

LBO-518

100MHz QUAD TRACE,  
DELAYED TIME BASE  
OSCILLOSCOPE

SERVICE MANUAL

## CONTENTS

	Page
1. Test Equipment Required	2
2. Calibration Procedure	3
1) Initial Control Settings	3
2) Power Supply	4
3) Display	4
4) Vertical Amplifier	5
5) CH-3/CH-4	10
6) Time Base/Horizontal Amplifier	12
7) Trigger	16
8) X-Y Operation	20
9) Calibrator	20
3. Troubleshooting Procedure	21
4. Location of Adjustment	23
5. Printed Circuit Board	27
6. Block Diagram & Schematic Diagram	33

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### NOTE

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the service manual unless you are qualified to do so.

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## 1. Test Equipment Required

The following test equipment is required for calibration and servicing of the Model LBO-518. The suggested specifications are the minimum necessary for proper calibration of this instrument.

Test Equipment	Minimum Spec.
- Multimeter	0-2000Vdc Accuracy $< \pm 1\%$
- Oscilloscope	5mV sensitivity 100MHz bandwidth
- Amplitude Calibrator	1kHz square wave 5mV- 50Vp-p Accuracy $< \pm 0.5\%$
- Square Wave Generator	Rise time $< 1\text{nS}$
- Time Mark Generator	0.5S-10nS Accuracy $< 0.5\%$
- Sine Wave Generator	10Hz-100MHz Flatness $< 0.2\text{dB}$
- Capacitance Meter	30pF

## 2. Calibration Procedure

\* Calibration should be performed after a 30 minute warm-up period. It should also be confirmed that the unit is connected to the rated power line voltage.

\* All adjustment should be completed in the given order, because some adjustments interact with others.

\* During the adjustment procedure, remove the case only when necessary and replace immediately after making an adjustment. This will maintain all circuit at constant operating temperature.

### 1) Initial Control Settings

The initial control settings to be used for each check and adjustment are listed below. Any variations from these settings are stated in the applicable procedure.

#### - DISPLAY

A INTEN	As desired
B INTEN	As desired
FOCUS	Best focused display
ILLUM	As desired

#### - VERTICAL

VOLTS/DIV	0.1V (CH-1, CH-2)
VARIABLE	CAL'D (CH-1, CH-2)
x10 MAG	OFF (CH-1, CH-2)
POSITION	Center (CH-1 to CH-4)
AC-GND-DC	DC (CH-1, CH-2)
V MODE	CH-1
20MHz BW LIMIT	OFF
CH-2 INV	OFF

#### - TIME BASE

A TIME/DIV	0.5mS
B TIME/DIV	0.1mS

VARIABLE	CAL'D
POSITION	Center (Both)
HORIZ DISPLAY	A
SWEEP MODE	AUTO
DLY TIME MULT	0.2.

- TRIGGER

COUPLING	DC (A, B)
SOURCE	CH-1 (A, B)
LEVEL	0 (A, B)
A/B TRACE SEP	Center
A HOLDOFF	NORM
SLOPE	+ (A, B)

2) Power Supply

a) Connect the DC voltmeter between test point on the pc board (# T-2735) and chassis.

b) Adjust as required, using the adjustment shown in Table-1.

Test point	Voltage	Tolerance	Adjustment
TP5 (T-2735)	-8.0V	-	VR1 (T-2735)
TP1 (T-2735)	+100V	+98V to +102V	-
TP2 (T-2735)	+50V	+49V to +51V	-
TP3 (T-2735)	+12V	+11.75V to +12.25V	-
TP4 (T-2735)	+8V	+7.85V to +8.15V	-
TP6 (T-2735)	+5V	+4.8V to +5.2V	-
TP7 (T-2735)	+19V	+17.5V to +20.5V	-
TP8 (T-2735)	-1950V	-	VR12 (T-2735)

Table-1

3) Display

a) Intensity Adjustment

- Set: AC-GND-DC	GND
A TIME/DIV	1mS

- Set the INTEN control as shown in Figure-1.

A INTEN



Figure-1

- Adjust INTEN ADJ (VR11 T-2735) so that the trace just appears on the CRT.

b) Astigmatism Adjustment

- Adjust ASTIG (VR14 T-2735) and FOCUS control for optimum trace sharpness.

4) Vertical Amplifier

a) DC Balance Adjustment

- Set: AC-GND-DC

GND

- Position the trace to the center horizontal graticule line using the V-POSITION control.
- Pull x10 MAG on.
- Position the trace to the center horizontal graticule line by adjusting CH-1 DC BAL (VR5 T-2736).
- Repeat above procedure for minimum trace shift when x10 MAG knob is switched between on and off.
- Apply the same procedure for CH-2 by adjusting CH-2 DC BAL (VR15 T-2736).

b) Step Attenuator Balance Adjustment

- Set: AC-GND-DC

GND

VOLTS/DIV

20mV

- Position the trace to the center horizontal graticule line using V-POSITION control.
- Set the VOLTS/DIV switch to 5mV.



e) Sensitivity Adjustment

- Set: V MODE CH-1  
VOLTS/DIV 5mV  
VARIABLE CAL'D

- Connect the amplitude calibrator to CH-1 INPUT connector and set the output amplitude to 25mVp-p.
- Adjust CH-1 GAIN (VR21 T-2737) for 5 divisions display.
- Apply the same procedure for CH-2 by adjusting CH-2 GAIN (VR23 T-2737).
- Check accuracy for all settings of VOLTS/DIV switch.

f) CH-2 Invert Balance

- Set: V MODE CH-2
- Adjust INV BAL (VR11 T-2737) for minimum trace shift between CH-2 INV in and out.

g) Input Capacitance Adjustment

- Set: VOLTS/DIV 20mV
- Connect the capacitance meter to CH-1 INPUT connector.
- Adjust Ci (VC1 T-2736) for a reading of 26pF.
- Check and adjust for all VOLTS/DIV ranges according to Table-2.

VOLTS/DIV	INPUT CAP ADJ	
	CH-1	CH-2
5mV-20mV	VC1 (T-2736)	VC11 (T-2736)
50mV-0.2V	Ci 1/10 (T-2736)	Ci 1/10 (T-2736)
0.5V-2V	Ci 1/100 (T-2736)	Ci 1/100 (T-2736)
5V	Ci 1/250 (T-2736)	Ci 1/250 (T-2736)

Table-2



#### h) Attenuator Phase Compensation

- Set: VOLTS/DIV 50mV
- Connect the square wave generator to CH-1 INPUT connector and set the frequency to 10kHz, output amplitude for 5 divisions display.
- Adjust Cc (1/10 T-2736) for best flat-top square wave.
- Check and adjust for all VOLTS/DIV ranges according to Table-3.

VOLTS/DIV	PHASE COMP ADJ	
	CH-1	CH-2
5mV-20mV	-	-
50mV-0.2V	Cc 1/10 (T-2736)	Cc 1/10 (T-2736)
0.5V-2V	Cc 1/100 (T-2736)	Cc 1/100 (T-2736)
5V	Cc 1/250 (T-2736)	Cc 1/250 (T-2736)

Table-3

\* Repeat g) and h) if necessary.

#### i) CH-1 OUTPUT

- Output Voltage Adjustment

Set: VOLTS/DIV 20mV

Connect the amplitude calibrator to CH-1 INPUT connector and set the output amplitude to 100mV (5 divisions display).

Adjust CH-1 VARIABLE control for 4 divisions display.

Connect the test oscilloscope to CH-1 OUTPUT connector via 50 ohm termination.

Adjust CH-1 OUT GAIN (VR2 T-2737) for a display of 0.1Vp-p on the test oscilloscope.

Remove the calibrator and oscilloscope.

- DC Level Adjustment

Set: AC-GND-DC                      GND

Connect the DC voltmeter to CH-1 OUTPUT connector.

Adjust CH-1 OUT DC ADJ (VR3 T-2737) for meter reading of 0V.

- High Frequency Compensation

Set: AC-GND-DC                      DC  
VOLTS/DIV                              5mV

Connect the test oscilloscope to CH-1 OUTPUT connector via 50 ohm termination.

Connect the square wave generator to CH-1 INPUT connector and set the frequency to 100kHz, output amplitude for 4 divisions display on the test oscilloscope.

Adjust VC3 (T-2736) and VC1 (T-2737) for a best flat-top square wave.

j) High Frequency Compensation

- Set: VOLTS/DIV                      5mV

- Connect the square wave generator to CH-1 INPUT connector and set the frequency to 100kHz, output amplitude for 5 divisions display.

- Adjust following adjustment to obtain a best flat-top square wave.

CH-1	CH-2
VC21 (T-2737)	VC13 (T-2736)
VC1 (T-2738)	VC11 (T-2737)
VR1 (T-2738)	VC22 (T-2737)
VC2 (T-2738)	
VR2 (T-2738)	
VC3 (T-2738)	

- Connect the sine wave generator to CH-1 INPUT connector and set the frequency to 1kHz, output amplitude for 8 divisions display.
- Change the frequency to 100MHz.
- Display should be 5.6 divisions or more.

k) Position Centering

- Set: CH-1 V-POSITION                      Center
- Adjust CH-1 POS (VR22 T-2737) so that the trace is positioned to the center horizontal graticule line.
- Apply the same procedure for CH-2 by adjusting CH-2 POS (VR24 T-2737).

l) ADD Balance Adjustment

- Set: V MODE                                      CHOP
- Position the two traces to the center horizontal graticule line.
- Depress the ADD button of V MODE switch.
- Adjust ADD BAL (VR29 T-2737) for minimum trace shift between CHOP and ADD mode.

5) CH-3/CH-4

a) Sensitivity Adjustment

- Set: V MODE                                      CHOP
- TRIPLE (pull on)
- DC
- .2V/DIV

- Connect the amplitude calibrator to CH-3 INPUT connector and set the output amplitude to 1Vp-p.

