INSTRUCTION MANUAL

Serial Number B102779

206-0180-00-Prelim tp

7A11 AMPLIFIER

Tektronix, Inc.
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070-0984-00

1269

c. Reset the Frequency Range to 65-500 megahertz. Starting at 65 megahertz, slowly increase the frequency until the amplitude of the CRT display decreases to 4.2 divisions.

d. CHECK—The frequency of the 067-0532-00 Signal Generator is 75 megahertz or greater with the 7500 series Oscilloscope, or 105 megahertz or greater with the 7700 series Oscilloscope.

e. Remove the Calibration Fixture from the 067-0532-00 Signal Generator and connect it to the output connector of the Type 191 Signal Generator. Replace the P6022 Current Probe with the P6021 Current Probe. Set the Type 191 to 50 kHz and adjust the amplitude for a six-division display on the CRT.

f. Reset the Type 191 Frequency Range to 42-100 megahertz. Starting at 42 megahertz slowly increase the frequency until the amplitude of the CRT display decreases to 4.2 divisions.

g. CHECK—The frequency of the Type 191 is 45 megahertz or greater with the 7500 series Oscilloscope, or 50 megahertz or greater with the 7700 series Oscilloscope.

15. Check Overall Noise Level Tangentially

a. Reset the Type 7A14 CURRENT/DIV to 1 mA; set the Indicator Oscilloscope Calibrator Volts to 4 volts and the Calibrator Rate to 1 kHz; set the Time-Base TIME/DIV to 10 μs and the Triggering MODE to AUTO.

b. Connect the Type 7A14 through the P6021 Current Probe, the Calibration Fixture, a Variable Attenuator, a ×10 Attenuator, and a GR to BNC Adapter to the Calibrator Volts Output connector.

c. Turn the Variable Attenuator fully clockwise (minimum resistance) and adjust the Time-Base LEVEL/SLOPE to obtain a free-running trace. Observe two noise bands displayed on the CRT (noise and free-running square-wave). See Fig. 5-9.

d. Reduce the input to the Type 7A14 by slowly turning the Variable Attenuator counterclockwise until the two noise bands merge to the point where the darker band between the two noise bands just disappears. See Fig. 5-9.

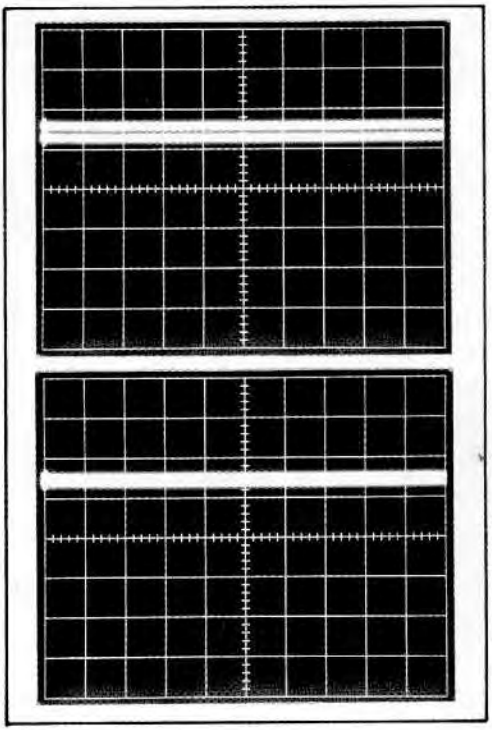


Fig. 5-9. (a) Display showing two noise bands when checking overall noise level, tangentially. (b) Two noise bands merged.

e. Remove the ×10 Attenuator and connect the Variable Attenuator to the GR to BNC Adapter.

f. Reset the Type 7A14 CURRENT/DIV to 10 mA and the Time-Base TIME/DIV to .5 ms.

g. CHECK—The square-wave amplitude should not exceed 0.2 division.

h. This completes the calibration procedure for the Type 7A14. Disconnect all test equipment.

PARTS LIST ABBREVIATIONS

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

PARTS ORDERING INFORMATION

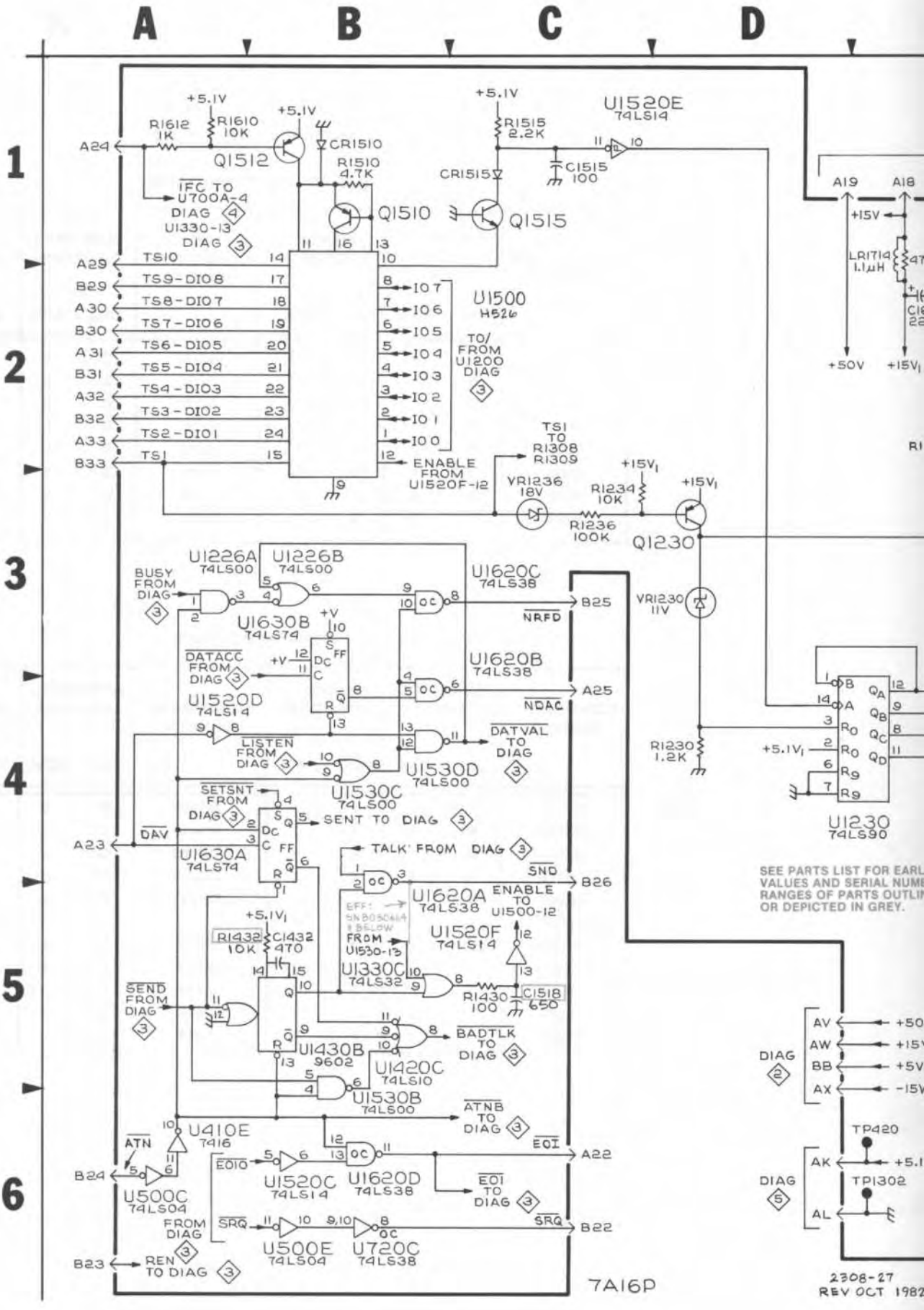
Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

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

X000	Part first added at this serial number
00X	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.


A
B
C
D
1
2
3
4
5
6
+5.1V
R1612 1K
R1610 10K
Q1512
CR1510
R1510 4.7K
Q1510
U1520E 74LS14
R1515 2.2K
CR1515
C1515 100
Q1515
A24
IFC TO U700A-4
DIAG 4
U1330-13
DIAG 3
A19
A18
+15V
LR1714 1.1μH
+50V
+15V
U1500 H526
TO/ FROM U1200 DIAG 3
TS10
TS9-DIO8
TS8-DIO7
TS7-DIO6
TS6-DIO5
TS5-DIO4
TS4-DIO3
TS3-DIO2
TS2-DIO1
TS1
A29
B29
A30
B30
A31
B31
A32
B32
A33
B33
IO7
IO6
IO5
IO4
IO3
IO2
IO1
IO0
ENABLE FROM U1520F-12
TS1 TO R1308 R1309
VR1236 18V
R1234 10K
R1236 100K
Q1230
U1226A 74LS00
U1226B 74LS00
U1620C 74LS38
BUSY FROM DIAG 3
U1630B 74LS74
NRFD
B25
VR1230 11V
DATACC FROM DIAG 3
U1520D 74LS14
U1620B 74LS38
NDAC
A25
LISTEN FROM DIAG 3
U1530D 74LS00
DATVAL TO DIAG 3
U1530C 74LS00
SETSNT FROM DIAG 3
SENT TO DIAG 3
DAV
A23
U1630A 74LS74
TALK FROM DIAG 3
SND
B26
U1620A 74LS38
ENABLE TO U1500-12
U1520F 74LS14
+5.1V
R1432 10K
C1432 470
U1330C 74LS32
R1430 100
C1518 650
SEND FROM DIAG 3
U1430B 9602
U1420C 74LS10
BADTLK TO DIAG 3
U1530B 74LS00
ATNB TO DIAG 3
U410E 7416
ATN
B24
U500C 74LS04
EOI0
U1520C 74LS14
U1620D 74LS38
EOI TO DIAG 3
EOI
A22
FROM DIAG 3
SRQ
U500E 74LS04
U720C 74LS38
SRQ
B22
B23
REN TO DIAG 3
7A16P
U1230 74LS90
SEE PARTS LIST FOR EARL
VALUES AND SERIAL NUM
RANGES OF PARTS OUTLI
OR DEPICTED IN GREY.
DIAG 2
AV +50
AW +15
BB +5V
AX -15V
TP420
AK +5.1
DIAG 5
TP1302
AL
2308-27
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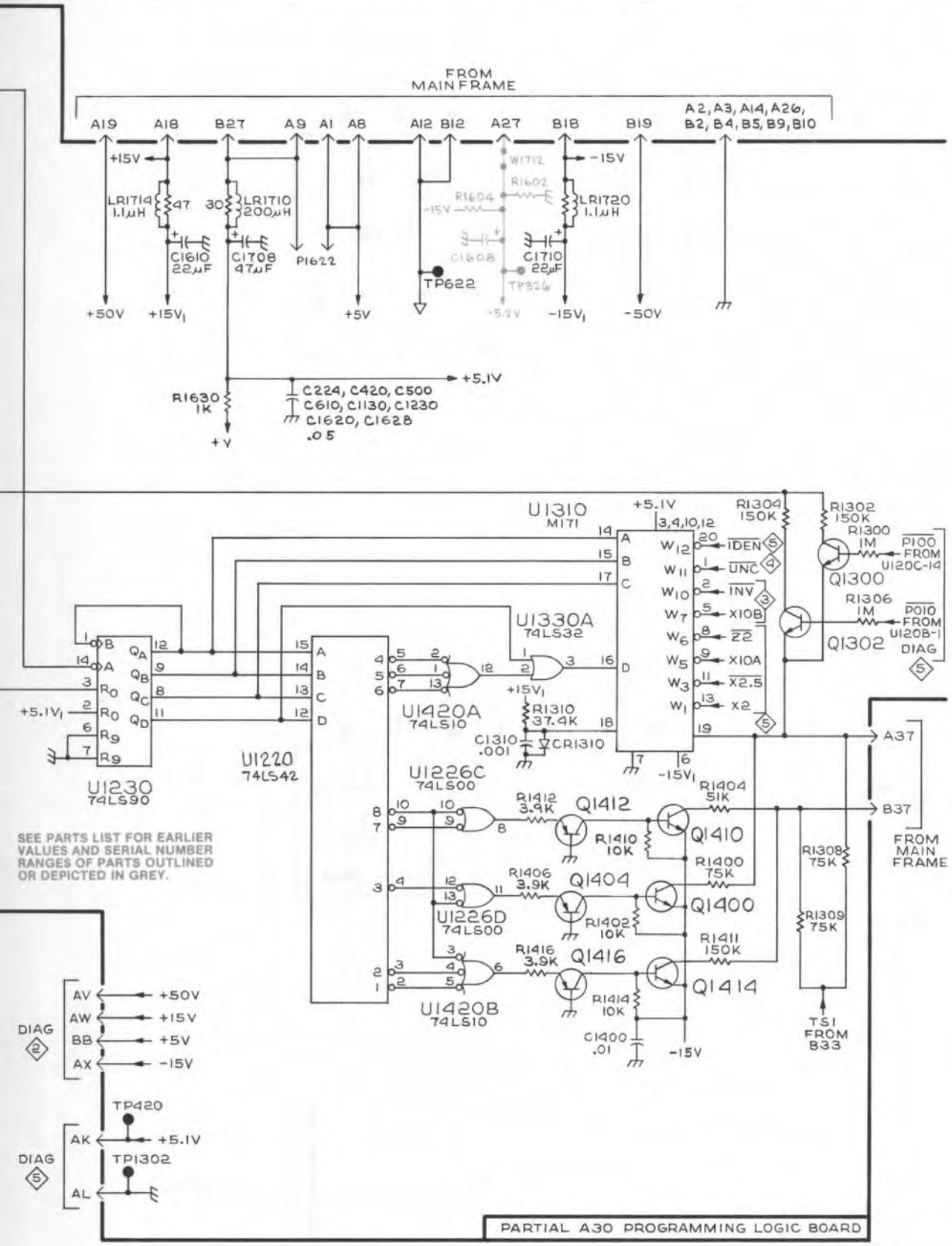

