TEKTRONIX 5A45

OPERATING INSTRUCTIONS

INTRODUCTION

INSTRUMENT DESCRIPTION

The 5A45 is a general-purpose, medium-bandwidth, single-channel plug-in unit for use with the Tektronix 5400-series oscilloscopes. An illuminated VOLTS/DIV knob skirt directly indicates deflection sensitivities. The plug-in unit also has readout encoding capabilities. When used in a main frame with readout capabilities, the deflection sensitivities are displayed directly on the crt. When used with Tektronix probes with readout capabilities, the plug-in indicates the decreased deflection sensitivity on the knob skirt, as well as on the crt. When operating in the two most sensitive positions, the reduced bandwidth is visible through the VOLTS/DIV knob skirt.

PREPARATION FOR USE

Your 5A45 is calibrated and ready for use when received. Fig. 1-1 shows the installation and removal procedure. The 5A45 will operate in the horizontal compartment for X-Y displays. When using X-Y displays, remember that the vertical channel is delayed approximately 150 nanoseconds (3° phase shift at 50 kHz) by the vertical delay line.

Refer to the Front Panel Controls and Connectors illustration, in the foldout pages at the rear of this manual, for a complete description of the front panel.

BASIC OPERATION

Push the DISPLAY ON button in the blue area. Set the time base plug-in unit to two milliseconds per division sweep rate, and the trigger on automatic. Set the display module intensity control to midrange. Turn the 5A45 POSITION control until a trace appears on the crt. Set the VOLTS/DIV switch to .2. Make certain the slide switch is in the DC position.

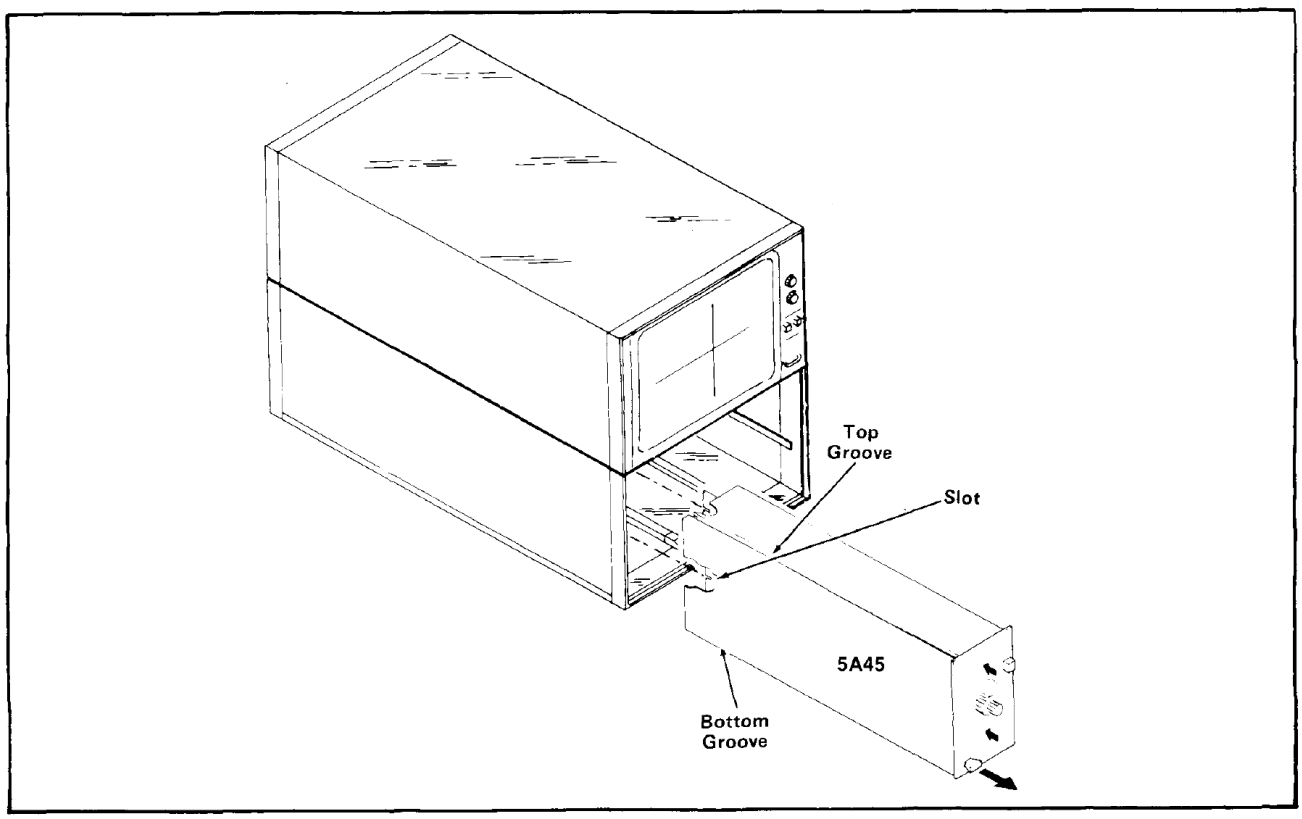


Fig. 1-1. 5A45 Installation-removal Procedure.

Apply the calibrator signal to the input connector. Adjust the triggering of the time base, if necessary, for a stable square wave display, approximately two major divisions in amplitude. Move the slide switch to the GND position and position the single trace to the graticule center. Now move the slide switch to the AC position. Notice that the square wave centers around the graticule center, and shows a slight slope. This indicates that the signal is capacitively coupled to the input. The slope indicates low frequency rolloff due to the ac coupling.