- Adjust CH-3 GAIN (VR26 T-2737) for 5 divisions display.
  - Apply the same procedure for CH-4 by adjusting CH-4 GAIN (VR28 T-2737).
- b) Input Capacitance Adjustment-1 (.2V/DIV)
- Connect the capacitance meter to CH-3 INPUT connector.
  - Adjust CH-3 Ci (VC5 T-2741) for a meter reading of 26pF.
  - Apply the same procedure for CH-4 by adjusting CH-4 Ci (VC30 T-2741).
- c) Phase Compensation
- Set: A TRIG SOURCE                      2V/DIV
  - Connect the square wave generator to CH-3 INPUT connector and set the frequency to 1kHz, output amplitude for 5 divisions display.
  - Adjust CH-3 Cc (VC4 T-2741) for a best flat-top square wave.
  - Apply the same procedure for CH-4 by adjusting CH-4 Cc (VC29 T-2741).
- d) Input Capacitance Adjustment-2 (2V/DIV)
- Set: A TRIG SOURCE                      2V/DIV
  - Connect the capacitance meter to CH-3 INPUT connector.
  - Adjust CH-3 Ci (VC3 T-2741) for a meter reading of 26pF.
  - Apply the same procedure for CH-4 by adjusting CH-4 Ci (VC28 T-2741).

## 6) Time Base / Horizontal Amplifier

a) A Sweep Starting Point Adjustment

- Set: AC-GND-DC GND  
A TIME/DIV 0.1mS  
HORIZ DISPLAY A
- Position the left end of trace to the center vertical graticule line using H-POSITION control.
- Turn the A TIME/DIV switch to 50μS
- Adjust A START (VC1 T-2744) so that the trace starts 0.2 division left from the center vertical graticule line.

b) A TIME/DIV Adjustment

- Set: A TIME/DIV 0.5mS
- Connect the time mark generator to CH-1 INPUT connector and set the time to 0.5mS.
- Adjust A TIME-1 (VR2 T-2744) for exactly 1 marker/1 division.
- Set the A TIME/DIV switch to 0.5μS.
- Set the time mark generator to 0.5μS
- Adjust A TIME-2 (VC2 T-2744) for exactly 1 marker/1 division.
- Check all ranges to verify that accuracy is within ±3%.

c) A Sweep Length Adjustment

- Set: A TIME/DIV 0.5mS
- Connect the time mark generator to CH-1 INPUT connector and set the time to 0.5mS.
- Adjust A LENGTH (VR1 T-2744) as shown in Figure-2.

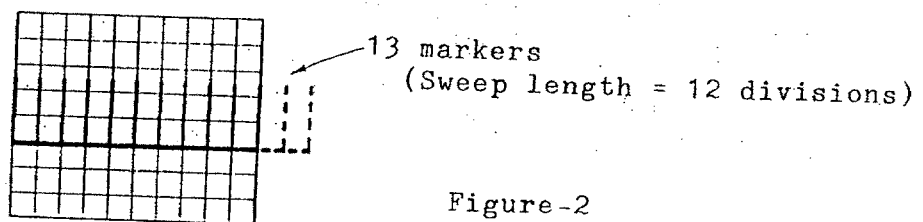


Figure-2

d) x10 MAG Gain Adjustment

- Set: A TIME/DIV
- x10 MAG

1mS ) 0.1mS/DIV  
ON

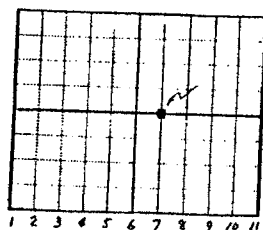
- Connect the time mark generator to CH-1 INPUT connector and set the time to 0.1mS.
- Adjust MAG x10 GAIN (VR5 T-2745) for 1 marker/1 division.

e) x10 MAG, x1 Centering

- Set: AC-GND-DC
- HORIZ DISPLAY
- A TIME/DIV
- B TIME/DIV

GND  
INTEN BY B  
0.5mS  
0.5μS

- Position the A sweep to begin at the leftmost vertical graticule line using H-POSITION control.
- Set the B sweep (Intensified portion on the A sweep) to the 7th vertical graticule line using DLY TIME MULT dial.



- Set the H-POSITION controls to the center.
- Pull x10 MAG knob of TIME/DIV on.

- Position the B sweep to center vertical graticule line by adjusting MAG x10 POS (VR3 T-2745).
  - Push the x10 MAG knob off.
  - Position the B sweep to the center vertical graticule line by adjusting MAG x1 POS (VR4 T-2745).
- f) B Offset and starting Point Adjustment
- Set:
 

HORIZ DISPLAY	B
A TIME/DIV	0.2mS
B TIME/DIV	0.1mS
  - Position the B trace to the leftmost vertical graticule line using H-POSITION control.
  - Set the B TIME/DIV switch to 50μS.
  - Adjust B SWEEP START (VC11 T-2744) so that the B trace starts 0.2 division left from the leftmost vertical graticule line.
- g) B TIME/DIV Adjustment
- Set:
 

HORIZ DISPLAY	B
A TIME/DIV	1mS
B TIME/DIV	0.5mS
  - Connect the time mark generator to CH-1 INPUT connector and set the time to 0.5mS.
  - Adjust B TIME-1 (VR12 T-2744) for 1 marker/1 division.
  - Set:
 

A TIME/DIV	1μS
B TIME/DIV	0.5μS
  - Set the time mark generator to 0.5μS.
  - Adjust B TIME-2 (VC12 T-2744) for 1marker/1division.





## 7) Trigger

### a) A TRIG CH-1 BAL Adjustment

- Set:	AC-GND-DC	AC
	A TIME/DIV	0.2mS
	A TRIG COUPLING	DC
	A TRIG SOURCE	CH-1
	A TRIG LEVEL	0

- Connect the sine wave generator to CH-1 INPUT connector and set the frequency to 1kHz, output amplitude for 6 divisions display.
- Position the sine wave to center of graticule using V-POSITION control.
- Adjust A TRIG CH-1 BAL (VR1 T-2741) and A TRIG LEVEL CENTER (VR12 T-2741) for the sine wave starts at the same vertical point when SLOPE button is switched between + and - as shown in Figure-5.

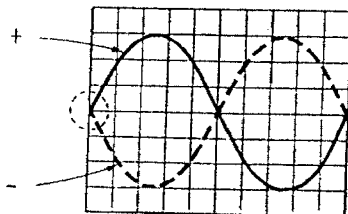


Figure-5

- Reduce the generator output for 0.4 division display.
- Adjust the VR1 and VR12 again to obtain a stable display when SLOPE button is switched between + and -.
- Remove the generator.
- Set the CH-3 POSITION control to center.
- Adjust CH-3 POS (VR25 T-2737) so that the trace is positioned at the center horizontal graticule line.

- Adjust following adjustments for minimum CH-3 trace shift between SLOPE + and -.

Adjustment	A TRIG	
	COUPLING	SOURCE
A TRIG CH-2 BAL (VR2 T-2741)	DC	CH-2
A TRIG EXT BAL (VR3 T-2741)	DC	.2V/DIV
A TRIG AC BAL (VR11 T-2741)	AC	.2V/DIV

Table-4

b) A TRIG PRESET Adjustment

- Set: A TRIG COUPLING                      DC
- A TRIG SOURCE                      CH-1
- PRESET                              ON

- Connect the sine wave generator to CH-1 INPUT connector and set the frequency to 1kHz, output amplitude for 0.4 division display.

- Adjust A PRESET (VR2 T-2742) for a stable display.

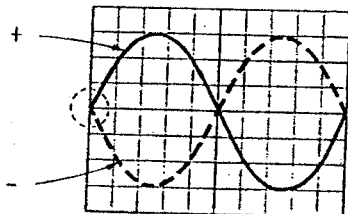
c) B TRIG CH-1 BAL Adjustment

- Set: HORIZ DISPLAY                      INTEN BY B
- B TRIG'D
- A TIME/DIV                      0.5mS
- B TIME/DIV                      0.2mS
- B TRIG COUPLING                  DC
- B TRIG SOURCE                   CH-1
- B TRIG LEVEL                    0

- Connect the sine wave generator to CH-1 INPUT connector and set the frequency to 1kHz, output amplitude for 6 divisions display.

- Position the sine wave generator to center of graticule using V-POSITION control.

- Adjust B TRIG CH-1 BAL (VR21 T-2741) and B TRIG LEVEL CENTER (VR32 T-2741) for the sine wave starts at same vertical point when SLOPE button is switched between + and -.



- Reduce the generator output for 0.4 division display.
- Adjust the VR21 and VR32 again to obtain a stable display when SLOPE button is switched between + and -.
- Remove the generator.
- Set CH-4 POSITION control to center.
- Adjust CH-4 POS (VR27 T-2737) so that the trace is positioned to the center horizontal graticule line.
- Adjust following adjustment for minimum trace shift between SLOPE + and -.

Adjustment	B TRIG	
	COUPLING	SOURCE
B TRIG CH-2 BAL (VR22 T-2741)	DC	CH-2
B TRIG EXT BAL (VR23 T-2741)	DC	.2V/DIV
B TRIG AC BAL (VR31 T-2741)	AC	.2V/DIV

Table-5

#### d) B TRIG PRESET Adjustment

- Set: B TRIG COUPLING DC  
B TRIG SOURCE CH-1  
PRESET ON
- Connect the sine wave generator to CH-1 INPUT connector and set the frequency to 1kHz, output amplitude for 0.4 division display.

- Adjust B PRESET (VR2 T-2741) for a stable display.

e) High Frequency Compensation-1 (CH-3)

- Set: V MODE ALT  
TRIPLE (pull on)  
A TRIG COUPLING DC  
A TRIG SOURCE .2V/DIV

- Connect the square wave generator to CH-3 INPUT connector and set the frequency to 100kHz, output amplitude for 5 divisions display.

- Adjust HF (VC6 T-2741, VC23 T-2737) for best flat-top square wave.

f) High Frequency Compensation-2 (CH-4)

- Set: V MODE ALT  
QUAD (pull on)  
HORIZ DISPLAY B  
B TRIG'D  
B TRIG COUPLING DC  
B TRIG SOURCE .2V/DIV

- Connect the square wave generator to CH-4 INPUT connector and set the frequency to 100kHz, output amplitude for 5 divisions display.