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

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READOUT & I/O ⟨6⟩

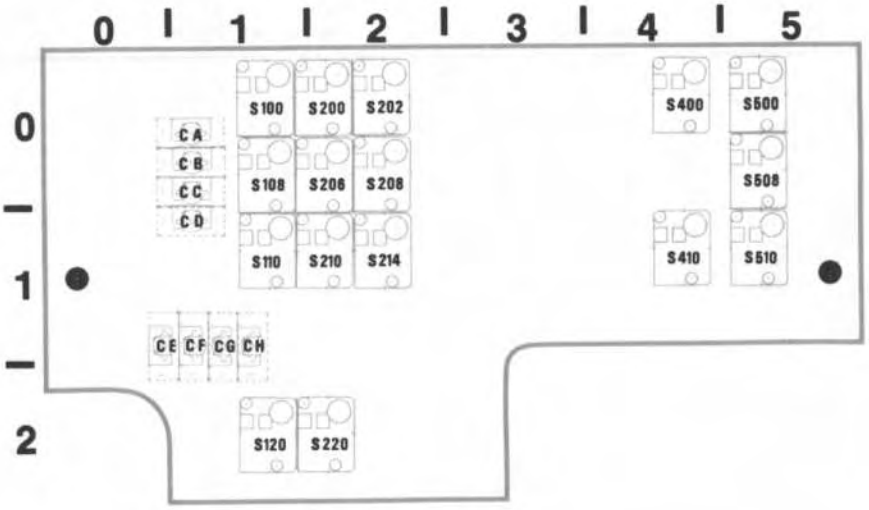


Fig. 8-8. A50 Switch Board.

FIG. 8-8. A50 SWITCH BOARD
FIG. 8-9. A40 LED BOARD

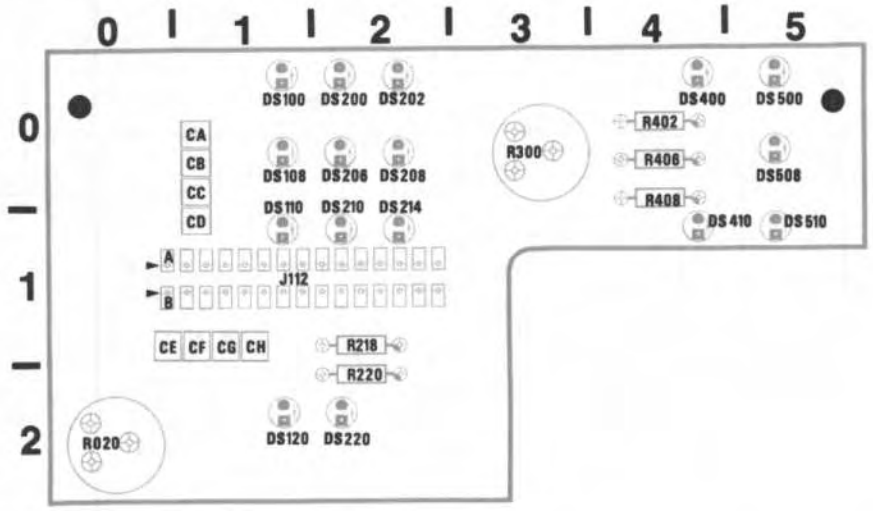


Fig. 8-9. A40 LED Board.

CKT NUMBERING EXAMPLE

R162 on A12 Assembly = R12162 in Parts List

Assembly Number

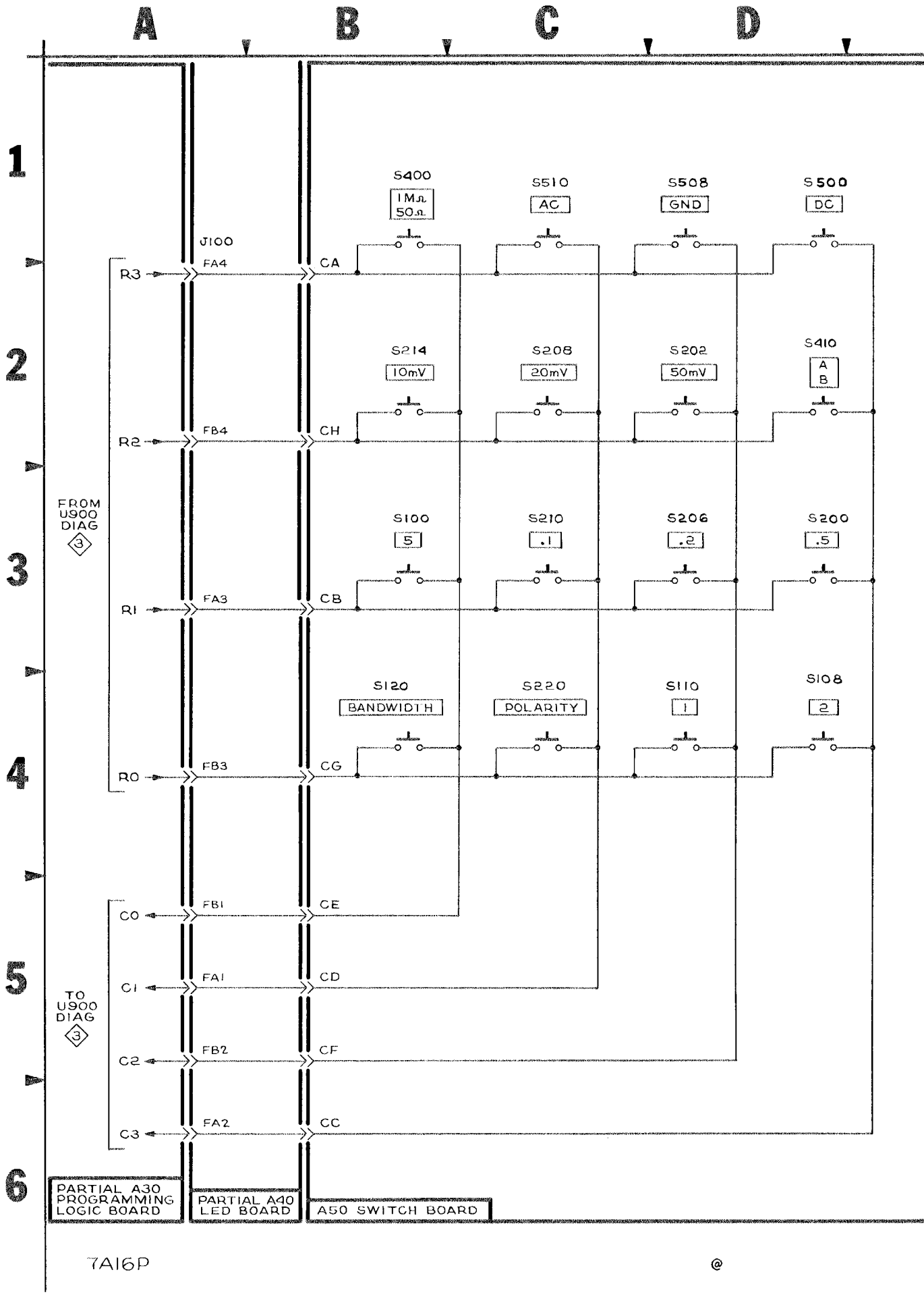
FRONT PANEL 7

P/O A50 SWITCH BOARD

COMPONENT NUMBER	SCHEMATIC LOCATION		BOARD LOCATION		COMPONENT NUMBER	SCHEMATIC LOCATION		BOARD LOCATION	
	COL	ROW	COL	ROW		COL	ROW	COL	ROW
S100	B	3	1	0	S210	C	3	2	1
S108	D	4	1	0	S214	B	2	2	1
S110	D	4	1	1	S220	C	4	2	2
S120	B	4	1	2	S400	B	1	4	0
S200	D	3	2	0	S410	D	2	4	1
S202	D	2	2	0	S500	D	1	5	0
S206	D	3	2	0	S508	D	1	5	0
S208	C	2	2	0	S510	C	1	5	1

