INSTRUCTION MANUAL

Serial Number _____

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070-1210-00

871

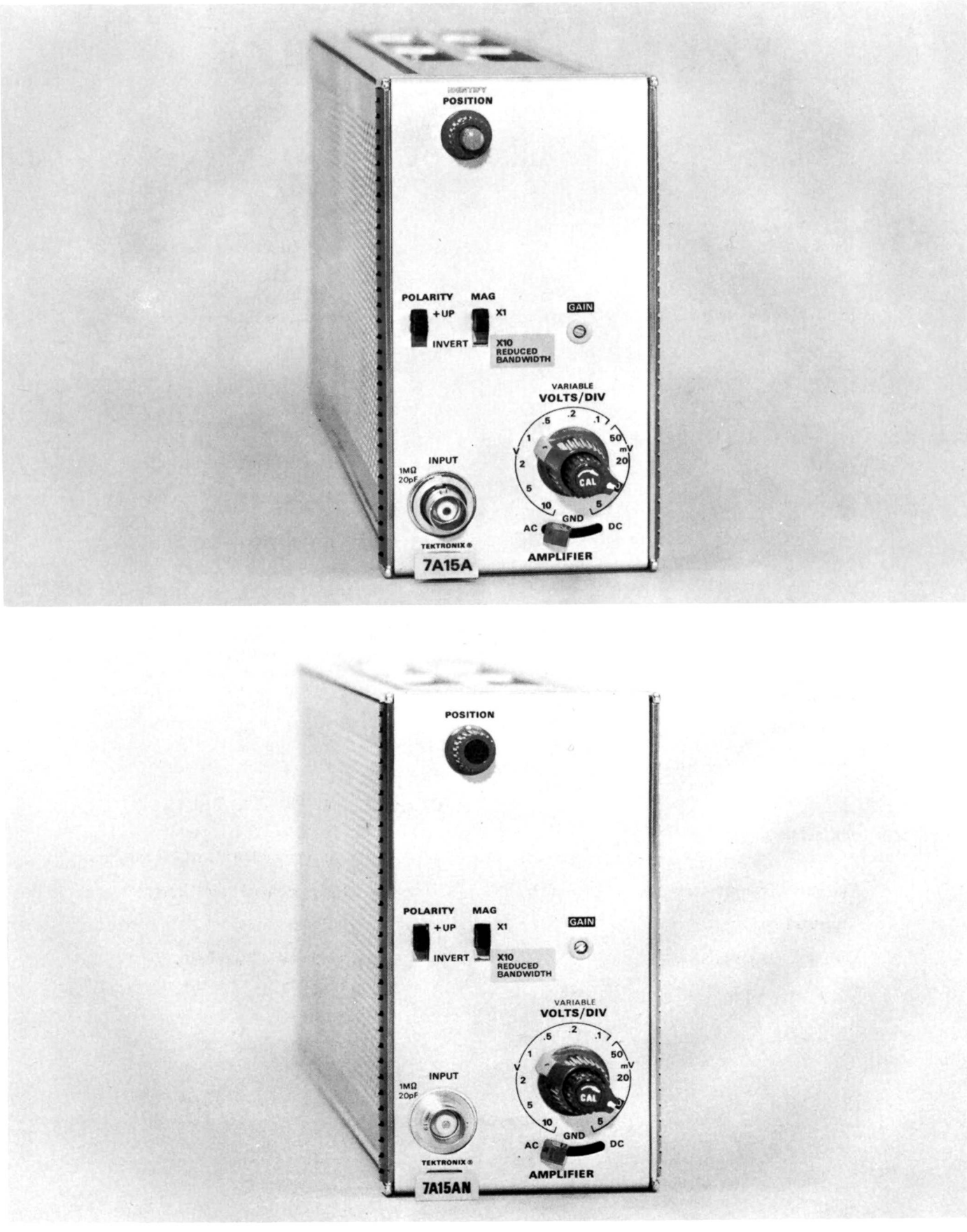


Fig. 1-1. 7A15A and 7A15AN Amplifier.