If any of the above displays cannot be obtained, refer to the Service section of this manual.

GENERAL OPERATING INFORMATION

APPLYING SIGNALS

When making measurements of unknown voltages, use the highest deflection factor first. If the deflection is too small, switch to a lower deflection factor. In general, probes offer the most convenient method of applying signals to the 5A45. Tektronix probes are shielded to prevent pickup of electrostatic and electromagnetic interference. A 10X probe offers a relatively high input impedance and minimum loading to the circuit under test. The 5A45 is compatible with readout coded probes, such as the P6065 passive probe. The Tektronix catalog lists other probes compatible with the 5A45. The input connector has an outer ring to which the coding ring on the probe connector makes contact. This allows the deflection factor (indicated on the knob skirt and the crt readout) to correspond with the actual deflection factor at the probe tip. Notice the notation WITH PROBE on the front panel.

Sometimes unshielded test leads can be used to connect the 5A45 to a signal source. This method works best when measuring high-level signals with relatively low source impedances. Coaxial cable with bnc connectors works well in certain applications. When using unterminated coaxial cable, use the shortest possible lengths to prevent unnecessary capacitive loading of the signal source. A common ground between the signal source and 5A45 is required. The probe ground connection or the shield of a coaxial cable works well as a ground return.

INPUT COUPLING

Dc coupling can be used in most applications. If the dc component of the measured signal is large compared to the ac component, ac coupling should be used. Use dc coupling for ac signals below about 10 hertz, to avoid signal attenuation in the ac position.

The GND position provides a ground reference at the 5A45 input. The amplifier input is grounded, and the signal is connected to ground through a 1 MΩ resistor. Obtain a ground reference in this manner.

PRE-CHARGING

This feature prevents surge currents, due to charging the ac coupling capacitor, from damaging the circuit under test. When using deflection factors of 20 mV/div through 1 mV/div with a test lead or 1X probe, place the slide switch in the GND position. Connect the 5A45 input to the circuit under test and wait about one second. This allows the coupling capacitor to charge to the dc input voltage. Then move the slide switch to the AC position.

SPECIFICATIONS

ELECTRICAL

BANDWIDTH: In the 5403, 6 division reference signal, dc-coupled, 1 mV/DIV and 2 mV/DIV ≥ 25 MHz; 5 mV/DIV through 10 V/DIV, ≥ 60 MHz. Lower end response ac-coupled, ≤ 10 Hz (≤ 1.0 Hz with 10X probe) at all deflection factors.

RISETIME: ≤ 14 ns, 1 mV/DIV and 2 mV/DIV. ≤ 5.8 ns, 5 mV/DIV through 10 V/DIV.

DEFLECTION FACTOR ACCURACY: ≤ 5% at 1 mV/DIV and 2 mV/DIV, ≤3% from 5 mV/DIV to 10 V/DIV from 15°C to 35°C, ≤4% from 5 mV/DIV to 10 V/DIV from 0°C to 50°C. A continuously variable control provides ≥ 2.5X additional attenuation on each range.

ABERRATIONS: +2%, −2%, total of 3% of displayed step amplitude.

STABILITY: ≤0.3 mV vertical shift in any one minute after one hour warmup, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

INPUT RESISTANCE AND CAPACITANCE: 1 MΩ, within 0.5% shunted by approximately 20 pF.

MAXIMUM SAFE INPUT VOLTAGE: DC coupled, 250 V (dc + peak ac), ac component 500 V peak-to-peak maximum, 1 kHz or less. AC coupled, 500 V (dc + peak ac), ac component 500 V peak-to-peak maximum, 1 kHz or less.

PHYSICAL

TEMPERATURE RANGE: 0°C to 50°C operating, −40°C to +70°C nonoperating.

ALTITUDE RANGE: ≤15,000 feet operating, ≤50,000 feet nonoperating.

DIMENSIONS: 5.0 in (12.5 cm) H. 2.6 in (6.7 cm) W. 12.0 in (30.5 cm) L.

WEIGHT: ≈1.5 lbs (0.7 kg).

SUPPLEMENTAL INFORMATION

DISPLAYED NOISE: ≤300 μV at 5 mV/DIV tangentially measured in a 5400 series mainframe.

STEP ATTENUATOR BALANCE: ≤2 division vertical trace movement as VOLTS/DIV switch is rotated through its range.

POSITION RANGE: ≥± 7 major divisions from graticule center.

THEORY OF OPERATION

INTRODUCTION

Refer to the complete schematic diagram and the block diagram located in the pullout pages at the back of this manual, along with this discussion, to understand the operation of the 5A45.

INPUT COUPLING

Signals applied to the front panel bnc connector pass to the attenuators through the input coupling circuitry. C105 serves as the ac-coupling capacitor and R105 connects this capacitor to ground when the slide switch is in the GND position. The coupling capacitor is then precharged to the input dc level, and the input to the attenuators is grounded for reference. C102 sets the plug-in input capacity to the correct value.

The outer ring on the bnc connector is connected to the base of Q140 in the readout circuit, and to the base of Q128, which operates the WITH PROBE neon behind the VOLTS/DIV switch skirt. The readout probes have various resistances to ground. The resistance values are determined by the attenuation ratio of the probe. With no probe (or a 1X probe) connected to the input bnc connector, voltage levels are such that the voltage drop across DS128 is insufficient to light the neon. However, the drop across DS130 through Q130 is sufficient to illuminate this neon, showing the normal attenuation ratio.

