

# INSTRUCTION MANUAL

Serial Number 3030312

## **7A15A/AN AMPLIFIER**

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Any questions with respect to the warranty, mentioned above, should be taken up with your Tektronix Field Engineer or representative.

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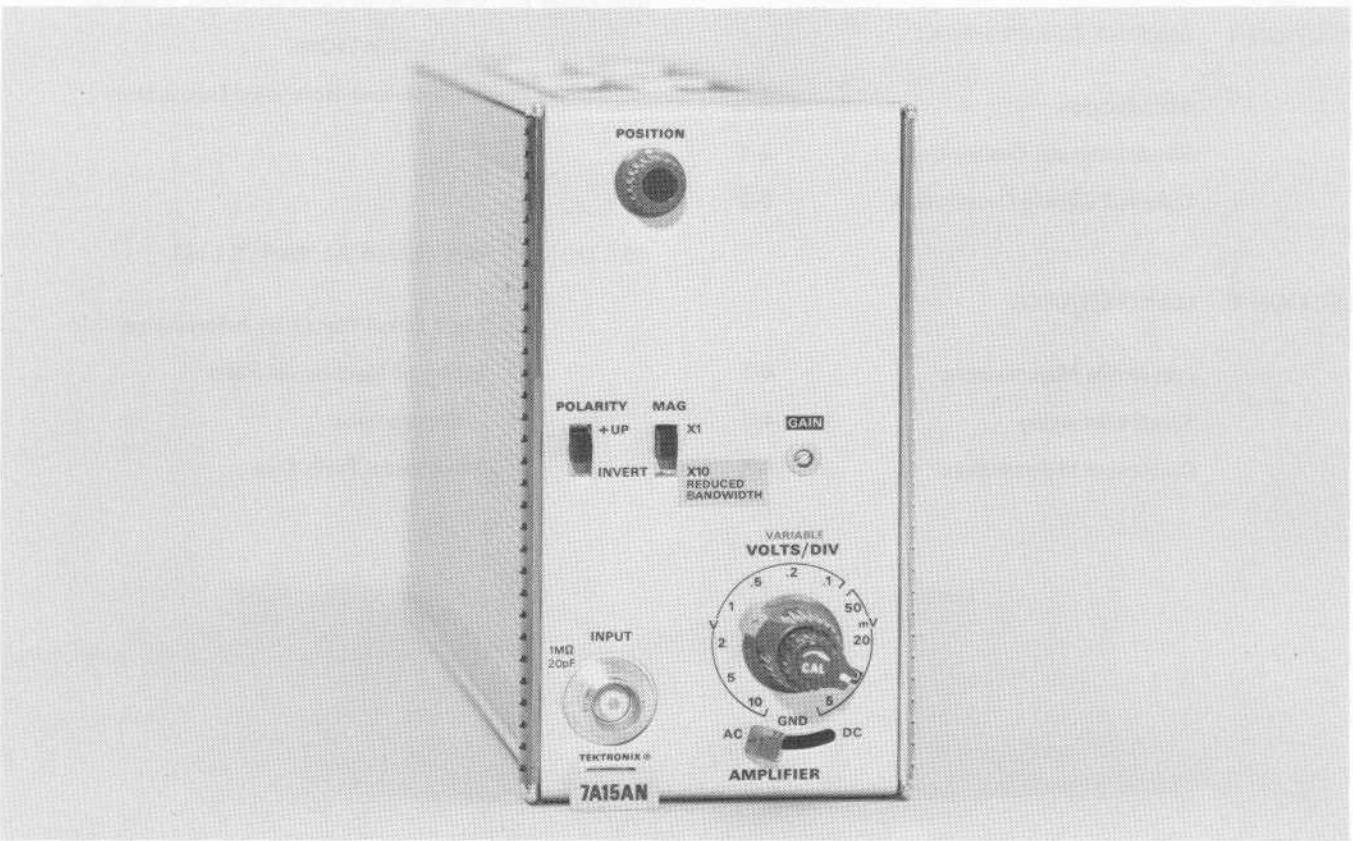
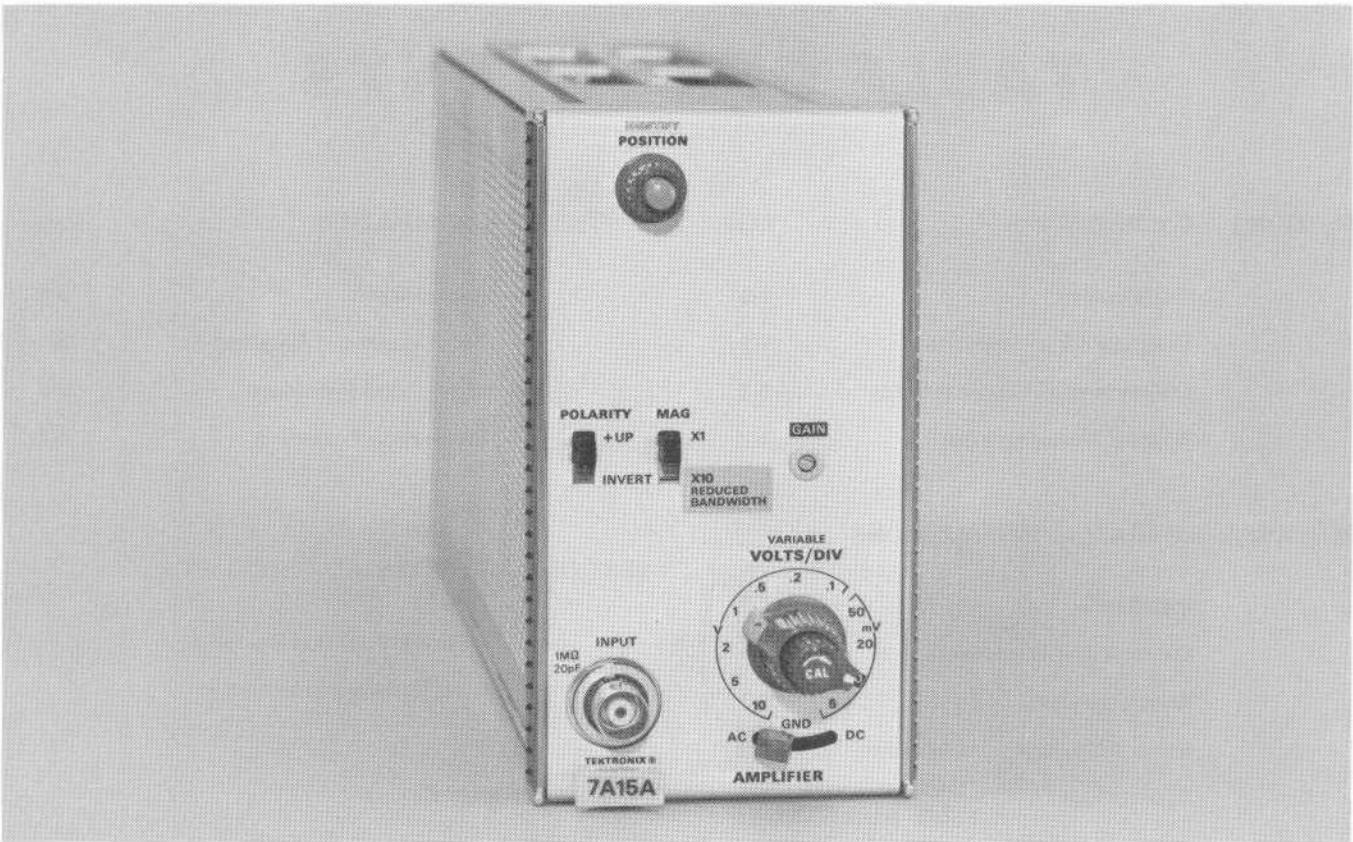


Fig. 1-1. 7A15A and 7A15AN Amplifier.

# SECTION 1

## SPECIFICATION

### Introduction

The 7A15A/7A15AN Amplifier plug-in unit is a wide band amplifier designed for use with Tektronix 7000-Series oscilloscopes. The 7A15A and 7A15AN are electrically identical except that encoding capabilities and an "IDENTIFY" function are provided in the 7A15A. The

7A15A/7A15AN can be operated in any plug-in compartment of 7000-Series oscilloscopes.

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 five minute warmup unless otherwise noted.

**TABLE 1-1**  
**ELECTRICAL**

| Characteristic                                 | Performance Requirement   |                            | Supplemental Information |
|--|---|----------------------------|--------------------------|
| Deflection Factor                              |   |                            |                          |
| Calibrated Range                               | 5 mV/Div to 10 V/Div, 11 steps in a 1-2-5 sequence  |                            |                          |
| Deflection Factor Accuracy                     | Within 2% of indicated deflection factor with GAIN adjusted at 10 mV/Div                          |                            |                          |
| Uncalibrated (VARIABLE)                        | Continuously variable between calibrated steps; extends deflection factor to at least 25 V/Div    |                            |                          |
| X10 GAIN                                       | Increases amplifier gain by a factor of 10 within 10%, decreasing deflection factor to 500 µV/Div |                            |                          |
| Frequency Response                             |   |                            |                          |
| Upper Bandwidth Frequency<br>(at -3 dB)        |   |                            |                          |
| X1 (System Dependent)                          | With 7900-series<br>80 MHz  | With 7700-series<br>75 MHz |                          |
|  | With 7500-series<br>60 MHz  | With 7400-series<br>50 MHz |                          |
| X10  | 10 MHz  |                            |                          |
| Low-Frequency Response                         | 10 Hz or less without probe   |                            |                          |
| (Lower -3 dB point)<br>AC (Capacitive) coupled | 1 Hz or less with probe   |                            |                          |

TABLE 1-1 (cont)

| Characteristic          | Performance Requirement | Supplemental Information   |
|-------------------------|-------------------------|--|
| Maximum Input Voltage   |                         |  |
| DC Coupled              |                         | 250 V (DC + Peak AC); AC component 500 V P-P maximum, 1 kHz or less  |
| AC Coupled              |                         | 500 V (DC + Peak AC); AC component 500 V P-P maximum, 1 kHz or less  |
| Input R and C           |                         |  |
| Resistance              |                         | Approximately 1 megohm   |
| Capacitance             |                         | Approximately 20 pF  |
| RC Tolerance            |                         | Within 1% at all deflection factors  |
| Overdrive Recovery Time |                         | 0.1 ms or less to recover to within one division after removal of overdrive signal of up to +75 divisions to -75 divisions regardless of overdrive signal duration |

TABLE 1-2

## ENVIRONMENTAL CHARACTERISTICS

Refer to the specifications for the associated oscilloscope

TABLE 1-3

## PHYSICAL

|        |   |
|--------|---|
| Size   | Fits all 7000-series plug-in compartments |
| Weight | 1 pound 13 ounces (0.82 kilogram)         |

# SECTION 2

## OPERATING INSTRUCTIONS

### General

To effectively use the 7A15A/7A15AN, the operation and capabilities of the instrument must be known. This section describes front-panel control functions, general information on signal input connections, and other subjects that pertain to various measurement applications.

### Installation

The 7A15A/7A15AN is calibrated and ready for use as received. It can be installed in any compartment of Tektronix 7000-Series Oscilloscopes, but is intended for use primarily in vertical plug-in compartments. To install, align the upper and lower rails of the 7A15A/7A15AN with the oscilloscope tracks and insert the plug-in. The front panel will be flush with the front of the oscilloscope when the 7A15A/7A15AN is fully inserted, and the latch at the bottom-left corner will be in place against the front panel.

To remove the 7A15A/7A15AN, pull on the latch (which is inscribed with the unit identification "7A15A" or "7A15AN") and the 7A15A/7A15AN will unlatch. Continue pulling on the latch to slide the 7A15A/7A15AN out of the oscilloscope.

### FRONT PANEL CONTROLS AND CONNECTORS

|                 |  |                          |   |
|-----------------|--|--------------------------|---|
| VOLTS/DIV       | Selects calibrated deflection factors from 5 mV/Div to 10 V/Div; 11 steps in a 1-2-5 sequence.   | MAG                      | INVERT: A positive-going signal at the Input connector deflects the CRT display downward.   |
| VARIABLE        | Provides continuously variable uncalibrated settings between calibrated steps. Extends the deflection factor range to 25 volts/division or more. | Input Connector          | Provides means of decreasing the deflection factor.   |
| GAIN Adjustment | Screwdriver adjustment permits calibration of deflection factor.   | AC-GND-DC                | X1: Deflection factor is that selected by VOLTS/DIV and VARIABLE controls.  |
| POLARITY        | Provides means of inverting the display.<br><br>+UP: A positive-going signal at the Input connector deflects the CRT display upward.             | POSITION                 | X10 REDUCED BANDWIDTH: Deflection factor is one-tenth of the value selected by the VOLTS/DIV and VARIABLE controls.   |
|                 |  | IDENTIFY<br>(7A15A Only) | Provides signal connection to the amplifier.  |
|                 |  |                          | Selects signal input coupling mode.   |
|                 |  |                          | AC: The AC component of the signal is coupled to the amplifier input, while the DC component is blocked.  |
|                 |  |                          | DC: Both AC and DC components of the signal are coupled to the amplifier input.   |
|                 |  |                          | GND: Grounds the amplifier input while maintaining the same load for the input signal. Provides a charge path for the AC coupling capacitor to pre-charge the input circuit before switching the input to AC. |
|                 |  |                          | Controls position of the trace.   |
|                 |  |                          | Deflects trace about 0.3 division for trace identification. In instruments with readout, also replaces readout with the word "IDENTIFY".  |

## BASIC OPERATION

**General.** This procedure demonstrates the use of the connectors and controls of the 7A15A/7A15AN, while at the same time providing a means of checking the basic operation of the instrument.

**Preliminary Setup.** Install the 7A15A/7A15AN into any 7000-series oscilloscope vertical compartment and set the oscilloscope VERTICAL MODE and TRIGGER SOURCE to the proper settings.

Install a 7-series time-base unit into a horizontal compartment and set the oscilloscope HORIZONTAL MODE to the proper setting. Set the time-base unit to a sweep rate of one-millisecond per division and set the triggering mode to AUTO.

### Procedure

1. Set the 7A15A/7A15AN AC-GND-DC switch to GND and position the trace to the center of the graticule.
2. Set the VOLTS/DIV switch to 10 mV and apply a 40 mV 1 kHz square-wave signal from the oscilloscope CALIBRATOR to the 7A15A/7A15AN INPUT connector. Set the AC-GND-DC switch to DC and check for a four-division display.
3. Set POLARITY switch to INVERT and check that the displayed signal is inverted as compared to its appearance in step 2.
4. Set the AC-GND-DC switch to AC and check that the trace is centered on the CRT graticule.
5. Set the oscilloscope CALIBRATOR to 4 mV and the 7A15A/7A15AN MAG switch to X10. Check for a four-division display.
6. (7A15A Only) Press the 7A15A IDENTIFY button, check that the display moves upward approximately 0.3 division and the readout (if so equipped) reads "IDENTIFY".

## GENERAL OPERATING INFORMATION

### Signal Connections

In general, probes offer the most convenient means of connecting a signal to the input of the 7A15A/7A15AN. A 10X attenuator probe offers a high impedance and allows

the circuit under test to perform very close to normal operating conditions.

The Tektronix P6053 probe is equipped with a readout coding ring which connects to a circuit in the amplifier unit. This automatically corrects the readout displayed on the CRT to the actual deflection factor at the tip of the probe. This probe is recommended for use with the 7A15A and an oscilloscope equipped with readout. The Tektronix P6054 probe is electrically identical to the P6053 but is intended for use with systems not equipped with readout. For more information refer to the Tektronix Inc. catalog.

### Vertical Gain Check and Adjustment

To check the gain of the 7A15A/7A15AN, set the VOLTS/DIV switch to 10 mV and connect a 40 mV, 1 kHz signal from the oscilloscope calibrator to the Input connector. The vertical deflection should be exactly four divisions. If not, adjust the front panel GAIN for exactly four divisions.

### Input Coupling

The AC-GND-DC switch allows a choice of input coupling methods. The type of display desired and the applied signal will determine the coupling to use.

The DC coupling position can be used for most applications. For AC signals with frequencies below about 30 Hz (10 Hz with a 10X probe), and square waves whose low-frequency components are important to the display, it is necessary to use DC coupling to obtain a satisfactory presentation.

In the AC coupling position the DC component of the signal is blocked by a capacitor in the input circuit. The AC coupling position provides the best display of signals with a DC component much larger than the AC component. The pre-charge feature should be used when there is a possibility of having a residual charge on the input capacitor of the opposite polarity to the intended input, and when the algebraic sum of the combination of charges may be greater than the maximum input limitations of the amplifier. To use this feature, first set the coupling switch to GND, then connect the probe to the circuit and wait about two seconds for the coupling capacitor to charge, set the coupling switch to AC.

The GND position provides a ground reference at the input of the amplifier without externally grounding the Input connectors. However, the signals connected to the inputs are not grounded, and the same DC load is presented to the signal source.

## VOLTS/DIV, VARIABLE and MAG Controls

The amount of deflection produced by a signal is determined by the signal amplitude, the attenuation factor of the probe, the setting of the VOLTS/DIV switch, the setting of the VARIABLE Control, and the setting of the MAG switch. Calibrated deflection factors represented by the setting of the VOLTS/DIV switch apply only when the VARIABLE control is in the CAL position (fully clockwise) and when the MAG switch is set to X1.

The VARIABLE control provides variable uncalibrated settings between the calibrated steps of the VOLTS/DIV switch. With the VARIABLE control set fully counter-clockwise and the VOLTS/DIV switch set to 5 volts/div, the uncalibrated deflection factor is extended to at least 2.5 times the attenuator setting. By applying a calibrated voltage source to the Input connector, any specific deflection factor can be set within the range of the VARIABLE control.

The MAG switch increases the VOLTS/DIV switch sensitivity by a factor of 10 when in the X10 position. Thus, with the MAG switch set to X10 and the VOLTS/DIV switch set to 5 mV/div, the deflection factor is extended to 500  $\mu$ V/div. The MAG switch also effects a circuit in the 7A15A which corrects the readout. With the MAG switch set to X10, the bandwidth of the amplifier is reduced. Refer to specifications in Section 1.