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 (at −3 dB)			
X1 (System Dependent)	With 7900-series 80 MHz	With 7700-series 75 MHz	
	With 7500-series 60 MHz	With 7400-series 50 MHz	
X10	10 MHz		
Low-Frequency Response	10 Hz or less without probe		
(Lower −3 dB point) 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	1 MΩ ± 2%	
Capacitance	Approximately 20.0 pf	
RC Tolerance		Within ± 1% between 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 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 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 1 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.

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 ± (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 cascoded 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 cascoded 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 ↓ (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.

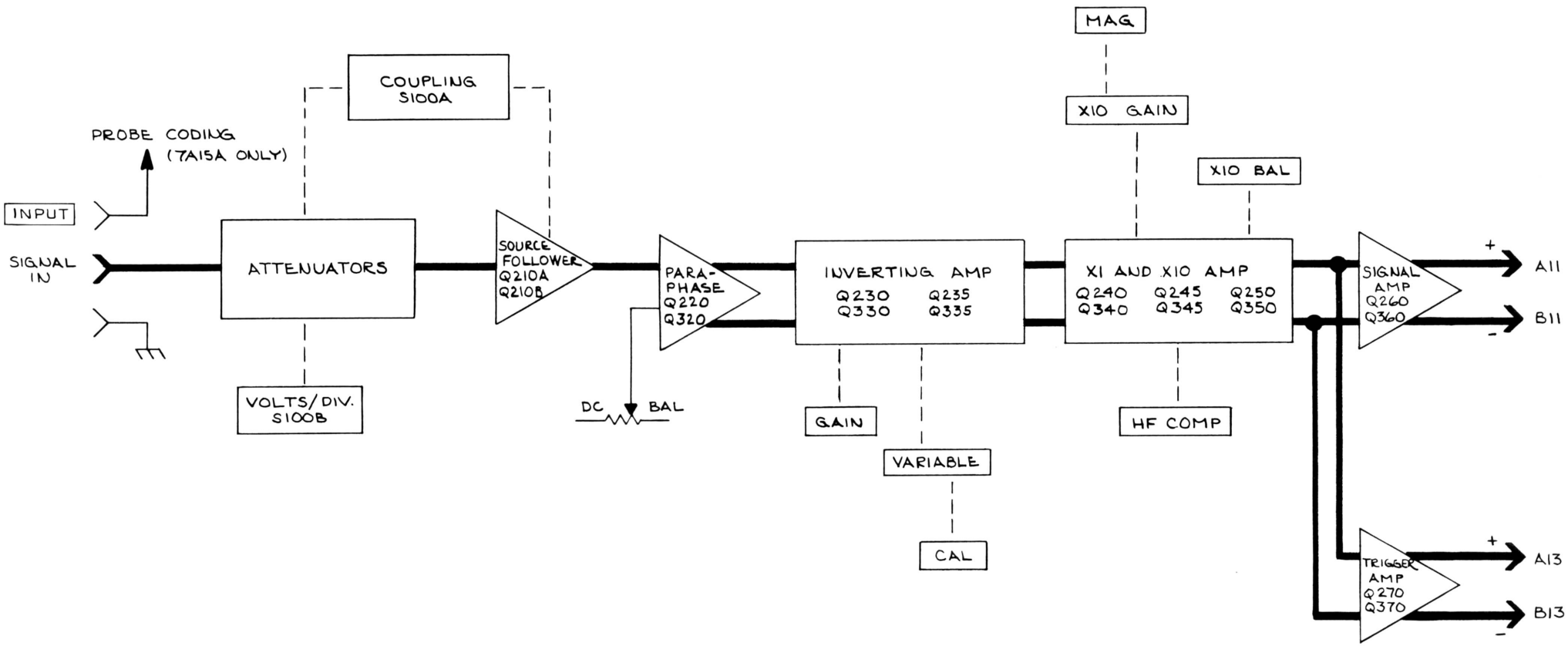
The IDENTIFY button (S45 on Diagram 1) does two things when pressed:

1. It causes the trace representing the appropriate channel of the 7A15A to move.

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

These two actions aid in identifying the 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.