P/O A40 LED Board

COMPONENT NUMBER	SCHEMATIC LOCATION		BOARD LOCATION		COMPONENT NUMBER	SCHEMATIC LOCATION		BOARD LOCATION	
	COL	ROW	COL	ROW		COL	ROW	COL	ROW
DS100	F	1	1	0	DS400	F	5	4	0
DS108	F	1	1	0	DS410	F	5	4	1
DS110	G	1	1	1	DS500	G	3	5	0
DS120	G	4	1	2	DS508	F	3	5	0
DS200	G	1	2	0	DS510	F	3	5	1
DS202	G	2	2	0					
DS206	F	1	2	0	R218	G	4	2	1
DS208	F	2	2	0	R220	F	4	2	2
DS210	F	1	2	1	R402	F	5	4	0
DS214	F	2	2	1	R406	F	3	4	0
DS220	G	4	2	2	R408	F	5	4	0


A
B
C
D
1
2
3
4
5
6
S400
1MΩ
50Ω
S510
AC
S508
GND
S500
DC
J100
FA4
R3
CA
S214
10mV
S208
20mV
S202
50mV
S410
A
B
FB4
R2
CH
FROM
U900
DIAG
3
S100
5
S210
.1
S206
.2
S200
.5
FA3
R1
CB
S120
BANDWIDTH
S220
POLARITY
S110
1
S108
2
FB3
R0
CG
FB1
C0
CE
FA1
C1
CD
TO
U900
DIAG
3
FB2
C2
CF
FA2
C3
CC
PARTIAL A30
PROGRAMMING
LOGIC BOARD
PARTIAL A40
LED BOARD
A50 SWITCH BOARD

7A16P

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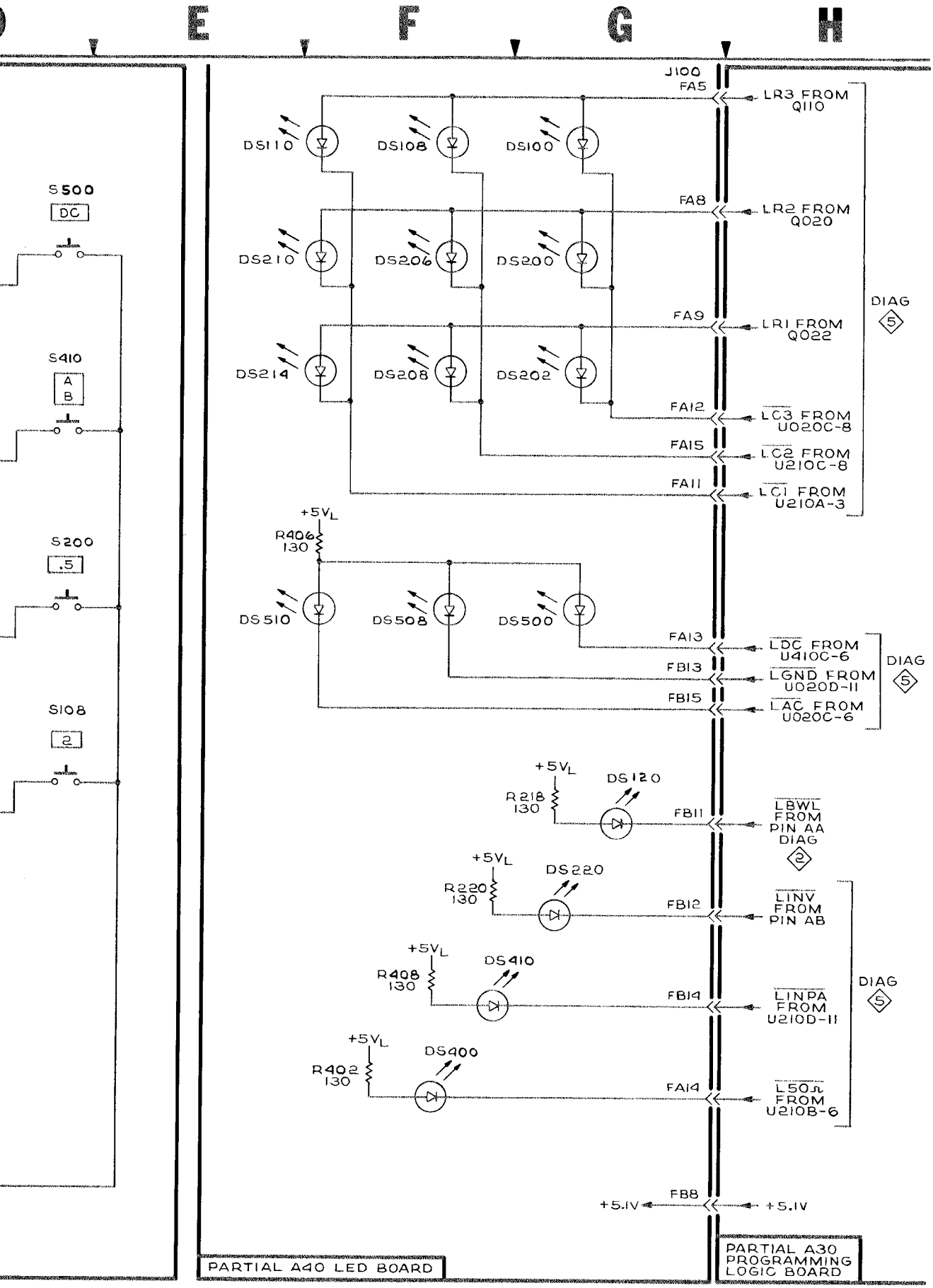


FRONT PANEL 7

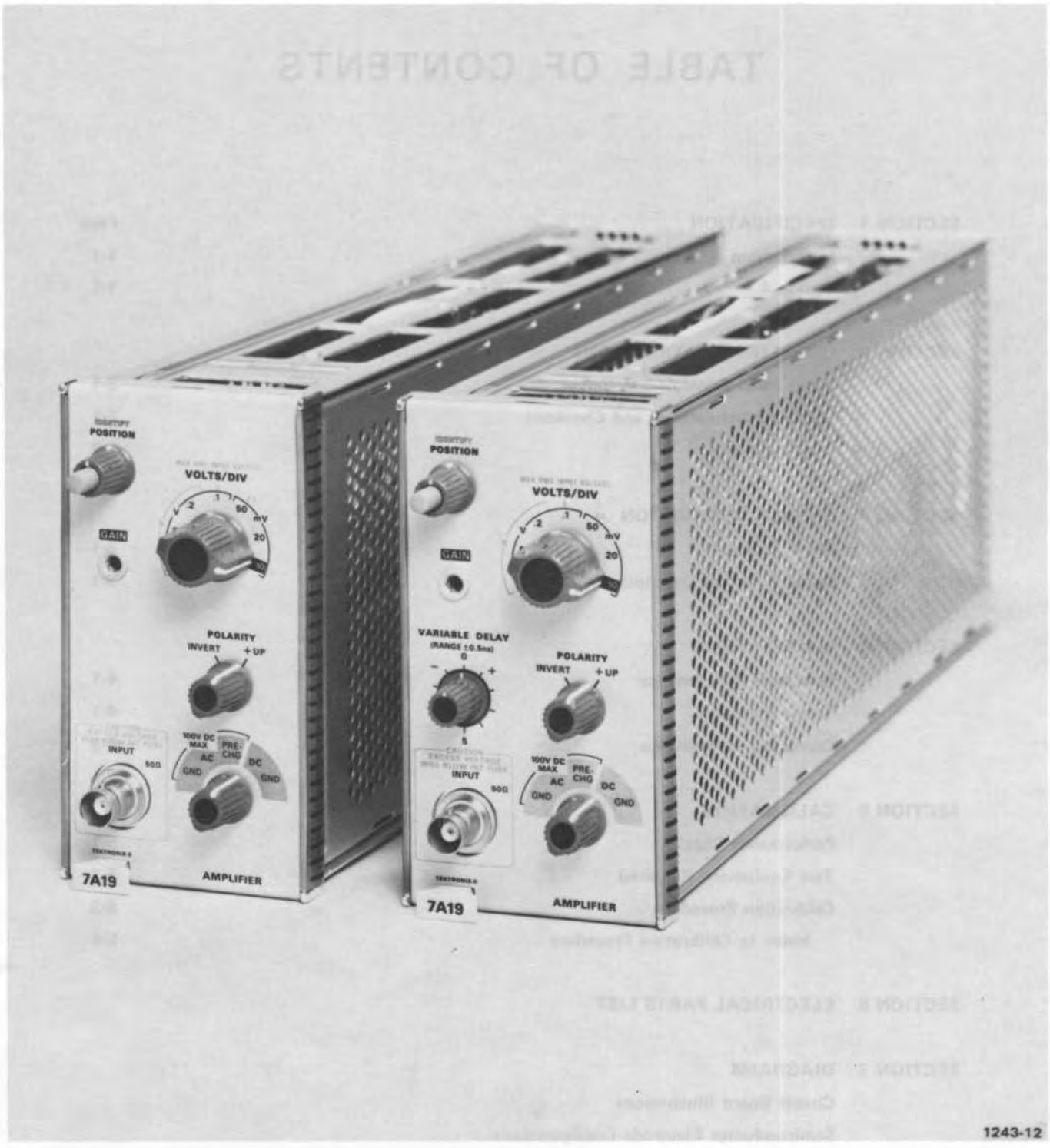


Fig. 1-1. 7A19 Amplifier plug-in (Left) and 7A19 with Variable delay option (Right).

SPECIFICATION

Introduction

The 7A19 Amplifier plug-in unit is a wide band amplifier designed for use with TEKTRONIX 7000-Series oscilloscopes. Readout encoding circuitry is provided in the 7A19 to allow probe coding, deflection factor readout, and IDENTIFY functions. The 7A19 can be operated in any compartment of the 7000-Series oscilloscopes, but is primarily intended for use in the vertical plug-in compartments.

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.

Option 4

An optional VARIABLE DELAY may be ordered with the 7A19 to provide a signal delay of up to ±500 ps.

TABLE 1-1

ELECTRICAL

Characteristic	Performance Requirement	Supplemental Information
Deflection Factor		
Calibrated Range	10 mV/div to 1 V/div, 7 steps in a 1, 2, 5 sequence	Pre-Charge circuit may be used as a calibrated 100X attenuator
Gain Ratio Accuracy	Within 3% with GAIN adjusted at 10 mV/div when driven from 50 ohm source.	Front panel GAIN control allows calibration to mainframe.
Frequency Response (8 division reference, mainframe dependent)		
Upper Bandwidth AC or DC coupled 10 mV/div to 1 V/div	With 7400, 65 MHz; With 7500, 100 MHz; With 7700, 175 MHz; With 7900, 500 MHz	
Lower Bandwidth AC Coupled	1 kHz or less	
Maximum Input Power		
DC or AC coupled	2 watts average or 50 divisions peak deflection.	*CAUTION* *Pre-charge circuit must be used for both charging and discharging AC coupling capacitor to potentials greater than 50 divisions equivalent voltage.*
Voltage (AC coupled)	100 volts (DC + peak AC) not to exceed 2 watts average or 50 divisions peak.	
Input Impedance		
Resistance (DC or DC GND)	50 ohms ±1 ohm	VSWR is typically less than 1.25 @ 500 MHz
Reflection Coefficient (Time Domain)	Less than 0.1 peak to peak	
Maximum Input Current	Less than 0.2 mA	

THEORY OF OPERATION

INTRODUCTION

This section of the manual contains a description of the circuitry used in the 7A24. The 7A24 description begins with a discussion of the instrument using the block diagram shown in the Diagrams section. The circuit diagrams are segmented with gray-tint blocks named according to circuit function. These circuit block titles serve as indexes to the circuit discussion. Detailed diagrams of each circuit are located in the diagram foldout section at the rear of this manual. Refer to the appropriate diagram when reading this discussion.

