate CH 1 or CH 2 position.

Alternate Mode. The ALT position of the DISPLAY MODE switch produces a display which alternates between Channel 1 and Channel 2 with each sweep on the crt. Although the ALT mode can be used at all sweep rates, the CHOP mode provides a more satisfactory display at sweep rates below about 0.5 millisecond/division. At slow sweep rates, alternate mode switching becomes visually perceptible.

Add Mode. The ADD position of the DISPLAY MODE switch can be used to display the sum or difference of two signals, for common-mode rejection to remove an undesired signal, or for dc offset (applying a dc voltage to one channel to offset the dc component of a signal on the other channel). The overall deflection factor in the ADD mode with both VOLTS/DIV switches set to the same position is the deflection factor indicated by either VOLTS/DIV switch. However, if the CH 1 and CH 2 VOLTS/DIV switches are set to different deflection factors, the resultant amplitude is difficult to determine from the crt display. In this case, the voltage amplitude of the resultant display can be determined accurately only if the amplitude of the signal applied to one channel is known. In the ADD mode, positioning of the trace is controlled by the Channel 1 POSITION control only.

Chop Mode. The CHOP position of the DISPLAY MODE switch produces a display which is electronically switched between channels at approximately a 500 kilohertz rate (controlled by mainframe). In general the CHOP mode provides the best display at sweep rates slower than about 0.5 millisecond/division or whenever dual-trace, non-repetitive phenomena is to be displayed.

TRIGGER SOURCE Switch

CH 1. The CH 1 position of the TRIGGER SOURCE switch provides a trigger signal obtained from the signal applied to the CH 1 input connector. This provides a stable display of the signal applied to the CH 1 input connector.

CH 2. The CH 2 position of the TRIGGER SOURCE switch provides a trigger signal obtained from the signal applied to the CH 2 input connector. This provides a stable display of the signal applied to the CH 2 input connector.

MODE. In this position of the TRIGGER SOURCE switch, the trigger signal for the time-base unit is dependent

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on the setting of the DISPLAY MODE switch. The trigger source for each position of the DISPLAY MODE switch is as follows:

MODE	TRIGGER SIGNAL SOURCE
CH 1	Channel 1
CH 2	Channel 2
ADD	Algebraic sum of Channel 1 and Channel 2
CHOP	Algebraic sum of Channel 1 and Channel 2
ALT	Alternates between Channel 1 and Channel 2

Trace Identification

When the IDENTIFY button is pressed, the trace is deflected about 0.3 division to identify the 7A24 trace. This feature is particularly useful when multiple traces are displayed. In instruments with readout, pressing the IDENTIFY button also replaces the deflection factor readout with the word "IDENTIFY".

BASIC APPLICATIONS

General

The following information describes the procedures and techniques for making basic measurements with a 7A24 and the associated Tektronix oscilloscope and time-base. These applications are not described in detail since each application must be adapted to the requirements of the individual measurements. This instrument can also be used for many applications not described in this manual. Contact your local Tektronix Field Office or representative for assistance in making specific measurements with this instrument.

Peak-to-Peak Voltage Measurements

To make peak-to-peak voltage measurements, use the following procedure:

1. Apply the signal to either input connector.
2. Set the DISPLAY MODE and TRIGGER SOURCE switches to display the channel used.
3. Set the Input switch to DC.
4. Set the VOLTS/DIV switch to display about five divisions of the waveform vertically.
5. Set the time-base Triggering controls for a stable display. Set the time-base unit to a sweep rate that displays several cycles of the waveform.

6. Turn the 7A24 POSITION control so the lower portion of the waveform coincides with one of the graticule lines below the center horizontal line, and the top of the waveform is within the viewing area. With the time-base Position control, move the display so one of the upper peaks lies near the center vertical line (see Fig. 1-4).

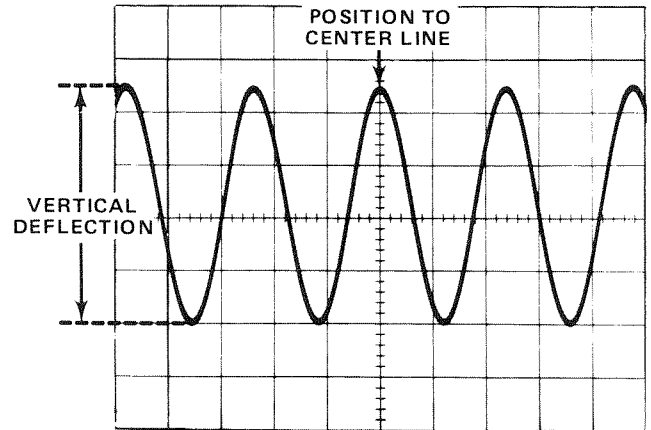


Fig. 1-4. Measuring the peak-to-peak voltage of a waveform.

7. Measure the divisions of vertical deflection peak-to-peak. Check that the VARIABLE (VOLTS/DIV) control is in the CAL IN position.

NOTE

This technique can also be used to make measurements between two points on the waveform, rather than peak to peak.

8. Multiply the deflection measured in step 7 by the VOLTS/DIV switch setting. Include the attenuation factor of the probe if used.

EXAMPLE: Assume that the peak-to-peak vertical deflection is 4.5 divisions (see Fig. 1-4) using a 10X attenuator probe, and the VOLTS/DIV switch is set to 1 V.

$$\text{Volts Peak to Peak} = \frac{\text{vertical deflection (divisions)}}{\text{VOLTS/DIV setting}} \times \text{probe attenuation factor}$$

Substituting the given values:

$$\text{Volts Peak-to-Peak} = 4.5 \times 1 \times 10$$

The peak-to-peak voltage is 45 volts.

Instantaneous Voltage Measurements

To measure the dc level at a given point on a waveform, proceed as follows:

1. Connect the signal to either input connector.
2. Set the DISPLAY MODE and TRIGGER SOURCE switches to display the channel used.
3. Set the VOLTS/DIV switch to display about five divisions of the waveform.
4. Set the Input switch to OFF and position the trace to the bottom graticule line or other reference line. If the voltage is negative with respect to ground, position the trace to the top graticule line. Do not move the POSITION control after this reference line has been established.

NOTE

To measure a voltage level with respect to a voltage other than ground, make the following changes to step 4. Set the Input switch to DC and apply the reference voltage to the input connector. Then position the trace to the reference line.

5. Set the Input switch to DC. The ground reference line can be checked at any time by switching to the OFF position.
6. Set the time-base Triggering controls for a stable display. Set the time-base sweep rate for an optimum display of the waveform.
7. Measure the distance in divisions between the reference line and the point on the waveform at which the dc level is to be measured. For example, in Fig. 1-5 the measurement is between the reference line and point A.
8. Establish the polarity of the waveform. With the CH 2 POLARITY switch in the +UP position, any point above the reference line is positive.
9. Multiply the distance measured in step 7 by the VOLTS/DIV setting. Include the attenuation factor of the probe, if used.

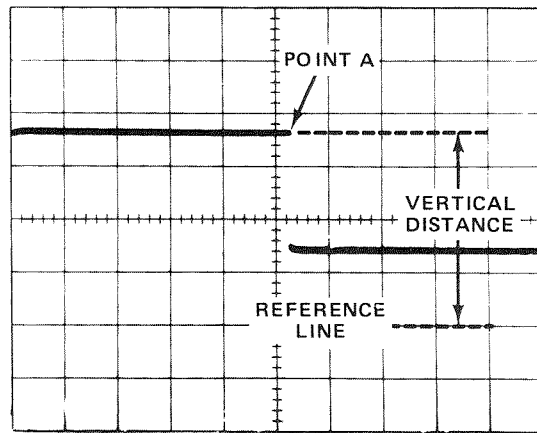


Fig. 1-5. Measuring instantaneous voltage with respect to some reference.

EXAMPLE: Assume the vertical distance measured is 3.6 divisions (see Fig. 1-5) and the waveform is above the reference line using a 10X probe with a VOLTS/DIV setting of .5 V.

Using the formula:

$$\text{Instantaneous Voltage} = \text{vertical distance (divisions)} \times \text{polarity} \times \text{VOLTS/DIV setting} \times \text{probe attenuation factor}$$

Substituting the given values:

$$\text{Instantaneous Voltage} = 3.6 \times +1 \times 0.5 \text{ V} \times 10$$

The instantaneous voltage is 18 volts.

Comparison Measurements

In some applications it may be desirable to establish arbitrary units of measurement other than those indicated by the VOLTS/DIV switch. This is particularly useful when comparing unknown signals to a reference amplitude. One use for the comparison-measurement technique is to facilitate calibration of equipment where the desired amplitude does not produce an exact number of divisions of deflection. The adjustment will be easier and more accurate if arbitrary units of measurement are established so that the correct adjustment is indicated by an exact number of divisions of deflection. The following procedure describes how to establish arbitrary units of measure for comparison measurements.

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To establish an arbitrary vertical deflection factor based upon a specific reference amplitude, proceed as follows:

1. Connect the reference signal to the input connector. Set the time-base unit sweep rate to display several cycles of the signal.

2. Set the VOLTS/DIV switch and the VARIABLE control to produce a display which is an exact number of vertical divisions in amplitude. Do not change the VARIABLE control after obtaining the desired deflection.

3. To establish an arbitrary vertical deflection factor so the amplitude of an unknown signal can be measured accurately at any setting of the VOLTS/DIV switch, the amplitude of the reference signal must be known. If it is not known, it can be measured before the VARIABLE VOLTS/DIV control is set in step 2.

4. Divide the amplitude of the reference signal (volts) by the product of the vertical deflection (divisions) established in step 2 and the setting of the VOLTS/DIV switch. This is the vertical conversion factor.

$$\text{Vertical Conversion Factor} = \frac{\text{reference signal amplitude (volts)}}{\text{vertical deflection (divisions)} \times \text{VOLTS/DIV switch setting}}$$

5. To measure the amplitude of an unknown signal, disconnect the reference signal and connect the unknown signal to the input connector. Set the VOLTS/DIV switch to a setting that provides sufficient vertical deflection to make an accurate measurement. Do not re-adjust the VARIABLE control.

6. Measure the vertical deflection in divisions and calculate the amplitude of the unknown signal using the following formula.

$$\text{Signal Amplitude} = \text{VOLTS/DIV setting} \times \text{vertical conversion factor} \times \text{vertical deflection (divisions)}$$

EXAMPLE: Assume a reference signal amplitude of 3 volts, a VOLTS/DIV setting of .5 V and the VARIABLE control adjusted to provide a vertical deflection of four divisions. Substituting these values in the vertical conversion factor formula (step 4):

$$\text{Vertical Conversion Factor} = \frac{3 \text{ V}}{4 \times .5 \text{ V}} = 1.5$$

Then with a VOLTS/DIV setting of .2 V, the peak-to-peak amplitude of an unknown signal which produces a vertical deflection of five divisions can be determined by using the signal amplitude formula (step 6):

$$\text{Signal Amplitude} = .2 \text{ V} \times 1.5 \times 5 = 1.5 \text{ volts}$$

Dual-Trace Phase Difference Measurements

Phase comparison between two signals of the same frequency can be made using the dual-trace feature of the 7A24. This method of phase-difference measurement can be used up to the frequency limit of the oscilloscope system. To make the comparison, use the following procedure:

1. Set the CH 1 and CH 2 Input switches to DC.

2. Set the DISPLAY MODE to ALT or CHOP. In general, CHOP is more suitable for low frequencies and ALT is more suitable for high frequencies. Set the TRIGGER SOURCE to CH 1.

3. Connect the reference signal to the CH 1 input and the comparison signal to the CH 2 input. Use coaxial cables or probes which have similar time-delay characteristics to connect the signals to the input connectors.

4. If the signals are of opposite polarity, set the CH 2 POLARITY switch to invert the Channel 2 display. (Signals may be of opposite polarity due to 180° phase difference; if so, take this into account in the final calculation.)

5. Set the VOLTS/DIV switches and the VARIABLE controls of the two channels so the displays are equal and about five divisions in amplitude.

6. Set the time-base unit to a sweep rate which displays about one cycle of the waveforms. Set the Triggering controls for a stable display.

7. Center the waveforms on the graticule with the 7A24 POSITION controls.

8. Adjust the time-base Variable Time/Div control until one cycle of the reference signal occupies exactly eight

horizontal divisions between the second and tenth vertical lines of the graticule (see Fig. 1-6). Each division of the graticule represents 45° of the cycle ($360^\circ \div 8 \text{ divisions} = 45^\circ/\text{division}$). The sweep rate can now be stated in terms of degrees as $45^\circ/\text{division}$.

9. Measure the horizontal difference between corresponding points on the waveform.

10. Multiply the measured distance (in divisions) by $45^\circ/\text{division}$ to obtain the exact amount of phase difference.

EXAMPLE: Assume a horizontal difference of 0.3 division with a sweep rate of $45^\circ/\text{division}$ as shown in Fig. 1-6.

Using the formula:

$$\text{Phase Difference} = \begin{matrix} \text{horizontal} \\ \text{difference} \\ \text{(divisions)} \end{matrix} \times \begin{matrix} \text{sweep rate} \\ \text{(degrees/division)} \end{matrix}$$

Substituting the given values:

$$\text{Phase Difference} = 0.3 \times 45^\circ$$

The phase difference is 13.5° .

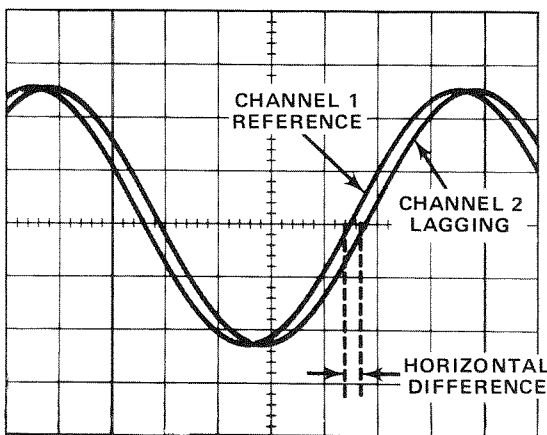


Fig. 1-6. Measuring phase difference between two signals.

High Resolution Phase Measurements

More accurate dual-trace phase measurements can be made by increasing the sweep rate (without changing the Variable Time/Div control). One of the easiest ways to increase the sweep rate is with the time-base Magnifier switch. Set the Magnifier to X10 and determine the magnified sweep rate by dividing the sweep rate obtained previously by the amount of sweep magnification.

EXAMPLE: If the sweep rate is increased 10 times by the Magnifier, the magnified sweep rate is $45^\circ/\text{division} \div 10 = 4.5^\circ/\text{division}$. Fig. 1-7 shows the same signals as used in Fig. 1-6 but with the Magnifier set to X10. With a horizontal difference of 3 divisions, the phase difference is:

$$\text{Phase Difference} = \begin{matrix} \text{horizontal} \\ \text{difference} \\ \text{(divisions)} \end{matrix} \times \begin{matrix} \text{magnified} \\ \text{sweep rate} \\ \text{(degrees/division)} \end{matrix}$$

Substituting the given values:

$$\text{Phase Difference} = 3 \times 4.5^\circ$$

The phase difference is 13.5° .

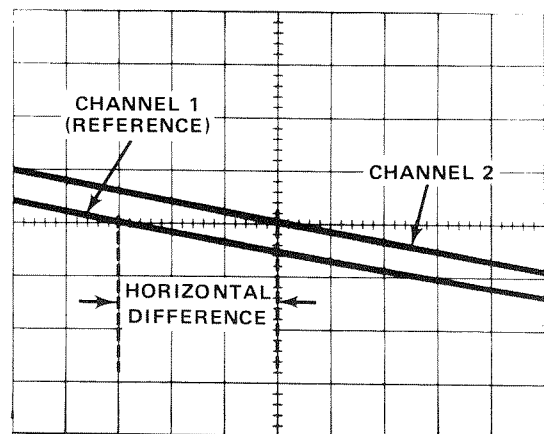


Fig. 1-7. High resolution phase measurement using time-base magnifier.

Common Mode Rejection

The ADD feature of the 7A24 can be used to display signals which contain undesirable components. These

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undesirable components can be eliminated through common-mode rejection. The procedure is as follows:

1. Set the DISPLAY MODE switch to ALT or CHOP and the TRIGGER SOURCE switch to MODE.

2. Connect the signal containing both the desired and undesired information to the CH 1 input connector.

3. Connect a signal similar to the unwanted portion of the CH 1 signal to the CH 2 input connector. For example, in Fig. 1-8 a line-frequency signal is connected to channel 2 to cancel out the line-frequency component of the channel 1 signal.

4. Set both Input switches to the DC position.

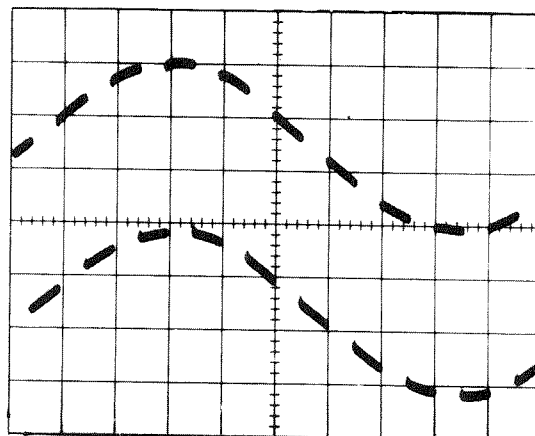
5. Set the VOLTS/DIV switches so the signals are about equal in amplitude.

6. Set the DISPLAY MODE switch to ADD. Set the CH 2 POLARITY switch to INVERT so the common-mode signals are of opposite polarity.

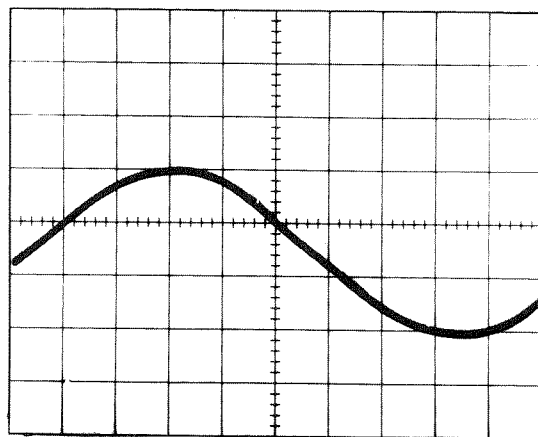
7. Adjust the Channel 2 VOLTS/DIV switch and VARIABLE control for maximum cancellation of the common-mode signal. The signal which remains should be only the desired portion of the channel 1 signal.

EXAMPLE: An example of this mode of operation is shown in Fig. 1-8. The signal applied to Channel 1 contains unwanted line-frequency components (Fig. 1-8A). A corresponding line-frequency signal is connected to Channel 2 (Fig. 1-8B). Fig. 1-8C shows the desired portion of the signal as displayed when common-mode rejection is used.

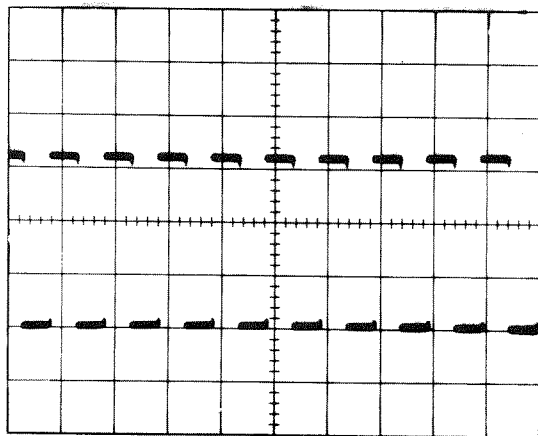
The above procedure can also be used for examining a signal superimposed on some dc level. A dc voltage of the proper polarity applied to Channel 2 can be used to cancel out the dc portion of the signal applied to Channel 1.



(A) CHANNEL 1 SIGNAL.



(B) CHANNEL 2 SIGNAL.



(C) RESULTANT DISPLAY.

Fig. 1-8. Using the ADD mode for common-mode rejection. (A) Channel 1 signal contains desired information along with line-frequency component. (B) Channel 2 contains line frequency only. (C) Resultant CRT display using common-mode rejection.

SPECIFICATION

Introduction

The following electrical characteristics are valid over the stated environmental range for instruments calibrated at an ambient temperature of +20°C to +30°C, and after a twenty-minute warmup unless otherwise noted.

TABLE 2-1

Electrical

Characteristic	Performance Requirement	Supplemental Information
Deflection Factor		
Calibrated Range	5 mV/Div to 1 V/Div; eight steps in a 1, 2, 5 sequence.	
Gain Ratio Accuracy	Within 2% of indicated deflection factor with GAIN adjusted at 5 mV/Div.	
Uncalibrated (VARIABLE)		Continuously variable between calibrated steps; extends deflection factor to at least 2.5 volts per division.
GAIN Range		Permits adjustment of deflection factor for calibrated operation with all 7000-series oscilloscopes.
Frequency Response Bandwidth	Depends upon oscilloscope used.	See the oscilloscope mainframe specifications or the current Tektronix catalog.
Maximum Input Voltage	5 volts (0.5 watts).	Up to 10 volts (2 watts) can be applied to the input without damage to the instrument.
Input Characteristics	50.0 ohms, within 2%.	
DC Resistance	Equal to, or less than 1.25 at 5 mV and 10 mV; equal to, or less than 1.15 at 20 mV to 1 V; from dc to 350 MHz.	
VSWR		
Overdrive Recovery Time		0.1 millisecond or less to recover to within one division after removal of over-drive signal of up to +75 divisions or -75 divisions regardless of overdrive signal duration.

Characteristic	Performance Requirement	Supplemental Information
Delay Time Difference Between Channels		200 picoseconds or less.
Channel Isolation		50:1 display ratio up to 200 megahertz.
Common Mode Rejection Ratio	At least 10:1, dc to 50 MHz.	
Chop Frequency		See the oscilloscope mainframe specifications.
Display Modes	Channel 1 only.	
	Dual-trace, alternate between channels.	
	Added algebraically.	
	Dual-trace, chopped between channels.	
	Channel 2 only.	
Trigger Source Selection	Channel 1 only.	
	Follows DISPLAY MODE selection.	
	Channel 2 only.	

TABLE 2-2

Environmental
Refer to the specification for the associated mainframe.

TABLE 2-3

Physical	
Size	Fits all 7000-series plug-in compartments.
Weight	2 Pounds 9 Ounces (1.2 Kilograms).

THEORY OF OPERATION

INTRODUCTION

This section of the manual contains a description of the circuitry used in the 7A24. The 7A24 description begins with a discussion of the instrument using the block diagram shown in the Diagrams section. Then, each circuit is described in detail using the block diagram to show the interconnections between stages in each major circuit 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 schematics throughout the following circuit description for electrical values and relationship.

BLOCK DIAGRAM

The Channel 1 Amplifier circuit provides gain setting, variable gain control, and trace positioning. The Channel 2 Amplifier provides signal-polarity inversion in addition to gain setting, variable gain control, and trace positioning.

The signal to be displayed on the crt is applied to the CH 1 or CH 2 input connector. The signal passes through the Input switch, where it is either connected to the attenuators or to a 50-ohm dummy load. The VOLTS/DIV switch selects the correct amount of attenuation, and the signal is passed to the Switched-Gain Amplifier.

When the VOLTS/DIV switch is set to the 5 mV and 10 mV positions, the signal connected to the input connector is passed through the attenuators without attenuation. When the VOLTS/DIV switch is set in the 5 mV position, the Switched-Gain Amplifier operates at full gain. In all other positions of the VOLTS/DIV switch, the gain of the Switched-Gain Amplifier is reduced by two. Internal gain and balance adjustments are included in the Switched-Gain Amplifier.

Overall GAIN and VARIABLE gain are adjusted in the Gain Amplifier. Variable Balance and high-frequency adjustments are also controlled in the Gain Amplifier. The output of the Gain Amplifier is connected to the Positioning circuitry where the POSITION and IDENTIFY functions are controlled. Channel 2 is identical to Channel 1, with the exception of the polarity-inversion function in Channel 2.

The Display and Trigger Channel Switching Amplifiers provide differential signal outputs for the signal and trigger lines, from each channel, to a common display and trigger output.

The output of the Display and Trigger Channel Switching Amplifiers are connected to the oscilloscope mainframe via the interface connector.

Readout encoding circuitry used in the 7A24 is standard to the 7000-series.

CH 1 AND CH 2 ATTENUATORS

NOTE

The CH 1 and CH 2 amplifier circuits are identical with the exception of the CH 2 GAIN stage U2450, which includes a POLARITY inverting circuit. Only CH 1 is described in detail throughout this discussion.

Delay Line and Fuse

Signals connected to the input connector pass through a delay line and a 0.2 amp. fuse (F100) before reaching the Input switch. The delay line is used to produce a standardized time delay through the plug-in. The fuse protects the attenuators and amplifier by preventing excessive voltages from reaching these components.

Input Switch

Input signals can be dc-coupled or internally disconnected. S100A is a cam-type switch; a contact-closure chart showing the operation is given on the schematic diagrams. When the Input switch is in the DC position, the input signal is connected to the attenuators. The OFF position opens the signal path to the attenuators and connects the input to an internal 50-ohm dummy load. This provides a ground reference without the need to disconnect the applied signal from the input connector, while presenting a constant 50-ohm load at the input connector.

Input Attenuator

The effective overall deflection factor of the 7A24 is determined by the setting of the VOLTS/DIV switch, S100B. The basic deflection factor is 5 millivolts per division of crt deflection. To increase the deflection factor

Theory of Operation—7A24

to the values indicated on the front panel, precision attenuators are switched into the circuit. S100B is a cam-type switch. The dots on the contact-closure chart (see Diagram 1) indicate when the associated contacts are in the position shown (open or closed). In the 5 mV/Div and 10 mV/Div positions, the attenuators are not used; the input signal is connected directly to the Switched-Gain Amplifier. The 10 mV/Div position decreases the gain of the Switched-Gain Amplifier. For switch positions above 10 mV/Div, the attenuators are switched into the circuit, singly or stacked, to produce the deflection factor indicated on the front panel. The hybrid attenuators are constant impedance, T-pad dividers. In addition to providing constant attenuation at all frequencies within the bandwidth of the instrument, the input attenuators are designed to maintain the same input impedance (50 ohms) for all settings of the VOLTS/DIV switch.

CH 1 AND CH 2 AMPLIFIERS

Switched-Gain Amplifier

The coax coupler between the Attenuator circuit board and the Main Amplifier circuit board acts as a balun transformer to provide differential drive to U1350 at high frequencies. U1350 is a paraphase-type amplifier with dual differential outputs.

In the 5 mV position, full drive is provided from pins 5 and 9 of U1350 to the U1450 load resistors, R1401 and R1403. In all other attenuator positions, the signal-path drive current through the load resistors is divided in half. The other half is diverted through pins 6 and 8 of U1350 and is dissipated in dummy-load resistors R1341 and R1343. R1337 sets the basic gain of amplifier U1350. R1317 is used to divide the basic gain by a factor of two for all positions of the VOLTS/DIV switch except 5 mV.

CR1319 and R1319 maintain proper collector voltage while switching between the 5 mV and 10 mV positions. C1332 and R1332 are thermal compensations. R1336 and C1336 are high-frequency adjustments.

Fixed length inductors and capacitors are part of the Amplifier etched circuit board and provide T-coil peaking at the input of U1350.

Gain Amplifier

U1450 is a variable-gain cascode amplifier which sets the overall channel gain. The GAIN (R1423A) and VARIABLE (R1423B) controls determine the ratio of base currents through pins 11 and 12 of U1450. The base-current ratio determines the shared collector output levels between pins 5, 6 and 8, 9.

R1436 provides adjustable low-frequency compensation. R1434, C1436, and RT1437 compensate for temperature variations. R1435, C1435, R1445, and L1445 are adjustable high-frequency compensations. U1450 input T-coil peaking inductors and capacitors are part of the etched circuit board. Dc balance over the variable range is adjusted by R1353.

Position Circuit

Positioning current is added to the signal current of U1450 output from current sources Q1470 and Q1490. R1465 controls the voltage at the bases of the current sources, which in turn determines the amount of positioning current added. R1467, R1465, and CR1465 provide trace shift current for the IDENTIFY function.

Display Channel Switching Amplifier

The third cascode amplifier, U1550, is used for controlling the Channel 1 display modes. When the DISPLAY CH 1 ON level at pin 11 is HI, the Channel 1 signal passes through the transistor pair with outputs at pins 6 and 8 to the level shifters. At the same time the DISPLAY CH 1 OFF level at pin 12 is LO, turning off the second transistor pair collectors, pins 5 and 9. When pin 11 is HI, Channel 1 is displayed and when pin 12 is HI Channel 1 is not displayed. Pins 11 and 12 are always in opposite states, the levels being selected by the DISPLAY MODE switch S30A.

Trigger Channel Switching Amplifier

U1750 is a cascode amplifier used as the trigger switch, and operates similarly to the Display Channel Switching Amplifier, U1550. The TRIGGER SOURCE switch, S30B determines the base levels on pins 11 and 12 of U1750 for trigger selection.

Output Level Shifting

Zener diodes, VR850, VR854, VR860, and VR864 are used to return the display signal dc level to zero volts at the plug-in interface. C850 and C860 provide a high-frequency path around the zener diodes. R894 balances the differential output, and R896 sets the common-mode level to zero volts. These adjustments compensate for variations in the zener diodes.

Trigger Output Amplifier

Common base transistors Q920 and Q940 are used as Trigger Output dc level shifters to return the dc level to zero volts at the plug-in interface.

Channel 2 Gain-Polarity Amplifier

CH 2 operation is the same as CH 1. For circuit number reference the prefix number for CH 1 is 1 and CH 2 is 2. For instance, U2350 functions in CH 2 the same as does U1350 in CH 1. In CH 2 a Polarity feature is included in the second cascode amplifier, U2450. S22A allows base drives to be reversed to U2450. Polarity Gain R2411, matches the gain in both polarity positions.

DISPLAY SWITCHING AND OUTPUT

Translator

The Translator, Q1050 and Q1070, increase the CHOP and ALT control logic levels from the mainframe to a usable level in the 7A24. CR1060 and CR1062 keep Q1050 and Q1070 from going into saturation.

CH 1 AND CH 2 READOUT

Readout Encoding

The Readout Encoding circuit consists of switching resistors and probe sensing stage Q620. This circuit encodes the Channel 1 and 2, Row and Column output lines for readout of deflection factor, uncalibrated deflection factor (VARIABLE) information, and signal inversion (Channel 2 only). Data is encoded on these output lines by switching resistors between them and the time-slot input lines, or by adding current through Q620.

R647-CR647 are switched between time-slot three (TS-3) and Column output line when the CAL IN switch is in the uncal position. This results in the symbol > (greater than) being displayed preceding the deflection factor readout. R648 (Channel 2 only) is switched between TS-2 and the Column output line when the CH 2 POLARITY switch is in the INVERT position. This results in the symbol ↓ (inverted) being displayed preceding the deflection factor readout.

Switching resistors are used to indicate the setting of the VOLTS/DIV switch to the mainframe readout system. The VOLTS/DIV switch is a cam-type switch. The dots on the contact-closure chart (see Diagram 5) indicate when the associated contacts are closed. R633, R634, and R635 select the number 1, 2, or 5 depending on the resistor combination that is switched in. R637 selects the m (milli-) prefix and R639 selects the symbol V (volts) in the 5 mV through .5 V (500 mV) positions of the VOLTS/DIV switch. R638 selects the symbol V in the 1 V position. R630, R631, and the output of the probe sensing stage

(Q620) select the decimal point (number of zeroes) again depending on the resistor combination switched in by the VOLTS/DIV switch.