7A15A/7A15N

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BLOCK DIAGRAM

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RHL

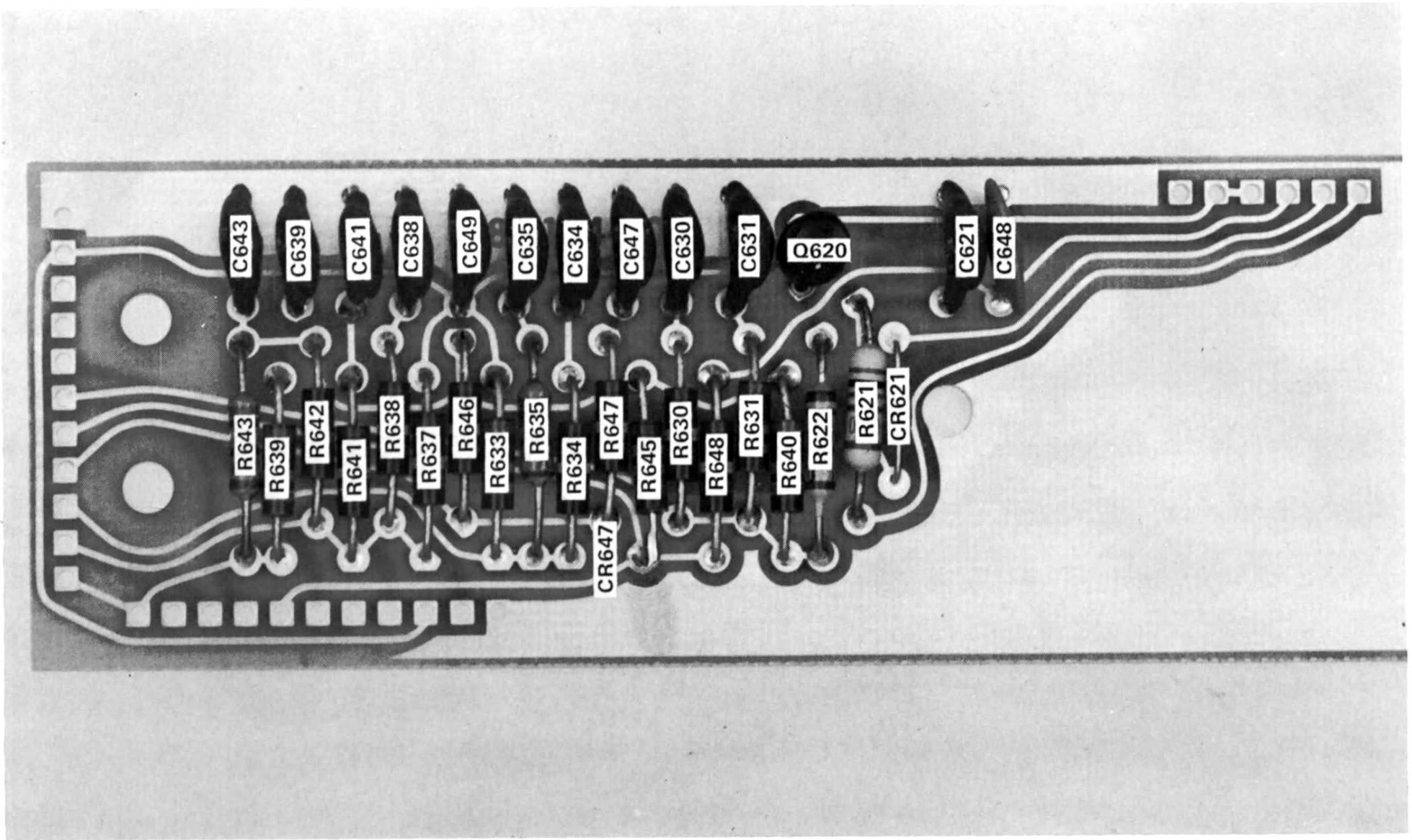

Fig. 7-1. Readout circuit board with component location (7A15A Only).