- Adjust HF (VC31 T-2741, VC24 T-2737) for best flat-top square wave.

g) High Frequency Compensation-3 (A TRIG CH-1/CH-2)

- Set: V MODE ALT  
TRIPLE (pull on)  
VOLTS/DIV 5mV (CH-1, CH-2)  
A TRIG COUPLING DC  
A TRIG SOURCE CH-1

- Apply the same procedure for CH-2 by adjusting HF (VC27 T-2741).

### 8) X-Y Operation

a) X Gain Adjustment

- Set: V MODE X-Y  
X VOLTS/DIV 20mV
- Connect the amplitude calibrator to X INPUT connector and set the output amplitude to 0.1Vp-p.
- Adjust X-Y GAIN (VR1 T-2745) for a horizontal deflection of 5 divisions.

### b) X Position Centering

- Set: X AC-GND-DC GND  
X-POSITION Center
- Adjust X-Y BAL (VR2 T-2745) so that the dot is positioned at center vertical graticule line.

9) Calibrator

a) Amplitude Adjustment

- Connect the test oscilloscope to CAL tip.
- Adjust CAL 0.5V ADJ (VR3 T-2747) for voltage of 0.5Vp-p.

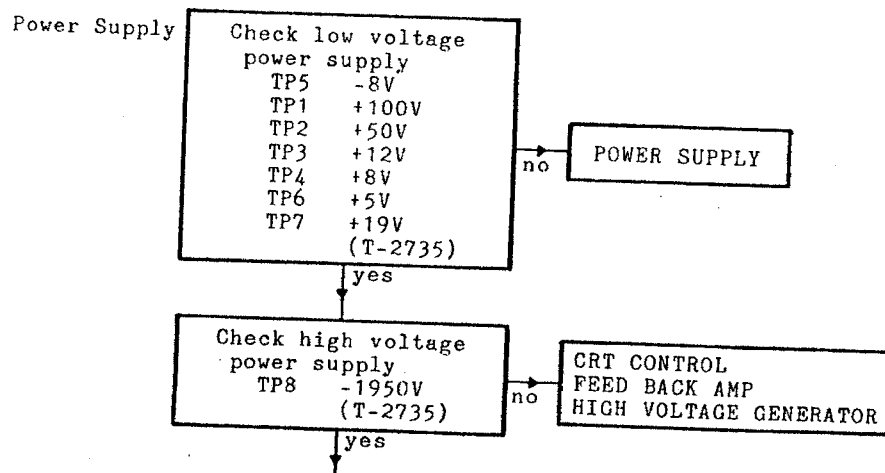
b) Frequency Adjustment

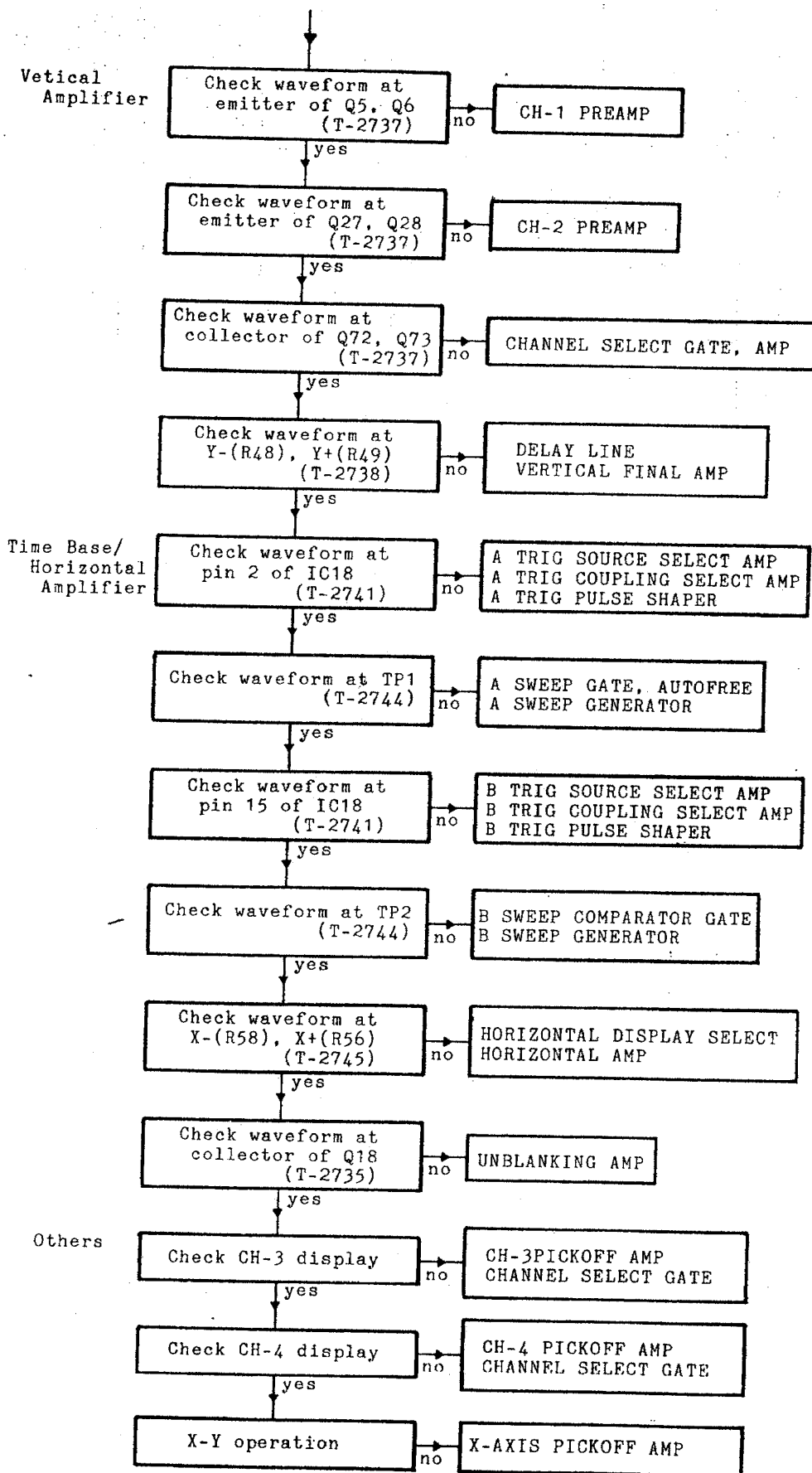
- Adjust DUTY 1, 2 (VR1, VR2 T-2747) alternately to obtain a symmetrical square wave.

3. Troubleshooting Procedure

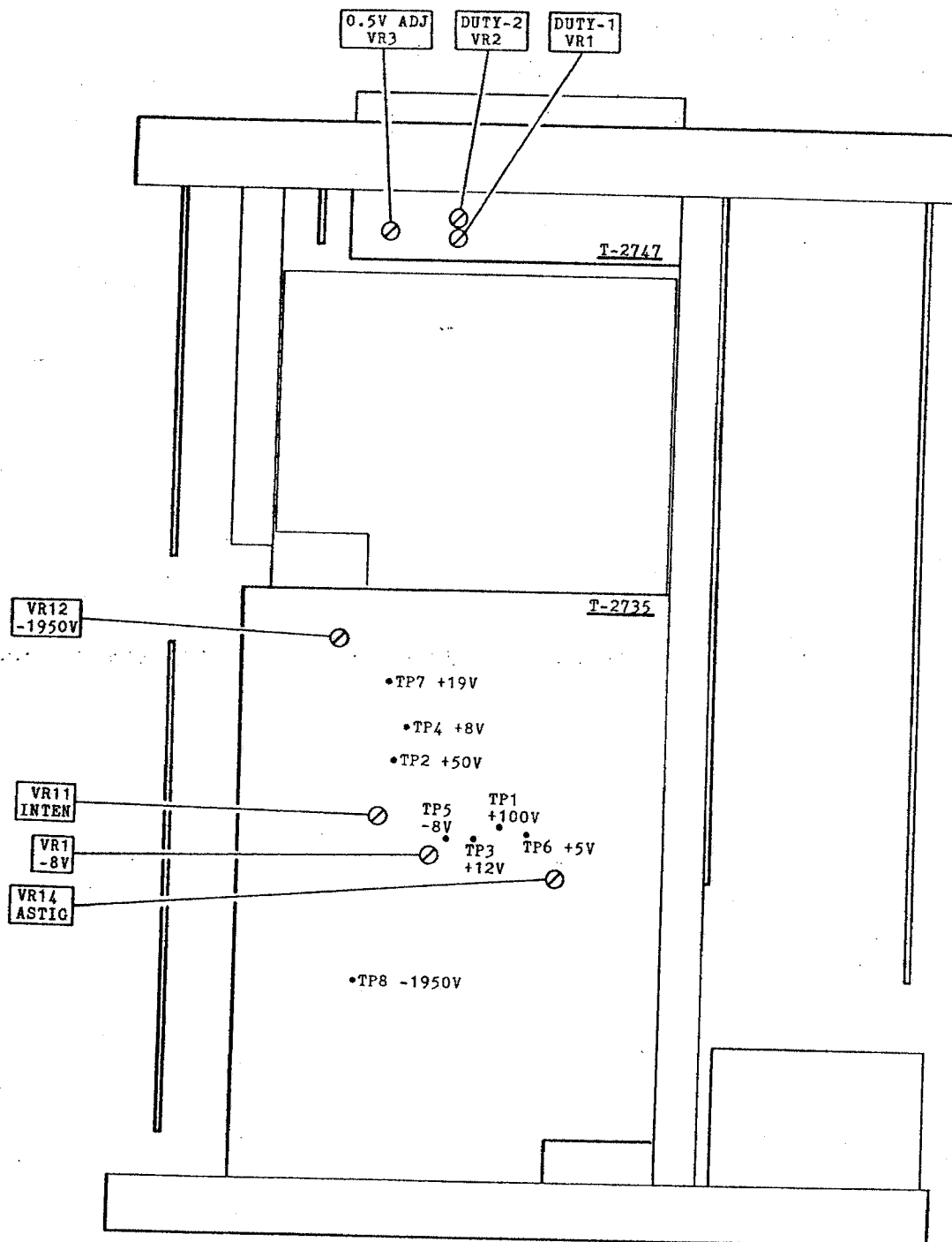
- 1) Check all control settings, because an incorrect setting can make a good unit appear defective.
- 2) Some trouble can be solved with proper adjustment.
- 3) Check the DC voltage and waveform as shown in the schematic diagram to locate the defective circuit.  
Start with the power supply.
- 4) Check all circuit for visual defects such as broken components, loose connections and poor soldering which could be a cause of trouble.