Probe sensing stage Q620 identifies the attenuation factor of the probe connected to the input connector by sensing the amount of current flowing from the current sink through the probe coding resistance. The output of this circuit corrects the mainframe readout system to include the probe attenuation factor. The third contact of the input connector provides the input to the probe sensing stage from the probe coding resistance (coded probes only; see Operating Instructions). The third contact is also used for the IDENTIFY input. The coding resistor forms a voltage divider with R621 through CR621 to the -15 V supply. The resultant voltage sets the bias on Q620 and determines, along with emitter resistor R622, the collector current. When the -15 volt time-slot pulse is applied to Interface Connector B33, Q620 is interrogated and its collector current is added to the Column current output through Interface Connector A37.

With a 1X probe (or no probe) connected to the input connector, Q620 is turned off. The deflection factor readout is determined by the VOLTS/DIV switch position. With a 10X probe connected, the bias on Q620 will allow 100 microamperes of collector current to flow. This increases the deflection factor readout by a factor of 10.

The IDENTIFY button (S1465 on Diagram 2 or S2465 on Diagram 3) does two things when pressed:

1. It causes the trace representing the appropriate channel of the 7A24 to move about 0.3 division (see the Front-Panel Controls and Connectors, Fig. 1-3).

2. It forward biases CR621 and Q620 to result in a sufficient amount of collector current which, when added to the Column current output, replaces the deflection factor readout with the word "IDENTIFY".

These two actions aid in identifying the 7A24 trace when multiple traces are displayed. When the IDENTIFY button is released, the deflection factor readout and trace position are restored.

CR1465 in CH 1, and CR2465 in CH 2 isolate readout circuitry from the position circuitry. For further information on the operation of the readout system, see the oscilloscope instruction manual.

MAINTENANCE

INTRODUCTION

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, and troubleshooting of the 7A24.

Further maintenance information relating to general maintenance can be found in the instruction manuals for the 7000-series oscilloscopes.

PREVENTIVE MAINTENANCE

General

Preventive maintenance, consisting of cleaning, visual inspection, etc., performed on a regular basis, will improve the reliability of this instrument. Periodic checks of the semiconductor devices used in the unit are not recommended as a preventive maintenance measure.

Cleaning



Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Do not apply any solvent containing ketones, esters or halogenated hydrocarbons. To clean, use only water soluble detergents, ethyl, methyl or isopropyl alcohol.

Front Panel. Loose dust may be removed with a soft cloth or a dry brush. Water and mild detergent may be used; however, abrasive cleaners should not be used.

Interior. Cleaning the interior of the unit should precede calibration, since the cleaning process could alter the settings of the calibration adjustments. Use low-velocity compressed air to blow off the accumulated dust. Hardened dirt can be removed with a soft dry brush, cotton-tipped swab, or cloth dampened with a mild detergent and water solution.

Lubrication

Use a cleaning-type lubricant on shaft bushings, interconnecting plug contacts, and switch contacts. Lubricate switch detents with a heavier grease. A lubrication kit containing the necessary lubricating materials and instructions is available through any Tektronix Field Office. Order Tektronix Part 003-0342-00.

TROUBLESHOOTING

General

The following is provided to augment information contained in other sections of this manual when troubleshooting the 7A24. The schematic diagrams, circuit description, and calibration sections should be used to full advantage. The theory of operation section gives detailed information on circuit behavior and output requirements.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 7. The circuit number and electrical value of each component in this instrument are shown on the diagrams.

Circuit Boards. The circuit boards used in the 7A24 are outlined on the schematic diagrams, and illustrations of the boards are shown on the backs of preceding diagram pages. Each board-mounted electrical component is identified on the illustration by its circuit number.

Component and Wiring Color Code. Colored stripes or dots on resistors and capacitors signify electrical values, tolerances, etc., according to the EIA standard color code. Components not color coded usually have the value printed on the body.

The insulated wires used for interconnection in the 7A24 are color coded to facilitate tracing wires from one point to another in the unit.

Semiconductor Lead Configuration. The lead configurations of the semiconductor devices used in this instrument are shown on the foldout page preceding the diagrams.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 7A24.

1. Semiconductor Tester—Some method of testing the transistors and diodes used in this instrument is helpful. A transistor-curve tracer such as the Tektronix Type 576 will give the most complete information.

2. DC Voltmeter and Ohmmeter—A voltmeter is required for checking voltages within the circuits, and an ohmmeter for checking resistors and diodes.

3. Test Oscilloscope—A test oscilloscope is required to view waveforms at different points in the circuit. A Tektronix 7000-series mainframe equipped with a readout system, 7D13 Digital Multimeter unit, 7B-series Time-Base unit, and a 7A-series amplifier unit with a 10X probe will meet the needs of both items 2 and 3.

4. Plug-in Extender—A fixture that permits operation of the unit outside of the plug-in compartment for better accessibility during troubleshooting. Order Tektronix Part 067-0589-00.

Troubleshooting Procedure

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting.

1. Check Control Settings. An incorrect setting of the 7A24 controls can indicate a trouble that does not exist. If there is any question about the correct function or operation of a control or front-panel connector, see the Operating Instructions section.

2. Check Associated Equipment. Before proceeding with troubleshooting of the 7A24 check that the equipment used with this instrument is operating correctly. If possible, substitute an amplifier unit known to be operating correctly into the indicator unit and see if the problem persists. Check that the input signals are properly connected and that the interconnecting cables are not defective.

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

4. Check Input Protection Fuse. If no waveform can be displayed, but the POSITION control will move the trace on the crt, check the condition of the input fuse. (See Component Replacement for fuse replacement instructions.)

5. Check Instrument Performance. Check the calibration of the unit or the affected circuit, by performing the Performance Check in Section 5. The apparent trouble may

only be a result of misadjustment, and may be corrected by calibration. Complete calibration instructions are given in Section 5.

6. Check Voltages. Often the defective component or stage can be located by checking the voltage in the circuit.

7. Check Individual Components. The following methods are provided for checking the individual components. Components which are soldered in place are best checked by disconnecting one end to isolate the measurement from the effects of surrounding circuitry.

NOTE

To locate intermittent or temperature sensitive components, Quik Freeze (Miller Stephenson, MS-240, Tektronix Part Number 006-0173-01) is recommended. Dry ice or dichloro-difluoromethane (Freon 12, Dupont or Can-O-Gas) may also be used.

A. TRANSISTORS. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can best be checked by substituting a component known to be good; however, be sure that circuit conditions are not such that a replacement might also be damaged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 576). Static-type testers may be used, but since they do not check operation under simulated operating conditions, some defects may go unnoticed. Be sure the power is off before attempting to remove or replace any transistor.

B. 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 diodes.

C. RESISTORS. Check resistors with an ohmmeter. Resistor tolerance is given in the Electrical Parts List. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

D. CAPACITORS. A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the

highest scale. Use an ohmmeter which will 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.

E. FUSES. The Input Protection Fuse can be checked by measuring the resistance from the center conductor of the Input BNC connector to ground (plug-in frame). This resistance should be approximately 50 ohms. If the input appears open, replace the fuse. (See Component Replacement for fuse replacement instructions.)

F. ATTENUATORS. The thick film attenuators are best checked by substitution. If only one channel of the 7A24 is not operating properly, and there is reason to believe an attenuator is defective, replace the suspected attenuator with the same attenuator from the other channel and check instrument operation. If proper operation results, order a new attenuator. (See Component Replacement for replacement instructions.)

7. **Repair and Readjust the Circuit.** Special techniques required to replace components in this unit are given under Component Replacement. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced. Recalibration of the affected circuit may be necessary.

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 7A24 can be obtained through your local Tektronix Field Office or representative. However, many of the 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 affect the performance of the instrument, particularly at high frequencies. All replacement 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 7A24. These parts are manufactured or selected by Tektronix, Inc. in accordance with our specifications. 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.

The following rules should be observed when removing or replacing parts:

1. Use a low-wattage soldering iron (not over 15 watts).
2. Do not apply more heat, or apply heat for a longer time, than is absolutely necessary.
3. Use some form of vacuum solder remover when removing multi-lead devices.
4. Do not apply any solvent containing ketones, esters or halogenated hydrocarbons.
5. To clean, use only water-soluble detergents, ethyl, methyl or isopropyl alcohol.

Circuit Boards. The components mounted on the circuit boards in the amplifier can be replaced using normal circuit

Maintenance—7A24

board soldering techniques. Keep the following points in mind when soldering on the circuit boards:

1. Use a pencil-type soldering iron with a (wattage) 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-nose pliers.
4. Avoid excessive heating of the junction with the circuit board, as this could separate the circuit board wiring from the base material.
5. Use electronic grade 60-40 tin lead solder.
6. Clip off any excess lead length extending beyond the circuit board. Clean off any residual flux with a flux-removing solvent.

Metal Terminals. When soldering metal 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.

Fuse and Attenuator Replacement. To remove fuses or attenuators, press down on both ends of the spring clip and push the clip towards the bottom of circuit board until the clip is disengaged from studs. Remove the clip and lift the ceramic fuse or attenuator straight up and off the board, being careful not to damage cam switch contacts.

When reinstalling fuses or attenuators, align the ceramic with the open end towards the bottom of the 7A24, being careful not to damage the thick film with mounting studs. Slide the open end of clip under the top stud and align the large bottom hole with the bottom stud. Press down on both ends of the spring clip and push up until the clip snaps into position.

Semiconductor Replacement. Transistors should not be replaced unless actually defective. If removed from their sockets during routing maintenance, return them to their original sockets. Unnecessary replacement of transistors may affect the calibration of this instrument. When transistors are replaced, check the performance of the part of the instrument which may be affected.

Replacement semiconductors should be of the original type or a direct replacement. The pullout following the schematic diagram section shows the lead configurations of the semiconductors used in this instrument. If the replacement semiconductor is not of the original type, check the manufacturer's basing diagram for proper basing.

Circuit Board Removal

In general, the circuit boards used in the 7A24 need never be removed unless they must be replaced. Electrical connections to the boards are made by soldered connections. If it is necessary to replace a circuit board assembly, use the following procedures.

A. READOUT CIRCUIT BOARD REMOVAL

1. Disconnect the wires connected to the outside of the board.
2. Remove the screws holding the board to the mounting surface.
3. Disconnect the wires connected to the inside of the board.
4. Remove the board from the unit.
5. To replace the board, reverse the order of removal.

B. ATTENUATOR CIRCUIT BOARD REMOVAL

1. Remove the readout board for either channel as outlined in the previous procedure.
2. Disconnect the coaxial jumper and delay line mounting bracket from the rear of the board.
3. Disconnect the input cable from the rear of the input BNC connector.
4. Loosen the front set screw on the VARIABLE control shaft coupling (use a 0.050-inch hex-key wrench).
5. Remove the red VARIABLE control knob and fiberglass rod from the control shaft.
6. Remove the VOLTS/DIV, and POSITION knobs using a 1/16 inch hex-key wrench. (The IDENTIFY knob will pull off with the POSITION knob.)
7. Remove the input BNC connector, and POSITION control.
8. Remove the two screws from the bracket on the rear of the board.
9. Remove the attenuator board with cam switch from the instrument.
10. Replace by reversing the removal procedure.

C. AMPLIFIER CIRCUIT BOARD REMOVAL

1. Remove the plastic plug-in guide from the rear of the instrument.
2. Disconnect the wires connected to the amplifier board from the CH 1 readout board and all front panel controls, with the exception of the TRIGGER SOURCE/DISPLAY MODE switch.
3. Loosen the hex-socket screw in the coupling of both the VARIABLE control shafts using a 0.050-inch hex-key wrench. Pull both the VARIABLE knobs and shafts from the front of the instrument.
4. Loosen the hex-socket screws in both the TRIGGER SOURCE and DISPLAY MODE knobs. Remove knobs.

5. Disconnect the coaxial jumper and delay line mounting bracket from the front of the board.
6. Remove the screws and nuts securing the board to the chassis or other mounting surface.
7. Remove the board from the instrument.
8. To replace, reverse the order of removal.

Switch Replacement

The following special maintenance information is provided for the cam-type switches.



Repair of cam-type switches should be undertaken only by experienced maintenance personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For this reason, it is recommended that the switch assembly be replaced as a unit. For assistance in maintenance of cam-type switches, contact your local Tektronix Field Office or representative.

A. CAM-TYPE SWITCHES

A cam-type switch consists of a rotating cam, which is turned by the front-panel knobs, and a set of contacts mounted on an adjacent circuit board. These switch contacts are actuated by lobes on the cam. The VOLTS/DIV and Input cam-type switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Remove the Readout board and the Attenuator board/switch assembly as described previously. The front switch section on the Attenuator board is the Input switch and the rear switch section is the VOLTS/DIV switch. The switches are now open for inspection or cleaning.
2. To completely remove the switch from the board, remove the two screws and two hexagonal posts which hold the cam-type switch to the circuit board.
3. To remove the cam from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam out of the support block. Be careful not to lose the small detent roller.

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4. To replace defective switch contacts, follow the instructions given in the switch repair kit.

5. To re-install the switch assembly, reverse 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. Refer to Section 5 for these procedures.

CALIBRATION

PRELIMINARY INFORMATION

Calibration Interval

To ensure instrument accuracy, check the calibration of the 7A24 every 1000 hours of operation, or every six months if used infrequently. Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section of the manual.

Tektronix Field Service

Tektronix, Inc. provides complete instrument repair and recalibration at local Field Service Centers and the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

Using This Procedure

Outline. To aid in locating a step in the Performance Check or Calibration Procedure, an outline is given preceding Part I—Performance Check and Part III—Calibration Procedure.

Performance Check. The performance of this instrument can be checked without removing the covers or making internal adjustments, by performing only Part I—Performance Check. This procedure does not check every facet of the instrument's calibration; rather it is concerned primarily with those portions of the instrument essential to measurement accuracy and correct operation.

Short-Form Procedure. A short-form calibration procedure is provided for the technician experienced with the 7A24 as a guideline for the calibration of this instrument, in Part II—Short-Form Procedure.

Calibration Procedure. Completion of each step in Part III—Calibration Procedure, ensures that this instrument meets the electrical specifications given in the front of this manual. Where possible, instrument performance is checked before an adjustment is made. 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.

Partial Procedures. A partial check or adjustment is often desirable after replacing components or to touch up the adjustment of a portion of the instrument between

major recalibrations. To check or adjust only part of the instrument, set the controls as given under the nearest Control Settings and use the Equipment Required list preceding the desired portion of the step. To prevent unnecessary recalibration of other parts of the instrument, re-adjust only if the tolerance given in the CHECK— part of the step is not met.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or its equivalent, are required for complete calibration of the 7A24. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may differ from the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within the listed specifications. 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 needed.

If only a Performance Check procedure is performed, not all of the listed test equipment will be required. Items used only for the Calibration procedures are indicated by footnote 1. The remaining pieces of equipment are items common to both the Performance Check and the Calibration Procedure.

Special Calibration Fixtures

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

Calibration Equipment Alternatives

All of the listed test equipment is required to completely check and calibrate this instrument. However, complete checking or calibration may not always be necessary. The user may be satisfied with checking only selected characteristics, thereby reducing the amount of test equipment required.

The Performance Check and Calibration Procedures are based on the first item of equipment given as an example of applicable equipment. When other equipment is substi-

tuted, control settings or calibration setup may need to be altered to meet the requirements of the substitute equipment. If the exact item of test equipment given as an example in the Test Equipment list is not available, first check the Specifications column carefully to see if any

other equipment is available which might suffice. Then check the Usage column to see what this item is used for. If used for a check or adjustment that is of little or no importance to your measurement requirements, the item and corresponding step(s) can be deleted.

TABLE 5-1
Test Equipment

Description	Minimum Specifications	Usage	Examples
1. Test Oscilloscope	Tektronix 7000-series. 500 MHz bandwidth required for complete procedure.	Used throughout the procedures to provide display.	a. Tektronix 7904 oscilloscope.
2. Time Base Plug-in Unit	Tektronix 7B-series time-base unit. Fastest sweep, 0.5 ns required for complete procedure.	Used throughout the procedures to provide sweep.	a. Tektronix 7B92 Time Base.
3. Amplifier Plug-in Unit ²	Tektronix 7A-series Differential Amplifier unit. Sensitivity, at least 0.5 mV/div.; CMRR, at least 10,000:1	Used for Input Resistance Check and Adjust.	a. Tektronix 7A22 Differential Amplifier. b. Tektronix 7A13 Differential Comparator.
4. 50-Ohm Amplitude Calibrator	Amplitude accuracy, within 0.25%; range, 30 mV to 2 V into 50 Ohms; frequency, 1 kHz.	Used for Gain Check and Adjust and Display Mode, Trigger Source Checks.	a. Tektronix Calibration Fixture 067-0508-00.
5. High Amplitude Square-Wave Generator ³	Amplitude, at least 100 V; frequency, at least 1 kHz.	Used (with Tunnel Diode Pulser) for High Frequency Compensation Check and Adjust.	a. Tektronix Type 106 Square-Wave Generator. b. Tektronix Calibration Fixture 067-0502-01. c. See footnote 3.
6. Tunnel Diode Pulser ³	Amplitude, 200 mV; Risetime, less than 100 pico-seconds; Aberration, less than 1%.	Used (with High Amplitude Square-Wave Generator) for High Frequency Compensation Check and Adjust.	a. Tektronix Calibration Fixture 067-0554-00. b. See footnote 3.
7. Medium Frequency Constant-Amplitude Signal Generator	Frequency range, to at least 50 MHz; reference frequency, 50 kHz; output amplitude, at least 50 millivolts into 50 Ohms; amplitude accuracy, within 3%.	Used for Common Mode Rejection Ratio Check and Display Mode, Trigger Source Checks.	a. Tektronix Type 191 Constant-Amplitude Signal Generator. b. General Radio 1211-C with 1263-C Amplitude Regulating Power Supply.
8. High Frequency Constant-Amplitude Signal Generator	Frequency Range, to at least 375 MHz; reference frequency, 3 MHz; output amplitude, at least 3 volts into 50 Ohms; amplitude accuracy, within 5%.	Used for Bandwidth Check.	a. Tektronix Calibration Fixture 067-0532-01. b. General Radio 1362 with 1263-C Amplitude Regulating Power Supply.
9. Dc Voltmeter ¹ (VOM)	Sensitivity, less than 2 volts full scale.	Used for Output Balance Adjust and Output Level Adjust.	a. Triplet 630-NA. b. Simpson 262.
10. Plug-in Extender ¹	Rigid plug-in extender for 7000-series plug-ins.	Used for Trigger adjustments and checks.	a. Tektronix Calibration Fixture 067-0589-00.
11. Cable (two required)	Connectors, BNC; impedance, 50 Ohms; length, 42 inches.	Used throughout the procedures.	a. Tektronix Part 012-0057-00.

TABLE 5-1 (cont)

Description	Minimum Specifications	Usage	Examples
12. Adapter	BNC male to GR.	Used with 191, 106, and 50 Ohm Amplitude Calibrator.	a. Tektronix Part 017-0064-00.
13. Adapter	BNC female to GR.	Used with Constant-Amplitude Signal Generator (067-0532-00).	a. Tektronix Part 017-0063-00.
14. 2X Attenuator	Connectors, BNC; impedance, 50 ohms.	Used with Tunnel Diode Pulser (067-0554-00).	a. Tektronix Part 011-0069-01.
15. Dual-Input Coupler (two required)	Connectors, BNC; matched signal transfer to each input.	Used for Common Mode Rejection Ratio Check	a. Tektronix Calibration Fixture 067-0525-00.
16. Screwdriver ¹	Three inch shaft, 3/32-inch blade.	Used for adjusting potentiometers.	a. Xcelite R-3323.
17. Low-Capacitance Screwdriver ¹	1 1/2-inch shaft.	Used for adjusting variable capacitors.	a. Tektronix Part 003-0000-00.

¹Used for calibration only: NOT used for performance check.

²Any method of accurately ($\pm 0.5\%$) measuring resistance may be substituted for this piece of equipment and the test circuit shown in Fig. 5-1.

³Any pulse generator that meets the specifications for the Tunnel Diode Pulser may be substituted for these two instruments.

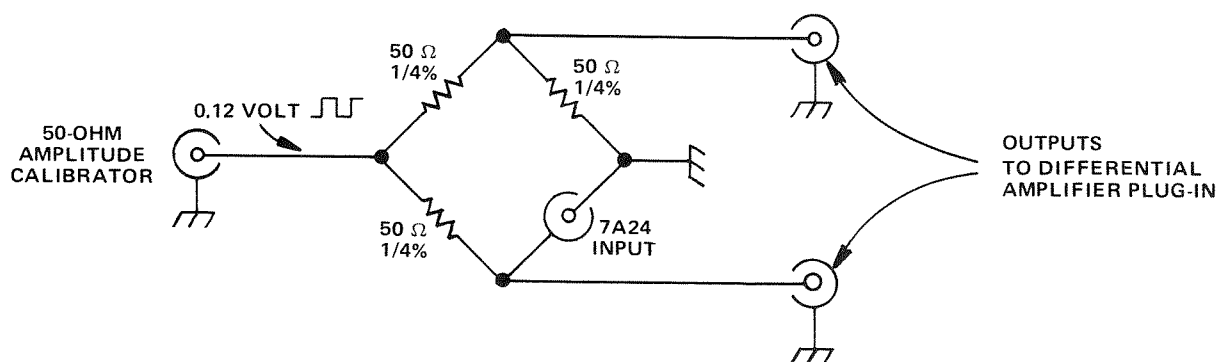


Fig. 5-1. Test circuit for Input Resistance Check/Adjust.

Preliminary Procedure

1. Remove left side covers from the 7A24 and the test oscilloscope (only if Short-Form Procedure or Calibration Procedure is to be performed).
2. Insert the 7A24 into the test oscilloscope Left Vertical compartment.
3. Insert the differential amplifier plug-in unit into the Right Vertical compartment.
4. Insert the time-base plug-in unit into a horizontal compartment.

5. Set the 7A24 front panel controls as follows:

CH 1 and CH 2 POSITION	midrange
CH 1 and CH 2 VOLTS/DIV	5 mV
CH 1 and CH 2 VARIABLE VOLTS/DIV	CAL IN
CH 1 and CH 2 Input switches	DC
CH 2 POLARITY	+UP
DISPLAY MODE	CH 1
TRIGGER SOURCE	MODE

6. Apply power and allow at least 20 minutes warm-up before proceeding.

PART 1 — PERFORMANCE CHECK

Introduction

The following procedure is intended to be used for incoming inspection and periodic calibration checks to confirm that the 7A24 is operating within acceptable limits. This procedure is concerned with those portions of the instrument calibration that are essential to measurement accuracy and correct operation. Removal of the side covers is not necessary to perform this procedure in that all checks are made from the front panel.

Outline for Part 1 - Performance Check

1. Check Input Resistance	Page 5-4
2. Check Offset Current	Page 5-4
3. Check 2X Balance	Page 5-4
4. Check DC Balance	Page 5-4
5. Check Vertical Deflection Accuracy	Page 5-4
6. Check TRIGGER SOURCE and DISPLAY MODE Operation	Page 5-5
7. Check High Frequency Compensation	Page 5-5
8. Check Common Mode Rejection Ratio	Page 5-6
9. Check Bandwidth	Page 5-6
10. Check Readout and IDENTIFY Operation	Page 5-6

Performance Check

1. Check Input Resistance

- Set the test-oscilloscope Vertical Mode switch to Right.
- Connect the test circuit, as shown in Fig. 5-1, to the CH 1 input.
- Connect the test circuit outputs to the differential plug-in + and - inputs.
- Set the differential plug-in for 0.5 millivolts per division, ac coupled.
- Check for less than 1.2 divisions of display amplitude (0.6 mV).
- Remove the test circuit from the CH 1 input.
- Connect the test circuit to the CH 2 input.
- Repeat parts e and f, substituting CH 2 controls.
- Remove all connections from the test circuits.

2. Check Offset Current

- Set the test-oscilloscope Vertical Mode to Left.

- Set the 7A24 CH 1 POSITION control to center the trace on the graticule.

- Check for 0.1 division, or less, trace shift while switching the CH 1 Input switch between the OFF and DC positions.

- Set the DISPLAY MODE switch to CH 2.

- Repeat parts b and c, substituting CH 2 controls.

3. Check 2X Balance

- Check for 0.5 division, or less, trace shift while switching the CH 2 VOLTS/DIV switch between the 5 mV and 10 mV positions.

- Set the DISPLAY MODE switch to CH 1.

- Repeat part a, substituting CH 1 controls.

4. Check DC Balance

- Set the CH 1 VOLTS/DIV switch to 5 mV.

- Engage the CH 1 VARIABLE gain control by pushing in, and then releasing the VARIABLE knob.

- Check for 0.5 division, or less, trace shift while rotating the VARIABLE knob.

- Reset the CH 1 VARIABLE to the CAL IN position by again pushing in the VARIABLE knob and releasing.

- Set the DISPLAY MODE switch to CH 2.

- Repeat parts a, b, c, and d, substituting CH 2 controls.

5. Check Vertical Deflection Accuracy

- Connect a 0.03-volt signal from the 50-ohm Amplitude Calibrator (067-0508-00) to the CH 2 input.

- Check, using the VOLTS/DIV switch and 50-ohm Amplitude Calibrator settings given in Table 5-2, that the vertical deflection is within 2% for each position.

- Remove the connection from the CH 2 input.

- Set the DISPLAY MODE switch to CH 1.

- Repeat parts a through c, substituting CH 1 controls.

TABLE 5-2

Vertical Deflection Check

VOLTS/DIV switch setting	50 ohm Amplitude Calibrator	Vertical Deflection (divisions)	Maximum Error (divisions)
5 mV	.03 volts	6	1.2
10 mV	.06 volts	6	1.2
20 mV	0.12 volts	6	1.2
50 mV	0.30 volts	6	1.2
0.1 V	0.60 volts	6	1.2
0.2 V	1.2 volts	6	1.2
0.5 V	2.0 volts	4	0.8
1 V	2.0 volts	2	0.4

6. Check TRIGGER SOURCE and DISPLAY MODE Operation

- a. Set the CH 1 and CH 2 VOLTS/DIV switches to 10 mV.
- b. Set the DISPLAY MODE switch to ALT.
- c. Connect the medium-frequency signal generator to the CH 2 input and set for three divisions of display at 50 kHz.
- d. Connect a 0.03-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.
- e. Set the TRIGGER SOURCE switch to CH 1.
- f. Check that both signals are displayed, but only the square wave is triggered.
- g. Set the TRIGGER SOURCE switch to MODE.
- h. Check that both signals are displayed and triggered.
- i. Set the TRIGGER SOURCE switch to CH 2.
- j. Check that both signals are displayed, but only the sine wave is triggered.
- k. Set the TRIGGER SOURCE switch to MODE.
- l. Set the DISPLAY MODE switch to CH 1.
- m. Check that only the square wave is displayed and triggered.
- n. Set the DISPLAY MODE switch to ADD.

- o. Set the CH 1 Input switch to OFF.
- p. Check that only the sine wave is displayed and triggered.
- q. Set the CH 1 Input switch to DC and the CH 2 Input switch to OFF.
- r. Check that only the square wave is displayed and triggered.
- s. Set the DISPLAY MODE switch to CHOP.
- t. Check that the square wave and a straight line are displayed and that the square wave is triggered.
- u. Set the CH 2 Input switch to DC and CH 1 Input switch to OFF.
- v. Check that the sine wave and a straight line are displayed and that the sine wave is triggered.
- w. Set the DISPLAY MODE switch to CH 2.
- x. Check that only the sine wave is displayed and triggered.
- y. Set both Input switches to DC.
- z. Remove the signals from the CH 1 and CH 2 inputs.

7. Check High-Frequency Compensation

- a. Set the 7A24 DISPLAY MODE switch to CH 1.
- b. Set the CH 1 and CH 2 VOLTS/DIV switches to 20 mV.
- c. Connect the high-amplitude square-wave generator to the Tunnel Diode Pulser (067-0554-00) input.
- d. Set the time-base for 10 ns/division.
- e. Connect the Tunnel Diode Pulser output, through a 2X, 50-ohm attenuator (011-0069-01), to the CH 1 input.
- f. Set the pulser level control to the minimum setting which will produce a fast-rise output.
- g. Set the top of the waveform two divisions above the graticule center with the CH 1 POSITION control.
- h. Check for peak-to-peak aberration of 6% or less.
- i. Remove the 2X attenuator and Tunnel Diode Pulser from the CH 1 input.
- j. Repeat parts e, f, g, h, and i, substituting CH 2 controls.

8. Check Common Mode Rejection Ratio

- a. Set both VOLTS/DIV switches to 5 mV.
- b. Set the CH 2 POLARITY switch to INVERT.
- c. Connect a 50 MHz signal from the medium-frequency signal generator to the CH 1 and CH 2 inputs through a Dual Input cable (067-0525-00).
- d. Set the signal generator amplitude for eight divisions of display.
- e. Set the DISPLAY MODE switch to ADD.
- f. Check for 0.8 divisions of display, or less.
- g. Remove the connections from the 7A24 inputs.

9. Check Bandwidth

- a. Set both VOLTS/DIV switches to 0.5 V.
- b. Set the CH 2 POLARITY switch to +UP.
- c. Set the DISPLAY MODE switch to CH 1.
- d. Connect the high frequency signal generator to the CH 1 input.
- e. Set the signal generator for six divisions of display at its reference frequency.

- f. Set the signal generator frequency to 375 MHz.
- g. Check for at least 4.2 divisions of display amplitude.
- h. Remove the connection from the CH 1 input.
- i. Repeat parts c, d, e, f, g, and h, substituting CH 2 controls.

10. Check Readout and IDENTIFY Operation

- a. Set the DISPLAY MODE switch to ALT.
- b. Check that the channel 1 (upper) readout corresponds to the CH 1 VOLTS/DIV switch settings, and that the channel 2 (lower) readout corresponds to the CH 2 VOLTS/DIV switch settings for all positions of the VOLTS/DIV switches.
- c. Press the CH 1 IDENTIFY button.
- d. Check that the channel 1 readout is replaced by the word "IDENTIFY", and that the channel 1 trace moves up 0.2 to 0.4 divisions.
- e. Release the CH 1 IDENTIFY button.
- f. Repeat parts c, d, and e, substituting CH 2 controls.

PART II — SHORT-FORM PROCEDURE

BEFORE YOU BEGIN, see **ADJUSTMENT LOCATIONS** in the Diagrams section.

Introduction

The following procedure is intended to be used as a guide for calibration of the 7A24 by experienced technicians familiar with the instrument. All steps are in the same order as in the main Calibration Procedure. Only essential information is given. If more information is required, consult the Calibration Procedure.

Short-Form Procedure

1. Adjust Input Resistance (DC, 50Ω , $\pm 1\Omega$)

- Set both VOLTS/DIV switches to 5 mV and both Input switches to DC.
- Connect the test circuit, as shown in Fig. 5-1, to the CH 1 input.
- Set the differential plug-in unit for 0.5 mV per division, ac coupled.
- ADJUST — The CH 1 Input R (R1307) for minimum display amplitude (1.2 divisions maximum).
- Repeat for CH 2 (R2307).

2. Adjust Offset Current (0.1 division maximum trace shift)

- Set the DISPLAY MODE switch to CH 1.

- ADJUST — The CH 1 Offset Null (R1305) for minimum trace shift while switching the CH 1 Input switch between the OFF and DC positions.

- Repeat for CH 2 (R2305).

3. ADJUST 2X Balance (0.5 division maximum trace shift)

- ADJUST — The CH 1 2X Bal (R1324) for minimum trace shift while switching the CH 1 VOLTS/DIV switch between the 5 mV and 10 mV positions.

- Repeat for CH 2 (R2324).

4. Adjust DC Balance (0.5 division, maximum trace shift)

- ADJUST — The CH 1 Dc Bal (R1353) for minimum trace shift while rotating the CH 1 VARIABLE.

- Repeat for CH 2 (R2353).

- Reset VARIABLE knobs to CAL IN.