ATTENUATORS

The attenuators are ac-compensated thick-film hybrid circuits on ceramic substrates. C108 sets the proper input capacitance, and C110 provides the correct series compensation for the 100X chip. C112 and C114 perform identical functions for the 10X attenuator chip. The combination of these attenuators, switched according to the charts shown on the schematics, attenuate the signals to the 5A45 amplifiers.

MAIN AMPLIFIER

The signal is fed to fet Q170A paired with Q170B. The STEP ATTEN BAL control, connected to the gate of Q170B sets the dc balance for the amplifier. Signals flow past the protective diode CR170 to the base of Q180. Signals at the emitter of Q180 follow signals at the gate of Q170A. A divider string consisting of R189, R191, R193 and R194 attenuates signals to Q200. Attenuation is 1X through R188, 2X through R189, and 4X through R193. The gain of Q180 and Q185 does not change; only the signal driving Q200 is attenuated. See Fig. 2-1 for a simplified diagram of this attenuation circuit. R182 sets the correct dc operating point for Q180 and Q185.

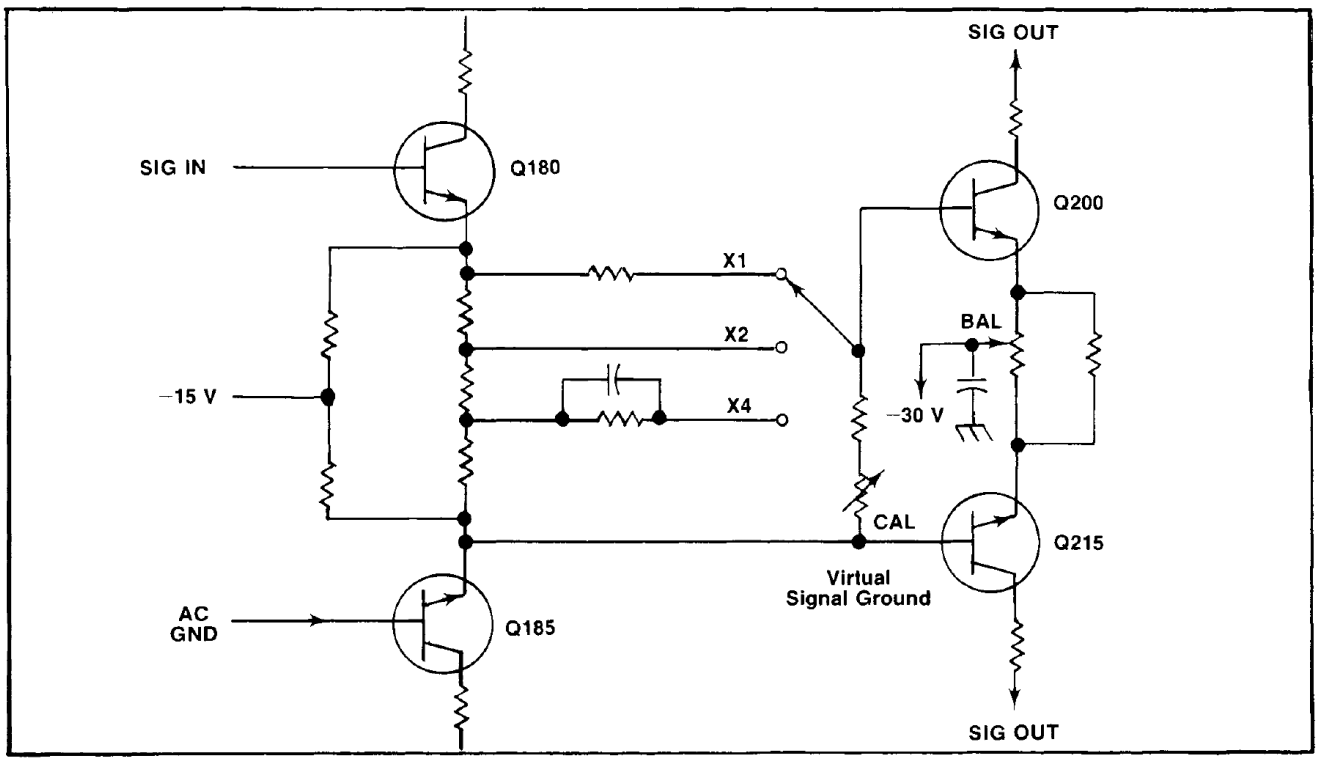


Fig. 2-1. Simplified diagram of attenuation network and single ended to paraphase transition.

Q200 and Q215 form an emitter-coupled paraphase amplifier. Their collectors drive Q202 and Q217. RT208 changes resistance with temperature so that the gain of Q200 and Q215 remains constant with temperature. This portion of the circuit provides a gain of about three. Q200 and Q215 current drive the emitters of Q202 and Q217. The current drive configuration improves high frequency response. R249 is switched from the circuit in the two most sensitive positions of the VOLTS/DIV switch, increasing the circuit gain to about fifteen.

Q220 and Q240 provide additional amplification. C229 affects high-frequency gain. The collectors of Q220 and Q240 drive the bases of the output transistors Q270 and Q280. R255, with constant current source Q250, varies the current division between Q270 and Q280, positioning the trace. The collectors of the output transistors drive the vertical amplifier in the main frame through the rear interface connector.