5) Troubleshooting Chart

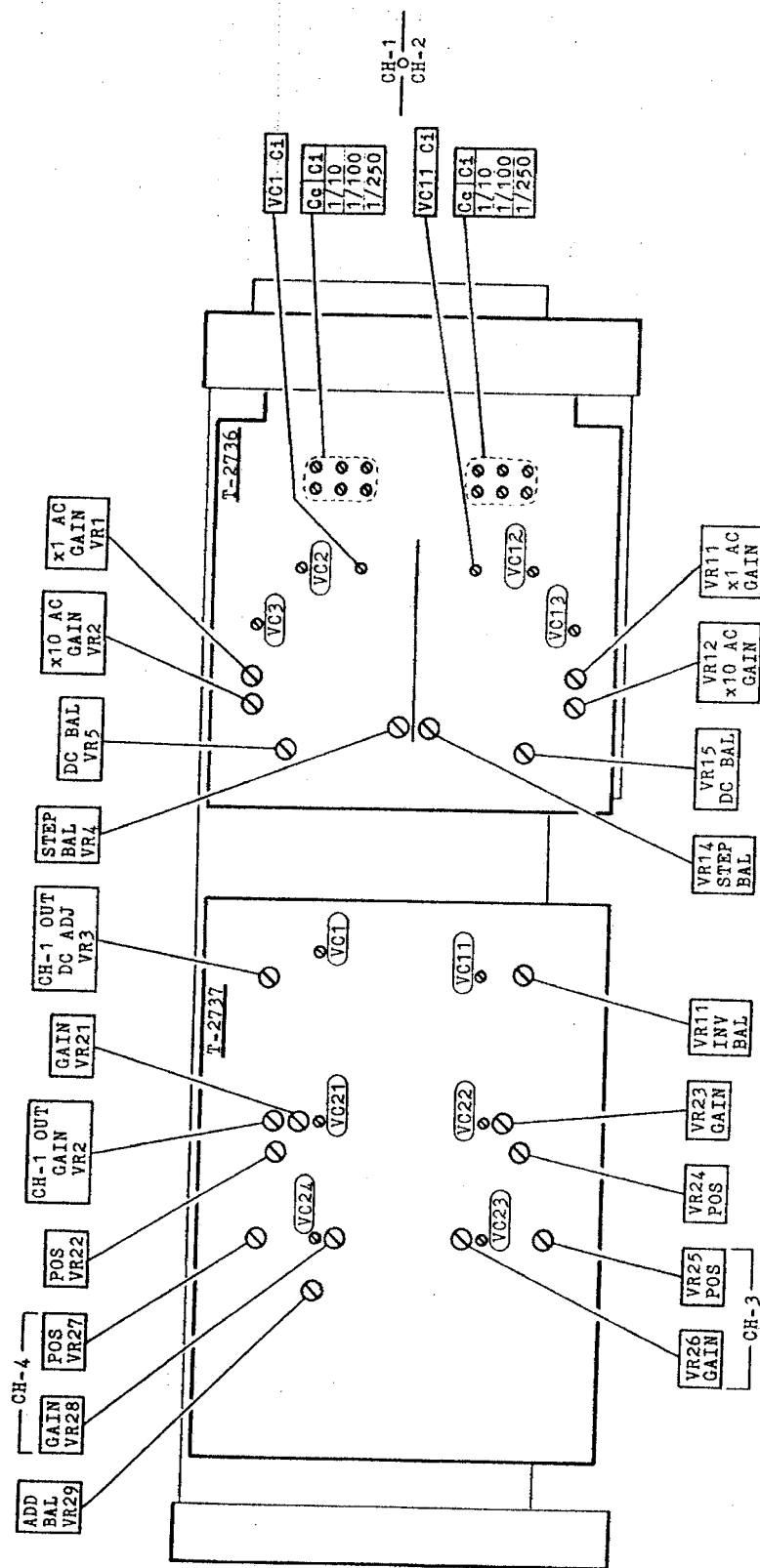


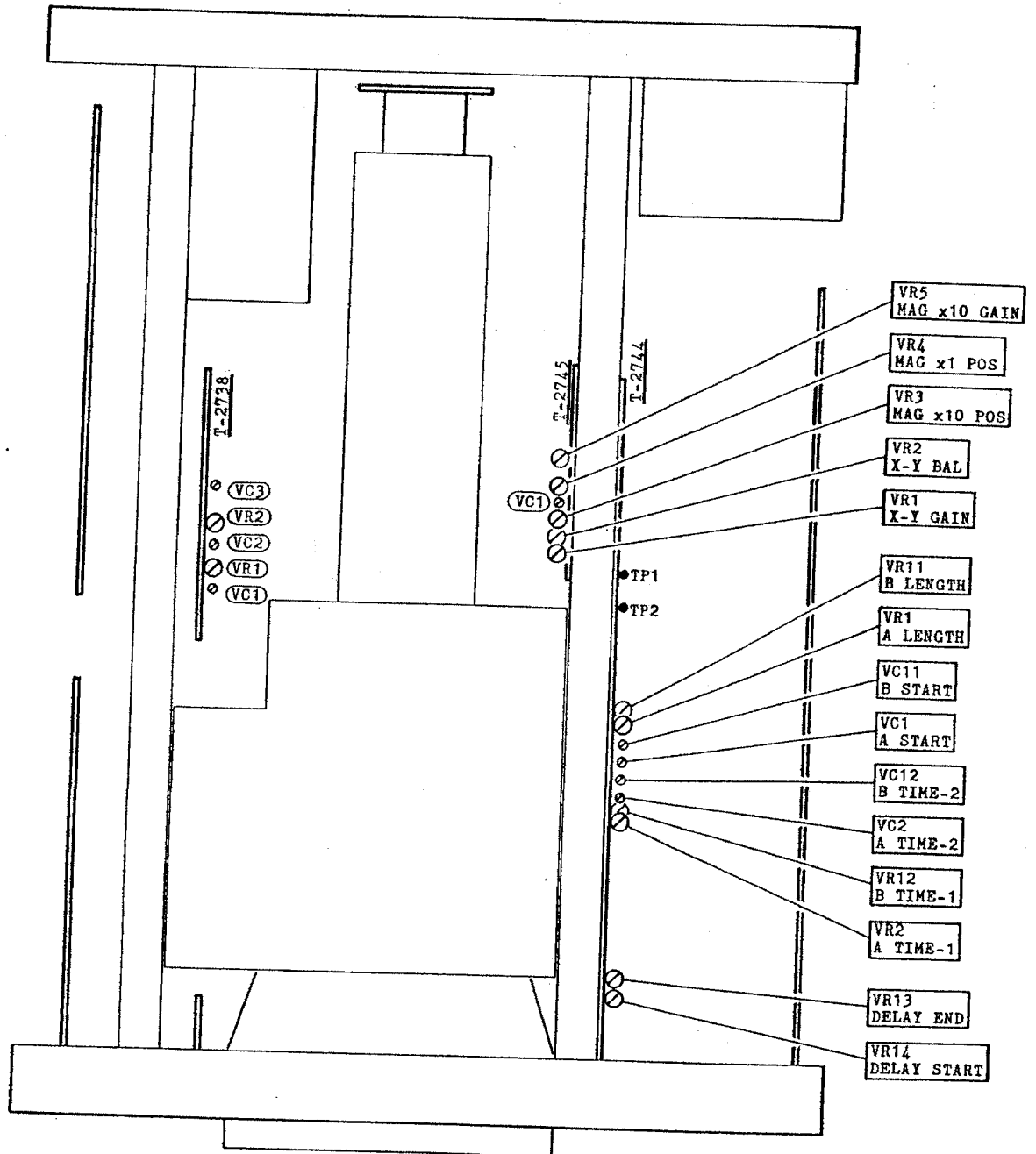


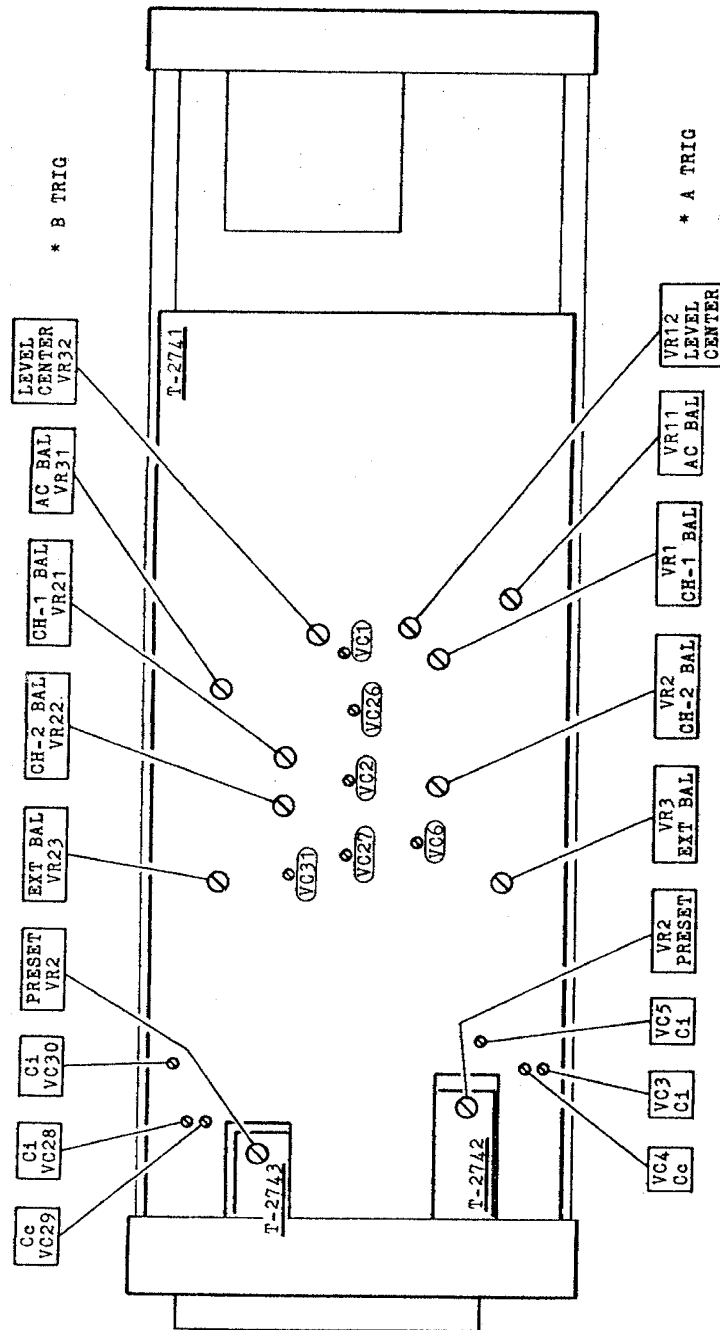