BLOCK DIAGRAM

The Channel 1 Amplifier circuit provides gain setting, variable gain control, and trace positioning. The Channel 2 Amplifier provides signal-polarity inversion in addition to gain setting, variable gain control, and trace positioning. The signal to be displayed on the crt is applied to the CH 1 or CH 2 Input connector. The signal passes through the Input Coupling switch, where it is either connected to the attenuators or to a 50-ohm dummy load. The VOLTS/DIV switch selects the correct amount of attenuation, and the signal is passed to the Switched-Gain Amplifier.

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

Overall GAIN and VARIABLE gain are adjusted in the Gain Amplifier. Variable balance and high-frequency adjustments are also controlled in the Gain Amplifier. The output of the Gain Amplifier is connected to the Positioning circuitry where the POSITION and IDENTIFY functions are controlled. This circuitry also shifts the signal level to provide zero volts at the plug-in output. Channel 2 is identical to Channel 1, with the exception of the polarity-inversion function in Channel 2.

The Signal Splitter Amplifier divides the signal for use at the Display and Trigger Channel Switching amplifiers.

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

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

Readout encoding circuitry used in the 7A24 is compatible with all 7000-series mainframes.

CH 1 AND CH 2 ATTENUATORS ①

NOTE

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

INPUT FUSE AND SWITCH

Signals connected to the Input connector pass through a 0.2 ampere fuse (F100) before reaching the Input Coupling switch. The fuse protects the attenuators and amplifier by preventing excessive voltages from reaching these components.

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

INPUT ATTENUATOR

The effective overall deflection factor of the 7A24 is determined by the setting of the VOLTS/DIV switch, S100B. The basic deflection factor is 10 millivolts per division of crt deflection. To increase the deflection factor to the values indicated on the front panel, precision attenuators are switched into the circuit. S100B is a cam-type switch. The dots on the contact-closure chart (see Diagram 1) indicate when the associated contacts are in the position shown (open or closed). In the 5 mV/Div and 10 mV/Div positions, the attenuators are not used; the input signal is connected directly to the Switched-Gain Amplifier. The 10 mV/Div position decreases the gain of the Switched-Gain Amplifier. For switch positions above 10 mV/Div, the attenuators are either switched into the circuit singly or are stacked, producing the

deflection factor indicated on the front panel. The hybrid attenuators are constant impedance, T-pad dividers. In addition to providing constant attenuation at all frequencies within the bandwidth of the instrument, the input attenuators are designed to maintain the same input impedance (50 ohms) for all settings of the VOLTS/DIV switch.

CH 1 AND CH 2 AMPLIFIERS ②

SWITCHED-GAIN AMPLIFIER

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

In the 5 mV position, full drive is provided from pins 5 and 9 of U1350 to the U1450 load resistors, R1401 and R1403. In all other attenuator positions, the signal-path drive current through the load resistors is divided in half. The other half is diverted through pins 6 and 8 of U1350 and is dissipated in dummy-load resistors R1334 and R1336. Resistor R1332 sets the basic gain by a factor of two for all positions of the VOLTS/DIV switch except 5 mV.

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

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

GAIN AND POLARITY INVERT AMPLIFIER

Integrated circuit U2450 is a variable-gain cascode amplifier which sets the overall channel gain. The GAIN (R2432B) and VARIABLE (R2432A) controls determine the ratio of base currents through pins 11 and 12 of U2450. The base-current ratio determines the shared collector output levels between pins 5-6, 8-9.

Variable resistor R2424 provides adjustable low-frequency compensation. Resistors R2422 and RT2420 compensate for temperature variations. Components R2430 and C2430 provide adjustable high-frequency compensation. The U2450 input T-coil peaking inductors and capacitors are part of the circuit board. Dc balance over the variable range is adjusted by R2410.

LEVEL SHIFT AND POSITION CONTROL

This circuitry shifts the dc level between U2450 and U2550, and provides positioning current.

Low frequency and dc signals are coupled through R2450, L2450, Q2450, R2455 and R2460, L2460, Q2460, R2455 which shifts the quiescent level from +8 volts to -8 volts. Capacitors C2450 and C2460, located in the transmission line between U2450 and U2550, provide ac coupling for high-frequency signals. Resistors R2452 and R2462 provide operating current for Q2450, Q2460, and U2450 while R2467 and R2468 set the operating point of these devices. The level shifter gain is unity.

Transistors Q2470 and Q2480 are current sources which add positioning current to the input of U2550. When POSITION control R2487 is at center, Q2470 and Q2480 provide equal currents resulting in zero offset current. As the control is rotated from center the differential offset at Q2470 and Q2480 produces a corresponding amount of positioning current. Resistors R2473, R2483, R2486, and R2487 form a base voltage divider for Q2470 and Q2480 in all display modes except ADD. In ADD, CR2474 and CR2484 conduct, which replaces R2487 with R2474 and R2484. Thus, the CH 2 POSITION control is disabled in ADD mode which limits position control to Channel 1 only.

The IDENTIFY circuit, composed of R2488, CR2488, and S2465, adds enough current to Q2480 to produce approximately 0.3 division trace shift at the crt for trace identification. When S2465 is closed, the junction of CR2488, R2488, and R2489 becomes more positive resulting in additional emitter current at Q2480 (approximately 200 microamps). When the switch is open, the junction shifts more negative and less emitter current flows. In this condition, when a multiplier probe is connected to the CH 2 Input, the additional resistance to ground produces just enough current shift at the readout circuit (Diagram 4) to indicate the appropriate multiplier on the crt.

SIGNAL SPLITTER AMPLIFIER

Integrated circuit U2550 provides two separate signals for use in the display and trigger channel switches on Diagram 3. Components C2515 and R2515 provide adjustable high frequency compensation. Output transient response is adjustable at C2560, C2562, R2560, and R2562.

DISPLAY SWITCHING AND OUTPUT ③

DISPLAY AND TRIGGER SWITCHING

The display and trigger channel switches provide selection of the channel one and/or channel two signals from the Switching Amplifiers on Diagram 2 for use in the mainframe.

Switching control is provided by the Switch Control circuits described later.

Integrated circuit U2750 passes or blocks the Channel 2 display signal depending on logic levels at pins 11 and 12. The signal is passed when a high appears at pin 12 and blocked when a low is at pin 12. Pin 11 follows the opposite state. When the switch is off, the signal appears at output pins 6 and 8. Ic U1750's operation is identical to U2750. The output signals of both switches are combined, terminated, and fed to display out terminals. Capacitor C2753 adjusts high-frequency compensation.

Trigger channel switches U1850 and U2850 operate in a similar manner as the display channel switches. Components C1857, C2857, R1857, and R2857 compensate for additional trigger pickoff transmission line losses.

SWITCH CONTROL

Since the display and trigger switch control circuits are identical, only the display circuit is described in detail.

Transistors Q1920, Q1930 and Q1940, Q1950 are unity gain paraphrase amplifiers that control the channel one and channel two switches, respectively. Display commands from the mode switch are level shifted and applied to the channel switches. Transistor Q1910 is a voltage source for both amplifiers. In the ADD mode, Q1950 is forced on by Q1960 causing both channel switches to simultaneously pass signals. Components CR1970 and R1970 correct the common mode output voltage level when the channel switches are in ADD mode.

CH 1 AND CH 2 READOUT ◈4

READOUT ENCODING

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

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

Switching resistors are used to indicate the setting of the VOLTS/DIV switch to the mainframe readout system. The VOLTS/DIV switch is a cam-type switch. The dots on the contact-closure chart (see Diagram 4) indicate when the associated contacts are closed. Resistors R633, R634, and R635 select the numbers 1, 2, or 5 depending on the resistor combination that is switched in. Resistors R636, R642 select the m (milli-) prefix and R639 and R643 select the symbol V (volts) in the 5 mV through 0.5 V (500 mV) positions of the VOLTS/DIV switch. Resistors R636 and R642 select the symbol V in the 1 V position. Resistors R630, R631, and the output of the probe sensing stage (Q620) select the decimal point (number of zeroes), again depending on the resistor combination switched in by the VOLTS/DIV switch.