TRIGGER AMPLIFIER

The paraphase trigger signal from the emitter of Q220 is applied to the base of Q290; the same occurs for Q240 and Q295. The collector current of Q290 drives the emitter of Q300, and the collector current of Q295 drives the emitter of Q305. The collectors of Q300 & Q305 drive the bases of Q310 and Q320 respectively. Q320 drives Q325, whose output is the trigger signal. This signal is transferred to the horizontal plug-in through the rear interface connector. Q310 drives Q315, an additional transistor used as a phase inverter. The output signal at the collector of Q315 is now in phase with the collector signal of Q325. This circuitry provides single-ended output for differentially applied signals, providing cancellation of common mode signals.

READOUT

The DISPLAY, CAL, and VOLTS/DIV switches have contacts wired into the readout circuitry. A 0 V to −15 V pulse, approximately 125 μs in length, is applied at different times (in proper sequence) to all of the rear interface connectors associated with the readout circuitry, except the column and row lines (pins 28A and 28B). These are the output lines. The switches and resistances in the 5A45 allow the correct amount of current to the row and column lines during the prescribed pulse time for the particular character desired. See the main frame manual for more details concerning operation of the readout circuitry, including time slots and current required for each character displayed. Q140 applies the correct readout current for the attenuation of the probe used.

INTERNAL ADJUSTMENT PROCEDURE

generator, set for a 50-mV square-wave output, to the input of the 5A45 through a coaxial cable. Adjust the time base triggering for a stable display. Adjust R235, Gain Adj., for five major divisions of display.

6. ADJUST INPUT CAPACITANCE and COMPENSATE ATTENUATOR

Set the VOLTS/DIV switch to the 20 m position. Connect the calibration generator through a 50 Ω cable, 5X attenuator, 50 Ω termination, and the 20 pF normalizer in that order to the 5A45 input connector. Set the calibration generator frequency to 1 kHz. Adjust the output amplitude of the calibration generator for a square-wave display of five major divisions. Proceed to Table 3-1 and perform the adjustments as indicated. Adjust the calibration generator for an output amplitude of five major divisions for each position of the VOLTS/DIV switch. The square-wave level, rolloff, or overshoot must not exceed 0.1 major division in any position of the VOLTS/DIV switch.

ATTENUATOR COMPENSATION

TABLE 3-1

VOLTS/ DIV	Adjust Level	Adjust Front Corner
20 m	C102	
50 m	C112	C114
.1	Check front corner	
.2	Check front corner	
Remove 5X attenuator		
.5	C108	C110
1	Check front corner	
2	Check front corner	
5	Check front corner	
10	Check front corner	

7. CHECK VOLTS/DIV ACCURACY

Remove the 20 pF normalizer. Connect the amplitude calibration portion of the calibration generator to the input connector. Set the VOLTS/DIV switch to the 1 m position. The slide switch should be in the DC position. Set the calibration generator for a square-wave output of 5 mV. Follow the directions listed in Table 3-2, noting the maximum error.