5. Adjust Output Balance (within 0.5 division of graticule center)

- Set the DISPLAY MODE switch to CH 1.
- Set the CH 1 POSITION for zero volts between pins 1 and 13 of U1550 (see Fig. 5-2).

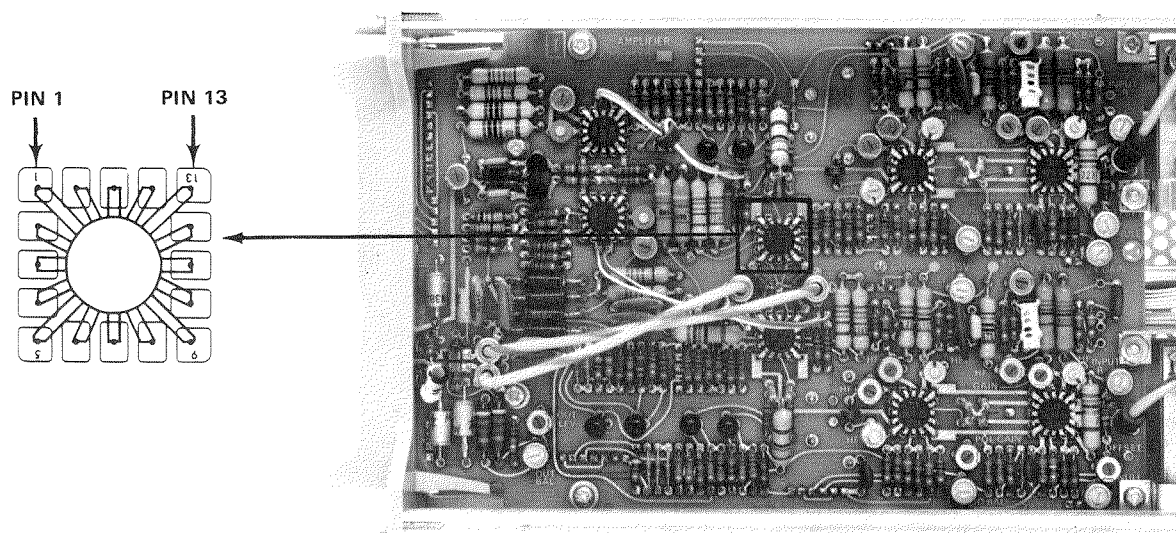


Fig. 5-2. Location of pins 1 and 13, U1550.

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c. ADJUST — The Out Bal (R894) to center the trace on the graticule.

6. Adjust Output Level (0 volts, ± 50 millivolts)

a. ADJUST — The Out Lev (R896) for zero volts from the +Signal Output (see Fig. 5-3) to ground.

7. Adjust GAIN ($\pm 2\%$)

a. Set both VOLTS/DIV switches to 5 mV.

b. Connect a 0.03 volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.

c. ADJUST — The CH 1 GAIN for six divisions of display amplitude.

d. NOTE — If the CH 1 GAIN cannot be set to six divisions, see the main Calibration Procedure.

e. Engage the CH 1 VARIABLE and turn fully counter-clockwise.

f. CHECK — The display amplitude should be 2.4 divisions or less.

g. Reset the CH 1 VARIABLE to CAL IN.

h. Set the CH 1 VOLTS/DIV to 10 mV and the 50-ohm Amplitude Calibrator for 0.06 volts.

i. ADJUST — The CH 1 2X Gain (R1317) for six divisions of display amplitude.

j. CHECK — That the gain is within $\pm 2\%$ for all positions of the CH 1 VOLTS/DIV switch.

k. Repeat for CH 2 (R2317).

8. Adjust CH 2 POLARITY Gain

a. Set the DISPLAY MODE switch to CH 2 and the CH 2 VOLTS/DIV switch to 5 mV.

b. Connect a 0.03-volt signal from 50-ohm Amplitude Calibrator to the CH 2 input.

c. ADJUST — The Pol Gain (R2411) for minimum amplitude change while switching the CH 2 POLARITY from +UP to INVERT.

d. Recheck the CH 2 gain for six divisions of display in the +UP position.

9. Check TRIGGER SOURCE and DISPLAY MODE Operation

a. Set both VOLTS/DIV switches to 10 mV.

b. Connect a 0.03-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.

c. Connect a 50-kHz signal from the medium-frequency signal generator to the CH 2 input and set for three divisions of display.

d. CHECK — For proper operation of the DISPLAY MODE and TRIGGER SOURCE switches.

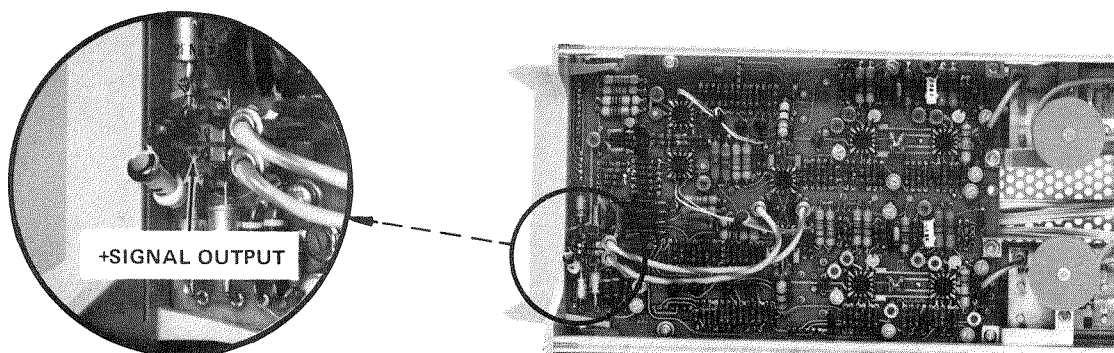


Fig. 5-3. + Signal Output location.

10. Adjust Low Frequency Compensation

- a. Set the time-base for 0.2 milliseconds per division.
- b. Connect a 0.06-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.
- c. Set the CH 1 VOLTS/DIV to 10 ms.
- d. ADJUST — The CH 1 Lf (R1436) for minimum long-term tilt.
- e. Repeat for CH 2 (R2436).

11. Adjust High Frequency Compensation (6% aberration, maximum)

- a. Set both VOLTS/DIV switches to 20 mV.
- b. Connect the Tunnel Diode Pulser to the CH 1 input through a 2X attenuator.
- c. ADJUST — The CH 1 Hf adjustments (C1336, R1336, C1435, R1435, C1445, and R1445) for the best front corner and flat top.
- d. Repeat for CH 2 (C2336, R2336, C2435, R2435, C2445, R2445).

12. Check Bandwidth (at least 375 MHz.)

- a. Set both VOLTS/DIV switches to 0.5 V.
- b. Connect the high-frequency signal generator to the CH 1 input and set for six divisions of display at its reference frequency.
- c. Set the signal generator frequency to 375 MHz.
- d. CHECK — The display amplitude should be at least 4.2 divisions.
- e. Repeat for CH 2.

13. Check Common Mode Rejection Ratio (at least 10:1)

- a. Set both VOLTS/DIV switches to 5 mV.
- b. Set the DISPLAY MODE to CH 2 and the CH 2 POLARITY switch to INVERT.

c. Connect a 50-MHz signal from the medium-frequency signal generator to the CH 1 and CH 2 inputs through a Dual-Input cable and set for eight divisions of display.

d. Set the DISPLAY MODE to ADD.

e. CHECK — The display amplitude should be 0.8 division, or less.

f. Reset the CH 2 POLARITY switch to +UP.

14. Adjust Trigger Gain ($\pm 10\%$)

a. Exchange the Plug-in Extender cables A-11 with A-13 and B-11 with B-13.

b. Remove the 7A24 from the test oscilloscope, install the Plug-in Extender into the test oscilloscope and install the 7A24 into the Plug-in Extender.

c. Set the CH 1 VOLTS/DIV switch to 10 mV and the DISPLAY MODE switch to CH 1.

d. Connect a 0.06-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.

e. ADJUST — The Trig Gain (R946) for six divisions of display amplitude.

15. Adjust Trigger High Frequency Compensation (15% aberration maximum)

- a. Set both VOLTS/DIV switches to 20 mV.
- b. Connect the Tunnel Diode Pulser to the CH 1 input through a 2X attenuator.
- c. ADJUST — The CH 1 Trig adjustments (C1721, R1721) for the best front corner and flat top.
- d. Repeat for CH 2.

16. Check Readout and IDENTIFY Operation

a. CHECK — The channel 1 crt readout should correspond to the CH 1 VOLTS/DIV switch settings, and the channel 2 readout should correspond to the CH 2 VOLTS/DIV switch settings for all switch positions.

b. CHECK — The channel 1 readout should be replaced by the word "IDENTIFY" and the channel 1 trace should move up 0.2 to 0.4 divisions when the CH 1 IDENTIFY button is pushed.

c. Repeat part b for CH 2.

PART III – CALIBRATION PROCEDURE

BEFORE YOU BEGIN, see **ADJUSTMENT LOCATIONS** in the *Diagrams* section.

Introduction

The following procedure returns the 7A24 to correct calibration. All limits and tolerances given in this procedure are calibration guides and should not be interpreted as instrument specifications except as specified in the Specifications section of this manual. Where possible, instrument performance is checked before an adjustment is made. 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.

Outline for Part 3 – Calibration Procedure

1. Adjust Input Resistance.	Page 5-10
2. Adjust Offset Current.	Page 5-10
3. Adjust 2X Balance.	Page 5-10
4. Adjust DC Balance.	Page 5-10
5. Adjust Output Balance	Page 5-11
6. Adjust Output Level.	Page 5-11
7. Adjust GAIN.	Page 5-11
8. Adjust CH 2 POLARITY Gain.	Page 5-11
9. Check TRIGGER SOURCE and DISPLAY MODE Operation.	Page 5-12
10. Adjust Low Frequency Compensation.	Page 5-12
11. Adjust High Frequency Compensation.	Page 5-12
12. Check Bandwidth.	Page 5-13
13. Check Common Mode Rejection Ratio.	Page 5-13
14. Adjust Trigger Gain	Page 5-13
15. Adjust Trigger High Frequency Compensation	Page 5-13
16. Check Readout and IDENTIFY	Page 5-14

Calibration Procedure

1. Adjust Input Resistance (DC, $50\Omega \pm 1\Omega$)

- Set the test oscilloscope to display the differential plug-in unit's output.
- Connect the test circuit, as shown in Fig. 5-1, to the CH 1 input connector.
- Connect the test circuit outputs to the + and – inputs of the differential plug-in unit.
- Set the differential plug-in for 0.5 mV per division, ac coupled.
- Set both VOLTS/DIV switches to 5 mV.
- Set the CH 1 Input switch to DC.

- Check — The display should be 1.2 divisions or less.
- ADJUST — The CH 1 Input R (R1307) for minimum display amplitude.
- Remove the test circuit from the CH 1 input.
- Connect the test circuit to the CH 2 input.
- Repeat parts f through i, substituting CH 2 controls (R2307).

2. Adjust Offset Current (0.1 division, maximum trace shift)

- Set the test oscilloscope to display the 7A24 output.
- Set the DISPLAY MODE switch to CH 1.
- Set the CH 1 POSITION control to center the trace on the graticule.
- CHECK — The trace should not move more than 0.1 division vertically while switching the CH 1 Input switch between the OFF and DC positions.
- ADJUST — The CH 1 Offset Null (R1305) for minimum trace shift.
- Repeat parts b through k, substituting CH 2 controls (R2305).

3. Adjust 2X Balance (0.5 division, maximum trace shift)

- Set the DISPLAY MODE switch to CH 1.
- CHECK — The trace should not move more than 0.5 division vertically while switching the CH 1 VOLTS/DIV between the 5 mV and 10 mV positions.
- ADJUST — The CH 1 2X Bal (R1324) for minimum trace shift.
- Repeat parts a, b, and c, substituting CH 2 controls (R2324).

4. Adjust dc Balance (0.5 division, maximum trace shift)

- Set the DISPLAY MODE switch to CH 1.

- b. Engage the CH 1 VARIABLE VOLTS/DIV by pushing in and releasing the knob.
- c. CHECK — The trace should not move more than 0.5 division while rotating the CH 1 VARIABLE from fully clockwise to fully counterclockwise.
- d. ADJUST — The CH 1 dc Bal (R1353) for minimum trace shift.
- e. Reset the CH 1 VARIABLE to the CAL IN position.
- f. Repeat parts a through e, substituting CH 2 controls (R2353).

5. Adjust Output Balance

- a. Set the DISPLAY MODE switch to CH 1.
- b. Connect a voltmeter between pins 1 and 13 of U1550 (see Fig. 5-2).
- c. Set the CH 1 POSITION control for zero volts on the voltmeter.
- d. CHECK — The trace should be within 0.5 division of the center graticule line.
- e. ADJUST — The Out Bal (R894) to center the trace on the graticule.
- f. Remove the voltmeter connections.

6. Adjust Output Level

- a. Connect the voltmeter between ground and the + Signal Output (see Fig. 5-3).
- b. CHECK — The voltmeter should read zero volts, ± 50 millivolts.
- c. ADJUST — The Out Lev (R896) for zero volts on the voltmeter.
- d. Remove the voltmeter connections.

7. Adjust GAIN ($\pm 2\%$)

- a. Set both VOLTS/DIV switches to 5 mV.
- b. Connect a 0.03-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.
- c. CHECK — The Display should be six divisions in amplitude, within 2% (0.12 division).
- d. ADJUST — The CH 1 GAIN by pushing in on the knob with a screwdriver and turning it until the control

engages. Set the CH 1 GAIN for exactly six divisions of display amplitude.

- e. NOTE — If the CH 1 GAIN cannot be adjusted for six divisions of display, it will be necessary to adjust the channel 1 internal Gain (R1337). To do this, set the front panel CH 1 GAIN to the center of its range and adjust the channel 1 internal Gain for as close to six divisions of display amplitude as possible. Repeat step d.
- f. Set the CH 1 GAIN knob to the VARIABLE (out) position and turn fully counterclockwise.
- g. CHECK — The display amplitude should be 2.4 divisions or less.
- h. Set the CH 1 VARIABLE to the CAL IN position.
- i. Set the CH 1 VOLTS/DIV switch to 10 mV.
- j. Set the 50-ohm Amplitude Calibrator for 0.06 volts.
- k. CHECK — The display should be six divisions in amplitude, within 2% (0.12 divisions).
- l. ADJUST — The CH 1 2X Gain (R1317) for six divisions of display amplitude.
- m. CHECK — Using Table 5-3, check that gain is within $\pm 2\%$ for all positions of the CH 1 VOLTS/DIV switch.
- n. Remove the connection from the CH 1 input.
- o. Repeat parts b through n, substituting CH 2 controls (R2337, R2317).

TABLE 5-3

Vertical Deflection Adjust

VOLTS/DIV switch setting	50 ohm Amplitude Calibrator	Vertical Deflection (divisions)	Maximum Error (divisions)
5 mV	.03 volts	6	1.2
10 mV	.06 volts	6	1.2
20 mV	0.12 volts	6	1.2
50 mV	0.30 volts	6	1.2
0.1 V	0.60 volts	6	1.2
0.2 V	1.2 volts	6	1.2
0.5 V	2.0 volts	4	0.8
1 V	2.0 volts	2	0.4

8. Adjust CH 2 Polarity Gain

- a. Set the DISPLAY MODE switch to CH 2.

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b. Connect a 0.03 volt signal from the 50-ohm Amplitude Calibrator to the CH 2 input.

c. Set the CH 2 VOLTS/DIV switch to 5 mV.

d. Set the CH 2 POLARITY switch to INVERT.

e. CHECK — The display amplitude should match that of the +UP mode.

f. ADJUST — The Pol Gain (R2411) for minimum amplitude change while switching between the INVERT and +UP positions.

g. Reset the CH 2 POLARITY switch to the +UP position.

h. Recheck the CH 2 GAIN for six divisions of display amplitude and reset if necessary.

9. Check TRIGGER SOURCE and DISPLAY MODE Operation

a. Set both VOLTS/DIV switches to 10 mV.

b. Set the DISPLAY MODE switch to ALT.

c. Connect a 50-kHz signal from the medium-frequency signal generator to the CH 2 input and set the generator for three divisions of display.

d. Connect a 0.03-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.

e. Set the TRIGGER SOURCE switch to CH 1.

f. CHECK — Both signals should be displayed, but only the square wave should be triggered.

g. Set the TRIGGER SOURCE switch to MODE.

h. CHECK — Both signals should be displayed and triggered.

i. Set the TRIGGER SOURCE switch to CH 2.

j. CHECK — Both signals should be displayed, but only the sine wave should be triggered.

k. Set the TRIGGER SOURCE switch to MODE.

l. Set the DISPLAY MODE switch to CH 1.

m. CHECK — The square wave only should be displayed and triggered.

n. Set the DISPLAY MODE switch to ADD.

o. Set the CH 1 Input switch to OFF.

p. CHECK — The sine wave only should be displayed and triggered.

q. Set the CH 1 Input switch to DC and CH 2 Input switch to OFF.

r. CHECK — The square wave only should be displayed and triggered.

s. Set the DISPLAY MODE switch to CHOP.

t. CHECK — The square wave and a straight line should be displayed and the square wave should be triggered.

u. Set the CH 2 Input switch to DC and the CH 1 Input switch to OFF.

v. CHECK — The sine wave and a straight line should be displayed and the sine wave should be triggered.

w. Set the DISPLAY MODE switch to CH 2.

x. CHECK — The sine wave only should be displayed and triggered.

y. Set both input switches to DC.

z. Remove the connections from the CH 1 and CH 2 inputs.

10. Adjust Low Frequency Compensation

a. Set the time-base for 0.2 milliseconds per division.

b. Set both VOLTS/DIV switches to 10 mV.

c. Connect a 0.05-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.

d. Set the DISPLAY MODE switch to CH 1.

e. ADJUST — The CH 1 Lf (R1436) for minimum long-term tilt of the square wave flat-top.

f. Repeat parts c, d, and e, substituting CH 2 controls (R2436).

11. Adjust High Frequency Compensation (6% aberration, maximum)

a. Set the time-base for 10 nanoseconds per division.

b. Set both VOLTS/DIV switches to 20 mV.

c. Set the DISPLAY MODE switch to CH 1.

d. Connect the Tunnel Diode Pulser (067-0554-00) to the CH 1 input through a 50-ohm, 2X Attenuator (011-0069-01).

e. Connect a 100-volt square wave source to the Tunnel Diode Pulser and adjust the Pulser Level to the minimum setting that will produce a fast-rise output.

f. Position the top of the waveform to two divisions above the graticule center.

g. CHECK — The aberration should not exceed $\pm 4\%$ or 6% peak-to-peak.

h. ADJUST — The Hf compensations (C1336, R1336, C1435, R1435, C1445, and R1445) for the best front corner and flat top.

i. Remove the connection from the CH 1 input.

j. Repeat parts c through i, substituting CH 2 controls, (C2336, R2336, C2435, R2435, C2445, and R2445).

12. Check Bandwidth (at least 375 MHz)

a. Set both VOLTS/DIV switches to 0.5 V.

b. Set the DISPLAY MODE switch to CH 1.

c. Connect the high-frequency signal generator to the CH 1 input.

d. Set the signal generator for six divisions of display at its reference frequency.

e. Set the signal generator frequency to 375 MHz.

f. CHECK — The display amplitude should be at least 4.2 divisions.

g. Remove the connection from the CH 1 input.

h. Repeat parts b through g, substituting CH 2 controls.

13. Check Common Mode Rejection Ratio (at least 10:1)

a. Set both VOLTS/DIV switches to 5 mV.

b. Set the DISPLAY MODE switch to CH 2.

c. Set the CH 2 POLARITY switch to INVERT.

d. Connect a 50-MHz signal from the medium-frequency signal generator to the CH 1 and CH 2 inputs through a Dual Input cable (067-0252-00).

e. Set the signal-generator amplitude for eight divisions of display.

f. Set the DISPLAY MODE to ADD.

g. CHECK — The display amplitude should be 0.8 division, or less.

h. Remove the connections from the 7A24 inputs.

i. Reset the CH 2 POLARITY switch to +UP.

14. Adjust Trigger Gain ($\pm 10\%$)

a. Exchange the Plug-in Extender (067-0589-00) cables A-11 with A-13 and B-11 with B-13.

b. Remove the 7A24 from the test oscilloscope and install the Plug-in Extender into the test oscilloscope.

c. Install the 7A24 into the Plug-in Extender.

d. Set the CH 1 VOLTS/DIV switch to 10 mV.

e. Connect a 0.06-volt signal from the 50-ohm Amplitude Calibrator to the CH 1 input.

f. CHECK — The display amplitude should be six divisions, ± 0.6 division.

g. ADJUST — The Trig Gain (R946) for six divisions of display amplitude.

h. Remove the connection from the CH 1 input.

15. Adjust Trigger High Frequency Compensation (15% aberration, maximum)

a. Set the time-base for 10 nanoseconds per division.

b. Set both VOLTS/DIV switches to 20 mV.

c. Set the DISPLAY MODE switch to CH 1.

d. Connect the Tunnel Diode Pulser (067-0554-00) to the CH 1 input through a 50-ohm, 2X Attenuator (011-0069-01).

e. Connect a 100-volt square wave source to the Tunnel Diode Pulser and adjust the pulser level to the minimum setting which will produce a fast-rise output.

f. Position the top of the waveform to two divisions above the graticule center.

g. CHECK — The aberration should not exceed 15% peak-to-peak.

h. ADJUST — The CH 1 Trig adjustments (C1721, R1721) for the best front corner and flat top.

i. Remove the connection from the CH 1 input.

j. Repeat parts c through i, substituting CH 2 controls.

k. Remove the Plug-in Extender and insert the 7A24 directly into the test oscilloscope.

16. Check Readout and IDENTIFY Operation

- a. Set the DISPLAY MODE switch to ALT.
- b. Rotate both VOLTS/DIV switches through their range.
- c. CHECK — The channel 1 (upper) crt readout should correspond to the CH 1 VOLTS/DIV switch settings, and the channel 2 (lower) readout should correspond to the CH 2 VOLTS/DIV switch settings for all switch positions.
- d. Press the CH 1 IDENTIFY button.
- e. CHECK — The channel 1 readout should be replaced by the word "IDENTIFY" and the channel 1 trace should move up 0.2 to 0.4 division.
- f. Release the CH 1 IDENTIFY button.
- g. Repeat parts d, e, and f, substituting CH 2 controls.

ELECTRICAL REPLACEABLE PARTS LIST

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	SEP	SEPARATELY
FXD	FIXED	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
01121	Allen-Bradley Co.	1201 2nd St.	Milwaukee, WI 53212
01295	Texas Instruments, Inc., Components Group	P. O. Box 5012	Dallas, TX 75222
03508	General Electric Co., Semi-Conductor Products Dept., Electronics Park		Syracuse, NY 13201
07263	Fairchild Semiconductor, A Div. of Fairchild Camera and Instrument Corp.	464 Ellis St.	Mountain View, CA 94040
07910	Teledyne Semiconductor	12515 Chadron Ave.	Hawthorne, CA 90250
12697	Clarostat Mfg. Co., Inc.	Lower Washington St.	Dover, NH 03820
14193	Cal-R, Inc.	1601 Olympic Blvd.	Santa Monica, CA 90404
18796	Erie Technological Products, Inc. State College Division		State College, PA 16801
19701	Electra/Midland Corp., A North American Phillips Co.	P. O. Box 760	Mineral Wells, TX 76067
24931	Specialty Connector Co., Inc.	3560 Madison Ave.	Indianapolis, IN 46227
56289	Sprague Electric Co.		North Adams, MA 01247
71590	Centralab Electronics, Div. of Globe-Union, Inc.	5757 N. Green Bay Ave.	Milwaukee, WI 53201
72982	Erie Technological Products, Inc.	644 W. 12th St.	Erie, PA 16512
73138	Beckman Instruments, Inc., Helipot Div.	2500 Harbor Blvd.	Fullerton, CA 92634
74970	Johnson, E. F., Co.	299 10th Ave. S. W.	Waseca, MN 56093
75042	TRW Electronic Components, IRC Philadelphia Div.	401 N. Broad St.	Philadelphia, PA 19108
76854	Oak Mfg. Co., Division of Oak Electro/Netics Corp.	S. Main St.	Crystal Lake, IL 60014
78488	Stackpole Carbon Co.		St. Marys, PA 15857
79727	Continental-Wirt Electronics Corp.		Warminster, PA 18974
80009	Tektronix, Inc.	P. O. Box 500	Beaverton, OR 97005
80294	Bourns, Inc.	1200 Columbia Ave.	Riverside, CA 92507
81483	International Rectifier Corp.	9220 Sunset Blvd.	Los Angeles, CA 90069
91637	Dale Electronics, Inc.	P. O. Box 609	Columbus, NB 68601

Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont			
A1	670-2464-00			CKT BOARD ASSY:--CH1 ATTENUATOR	80009	670-2464-00
A2	670-2310-00			CKT BOARD ASSY:--CH1 READOUT	80009	670-2310-00
A3	670-2464-00			CKT BOARD ASSY:--CH2 ATTENUATOR	80009	670-2464-00
A4	670-2310-00			CKT BOARD ASSY:--CH2 READOUT	80009	670-2310-00
A5	670-2710-00			CKT BOARD ASSY:--AMPLIFIER	80009	670-2710-00
C621	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C630	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C634	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C635	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C638	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C643	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C647	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C648	283-0003-00			CAP.,FXD,CER DI:0.01UF,+80-20%,150V	56289	20C205A1
C649	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C850	283-0309-00			CAP.,FXD,CER DI:150PF,10%,50V	72982	CC1210C0G151K
C860	283-0309-00			CAP.,FXD,CER DI:150PF,10%,50V	72982	CC1210C0G151K
C866	281-0603-00			CAP.,FXD,CER DI:39PF,5%,500V	72982	308-000C0G0390J
C920	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C940	283-0010-00			CAP.,FXD,CER DI:0.05UF,+100-20%,50V	56289	273C20
C1012	283-0002-00			CAP.,FXD,CER DI:0.01UF,500V	72982	811-546F103Z
C1014	283-0002-00			CAP.,FXD,CER DI:0.01UF,500V	72982	811-546F103Z
C1018	283-0002-00			CAP.,FXD,CER DI:0.01UF,500V	72982	811-546F103Z
C1022	283-0002-00			CAP.,FXD,CER DI:0.01UF,500V	72982	811-546F103Z
C1024	283-0002-00			CAP.,FXD,CER DI:0.01UF,500V	72982	811-546F103Z
C1028	283-0002-00			CAP.,FXD,CER DI:0.01UF,500V	72982	811-546F103Z
C1327	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C1332	283-0203-00			CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131-050651474M
C1334	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	71590	TCZ33
C1336	281-0158-00			CAP.,VAR,CER DI:7-45PF,50V	18796	518-000-G7-45
C1432	283-0083-00			CAP.,FXD,CER DI:0.0047UF,20%,500V	56289	33C154A1
C1435	281-0158-00			CAP.,VAR,CER DI:7-45PF,50V	18796	518-000-G7-45
C1436	283-0058-00			CAP.,FXD,CER DI:0.027UF,10%,100V	72982	8131N147C271K
C1445	281-0186-00			CAP.,VAR,PLSTC:1.1-3.5PF,100V	74970	273-0005-005
C1721	281-0123-00			CAP.,VAR,CER DI:5-25PF,100V	72982	518-000A5-25
C2327	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C2332	283-0203-00			CAP.,FXD,CER DI:0.47UF,20%,50V	72982	8131-050651474M
C2334	281-0629-00			CAP.,FXD,CER DI:33PF,5%,600V	71590	TCZ33
C2336	281-0158-00			CAP.,VAR,CER DI:7-45PF,50V	18796	518-000-G7-45
C2413	283-0000-00			CAP.,FXD,CER DI:0.001UF,+100-0%,500V	56289	40C626
C2432	283-0083-00			CAP.,FXD,CER DI:0.0047UF,20%,500V	56289	33C154A1
C2435	281-0158-00			CAP.,VAR,CER DI:7-45PF,50V	18796	518-000-G7-45
C2436	283-0058-00			CAP.,FXD,CER DI:0.027UF,10%,100V	72982	8131N147C271K
C2445	281-0186-00			CAP.,VAR,PLSTC:1.1-3.5PF,100V	74970	273-0005-005
C2721	281-0123-00			CAP.,VAR,CER DI:5-25PF,100V	72982	518-000A5-25
CR621	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR631	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR647	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1050	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1052	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1058	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1060	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1062	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1301	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1303	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1319	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1465	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1541	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR1543	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220
CR2301	152-0141-02			SEMICOND DEVICE:SILICON,30V,150MA	07910	CD8220

Electrical Parts List-7A24

Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr	
		Eff	Dscont		Code	Mfr Part Number
CR2303	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	CD8220
CR2319	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	CD8220
CR2465	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	CD8220
CR2476	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	CD8220
CR2496	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	CD8220
CR2541	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	CD8220
CR2543	152-0141-02			SEMICONV DEVICE:SILICON,30V,150MA	07910	CD8220
DL10	119-0419-00			DELAY LINE,ELEC:	80009	119-0419-00
F100	159-0118-00			FUSE,THERMAL:50 OHM	80009	159-0118-00
J10	131-1171-00			CONN,RCPT,ELEC:BNC,50 OHM	24931	28JR231-1
J100	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J175	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J830	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J840	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J850	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J860	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J1301	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
J2301	131-1003-00			CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
L1445	108-0420-00			COIL,FIXED:60NH	80009	108-0420-00
L2445	108-0420-00			COIL,FIXED:60NH	80009	108-0420-00
LR1010	108-0184-00			COIL,FIXED:3.2UH	80009	108-0184-00
LR1014	108-0184-00			COIL,FIXED:3.2UH	80009	108-0184-00
LR1020	108-0184-00			COIL,FIXED:3.2UH	80009	108-0184-00
LR1024	108-0184-00			COIL,FIXED:3.2UH	80009	108-0184-00
Q620	151-0254-00			TRANSISTOR:SILICON,NPN	03508	2N5308
Q920	151-0271-00			TRANSISTOR:SILICON,PNP	01295	SRA4504
Q940	151-0271-00			TRANSISTOR:SILICON,PNP	01295	SRA4504
Q1050	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1070	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1470	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q1490	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q2470	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
Q2490	151-0341-00			TRANSISTOR:SILICON,NPN	07263	2N3565
R100	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R101	305-0510-00			RES.,FXD,COMP:51 OHM,5%,2W	01121	HB5105
R106	307-1020-00			ATTEN STRIP:2X	80009	307-1020-00
R110	307-1023-00			ATTEN STRIP:5X	80009	307-1023-00
R119	307-1024-00			ATTEN STRIP:10X	80009	307-1024-00
R621	321-0223-00			RES.,FXD,FILM:2.05K OHM,1%,0.125W	75042	CEAT0-2051F
R622	321-0299-00			RES.,FXD,FILM:12.7K OHM,1%,0.125W	75042	CEAT0-1272F
R630	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R631	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R633	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R634	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R635	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R636	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R639	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R640	315-0753-00			RES.,FXD,COMP:75K OHM,5%,0.25W	01121	CB7535
R642	315-0513-00			RES.,FXD,COMP:51K OHM,5%,0.25W	01121	CB5135
R643	321-0344-00			RES.,FXD,FILM:37.4K OHM,1%,0.125W	75042	CEAT0-3742F
R645	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R646	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R647	315-0133-00			RES.,FXD,COMP:13K OHM,5%,0.25W	01121	CB1335
R648	315-0154-00			RES.,FXD,COMP:150K OHM,5%,0.25W	01121	CB1545
R806	323-0099-00			RES.,FXD,FILM:105 OHM,1%,0.50W	75042	CECT0-1050F
R808	323-0099-00			RES.,FXD,FILM:105 OHM,1%,0.50W	75042	CECT0-1050F
R810	315-0111-00			RES.,FXD,COMP:110 OHM,5%,0.25W	01121	CB1115

Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr Code	Mfr Part Number
		Eff	Dscont			
R811	315-0111-00			RES.,FXD,COMP:110 OHM,5%,0.25W	01121	CB1115
R850	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R854	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R860	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R864	315-0100-00			RES.,FXD,COMP:10 OHM,5%,0.25W	01121	CB1005
R866	315-0241-00			RES.,FXD,COMP:240 OHM,5%,0.25W	01121	CB2415
R890	301-0471-00			RES.,FXD,COMP:470 OHM,5%,0.50W	01121	EB4715
R892	301-0471-00			RES.,FXD,COMP:470 OHM,5%,0.50W	01121	EB4715
R894	311-1262-00			RES.,VAR,NONWIR:750 OHM,10%,0.50W	73138	62PT-3620-751K
R896	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R902	315-0111-00			RES.,FXD,COMP:110 OHM,5%,0.25W	01121	CB1115
R904	315-0111-00			RES.,FXD,COMP:110 OHM,5%,0.25W	01121	CB1115
R906	323-0094-00			RES.,FXD,FILM:93.1 OHM,1%,0.50W	19701	MF7CD93R10F
R908	323-0094-00			RES.,FXD,FILM:93.1 OHM,1%,0.50W	19701	MF7CD93R10F
R912	315-0390-00			RES.,FXD,COMP:39 OHM,5%,0.25W	01121	CB3905
R914	315-0390-00			RES.,FXD,COMP:39 OHM,5%,0.25W	01121	CB3905
R916	321-0167-00			RES.,FXD,FILM:536 OHM,1%,0.125W	75042	CEAT0-5360F
R918	321-0195-00			RES.,FXD,FILM:1.05K OHM,1%,0.125W	75042	CEAT0-1051F
R920	315-0221-00			RES.,FXD,COMP:220 OHM,5%,0.25W	01121	CB2215
R940	315-0221-00			RES.,FXD,COMP:220 OHM,5%,0.25W	01121	CB2215
R946	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R990	323-0193-00			RES.,FXD,FILM:1K OHM,1%,0.5W	75042	CECT0-1001F
R992	323-0193-00			RES.,FXD,FILM:1K OHM,1%,0.5W	75042	CECT0-1001F
R1010	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1012	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1050	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1052	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1060	315-0272-00			RES.,FXD,COMP:2.7K OHM,5%,0.25W	01121	CB2725
R1062	315-0103-00			RES.,FXD,COMP:10K OHM,5%,0.25W	01121	CB1035
R1063	315-0751-00			RES.,FXD,COMP:750 OHM,5%,0.25W	01121	CB7515
R1065	315-0241-00			RES.,FXD,COMP:240 OHM,5%,0.25W	01121	CB2415
R1070	315-0302-00			RES.,FXD,COMP:3K OHM,5%,0.25W	01121	CB3025
R1072	315-0623-00			RES.,FXD,COMP:62K OHM,5%,0.25W	01121	CB6235
R1081	315-0241-00			RES.,FXD,COMP:240 OHM,5%,0.25W	01121	CB2415
R1083	315-0621-00			RES.,FXD,COMP:620 OHM,5%,0.25W	01121	CB6215
R1085	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R1301	323-0073-00			RES.,FXD,FILM:56.2 OHM,1%,0.50W	91637	MFF1226G56R20F
R1303	315-0123-00			RES.,FXD,COMP:12K OHM,5%,0.25W	01121	CB1235
R1305	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1307	311-1263-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	73138	62PT-347-0-102K
R1311	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R1313	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R1315	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R1317	311-1265-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	80294	3326P-L58-202
R1319	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R1320	323-0176-00			RES.,FXD,FILM:665 OHM,1%,0.50W	75042	CECT0-6650F
R1323	323-0176-00			RES.,FXD,FILM:665 OHM,1%,0.50W	75042	CECT0-6650F
R1324	311-1259-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	80294	3326P-L58-101
R1327	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R1329	315-0822-00			RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R1332	315-0432-00			RES.,FXD,COMP:4.3K OHM,5%,0.25W	01121	CB4325
R1334	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R1336	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R1337	311-1261-00			RES.,VAR,NONWIR:500 OHM,10%,0.50W	80294	3326P-L58-501
R1338	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1339	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1340	315-0181-00			RES.,FXD,COMP:180 OHM,5%,0.25W	01121	CB1815
R1341	321-0076-00			RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R1343	321-0076-00			RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R1347	323-0140-00			RES.,FXD,FILM:280 OHM,1%,0.50W	75042	CECT0-2800F

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Ckt No.	Tektronix Part No.	Serial/Model No.		Name & Description	Mfr	
		Eff	Dscont		Code	Mfr Part Number
R1351	315-0472-00			RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R1353	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R1401	321-0076-00			RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R1403	321-0076-00			RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R1413	315-0332-00			RES.,FXD,COMP:3.3K OHM,5%,0.25W	01121	CB3325
R1416	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1418	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1419	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R1420	323-0190-00			RES.,FXD,FILM:931 OHM,1%,0.50W	75042	CECT0-9310F
R1421	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1422	323-0190-00			RES.,FXD,FILM:931 OHM,1%,0.50W	75042	CECT0-9310F
R1423A, B ¹	311-1465-01			RES.,VAR,NONWIR:1K OHM X 2.5K OHM,10%,0.50W	80009	311-1465-01
R1425	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R1432	315-0911-00			RES.,FXD,COMP:910 OHM,5%,0.25W	01121	CB9115
R1434	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1435	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R1436	311-1269-00			RES.,VAR,NONWIR:20K OHM,10%,0.50W	73138	62PT-3520-203K
R1438	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1439	315-0470-00			RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R1445	311-1260-00			RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R1465 ²	311-1320-00			RES.,VAR,NONWIR:5K OHM,10%,1W	12697	381-CM39700
R1466	315-0273-00			RES.,FXD,COMP:27K OHM,5%,0.25W	01121	CB2735
R1467	315-0273-00			RES.,FXD,COMP:27K OHM,5%,0.25W	01121	CB2735
R1470	315-0511-00			RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R1472	315-0183-00			RES.,FXD,COMP:18K OHM,5%,0.25W	01121	CB1835
R1474	315-0331-00			RES.,FXD,COMP:330 OHM,5%,0.25W	01121	CB3315
R1490	315-0561-00			RES.,FXD,COMP:560 OHM,5%,0.25W	01121	CB5615
R1492	315-0183-00			RES.,FXD,COMP:18K OHM,5%,0.25W	01121	CB1835
R1494	315-0331-00			RES.,FXD,COMP:330 OHM,5%,0.25W	01121	CB3315
R1498	315-0471-00			RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R1501	321-0076-00			RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R1503	321-0076-00			RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R1505	323-0112-00			RES.,FXD,FILM:143 OHM,1%,0.50W	75042	CECT0-1430F
R1511	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1512	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1514	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1516	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1517	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1519	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1520	323-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
R1523	323-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
R1525	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1527	315-0101-00			RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R1711	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1712	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1714	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1716	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1717	315-0202-00			RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R1719	315-0152-00			RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R1720	323-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
R1721	311-1259-00			RES.,VAR,NONWIR:100 OHM,10%,0.50W	80294	3326P-L58-101
R1723	323-0206-00			RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
R2301	323-0073-00			RES.,FXD,FILM:56.2 OHM,1%,0.50W	91637	MFF1226G56R20F
R2303	315-0123-00			RES.,FXD,COMP:12K OHM,5%,0.25W	01121	CB1235
R2305	311-1268-00			RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R2307	311-1263-00			RES.,VAR,NONWIR:1K OHM,10%,0.50W	73138	62PT-347-0-102K
R2311	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R2313	315-0512-00			RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R2315	315-0392-00			RES.,FXD,COMP:3.9K OHM,5%,0.25W	01121	CB3925
R2317	311-1265-00			RES.,VAR,NONWIR:2K OHM,10%,0.50W	80294	3326P-L58-202

¹Furnished as a unit with S1423A,B.
²Furnished as a unit with S1465.

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R2319	315-0472-00		RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R2320	323-0176-00		RES.,FXD,FILM:665 OHM,1%,0.50W	75042	CECT0-6650F
R2323	323-0176-00		RES.,FXD,FILM:665 OHM,1%,0.50W	75042	CECT0-6650F
R2324	311-1259-00		RES.,VAR,NONWIR:100 OHM,10%,0.50W	80294	3326P-L58-101
R2327	315-0822-00		RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R2329	315-0822-00		RES.,FXD,COMP:8.2K OHM,5%,0.25W	01121	CB8225
R2332	315-0432-00		RES.,FXD,COMP:4.3K OHM,5%,0.25W	01121	CB4325
R2334	315-0471-00		RES.,FXD,COMP:470 OHM,5%,0.25W	01121	CB4715
R2336	311-1260-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R2337	311-1261-00		RES.,VAR,NONWIR:500 OHM,10%,0.50W	80294	3326P-L58-501
R2338	315-0470-00		RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R2339	315-0470-00		RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R2340	315-0181-00		RES.,FXD,COMP:180 OHM,5%,0.25W	01121	CB1815
R2341	321-0076-00		RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R2343	321-0076-00		RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R2347	323-0140-00		RES.,FXD,FILM:280 OHM,1%,0.50W	75042	CECT0-2800F
R2351	315-0472-00		RES.,FXD,COMP:4.7K OHM,5%,0.25W	01121	CB4725
R2353	311-1268-00		RES.,VAR,NONWIR:10K OHM,10%,0.50W	73138	62PT-351-0-103K
R2401	321-0076-00		RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R2403	321-0076-00		RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R2410	315-0162-00		RES.,FXD,COMP:1.6K OHM,5%,0.25W	01121	CB1625
R2411	311-1263-00		RES.,VAR,NONWIR:1K OHM,10%,0.50W	73138	62PT-347-0-102K
R2413	315-0470-00		RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R2415	315-0102-00		RES.,FXD,COMP:1K OHM,5%,0.25W	01121	CB1025
R2416	315-0470-00		RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R2418	315-0152-00		RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R2419	315-0511-00		RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R2420	323-0190-00		RES.,FXD,FILM:931 OHM,1%,0.50W	75042	CECT0-9310F
R2421	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2422	323-0190-00		RES.,FXD,FILM:931 OHM,1%,0.50W	75042	CECT0-9310F
R2423A, ¹ B ¹	311-1465-01		RES.,VAR,NONWIR:1K OHM X 2.5K OHM,10%,0.50W	80009	311-1465-01
R2425	315-0512-00		RES.,FXD,COMP:5.1K OHM,5%,0.25W	01121	CB5125
R2432	315-0911-00		RES.,FXD,COMP:910 OHM,5%,0.25W	01121	CB9115
R2434	315-0101-00		RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R2435	311-1260-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R2436	311-1269-00		RES.,VAR,NONWIR:20K OHM,10%,0.50W	73138	62PT-3520-203K
R2438	315-0470-00		RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R2439	315-0470-00		RES.,FXD,COMP:47 OHM,5%,0.25W	01121	CB4705
R2445	311-1260-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	62PT-3450-251K
R2465 ²	311-1320-00		RES.,VAR,NONWIR:5K OHM,10%,1W	12697	381-CM39700
R2466	315-0273-00		RES.,FXD,COMP:27K OHM,5%,0.25W	01121	CB2735
R2467	315-0273-00		RES.,FXD,COMP:27K OHM,5%,0.25W	01121	CB2735
R2470	315-0511-00		RES.,FXD,COMP:510 OHM,5%,0.25W	01121	CB5115
R2472	315-0183-00		RES.,FXD,COMP:18K OHM,5%,0.25W	01121	CB1835
R2474	315-0331-00		RES.,FXD,COMP:330 OHM,5%,0.25W	01121	CB3315
R2476	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2490	315-0561-00		RES.,FXD,COMP:560 OHM,5%,0.25W	01121	CB5615
R2492	315-0183-00		RES.,FXD,COMP:18K OHM,5%,0.25W	01121	CB1835
R2494	315-0331-00		RES.,FXD,COMP:330 OHM,5%,0.25W	01121	CB3315
R2496	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2498	315-0911-00		RES.,FXD,COMP:910 OHM,5%,0.25W	01121	CB9115
R2501	321-0076-00		RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R2503	321-0076-00		RES.,FXD,FILM:60.4 OHM,1%,0.125W	75042	CEAT0-60R40F
R2505	323-0112-00		RES.,FXD,FILM:143 OHM,1%,0.50W	75042	CECT0-1430F
R2511	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2512	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2514	315-0152-00		RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R2516	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2517	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2519	315-0152-00		RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525

¹Furnished as a unit with S2423A,B.²Furnished as a unit with S2465.

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Kct No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R2520	323-0206-00		RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
R2523	323-0206-00		RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
R2525	315-0101-00		RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R2527	315-0101-00		RES.,FXD,COMP:100 OHM,5%,0.25W	01121	CB1015
R2711	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2712	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2714	315-0152-00		RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R2716	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2717	315-0202-00		RES.,FXD,COMP:2K OHM,5%,0.25W	01121	CB2025
R2719	315-0152-00		RES.,FXD,COMP:1.5K OHM,5%,0.25W	01121	CB1525
R2720	323-0206-00		RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
R2721	311-1259-00		RES.,VAR, NONWIR:100 OHM,10%,0.50W	80294	3326P-L58-101
R2723	323-0206-00		RES.,FXD,FILM:1.37K OHM,1%,0.50W	75042	CECT0-1371F
RT1437	307-0127-00		RES.,THERMAL:1K OHM,10%	14193	2D13-102K
RT2437	307-0127-00		RES.,THERMAL:1K OHM,10%	14193	2D13-102K
S22A,B	260-0816-00		SWITCH,SLIDE:CH 2 POLARITY	79727	G-126MOD6914
S30A}	260-1493-00		SWITCH,ROTARY:DISPLAY MODE	76854	5-43681-411
S30B}			:TRIGGER SOURCE		
S30A}	262-0965-00		SWITCH ASSY,ROT:DISPLAY MODE	80009	262-0965-00
S30B}			:TRIGGER SOURCE		
S100A}			:COUPLING		
S100B}	263-1021-00		ACTR ASSY,CAM S:VOLTS/DIV	80009	263-1021-00
S100C}			:VOLTS/DIV		
S1423A,B ²			CH1 CAL IN		
S1465 ³			CH1 IDENTIFY		
S2423A,B ⁴			CH2 CAL IN		
S2465 ⁵			CH2 IDENTIFY		
T1301	119-0418-00		CPLR,XMSN LINE:BALUN	80009	119-0418-00
T1527	276-0557-00		CORE,TOROID:	78488	57-0131
T2301	119-0418-00		CPLR,XMSN LINE:BALUN	80009	119-0418-00
T2527	276-0557-00		CORE,TOROID:	78488	57-0131
U1350	155-0078-03		INTEGRATED CKT:ML,VERTICAL AMPL,SEL	80009	155-0078-03
U1450	155-0078-03		INTEGRATED CKT:ML,VERTICAL AMPL,SEL	80009	155-0078-03
U1550	155-0078-01		INTEGRATED CKT:ML,VERTICAL AMPL,SEL	80009	155-0078-01
U1750	155-0078-01		INTEGRATED CKT:ML,VERTICAL AMPL,SEL	80009	155-0078-01
U2350	155-0078-03		INTEGRATED CKT:ML,VERTICAL AMPL,SEL	80009	155-0078-03
U2450	155-0078-00		INTEGRATED CKT:ML,VERTICAL AMPL	80009	155-0078-00
U2550	155-0078-01		INTEGRATED CKT:ML,VERTICAL AMPL,SEL	80009	155-0078-01
U2750	155-0078-01		INTEGRATED CKT:ML,VERTICAL AMPL,SEL	80009	155-0078-01
VR850	152-0481-00		SEMICONV DEVICE:ZENER,1W,5.1V,5%	81483	1N3826A
VR854	152-0481-00		SEMICONV DEVICE:ZENER,1W,5.1V,5%	81483	1N3826A
VR860	152-0481-00		SEMICONV DEVICE:ZENER,1W,5.1V,5%	81483	1N3826A
VR864	152-0481-00		SEMICONV DEVICE:ZENER,1W,5.1V,5%	81483	1N3826A
VR1301	152-0226-00		SEMICONV DEVICE:ZENER,0.4W,5.1V,5%	81483	69-6584
VR1303	152-0226-00		SEMICONV DEVICE:ZENER,0.4W,5.1V,5%	81483	69-6584
VR2301	152-0226-00		SEMICONV DEVICE:ZENER,0.4W,5.1V,5%	81483	69-6584
VR2303	152-0226-00		SEMICONV DEVICE:ZENER,0.4W,5.1V,5%	81483	69-6584

¹See Mechanical Parts List for replacement parts.

²Furnished as a unit with R1423A,B.

³Furnished as a unit with R1465.

⁴Furnished as a unit with R2423A,B.

⁵Furnished as a unit with R2465.



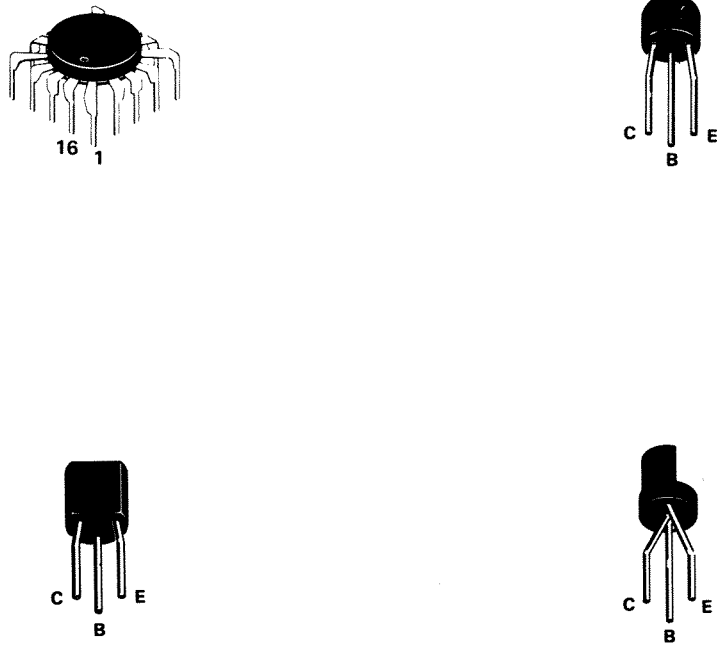


Fig. 7-1. Semiconductor electrode configurations.

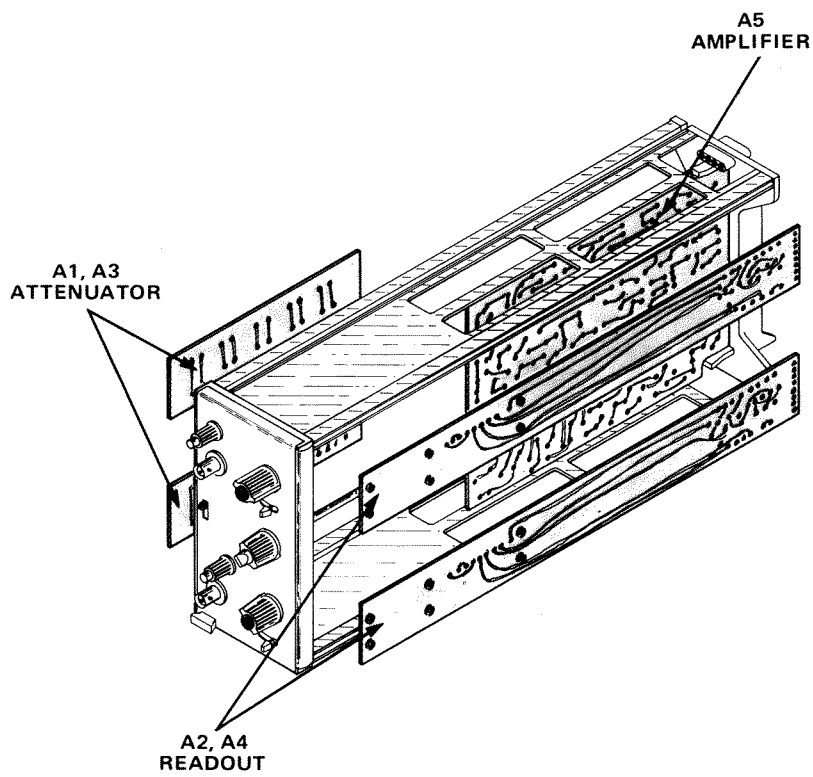


Fig. 7-2. Circuit board locations.

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

Electrical components shown on the diagrams are in the following units unless noted otherwise:

- Capacitors = Values one or greater are in picofarads (pF).
 Values less than one are in microfarads (μ F).
 Resistors = Ohms (Ω).

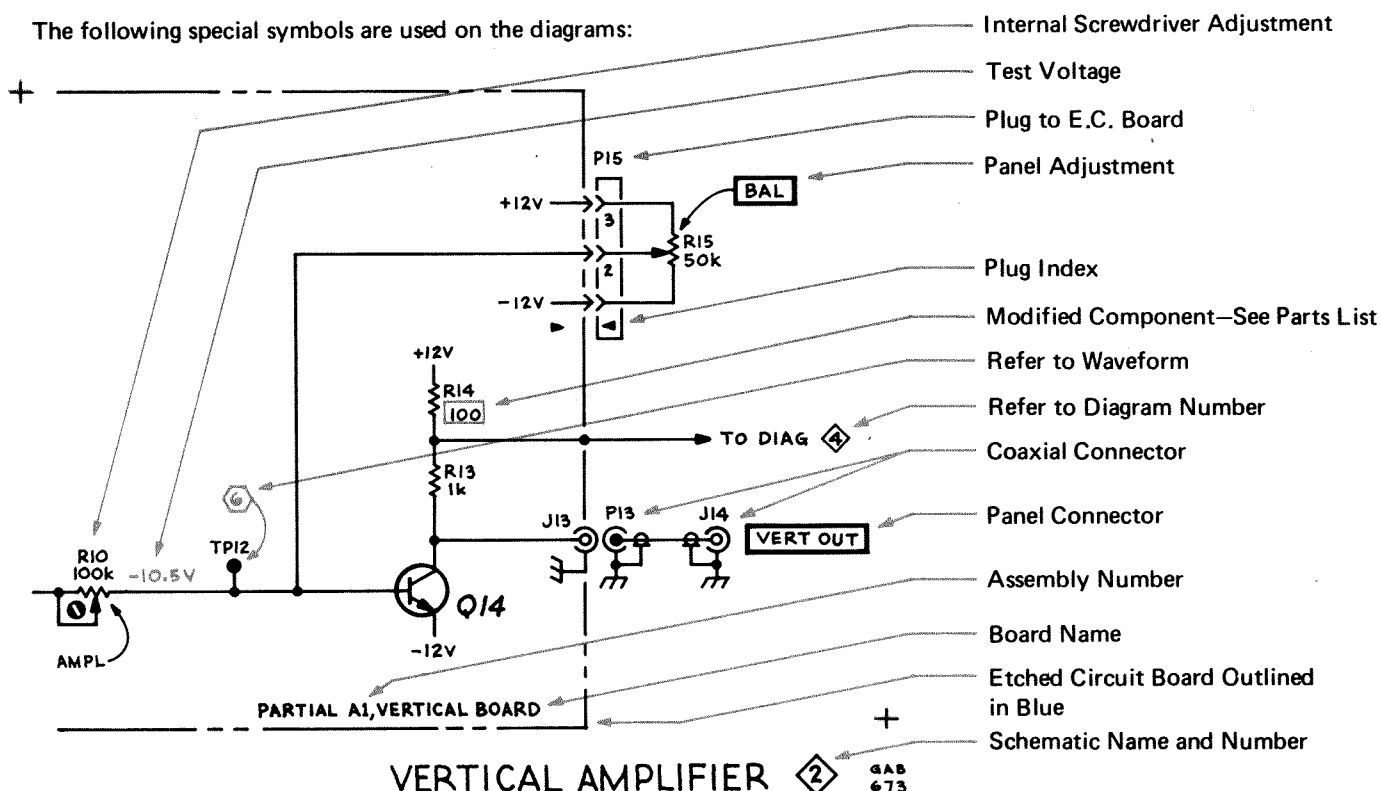
Symbols used on the diagrams are based on USA Standard Y32.2-1967.

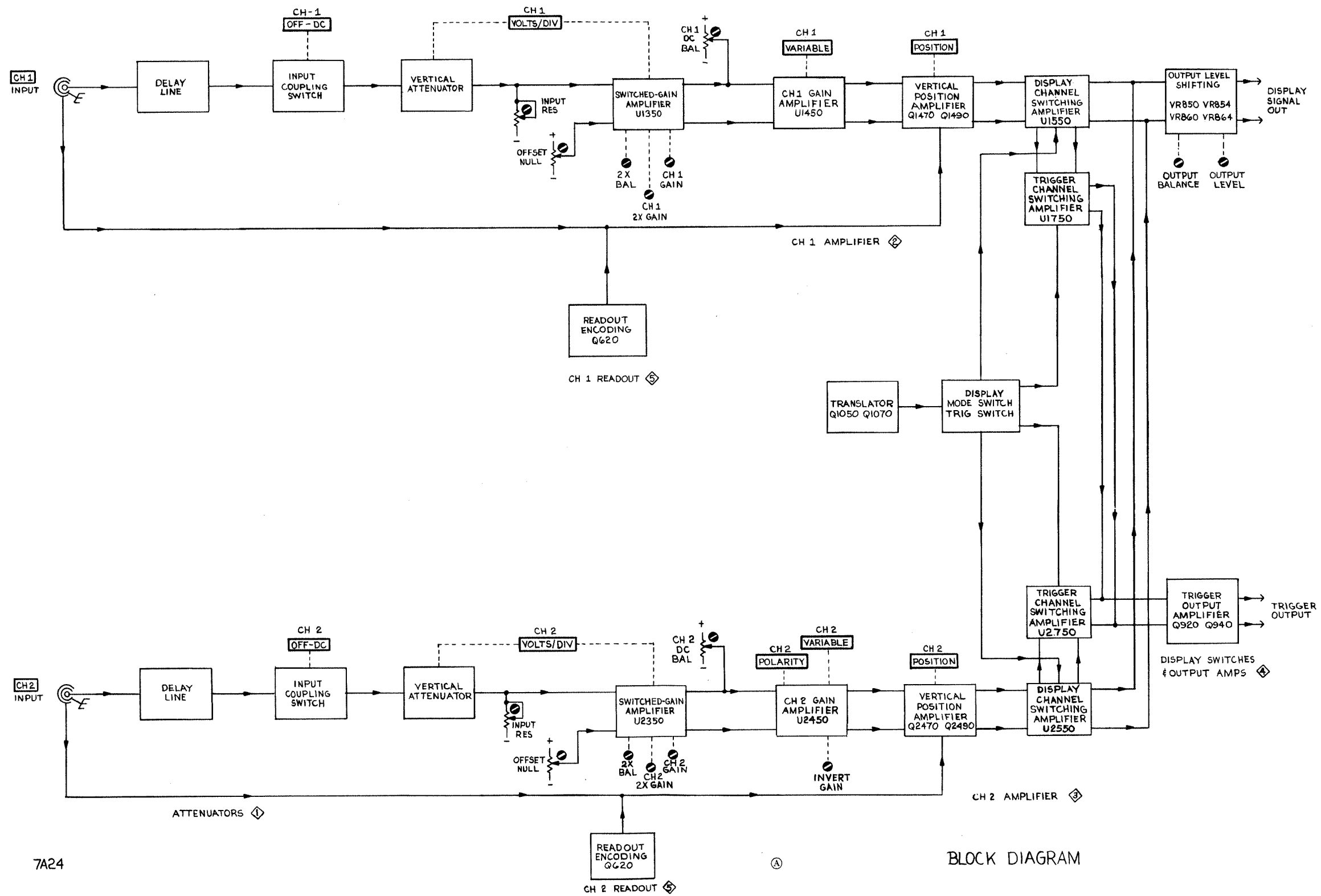
Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	H	Heat dissipating device (heat sink, heat radiator, etc.)	RT	Thermistor
AT	Attenuator, fixed or variable	HR	Heater	S	Switch
B	Motor	HY	Hybrid circuit	T	Transformer
BT	Battery	J	Connector, stationary portion	TC	Thermocouple
C	Capacitor, fixed or variable	K	Relay	TP	Test point
CB	Circuit breaker	L	Inductor, fixed or variable	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	V	Electron tube
DL	Delay line	M	Meter	VR	Voltage regulator (zener diode, etc.)
DS	Indicating device (lamp)	P	Connector, movable portion	Y	Crystal
E	Spark Gap	Q	Transistor or silicon-controlled rectifier	Z	Phase shifter
F	Fuse	R	Resistor, fixed or variable		
FL	Filter				

The following special symbols are used on the diagrams:





BLOCK DIAGRAM

BLOCK DIAGRAM

+ 7A24

673 369

7A24

A1 and A3 ATTENUATOR BOARD

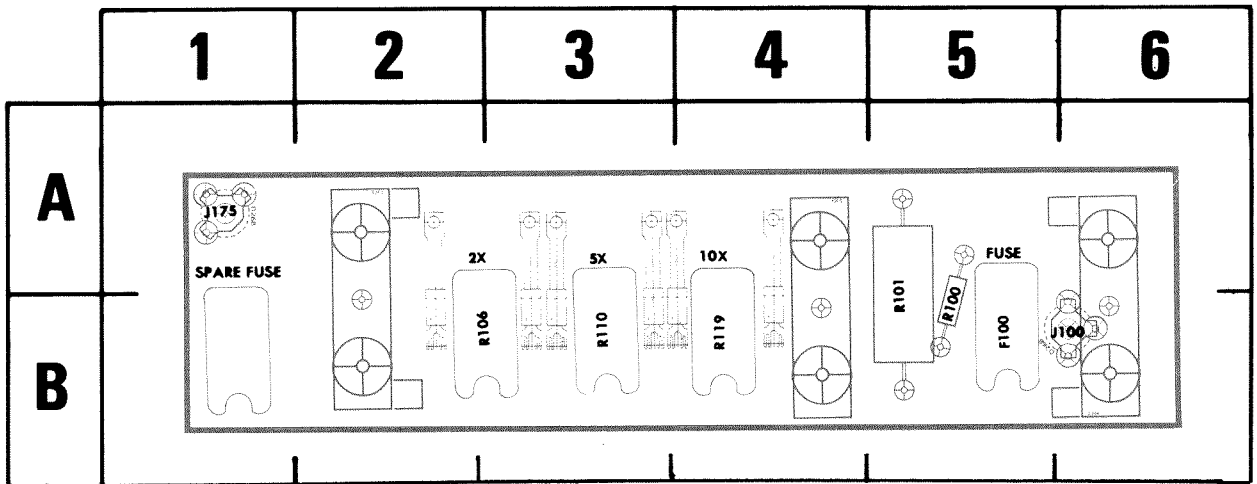
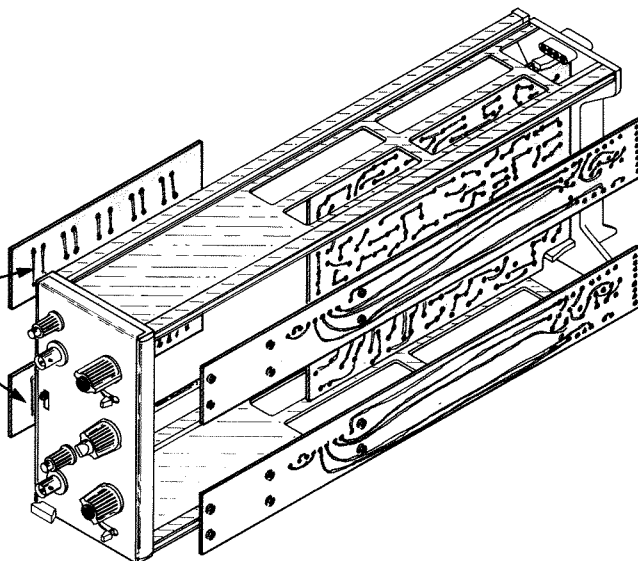
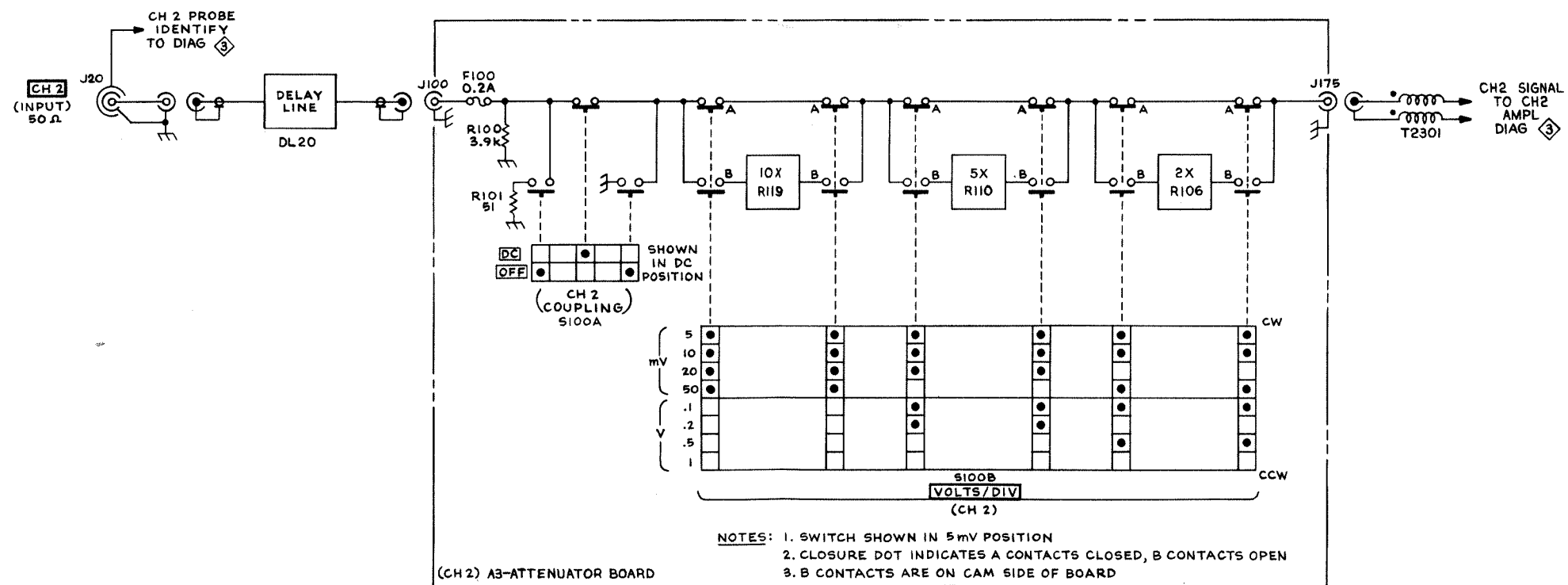
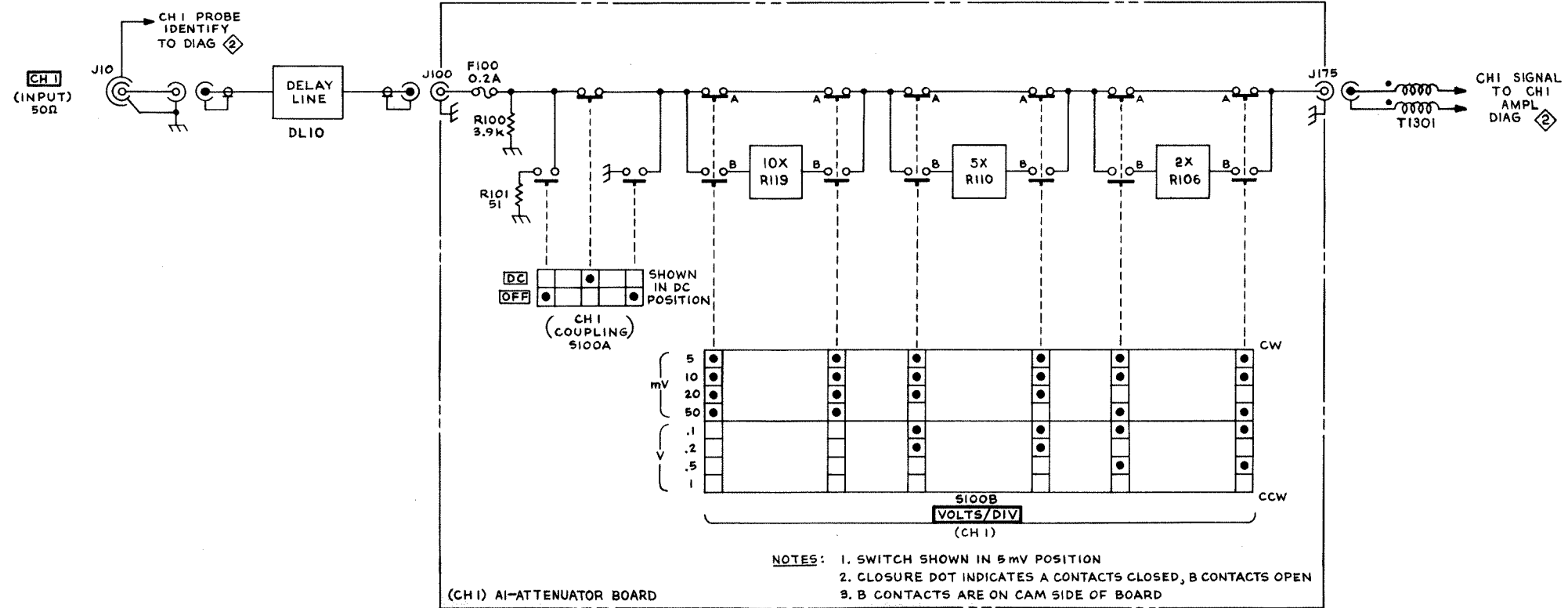


Fig. 7-3. A1 and A3—Attenuator circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC
F100	5B	R100	5B
		R101	5B
		R106	2B
J100	6B	R110	3B
J175	1 A	R119	4B

A1, A3
ATTENUATOR





+

7A24

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CH 1 & CH 2 ATTENUATORS ①

44
6/75

CH 1 and CH 2
ATTENUATORS

①

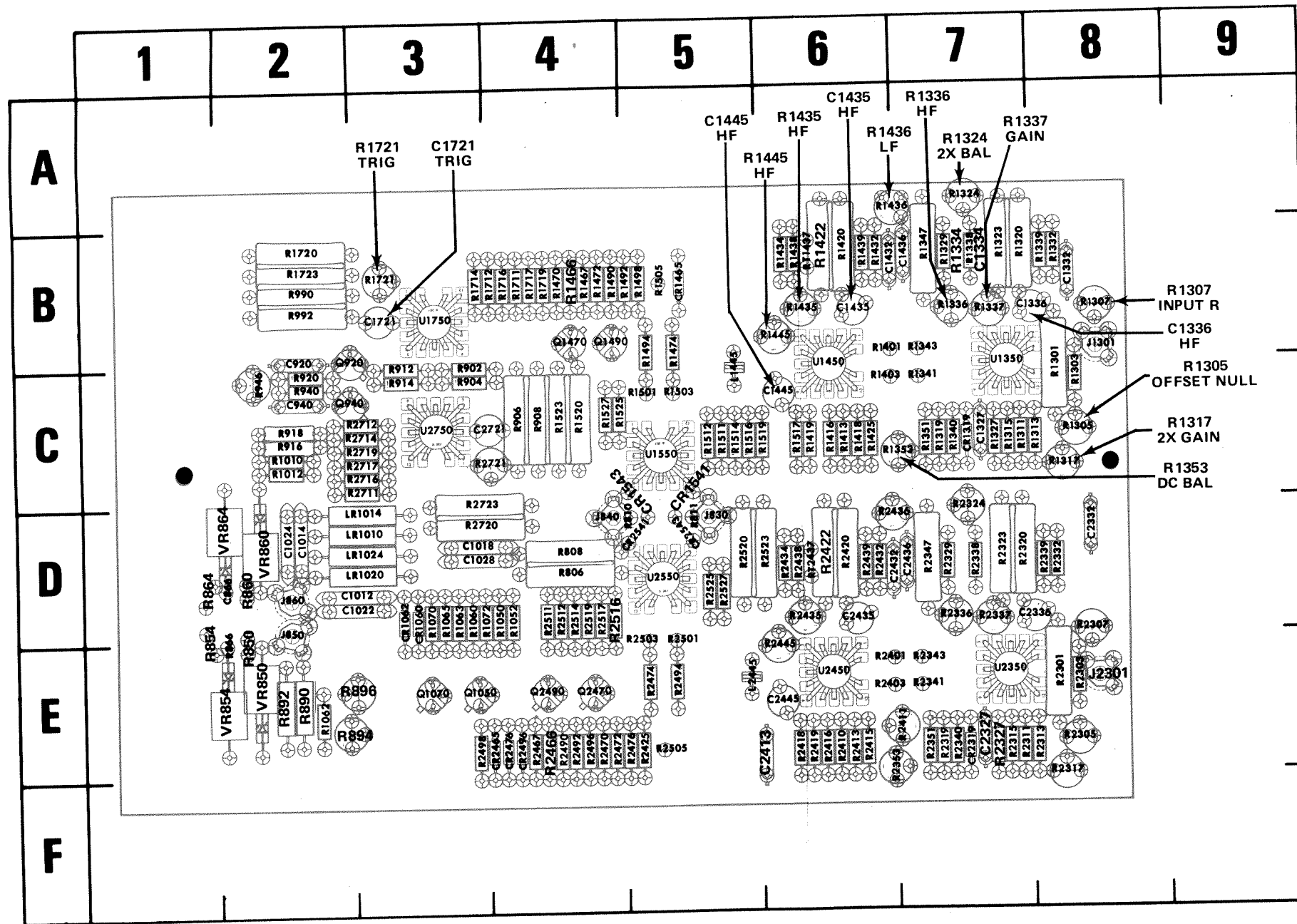
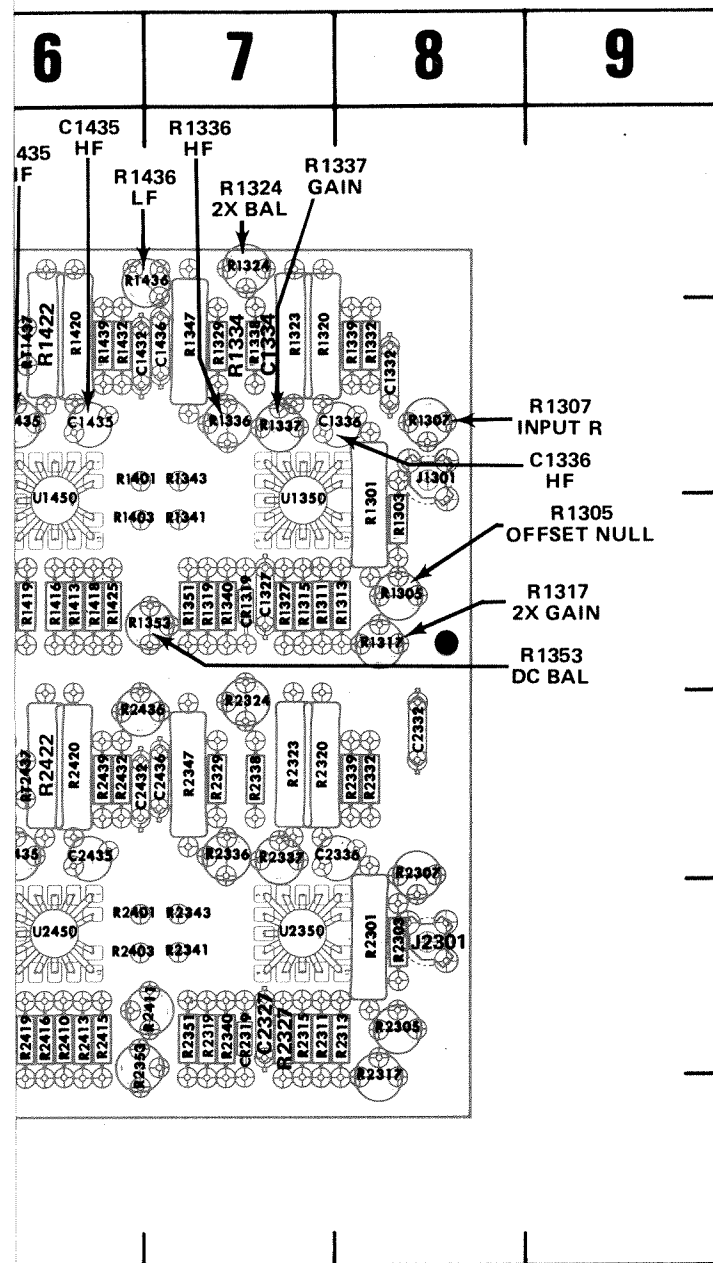


Fig. 7-4. A5-Amplifier circuit board.

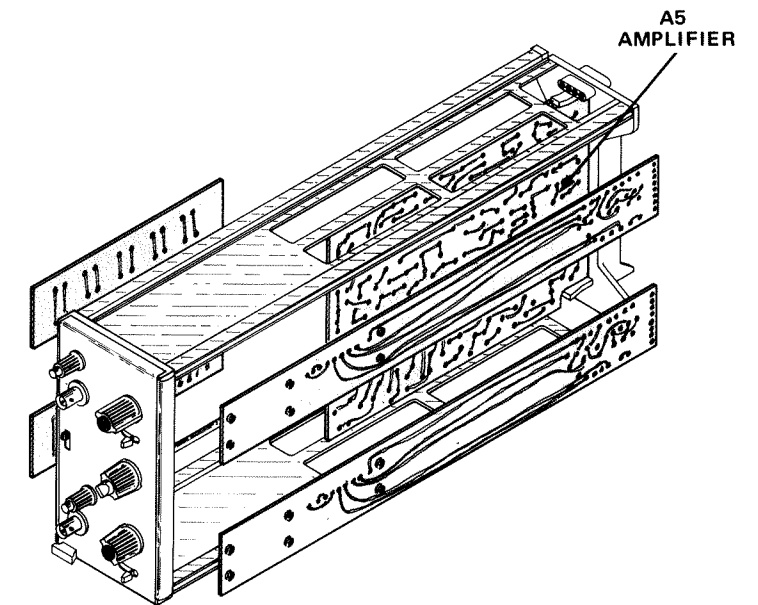
CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C866	1D	Q920	2B	R1323	7B	R1712	3B
C920	2B	Q940	2C	R1324	7A	R1714	3B
C940	2C	Q1050	3E	R1327	7C	R1716	4B
C1012	3D	Q1070	3E	R1329	7B	R1717	4B
C1014	2D	Q1470	4B	R1332	8B	R1719	4B
C1018	3D	Q1490	4B	R1334	7B	R1720	2B
C1022	3D	Q2470	4E	R1336	7B	R1721	3B
C1024	2D	Q2490	4E	R1337	7B	R1723	2B
C1028	3D			R1338	7B	R2301	8E
C1327	7C	R806	4D	R1339	8B	R2303	8E
C1332	8B	R808	4D	R1340	7C	R2305	8E
C1334	7B	R810	4D	R1341	7C	R2307	8D
C1336	7B	R811	5D	R1343	7B	R2311	7E
C1432	6B	R850	2D	R1347	7B	R2313	7E
C1435	6B	R860	2D	R1351	7C	R2315	7E
C1436	7B	R864	1D	R1353	6C	R2317	7E
C1445	6C	R866	2D	R1401	6B	R2319	7E
C1721	3B	R890	2E	R1403	6C	R2320	7D
C2213	6E	R892	2E	R1413	6C	R2323	7D
C2327	7E	R894	2E	R1416	6C	R2324	6C
C2332	8D	R896	2E	R1418	6C	R2327	7E
C2334	7D	R902	3B	R1419	6C	R2329	7D
C2336	7D	R904	3C	R1420	6B	R2332	8D
C2413	5E	R906	4C	R1425	6C	R2334	7D
C2432	6D	R908	4C	R1432	6B	R2338	7D
C2435	6D	R912	3B	R1434	6B	R2336	7D
C2436	6D	R914	3C	R1435	6B	R2337	7D
C2445	6E	R916	2C	R1436	6A	R2339	8D
C2721	3C	R918	2C	R1438	6B	R2340	7E
CR1060	3D	R920	2C	R1439	6B	R2341	7E
CR1062	3D	R940	2C	R1445	6B	R2343	7E
CR1319	7C	R946	2C	R1422	6B	R2347	7D
CR1465	5B	R990	2B	R1466	4B	R2351	7E
CR1541	5C	R992	2B	R1467	4B	R2353	6E
CR1543	5C	R1010	2C	R1470	4B	R2401	6E
CR2319	7E	R1012	2C	R1472	4B	R2403	6E
CR2476	4E	R1050	4D	R1474	5B	R2410	6E
CR2465	3E	R1052	4D	R1490	4B	R2411	6E
CR2496	4E	R1060	3D	R1492	4B	R2413	6E
CR2541	5D	R1062	2E	R1494	5B	R2415	6E
CR2543	5D	R1063	3D	R1498	5B	R2416	6E
J830	5D	R1065	3D	R1501	5C	R2418	6E
J840	4D	R1070	3D	R1503	5C	R2419	6E
J850	2D	R1072	3D	R1505	5B	R2420	6D
J860	2D	R1301	8C	R1511	5C	R2422	6D
J1301	8B	R1303	8C	R1512	5C	R2425	5E
J2301	8E	R1305	8C	R1514	5C	R2432	6D
L1445	5B	R1307	8B	R1516	5C	R2434	6D
L2445	5E	R1311	7C	R1517	6C	R2435	6D
		R1313	7C	R1519	5C	R2436	6D
		R1315	7C	R1520	4C	R2438	6D
LR1010	3D	R1315	7C	R1523	4C	R2439	6D
LR1014	3D	R1317	8C	R1525	4C	R2445	6E
LR1020	3D	R1319	7C	R1527	4C	R2466	4E
LR1024	3D	R1320	7B	R1711	4B	R2467	4E

A5 AMPLIFIER BOARD





CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C866	1D	Q920	2B	R1323	7B	R1712	3B	R2470	4E
C920	2B	Q940	2C	R1324	7A	R1714	3B	R2472	4E
C940	2C	Q1050	3E	R1327	7C	R1716	4B	R2474	5E
C1012	3D	Q1070	3E	R1329	7B	R1717	4B	R2476	4E
C1014	2D	Q1470	4B	R1332	8B	R1719	4B	R2490	4E
C1018	3D	Q1490	4B	R1334	7B	R1720	2B	R2492	4E
C1022	3D	Q2470	4E	R1336	7B	R1721	3B	R2494	5E
C1024	2D	Q2490	4E	R1337	7B	R1723	2B	R2496	4E
C1028	3D			R1338	7B	R2301	8E	R2498	3E
C1327	7C	R806	4D	R1339	8B	R2303	8E	R2501	5D
C1332	8B	R808	4D	R1340	7C	R2305	8E	R2503	5D
C1334	7B	R810	4D	R1341	7C	R2307	8D	R2505	5E
C1336	7B	R811	5D	R1343	7B	R2311	7E	R2511	4D
C1432	6B	R850	2D	R1347	7B	R2313	7E	R2512	4D
C1435	6B	R860	2D	R1351	7C	R2315	7E	R2514	4D
C1436	7B	R864	1D	R1353	6C	R2317	7E	R2516	4D
C1445	6C	R866	2D	R1401	6B	R2319	7E	R2517	4D
C1721	3B	R890	2E	R1403	6C	R2320	7D	R2519	4D
C2213	6E	R892	2E	R1413	6C	R2323	7D	R2520	5D
C2327	7E	R894	2E	R1416	6C	R2324	6C	R2523	5D
C2332	8D	R896	2E	R1418	6C	R2327	7E	R2525	5D
C2334	7D	R902	3B	R1419	6C	R2329	7D	R2527	5D
C2336	7D	R904	3C	R1420	6B	R2332	8D	R2711	3C
C2413	5E	R906	4C	R1425	6C	R2334	7D	R2712	3C
C2432	6D	R908	4C	R1432	6B	R2338	7D	R2714	3C
C2435	6D	R912	3B	R1434	6B	R2336	7D	R2716	3C
C2436	6D	R914	3C	R1435	6B	R2337	7D	R2717	3C
C2445	6E	R916	2C	R1436	6A	R2339	8D	R2719	3C
C2721	3C	R918	2C	R1438	6B	R2340	7E	R2720	3D
CR 1060	3D	R920	2C	R1439	6B	R2341	7E	R2721	3C
CR 1062	3D	R940	2C	R1445	6B	R2343	7E	R2723	3C
CR 1319	7C	R946	2C	R1466	4B	R2347	7D	R2854	1D
CR 1465	5B	R990	2B	R1467	4B	R2351	7E		
CR 1541	5C	R992	2B	R1470	4B	R2353	6E	RT1437	6B
CR 1543	5C	R1010	2C	R1472	4B	R2401	6E	RT2437	6D
CR 2319	7E	R1012	2C	R1474	4B	R2403	6E		
CR 2476	4E	R1050	4D	R1490	4B	R2410	6E	U1350	7B
CR 2465	3E	R1052	4D	R1492	4B	R2411	6E	U1450	6B
CR 2496	4E	R1060	3D	R1494	4B	R2413	6E	U1550	5C
CR 2541	5D	R1062	2E	R1498	5B	R2415	6E	U1750	3B
CR 2543	5D	R1063	3D	R1501	5C	R2416	6E	U2350	7E
		R1065	3D	R1503	5C	R2418	6E	U2450	6E
J830	5D	R1070	3D	R1505	5B	R2419	6E	U2550	5D
J840	4D	R1072	3D	R1511	5C	R2420	6D	U2750	3C
J850	2D	R1301	8C	R1512	5C	R2422	6D		
J860	2D	R1303	8C	R1514	5C	R2425	5E	VR850	2E
J1301	8B	R1305	8C	R1516	5C	R2432	6D	VR854	1D
J2301	8E	R1307	8B	R1517	6C	R2434	6D	VR860	2D
L1445	5B	R1311	7C	R1519	5C	R2435	6D	VR864	1E
L2445	5E	R1313	7C	R1520	4C	R2436	6D		
		R1315	7C	R1523	4C	R2438	6D		
LR 1010	3D	R1317	8C	R1525	4C	R2439	6D		
LR 1014	3D	R1319	7C	R1527	4C	R2445	6E		
LR 1020	3D	R1320	7B	R1711	4B	R2466	4E		
LR 1024	3D					R2467	4E		



ONENT
ON INDEX

VOLTAGES AND WAVEFORMS

The voltages and waveforms shown on this diagram were obtained by using the recommended test equipment and test set-ups listed below, except as noted.

RECOMMENDED TEST EQUIPMENT

ITEM	SPECIFICATIONS	RECOMMENDED TYPE
Oscilloscope system	Deflection factor 10 mV to 2 V/div. Input impedance 10 Megohms Frequency response dc to 25 MHz.	a. Tektronix 7000-series oscilloscope equipped with readout, 7B-series Time-Base, 7A15A Amplifier, and a 10X probe. (7A13 Differential Comparator used in place of 7A15A for calibrated offset voltages.)
Voltmeter (Non-loading digital multimeter)	Input impedance 10 Megohms Range (full scale) 2 V to 20 V	a. Tektronix 7D13 Digital Multimeter (oscilloscope system must have readout). b. Fairchild Model 7050, or equivalent.
Plug-in extender	Capable of extending the 7A24 from the oscilloscope plug-in compartment	a. Tektronix Part No. 067-0589-00 (rigid) or Tektronix Part No. 067-0616-00 (flexible).

7A24 Control Settings

CH 1 and CH 2 VOLTS/DIV	5 mV
CH 1 and CH 2 Input switches	DC
CH 1 and CH 2 POSITION	center trace on graticule
DISPLAY MODE	CH 1
TRIGGER SOURCE	MODE
CH 2 POLARITY	+ UP

Voltage Conditions

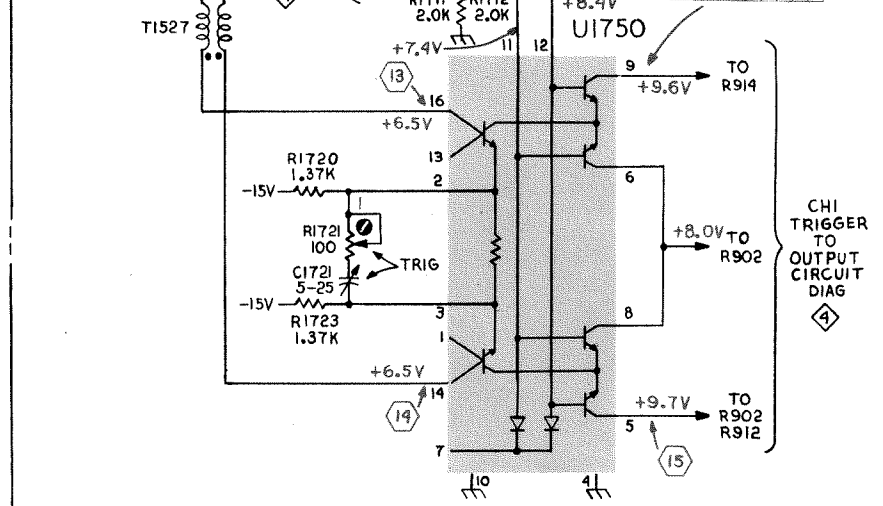
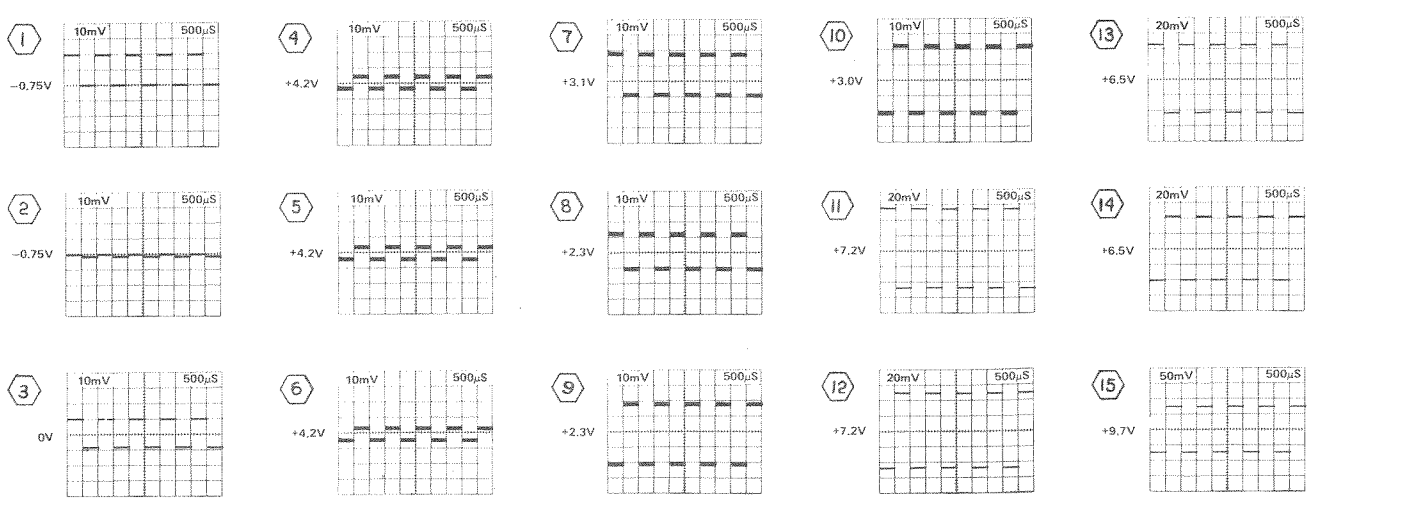
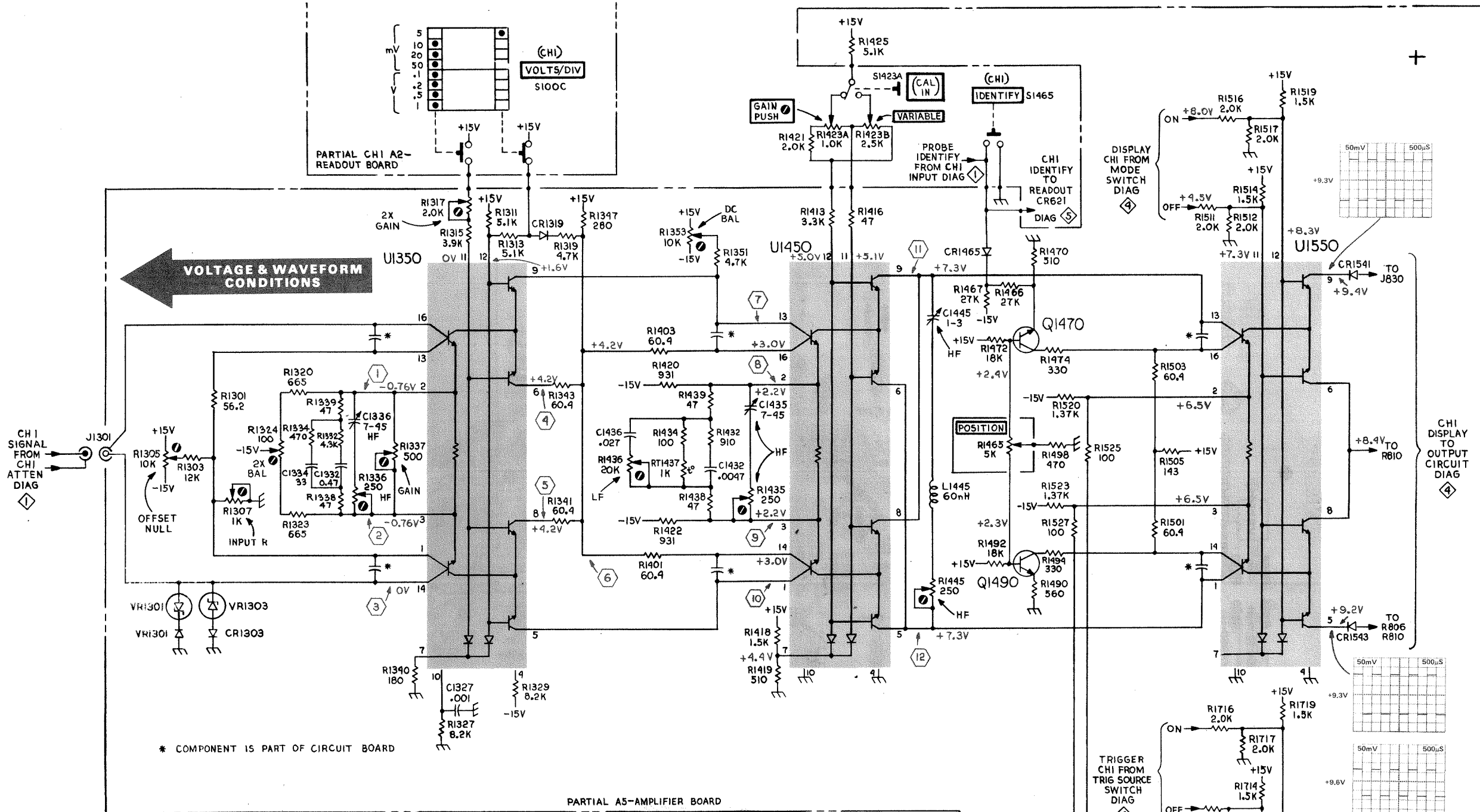
Voltage measurements are taken with no signal applied and the trace centered on the graticule. The voltmeter common is connected to chassis ground. The 7A24 is connected to one of the vertical compartments of the oscilloscope mainframe through the plug-in extender. The 7D13, if used, is inserted into the other vertical compartment.