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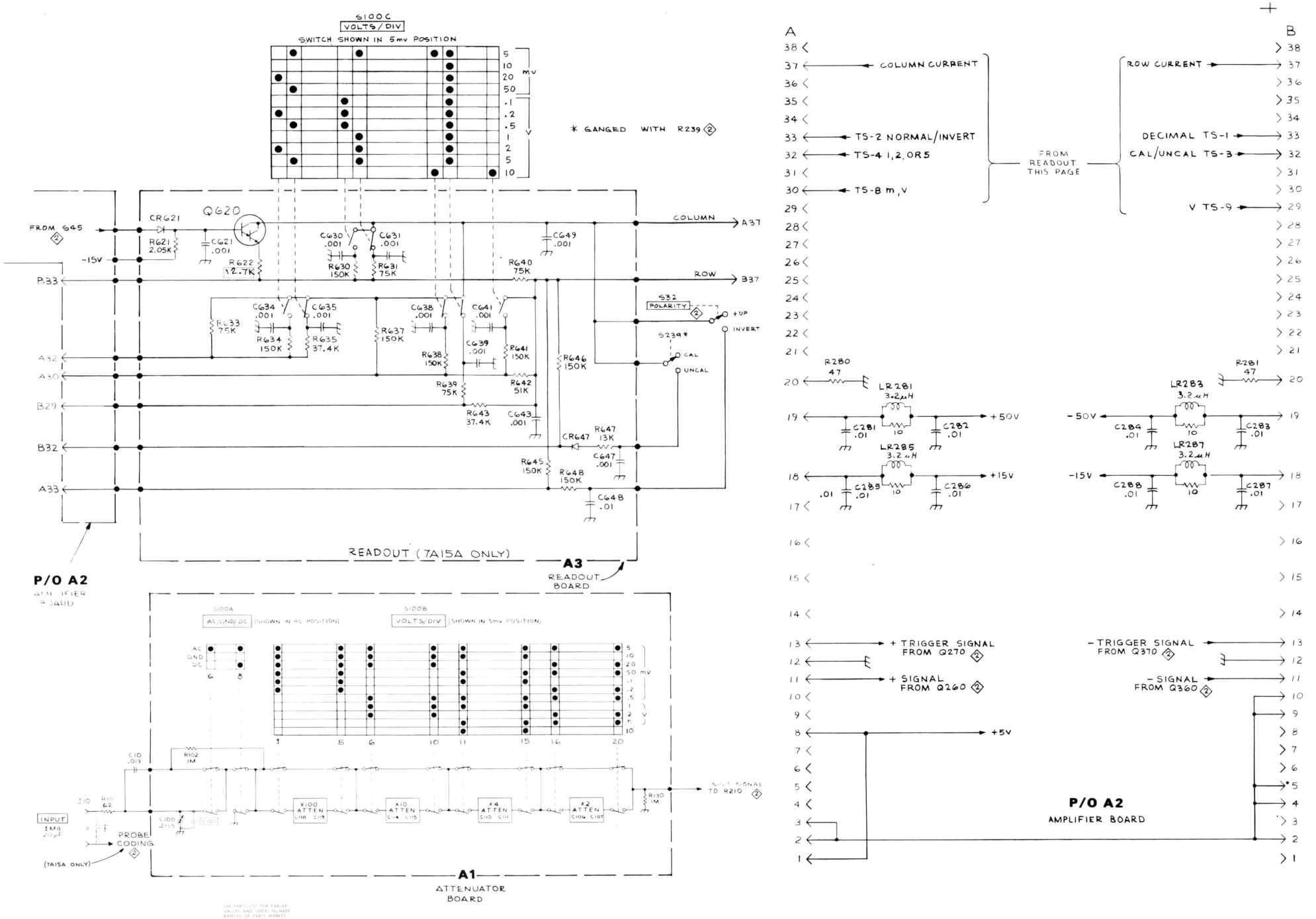


SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE

ATTENUATOR, READOUT & CONNECTORS 1 BT2 RHL

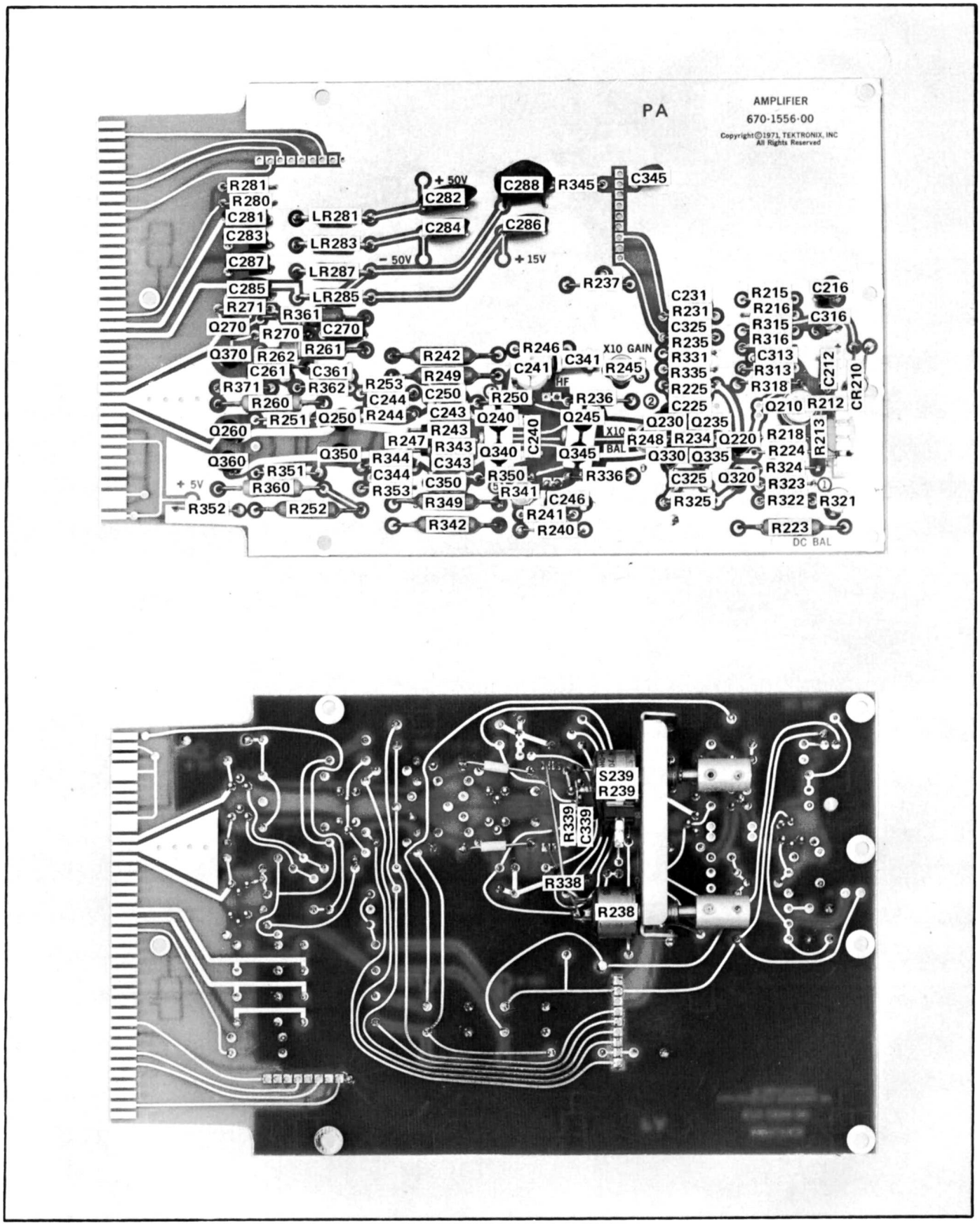
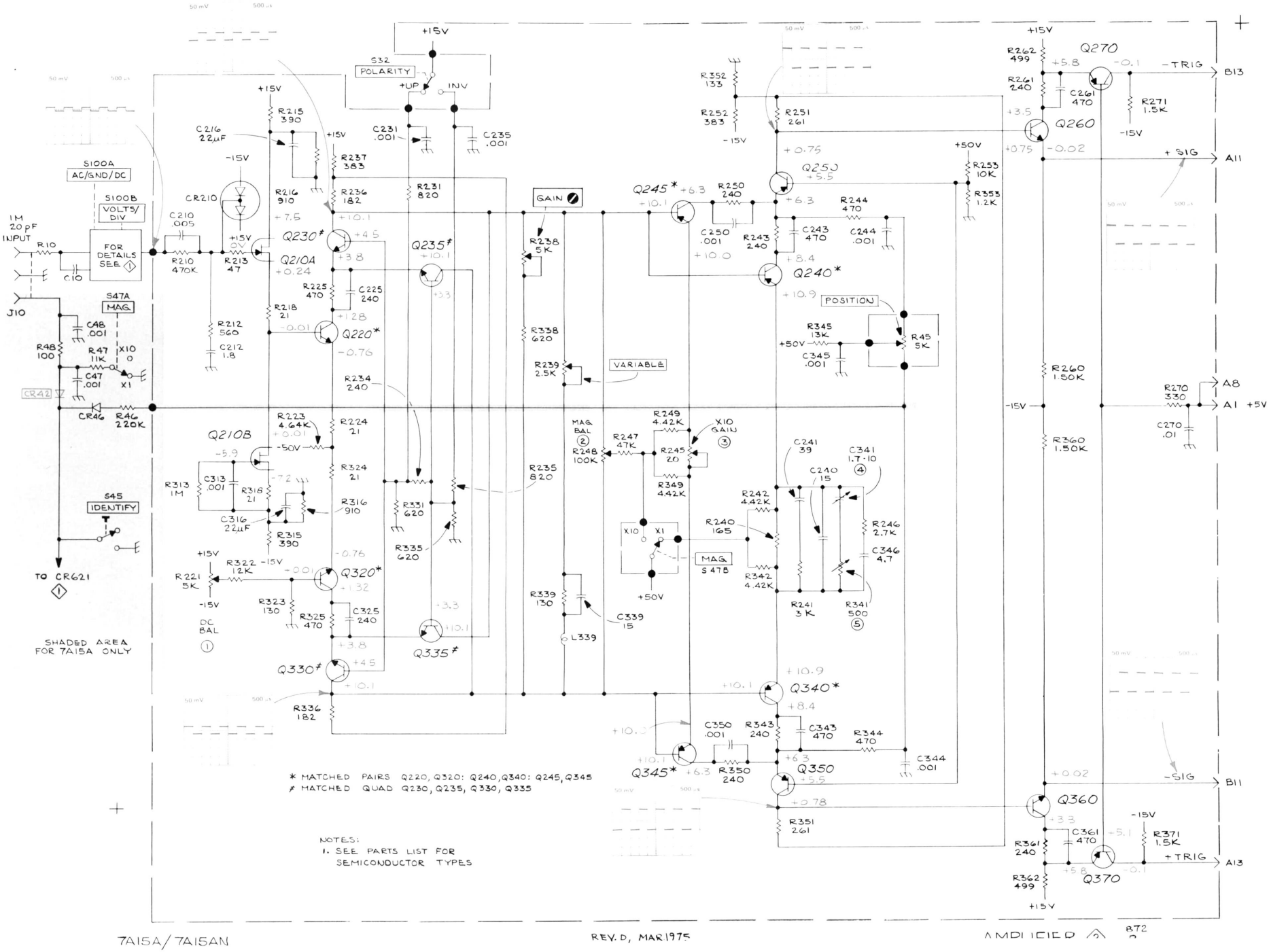