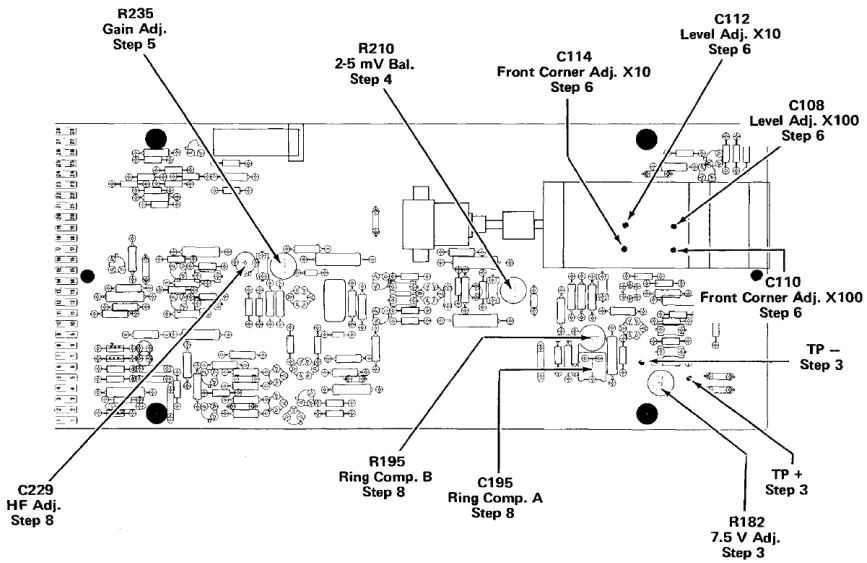
DEFLECTION FACTOR TOLERANCES

TABLE 3-2

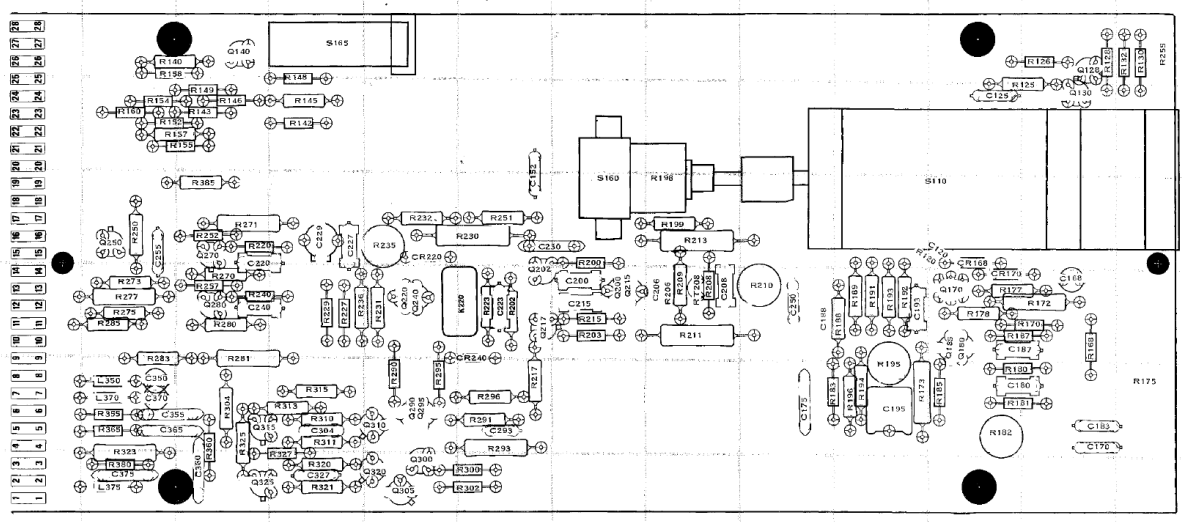
CALIBRATION AMPLITUDE	5A45 VOLTS/DIV	Display Amplitude	Max Error
5 mV	1 m	5 div	.25 div (5%)
10 mV	2 m	5 div	.25 div (5%)
20 mV	5 m	4 div	.12 div (3%)
50 mV	10 m	5 div	.15 div (3%)
.1 V	20 m	5 div	.15 div (3%)
.2 V	50 m	4 div	.12 div (3%)
.5 V	.1	5 div	.15 div (3%)
1 V	.2	5 div	.15 div (3%)
2 V	.5	4 div	.12 div (3%)
5 V	1	5 div	.15 div (3%)
10 V	2	5 div	.15 div (3%)
20 V	5	4 div	.12 div (3%)
50 V	10	5 div	.15 div (3%)

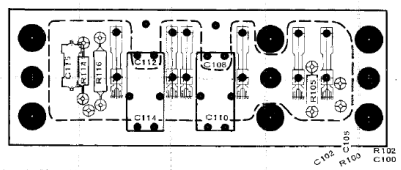
8. ADJUST TRANSIENT RESPONSE

Connect the calibration generator set for a 500 kHz square wave through a 50 Ω cable and 50 Ω termination to the input connector. Set the VOLTS/DIV switch to the 10 m position. Adjust the amplitude of the calibration generator for a five major division display. Set the time base for a 0.1 sweep speed and obtain a stable triggered display. Center the display using the vertical and horizontal position controls. Then adjust C195, Ring Comp A, and R195, Ring Comp B, for the least amount of ringing on the front corner of the waveform. Then adjust C229, Hf Adj, for the best square corner on the waveform.