#### 4. Location of Adjustment



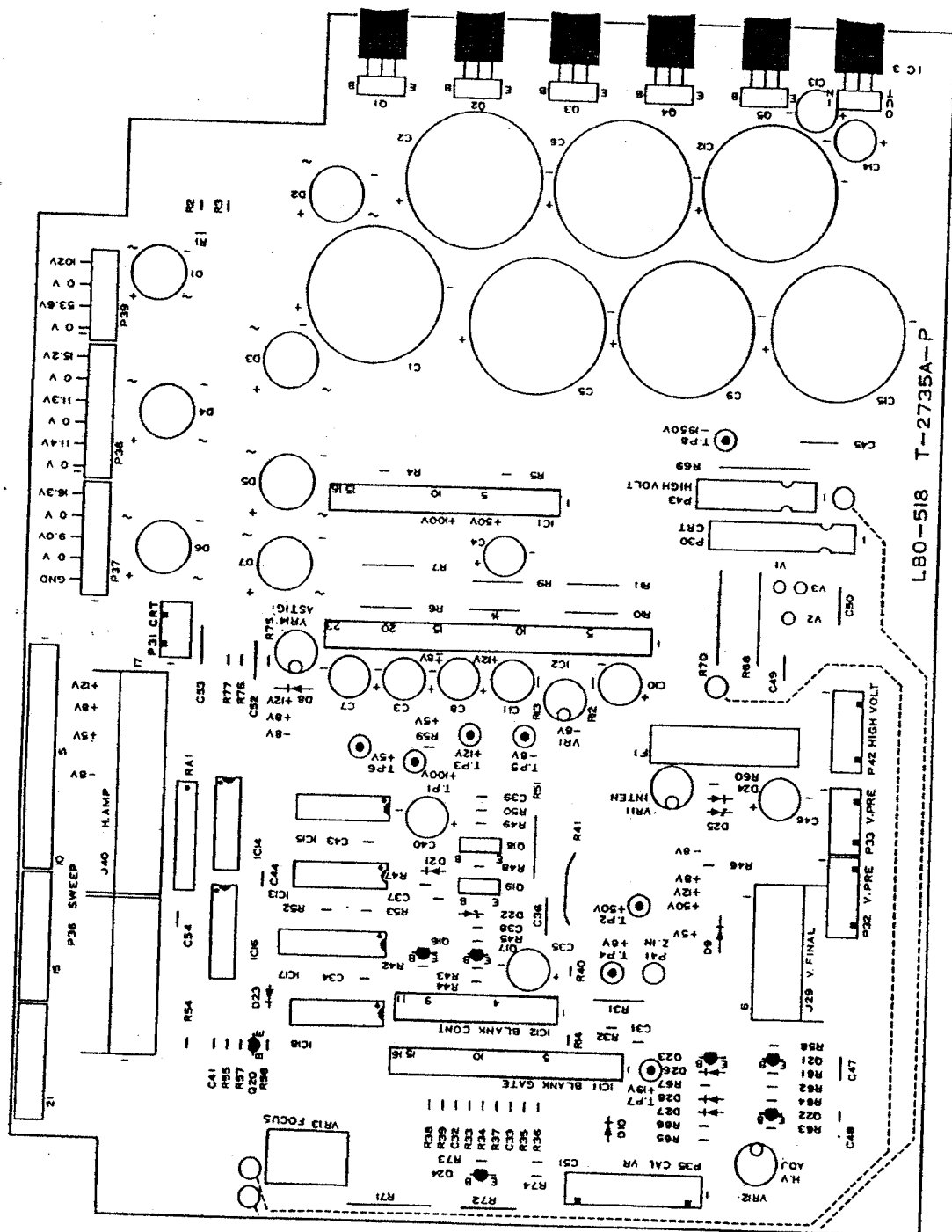






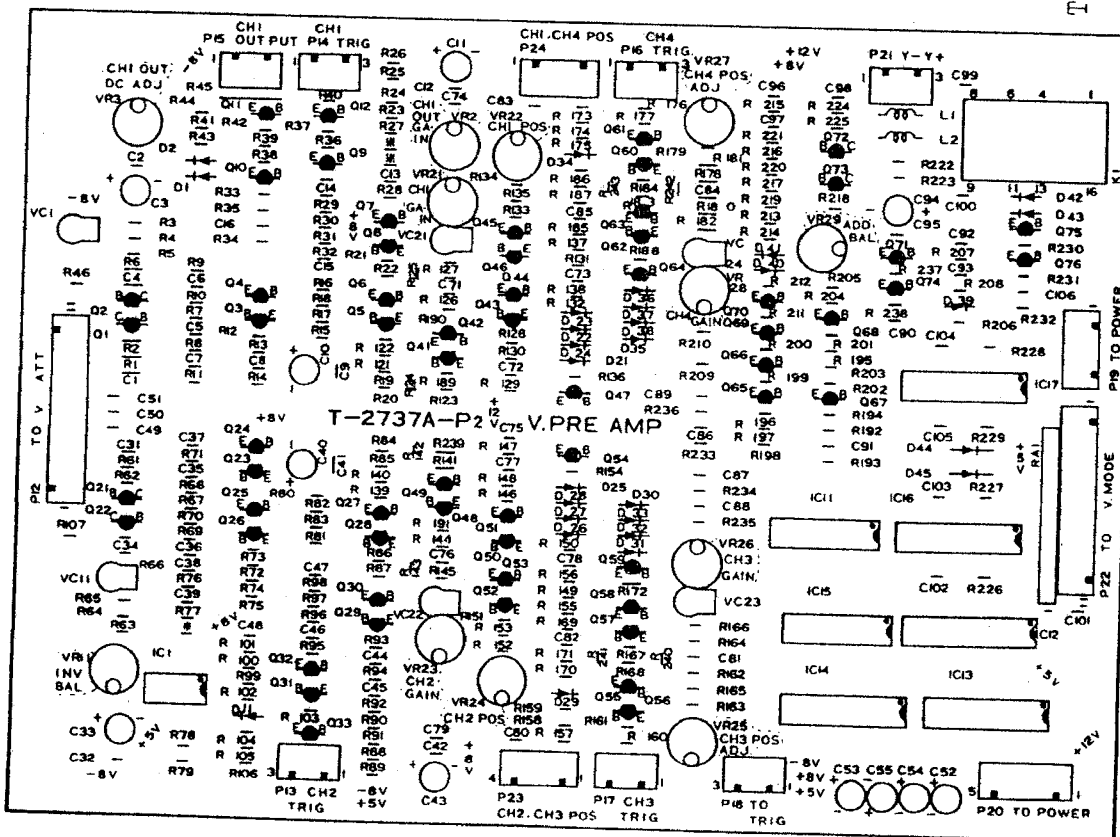
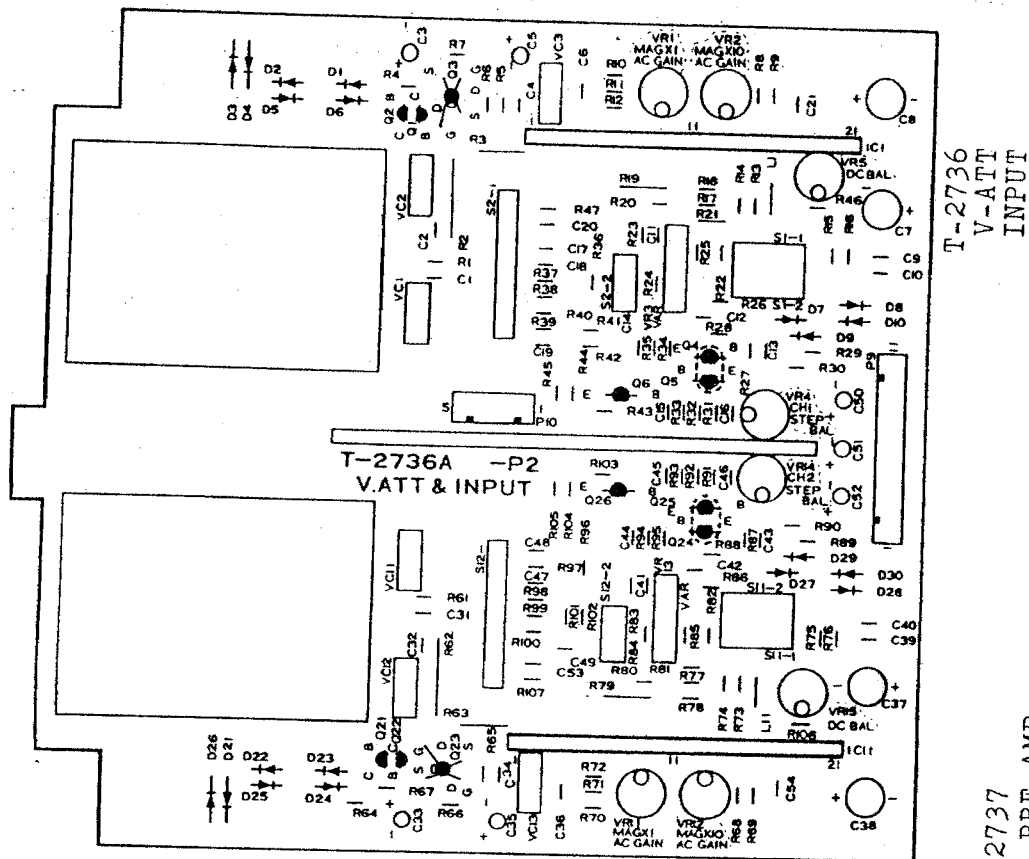