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

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

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

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

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

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

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

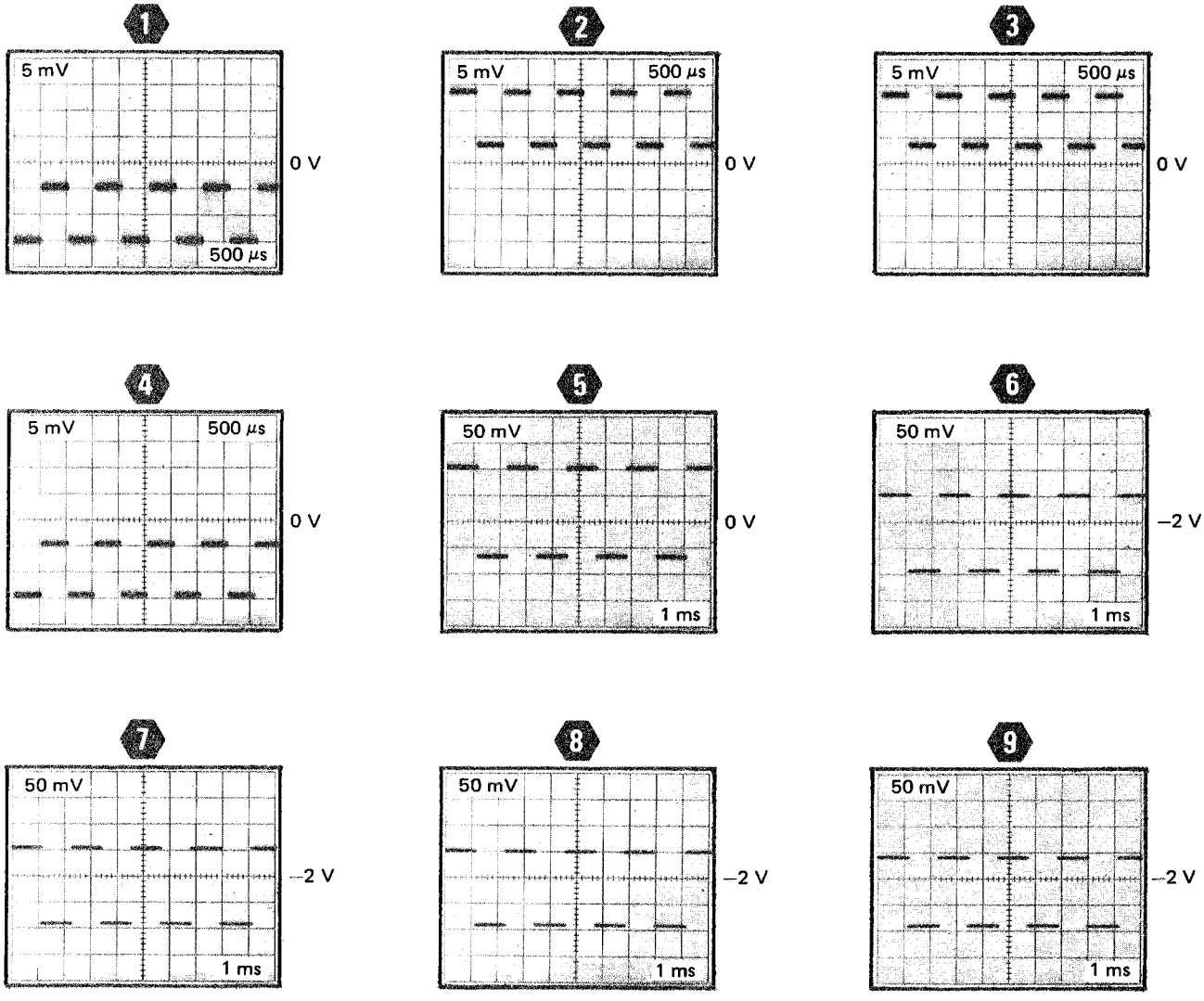
VOLTAGE AND WAVEFORM CONDITIONS

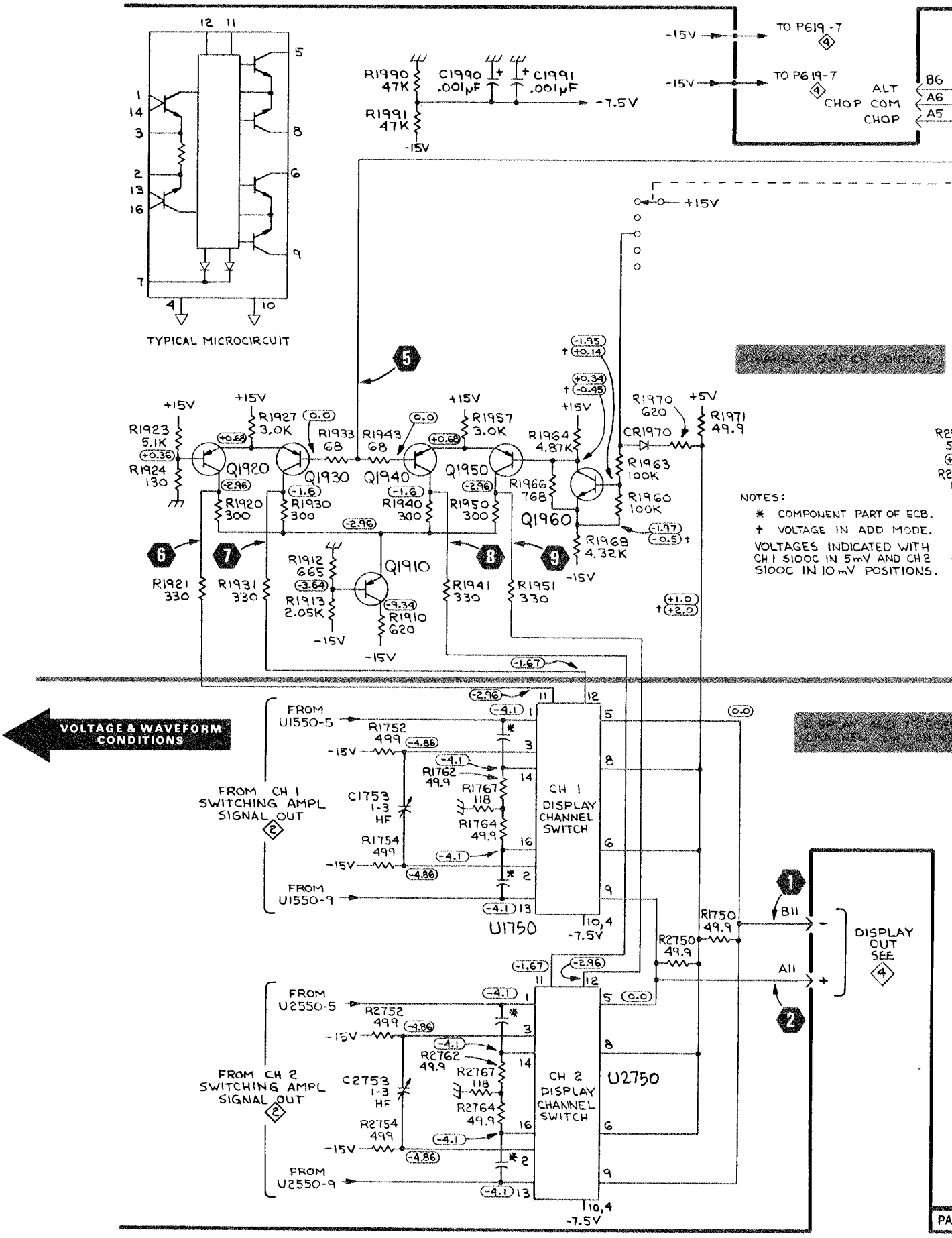
The voltages and waveforms shown were obtained with the 7A24 controls set as follows:

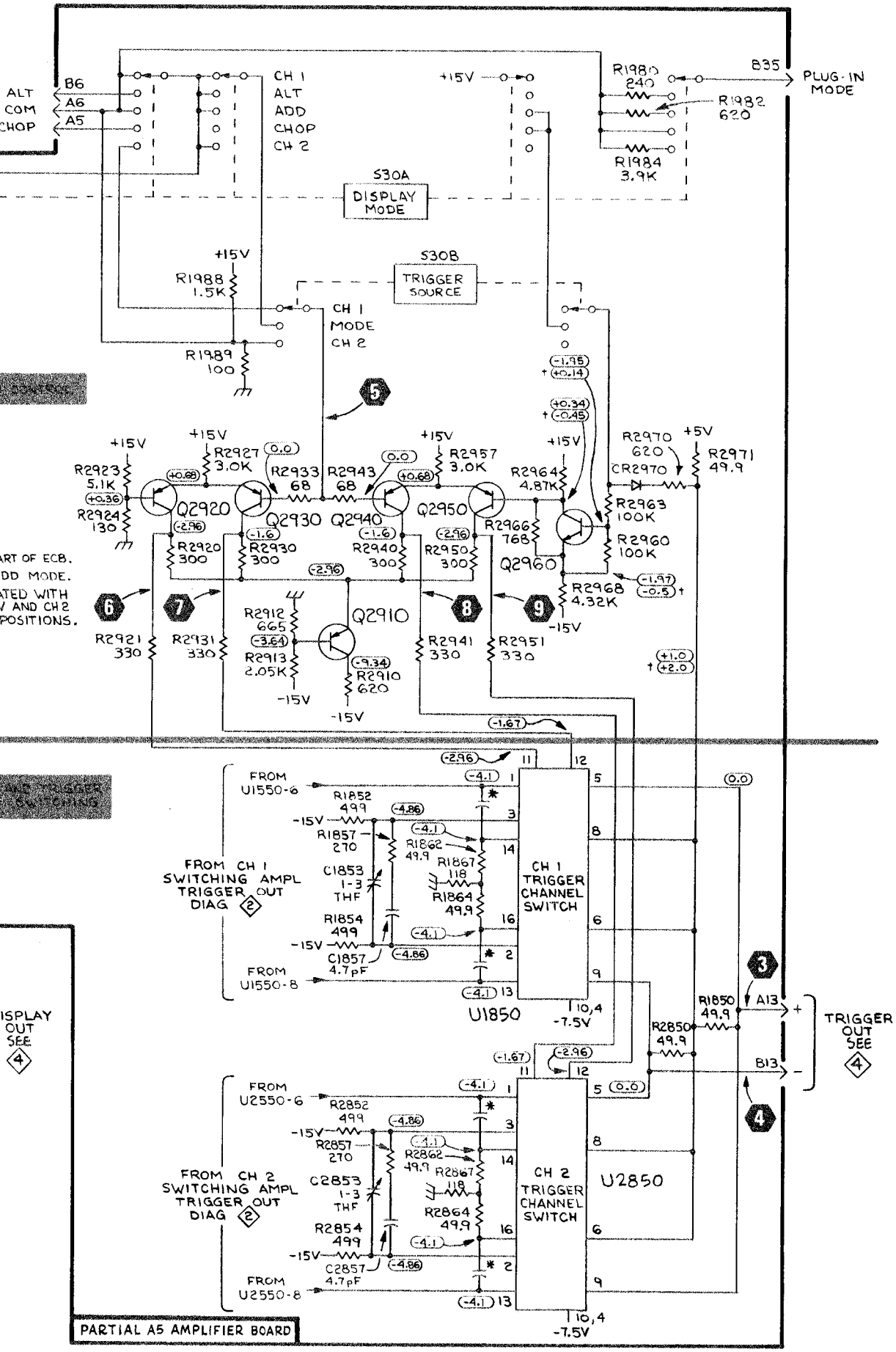
CH 1 and CH 2 VOLTS/DIV, 5 mV; CH 1 and CH 2 Input switches, DC; CH 1 and CH 2 POSITION, center trace on graticule; DISPLAY MODE, CH 1; TRIGGER SOURCE, MODE; CH 2 POLARITY, +UP.

Waveform Conditions. The waveforms shown below were obtained using a test oscilloscope system with 10 MΩ input impedance and at least 30 MHz bandwidth (Tektronix 7603, 7B53A Time Base, and 7A13 Differential Comparator equipped with 10X probe). A 1 kHz, 20 mV into 50 Ω signal was fed to CH 1 of the 7A24.

Voltage Conditions. The voltages shown on the diagram were obtained using a digital multimeter with a 10 mΩ input impedance (Tektronix DM501 or Tektronix 7D13 Digital Multimeter used with readout equipped, 7000-series oscilloscope). The 7A24 CH 2 VOLTS/DIV is set to 10 mV.