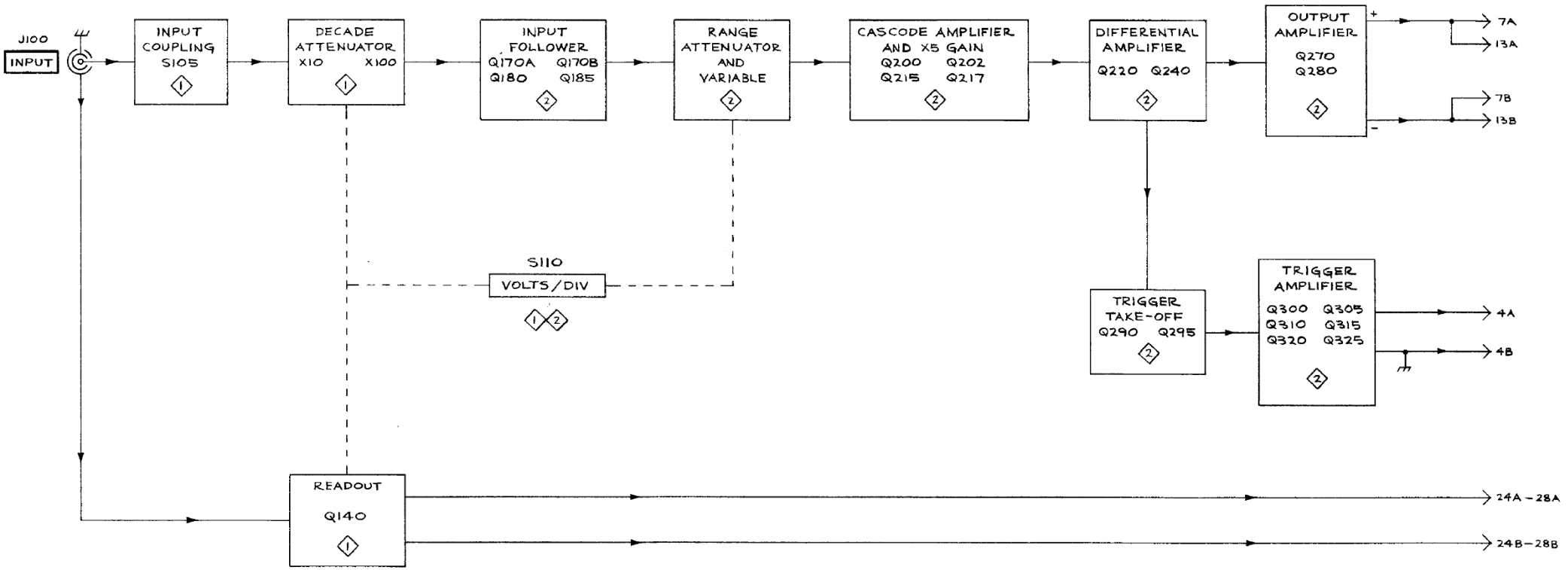
PARTS LOCATION GRID





CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C100	R3	Q128	L1	R188	J4	R310	D5
C102	C3	Q130	L2	R189	J4	R311	D5
C105	C3	Q140	C1	R191	J4	R313	D5
C108	P2	Q170	K4	R192	J4	R315	D5
C110	P3	Q180	K4	R193	J4	R320	D6
C112	O2	Q185	K4	R194	J5	R321	D6
C114	O2	Q200	G4	R195	J5	R323	B5
C116	N2	Q202	F4	R196	J5	R325	C5
C120	J3	Q215	G4	R198	H3	R327	D5
C125	K2	Q217	F4	R199	H3	R355	B5
C152	F2	Q220	E4	R200	G3	R360	C5
C168	L4	Q240	E4	R202	F4	R365	B5
C170	L5	Q250	B3	R203	G4	R380	B6
C175	I5	Q270	C3	R206	H4	R385	C3
C180	K5	Q280	C4	R208	H4		
C183	L5			R209	H4		
C187	K4			R210	I4	RT208	H4
C188	I4	R100	Q3	R211	H4		
C193	J4	R102	R3	R213	H3	S110	K3
C195	J5	R105	Q3	R215	G4	S160	G3
C200	G4	R114	O2	R217	F5	S165	D1
C206	H4	R116	O2	R220	C3		
C208	H4	R120	J3	R223	F4		
C215	G4	R125	K2	R227	D4		
C220	C3	R126	L1	R229	D4		
C223	F4	R128	L1	R230	F3		
C227	D3	R130	M1	R231	E4		
C229	D3	R132	M1	R232	E3		
C230	F3	R140	B1	R235	E3		
C240	C4	R142	D2	R236	D4		
C250	I4	R143	C2	R240	C4		
C255	B3	R145	D2	R250	B3		
C293	F5	R146	C2	R251	F3		
C304	D5	R148	D1	R252	C3		
C327	D6	R149	C2	R255	M1		
C350	B5	R162	B2	R257	C4		
C365	B5	R154	B2	R270	C4		
C380	C6	R155	C2	R271	C3		
C385	B5	R157	B2	R273	B4		
C370	B5	R158	B1	R275	B4		
C375	B6	R160	B2	R277	B4		
		R168	L4	R280	C4		
CR168	K3	R170	L4	R281	C4		
CR170	K4	R172	L4	R283	B4		
CR220	E3	R173	J5	R286	B4		
CR240	F4	R175	M5	R290	E5		
		R177	K4	R291	F5		
K220	F4	R178	K4	R293	F5		
		R180	K5	R295	E5		
		R181	K5	R296	F5		
		R182	K5	R300	F6		
L350	B5	R183	I5	R302	F6		
L370	B5	R185	K5	R304	C5		
L375	B6	R187	K4				