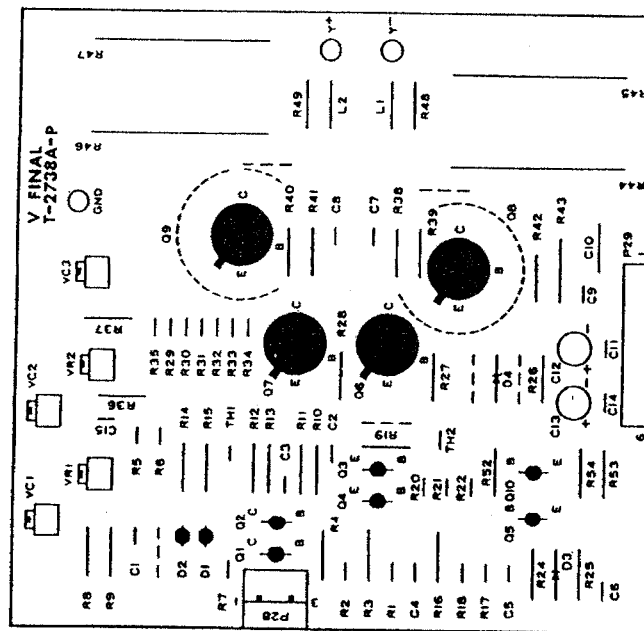
# 5. Printed Circuit Board



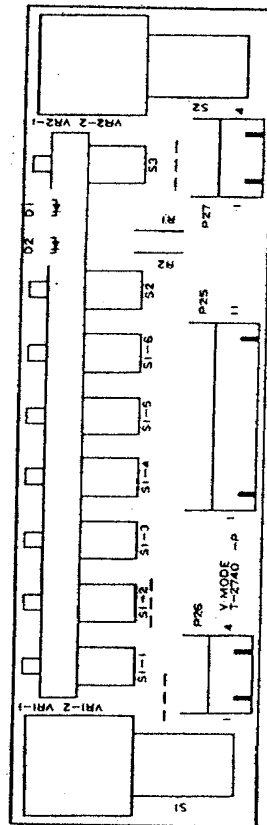
T-2735  
POWER SUPPLY  
CRT CONTROL

LB0-518 T-2735A-P

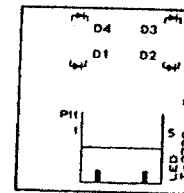




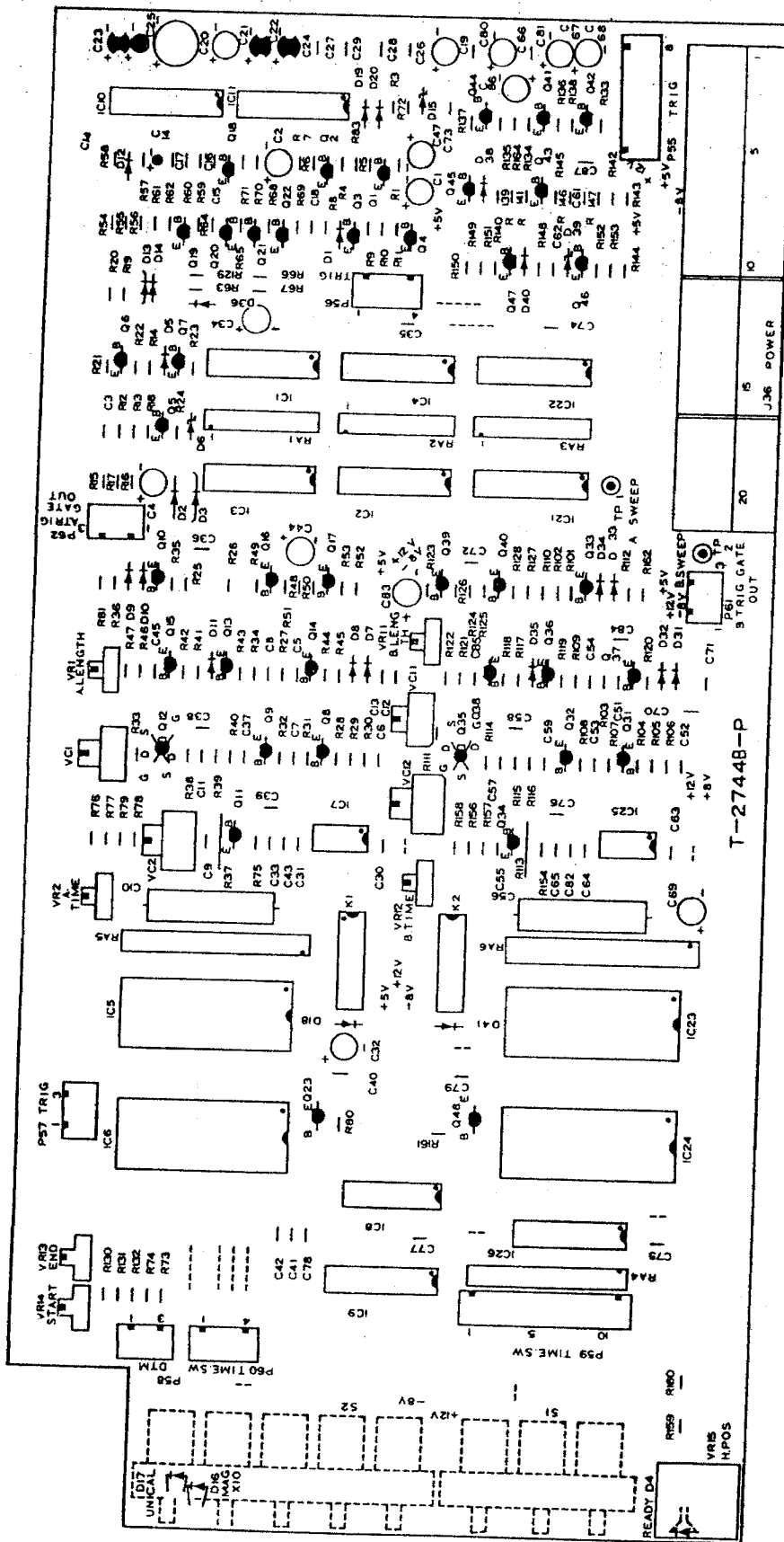
T-2738  
V FINAL AMP



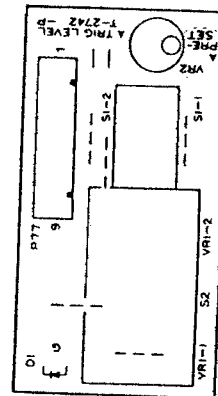
T-2740  
V MODE



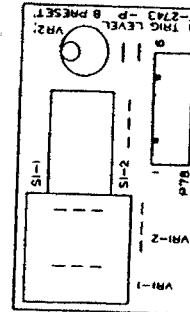
T-2739  