## Polarity Switch

The POLARITY switch provides a means of inverting the displayed signal. With the POLARITY set to +UP, a positive-going signal at the INPUT produces an upward deflection of the CRT display. With the POLARITY set to INVERT, a positive-going signal will produce a downward deflection of the CRT display.

## Trace Identification (7A15A only)

When the IDENTIFY button is pressed, the trace is deflected upward about 0.3 division to identify the 7A15A trace. This feature is particularly useful when multiple traces are displayed on the CRT. In mainframes with readout, it also replaces the deflection factor readout with the word "IDENTIFY".

## APPLICATIONS

### General

The following information describes the procedures and techniques for making measurements with a 7A15A/7A15AN 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 which are 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 (AC)

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

1. Apply the signal to the Input connector.
2. Set the Coupling switch to AC.

#### NOTE

*For low-frequency signals below about 30 hertz, use the DC position to prevent attenuation of the signal.*

3. Set the VOLTS/DIV switch to display about five vertical divisions of the waveform.
4. Set the time-base Triggering controls for a stable display. Set the Time Base to a sweep rate which displays several cycles of the waveform.
5. Turn the 7A15A/7A15AN 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. 2-1).

6. Measure the divisions of vertical deflection peak to peak. Check that the VARIABLE control is in the CAL position.

#### NOTE

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

7. Multiply the distance 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 using a 10X attenuator probe, and the VOLTS/DIV switch is set to 1 V.

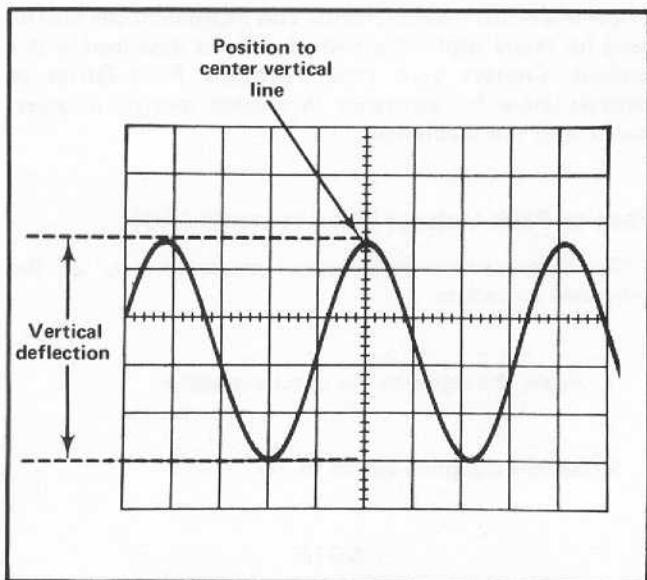


Fig. 2-1. Measuring the Peak-to-Peak voltage of a waveform.

$$\text{Volts} = \frac{\text{vertical deflection}}{\text{divisions}} \times \frac{\text{VOLTS/DIV setting}}{\text{probe factor}}$$

Substituting the given values:

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

The peak-to-peak voltage is 45 volts.

If you are using a 7A15A with a coded probe and an oscilloscope equipped with readout, simply multiply the distance measured in step 7 by the deflection factor displayed on the CRT.

### Instantaneous Voltage Measurements (DC)

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

1. Connect the signal to the Input connector.
2. Set the VOLTS/DIV switch to display about five divisions.
3. Set the Coupling switch to GND 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 another voltage rather than ground, make the following changes to Step 4. Set the Coupling switch to DC and apply the reference voltage to the Input connector. Then position the trace to the reference line and disconnect the reference voltage.

4. Set the Coupling switch to DC. The ground reference line can be checked at any time by switching to the GND position.

5. Set the time-base Triggering controls for a stable display. Set the Time Base sweep rate for an optimum display of the waveform.

6. 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. 2-2 the measurement is between the reference line and point A.

7. Establish the polarity of the waveform. With the +UP/INV switch in the +UP position, any point above the reference line is positive.

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

**EXAMPLE:** Assume the vertical distance measured is 3.6 divisions (see Fig. 2-2) and the waveform is above the reference line using a 10X probe with a VOLTS/DIV switch setting of 0.5 V.

Using the formula:

$$\text{Instantaneous Voltage} = \frac{\text{vertical distance}}{\text{divisions}} \times \frac{\text{VOLTS/DIV setting}}{\text{probe factor}}$$

Substituting the given values:

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

The instantaneous voltage is 18 volts.

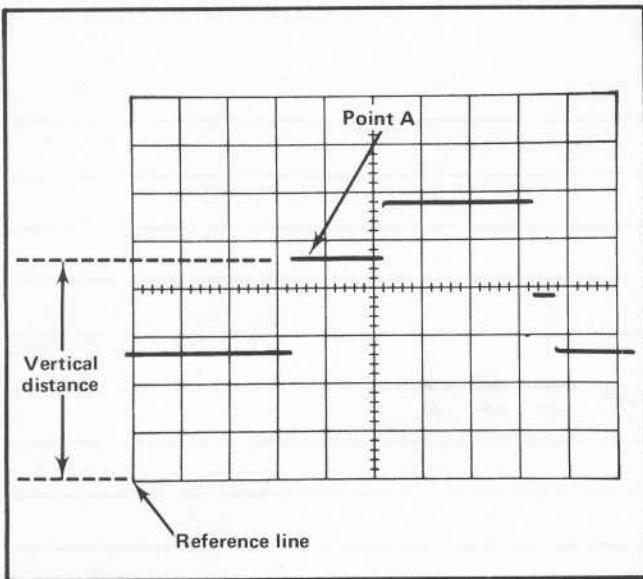


Fig. 2-2. Measuring instantaneous voltage with respect to same reference.

### Comparison Measurements

In some applications it may be desirable to establish 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.

To establish a 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 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 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.

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

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:

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

**EXAMPLE:** Assume a reference signal amplitude of 30 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):

$$\text{Vertical Conversion Factor} = \frac{30 \text{ V}}{4 \times 5 \text{ V}} = 1.5$$

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):

$$\text{Signal Amplitude} = 2 \text{ V} \times 1.5 \times 5 = 15 \text{ volts}$$

## NOTES

# SECTION 3

## CIRCUIT DESCRIPTION

### Introduction

This section of the manual contains a description of the circuitry used in the 7A15A/7A15AN amplifier. The 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 block diagrams 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 following discussion is provided to aid in understanding the overall concept of the 7A15A/7A15AN before the individual circuits are discussed in detail. Only the basic interconnections between the individual blocks are shown on the block diagram (see Diagrams section). Each block represents a major circuit within the instrument. The number on each block refers to the schematic on which the complete circuit is found.

The signal to be displayed on the CRT is applied to the Input connector. The signal passes through the input coupling switch, where the appropriate coupling is selected, to the attenuators. The VOLTS/DIV switch selects the correct amount of attenuation and the signal is passed to the Input Amplifier.

The Input Amplifier provides signal polarity inversion in addition to gain setting, variable gain control, and trace positioning. The output of this circuit is applied push-pull to the Signal and Trigger Amplifiers.

The signal and trigger outputs are provided to the oscilloscope via the Interface connector.

The Readout encoding circuit (7A15A only) provides readout logic for the oscilloscope readout system. Logic is supplied identifying the polarity, deflection factor, and the

uncalibrated symbol (when the VARIABLE knob is not fully clockwise). When the IDENTIFY button is pressed, the trace is deflected about 0.3 division and the deflection factor readout is replaced by the word "IDENTIFY" (7A15A only).

### DETAILED CIRCUIT DESCRIPTION

#### Attenuator

##### General

The Attenuator circuit determines the input coupling and the deflection factor. A diagram of this circuit is shown on Diagram 2 in the Diagrams section.

#### AC-GND-DC Switch

Input signals connected to the Input connector can be AC-coupled, DC-coupled, or internally disconnected. S100A is a cam-type switch; a contact-closure chart showing the operation is given on Diagram 1. The dots on this chart indicate when the associated contacts are in the position shown (open or closed). When the AC-GND-DC switch is in the DC position, the input signal is coupled directly to the Input Attenuator stage. In the AC position, the input signal passes through capacitor C10. The capacitor prevents the DC component of the signal from passing to the amplifier. The GND position opens the signal path and connects the input circuit of the amplifier to ground. This provides a ground reference without the need to disconnect the applied signal from the Input connector. Resistor R102, connected across the AC-GND-DC switch, allows C10 to be pre-charged in the GND position so the trace remains on screen when switching to the AC position if the applied signal has a high DC level.

#### Input Attenuator

The effective overall deflection factor of the 7A15A/7A15AN is determined by the setting of the VOLTS/DIV switch, S100B. The basic deflection factor is five millivolts per division of CRT deflection (with Mag switch set to X1). To increase the basic deflection factor to the values indicated on the front panel, precision attenuators are switched into the circuit. S100B is a cam-type switch and 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 position, input attenuation is not used; the input signal is connected directly to the input amplifier.

## Circuit Description—7A15A/7A15AN

For switch positions above five millivolts, the attenuators are switched into the circuit singly or in pairs to produce the deflection factor indicated on the front panel. These hybrid attenuators are frequency-compensated voltage dividers. For DC and low-frequency signals, the attenuators are primarily resistance dividers and the voltage attenuation is determined by the resistance ratio in the circuit. The reactance of the capacitors in the circuit is so high at low frequencies that their effect is negligible. However, at higher frequencies, the reactance of the capacitors decreases and the attenuator becomes primarily a capacitance divider.

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 RC characteristics (one megohm X 20 pF) for each setting of the VOLTS/DIV switch. Each attenuator contains an adjustable series capacitor to provide correct attenuation at high frequencies, and an adjustable shunt capacitor to provide correct input capacitance.

### Input Amplifier

#### General

The Input Amplifier converts the single-ended signal applied to the Input connector to a differential (push-pull) output. A schematic of this circuit is shown on Diagram 2 in the Diagrams section.

#### Input Source Follower

The Input Source Follower Q210A provides a high input impedance with a low impedance drive for the following stage. R210 limits the current drive to the gate of Q210A. Dual-diode CR210 provides circuit protection by limiting the voltage swing at the gate of Q210A to about  $\pm$  (positive or negative) 15 volts. Q210B provides a constant current source for Q210A. Q210A and Q210B are encapsulated in the same case so that Q210B temperature compensates the circuit.

#### Amplifier

The signal from the Input Source Follower is applied to paraphase amplifier Q220-Q320. The paraphase amplifier converts the single-ended input to a differential (push-pull) output. It also provides a means of compensating for stray currents throughout the entire amplifier by varying the DC Level at the base of Q320 via the DC Bal control R322. The differential signal from the paraphase amplifier is cascaded to the Inverting Amplifier, a set of common base differential amplifiers Q230-Q330 and Q235-Q335. With the POLARITY switch set to +UP, Q230 and Q330 are forward biased while Q235 and Q335 are reverse biased. The signal is therefore allowed to pass un-inverted through Q230-Q330. By setting the POLARITY switch to INVERT,

Q230 and Q330 are reverse biased and Q235 and Q335 are forward biased. The signal is inverted through Q235-Q335. Current gain for amplifiers Q230-Q330 and Q235-Q335 is controlled by the GAIN potentiometer R238 and VARIABLE control R239. The output from Q230-Q330 or Q235-Q335 (depending on the POLARITY switch) is connected to the X1 amplifier, Q240-Q340, and the X10 amplifier, Q245-Q345. The MAG switch determines which amplifier (X1 or X10) is on, by switching their emitter supply voltages. Current gain for the X10 amplifier is adjusted by R245. R341 and C341 provide frequency compensation for the X1 amplifier. The signal from the X1 or X10 amplifier (depending on the MAG switch) is cascaded through the common base amplifier, Q250-Q350, to the Signal Amplifier, Q260-Q360, and Trigger Amplifier, Q270-Q370.

### Connectors and Readout

#### General

The Connectors and Readout circuit consists of the power supply and signal distribution from the Interface Connector and the Readout Encoding circuit. A schematic of this circuit is shown on Diagram 3 in the Diagrams section.

#### Connectors

All the connections made to the mainframe by the 7A15A/7A15AN are shown on the Connectors portion of Diagram 1. Also shown are the power supply decoupling components.

#### Readout Encoding (7A15A only)

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

R647-C647 are switched between time-slot three (TS-3) and the Column output line when the CAL switch is in the uncal position. This results in the symbol  $>$  (greater than) being displayed preceding the deflection factor readout. R648 is switched between TS-2 and the Column output line when the POLARITY switch is in the INVERT position. This results in the symbol  $\downarrow$  (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 dots on the contact-closure chart (see Diagram 3) indicate when the associated contacts on the VOLTS/DIV cam

switch are closed. R633, R634, and R635 select the number 1, 2, or 5 depending on the 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, 2, and 5 V positions. 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 through the probe coding resistor located in the probe connector. 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 device 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 the collector current, along with emitter resistor R622. 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 allows 100 microamperes of collector current to flow. This increases the deflection factor readout by a factor of 10.

The IDENTIFY button (S45 on Diagram 1) does two things when pressed:

1. It causes the trace representing the appropriate channel of the 7A15A to move (see the discussion on the Input Amplifier).
2. Forward biases CR621 and Q620 to result in a sufficient amount of collector current which replaces the deflection factor readout with the word "IDENTIFY".

These two actions aid in identifying the 7A15A trace when multiple traces are displayed. When the IDENTIFY button is released, the deflection factor readout is restored.

For further information on the operation of the readout system, see the oscilloscope instruction manual.

## NOTES

# SECTION 4

## MAINTENANCE

### Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, and troubleshooting of the 7A15A/7A15AN.

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. See semiconductor-checking information given under Troubleshooting.

#### Cleaning

**CAUTION**

*Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Special care should be taken when cleaning the Polyphenylene Oxide attenuator board. 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 Number 003-0342-00.

### TROUBLESHOOTING

#### General

The following is provided to augment information contained in other sections of this manual when troubleshooting the 7A15A/7A15AN. The schematic diagrams, circuit description, and calibration sections should be used to full advantage. The circuit description 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. Important voltages are also shown.

**Circuit Boards.** The circuit boards used in the 7A15A/7A15AN are outlined on the schematic diagrams, and photographs of the boards are shown on the backs of the schematic diagrams. Each board-mounted electrical component is identified on the photograph 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 7A15A/7A15AN, are color coded to facilitate tracing wires from one point to another in the unit.

**Semiconductor Lead Configuration.** Fig. 4-1 shows the lead configurations of the semiconductor devices used in this instrument.

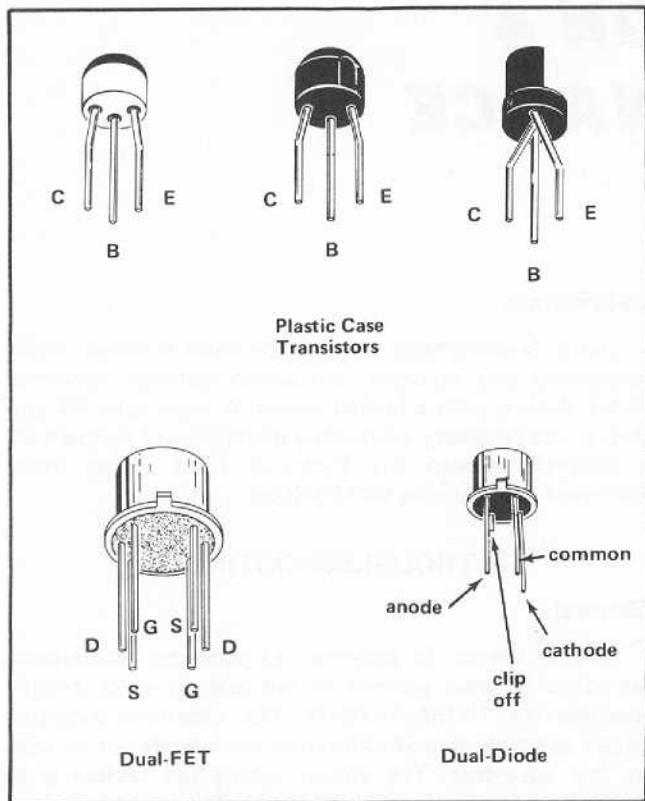


Fig. 4-1. Electrode configuration for semiconductors in the 7A15A/7A15AN.

## Troubleshooting Equipment

The following equipment is useful for troubleshooting the 7A15A/7A15AN.

1. Semiconductor Tester—Some means of testing the transistors, diodes, and FET's 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 Oscilloscope 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 number 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 7A15A/7A15AN 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 7A15A/7A15AN, 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 Instrument Performance.** Check the calibration of the unit or the affected circuit, by performing Performance Check of Section 5. The apparent trouble may only be a result of mis-adjustment, and may be corrected by calibration. Complete calibration instructions are given in Part II of Section 5.

**5. Check Voltages.** Often the defective component or stage can be located by checking for the correct voltage in the circuit. Typical voltages are given on the diagrams; however, these are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the instructions in the Diagrams section.

**6. Check Individual Components.** The following methods are provided for checking the individual components in the 7A15A/7A15AN. 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 mounted on the attenuator board, Quik Freeze (Miller Stephenson, MS-240, Tektronix Part Number 006-0173-01) is recommended. Dry ice or dichlorodi-fluoromethane (Freon 12, Dupont or Can-O-Gas) may also be used. Other types of circuit coolant may damage the polyphenylene oxide boards.

**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. Fig. 4-1 shows base pin and socket arrangements of semiconductor devices. 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.

**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 7A15A/7A15AN 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 7A15A/7A15AN. These parts are manufactured or selected by Tektronix, Inc. in accordance with our specifications. These special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

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

1. Instrument Type.
2. Instrument Serial Number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix Part Number.

### Soldering Techniques

### WARNING

*Disconnect the instrument from the power source before soldering.*

**Attenuator Circuit Board.** The Attenuator circuit board is made from polyphenylene oxide because of its excellent electrical characteristics. Use more than normal care when cleaning or soldering this material. The following rules should be observed when removing or replacing parts:

## Maintenance—7A15A/7A15AN

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 of halogenated hydrocarbons.
5. To clean, use only water-soluble detergents, ethyl, methyl or isopropyl alcohol.