TYPICAL MICROCIRCUIT
R1990 47K
C1990 .001μF
C1991 .001μF
-7.5V
R1991 47K
-15V
TO P619-7
ALT CHOP COM
CHOP
B6
A6
A5
+15V
R1923 5.1K
R1924 130
R1927 3.0K
R1933 68
R1943 68
R1957 3.0K
R1964 4.87K
R1970 620
+5V
R1971 49.9
CR1970
R1963 100K
R1960 100K
R1966 768
R1968 4.32K
Q1920
Q1930
Q1940
Q1950
Q1960
R1920 300
R1930 300
R1940 300
R1950 300
R1921 330
R1931 330
R1941 330
R1951 330
R1912 665
R1913 2.05K
R1910 620
Q1910
NOTES:
* COMPONENT PART OF ECB.
+ VOLTAGE IN ADD MODE.
VOLTAGES INDICATED WITH CH 1 S100C IN 5mV AND CH 2 S100C IN 10mV POSITIONS.
VOLTAGE & WAVEFORM CONDITIONS
FROM U1550-5
R1752 499
R1762 49.9
R1767 118
R1764 49.9
R1754 499
FROM U1550-9
FROM CH 1 SWITCHING AMPL SIGNAL OUT
C1753 1-3 HF
CH 1 DISPLAY CHANNEL SWITCH
U1750
R1750 49.9
R2750 49.9
DISPLAY OUT SEE
B11
A11
FROM U2550-5
R2752 499
R2762 49.9
R2767 118
R2764 49.9
R2754 499
FROM U2550-9
FROM CH 2 SWITCHING AMPL SIGNAL OUT
C2753 1-3 HF
CH 2 DISPLAY CHANNEL SWITCH
U2750



DISPLAY SWITCHING & OUTPUT 3

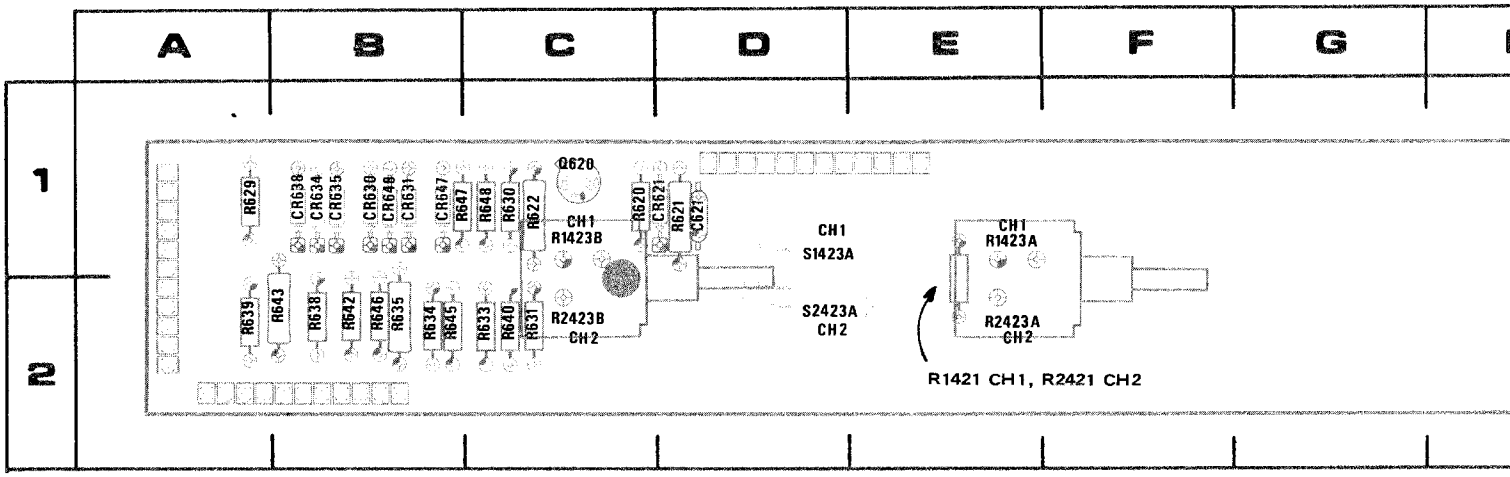
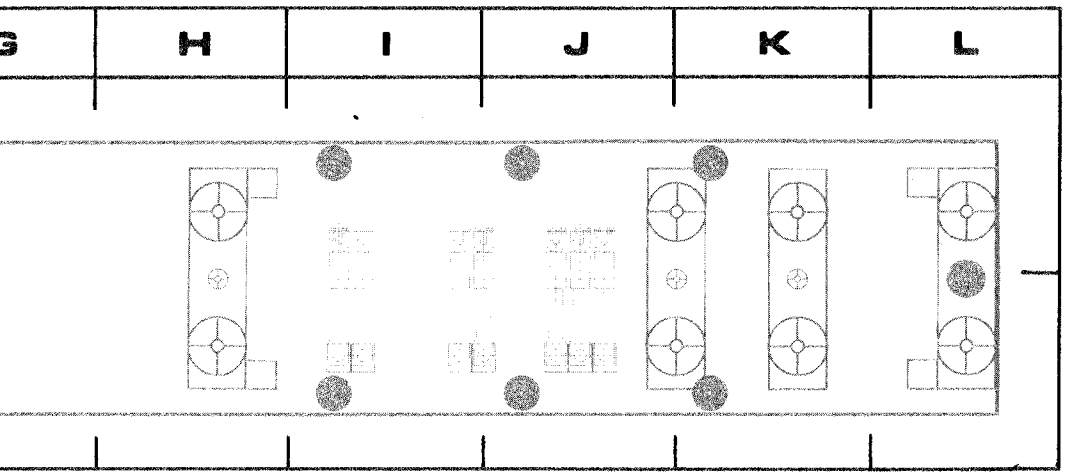


Figure 8-6. A2 and A4—Readout circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD
C621	1D	R633	2C
		R634	2B
CR621	1C	R635	2B
CR630	1B	R636	2B
CR631	1B	R638	2B
CR634	1B	R639	2A
CR635	1B	R640	2C
CR638	1B	R642	2B
CR647	1B	R643	2A
CR648	1B	R645	2B
		R647	1B
Q620	1C	R648	1C
		R1421	2E
R620	1C	R1423A	1E
R621	1D	R1423B	1C
R622	1C	R2421	2F
R629	1A	R2423A	2E
R630	1C	R2423B	2C
R631	2C	S1423	1D
		S2423	2D

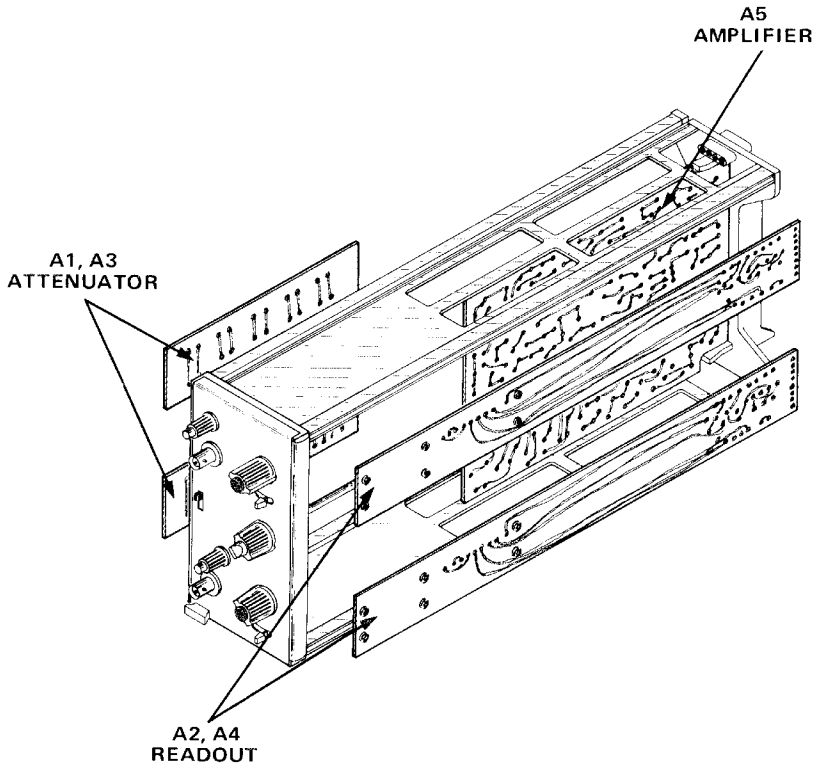
@



2391-24A

oard assembly.

RID OORD


A5
AMPLIFIER
A1, A3
ATTENUATOR
A2, A4
READOUT

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 (μF).

Resistors = Ohms (Ω).

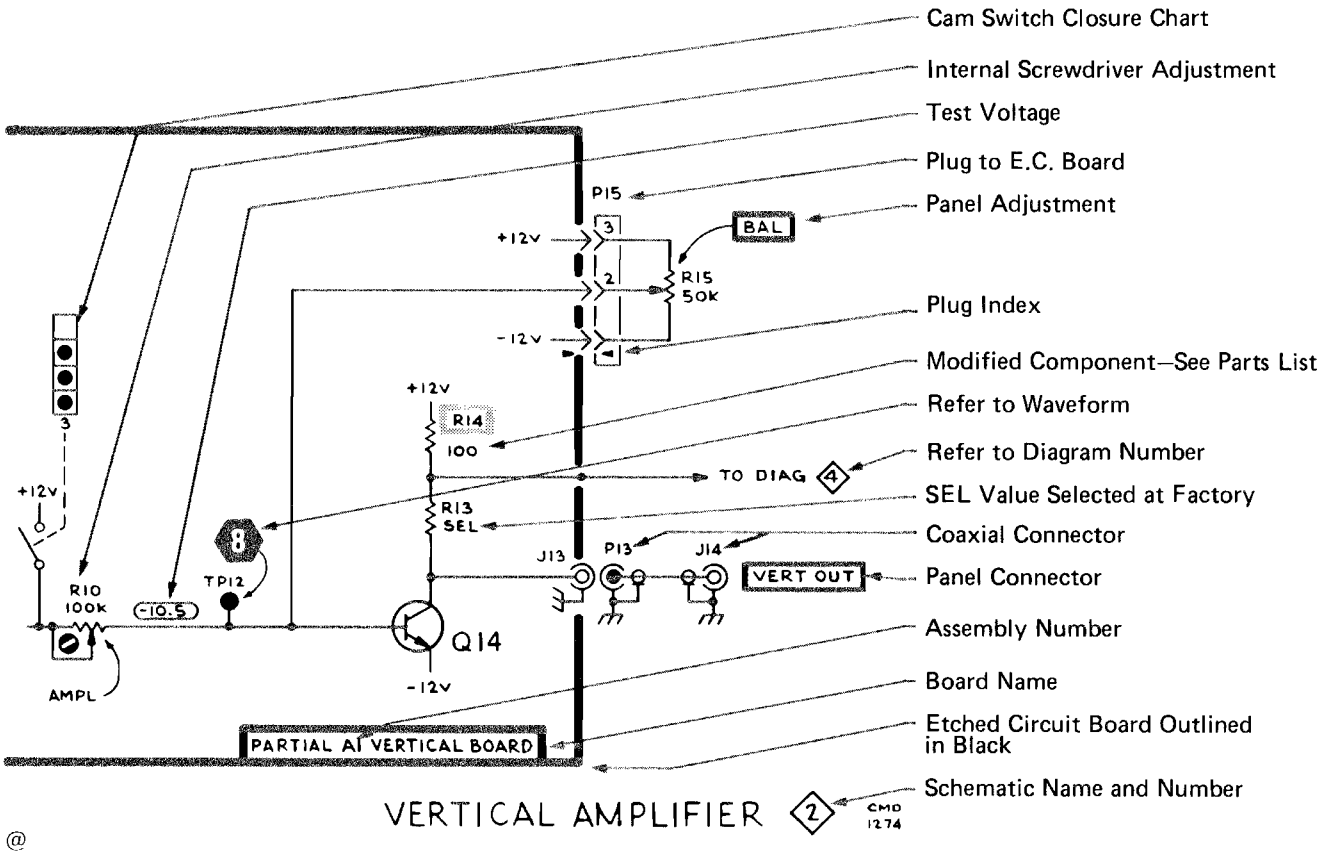
Symbols used on the diagrams are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

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

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

The following special symbols are used on the diagrams:



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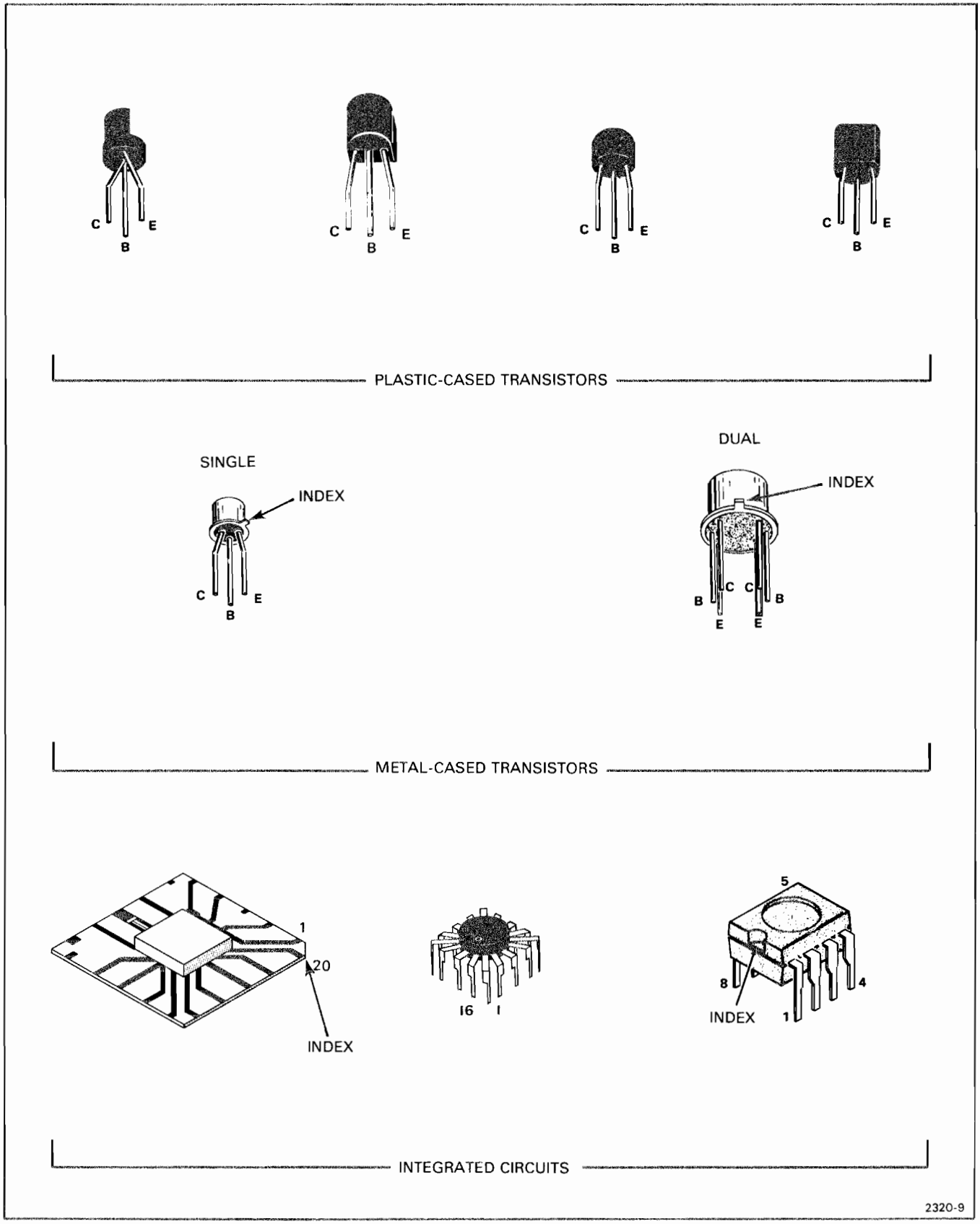


Figure 8-1. Semiconductor Lead Configurations.

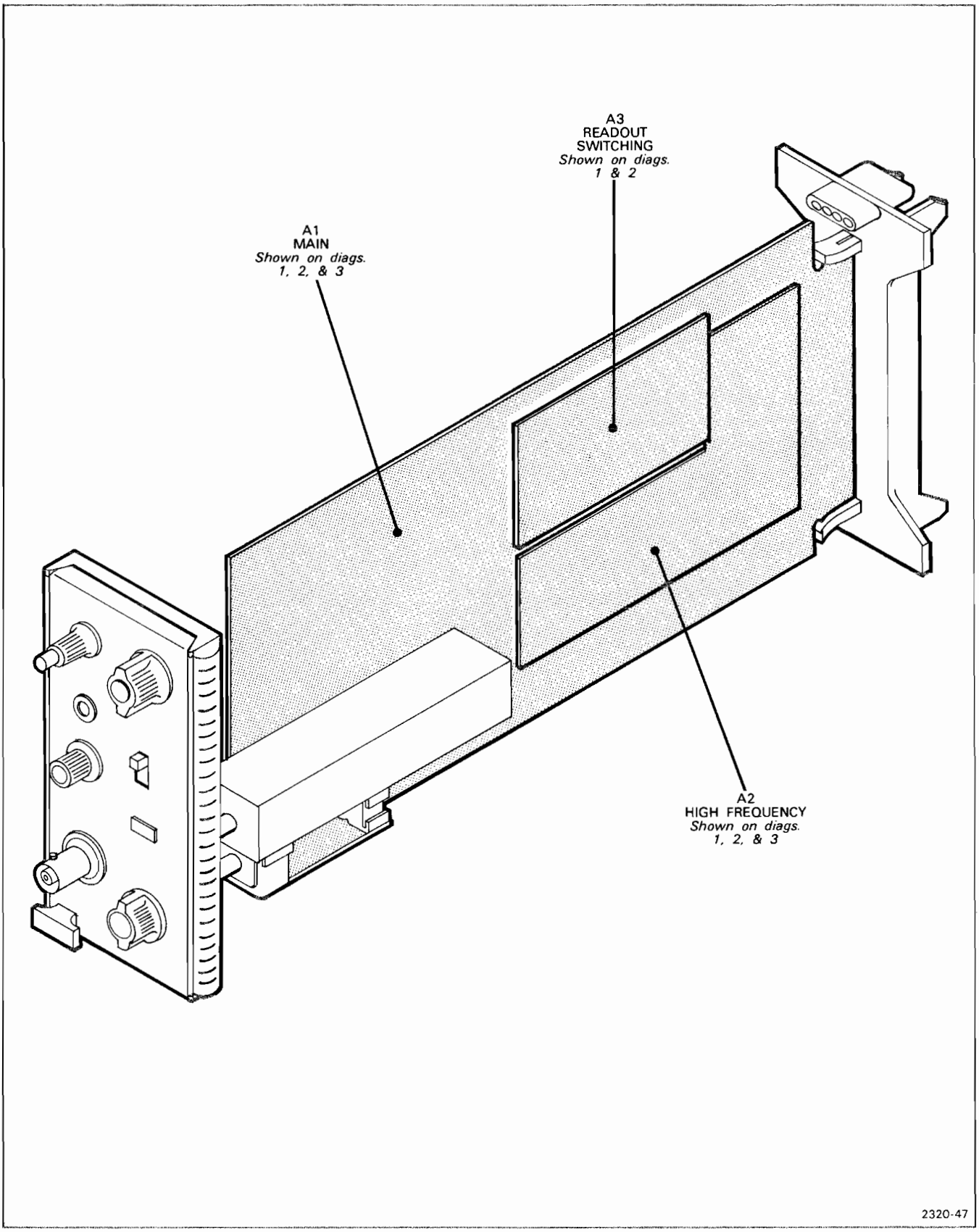


Figure 8-2. Circuit Board Locations.