V LED



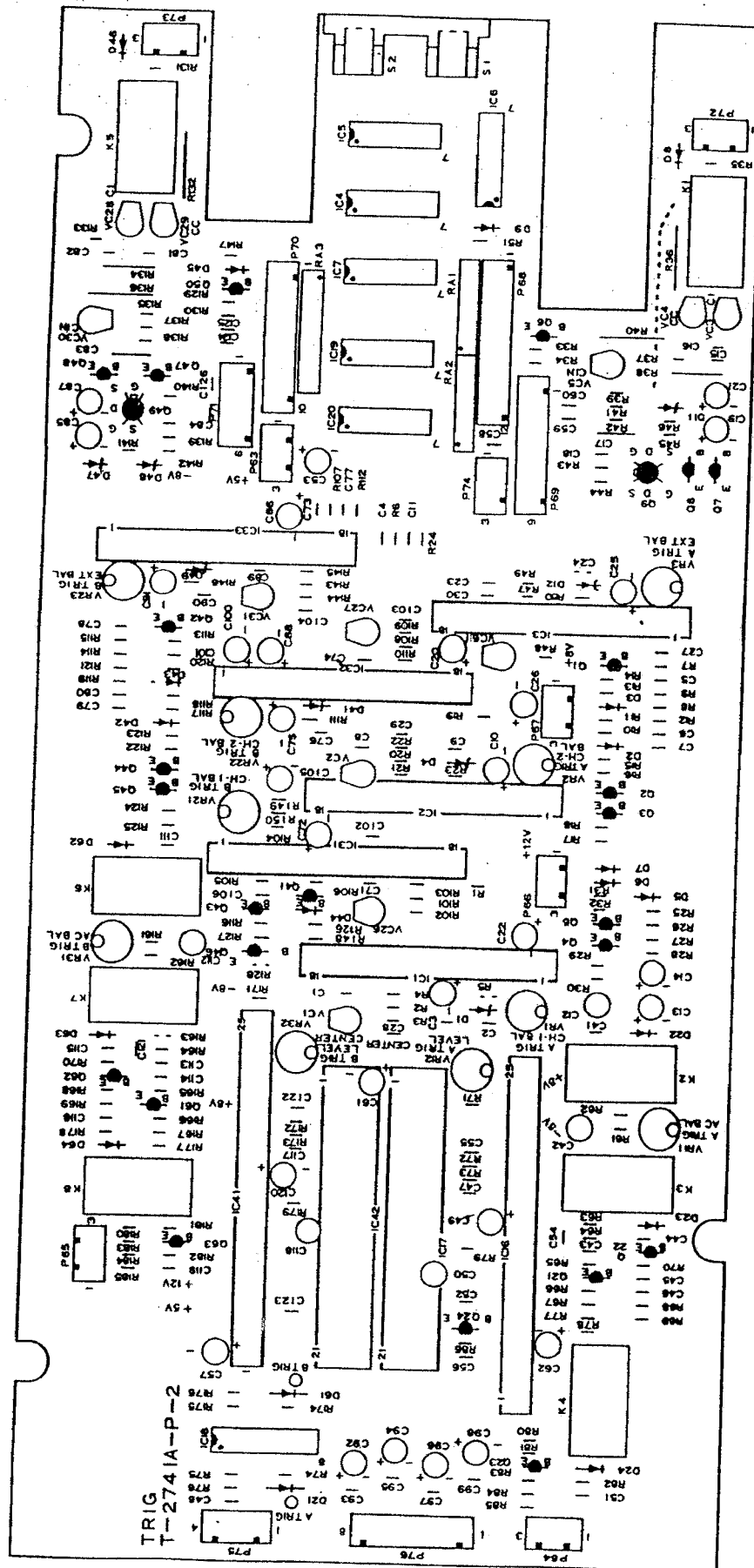
T-2744  
SWEEP GENERATOR



T-2742  
A TRIG LEVEL

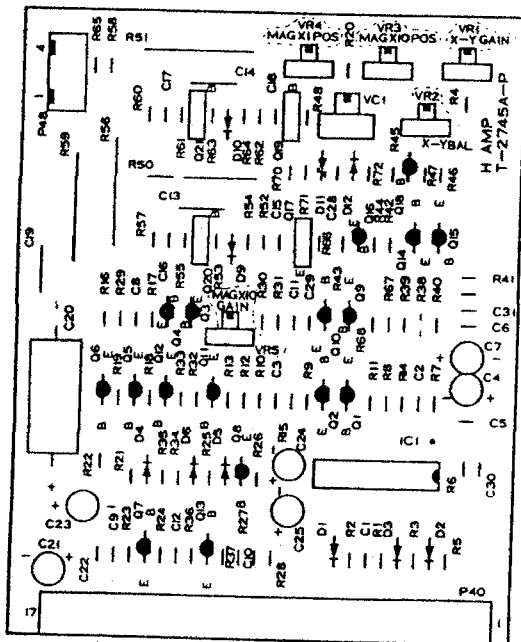


T-2743  
B TRIG LEVEL

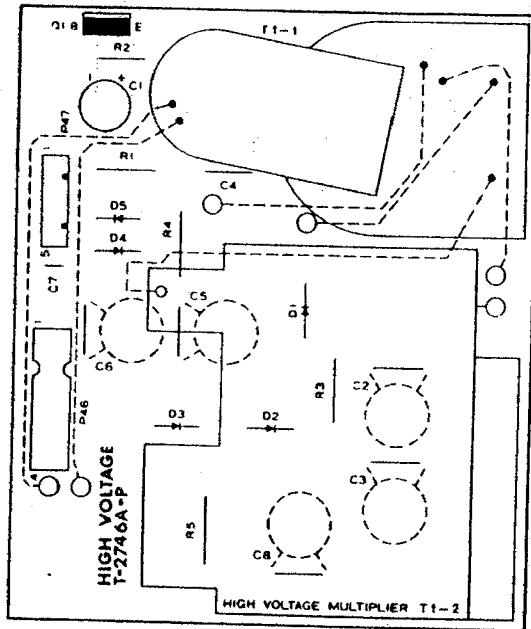


T-2741  
TRIGGER

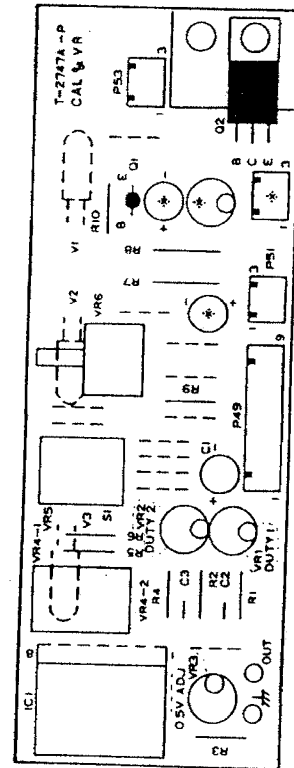




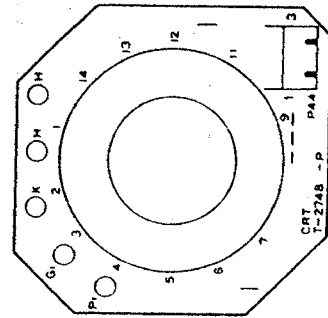
T-2745  
H AMP



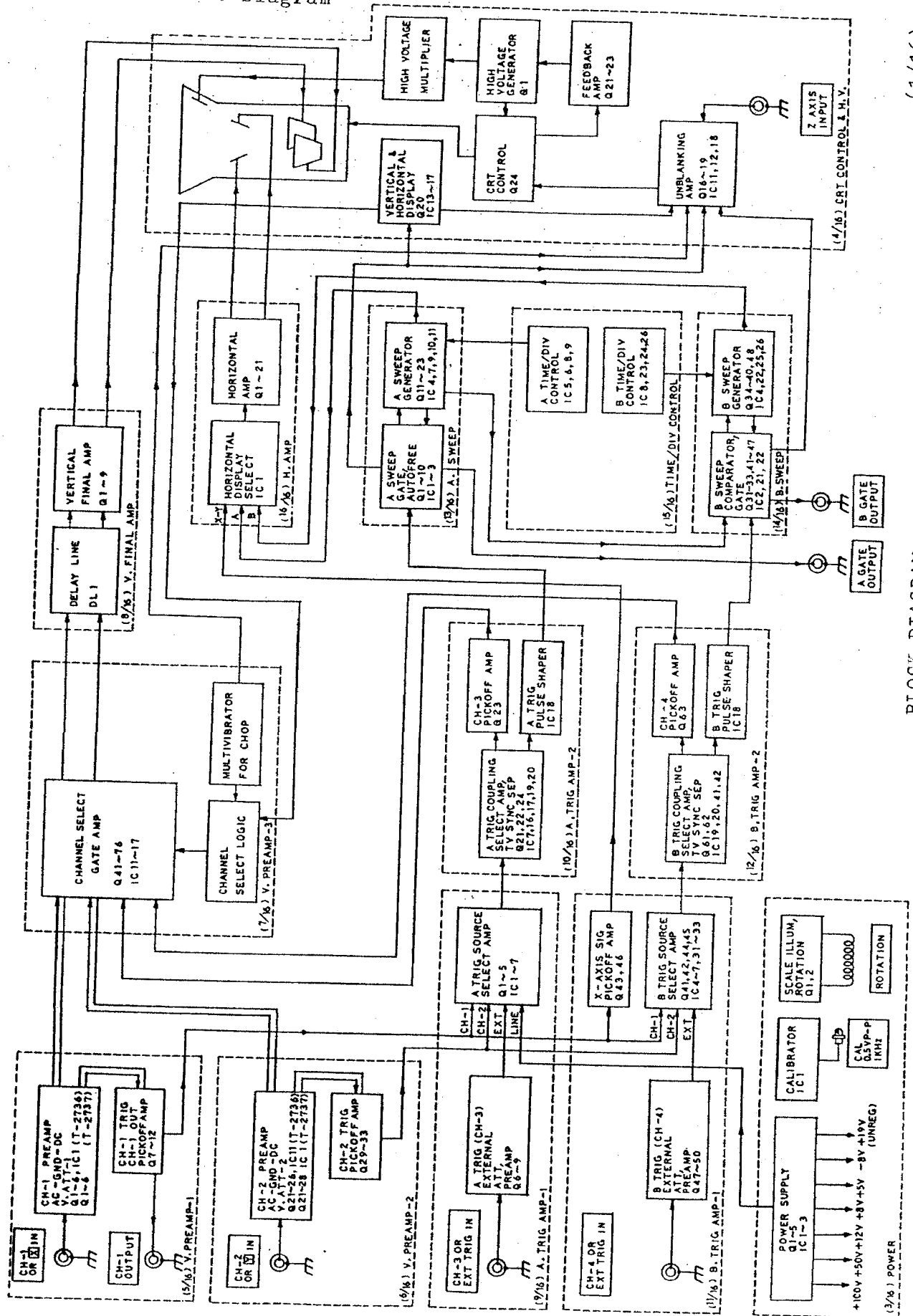
T-2746  