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

1. Use a pencil-type soldering iron with a (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.*

**Semiconductor Replacement.** Transistors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors may effect 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. Fig. 4-1 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 7A15A/7A15AN 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 (7A15A Only)

1. Disconnect the wires connected to the outside of the board.
2. Remove the seven 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 as outlined in the previous procedure.
2. Disconnect the resistor and capacitor connected to the rear of the board.
3. Loosen the front set screw on the VARIABLE control shaft coupling (use a 0.050-inch hex-key wrench).
4. Remove the red VARIABLE control knob and glass rod from the control shaft.
5. Remove the remaining front-panel knobs using a 1/16-inch hex-key wrench.
6. Remove the front panel from the instrument.
7. Remove the attenuator shields.
8. Disconnect the wires and resistor from the input BNC connector.
9. Remove the input BNC connector.
10. Remove the attenuator board with cam switch from the instrument.
11. Replace by reversing the Removal Procedures.

## 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 board from the front-panel controls.
3. Loosen the hex-socket screw in the coupling of the VARIABLE control shaft using a 0.050-inch hex-key wrench. Pull the VARIABLE knob and glass shaft from the front of the instrument.
4. Disconnect the resistor-capacitor combinations connected to the ceramic strip at the front of the board.
5. Remove the screws and nuts securing the board to the chassis or other mounting surface.
6. Remove the board from the instrument.
7. To replace, reverse the order of removal.

## Switch Replacement

Several types of switches are used in the 7A15A/7A15AN. The slide and micro switches should be replaced as a unit if damaged. 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 assistance in maintenance of the cam-type switches, contact your local Tektronix Field Office or representative.*

### A. CAM-TYPE SWITCHES

#### NOTE

*A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.*

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 AC-GND-DC (coupling) 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 AC-GND-DC 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 four 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.
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.

## NOTES

# SECTION 5

## CALIBRATION

### Introduction

To assure instrument accuracy, check the calibration of the 7A15A/7A15AN 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.

### Tektronix Field Service

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

### Using This Procedure

**General.** This section provides several features to facilitate checking or adjusting the 7A15A/7A15AN. These are:

**Short Form Procedure.** As an aid to the calibration of this instrument, a short form procedure is given prior to the complete procedure. To facilitate instrument calibration for the experienced calibrator, the short form procedure lists the calibration adjustments necessary for each step and the applicable tolerances.

**Partial Calibration Procedure.** A partial calibration is often desirable after replacing components, or to touch up the adjustment of a portion of the instrument between major recalibrations. To calibrate only part of the instrument, set the controls as given under Preliminary Control Settings and start with the nearest numbered step preceding the desired portion. To prevent unnecessary recalibration of other parts of the instrument, readjust only if the tolerance given in the CHECK— part of the step is not met.

**Complete Calibration Procedure.** Completion of each step in the Calibration Procedure insures that this instrument meets the electrical specifications given in Section 1. 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.

### TEST EQUIPMENT REQUIRED

#### General

The following test equipment and accessories, or its equivalent is required for complete calibration of the 7A15A/7A15AN. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may be somewhat less precise than the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within the listed specifications of the recommended equipment.

#### Test Equipment

1. Calibration Oscilloscope. Tektronix 7704 or equivalent 7000-series Oscilloscope.

2. 7B-Series Time Base plug-in unit.

3<sup>1</sup>. Standard Amplitude Calibrator. Amplitude accuracy, within 0.25%; signal amplitude, 5 millivolts to 50 volts; frequency, 1 kHz. Tektronix Calibration Fixture 067-0502-01 recommended.

4<sup>2</sup>. Square-wave Generator. Must have the following output capabilities: 12 volts amplitude into 50 ohms at one kilohertz with a rise time of 12 nanoseconds or less; 500 millivolts into 50 ohms at 100 kilohertz with a risetime of one nanosecond or less. Tektronix Type 106 Square-Wave Generator recommended.

#### Accessories

5. Cable. Impedance, 50 ohms; connector, BNC; length, 42 inches. Tektronix Part Number 011-0060-01.

6<sup>2</sup>. Five nanosecond GR cable. Tektronix Part Number 017-0512-00.

<sup>1</sup>Needed for Gain Calibration only.

<sup>2</sup>Needed for Compensation adjustments only.

## Calibration—7A15A/7A15AN

7<sup>2</sup>. Termination, thru-line. Impedance, 50 ohms; connectors, GR to BNC male. Tektronix Part Number 017-0083-00.

8<sup>2</sup>. Adapter, connectors, GR to BNC male. Tektronix Part Number 017-0064-00.

9<sup>2</sup>. 10X Attenuator. Impedance, 50 ohms; accuracy,  $\pm 2\%$ ; connectors, GR. Tektronix Part Number 017-0078-00.

10<sup>2</sup>. RC Normalizer. Time constant, 1 megohm X 20 picofarad; attenuation 2X; connectors BNC. Tektronix Part Number 067-0538-00.

### Adjustment Tools

11. Low-capacitance screwdriver. 1 1/2-inch shaft. Tektronix Part Number 003-0000-00.

12<sup>2</sup>. Tuning Tool. Handle with inserts for input capacitance and attenuator adjustments. Tektronix Part Numbers 003-0307-00, 003-0334-00, and 003-0497-00.

## SHORT-FORM PROCEDURE

### 1. Gain Calibration

Set GAIN adjustment for a vertical deflection within 2% of applied signal with VOLTS/DIV switch set to 10 mV.

Check that the VARIABLE control will reduce the vertical deflection by a factor of at least 2.5:1.

Set X10 Gain adjustment (number 3, Fig. 5-1) for a vertical deflection within 10% of applied signal with VOLTS/DIV switch set to 10 mV.

Check that the vertical deflection is accurate to within 2% at all VOLTS/DIV switch settings.

### 2. DC Balance Adjustments

Set DC Bal adjustment (number 1) for a VARIABLE trace shift of not more than 0.5 division.

Set X10 DC Bal adjustment (number 2) for a minimum MAG trace shift.

### 3. Compensation Adjustments

Adjust input capacitance (C100) for optimum square-wave response.

Adjust attenuator compensation (see Table 5-2) for flat top and square corner within 0.15 division at all VOLTS/DIV switch settings.

Adjust high-frequency compensation (numbers 4 and 5) for optimum square-wave response with aberrations not to exceed 5% peak to peak.

## CALIBRATION PROCEDURE

### General

The following procedure is arranged so that the 7A15A/7A15AN can be calibrated with the least interaction of adjustments and re-connection of equipment. The control settings and test equipment setup throughout this procedure continue from the preceding step(s) unless otherwise noted. Refer to Fig. 5-1 for location of adjustments.

### NOTE

*Control titles which are printed on the front panel of the 7A15A/7A15AN are capitalized in this procedure (e.g., POSITION). Internal adjustments and associated equipment controls are initially capitalized only (e.g., oscilloscope Vertical Mode).*

### Preliminary Procedure for Calibration

1. Remove the oscilloscope left side cover and side panel of plug-in.

2. Insert the 7A15A/7A15AN in the calibration oscilloscope left vertical compartment.

3. Insert the time base in the calibration oscilloscope A Horizontal compartment.

4. Connect the oscilloscope to a suitable power source.

5. Turn the oscilloscope on and allow 20 minutes warm-up before proceeding.

### NOTE

*This instrument should be calibrated at an ambient temperature of +20° C to +30° C for best overall accuracy. The performance of the instrument can be checked at any temperature within the 0° C to +50° C range.*

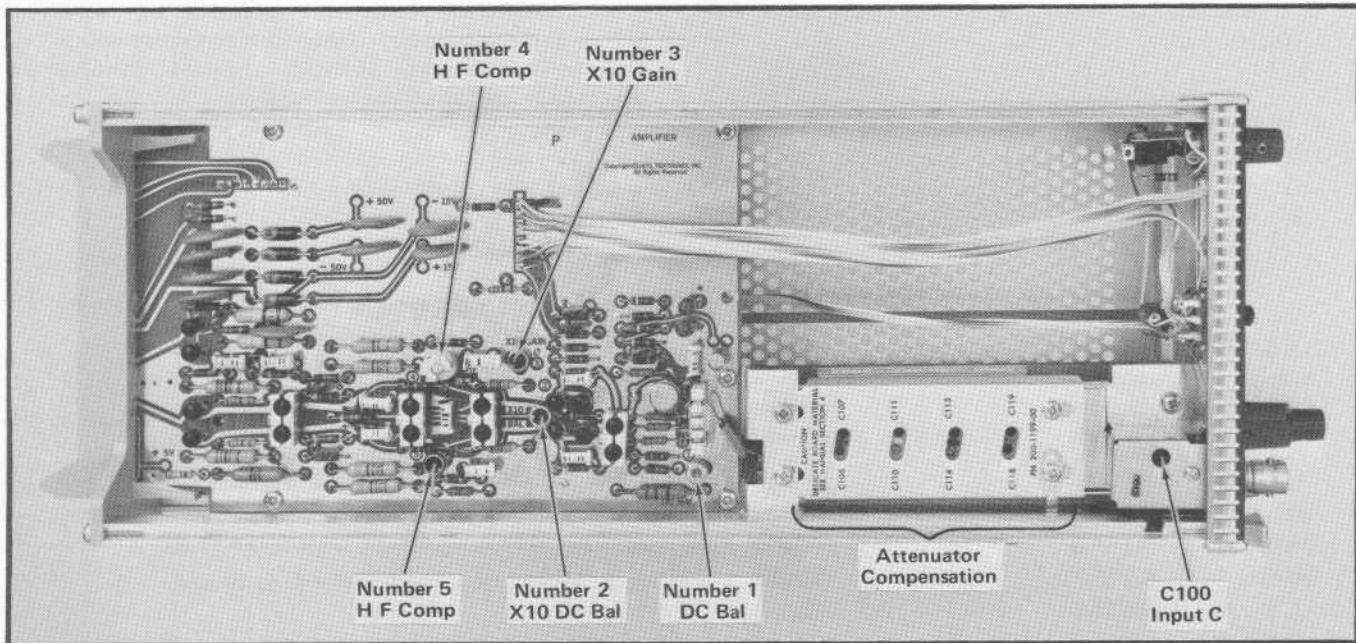


Fig. 5-1. Location of adjustments for 7A15A/7A15AN. (7A15A shown)

### Preliminary Control Settings

Set the calibration oscilloscope and 7A15A/7A15AN as follows:

#### Calibration Oscilloscope

|                |                             |
|----------------|-----------------------------|
| Intensity      | Midrange                    |
| Focus          | Adjust well-defined display |
| Readout        | Midrange (if so equipped)   |
| Control Illum  | As desired                  |
| Grat Illum     | As desired                  |
| Vertical Mode  | Left                        |
| Trigger Source | Left Vert                   |

#### 7A15A/7A15AN

|           |                      |
|-----------|----------------------|
| POSITION  | Midrange             |
| POLARITY  | +UP                  |
| MAG       | X1                   |
| VOLTS/DIV | 10 mV                |
| AC-GND-DC | DC                   |
| VARIABLE  | CAL (full clockwise) |

### 1. Check/Adjust GAIN

a. Connect the Standard Amplitude Calibrator output to the Input connector with a 42-inch BNC cable.

b. Set the Standard Amplitude Calibrator for a 50-millivolt square-wave output.

c. CHECK—CRT display for a vertical deflection of five-divisions  $\pm 0.1$  division.

d. ADJUST—Front panel GAIN control for exactly five-divisions vertical deflection.

#### CHECK VARIABLE GAIN RANGE

e. Rotate VARIABLE control fully counterclockwise.

f. CHECK—That the vertical deflection is equal to or less than two-divisions. Return VARIABLE control to the CAL position.

#### CHECK/ADJUST X10 GAIN

g. Set the Standard Amplitude Calibrator for a 5-millivolt square-wave output. Set MAG to X10.

h. CHECK—CRT display for a vertical deflection of five-divisions  $\pm 0.5$  division.

i. ADJUST—the X10 Gain adjustment (number 3) for exactly five vertical divisions. Return MAG to X1.

#### CHECK DEFLECTION FACTOR ACCURACY

j. CHECK—Using the VOLTS/DIV switch and Standard Amplitude Calibrator settings given in Table 5-1, check

## Calibration—7A15A/7A15AN

vertical deflection is within 2% for each position of the VOLTS/DIV switch.

k. Disconnect all test equipment and return the VOLTS/DIV switch to 10 mV.

**TABLE 5-1**  
**Vertical Deflection Accuracy**

| VOLTS/DIV<br>Switch<br>Setting | Standard<br>Amplitude<br>Calibrator<br>Output | Vertical<br>Deflection<br>in<br>Divisions | Maximum<br>Error for $\pm 2\%$<br>Accuracy<br>(divisions) |
|--------------------------------|---|---|---|
| 5 mV                           | 20 mV   | 4   | $\pm 0.08$  |
| 10 mV                          | 50 mV   | 5   | Set in step 4   |
| 20 mV                          | 0.1 V   | 5   | $\pm 0.1$   |
| 50 mV                          | 0.2 V   | 4   | $\pm 0.08$  |
| .1 V                           | 0.5 V   | 5   | $\pm 0.1$   |
| .2 V                           | 1 V   | 5   | $\pm 0.1$   |
| .5 V                           | 2 V   | 4   | $\pm 0.08$  |
| 1 V                            | 5 V   | 5   | $\pm 0.1$   |
| 2 V                            | 10 V  | 5   | $\pm 0.1$   |
| 5 V                            | 20 V  | 4   | $\pm 0.08$  |

## 2. Check/Adjust DC Bal

a. Set AC-GND-DC switch to GND.

b. CHECK—While rotating the VARIABLE control throughout its ranges check that the displayed trace does not move more than 0.5 divisions vertically.

c. ADJUST—DC Bal adjustment (number 1) for minimum vertical trace shift while rotating the VARIABLE control throughout its range.

### ADJUST X10 DC BAL

d. ADJUST—Center the display and adjust X10 Bal (number 2) for a minimum vertical trace shift while switching the MAG switch between X1 and X10.

e. Return the MAG switch to its X1 position.

f. Recheck X10 Gain (step 1).

## 3. Adjust Input Capacitance

a. Set VOLTS/DIV switch to 5 mV and AC-GND-DC switch to DC.

b. Connect the square-wave generator high amplitude (12 nanosecond) output to the Input connector with a five-nanosecond GR cable, 10X GR attenuator, thru-line GR termination and 20 pF normalizer.

c. Set the square-wave generator for a six-division display of a one-kilohertz signal.

d. Set the time-base unit for a triggered display at a sweep rate of 0.2 millisecond/division.

e. ADJUST—C100 for optimum square corner on the displayed waveform.

### ADJUST ATTENUATOR COMPENSATION

f. Set the VOLTS/DIV switch to 10 mV.

g. Set square-wave generator for a six-division display of one-kilohertz signal.

h. ADJUST—attenuator compensations as given in Table 5-2 for optimum square corner and flat top (within 0.15 divisions) on the displayed waveform (use tuning tool).

**TABLE 5-2**  
**Attenuator Compensation**

| VOLTS/DIV<br>Switch Setting | Adjust for Optimum<br>Square Corner | Flat Top |
|-----------------------------|-------------------------------------|----------|
| 10 mV                       | C106                                | C107     |
| 20 mV                       | C110                                | C111     |
| 50 mV                       | C114                                | C115     |
| 0.1 V                       | Check                               | Check    |

Remove 10X GR attenuator.

|       |       |       |
|-------|-------|-------|
| 0.2 V | Check | Check |
| 0.5 V | C118  | C119  |
| 1 V   | Check | Check |

Replace thru-line 50-ohm GR termination with GR to BNC male adapter

|     |       |       |
|-----|-------|-------|
| 2 V | Check | Check |
| 5 V | Check | Check |

### CHECK/ADJUST HIGH-FREQUENCY COMPENSATION

i. Set VOLTS/DIV switch to 5 mV.

j. Connect the square-wave generator fast-rise (1 nanosecond) output to the Input connector with the five-nanosecond GR cable, 10X GR attenuator, and thru-line 50-ohm GR attenuator.

k. Set square-wave generator for a six-division display (30 millivolts) of a 100 kilohertz signal.

l. Set time-base unit for a triggered display at a sweep rate of 2 microseconds/division.

*NOTE*

*In the following steps, change the time-base unit magnifier from X1 to X10 and compare the response at both sweep rates.*

m. CHECK—CRT display for optimum square-wave response with aberrations not to exceed 0.24 divisions peak to peak.

n. ADJUST—adjustments numbers 4 and 5 for optimum square-wave response with aberrations. Use low-capacitance screwdriver to adjust the variable capacitor. Repeat these adjustments until optimum response is obtained.

This completes the calibration of the 7A15A/7A15AN. Disconnect all test equipment.

## NOTES

## PARTS LIST ABBREVIATIONS

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

## **PARTS ORDERING INFORMATION**

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

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

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

## **SPECIAL NOTES AND SYMBOLS**

×000      Part first added at this serial number

00×      Part removed after this serial number

\*000-0000-00      Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.

Use 000-0000-00      Part number indicated is direct replacement.