Waveform Conditions

The 7A24 is connected to one of the vertical compartments of the oscilloscope mainframe through the plug-in extender. The amplifier plug-in, 7A15A or 7A13, is inserted into the other vertical compartment. A 1-kilohertz, 40 millivolt (20 mV, into 50 Ω) signal is applied to the CH 1 input of the 7A24. The oscilloscope Trigger Source is set to trigger the time-base unit from the 7A24 output.

If the 7A15A Amplifier plug-in is used, the input should be ac coupled.

Tolerances of the voltages and waveforms shown are $\pm 20\%$.



TA24

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CH1 AMPLIFIER ②

CH 1 AMPLIFIER ②

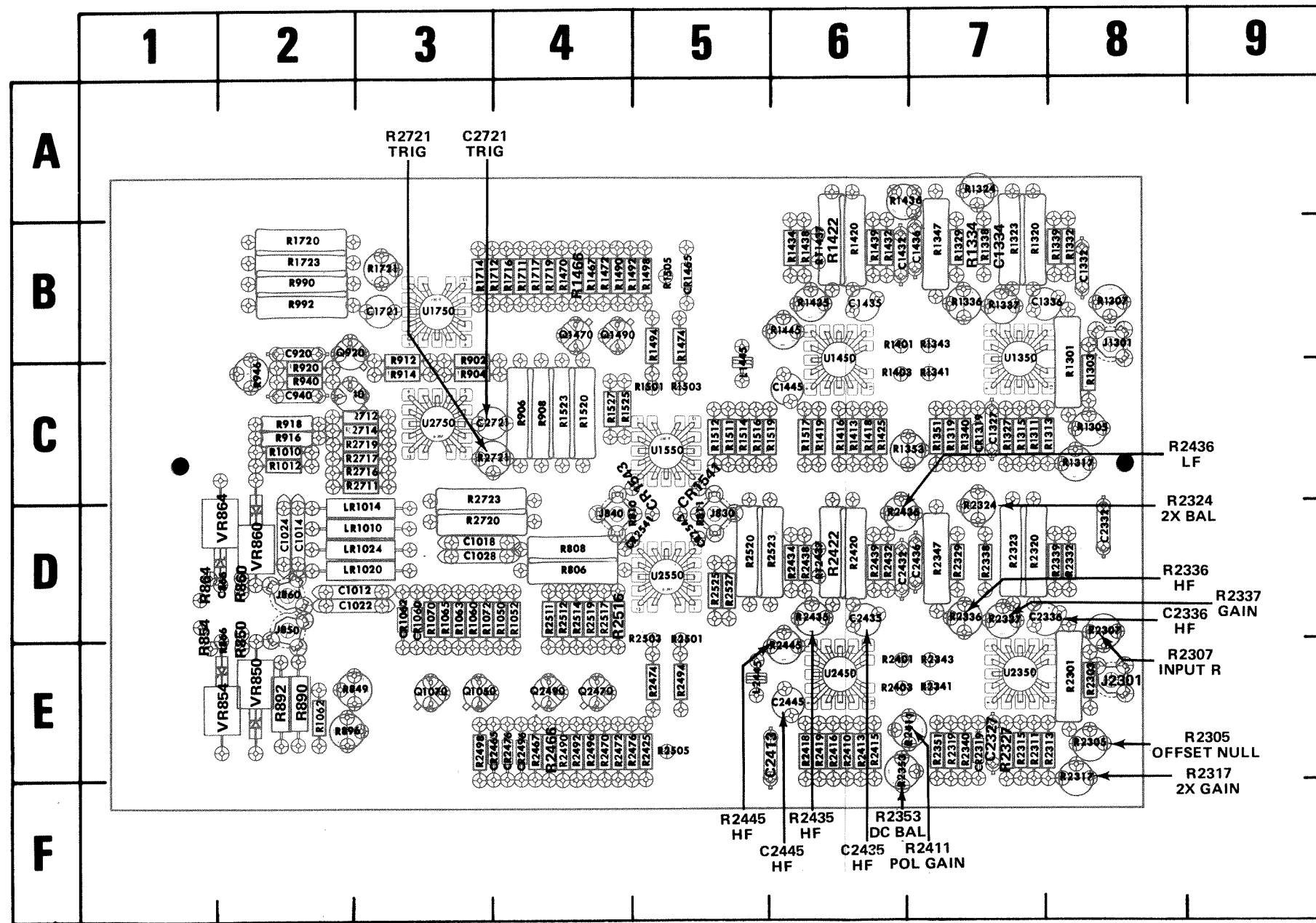
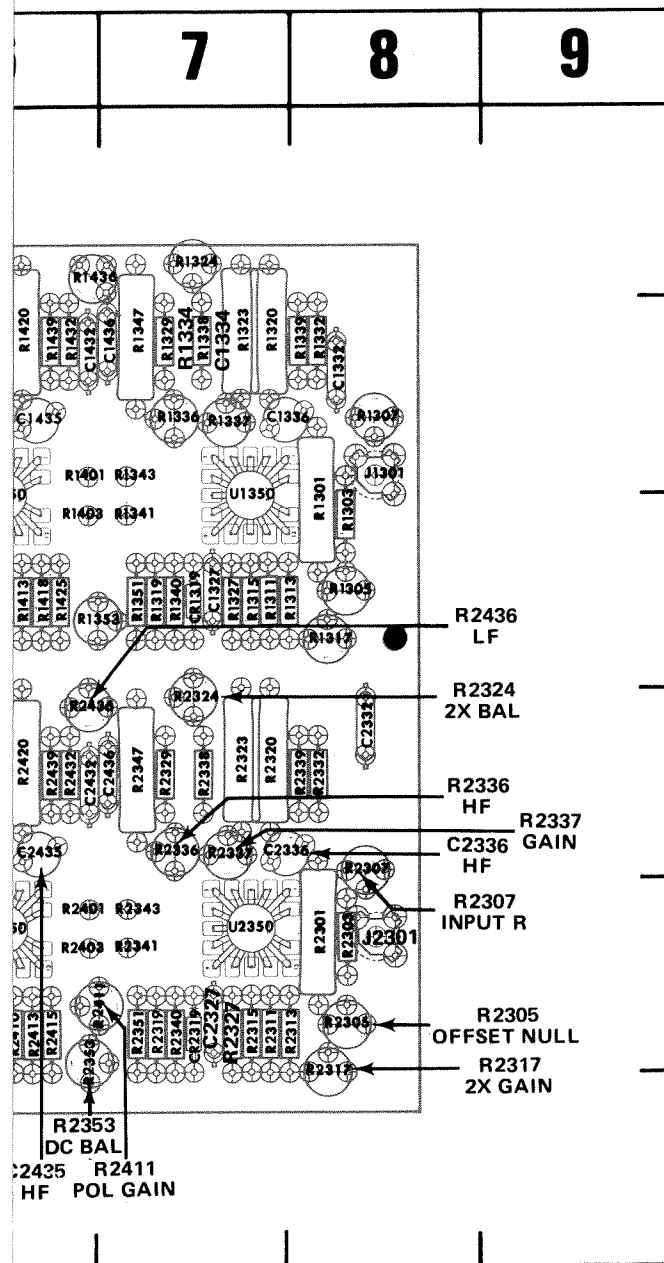


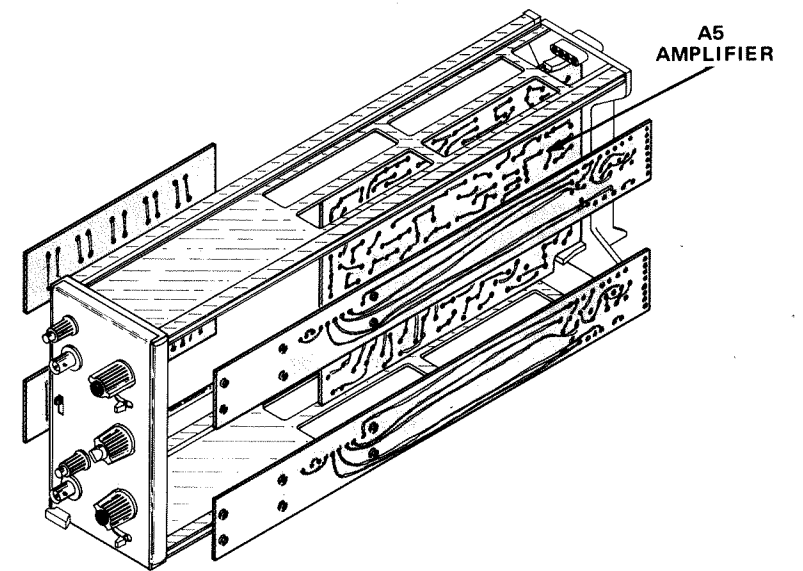
Fig. 7-5. A5—Amplifier circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C866	1D	Q920	2B	R1323	7B	R1712	3B	R2445	6E
C920	2B	Q940	2C	R1324	7A	R1714	3B	R2446	4E
C940	2C	Q1050	3E	R1327	7C	R1716	4B	R2466	4E
C1012	3D	Q1070	3E	R1329	7B	R1717	4B	R2467	4E
C1014	2D	Q1470	4B	R1332	8B	R1719	4B	R2472	4E
C1018	3D	Q1490	4B	R1334	7B	R1720	2B	R2476	4E
C1022	3D	Q2470	4E	R1336	7B	R1721	3B	R2477	4E
C1024	2D	Q2490	4E	R1337	7B	R1723	2B	R2478	4E
C1028	3D			R1338	7B	R2301	8E	R2479	4E
C1327	7C	R806	4D	R1339	8B	R2303	8E	R2480	4E
C1332	8B	R808	4D	R1340	7C	R2305	8E	R2481	4E
C1334	7B	R810	4D	R1341	7C	R2307	8D	R2482	4E
C1336	7B	R811	5D	R1343	7B	R2311	7E	R2483	4E
C1432	6B	R850	2D	R1347	7B	R2313	7E	R2484	4E
C1435	6B	R860	2D	R1351	7C	R2315	7E	R2485	4E
C1436	7B	R864	1D	R1353	6C	R2317	7E	R2486	4E
C1445	6C	R866	2D	R1401	6B	R2319	7E	R2487	4E
C1721	3B	R890	2E	R1403	6C	R2320	7D	R2488	4E
C2213	6E	R892	2E	R1413	6C	R2323	7D	R2489	4E
C2327	7E	R894	2E	R1416	6C	R2324	6C	R2490	4E
C2332	8D	R896	2E	R1418	6C	R2327	7E	R2491	4E
C2334	7D	R902	3B	R1419	6C	R2329	7D	R2492	4E
C2336	7D	R904	3C	R1420	6B	R2332	8D	R2493	4E
C2413	5E	R906	4C	R1425	6C	R2334	7D	R2494	4E
C2432	6D	R908	4C	R1432	6B	R2336	7D	R2495	4E
C2435	6D	R912	3B	R1434	6B	R2337	7D	R2496	4E
C2436	6D	R914	3C	R1435	6B	R2339	8D	R2497	4E
C2445	6E	R916	2C	R1436	6A	R2340	7E	R2498	4E
C2721	3C	R918	2C	R1438	6B	R2341	7E	R2499	4E
CR 1060	3D	R920	2C	R1439	6B	R2343	7E	R2500	4E
CR 1062	3D	R940	2C	R1445	6B	R2347	7D	R2501	4E
CR 1319	7C	R946	2C	R1422	6B	R2351	7E	R2502	4E
CR 1465	5B	R990	2B	R1466	4B	R2353	7E	R2503	4E
CR 1541	5C	R992	2B	R1467	4B	R2355	6E	R2504	4E
CR 1543	5C	R1010	2C	R1470	4B	R2357	6E	R2505	4E
CR 2319	7E	R1012	2C	R1472	4B	R2410	6E	R2506	4E
CR 2476	4E	R1050	4D	R1474	5B	R2411	6E	R2507	4E
CR 2465	3E	R1052	4D	R1490	4B	R2413	6E	R2508	4E
CR 2496	4E	R1060	3D	R1492	4B	R2415	6E	R2509	4E
CR 2541	5D	R1062	2E	R1498	5B	R2416	6E	R2510	4E
CR 2543	5D	R1063	3D	R1501	5C	R2418	6E	R2511	4E
J830	5D	R1065	3D	R1503	5C	R2419	6E	R2512	4E
J840	4D	R1070	3D	R1505	5B	R2420	6D	R2513	4E
J850	2D	R1072	3D	R1511	5C	R2422	6D	R2514	4E
J860	2D	R1301	8C	R1512	5C	R2425	5E	R2515	4E
J1301	8B	R1303	8C	R1514	5C	R2432	6D	R2516	4E
J2301	8E	R1305	8C	R1516	5C	R2434	6D	R2517	4E
L1445	5B	R1307	8B	R1517	6C	R2435	6D	R2518	4E
L2445	5E	R1311	7C	R1519	5C	R2436	6D	R2519	4E
		R1313	7C	R1520	4C	R2438	6D	R2520	4E
LR 1010	3D	R1315	7C	R1523	4C	R2439	6D	R2521	4E
LR 1014	3D	R1317	8C	R1525	4C	R2445	6E	R2522	4E
LR 1020	3D	R1319	7C	R1527	4C	R2466	4E	R2523	4E
LR 1024	3D	R1320	7B	R1711	4B	R2467	4E	R2524	4E





CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C866	1D	Q920	2B	R1323	7B	R1712	3B	R2470	4E
C920	2B	Q940	2C	R1324	7A	R1714	3B	R2472	4E
C940	2C	Q1050	3E	R1327	7C	R1716	4B	R2474	5E
C1012	3D	Q1070	3E	R1329	7B	R1717	4B	R2476	4E
C1014	2D	Q1470	4B	R1332	8B	R1719	4B	R2490	4E
C1018	3D	Q1490	4B	R1334	7B	R1720	2B	R2492	4E
C1022	3D	Q2470	4E	R1336	7B	R1721	3B	R2494	5E
C1024	2D	Q2490	4E	R1337	7B	R1723	2B	R2496	4E
C1028	3D			R1338	7B	R2301	8E	R2498	3E
C1327	7C	R806	4D	R1339	8B	R2303	8E	R2501	5D
C1332	8B	R808	4D	R1340	7C	R2305	8E	R2503	5D
C1334	7B	R810	4D	R1341	7C	R2307	8D	R2505	5E
C1336	7B	R811	5D	R1343	7B	R2311	7E	R2511	4D
C1432	6B	R850	2D	R1347	7B	R2313	7E	R2512	4D
C1435	6B	R860	2D	R1351	7C	R2315	7E	R2514	4D
C1436	7B	R864	1D	R1353	6C	R2317	7E	R2516	4D
C1445	6C	R866	2D	R1401	6B	R2319	7E	R2517	4D
C1721	3B	R890	2E	R1403	6C	R2320	7D	R2519	4D
C2213	6E	R892	2E	R1413	6C	R2323	7D	R2520	5D
C2327	7E	R894	2E	R1416	6C	R2324	6C	R2523	5D
C2332	8D	R896	2E	R1418	6C	R2327	7E	R2525	5D
C2334	7D	R902	3B	R1419	6C	R2329	7D	R2527	5D
C2336	7D	R904	3C	R1420	6B	R2332	8D	R2711	3C
C2413	5E	R906	4C	R1425	6C	R2334	7D	R2712	3C
C2432	6D	R908	4C	R1432	6B	R2338	7D	R2714	3C
C2435	6D	R912	3B	R1434	6B	R2336	7D	R2716	3C
C2436	6D	R913	3B	R1435	6B	R2337	7D	R2717	3C
C2445	6E	R914	3C	R1436	6A	R2339	8D	R2719	3C
C2721	3C	R916	2C	R1438	6B	R2340	7E	R2720	3D
CR1060	3D	R918	2C	R1439	6B	R2341	7E	R2721	3C
CR1062	3D	R920	2C	R1445	6B	R2343	7E	R2723	3C
CR1319	7C	R940	2C	R1446	4B	R2347	7D	R2854	1D
CR1465	5B	R946	2C	R1466	4B	R2351	7E		
CR1541	5C	R990	2B	R1467	4B	R2353	6E	RT1437	6B
CR1543	5C	R992	2B	R1470	4B	R2401	6E	RT2437	6D
CR2319	7E	R1010	2C	R1472	4B	R2403	6E		
CR2476	4E	R1012	2C	R1474	5B	R2410	6E	U1350	7B
CR2465	3E	R1050	4D	R1490	4B	R2411	6E	U1450	6B
CR2496	4E	R1052	4D	R1492	4B	R2413	6E	U1550	5C
CR2541	5D	R1060	3D	R1494	5B	R2415	6E	U1750	3B
CR2543	5D	R1062	2E	R1498	5B	R2416	6E	U2350	7E
		R1063	3D	R1501	5C	R2418	6E	U2450	6E
J830	5D	R1065	3D	R1503	5C	R2419	6E	U2550	5D
J840	4D	R1070	3D	R1505	5B	R2420	6D	U2750	3C
J850	2D	R1072	3D	R1511	5C	R2422	6D		
J860	2D	R1301	8C	R1512	5C	R2425	5E	VR850	2E
J1301	8B	R1303	8C	R1514	5C	R2432	6D	VR854	1D
J2301	8E	R1305	8C	R1516	5C	R2434	6D	VR860	2D
L1445	5B	R1307	8B	R1517	6C	R2435	6D	VR864	1E
L2445	5E	R1311	7C	R1519	5C	R2436	6D		
		R1313	7C	R1520	4C	R2438	6D		
LR1010	3D	R1315	7C	R1523	4C	R2439	6D		
LR1014	3D	R1317	8C	R1525	4C	R2445	6E		
LR1020	3D	R1319	7C	R1527	4C	R2466	4E		
LR1024	3D	R1320	7B	R1711	4B	R2467	4E		



ENT

 INDEX

VOLTAGES AND WAVEFORMS

The voltages and waveforms shown on this diagram were obtained by using the recommended test equipment and test set-ups listed below, except as noted.

RECOMMENDED TEST EQUIPMENT

ITEM	SPECIFICATIONS	RECOMMENDED TYPE
Oscilloscope system	Deflection factor 10 mV to 2 V/div. Input impedance 10 Megohms Frequency response dc to 25 MHz.	a. Tektronix 7000-series oscilloscope equipped with readout, 7B-series Time-Base, 7A15A Amplifier, and a 10X probe. (7A13 Differential Comparator used in place of 7A15A for calibrated offset voltages.)
Voltmeter (Non-loading digital multimeter)	Input impedance 10 Megohms Range (full scale) 2 V to 20 V	a. Tektronix 7D13 Digital Multimeter (oscilloscope system must have readout). b. Fairchild Model 7050, or equivalent.
Plug-in extender	Capable of extending the 7A24 from the oscilloscope plug-in compartment	a. Tektronix Part No. 067-0589-00 (rigid) or Tektronix Part No. 067-0616-00 (flexible).

7A24 Control Settings

CH 1 and CH 2 VOLTS/DIV	5 mV
CH 1 and CH 2 Input switches	DC
CH 1 and CH 2 POSITION	center trace on graticule
DISPLAY MODE	CH 2
TRIGGER SOURCE	MODE
CH 2 POLARITY	+ UP

Voltage Conditions

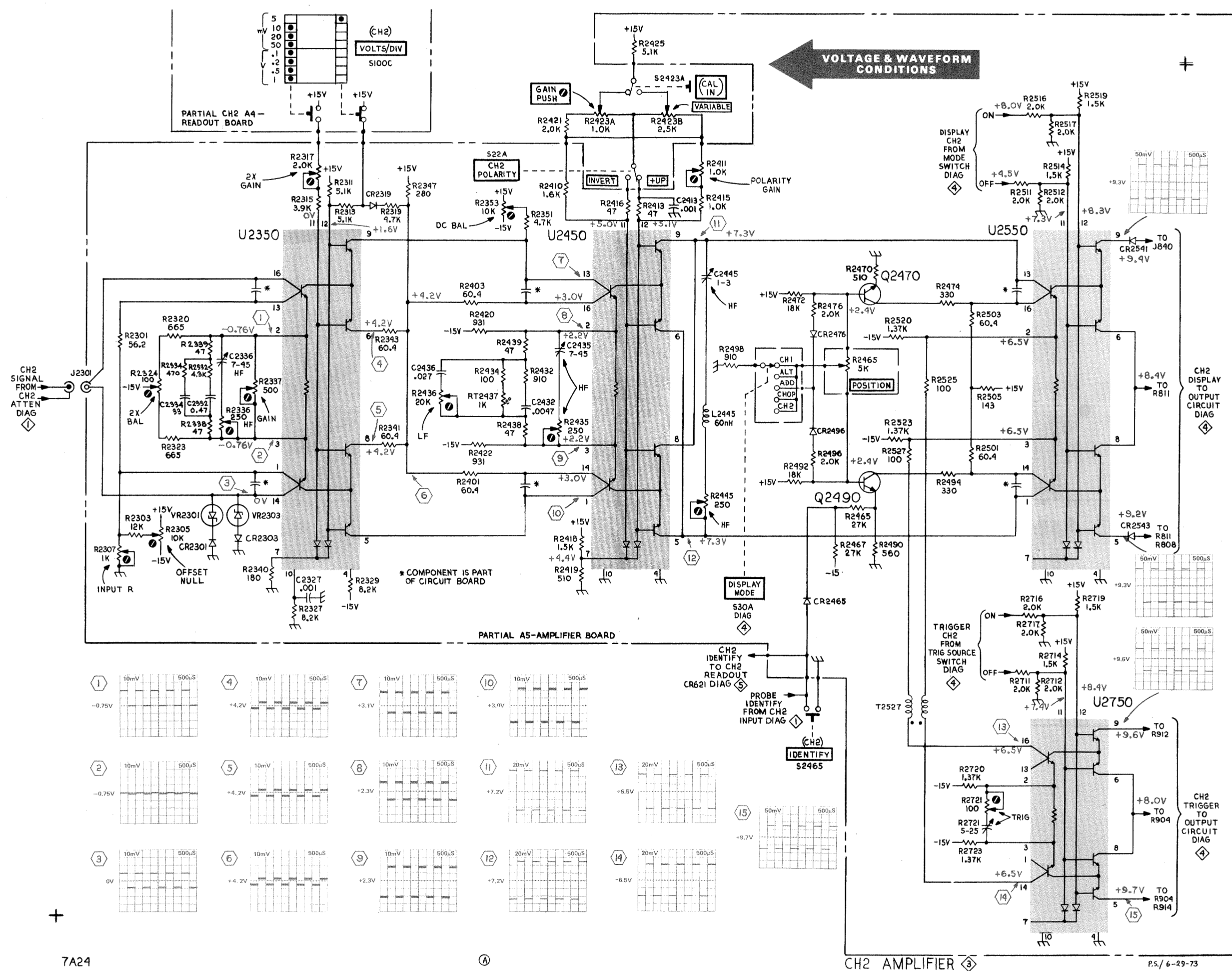
Voltage measurements are taken with no signal applied and the trace centered on the graticule. The voltmeter common is connected to chassis ground. The 7A24 is connected to one of the vertical compartments of the oscilloscope mainframe through the plug-in extender. The 7D13, if used, is inserted into the other vertical compartment.

Waveform Conditions

The 7A24 is connected to one of the vertical compartments of the oscilloscope mainframe through the plug-in extender. The amplifier plug-in, 7A15A or 7A13, is inserted into the other vertical compartment. A 1-kilohertz, 40 millivolt (20 mV, into 50 Ω) signal is applied to the CH 1 input of the 7A24. The oscilloscope Trigger Source is set to trigger the time-base unit from the 7A24 output.

If the 7A15A Amplifier plug-in is used, the input should be ac coupled.

Tolerances of the voltages and waveforms shown are $\pm 20\%$.



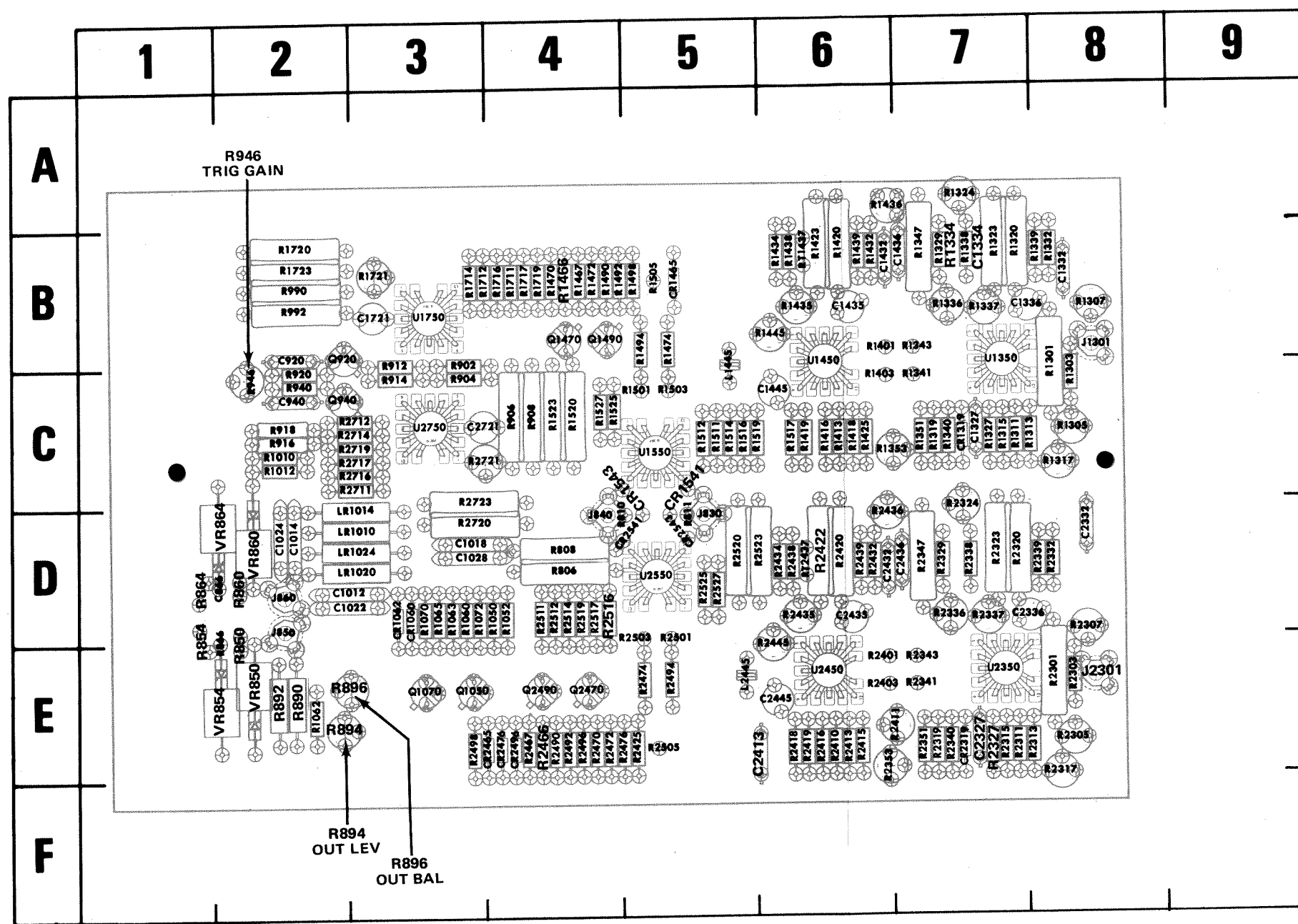
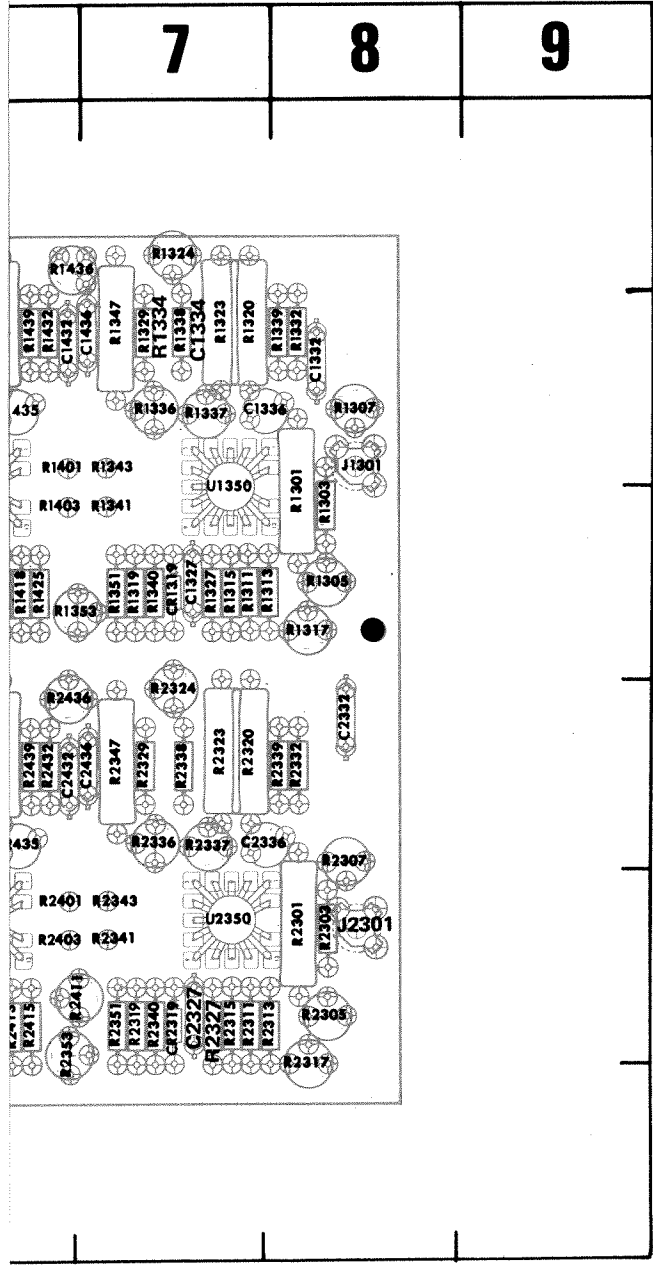


Fig. 7-6. A5-Amplifier circuit board.