REV. B, MAR. 1975



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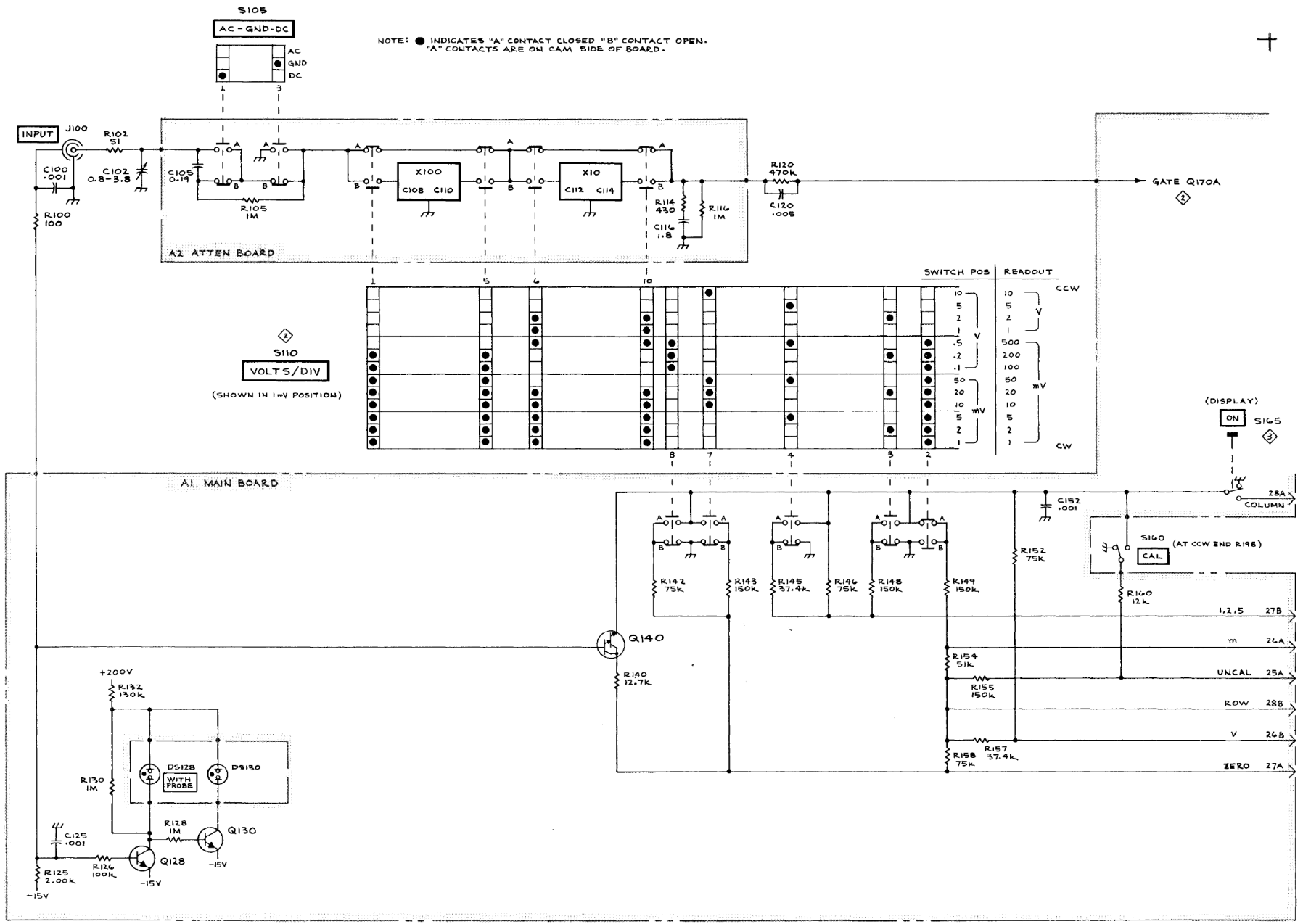
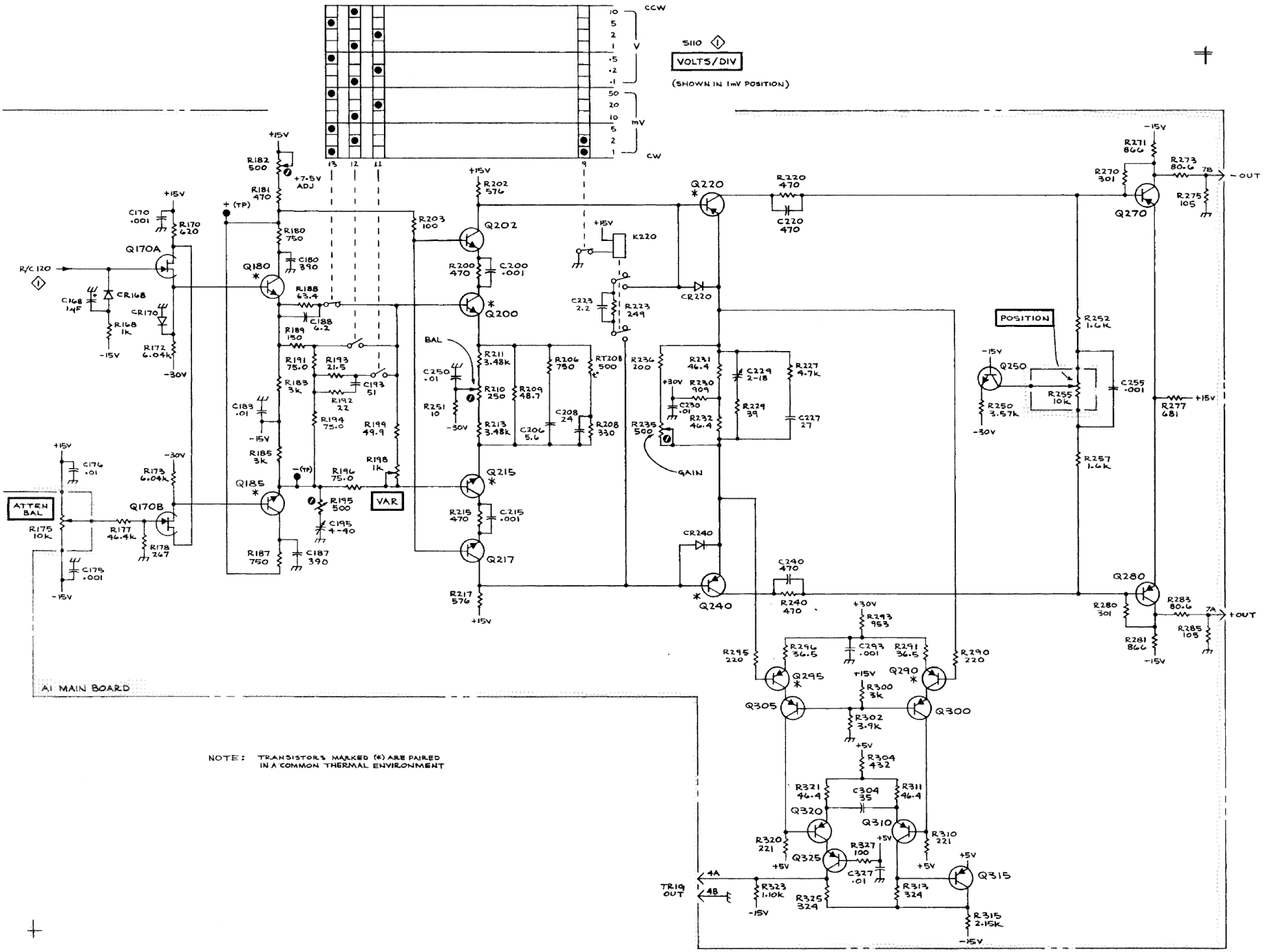
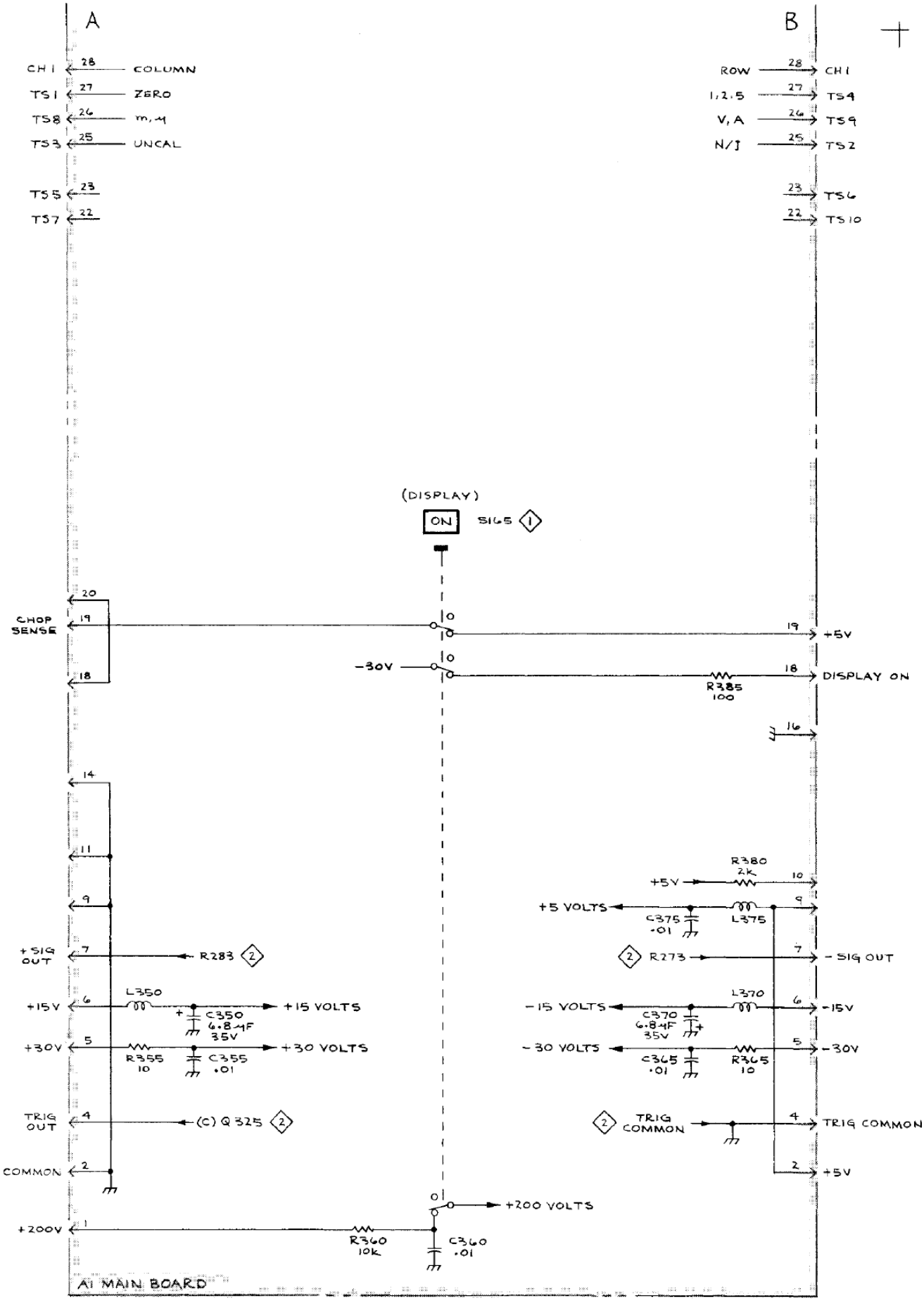
BLOCK DIAGRAM DEH 0174