# SECTION 6

## ELECTRICAL PARTS LIST

| Ckt. No.          | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Disc     | Description                       |
|-------------------|-----------------------|-------------------------|----------|-----------------------------------|
| <b>ASSEMBLIES</b> |                       |                         |          |                                   |
| A1 <sup>1</sup>   | 670-1706-00           |                         |          | ATTENUATOR Circuit Board Assembly |
| A2                | 670-1556-00           |                         |          | AMPLIFIER Circuit Board Assembly  |
| A3 <sup>2</sup>   | 670-1385-00           |                         |          | READOUT Circuit Board Assembly    |
| <b>CAPACITORS</b> |                       |                         |          |                                   |
| C10               | 285-0816-01           |                         |          | 0.019 μF, PTM, 600 V, 10%         |
| C47 <sup>2</sup>  | 283-0000-00           |                         |          | 0.001 μF, Cer, 500 V              |
| C48 <sup>2</sup>  | 283-0000-00           |                         |          | 0.001 μF, Cer, 500 V              |
| C100              | 281-0064-00           |                         |          | 0.25-1.5 pF, Var, Cer             |
| C101              | 281-0661-00           | B010100                 | B019999X | 0.8 pF, Cer, 500 V, ±0.1 pF       |
| C106 <sup>}</sup> | 307-1010-00           |                         |          | Attenuator strip 2X               |
| C107 <sup>}</sup> |                       |                         |          |                                   |
| C110 <sup>}</sup> | 307-1011-00           |                         |          | Attenuator strip 4X               |
| C111 <sup>}</sup> |                       |                         |          |                                   |
| C114 <sup>}</sup> | 307-1013-00           |                         |          | Attenuator strip 10X              |
| C115 <sup>}</sup> |                       |                         |          |                                   |
| C118 <sup>}</sup> | 307-1014-00           |                         |          | Attenuator strip 100"             |
| C119 <sup>}</sup> |                       |                         |          |                                   |
| C210              | 283-0001-00           |                         |          | 0.005 μF, Cer, 500 V              |
| C212              | 281-0557-00           |                         |          | 1.8 pF, Cer, 500 V                |
| C216              | 290-0512-00           |                         |          | 22 μF, Elect., 15 V               |
| C225              | 281-0638-00           |                         |          | 240 pF, Cer, 500 V, 5%            |
| C231              | 283-0000-00           |                         |          | 0.001 μF, Cer, 500 V              |
| C235              | 283-0000-00           |                         |          | 0.001 μF, Cer, 500 V              |
| C240              | 281-0628-00           |                         |          | 15 pF, Cer, 600 V, 5%             |
| C241              | 281-0517-00           |                         |          | 39 pF, Cer, 500 V, 10%            |
| C243              | 281-0580-00           |                         |          | 470 pF, Cer, 500 V, 10%           |
| C244              | 283-0000-00           |                         |          | 0.001 μF, Cer, 500 V              |
| C250              | 281-0536-00           |                         |          | 1000 pF, Cer, 500 V, 10%          |
| C261              | 281-0580-00           |                         |          | 470 pF, Cer, 500 V, 10%           |
| C270              | 283-0002-00           |                         |          | 0.01 μF, Cer, 500 V               |
| C281              | 283-0002-00           |                         |          | 0.01 μF, Cer, 500 V               |
| C282              | 283-0002-00           |                         |          | 0.01 μF, Cer, 500 V               |
| C283              | 283-0002-00           |                         |          | 0.01 μF, Cer, 500 V               |
| C284              | 283-0002-00           |                         |          | 0.01 μF, Cer, 500 V               |

<sup>1</sup>7A15AN only.<sup>2</sup>7A15A only.

| Ckt. No.                            | Tektronix Part No. | Serial/Model No.<br>Eff | Disc | Description   |
|-------------------------------------|--------------------|-------------------------|------|---|
| <b>CAPACITORS (cont)</b>            |                    |                         |      |   |
| C285                                | 283-0002-00        |                         |      | 0.01 $\mu$ F, Cer, 500 V                                  |
| C286                                | 283-0002-00        |                         |      | 0.01 $\mu$ F, Cer, 500 V                                  |
| C287                                | 283-0002-00        |                         |      | 0.01 $\mu$ F, Cer, 500 V                                  |
| C288                                | 283-0002-00        |                         |      | 0.01 $\mu$ F, Cer, 500 V                                  |
| C313                                | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C316                                | 290-0512-00        |                         |      | 22 $\mu$ F, Elect., 15 V, 20%                             |
| C325                                | 281-0638-00        |                         |      | 240 pF, Cer, 500 V, 5%                                    |
| C339                                | 281-0509-00        |                         |      | 15 pF, Cer, 500 V, 10%                                    |
| C341                                | 281-0153-00        |                         |      | 1.7 - 10 pF, Air, 250 V                                   |
| C343                                | 281-0580-00        |                         |      | 470 pF, Cer, 500 V, 10%                                   |
| C344                                | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C345                                | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C346                                | 281-0592-00        |                         |      | 4.7 pF, Cer, 500 V, $\pm$ 0.5 pF                          |
| C350                                | 281-0536-00        |                         |      | 1000 pF, Cer, 500 V, 10%                                  |
| C361 <sup>1</sup>                   | 281-0580-00        |                         |      | 470 pF, Cer, 500 V, 10%                                   |
| C621 <sub>1</sub>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C630 <sub>1</sub>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C631 <sub>1</sub>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C634 <sup>1</sup>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C635 <sup>1</sup>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C638 <sup>1</sup>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C639 <sup>1</sup>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C641 <sup>1</sup>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C643 <sup>1</sup>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C647 <sup>1</sup>                   | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| C648 <sup>1</sup>                   | 283-0003-00        |                         |      | 0.01 $\mu$ F, Cer, 150 V, $\pm$ 80%-20%                   |
| C649                                | 283-0000-00        |                         |      | 0.001 $\mu$ F, Cer, 500 V                                 |
| <b>SEMICONDUCTOR DEVICE, DIODES</b> |                    |                         |      |   |
| CR42 <sup>1</sup>                   | 152-0185-00        |                         |      | Silicon, selected from 1N4152 or 1N3605                   |
| CR46 <sup>1</sup>                   | 152-0185-00        |                         |      | Silicon, selected from 1N4152 or 1N3605                   |
| CR210                               | 152-0321-00        |                         |      | Silicon, replaceable by FSA1480                           |
| CR621 <sup>1</sup>                  | 152-0185-00        |                         |      | Silicon, selected from 1N4152 or 1N3605                   |
| CR647 <sup>1</sup>                  | 152-0185-00        |                         |      | Silicon, selected from 1N4152 or 1N3605                   |
| <b>CONNECTORS</b>                   |                    |                         |      |   |
| J10 <sup>1</sup>                    | 131-0679-00        |                         |      | Receptacle, electrical, BNC, 3 contact                    |
| J10 <sup>2</sup>                    | 131-0126-00        |                         |      | Receptacle, electrical, BNC, female                       |
| <b>INDUCTORS</b>                    |                    |                         |      |   |
| L339                                | 276-0507-00        |                         |      | Core, ferramic suppressor                                 |
| LR281                               | 108-0184-00        |                         |      | 3.2 $\mu$ H (wound on a 10 $\Omega$ , 1/2 W, 5% resistor) |
| LR283                               | 108-0184-00        |                         |      | 3.2 $\mu$ H (wound on a 10 $\Omega$ , 1/2 W, 5% resistor) |
| LR285                               | 108-0184-00        |                         |      | 3.2 $\mu$ H (wound on a 10 $\Omega$ , 1/2 W, 5% resistor) |
| LR287                               | 108-0184-00        |                         |      | 3.2 $\mu$ H (wound on a 10 $\Omega$ , 1/2 W, 5% resistor) |

<sup>1</sup> 7A15A only<sup>2</sup> 7A15AN only

| Ckt. No.           | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Serial/Model No.<br>Disc | Description   |
|--------------------|-----------------------|-------------------------|--------------------------|---|
| <b>TRANSISTORS</b> |                       |                         |                          |   |
| Q210A,B            | 151-1032-00           |                         |                          | Silicon, FET, selected from D/2N5397 or<br>replaceable by DN399 |
| Q220 <sup>1</sup>  | 153-0596-00           |                         |                          | Silicon, NPN, selected from 2N3563 or<br>replaceable by CS23366 |
| Q230 <sup>2</sup>  | 153-0595-00           |                         |                          | Silicon, NPN, selected from 2N3563 or<br>replaceable by CS23366 |
| Q235 <sup>3</sup>  | 153-0597-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q240 <sup>4</sup>  | 153-0597-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q245 <sup>4</sup>  | 153-0597-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q250               | 151-0221-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q260               | 151-0269-00           |                         |                          | Silicon, NPN, replaceable by SE3005                             |
| Q270               | 151-0221-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q320 <sup>5</sup>  | 153-0596-00           |                         |                          | Silicon, NPN, selected from 2N3563 or<br>replaceable by CS23366 |
| Q330 <sup>6</sup>  | 153-0595-00           |                         |                          | Silicon, NPN, selected from 2N3563 or<br>replaceable by CS23366 |
| Q335 <sup>6</sup>  | 153-0595-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q340 <sup>7</sup>  | 153-0597-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q345 <sup>8</sup>  | 153-0597-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q350               | 151-0221-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q360               | 151-0269-00           |                         |                          | Silicon, NPN, replaceable by SE3005                             |
| Q370 <sup>9</sup>  | 151-0221-00           |                         |                          | Silicon, PNP, replaceable by 2N4258                             |
| Q620               | 151-0254-00           |                         |                          | Silicon, NPN, replaceable by 2N5308                             |
| <b>RESISTORS</b>   |                       |                         |                          |   |
| R10 <sup>10</sup>  | 315-0620-00           |                         |                          | 62 Ω, 1/4 W, 5%   |
| R45 <sup>11</sup>  | 311-1320-00           |                         |                          | 5 kΩ, Var   |
| R45 <sup>9</sup>   | 311-0310-00           |                         |                          | 5 kΩ, Var   |
| R46 <sup>9</sup>   | 316-0224-00           |                         |                          | 220 kΩ, 1/4 W, 10%  |
| R47 <sup>9</sup>   | 315-0113-00           |                         |                          | 11 kΩ, 1/4 W, 5%  |
| R48 <sup>9</sup>   | 316-0101-00           |                         |                          | 100 Ω, 1/4 W, 10%   |
| R102               | 317-0105-00           |                         |                          | 1 MΩ, 1/8 W, 5%   |
| R130               | 322-0481-01           |                         |                          | 1 MΩ, 1/4 W, 1/2%   |
| R210               | 316-0474-00           |                         |                          | 470 kΩ, 1/4 W, 10%  |
| R212               | 315-0561-00           |                         |                          | 560 Ω, 1/4 W, 5%  |

<sup>1</sup> Furnished as a matched pair with Q320.

<sup>2</sup> Furnished as a matched quad with Q330 and Q335.

<sup>3</sup> Furnished as a matched pair with Q340.

<sup>4</sup> Furnished as a matched pair with Q345.

<sup>5</sup> Furnished as a matched pair with Q220.

<sup>6</sup> Furnished as a matched quad with Q230 and Q235.

<sup>7</sup> Furnished as a matched pair with Q240.

<sup>8</sup> Furnished as a matched pair with Q245.

<sup>9</sup> 7A15A only

<sup>10</sup> 7A15A only, furnished as a unit with S45.

<sup>11</sup> 7A15AN only

| Ckt. No.          | Tektronix<br>Part No. | Serial/Model<br>Eff | No.<br>Disc | Description        |
|-------------------|-----------------------|---------------------|-------------|--------------------|
| RESISTORS (cont)  |                       |                     |             |                    |
| R213              | 316-0470-00           |                     |             | 47 Ω, 1/4 W, 10%   |
| R215              | 315-0391-00           |                     |             | 390 Ω, 1/4 W, 5%   |
| R216              | 315-0911-00           |                     |             | 910 Ω, 1/4 W, 5%   |
| R218              | 321-0032-00           |                     |             | 21 Ω, 1/8 W, 1%    |
| R221              | 311-0633-00           |                     |             | 5 kΩ, Var          |
| R223              | 323-0257-00           |                     |             | 4.64 kΩ, 1/4 W, 1% |
| R224              | 321-0032-00           |                     |             | 21 Ω, 1/8 W, 1%    |
| R225              | 315-0471-00           |                     |             | 470 Ω, 1/4 W, 5%   |
| R231              | 315-0821-00           |                     |             | 820 Ω, 1/4 W, 5%   |
| R234              | 315-0241-00           |                     |             | 240 Ω, 1/4 W, 5%   |
| R235              | 315-0821-00           |                     |             | 820 Ω, 1/4 W, 5%   |
| R236              | 321-0122-00           |                     |             | 182 Ω, 1/8 W, 1%   |
| R237              | 321-0153-00           |                     |             | 383 Ω, 1/8 W, 1%   |
| R238 <sup>1</sup> | 311-0310-00           |                     |             | 5 kΩ, Var          |
| R239              | 311-1094-00           |                     |             | 2.5 kΩ, Var        |
| R240              | 321-0118-00           |                     |             | 165 Ω, 1/8 W, 1%   |
| R241              | 315-0302-00           |                     |             | 3 kΩ, 1/4 W, 5%    |
| R242              | 323-0255-00           |                     |             | 4.42 kΩ, 1/2 W, 1% |
| R243              | 315-0241-00           |                     |             | 240 Ω, 1/4 W, 5%   |
| R244              | 315-0471-00           |                     |             | 470 Ω, 1/4 W, 5%   |
| R245              | 311-1007-00           |                     |             | 20 Ω, Var          |
| R246              | 316-0272-00           |                     |             | 2.7 kΩ, 1/4 W, 10% |
| R247              | 316-0473-00           |                     |             | 47 kΩ, 1/4 W, 10%  |
| R248              | 311-0613-00           |                     |             | 100 kΩ, Var        |
| R249              | 323-0255-00           |                     |             | 4.42 kΩ, 1/2 W, 1% |
| R250              | 315-0241-00           |                     |             | 240 Ω, 1/4 W, 5%   |
| R251              | 321-0137-00           |                     |             | 261 Ω, 1/8 W, 1%   |
| R252              | 323-0153-00           |                     |             | 383 Ω, 1/2 W, 1%   |
| R253              | 315-0103-00           |                     |             | 10 kΩ, 1/4 W, 5%   |
| R260              | 323-0210-00           |                     |             | 1.5 kΩ, 1/2 W, 1%  |
| R261              | 315-0241-00           |                     |             | 240 Ω, 1/4 W, 5%   |
| R262              | 323-0164-00           |                     |             | 499 Ω, 1/2 W, 1%   |
| R270              | 316-0331-00           |                     |             | 330 Ω, 1/4 W, 10%  |
| R271              | 315-0152-00           |                     |             | 1.5 kΩ, 1/4 W, 5%  |
| R280              | 316-0470-00           |                     |             | 47 Ω, 1/4 W, 10%   |
| R281              | 316-0470-00           |                     |             | 47 Ω, 1/4 W, 10%   |
| R313              | 316-0105-00           |                     |             | 1 MΩ, 1/4 W, 10%   |
| R315              | 315-0391-00           |                     |             | 390 Ω, 1/4 W, 5%   |
| R316              | 315-0911-00           |                     |             | 910 Ω, 1/4 W, 5%   |
| R318              | 321-0032-00           |                     |             | 21 Ω, 1/8 W, 1%    |
| R322              | 315-0123-00           |                     |             | 12 kΩ, 1/4 W, 5%   |
| R323              | 315-0131-00           |                     |             | 131 Ω, 1/4 W, 5%   |
| R324              | 321-0032-00           |                     |             | 21 Ω, 1/8 W, 1%    |
| R325              | 315-0471-00           |                     |             | 470 Ω, 1/4 W, 5%   |
| R331              | 315-0621-00           |                     |             | 620 Ω, 1/4 W, 5%   |
| R335              | 315-0621-00           |                     |             | 620 Ω, 1/4 W, 5%   |
| R336              | 321-0122-00           |                     |             | 182 Ω, 1/8 W, 1%   |
| R338              | 315-0621-00           |                     |             | 620 Ω, 1/4 W, 5%   |
| R339              | 315-0131-00           |                     |             | 131 Ω, 1/4 W, 5%   |
| R341              | 311-0634-00           |                     |             | 500 Ω, Var         |
| R342              | 323-0255-00           |                     |             | 4.42 kΩ, 1/2 W, 1% |

<sup>1</sup> Furnished as a unit with S239.

| Ckt. No.               | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Serial/Model No.<br>Disc | Description |
|------------------------|-----------------------|-------------------------|--------------------------|-------------|
| RESISTORS (cont)       |                       |                         |                          |             |
| R343                   | 315-0241-00           |                         | 240 Ω, 1/4 W, 5%         |             |
| R344                   | 315-0471-00           |                         | 470 Ω, 1/4 W, 5%         |             |
| R345                   | 315-0133-00           |                         | 13 kΩ, 1/4 W, 5%         |             |
| R349                   | 323-0255-00           |                         | 4.42 kΩ, 1/2 W, 1%       |             |
| R350                   | 315-0241-00           |                         | 240 Ω, 1/4 W, 5%         |             |
| R351                   | 321-0137-00           |                         | 261 Ω, 1/8 W, 1%         |             |
| R352                   | 321-0109-00           |                         | 133 Ω, 1/8 W, 1%         |             |
| R353                   | 315-0122-00           |                         | 1.2 kΩ, 1/4 W, 5%        |             |
| R360                   | 323-0210-00           |                         | 1.5 kΩ, 1/2 W, 1%        |             |
| R361                   | 315-0241-00           |                         | 240 Ω, 1/4 W, 5%         |             |
| R362                   | 323-0164-00           |                         | 499 Ω, 1/2 W, 1%         |             |
| R371 <sup>1</sup>      | 315-0152-00           |                         | 1.5 kΩ, 1/4 W, 5%        |             |
| R621 <sup>1</sup>      | 321-0223-00           |                         | 2.05 kΩ, 1/8 W, 1%       |             |
| R622 <sup>1</sup>      | 321-0296-00           |                         | 11.8 kΩ, 1/8 W, 1%       |             |
| R630 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| R631 <sup>1</sup>      | 315-0753-00           |                         | 75 kΩ, 1/4 W, 5%         |             |
| R633 <sup>1</sup>      | 315-0753-00           |                         | 75 kΩ, 1/4 W, 5%         |             |
| R634 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| R635 <sup>1</sup>      | 321-0344-00           |                         | 37.4 kΩ, 1/8 W, 1%       |             |
| R637 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| R638 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| R639 <sup>1</sup>      | 315-0753-00           |                         | 75 kΩ, 1/4 W, 5%         |             |
| R640 <sup>1</sup>      | 315-0753-00           |                         | 75 kΩ, 1/4 W, 5%         |             |
| R641 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| R642 <sup>1</sup>      | 315-0513-00           |                         | 51 kΩ, 1/4 W, 5%         |             |
| R643 <sup>1</sup>      | 321-0344-00           |                         | 37.4 kΩ, 1/8 W, 1%       |             |
| R645 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| R646 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| R647 <sup>1</sup>      | 315-0133-00           |                         | 13 kΩ, 1/4 W, 5%         |             |
| R648 <sup>1</sup>      | 315-0154-00           |                         | 150 kΩ, 1/4 W, 5%        |             |
| SWITCHES               |                       |                         |                          |             |
| S32 <sup>2</sup>       | 260-0816-00           |                         | Slide, POLARITY          |             |
| S45 <sup>2</sup>       |                       |                         | Pushbutton, IDENTIFY     |             |
| S47A,B <sup>5</sup>    | 260-0816-00           |                         | Slide, MAG               |             |
| S239 <sup>5</sup>      |                       |                         | Rotary, CAL/UNCAL        |             |
| S100A,B,C <sup>3</sup> | 672-0023-00           |                         | Cam, VOLTS/DIV           |             |
| S100A,B,C <sup>4</sup> | 670-1706-00           |                         | Cam, VOLTS/DIV           |             |

<sup>1</sup> 7A15A only.<sup>2</sup> 7A15A only, furnished as a unit with R45.<sup>3</sup> 7A15A only. See Mechanical Parts List for replacement parts.<sup>4</sup> 7A15AN only. See Mechanical Parts List for replacement parts.<sup>5</sup> Furnished as a unit with R239.