Fig. 7-2. Amplifier circuit board and component location.


+15V
S32
POLARITY
+UP
INV
S100A
AC/GND/DC
S100B
VOLTS/DIV
1M
20pF
INPUT
R10
C10
FOR DETAILS SEE 1
J10
S47A
MAG.
R48 100
R47 11K
X10 0
X1
C48 .001
C47 .001
CR42
CR46
R46 220K
TO CR621
1
S45
IDENTIFY
SHADED AREA FOR 7A15A ONLY
C210 .005
R210 470K
CR210
R213 47
R215 390
C216 22μF
R216 910
R237 383
R236 182
R231 820
C231 .001
C235 .001
Q230*
Q210A
Q210B
Q220*
Q235≠
R225 470
C225 240
R218 21
R212 560
C212 1.8
R223 4.64K
R224 21
R324 21
R313 1M
C313 .001
R318 21
C316 22μF
R316 910
R315 390
R322 12K
R221 5K
DC BAL 1
R323 130
R325 470
C325 240
Q320*
Q330≠
Q335≠
R336 182
R331 620
R335 620
R235 820
GAIN
R238 5K
R338 620
R239 2.5K
VARIABLE
R234 240
MAG BAL 2
R248 100K
R247 47K
R249 4.42K
X10 GAIN 3
R245 20
R349 4.42K
X10
X1
MAG S47B
+50V
R339 130
C339 15
L339
R242 4.42K
R240 165
R342 4.42K
C241 39
C240 15
C341 1.7-10 4
R246 2.7K
C346 4.7
R241 3K
R341 500 5
Q245*
R250 240
C250 .001
R243 240
Q240*
R244 470
C243 470
C244 .001
POSITION
R345 13K
C345 .001
R45 5K
R352 133
R252 383
R251 261
Q250
Q340*
Q345*
R343 240
C343 470
R344 470
C350 .001
R350 240
Q350
C344 .001
R351 261
R253 10K
R353 1.2K
R260 1.50K
R360 1.50K
R270 330
C270 .01
A8
A1 +5V
R262 499
Q270
R261 240
C261 470
R271 1.5K
-TRIG
B13
Q260
+SIG
A11
-SIG
B11
Q360
R361 240
C361 470
R371 1.5K
+TRIG
A13
Q370
R362 499
* MATCHED PAIRS Q220, Q320: Q240, Q340: Q245, Q345
≠ MATCHED QUAD Q230, Q235, Q330, Q335
NOTES:
1. SEE PARTS LIST FOR SEMICONDUCTOR TYPES

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MANUAL CHANGE INFORMATION

PRODUCT 7A15A/AN
EFF SN B062205-up

CHANGE REFERENCE M23,481
DATE 10-14-75

CHANGE:	DESCRIPTION

070-1210-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGE

CHANGE TO:

A1	670-1706-02	CKT BOARD ASSY:ATTENUATOR
A2	670-1556-01	CKT BOARD ASSY:AMPLIFIER

DIAGRAM ◇2◇ AMPLIFIER - Partial

Remove common lead of Dual Diode CR210.

Move location of cathode lead of CR210 from +15V supply to gate of FET Q210A.

Move Anode lead of CR210 from -15V supply to junction of R315 and R316.