S105
AC - GND - DC
AC
GND
DC
NOTE: ● INDICATES "A" CONTACT CLOSED "B" CONTACT OPEN.
"A" CONTACTS ARE ON CAM SIDE OF BOARD.
INPUT
J100
R102 51
C100 .001
C102 0.8-3.8
C105 0.19
R105 1M
R100 100
A2 ATTEN BOARD
X100
C108 C110
X10
C112 C114
R114 430
C116 1.8
R116 1M
R120 470k
C120 .005
GATE Q170A
SWITCH POS
READOUT
CCW
CW
10
5
2
1
.5
.2
.1
500
200
100
50
20
10
5
2
1
V
mV
S110
VOLTS/DIV
(SHOWN IN 1mV POSITION)
A1 MAIN BOARD
(DISPLAY)
ON
S165
28A
COLUMN
C152 .001
S160 (AT CCW END R198)
CAL
R152 75k
R142 75k
R143 150k
R145 37.4k
R146 75k
R148 150k
R149 150k
R160 12k
1,2,5 27B
m 26A
UNCAL 25A
ROW 28B
V 26B
ZERO 27A
Q140
R140 12.7k
R154 51k
R155 150k
R157 37.4k
R158 75k
+200V
R132 130k
R130 1M
DS128 WITH PROBE
DS130
R128 1M
Q130
Q128
C125 .001
R126 100k
R125 2.00k
-15V



NOTE: TRANSISTORS MARKED (*) ARE PAIRED IN A COMMON THERMAL ENVIRONMENT

AMPLIFIER AND TRIGGER 2 DEM 0174



5A45 (A) VOLTAGE SUPPLIES 3 DEH 0174