# SECTION 7

## DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

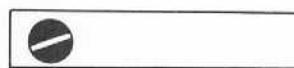
### Symbols and Reference Designators

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 ( $\mu\text{F}$ ).  
 Resistors = Ohms ( $\Omega$ )

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

The following special symbols are used on the diagrams:



External Screwdriver adjustment.



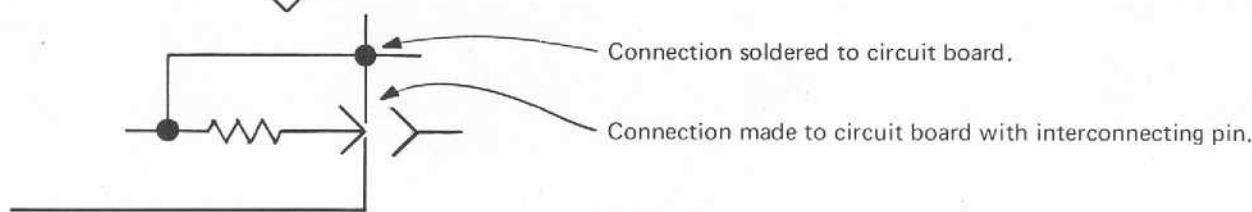
External control or connector.



Clockwise control rotation in direction of arrow.

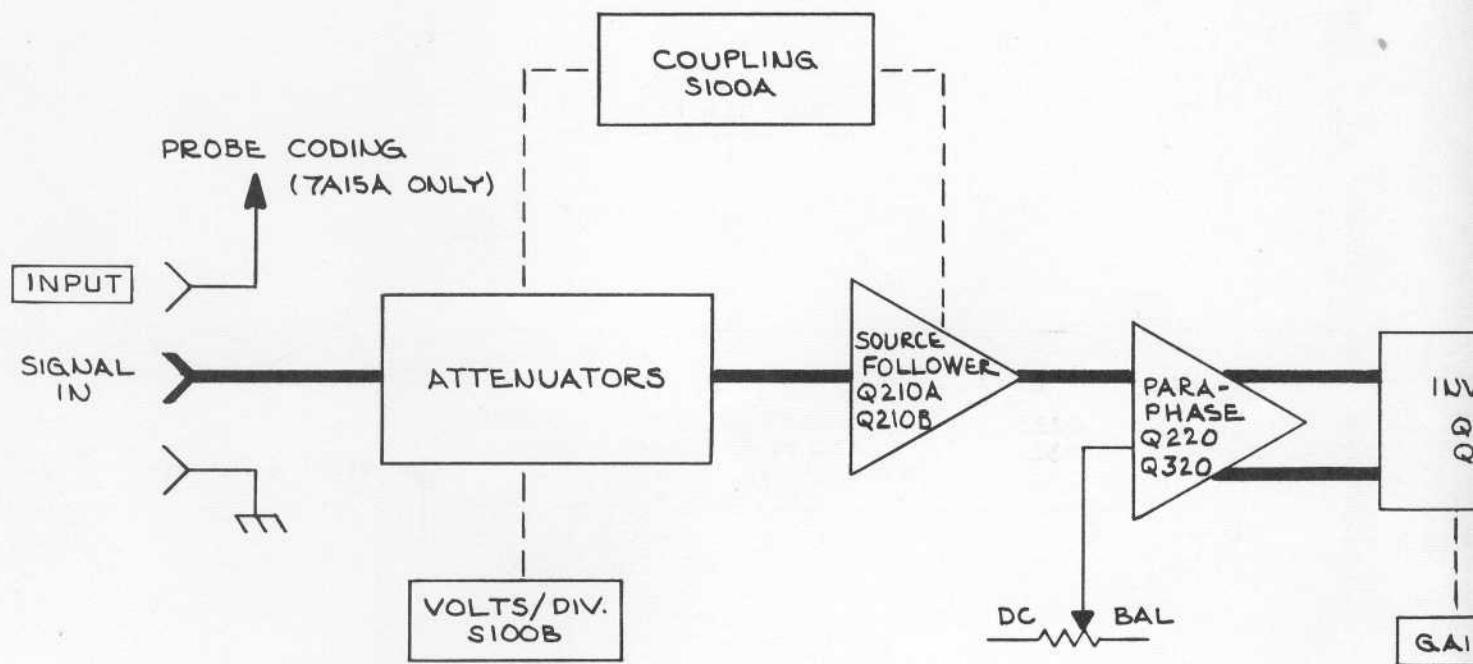


Refer to diagram number indicated in diamond.



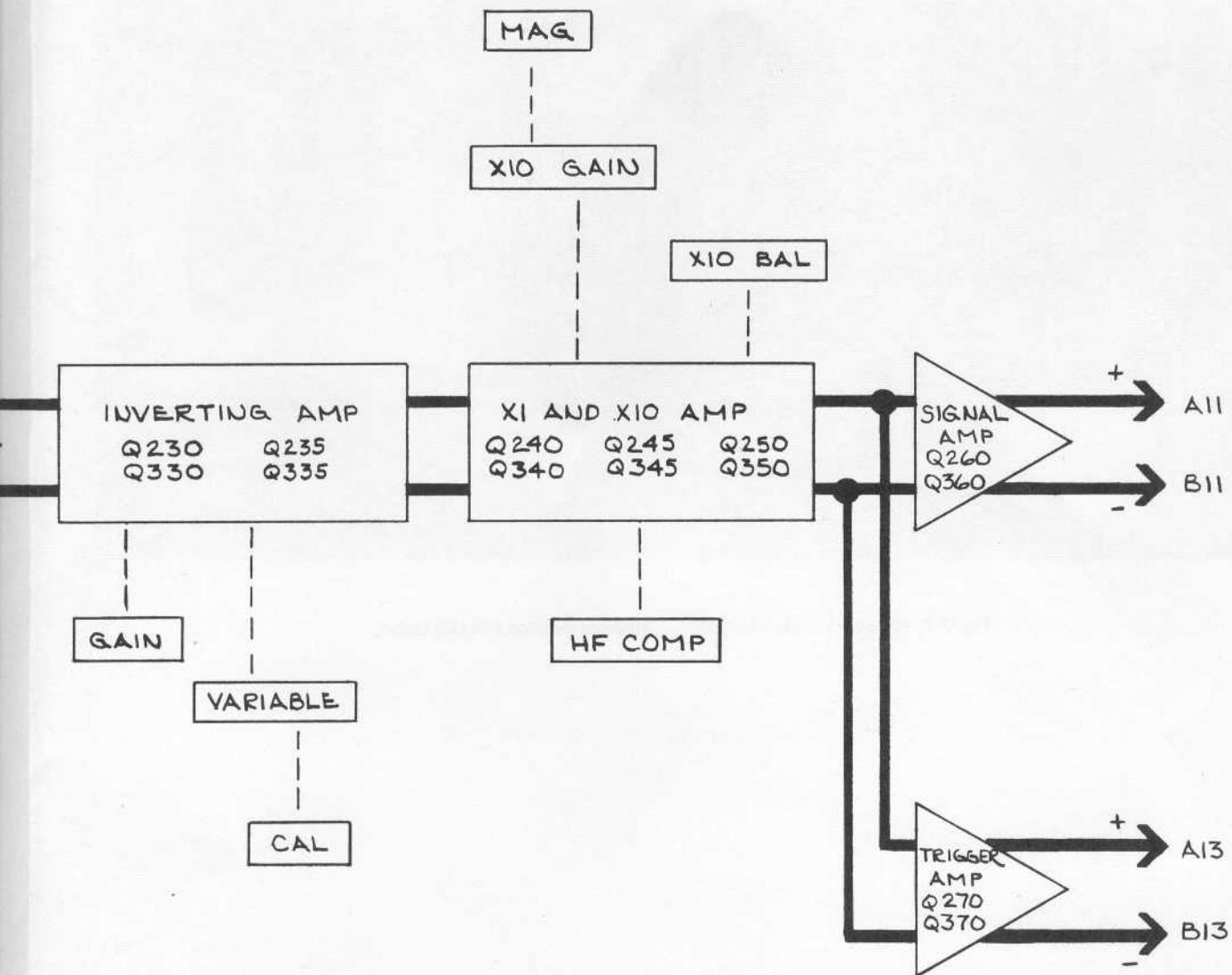
The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

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



7A15A / 7A15N

(A)



BLOCK DIAGRAM

671  
RHL

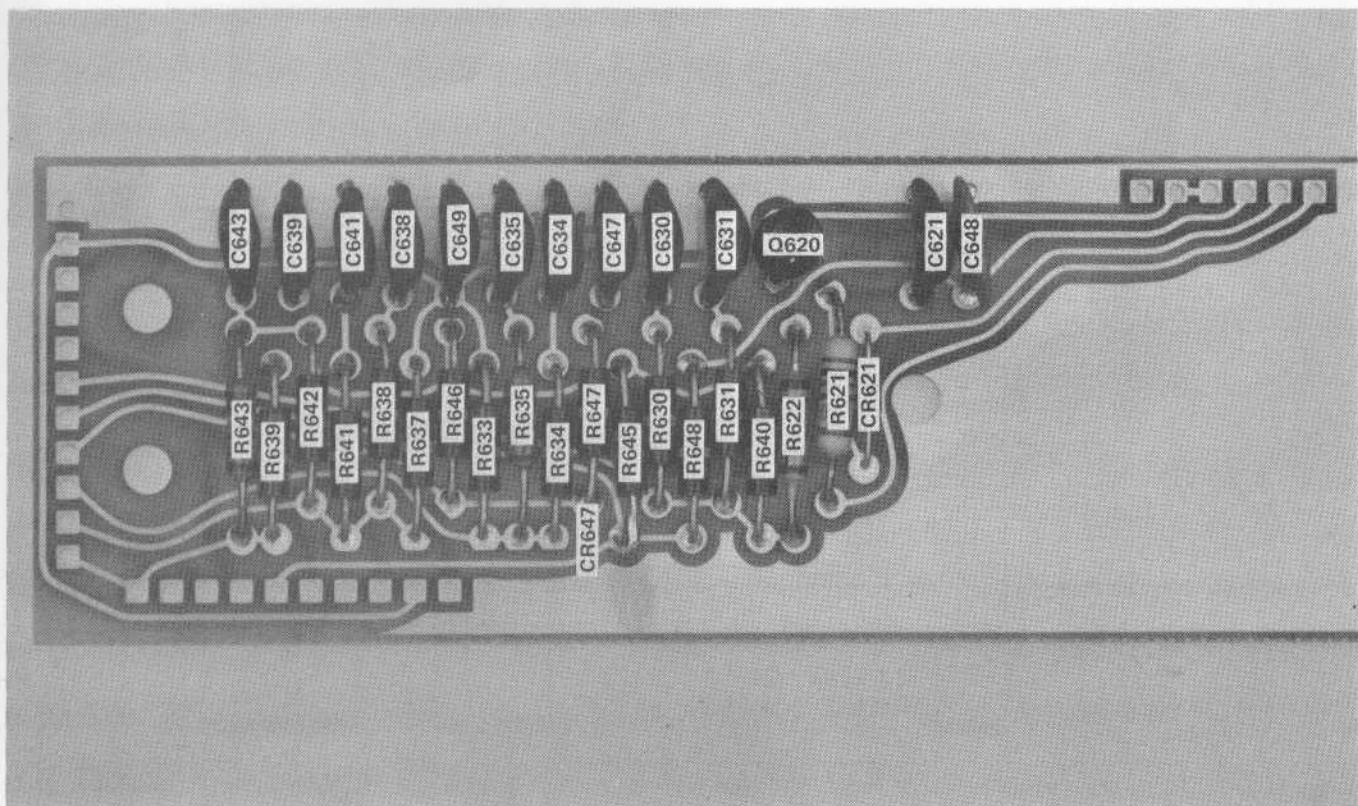
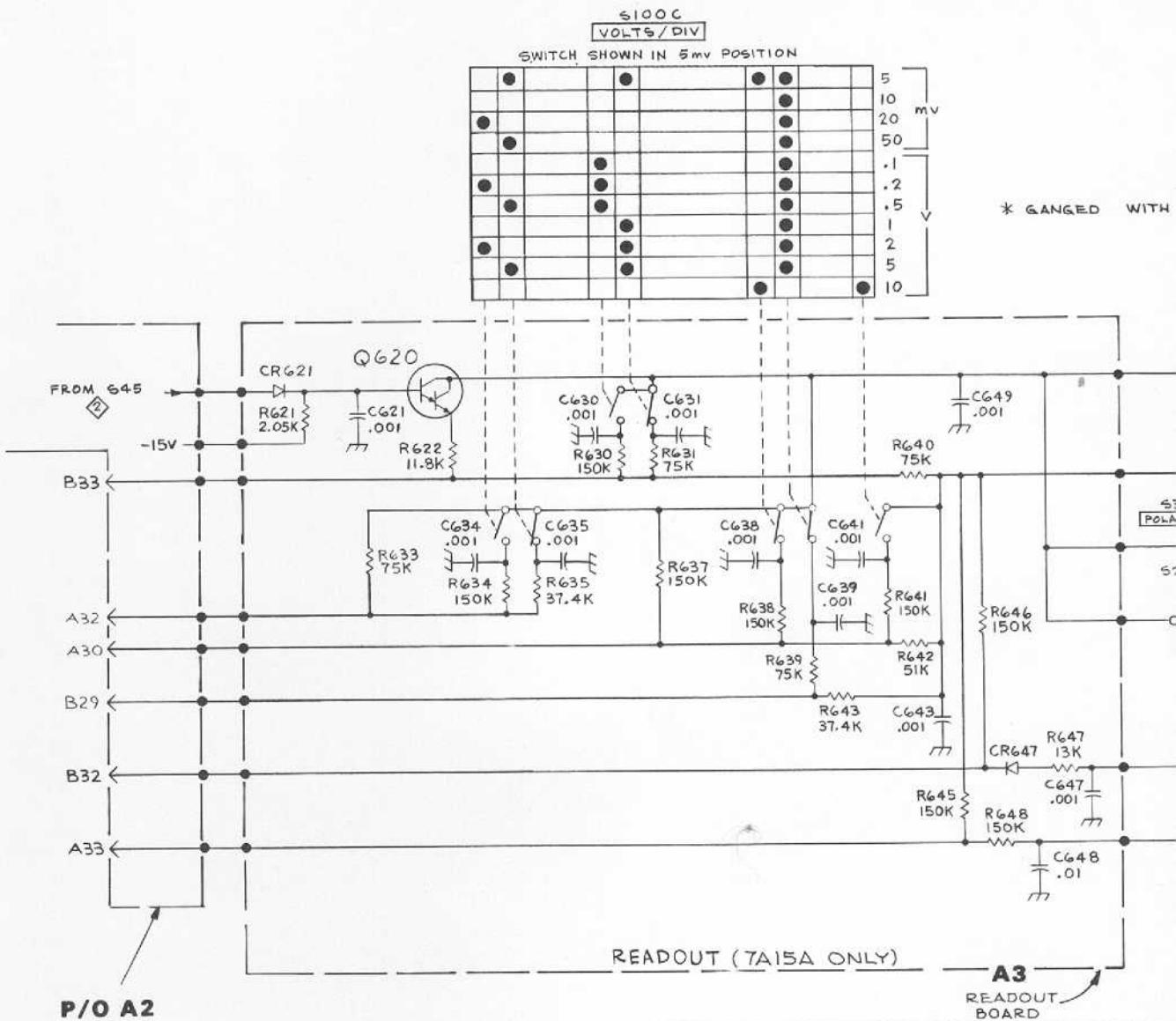
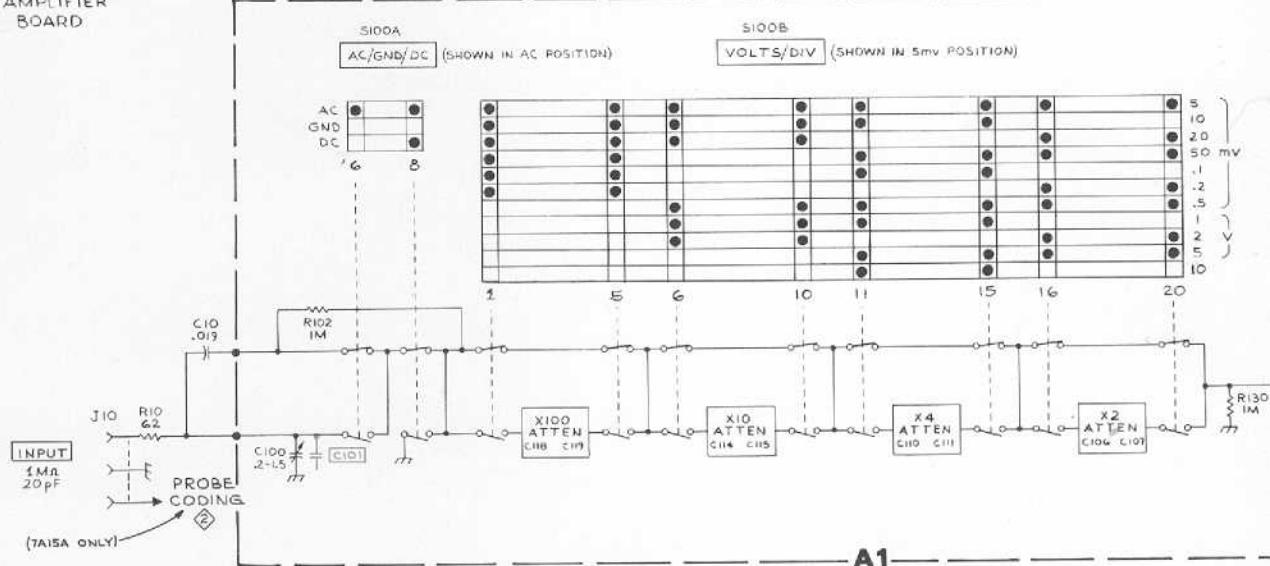


Fig. 7-1. Readout circuit board with component location (7A15A Only).