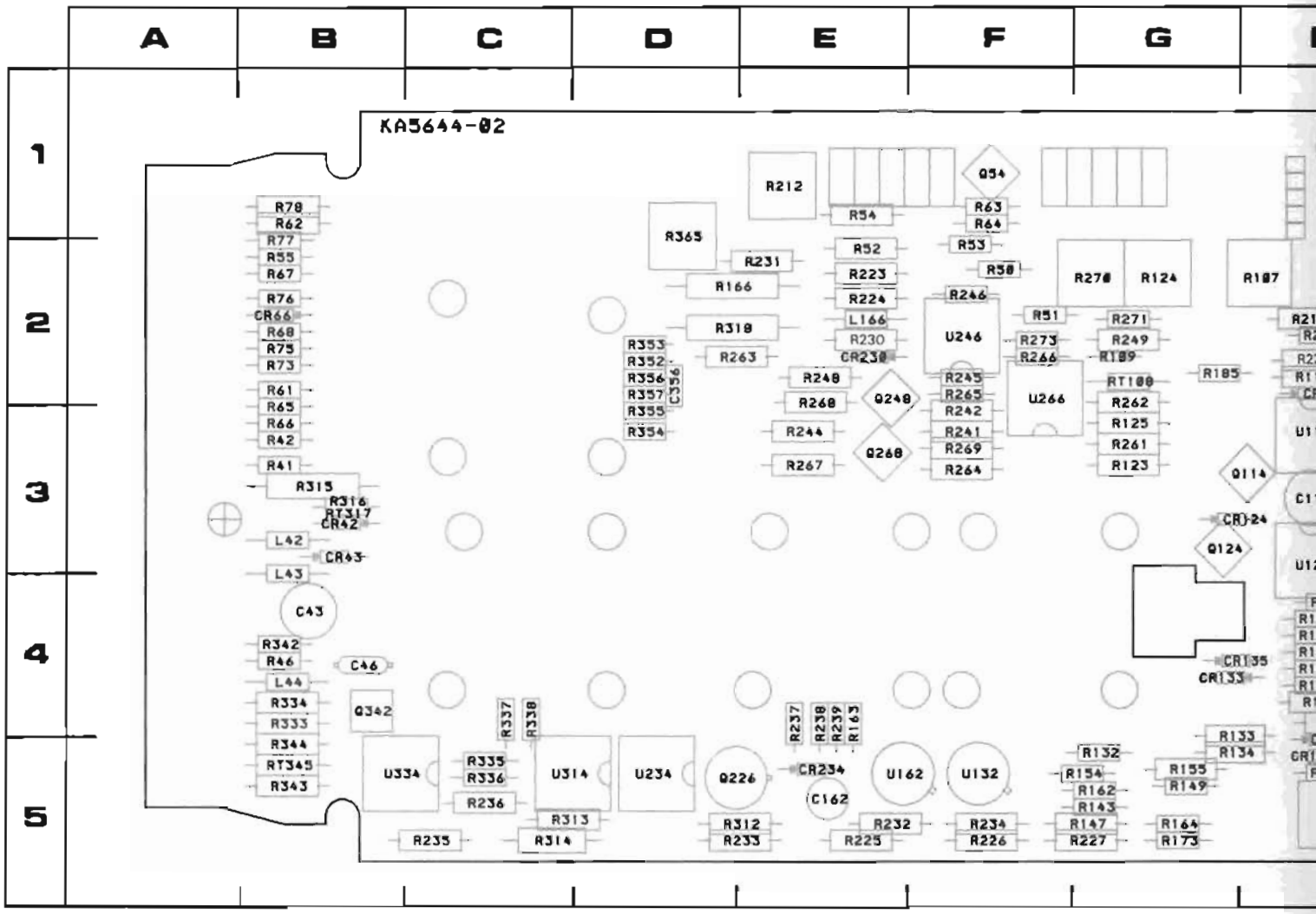
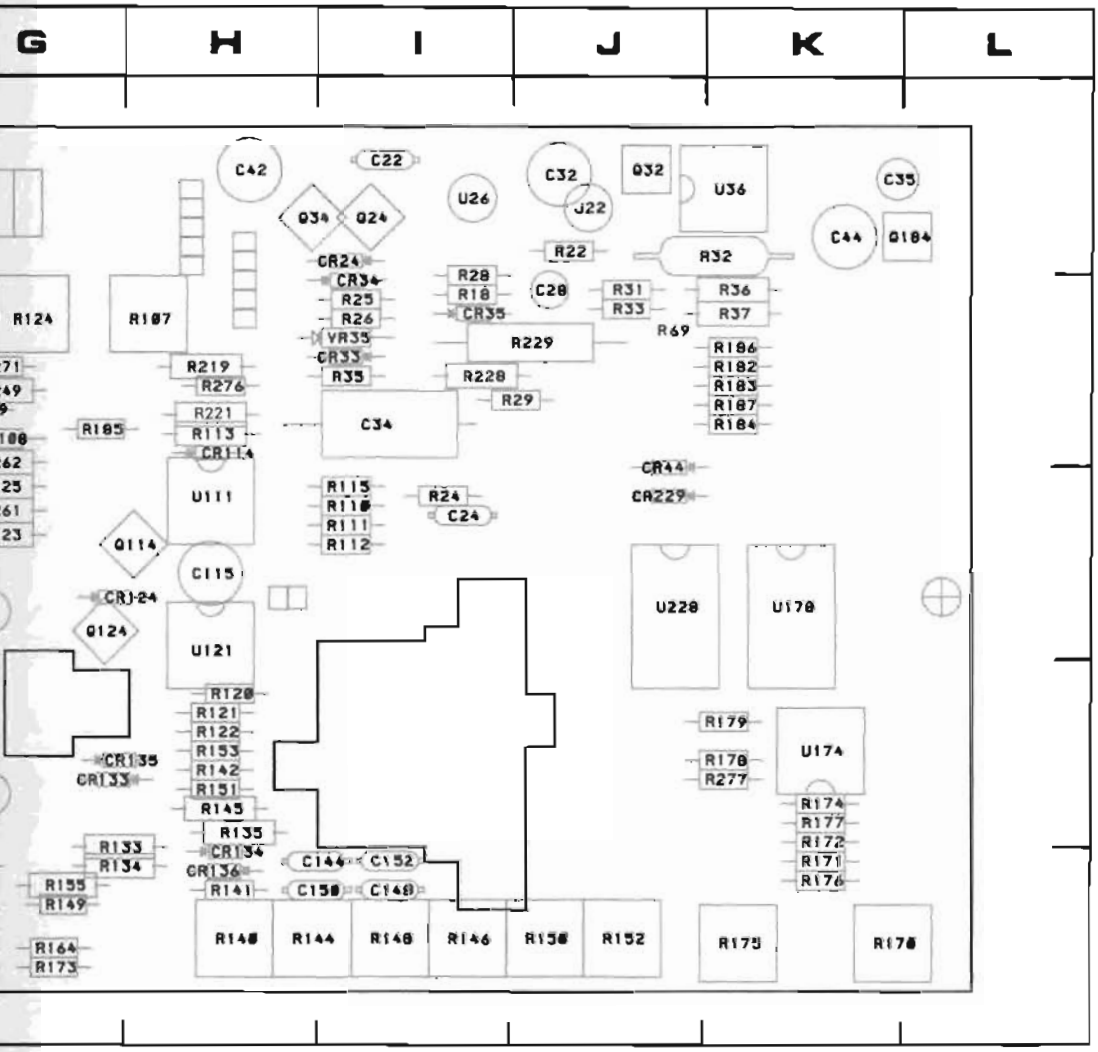


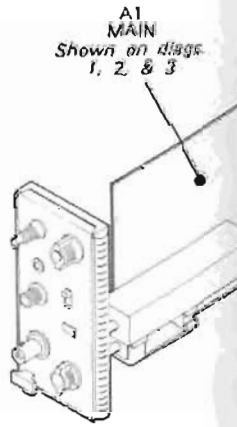
Figure 8-3. A1—Main circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO
C22	1I	CR43	3B	Q54	1F	R42	3B	R109	2G	R147	5G	R182
C24	3I	CR44	3J	Q114	3G	R46	4B	R110	3I	R148	5I	R183
C28	2J	CR66	2B	Q124	3G	R50	2F	R111	3I	R149	5G	R184
C32	1J	CR114	2H	Q184	1L	R51	2F	R112	3I	R150	5J	R185
C34	2I	CR124	3G	Q226	5D	R52	2E	R113	2H	R151	4H	R186
C35	1K	CR133	4G	Q248	3E	R53	2F	R115	3I	R152	5J	R187
C42	1H	CR134	5H	Q268	3E	R54	1E	R120	4H	R153	4H	R212
C43	4B	CR135	4G	Q342	4B	R55	2B	R121	4H	R154	5G	R215
C44	1K	CR136	5H			R61	2B	R122	4H	R155	5G	R221
C46	4B	CR229	3J	R18	2I	R62	1B	R123	3G	R162	5G	R223
C115	3H	CR230	2E	R22	1J	R63	1F	R124	2G	R163	4E	R224
C144	5I	CR234	5E	R24	3I	R64	1F	R125	2G	R164	5G	R225
C148	5I			R25	2I	R65	3B	R132	5G	R166	2D	R226
C150	5B	J22	1J	R26	2I	R66	3B	R133	5G	R170	5K	R227
C152	5I			R28	2I	R67	2B	R134	5G	R171	5K	R228
C162	5E	L42	3B	R29	2I	R68	2B	R135	4H	R172	4K	R229
C356	2D	L43	4B	R31	2J	R69	2J	R140	5H	R173	5G	R230
		L44	4B	R32	1K	R73	2B	R141	5H	R174	4K	R231
CR24	1I	L166	2E	R33	2J	R75	2B	R142	4H	R175	5K	R232
CR33	2I			R35	2I	R76	2B	R143	5G	R176	5K	R233
CR34	2I	Q24	1I	R36	2K	R77	2B	R144	5H	R177	4K	R234
CR35	2I	Q32	1J	R37	2K	R78	1B	R145	4H	R178	4K	R235
CR42	3B	Q34	1H	R41	3B	R107	2H	R146	5I	R179	4K	R236



rd assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD	CKT NO	GRID COORD
147	5G	R182	2K	R237	4E	R277	4K	RT108	2G
148	5J	R183	2K	R238	4E	R312	5D	RT317	3B
149	5G	R184	2K	R239	4E	R313	5C	RT345	5B
150	5J	R185	2G	R241	3F	R314	5C		
151	4H	R186	2K	R242	3F	R315	3B	U26	1I
152	5J	R187	2K	R244	3E	R316	3B	U36	1K
153	4H	R212	1E	R245	3F	R318	2D	U111	3H
154	5G	R219	2H	R246	2F	R333	4B	U121	3H
155	5G	R221	2H	R248	2E	R334	4B	U132	5F
162	5G	R223	2E	R249	2G	R335	5C	U162	5E
163	4E	R224	2E	R261	3G	R336	5C	U174	4K
164	5G	R225	5E	R262	3G	R337	4C	U178	3K
166	2D	R226	5F	R263	2D	R338	4C	U228	3J
170	5K	R227	5G	R264	3F	R342	4B	U234	5D
171	5K	R228	2I	R265	3F	R343	5B	U246	2F
172	4K	R229	2J	R266	2F	R344	5B	U286	3F
173	5G	R230	2E	R267	3E	R352	2D	U314	5C
174	4K	R231	2E	R268	2E	R353	2D	U334	5B
175	5K	R232	5E	R269	3F	R354	3D		
176	5K	R233	5D	R270	2G	R355	3D	VR35	2I
177	4K	R234	5F	R271	2G	R356	2D		
178	4K	R235	5C	R273	2F	R357	3D		
179	4K	R236	5C	R276	2H	R365	2D		



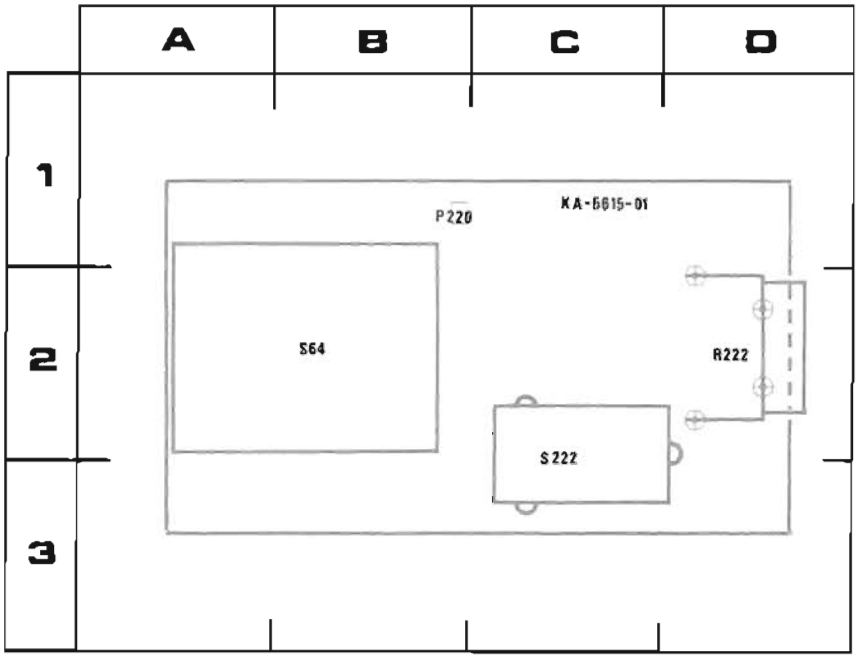
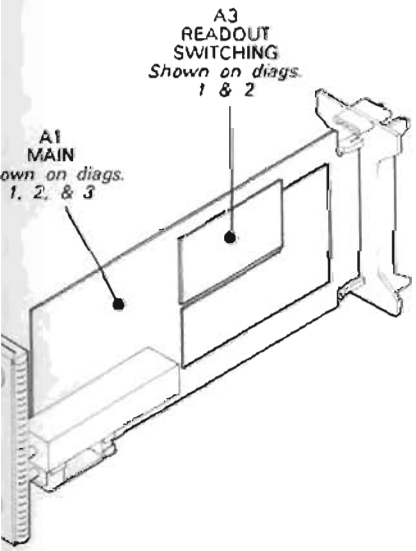


Figure 8-4. A3—Readout Switching circuit board assembly.

CKT NO	GRID COORD	CKT NO	GRID COORD
P220	1B		
		S64	2B
R222	2D	S222	2C



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