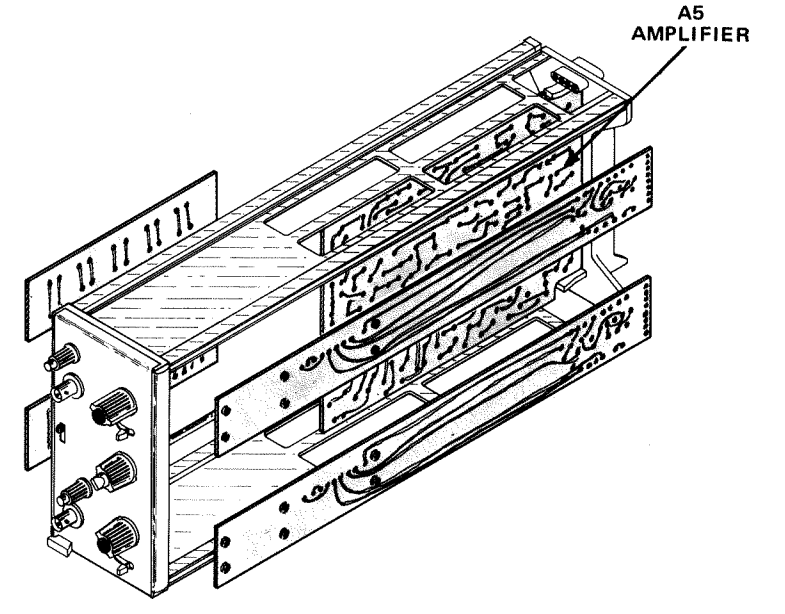
COMPONENT
LOCATION INDEX



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C866	1D	Q920	2B	R1323	7B	R1712	3B	R2470	4E
C920	2B	Q940	2C	R1324	7A	R1714	3B	R2472	4E
C940	2C	Q1050	3E	R1327	7C	R1716	4B	R2474	5E
C1012	3D	Q1070	3E	R1329	7B	R1717	4B	R2476	4E
C1014	2D	Q1470	4B	R1332	8B	R1719	4B	R2490	4E
C1018	3D	Q1490	4B	R1334	7B	R1720	2B	R2492	4E
C1022	3D	Q2470	4E	R1336	7B	R1721	3B	R2494	5E
C1024	2D	Q2490	4E	R1337	7B	R1723	2B	R2496	4E
C1028	3D			R1338	7B	R2301	8E	R2498	3E
C1327	7C	R806	4D	R1339	8B	R2303	8E	R2501	5D
C1332	8B	R808	4D	R1340	7C	R2305	8E	R2503	5D
C1334	7B	R810	4D	R1341	7C	R2307	8D	R2505	5E
C1336	7B	R811	5D	R1343	7B	R2311	7E	R2511	4D
C1432	6B	R850	2D	R1347	7B	R2313	7E	R2512	4D
C1435	6B	R860	2D	R1351	7C	R2315	7E	R2514	4D
C1436	7B	R864	1D	R1353	6C	R2317	7E	R2516	4D
C1445	6C	R866	2D	R1401	6B	R2319	7E	R2517	4D
C1721	3B	R890	2E	R1403	6C	R2320	7D	R2519	4D
C2213	6E	R892	2E	R1413	6C	R2322	7D	R2520	5D
C2327	7E	R894	2E	R1416	6C	R2324	6C	R2523	5D
C2332	8D	R896	2E	R1418	6C	R2327	7E	R2525	5D
C2334	7D	R902	3B	R1419	6C	R2329	7D	R2527	5D
C2336	7D	R904	3C	R1420	6B	R2332	8D	R2711	3C
C2413	5E	R906	4C	R1425	6C	R2334	7D	R2712	3C
C2432	6D	R908	4C	R1432	6B	R2338	7D	R2714	3C
C2435	6D	R912	3B	R1434	6B	R2336	7D	R2716	3C
C2436	6D	R914	3C	R1435	6B	R2337	7D	R2717	3C
C2445	6E	R916	2C	R1436	6A	R2339	8D	R2719	3C
C2721	3C	R918	2C	R1438	6B	R2340	7E	R2720	3D
CR 1060	3D	R920	2C	R1439	6B	R2341	7E	R2721	3C
CR 1062	3D	R940	2C	R1445	6B	R2343	7E	R2723	3C
CR 1319	7C	R946	2C	R1466	4B	R2347	7D	R2854	1D
CR 1465	5B	R990	2B	R1467	4B	R2351	7E		
CR 1541	5C	R992	2B	R1470	4B	R2353	6E	RT 1437	6E
CR 1543	5C	R1010	2C	R1472	4B	R2401	6E	RT 2437	6D
CR 2319	7E	R1012	2C	R1474	5B	R2403	6E		
CR 2476	4E	R1050	4D	R1490	4B	R2410	6E	U1350	7E
CR 2465	3E	R1052	4D	R1492	4B	R2411	6E	U1450	6E
CR 2496	4E	R1060	3D	R1494	5B	R2413	6E	U1550	5D
CR 2541	5D	R1062	2E	R1498	5B	R2415	6E	U1750	3E
CR 2543	5D	R1063	3D	R1501	5C	R2416	6E	U2350	7E
J830	5D	R1065	3D	R1503	5C	R2418	6E	U2450	5E
J840	4D	R1070	3D	R1505	5B	R2419	6E	U2550	6D
J850	2D	R1072	3D	R1511	5C	R2420	6D	U2750	3D
J860	2D	R1301	8C	R1512	5C	R2422	6D		
J1301	8B	R1303	8C	R1514	5C	R2425	5E	VR850	2D
J2301	8E	R1305	8C	R1516	5C	R2432	6D	VR854	1D
L1445	5B	R1307	8B	R1517	6C	R2434	6D	VR860	2D
L2445	5E	R1311	7C	R1519	5C	R2435	6D	VR864	1D
		R1313	7C	R1520	4C	R2436	6D		
LR 1010	3D	R1315	7C	R1523	4C	R2438	6D		
LR 1014	3D	R1317	8C	R1525	4C	R2439	6D		
LR 1020	3D	R1319	7C	R1527	4C	R2445	6E		
LR 1024	3D	R1320	7B	R1711	4B	R2466	4E		
						R2467	4E		



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C866	1D	Q920	2B	R1323	7B	R1712	3B	R2470	4E
C920	2B	Q940	2C	R1324	7A	R1714	3B	R2472	4E
C940	2C	Q1050	3E	R1327	7C	R1716	4B	R2474	5E
C1012	3D	Q1070	3E	R1329	7B	R1717	4B	R2476	4E
C1014	2D	Q1470	4B	R1332	8B	R1719	4B	R2490	4E
C1018	3D	Q1490	4B	R1334	7B	R1720	2B	R2492	4E
C1022	3D	Q2470	4E	R1336	7B	R1721	3B	R2494	5E
C1024	2D	Q2490	4E	R1337	7B	R1723	2B	R2496	4E
C1028	3D			R1338	7B	R2301	8E	R2498	3E
C1327	7C	R806	4D	R1339	8B	R2303	8E	R2501	5D
C1332	8B	R808	4D	R1340	7C	R2305	8E	R2503	5D
C1334	7B	R810	4D	R1341	7C	R2307	8D	R2505	5E
C1336	7B	R811	5D	R1343	7B	R2311	7E	R2511	4D
C1432	6B	R850	2D	R1347	7B	R2313	7E	R2512	4D
C1435	6B	R860	2D	R1351	7C	R2315	7E	R2514	4D
C1436	7B	R864	1D	R1353	6C	R2317	7E	R2516	4D
C1445	6C	R866	2D	R1401	6B	R2319	7E	R2517	4D
C1721	3B	R890	2E	R1403	6C	R2320	7D	R2519	4D
C2213	6E	R892	2E	R1413	6C	R2323	7D	R2520	5D
C2327	7E	R894	2E	R1416	6C	R2324	6C	R2523	5D
C2332	8D	R896	2E	R1418	6C	R2327	7E	R2525	5D
C2334	7D	R902	3B	R1419	6C	R2329	7D	R2527	5D
C2336	7D	R904	3C	R1420	6B	R2332	8D	R2711	3C
C2413	5E	R906	4C	R1425	6C	R2334	7D	R2712	3C
C2432	6D	R908	4C	R1432	6B	R2338	7D	R2714	3C
C2435	6D	R912	3B	R1434	6B	R2336	7D	R2716	3C
C2436	6D	R914	3C	R1435	6B	R2337	7D	R2717	3C
C2445	6E	R916	2C	R1436	6A	R2339	8D	R2719	3C
C2721	3C	R918	2C	R1438	6B	R2340	7E	R2720	3D
CR1060	3D	R920	2C	R1439	6B	R2341	7E	R2721	3C
CR1062	3D	R940	2C	R1445	6B	R2343	7E	R2723	3C
CR1319	7C	R946	2C	R1422	6B	R2347	7D	R2854	1D
CR1465	5B	R990	2B	R1466	4B	R2351	7E	RT1437	6B
CR1541	5C	R992	2B	R1467	4B	R2353	6E	RT2437	6D
CR1543	5C	R1010	2C	R1470	4B	R2401	6E	U1350	7B
CR2319	7E	R1012	2C	R1472	4B	R2403	6E	U1450	6B
CR2476	4E	R1050	4D	R1474	5B	R2410	6E	U1550	5C
CR2465	3E	R1052	4D	R1490	4B	R2411	6E	U1750	3B
CR2496	4E	R1060	3D	R1492	4B	R2413	6E	U2350	7E
CR2541	5D	R1062	2E	R1494	5B	R2415	6E	U2450	6E
CR2543	5D	R1063	3D	R1498	5B	R2416	6E	U2550	5D
J830	5D	R1065	3D	R1501	5C	R2418	6E	U2750	3C
J840	4D	R1070	3D	R1503	5C	R2419	6E	VR850	2E
J850	2D	R1072	3D	R1505	5B	R2420	6D	VR854	1D
J860	2D	R1301	8C	R1511	5C	R2422	6D	VR860	2D
J1301	8B	R1303	8C	R1512	5C	R2425	5E	VR864	1E
J2301	8E	R1305	8C	R1514	5C	R2432	6D		
L1445	5B	R1307	8B	R1516	5C	R2434	6D		
L2445	5E	R1311	7C	R1517	6C	R2436	6D		
LR1010	3D	R1313	7C	R1519	5C	R2438	6D		
LR1014	3D	R1315	7C	R1520	4C	R2439	6D		
LR1020	3D	R1317	8C	R1523	4C	R2445	6E		
LR1024	3D	R1319	7C	R1525	4C	R2466	4E		
		R1320	7B	R1527	4C	R2467	4E		
				R1711	4B				



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VOLTAGES AND WAVEFORMS

The voltages and waveforms shown on this diagram were obtained by using the recommended test equipment and test set-ups listed below, except as noted.

RECOMMENDED TEST EQUIPMENT

ITEM	SPECIFICATIONS	RECOMMENDED TYPE
Oscilloscope system	Deflection factor 10 mV to 2 V/div. Input impedance 10 Megohms Frequency response dc to 25 MHz.	a. Tektronix 7000-series oscilloscope equipped with readout, 7B-series Time-Base, 7A15A Amplifier, and a 10X probe. (7A13 Differential Comparator used in place of 7A15A for calibrated offset voltages.)
Voltmeter (Non-loading digital multimeter)	Input impedance 10 Megohms Range (full scale) 2 V to 20 V	a. Tektronix 7D13 Digital Multimeter (oscilloscope system must have readout). b. Fairchild Model 7050, or equivalent.
Plug-in extender	Capable of extending the 7A24 from the oscilloscope plug-in compartment	a. Tektronix Part No. 067-0589-00 (rigid) or Tektronix Part No. 067-0616-00 (flexible).

7A24 Control Settings

CH 1 and CH 2 VOLTS/DIV	5 mV
CH 1 and CH 2 Input switches	DC
CH 1 and CH 2 POSITION	center trace on graticule
DISPLAY MODE	CH 1
TRIGGER SOURCE	MODE
CH 2 POLARITY	+ UP

Voltage Conditions

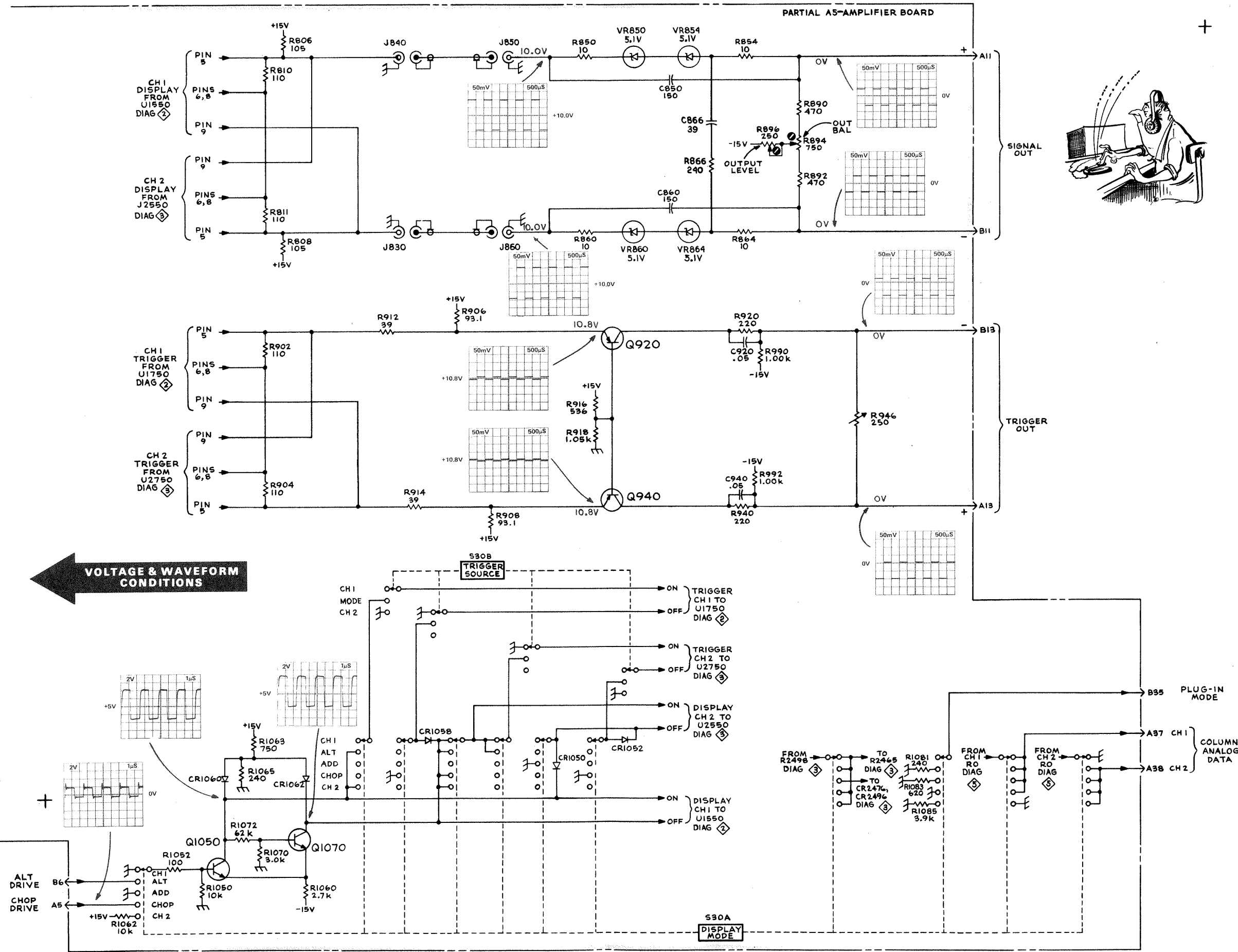
Voltage measurements are taken with no signal applied and the trace centered on the graticule. The voltmeter common is connected to chassis ground. The 7A24 is connected to one of the vertical compartments of the oscilloscope mainframe through the plug-in extender. The 7D13, if used, is inserted into the other vertical compartment.

Waveform Conditions

The 7A24 is connected to one of the vertical compartments of the oscilloscope mainframe through the plug-in extender. The amplifier plug-in, 7A15A or 7A13, is inserted into the other vertical compartment. A 1-kilohertz, 40 millivolt (20 mV, into 50 Ω) signal is applied to the CH 1 input of the 7A24. The oscilloscope Trigger Source is set to trigger the time-base unit from the 7A24 output.

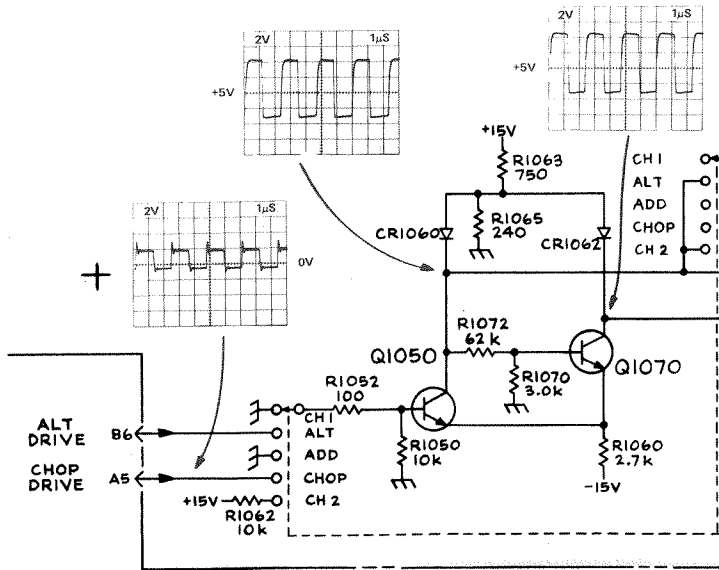
If the 7A15A Amplifier plug-in is used, the input should be ac coupled.

Tolerances of the voltages and waveforms shown are $\pm 20\%$.



DISPLAY SWITCHING AND OUTPUT 4

VOLTAGE & WAVEFORM CONDITIONS



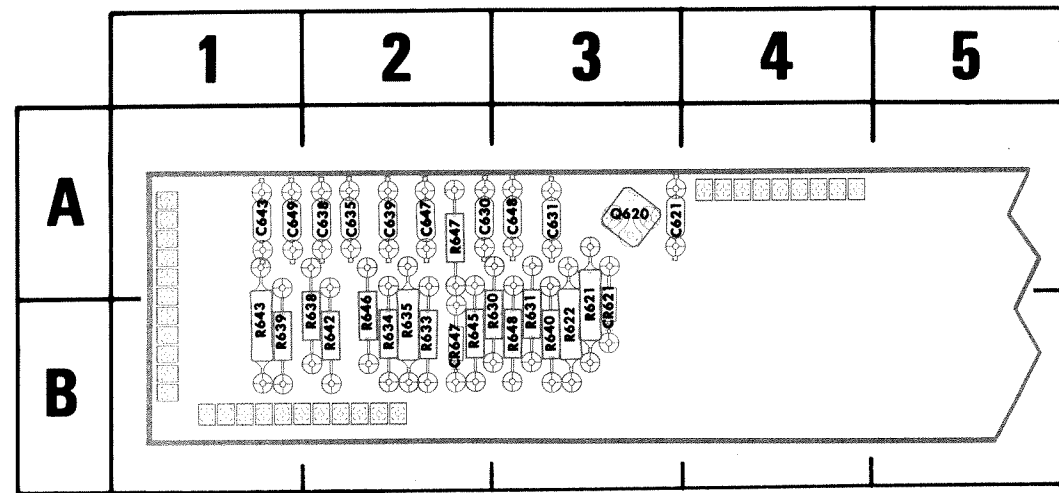
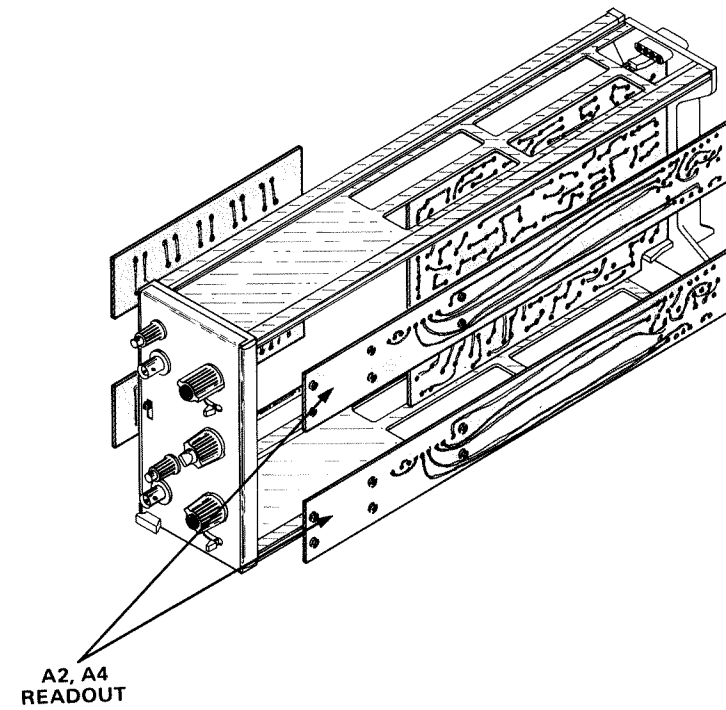
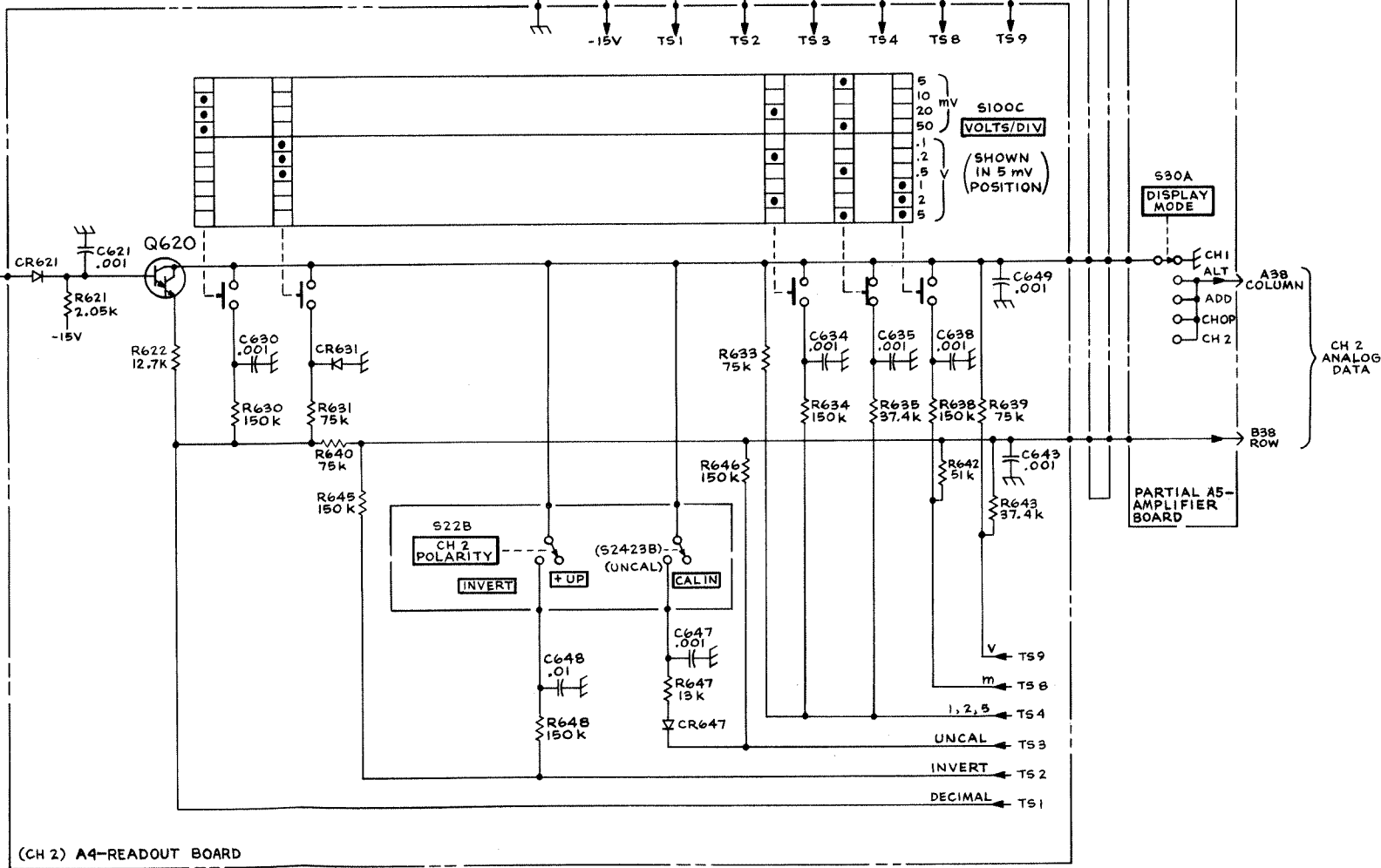
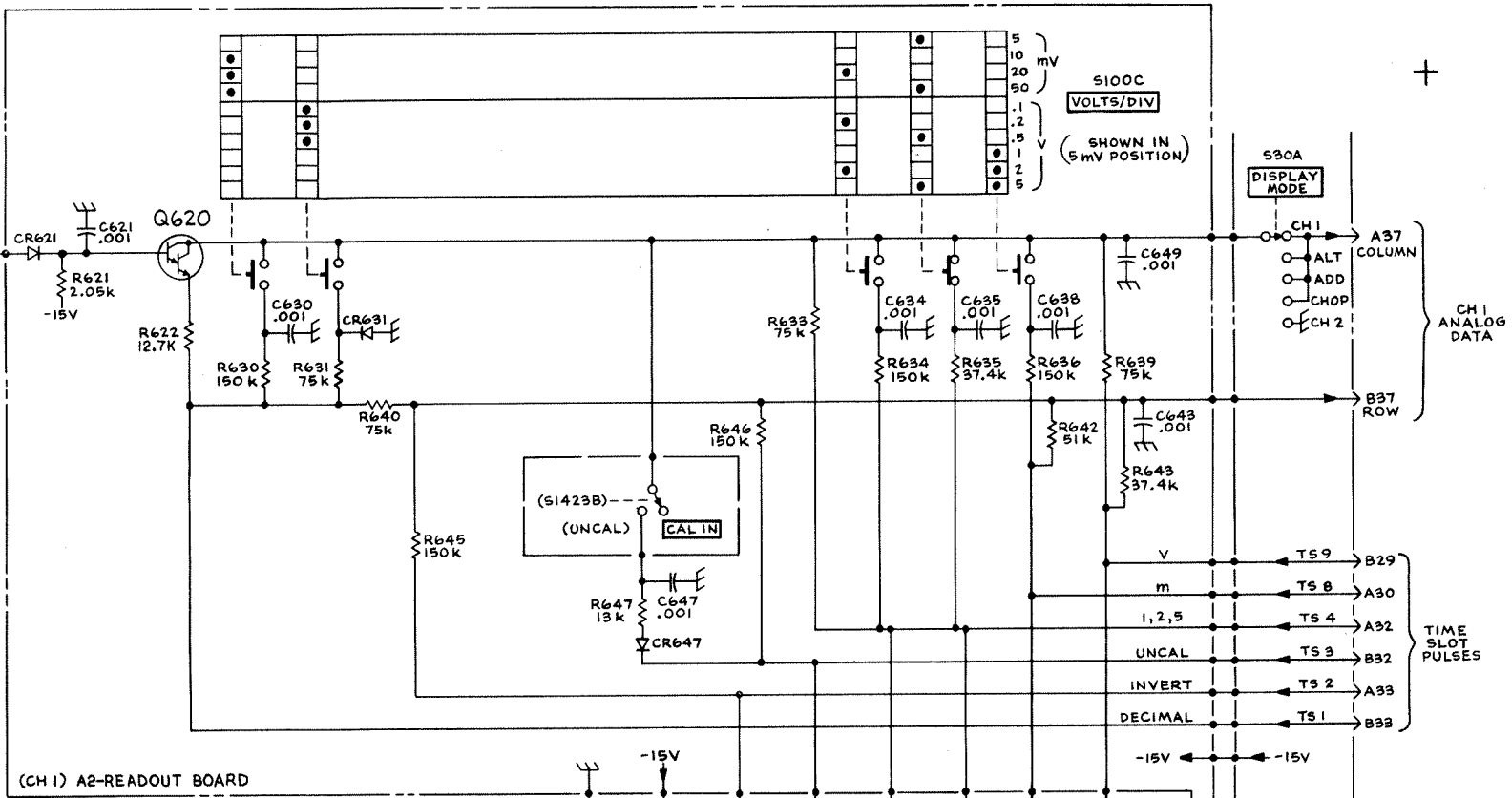
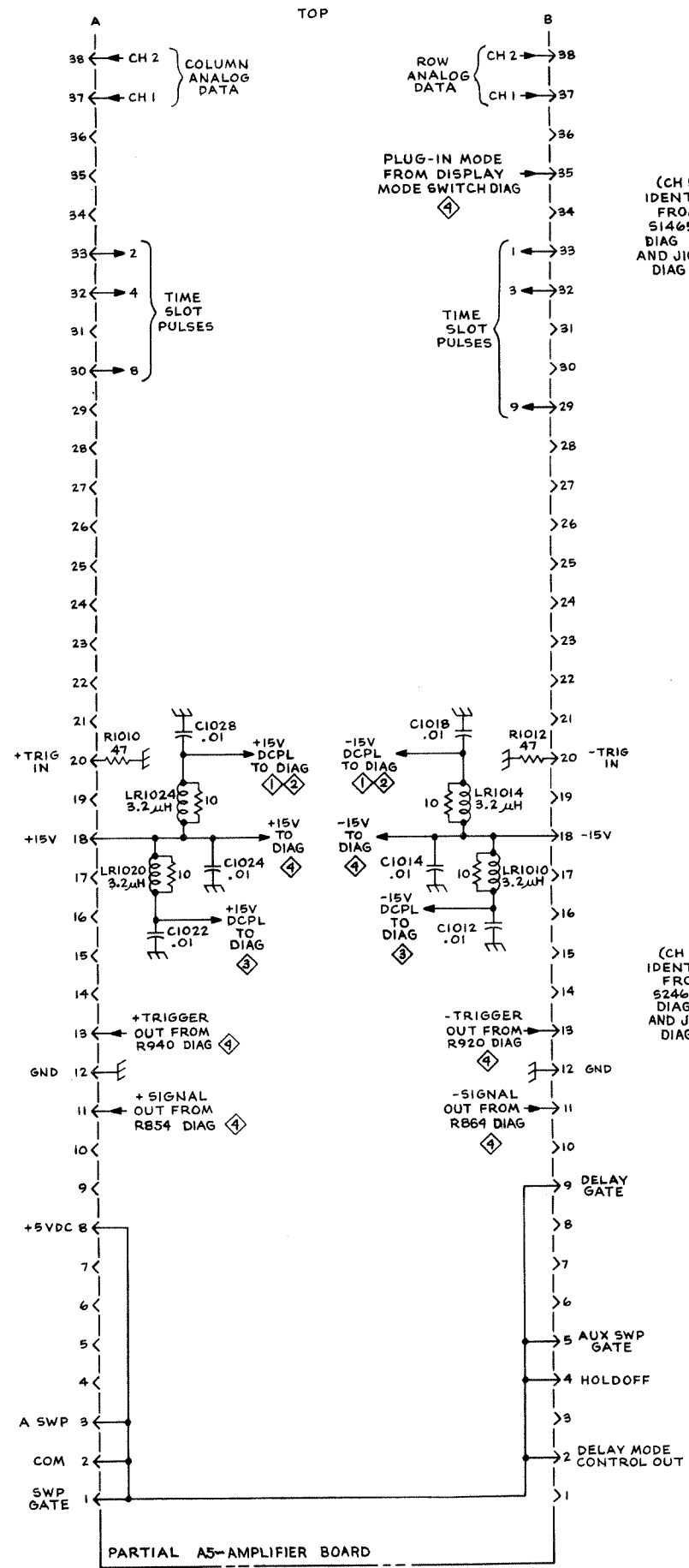
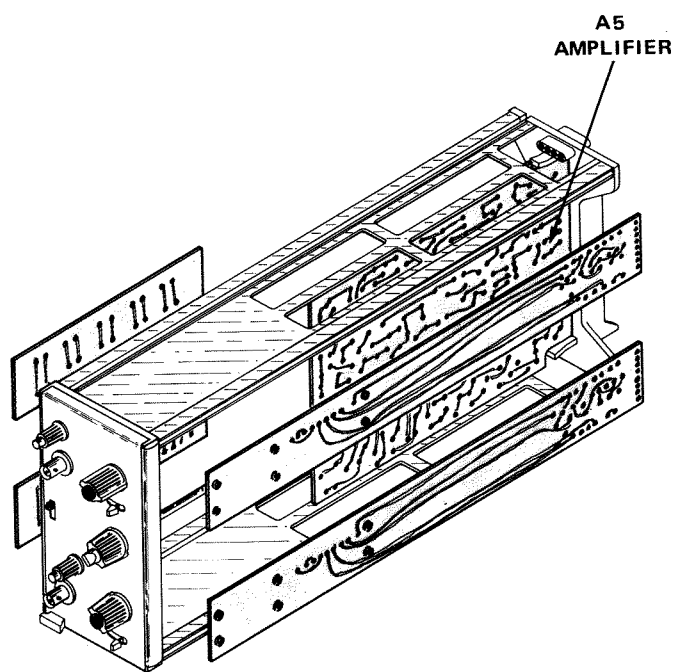


Fig. 7-7. A2 and A4. Readout circuit board.