(A)



**P/O A2**  
AMPLIFIER  
BOARD

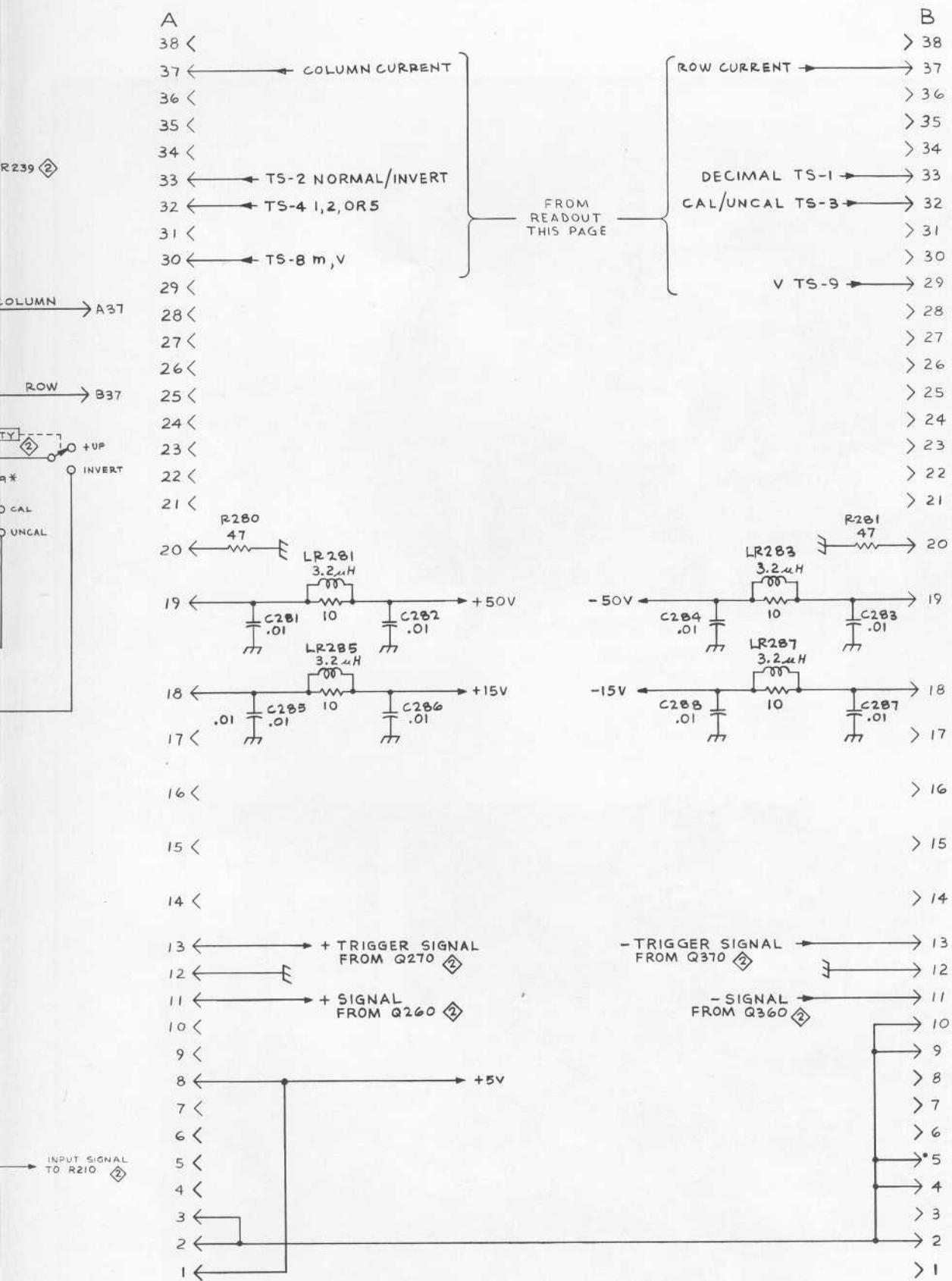


SEE PARTS LIST FOR EARLIER  
VALUES AND SERIAL NUMBER  
RANGES OF PARTS MARKED  
WITH BLUE OUTLINE.

7A15A / 7A15AN

ATTENUATOR, READOUT  
& CONNECTORS

1



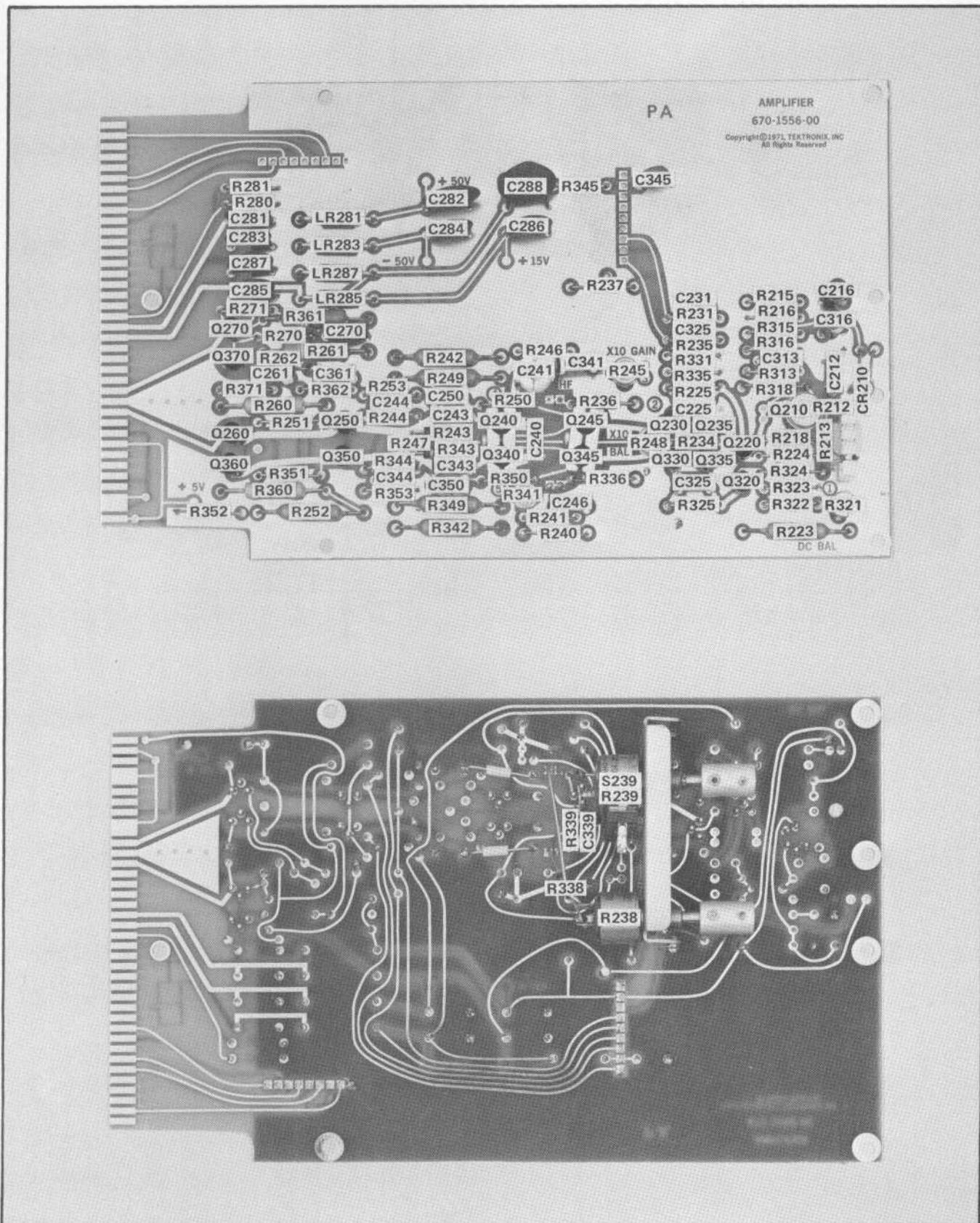
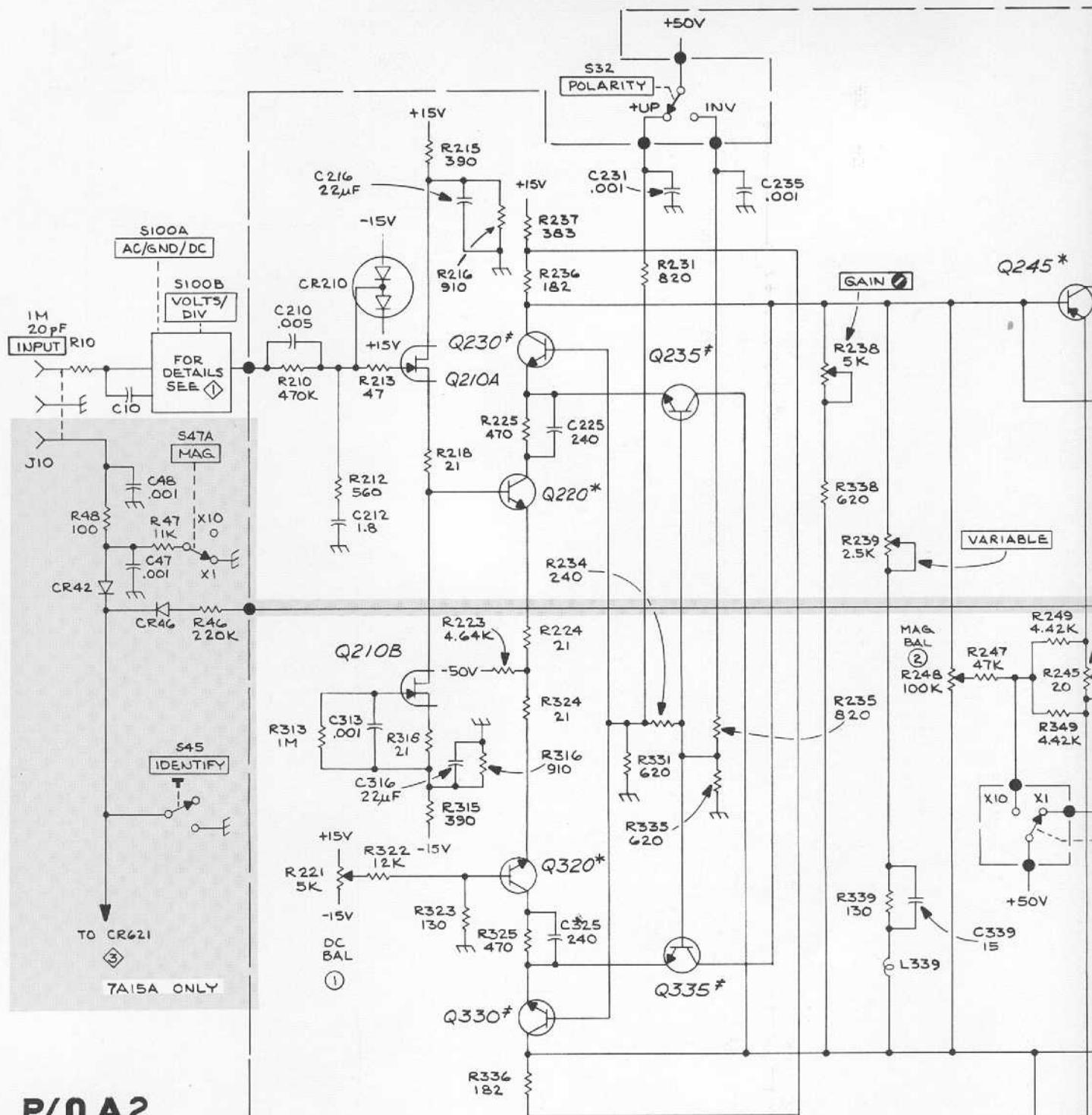


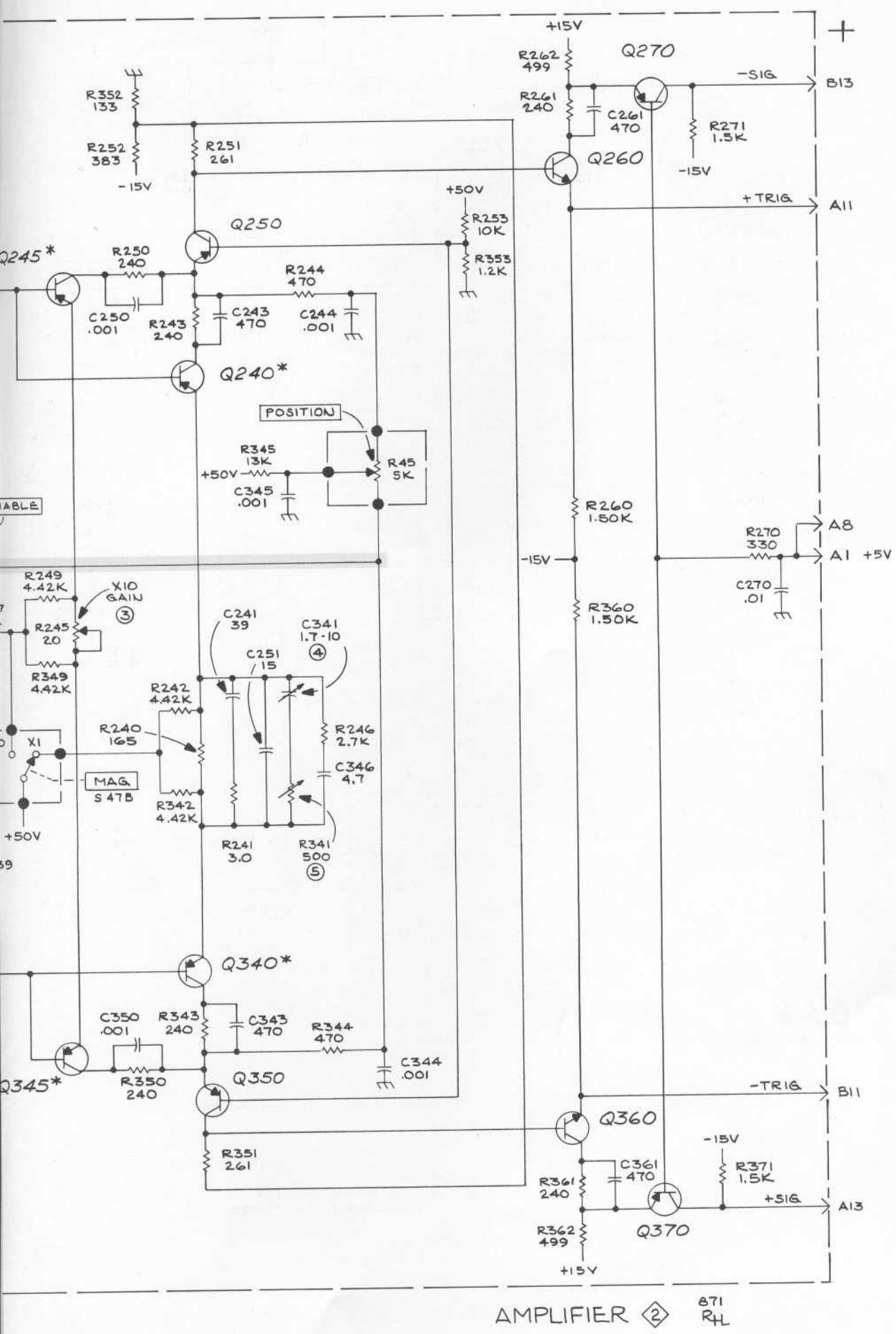
Fig. 7-2. Amplifier circuit board and component location.