CKT NO	GRID LOC	CKT NO	GRID LOC
C621	3A	R621	3B
C630	2B	R622	3B
C631	3A	R630	2B
C635	2B	R631	3B
C638	2A	R633	2B
C639	2B	R634	2B
C643	1A	R635	2B
C697	2B	R639	1B
C698	3B	R638	2B
C649	1A	R640	3B
		R642	2B
		R643	1B
CR621	3B	R645	2B
CR647	2B	R646	2B
		R647	2B
Q620	3A	R648	3B







Ⓐ

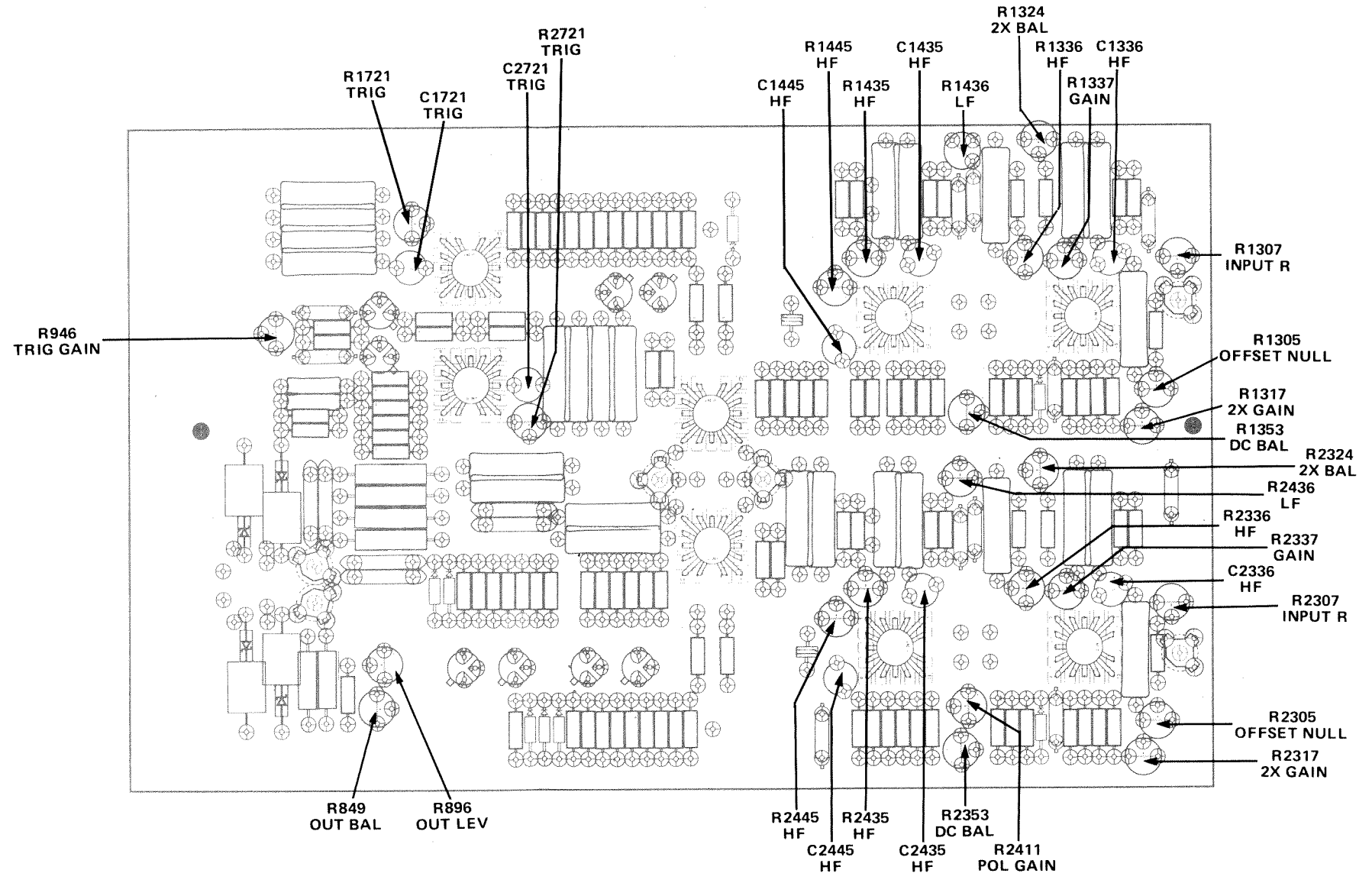


Fig. 7-8. Adjustment locations.

ADJUSTMENT LOCATIONS

MECHANICAL REPLACEABLE PARTS LIST

PARTS ORDERING INFORMATION

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

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

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

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

SPECIAL NOTES AND SYMBOLS

- X000 Part first added at this serial number
 00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

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.

```

1 2 3 4 5      Name & Description
                Assembly and/or Component
                Attaching parts for Assembly and/or Component
                ---- * ----
                Detail Part of Assembly and/or Component
                Attaching parts for Detail Part
                ---- * ----
                Parts of Detail Part
                Attaching parts for Parts of Detail Part
                ---- * ----
  
```

Attaching Parts always appear 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. The separation symbol --- * --- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH	FLH	FLAT HEAD	PWR	POWER
#	NUMBER SIZE	FLTR	FILTER	RCPT	RECEPTACLE
ACTR	ACTUATOR	FR	FRAME or FRONT	RES	RESISTOR
ADPTR	ADAPTER	FSTNR	FASTENER	RDG	RIGID
ALIGN	ALIGNMENT	FT	FOOT	RLF	RELIEF
AL	ALUMINUM	FXD	FIXED	RTNR	RETAINER
ASSEM	ASSEMBLED	GSKT	GASKET	SCH	SOCKET HEAD
ASSY	ASSEMBLY	HDL	HANDLE	SCOPE	OSCILLOSCOPE
ATTEN	ATTENUATOR	HEX	HEXAGON	SCR	SCREW
AWG	AMERICAN WIRE GAGE	HEX HD	HEXAGONAL HEAD	SE	SINGLE END
BD	BOARD	HEX SOC	HEXAGONAL SOCKET	SECT	SECTION
BRKT	BRACKET	HLCPS	HELICAL COMPRESSION	SEMICOND	SEMICONDUCTOR
BRS	BRASS	HLEXT	HELICAL EXTENSION	SHLD	SHIELD
BRZ	BRONZE	HV	HIGH VOLTAGE	SHLDR	SHOULDERED
BSHG	BUSHING	IC	INTEGRATED CIRCUIT	SKT	SOCKET
CAB	CABINET	ID	INSIDE DIAMETER	SL	SLIDE
CAP	CAPACITOR	IDENT	IDENTIFICATION	SLFLKG	SELF-LOCKING
CER	CERAMIC	IMPLR	IMPELLER	SLVG	SLEEVING
CHAS	CHASSIS	IN	INCH	SPR	SPRING
CKT	CIRCUIT	INCAND	INCANDESCENT	SQ	SQUARE
COMP	COMPOSITION	INSUL	INSULATOR	SST	STAINLESS STEEL
CONN	CONNECTOR	INTL	INTERNAL	STL	STEEL
COV	COVER	LPHLDR	LAMPHOLDER	SW	SWITCH
CPLG	COUPLING	MACH	MACHINE	T	TUBE
CRT	CATHODE RAY TUBE	MECH	MECHANICAL	TERM	TERMINAL
DEG	DEGREE	MTG	MOUNTING	THD	THREAD
DWR	DRAWER	NIP	NIPPLE	THK	THICK
ELCTR	ELECTRON	NON WIRE	NOT WIRE WOUND	TNSN	TENSION
ELEC	ELECTRICAL	OB	ORDER BY DESCRIPTION	TPG	TAPPING
ELCTLT	ELECTROLYTIC	OD	OUTSIDE DIAMETER	TRH	TRUSS HEAD
ELEM	ELEMENT	OVH	OVAL HEAD	V	VOLTAGE
EPL	ELECTRICAL PARTS LIST	PH BRZ	PHOSPHOR BRONZE	VAR	VARIABLE
EQPT	EQUIPMENT	PL	PLAIN or PLATE	W/	WITH
EXT	EXTERNAL	PLSTC	PLASTIC	WSHR	WASHER
FIL	FILLISTER HEAD	PN	PART NUMBER	XFMR	TRANSFORMER
FLEX	FLEXIBLE	PNH	PAN HEAD	XSTR	TRANSISTOR

CROSS INDEX MFR. CODE NUMBER TO MANUFACTURER

MFR.CODE	MANUFACTURER	ADDRESS	CITY,STATE,ZIP
08261	Spectra-Strip Corp.	7100 Lampson Ave.	Garden Grove, CA 92642
12327	Freeway Washer and Stamping Co.	P. O. Box 05206	Cleveland, OH 44105
13257	Esna, Ltd.	P. O. Box 250 Agincourt	Toronto, Ontario, Canada
22526	Berg Electronics, Inc.	Youk Expressway	New Cumberland, PA 17070
23499	Gavitt Wire and Cable, Division of Amerace Esna Corp.	455 N. Quince St.	Escondido, CA 92025
24931	Specialty Connector Co., Inc.	3560 Madison Ave.	Indianapolis, IN 46227
25543	Prime Publications	1160 Terra Bell Ave.	Mountain View, CA 94040
26365	Gries Reproducer Corp.	125 Beechwood Ave.	New Rochelle, NY 10802
42838	National Rivet and Mfg. Co.	1-21 East Jefferson St.	Waupun, WI 53963
70276	Allen Mfg. Co.	Box 570	Hartford, CT 06101
70278	Allied Steel and Conveyors, Div. of Sparton Corp.	17333 Healy	Detroit, MI 48212
73743	Fischer Special Mfg. Co.	446 Morgan St.	Cincinnati, OH 45206
74445	Holo-Krome Co.	31 Brook St. West	Hartford, CT 06110
76854	Oak Mfg. Co., Division of Oak Electro/Netics Corp.	S. Main St.	Crystal Lake, IL 60014
78189	Illinois Tool Works, Inc. Shakeproof Division	St. Charles Road	Elgin, IL 60126
79807	Wrought Washer Mfg. Co.	2100 S. O Bay St.	Milwaukee, WI 53207
80009	Tektronix, Inc.	P. O. Box 500	Beaverton, OR 97005
83385	Central Screw Co.	2530 Crescent Dr.	Broadview, IL 60153
83501	Gavitt Wire and Cable, Division of Amerace Esna Corp.	Central St.	Brookfield, MA 01506
87308	Southern Screw Co.	123 Barkley Road	Statesvill, NC 28677
97464	Industrial Retaining Ring Co.	57 Cordier St.	Irvington, NJ 07111

FIGURE 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty						Name & Description	Mfr Code	Mfr Part Number
				1	2	3	4	5			
1-1	131-1171-00		2						CONN, RCPT, ELEC: BNC	24931	28JR231-1
-2	366-1059-00		2						PUSH BUTTON:	80009	366-1059-00
-3	366-1077-00		2						KNOB: GRAY	80009	366-1077-00
	213-0153-00		1						. SETSCREW: 5-40 X 0.125 INCH, HEX SOC, STL	74445	OBD
-4	366-1308-00		2						KNOB: RED	80009	366-1308-00
	213-0153-00		1						. SETSCREW: 5-40 X 0.125 INCH, HEX SOC, STL	74445	OED
-5	366-1299-00		2						KNOB: GRAY	80009	366-1299-00
	213-0153-00		2						. SETSCREW: 5-40 X 0.125 INCH, HEX SOC, STL	74445	OBD
-6	366-1163-00		1						KNOB: LIGHT GRAY WITH SETSCREW	80009	366-1163-00
	213-0153-00		1						. SETSCREW: 5-40 X 0.125 INCH, HEX SOC, STL	74445	OBD
-7	366-1165-00		1						KNOB: GRAY	80009	366-1165-00
	213-0153-00		1						. SETSCREW: 5-40 X 0.125 INCH, HEX SOC, STL	74445	OED
-8	366-0215-02		2						KNOB: LEVER SWITCH	80009	366-0215-02
-9	366-1058-43		1						KNOB: LATCH	80009	366-1058-43
-10	214-1095-00		1						(ATTACHING PARTS) PIN, SPR, SPLIT:	13257	52-022-094-0187
-11	105-0076-00		1						REL BAR LATCH:	80009	105-0076-00
-12	214-1280-00		1						SPRING, HLCPS: 0.14 OD X 1.126 INCHES LONG	80009	214-1280-00
-13	214-1054-00		1						SPRING, DETENT: LATCH	80009	214-1054-00
-14	105-0075-00		1						BOLT, LATCH:	80009	105-0075-00
-15	337-1064-04		2						SHLD, SIDE, ELEC:	80009	337-1064-04
-16	348-0235-00		2						SHLD, GSKT, ELEC:	80009	348-0235-00
-17	333-1592-00		1						PANEL, FRONT: 7A24	80009	333-1592-00
-18	384-1165-00		2						EXTENSION, SHAFT: 7.80 INCHES LONG	80009	384-1165-00
-19	358-0216-00		1						BUSHING, PLASTIC: 0.257 ID X 0.412 INCH OD	80009	358-0216-00
-20	-----		2						RESISTOR, VAR:		
									(ATTACHING PARTS FOR EACH)		
-21	210-0583-00		1						NUT, PLAIN, HEX.: 0.25-32 X 0.312 INCH, BRS	73743	2X20319-402
-22	210-0223-00		1						TERMINAL, LUG: 0.25 INCH DIA, SE	78189	2101-14-03-2520N
-23	131-1075-00		1						CONTACT, ELEC: GROUNDING	80009	131-1075-00
-24	386-1447-54		1						SUBPANEL, FRONT:	80009	386-1447-54
									(ATTACHING PARTS)		
-25	213-0192-00		4						SCR, TAG, THD FOR: 6-32 X 0.50 INCH, PNH STL	87308	OBD
-26	260-0816-00		1						SWITCH, SLIDE:	80009	260-0816-00
									(ATTACHING PARTS)		
-27	211-0030-00		2						SCREW, MACHINE: 2-56 X 0.25" 82 DEG, FLH STL	83385	OBD
-28	210-0405-00		2						NUT, PLAIN, HEX.: 2-56 X 0.188 INCH, BRS	73743	2X12157-402
-29	119-0419-00		2						DELAY LINE, ELEC:	80009	119-0419-00
									(ATTACHING PARTS FOR EACH)		
-30	211-0109-00		1						SCREW, MACHINE: 4-40 X 0.875" 100DEG, FLH STL	83385	OBD
-31	407-1172-00		2						BRKT, CKT BOARD:	80009	407-1172-00
									(ATTACHING PARTS FOR EACH)		
-32	211-0008-00		2						SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL	83385	OBD
-33	210-0586-00		1						NUT, PLAIN, EXT W: 4-40 X 0.25 INCH, STL	78189	OBD
-34	211-0007-00		1						SCREW, MACHINE: 4-40 X 0.188 INCH, PNL STL	83385	OBD
-35	386-1402-00		1						PANEL, REAR:	80009	386-1402-00
									(ATTACHING PARTS)		
-36	213-0192-00		4						SCR, TAG, THD FOR: 6-32 X 0.50 INCH, PNH STL	87308	OBD
-37	361-0326-00		1						SPACER, SLEEVE: 0.18" ID X 0.25" OD X 0.10" LG	80009	361-0326-00
-38	376-0039-00		2						ADPT, SHAFT, CPLG: 0.128 AND 0.082" DIA SHAFT	80009	376-0039-00
	-----								. EACH COUPLING INCLUDES:		
	213-0075-00		2						. SETSCREW: 4-40 X 0.094 INCH, HEX SOC STL	70276	OBD
-39	376-0125-00		2						COUPLER, SWITCH:	80009	376-0125-00
									(ATTACHING PARTS FOR EACH)		
	213-0048-00		2						SETSCREW: 4-40 X 0.125 INCH HEX SOC STL	74445	OBD
-40	354-0251-00		4						RING, COUPLING:	80009	354-0251-00
-41	376-0124-00		2						COUPLER, DRIVER:	80009	376-0124-00
									(ATTACHING PARTS FOR EACH)		
	213-0048-00		2						SETSCREW: 4-40 X 0.125 INCH HEX SOC STL	74445	OBD

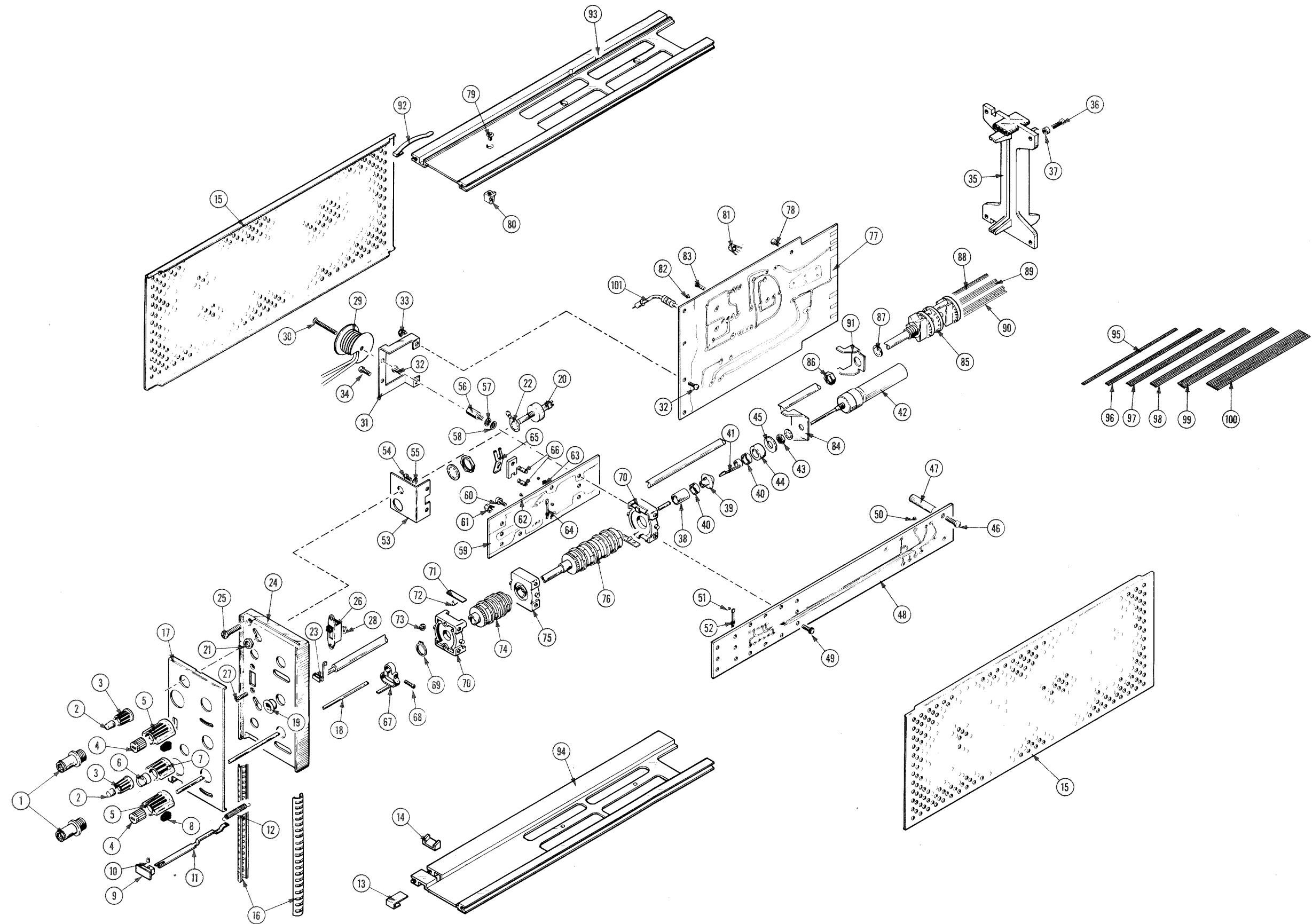
FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number	
		Eff	Dscont										
1-42	-----			2						RESISTOR,VAR:			
										(ATTACHING PARTS FOR EACH)			
-43	210-0583-00			1						NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20319-402	
	210-0046-00			1						WASHER,LOCK:INTL,0.26 ID X 0.40" OD,STL	78189	1214-05-00-0541C	
-44	210-0937-00			1						WASHER,NONMETAL:0.188 ID X 0.312"OD	76854	OBD	
-45	210-0940-00			1						WASHER,FLAT:0.25 ID X 0.375 INCH OD,STL	79807	OBD	
	672-0056-00			2						CKT BOARD ASSY:--READOUT/ATTENUATOR	80009	672-0056-00	
										(ATTACHING PARTS FOR EACH)			
-46	211-0008-00			2						SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD	
-47	129-0080-00			1						POST,NONMETAL:1:4-40 X 0.875 INCH LONG	80009	129-0080-00	
										-----*			
-48	-----			-						. EACH CKT BOARD ASSY INCLUDES:			
	-----			1						. CKT BOARD ASSY:--READOUT(SEE A2&A4 EPL)			
										(ATTACHING PARTS)			
-49	211-0116-00			6						. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD	
										-----*			
	-----			-						. EACH CKT BOARD ASSY INCLUDES:			
-50	136-0252-04			3						. . SOCKET,PIN CONN:0.188 INCH LONG	22526	75060-001	
-51	210-0779-00			7						. . RIVET,TUBULAR:0.051 OD X 0.115 INCH LONG	42838	RA-29952715	
-52	131-1031-00			7						. . CONTACT ASSY:CAM SWITCH TOP	80009	131-1031-00	
-53	407-1262-00			1						. BRKT,ATTENUATOR:	80009	407-1262-00	
										(ATTACHING PARTS)			
-54	211-0097-00			2						. SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD	
-55	210-0004-00			2						. WASHER,LOCK:INT,0.12 ID X0.26" OD,STL	78189	1204-00-00-0541C	
										-----*			
-56	129-0299-00			2						. POST,ELEC-MECH:HEX,0.333 INCH LONG	80009	129-0299-00	
										(ATTACHING PARTS FOR EACH)			
-57	210-0004-00			1						. WASHER,LOCK:INT,0.12 ID X0.26" OD,STL	78189	1204-00-00-0541C	
-58	210-1002-00			1						. WASHER,FLAT:0.125 ID X 0.25 INCH OD,BRS	12327	OBD	
										-----*			
-59	-----			-						. CKT BOARD ASSY:--ATTENUATOR(SEE A1&A3 EPL)			
	-----									(ATTACHING PARTS)			
-60	211-0116-00			2						. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH BRS	83385	OBD	
										-----*			
	-----			-						. . CKT BOARD ASSY INCLUDES:			
-61	131-1003-00			2						. . CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00	
-62	210-0779-00			8						. . RIVET,TUBULAR:0.051 OD X 0.115 INCH LONG	42838	RA-29952715	
-63	131-1030-00			8						. . CONTACT ASSY:CAM SWITCH,BOTTOM	80009	131-1030-00	
-64	131-1031-00			8						. . CONTACT ASSY:CAM SWITCH, TOP	80009	131-1031-00	
-65	344-0248-00			5						. . CLIP,ATTENUATOR:	80009	344-0248-00	
-66	214-1797-00			10						. . PIN,CLIP:	80009	214-1797-00	
	263-1021-00			1						. ACTR ASSY,CAM SW:	80009	263-1021-00	
	-----			-						. . ACTUATOR ASSY INCLUDES:			
-67	105-0243-00			1						. . LEVER,SWITCH:	26365	015-2300-0001	
										(ATTACHING PARTS)			
-68	213-0214-00			1						. . SCREW,CAP SCH:2-56 X 0.375"HEX HD STL	70278	OBD	
										-----*			
-69	354-0391-00			2						. . RING,RETAINING:0.395"FREE IDX 0.025"STL	97464	3100-43-CD	
-70	401-0081-02			2						. . BEARING,CAM SW:FRONT	80009	401-0081-02	
-71	214-1139-00			-						. . SPRING,FLAT:GOLD COLORED	80009	214-1139-00	
	214-1139-02			-						. . SPRING,FLAT:GREEN COLORED	80009	214-1139-02	
	214-1139-03			-						. . SPRING,FLAT:RED COLORED	80009	214-1139-03	
-72	214-1127-00			4						. . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00	
-73	210-0406-00			12						. . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402	
-74	105-0436-00			1						. . DRUM,CAM SWITCH:	80009	105-0436-00	
-75	401-0115-00			1						. . BEARING,CAM SW:CENTER	80009	401-0115-00	
-76	105-0437-00			1						. . DRUM,CAM SWITCH:	80009	105-0437-00	
-77	-----			1						CKT BOARD ASSY:--AMPLIFIER(SEE A5 EPL)			
										(ATTACHING PARTS)			
-78	211-0008-00			2						SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD	
-79	211-0105-00			4						SCREW,MACHINE:4-40 X 0.188"100 DEG,FLH STL	83385	OBD	
-80	220-0547-01			4						NUT BLOCK:	80009	220-0547-01	
										-----*			
	-----			-						. CKT BOARD ASSY INCLUDES:			
-81	131-1003-00			6						. CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00	
-82	136-0252-04			150						. SOCKET,PIN CONN:0.188 INCH LONG	22526	75060-001	
-83	214-0579-00			1						. TERM,TEST PT:0.40 INCH LONG	80009	214-0579-00	
-84	407-0553-00			2						. BRKT,COMPONENT:	80009	407-0553-00	



FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number	
		Eff	Dscont									Mfr	Part Number
1-85	262-0965-00			1	.					SW, RTRY, WIRED: (ATTACHING PARTS)	80009	262-0965-00	
-86	210-0590-00			1	.					NUT, PLAIN, HEX.: 0.375 X 0.438 INCH, STL	73743	2X28269-402	
-87	210-0012-00			1	.					WASHER, LOCK: INTL, 0.375 IDX 0.50" OD STL	78189	1220-02-00-0541C	
	-----			-						SWITCH INCLUDES:			
	260-1493-00			1	.	.				SWITCH, ROTARY:	25543	5-43681-411	
-88	175-0826-00			FT	.	.	.			WIRE, ELECTRICAL: 3 WIRE RIBBON	08261	TEK-175-0826-00	
-89	175-0827-00			FT	.	.	.			WIRE, ELECTRICAL: 4 WIRE RIBBON	08261	TEK-175-0827-00	
-90	175-0828-00			FT	.	.	.			WIRE, ELECTRICAL: 5 WIRE RIBBON	23499	TEK-175-0828-00	
-91	407-0912-00			1	.					BRKT COMPONENT:	80009	407-0912-00	
-92	214-1061-00			1						SPRING, GROUND: FLAT	80009	214-1061-00	
-93	426-0736-00			1						FR SECT, TOP:	80009	426-0736-00	
-94	426-0737-00			1						FR SECT, BOTTOM:	80009	426-0737-00	
-95	175-0825-00			FT						WIRE, ELECTRICAL: 2 WIRE RIBBON	23499	TEK-175-0825-00	
-96	175-0826-00			FT						WIRE, ELECTRICAL: 3 WIRE RIBBON	08261	TEK-175-0826-00	
-97	175-0827-00			FT						WIRE, ELECTRICAL: 4 WIRE RIBBON	08261	TEK-175-0827-00	
-98	175-0828-00			FT						WIRE, ELECTRICAL: 5 WIRE RIBBON	23499	TEK-175-0828-00	
-99	175-0829-00			FT						WIRE, ELECTRICAL: 6 WIRE RIBBON	83501	TEK-175-0829-00	
-100	175-0832-00			FT						WIRE, ELECTRICAL: 9 WIRE RIBBON	23499	TEK-175-0832-00	
-101	119-0418-00			2						CPLR, XMSN LINE:	80009	119-0418-00	



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7A24 DUAL TRACE AMPLIFIER

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ACCESSORIES

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty						Name & Description	Mfr.		
		Eff	Dscont		1	2	3	4	5		Code	Mfr. Part Number	
2-	070-1485-00			1							MANUAL, TECH:SERVICE	80009	070-1485-00

REPACKAGING

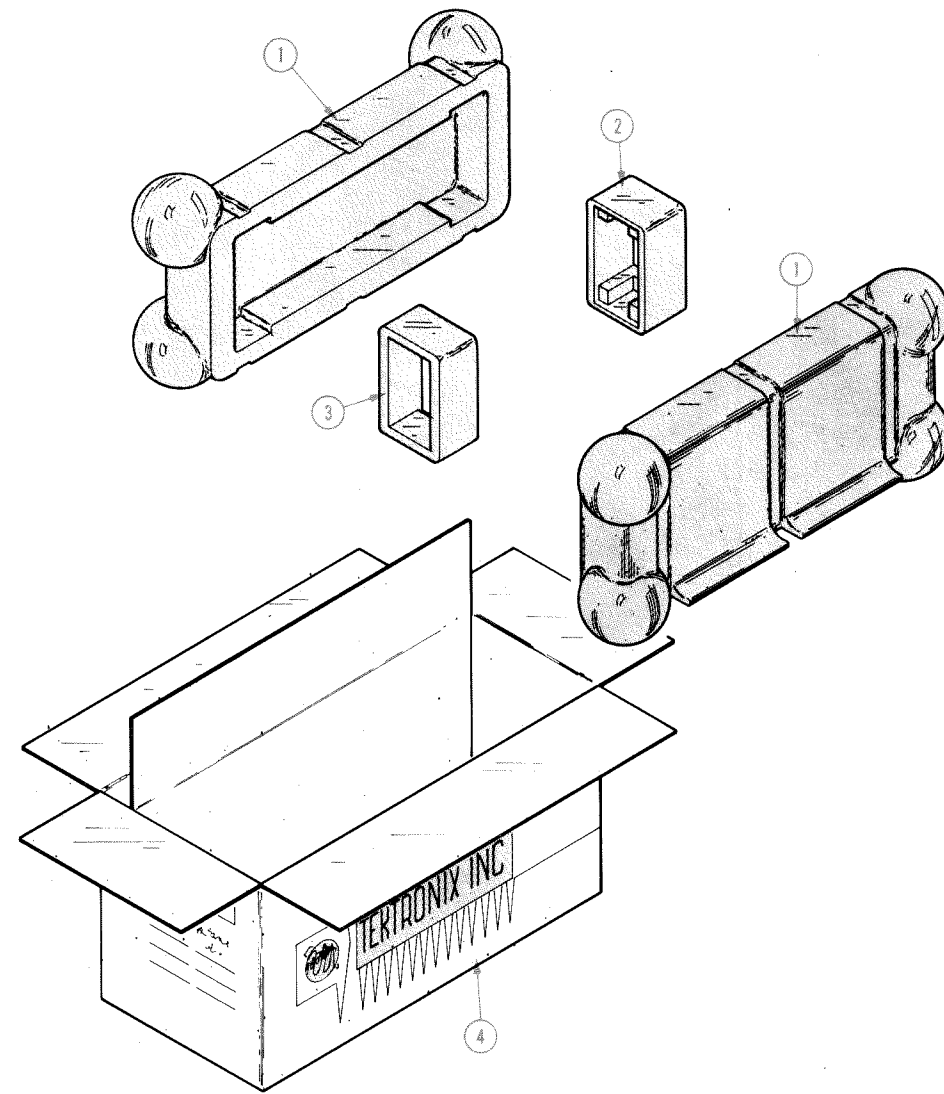


Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty						Name & Description	Mfr.		
		Eff	Dscont		1	2	3	4	5		Code	Mfr. Part Number	
2-	065-0125-00			1							CARTON ASSEMBLY:	80009	065-0125-00
-	-----			-							CARTON ASSEMBLY INCLUDES:		
-1	004-0241-00			2							CASE HALF:	80009	004-0241-00
-2	004-0242-00			1							END CAP, REAR:	80009	004-0242-00
-3	004-0243-00			1							END CAP, FRONT:	80009	004-0243-00
-4	004-0748-00			1							CARTON:	80009	004-0748-00

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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.