\* MATCHED PAIRS Q220, Q320: Q240, Q340; Q245, Q345  
# MATCHED QUAD Q230, Q235, Q330, Q335

NOTES:  
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

AMPLIFIER



# SECTION 8

## MECHANICAL PARTS LIST

FIGURE 1 EXPLODED

| Fig. &<br>Index<br>No. | Tektronix<br>Part No.    | Serial/Model No.<br>Eff | Disc | Q |   |   |  |   | Description |   |  |
|------------------------|--------------------------|-------------------------|------|---|---|---|--|---|-------------|---|--|
|                        |                          |                         |      | t | y | 1 | 2  | 3 | 4           | 5 |  |
| 1-1                    | 366-1058-34 <sup>1</sup> |                         |      |   |   | 1 | KNOB, latch                                      |   |             |   |  |
| -2                     | 366-1058-33 <sup>2</sup> |                         |      |   |   | 1 | KNOB, latch                                      |   |             |   |  |
|                        | -----                    |                         |      |   |   | - | mounting hardware: (not included w/knob)         |   |             |   |  |
| -3                     | 214-1095-00              |                         |      |   |   | 1 | PIN, spring                                      |   |             |   |  |
|                        |                          |                         |      |   |   |   |  |   |             |   |  |
| -4                     | 105-0076-00              |                         |      |   |   | 1 | RELEASE BAR, latch                               |   |             |   |  |
| -5                     | 214-1280-00              |                         |      |   |   | 1 | SPRING, helical extension                        |   |             |   |  |
| -6                     | 214-1054-00              |                         |      |   |   | 1 | SPRING, flat, latch detent                       |   |             |   |  |
| -7                     | 105-0075-00              |                         |      |   |   | 1 | BOLT, latch detent                               |   |             |   |  |
| -8                     | 348-0235-00              |                         |      |   |   | 2 | SHIELDING GASKET, electrical                     |   |             |   |  |
| -9                     | 366-1059-00 <sup>2</sup> |                         |      |   |   | 1 | KNOB, push-on, light gray--IDENTIFY              |   |             |   |  |
| -10                    | 366-1077-00 <sup>2</sup> |                         |      |   |   | 1 | KNOB, gray--POSITION                             |   |             |   |  |
|                        | -----                    |                         |      |   |   | - | knob includes:                                   |   |             |   |  |
|                        | 213-0153-00 <sup>1</sup> |                         |      |   |   | 1 | SETSCREW, 5-40 x 0.125 inch, HHS                 |   |             |   |  |
| -11                    | 366-0494-00 <sup>1</sup> |                         |      |   |   | 1 | KNOB, gray--POSITION                             |   |             |   |  |
|                        | -----                    |                         |      |   |   | - | knob includes:                                   |   |             |   |  |
|                        | 213-0153-00              |                         |      |   |   | 1 | SETSCREW, 5-40 x 0.125 inch, HHS                 |   |             |   |  |
| -12                    | 366-1031-03              |                         |      |   |   | 1 | KNOB, red--VARIABLE                              |   |             |   |  |
|                        | -----                    |                         |      |   |   | - | knob includes:                                   |   |             |   |  |
|                        | 213-0153-00              |                         |      |   |   | 1 | SETSCREW, 5-40 x 0.125 inch, HHS                 |   |             |   |  |
| -13                    | 366-1299-00              |                         |      |   |   | 1 | KNOB, gray--VOLTS/DIVISION                       |   |             |   |  |
|                        | -----                    |                         |      |   |   | - | knob includes:                                   |   |             |   |  |
|                        | 213-0153-00              |                         |      |   |   | 1 | SETSCREW, 5-40 x 0.125 inch, HHS                 |   |             |   |  |
| -14                    | 358-0378-00 <sup>2</sup> |                         |      |   |   | 1 | BUSHING, sleeve, front panel trim                |   |             |   |  |
| -15                    | 333-1474-00 <sup>1</sup> |                         |      |   |   | 1 | PANEL, front                                     |   |             |   |  |
| -16                    | 333-1475-00 <sup>1</sup> |                         |      |   |   | 1 | PANEL, front                                     |   |             |   |  |
| -17                    | 366-0215-02 <sup>2</sup> |                         |      |   |   | 1 | KNOB, push-on--AC GND DC                         |   |             |   |  |
| -18                    | 131-0679-00 <sup>2</sup> |                         |      |   |   | 1 | CONNECTOR, receptacle, 3 contact BNC, w/hardware |   |             |   |  |
|                        | -----                    |                         |      |   |   | - | mounting hardware: (not included w/connector)    |   |             |   |  |
| -19                    | 220-0569-00              |                         |      |   |   | 1 | NUT, knurled, 0.50-28 x 0.53 inch OD             |   |             |   |  |
|                        |                          |                         |      |   |   |   |  |   |             |   |  |
| -20                    | 131-0126-00 <sup>1</sup> |                         |      |   |   | 1 | CONNECTOR, receptacle, female BNC, w/hardware    |   |             |   |  |
|                        | -----                    |                         |      |   |   | - | mounting hardware: (not included w/connector)    |   |             |   |  |
|                        | 220-0569-00              |                         |      |   |   | 1 | NUT, knurled, 0.50-28 x 0.53 inch OD             |   |             |   |  |

<sup>1</sup>7A15AN only.<sup>2</sup>7A15A only.

FIGURE 1 EXPLODED (cont)

| Fig. &<br>Index | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Disc | Q  |   |  |   |   | Description |
|-----------------|-----------------------|-------------------------|------|----|---|--|---|---|-------------|
|                 |                       |                         |      | t  | y | 1  | 2 | 3 |             |
| 1-21            | 260-0816-00           |                         |      | 2  |   | SWITCH, slide--POLARITY & MAG                              |   |   |             |
|                 | -----                 |                         |      | -  |   | mounting hardware for each: (not included w/switch)        |   |   |             |
| -22             | 211-0030-00           |                         |      | 2  |   | SCREW, 2-56 x 0.25 inch, 82° csk, FHS                      |   |   |             |
| -23             | 210-0405-00           |                         |      | 2  |   | NUT, hex., 2-56 x 0.188 inch                               |   |   |             |
| <br>-24         |                       |                         |      | 1  |   | RESISTOR, variable   |   |   |             |
| -----<br>-25    |                       |                         |      | -  |   | mounting hardware: (not included w/resistor)               |   |   |             |
| -26             |                       |                         |      | 2  |   | NUT, hex., 0.25-32 x 0.312 inch                            |   |   |             |
| -27             |                       |                         |      | 1  |   | WASHER, lock, internal, 0.261 ID x 0.40 inch OD            |   |   |             |
| <br>-28         |                       |                         |      | 1  |   | RESISTOR, variable   |   |   |             |
| -29             |                       |                         |      | -  |   | mounting hardware: (not included w/resistor)               |   |   |             |
| -30             |                       |                         |      | 2  |   | NUT, hex., 0.25-32 x 0.312 inch                            |   |   |             |
| -31             |                       |                         |      | 1  |   | WASHER, lock, internal, 0.261 ID x 0.40 inch OD            |   |   |             |
| <br>-32         |                       |                         |      | 1  |   | SUBPANEL, front  |   |   |             |
| -----           |                       |                         |      | -  |   | mounting hardware: (not included w/subpanel)               |   |   |             |
| -33             |                       |                         |      | 4  |   | SCREW, thread forming, 6-32 x 0.50 inch, Fil HS            |   |   |             |
| <br>-34         |                       |                         |      | 2  |   | SHIELD, electrical, side                                   |   |   |             |
| -35             |                       |                         |      | 2  |   | SHIELD, electrical, side                                   |   |   |             |
| -36             |                       |                         |      | 1  |   | CIRCUIT BOARD ASSEMBLY--AMPLIFIER A2                       |   |   |             |
| -37             |                       |                         |      | -  |   | circuit board assembly includes:                           |   |   |             |
| -38             |                       |                         |      | 1  |   | CIRCUIT BOARD  |   |   |             |
| -39             |                       |                         |      | 53 |   | SOCKET, pin connector                                      |   |   |             |
| -40             |                       |                         |      | 3  |   | COVER HALF, temperature stabilizer                         |   |   |             |
| -41             |                       |                         |      | 3  |   | COVER HALF, temperature stabilizer, threaded               |   |   |             |
| -42             |                       |                         |      | 3  |   | SCREW, 2-56 x 0.25 inch, RHS                               |   |   |             |
| <br>-43         |                       |                         |      | 1  |   | TERMINAL STRIP, ceramic, 0.438 inch h w/4notches           |   |   |             |
| -----           |                       |                         |      | -  |   | terminal strip includes:                                   |   |   |             |
| -44             |                       |                         |      | 1  |   | STUD, plastic, short                                       |   |   |             |
| -45             |                       |                         |      | 1  |   | BRACKET, component mounting                                |   |   |             |
| -46             |                       |                         |      | 2  |   | RESISTOR, variable   |   |   |             |
| -47             |                       |                         |      | -  |   | mounting hardware for each: (not included w/resistor)      |   |   |             |
| -48             |                       |                         |      | 1  |   | NUT, hex., 0.25-32 x 0.312 inch                            |   |   |             |
| <br>-49         |                       |                         |      | 1  |   | WASHER, lock, internal, 0.261 ID x 0.40 inch OD            |   |   |             |
| -----           |                       |                         |      | -  |   | mounting hardware: (not included w/circuit board assembly) |   |   |             |
| -50             |                       |                         |      | 4  |   | SCREW, 4-40 x 0.25 inch, PHS                               |   |   |             |
| <br>-51         |                       |                         |      | 2  |   | COUPLING, shaft, w/2 setscrews                             |   |   |             |
| -----           |                       |                         |      | 1  |   | SHAFT, extension, 7.042 inches long                        |   |   |             |
| -52             |                       |                         |      | -  |   | shaft includes:  |   |   |             |
| -53             |                       |                         |      | 1  |   | SHAFT END  |   |   |             |
| -54             |                       |                         |      | 1  |   | SHAFT, extension, 8.122 inches long                        |   |   |             |
| -55             |                       |                         |      | 4  |   | NUT BLOCK  |   |   |             |
| <br>-56         |                       |                         |      | -  |   | mounting hardware for each: (not included w/nut block)     |   |   |             |
| -57             |                       |                         |      | 1  |   | SCREW, 4-40 x 0.188 inch, 100° csk, FHS                    |   |   |             |

<sup>1</sup>7A15A only<sup>2</sup>7A15AN only

## Mechanical Parts List—7A15A/AN

FIGURE 1 EXPLODED (cont)

| Fig. &<br>Index<br>No. | Tektronix<br>Part No.    | Serial/Model No.<br>Eff | Disc | Q |   |   |   |   | Description  |
|------------------------|--------------------------|-------------------------|------|---|---|---|---|---|--|
|                        |                          |                         |      | t | y | 1 | 2 | 3 |  |
| 1-49                   | 214-1061-00              |                         |      |   |   | 1 |   |   | SPRING, flat, sliding ground                               |
| -50                    | 386-1402-00              |                         |      |   |   | 1 |   |   | PANEL, rear  |
|                        | -----                    |                         |      |   |   | - |   |   | mounting hardware: (not included w/panel)                  |
| -51                    | 213-0192-00              |                         |      |   |   | 4 |   |   | SCREW, thread forming, 6-32 x 0.50 inch, Fil HS            |
| -52                    | 361-0326-00              |                         |      |   |   | 1 |   |   | SPACER, sleeve, 0.18 ID x 0.25 QD x 0.10 inch long         |
|                        |                          |                         |      |   |   |   |   |   |  |
| -53                    | 426-0736-00              |                         |      |   |   | 1 |   |   | FRAME SECTION, top   |
| -54                    | 210-0288-00              |                         |      |   |   | 1 |   |   | TERMINAL, lug, 0.125 ID x 1.125 inches long                |
|                        | -----                    |                         |      |   |   | - |   |   | mounting hardware: (not included w/terminal)               |
| -55                    | 211-0105-00              |                         |      |   |   | 1 |   |   | SCREW, 4-40 x 0.188 inch, 100° csk, FHS                    |
| -56                    | 210-0586-00              |                         |      |   |   | 1 |   |   | NUT, keps, 4-40 x 0.25 inch                                |
|                        |                          |                         |      |   |   |   |   |   |  |
| -57                    | 426-0737-00              |                         |      |   |   | 1 |   |   | FRAME SECTION, bottom                                      |
| -58                    | 129-0080-00 <sup>1</sup> |                         |      |   |   | 1 |   |   | POST, 4-40 x 0.875 inch long                               |
|                        | -----                    |                         |      |   |   | - |   |   | mounting hardware: (not included w/post)                   |
| -59                    | 211-0008-00              |                         |      |   |   | 2 |   |   | SCREW, 4-40 x 0.25 inch, PHS                               |
|                        |                          |                         |      |   |   |   |   |   |  |
| -60                    | 200-1199-00              |                         |      |   |   | 1 |   |   | COVER, attenuator  |
|                        | -----                    |                         |      |   |   | - |   |   | mounting hardware: (not included w/cover)                  |
| -61                    | 211-0007-00              |                         |      |   |   | 4 |   |   | SCREW, 4-40 x 0.188 inch, PHS                              |
| -62                    | 210-0994-00              |                         |      |   |   | 4 |   |   | WASHER, flat, 0.125 ID x 0.25 inch OD                      |
|                        |                          |                         |      |   |   |   |   |   |  |
| -63                    | 337-1423-00              |                         |      |   |   | 1 |   |   | SHIELD, attenuator, front                                  |
|                        | -----                    |                         |      |   |   | - |   |   | mounting hardware: (not included w/shield)                 |
| -64                    | 213-0055-00              |                         |      |   |   | 1 |   |   | SCREW, thread forming, 2-32 x 0.188 inch, PHS              |
|                        |                          |                         |      |   |   |   |   |   |  |
| -65                    | 407-0977-00              |                         |      |   |   | 1 |   |   | BRACKET  |
|                        | -----                    |                         |      |   |   | - |   |   | mounting hardware: (not included w/bracket)                |
| -66                    | 211-0008-00              |                         |      |   |   | 2 |   |   | SCREW, 4-40 x 0.25 inch, PHS                               |
| -67                    | 210-0586-00              |                         |      |   |   | 1 |   |   | NUT, keps, 4-40 x 0.25 inch                                |
|                        |                          |                         |      |   |   |   |   |   |  |
|                        | 672-0023-00 <sup>1</sup> |                         |      |   |   | 1 |   |   | CIRCUIT BOARD ASSEMBLY--READOUT ATTENUATOR                 |
|                        | 670-1706-00 <sup>2</sup> |                         |      |   |   | 1 |   |   | CIRCUIT BOARD ASSEMBLY--ATTENUATOR A1                      |
|                        | ----- <sup>2</sup>       |                         |      |   |   | - |   |   | circuit board assemblies include:                          |
| -68                    | 200-1227-00 <sup>2</sup> |                         |      |   |   | 1 |   |   | COVER, cam switch  |
|                        | ----- <sup>2</sup>       |                         |      |   |   | - |   |   | mounting hardware: (not included w/circuit board assembly) |
| -69                    | 211-0116-00              |                         |      |   |   | 4 |   |   | SCREW, sems, 4-40 x 0.312 inch, PHB                        |
|                        |                          |                         |      |   |   |   |   |   |  |
| -70                    | 670-1385-00 <sup>1</sup> |                         |      |   |   | 1 |   |   | CIRCUIT BOARD ASSEMBLY--READOUT A3                         |
|                        | ----- <sup>1</sup>       |                         |      |   |   | - |   |   | circuit board assembly includes:                           |
|                        | 388-1944-00              |                         |      |   |   | 1 |   |   | CIRCUIT BOARD  |
| -71                    | 136-0252-04              |                         |      |   |   | 3 |   |   | SOCKET, pin connector                                      |
|                        | ----- <sup>1</sup>       |                         |      |   |   | - |   |   | mounting hardware: (not included w/circuit board assembly) |
| -72                    | 211-0116-00              |                         |      |   |   | 6 |   |   | SCREW, sems, 4-40 x 0.312 inch, PHB                        |

<sup>1</sup> 7A15A only<sup>2</sup> 7A15AN only

FIGURE 1 EXPLODED (cont)

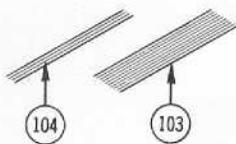
| Fig. &<br>Index<br>No. | Tektronix<br>Part No.    | Serial/Model No.<br>Eff<br>Disc | Q<br>t<br>y | Description   |   |   |   |   |  |
|------------------------|--------------------------|---------------------------------|-------------|---|---|---|---|---|--|
|                        |                          |                                 |             | 1   | 2 | 3 | 4 | 5 |  |
| 1-73                   | 337-1418-01 <sup>1</sup> |                                 | 2           | SCHILD, electrical                                  |   |   |   |   |  |
|                        | -----                    |                                 | -           | mounting hardware for each: (not included w/shield) |   |   |   |   |  |
| -74                    | 213-0277-00              |                                 | 3           | SCREW, thread forming, 2-56 x 0.312 inch, PHS       |   |   |   |   |  |
|                        | 210-1008-00              |                                 | 3           | WASHER, flat, 0.09 ID x 0.188 inch OD               |   |   |   |   |  |
| -75                    | 210-0053-00              |                                 | 3           | WASHER, lock, split, 0.092 ID x 0.175 inch OD       |   |   |   |   |  |
| -76                    | 105-0243-00              |                                 | 1           | LEVER   |   |   |   |   |  |
|                        | -----                    |                                 | -           | mounting hardware: (not included w/lever)           |   |   |   |   |  |
| -77                    | 213-0214-00              |                                 | 1           | SCREW, 2-56 x 0.375 inch, CHS                       |   |   |   |   |  |
| -78                    | 354-0391-00              |                                 | 2           | RING, retaining                                     |   |   |   |   |  |
| -79                    | 214-1127-00 <sup>2</sup> |                                 | 4           | ROLLER, detent                                      |   |   |   |   |  |
| -80                    | 214-1139-00 <sup>2</sup> |                                 | -           | SPRING, flat, gold                                  |   |   |   |   |  |
|                        | 214-1139-02 <sup>2</sup> |                                 | -           | SPRING, flat, green                                 |   |   |   |   |  |
|                        | 214-1139-03 <sup>2</sup> |                                 | -           | SPRING, flat, red                                   |   |   |   |   |  |
| -81                    | 401-0081-02              |                                 | 1           | BEARING, rear                                       |   |   |   |   |  |
|                        | -----                    |                                 | -           | mounting hardware: (not included w/bearing)         |   |   |   |   |  |
| -82                    | 211-0097-00              |                                 | 2           | SCREW, 4-40 x 0.312 inch, PHS                       |   |   |   |   |  |
| -83                    | 210-0004-00              |                                 | 2           | WASHER, lock, internal, 0.12 ID x 0.26 inch OD      |   |   |   |   |  |
| -84                    | 131-0963-00              |                                 | 2           | CONTACT, electrical, grounding                      |   |   |   |   |  |
| -85                    | 210-0591-00              |                                 | 2           | NUT, hex., 4-40 x 0.188 inch                        |   |   |   |   |  |
| -86                    | 401-0081-02              |                                 | 1           | BEARING, rear                                       |   |   |   |   |  |
|                        | -----                    |                                 | -           | mounting hardware: (not included w/bearing)         |   |   |   |   |  |
| -87                    | 129-0299-00              |                                 | 2           | POST, hex., 4-40 x 0.188 x 0.335 inch long          |   |   |   |   |  |
| -88                    | 210-0004-00              |                                 | 2           | WASHER, lock, internal, 0.12 ID x 0.26 inch OD      |   |   |   |   |  |
| -89                    | 210-0591-00              |                                 | 4           | NUT, hex., 4-40 x 0.188 inch                        |   |   |   |   |  |
| -90                    | 105-0242-00              |                                 | 1           | DRUM, cam switch, AC GND DC                         |   |   |   |   |  |
| -91                    | 401-0115-00              |                                 | 1           | BEARING, center                                     |   |   |   |   |  |
|                        | -----                    |                                 | -           | mounting hardware: (not included w/bearing)         |   |   |   |   |  |
| -92                    | 129-0299-00              |                                 | 2           | POST, hex., 4-40 x 0.188 x 0.335 inch long          |   |   |   |   |  |
| -93                    | 210-0004-00              |                                 | 2           | WASHER, lock, internal, 0.12 ID x 0.26 inch OD      |   |   |   |   |  |
| -94                    | 210-0591-00              |                                 | 4           | NUT, hex., 4-40 x 0.188 inch                        |   |   |   |   |  |
| -95                    | 105-0272-00              |                                 | 1           | DRUM, cam switch, VOLTS/DIV                         |   |   |   |   |  |
| -96                    | 131-1030-00 <sup>1</sup> |                                 | 10          | CONTACT ASSEMBLY, bottom                            |   |   |   |   |  |
| -97                    | 131-1031-00 <sup>1</sup> |                                 | 17          | CONTACT ASSEMBLY, top                               |   |   |   |   |  |
|                        | -----                    |                                 | -           | mounting hardware for each: (not included w/contact |   |   |   |   |  |
|                        | -----                    |                                 | -           | assembly)   |   |   |   |   |  |
|                        | 210-0779-00 <sup>3</sup> |                                 | 1           | EYELET  |   |   |   |   |  |
|                        | 131-1031-00 <sup>3</sup> |                                 | 10          | CONTACT ASSEMBLY, top                               |   |   |   |   |  |
|                        | -----                    |                                 | -           | mounting hardware for each: (not included w/contact |   |   |   |   |  |
|                        | -----                    |                                 | -           | assembly)   |   |   |   |   |  |
|                        | 210-0779-00              |                                 | 1           | EYELET  |   |   |   |   |  |
| -98                    | 136-0252-01              |                                 | 24          | SOCKET, pin connector, for 0.019 inch diameter pin  |   |   |   |   |  |
|                        | 136-0333-00              |                                 | 2           | SOCKET, pin connector, for 0.03 inch diameter pin   |   |   |   |   |  |

<sup>1</sup> 7A15A only<sup>2</sup> Replace only with part bearing the same color code as the original part in your instrument.<sup>3</sup> 7A15AN only

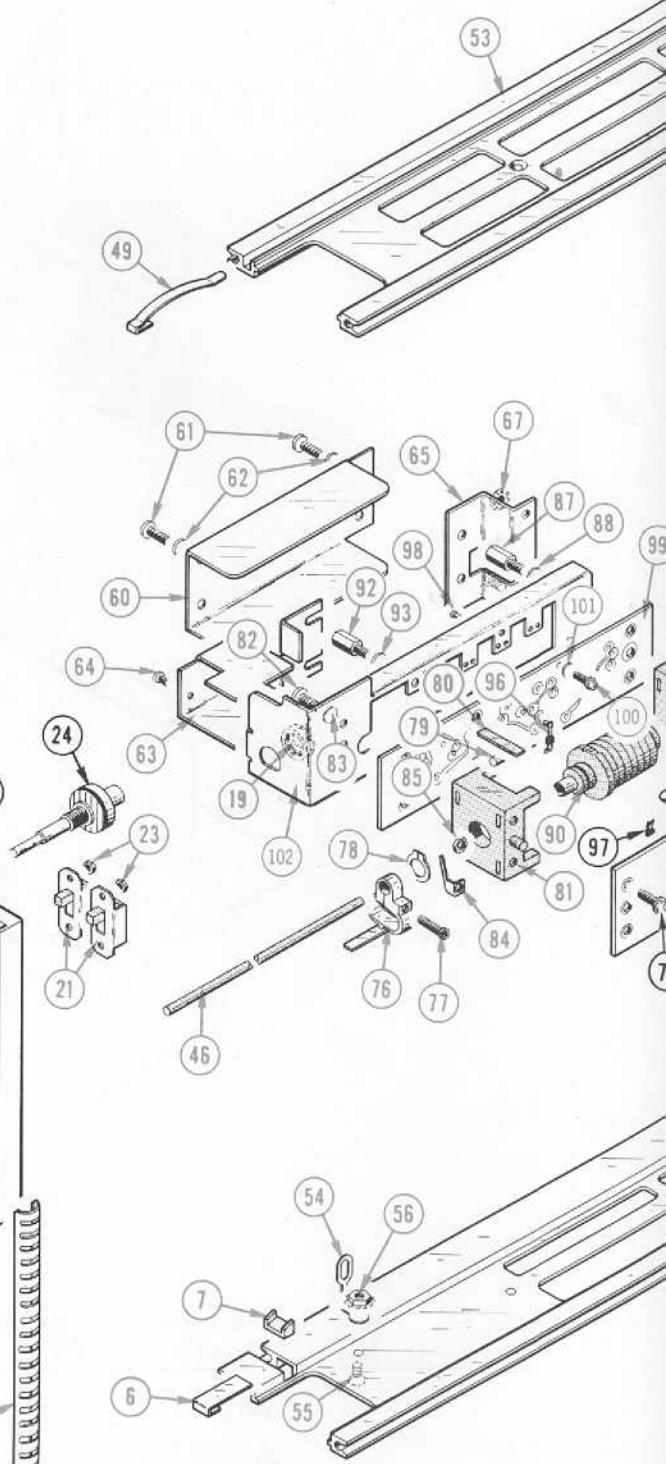
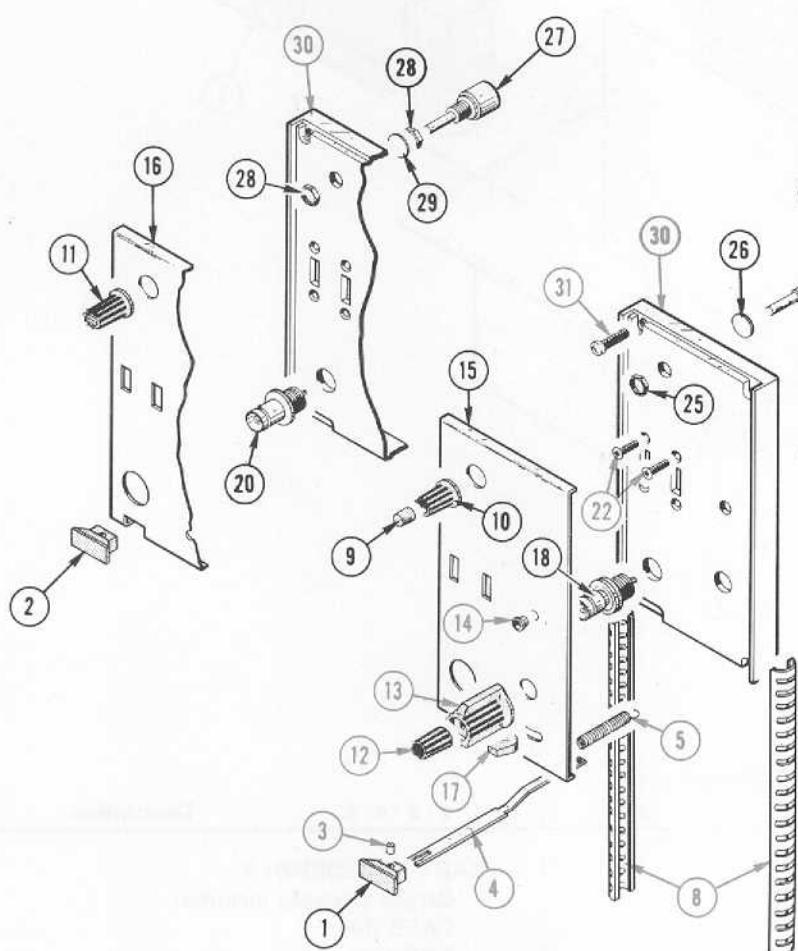
FIGURE 1 EXPLODED (cont)

| Fig. &<br>Index<br>No. | Tektronix<br>Part No.    | Serial/Model No.<br>Eff | Disc | Q  |   |  |   |   | Description |   |  |
|------------------------|--------------------------|-------------------------|------|----|---|--|---|---|-------------|---|--|
|                        |                          |                         |      | t  | y | 1  | 2 | 3 | 4           | 5 |  |
| 1-99                   | 388-1945-00              |                         |      | 1  |   | CIRCUIT BOARD--ATTENUATOR                          |   |   |             |   |  |
|                        | -----                    |                         |      | -  |   | mounting hardware: (not included w/circuit board)  |   |   |             |   |  |
| -100                   | 211-0001-00              |                         |      | 3  |   | SCREW, 2-56 x 0.25 inch, PHS                       |   |   |             |   |  |
|                        | 210-0053-00              |                         |      | 3  |   | WASHER, lock, split; 0.092 ID x 0.175 inch OD      |   |   |             |   |  |
| -101                   | 210-1134-00              |                         |      | 3  |   | WASHER, flat, 0.09 ID x 0.25 inch OD               |   |   |             |   |  |
|                        | 337-1406-00              |                         |      | 1  |   | SHIELD, contact                                    |   |   |             |   |  |
| -102                   | 441-0992-00 <sup>1</sup> |                         |      | 1  |   | CHASSIS, attenuator                                |   |   |             |   |  |
| -103                   | 175-0832-00 <sup>2</sup> |                         |      | ft |   | WIRE, electrical, 9 wire ribbon, 12.50 inches long |   |   |             |   |  |
|                        | 175-0832-00 <sup>1</sup> |                         |      | ft |   | WIRE, electrical, 9 wire ribbon, 9 inches long     |   |   |             |   |  |
| -104                   | 175-0826-00 <sup>1</sup> |                         |      | ft |   | WIRE, electrical, 3 wire ribbon, 8.50 inches long  |   |   |             |   |  |

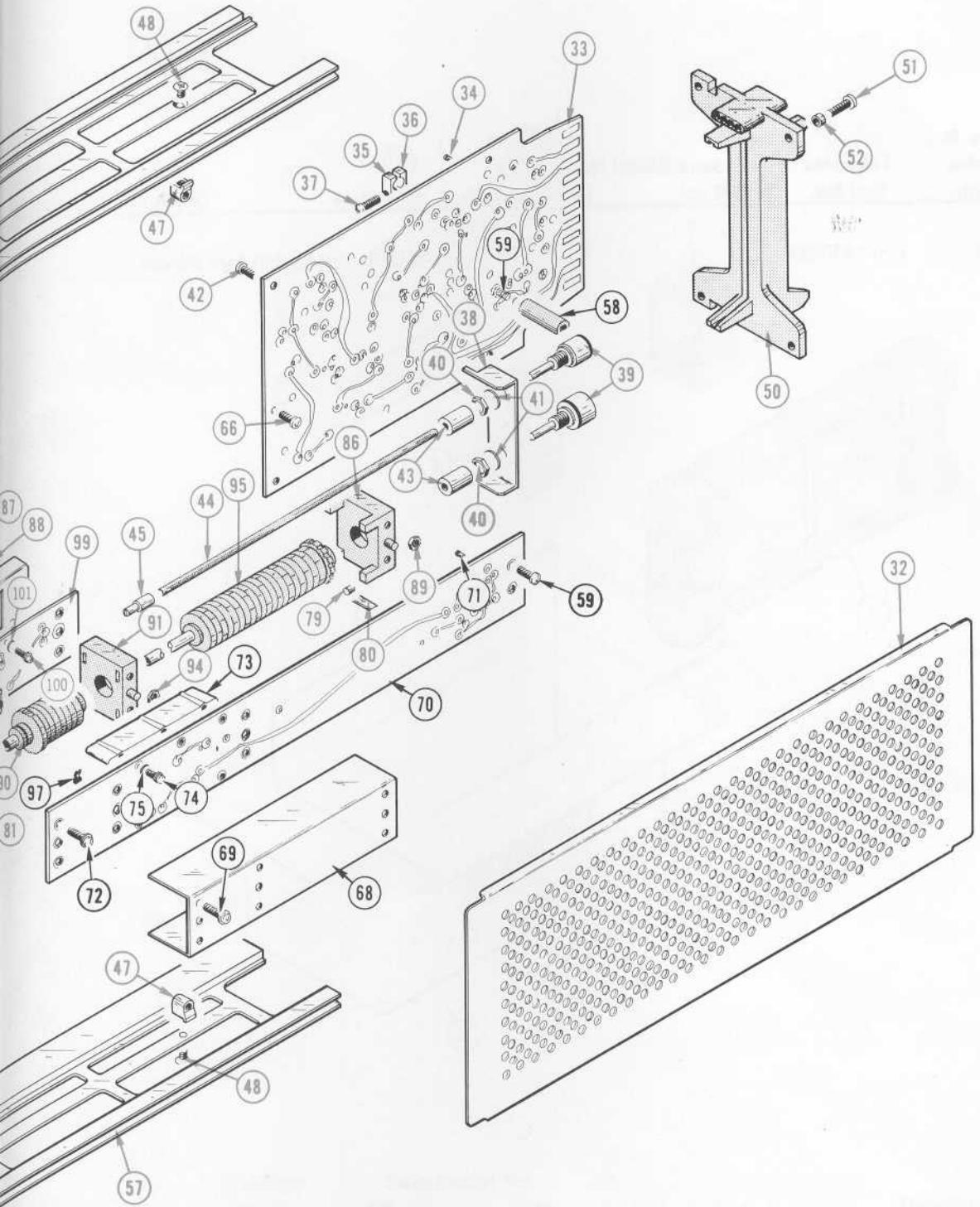
<sup>1</sup> 7A15A only<sup>2</sup> 7A15AN only



**Black reference numbers denote parts which are not common to both instruments.**



**FIG. 1 EXPLODED**



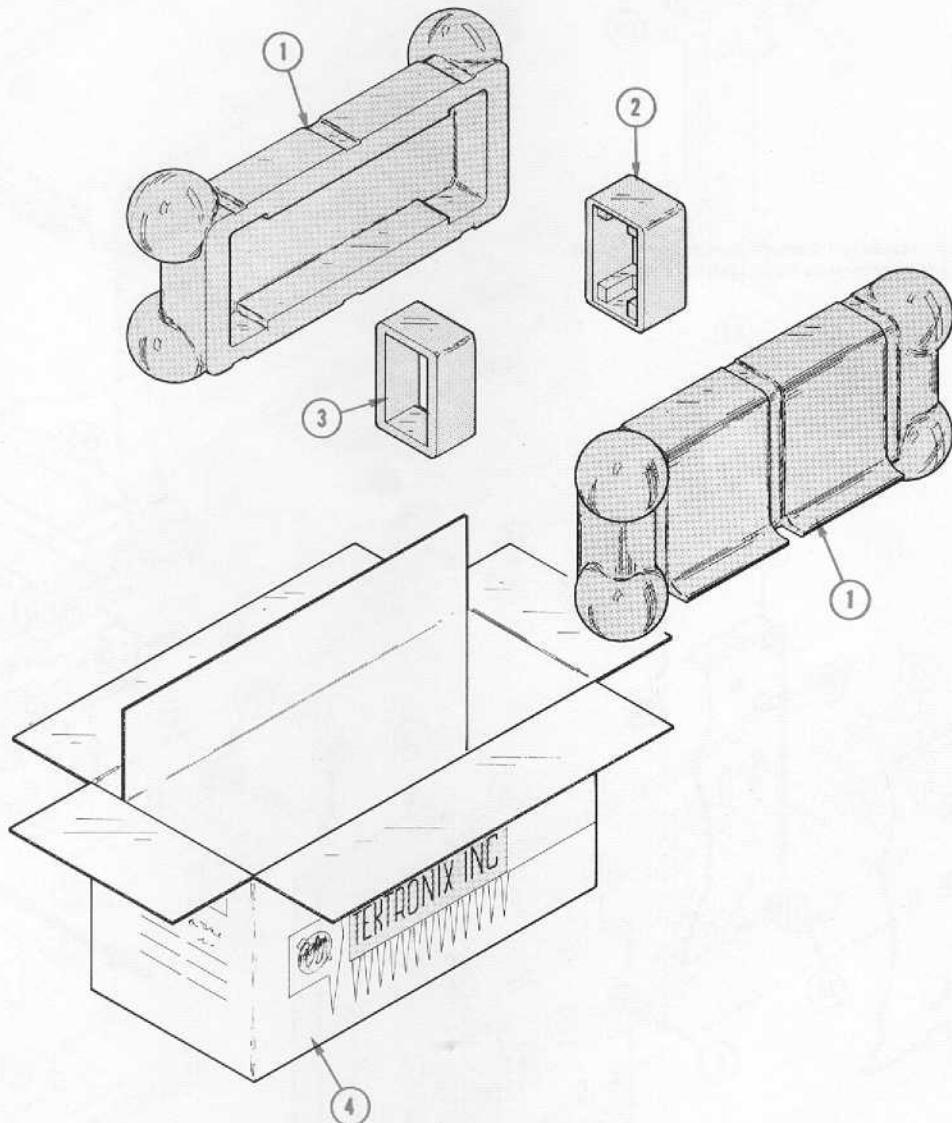
## 7A15A/7A15AN AMPLIFIERS

#

## STANDARD ACCESSORIES

| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Disc | Q |   |   |   |   | Description |                                 |
|------------------------|-----------------------|-------------------------|------|---|---|---|---|---|-------------|---------------------------------|
|                        |                       |                         |      | t | y | 1 | 2 | 3 | 4           | 5                               |
| 2-                     | 070-1210-00           |                         |      | 1 |   |   |   |   |             | MANUAL, instruction (not shown) |

**CARTON ASSEMBLY**  
 (Part No. 065-0125-00)



| Fig. &<br>Index<br>No. | Tektronix<br>Part No. | Serial/Model No.<br>Eff | Disc | Q<br>t<br>y | 1 2 3 4 5 | Description               |
|------------------------|-----------------------|-------------------------|------|-------------|-----------|---------------------------|
| 2-                     | 065-0125-00           |                         |      | 1           |           | CARTON ASSEMBLY           |
|                        | -                     |                         |      | -           |           | Carton assembly includes: |
| -1                     | 004-0241-00           |                         |      | 2           |           | CASE HALF                 |
| -2                     | 004-0242-00           |                         |      | 1           |           | END CAP, rear             |
| -3                     | 004-0243-00           |                         |      | 1           |           | END CAP, front            |
| -4                     | 004-0748-00           |                         |      | 1           |           | CARTON                    |