HIGH VOLTAGE



T-2747  
CAL CONTROLS

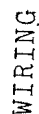


# 6. Block Diagram & Schematic Diagram

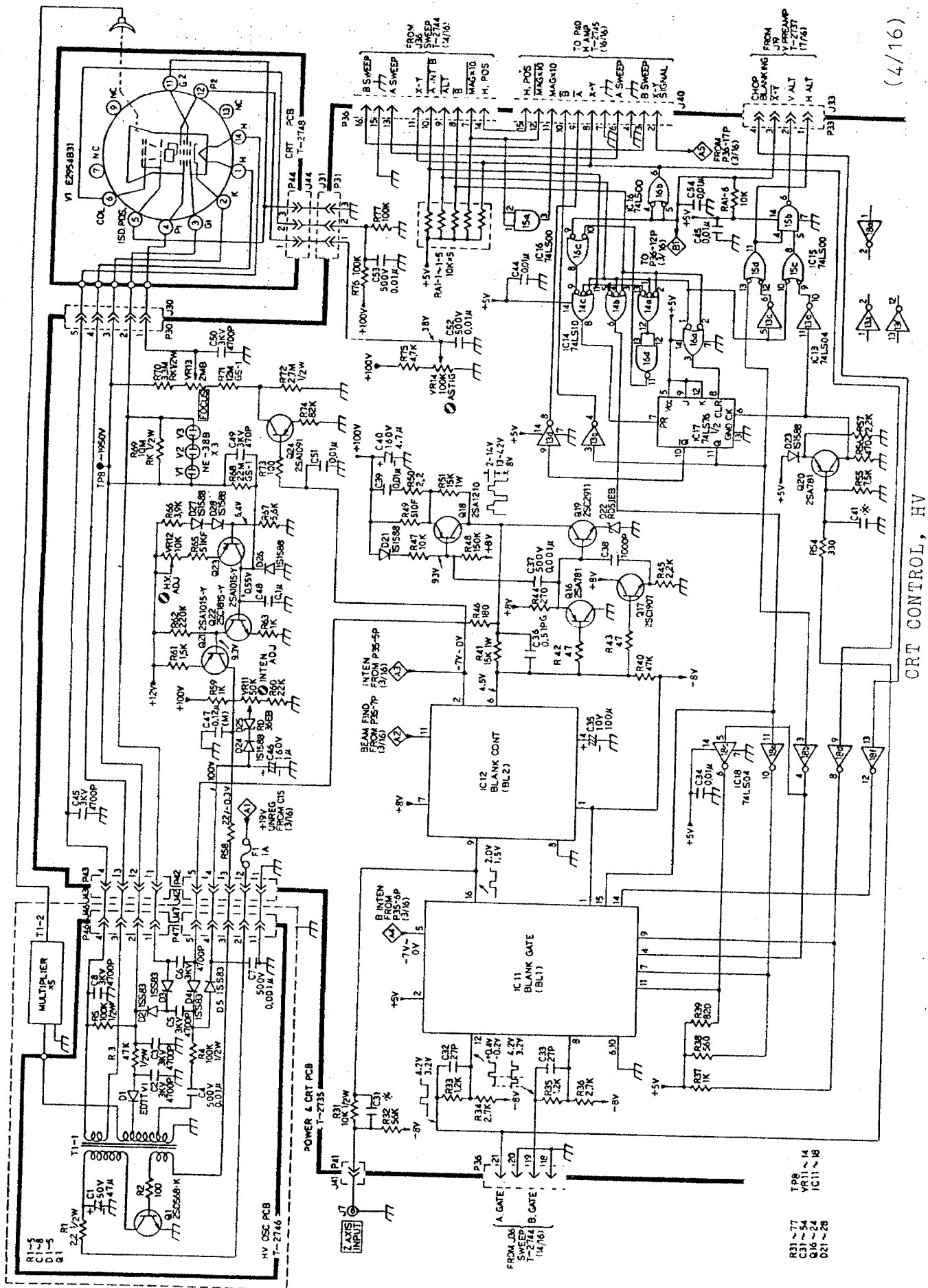


BLOCK DIAGRAM

(1/16)

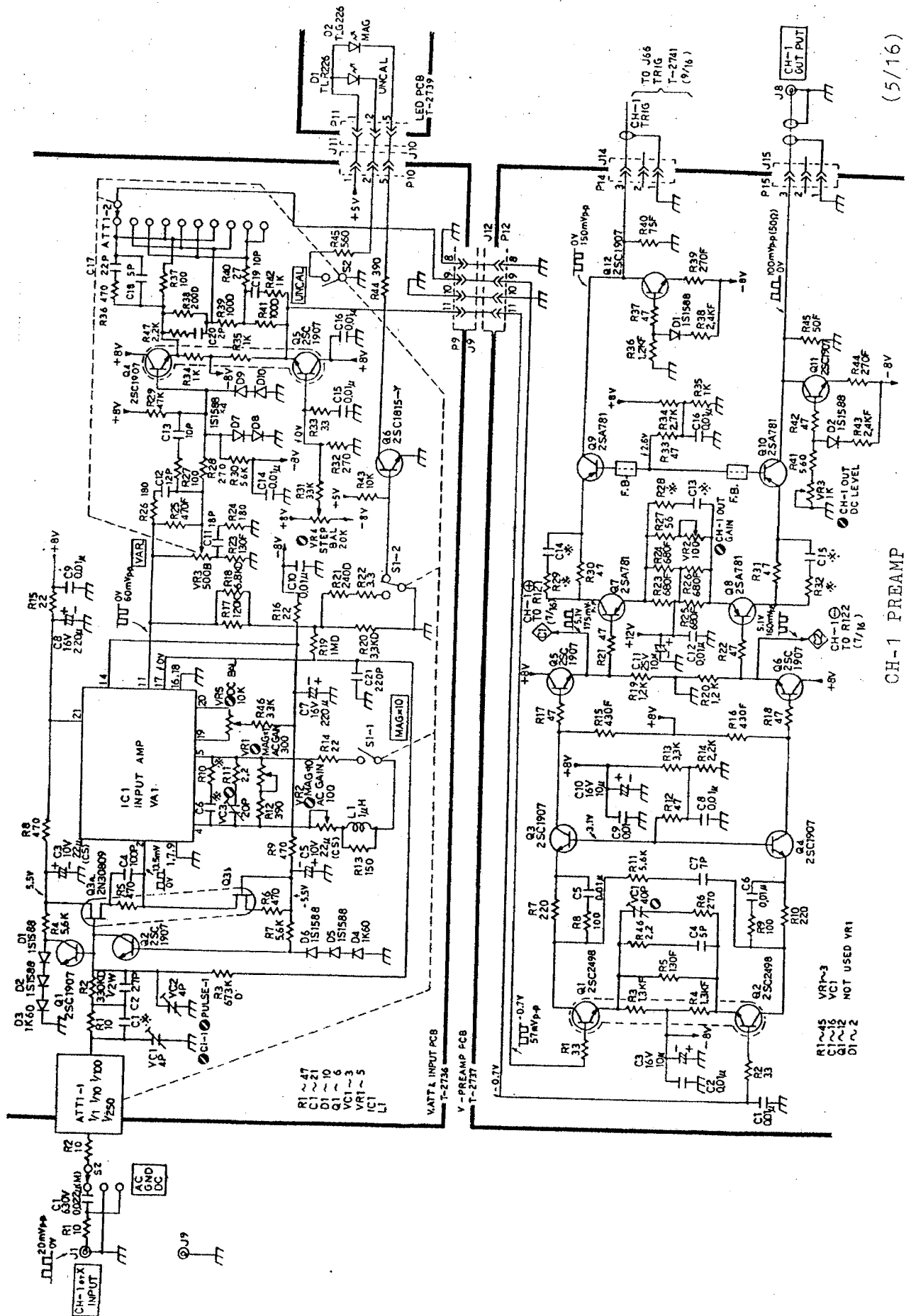






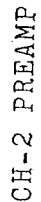
(4/16)

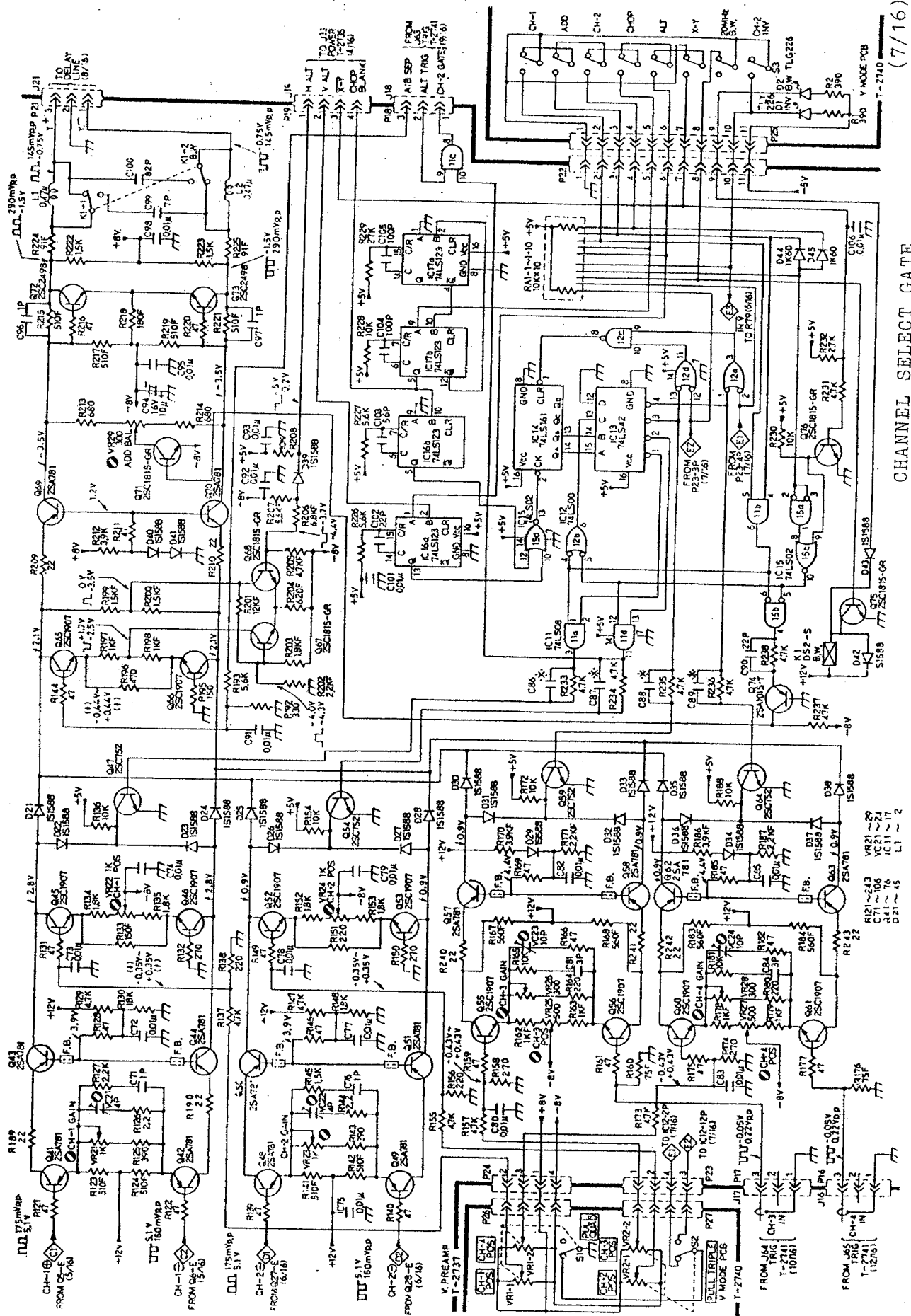
CRT CONTROL, HV



(5/16)

CH-1 PREAMP





CHANNEL SELECT GATE

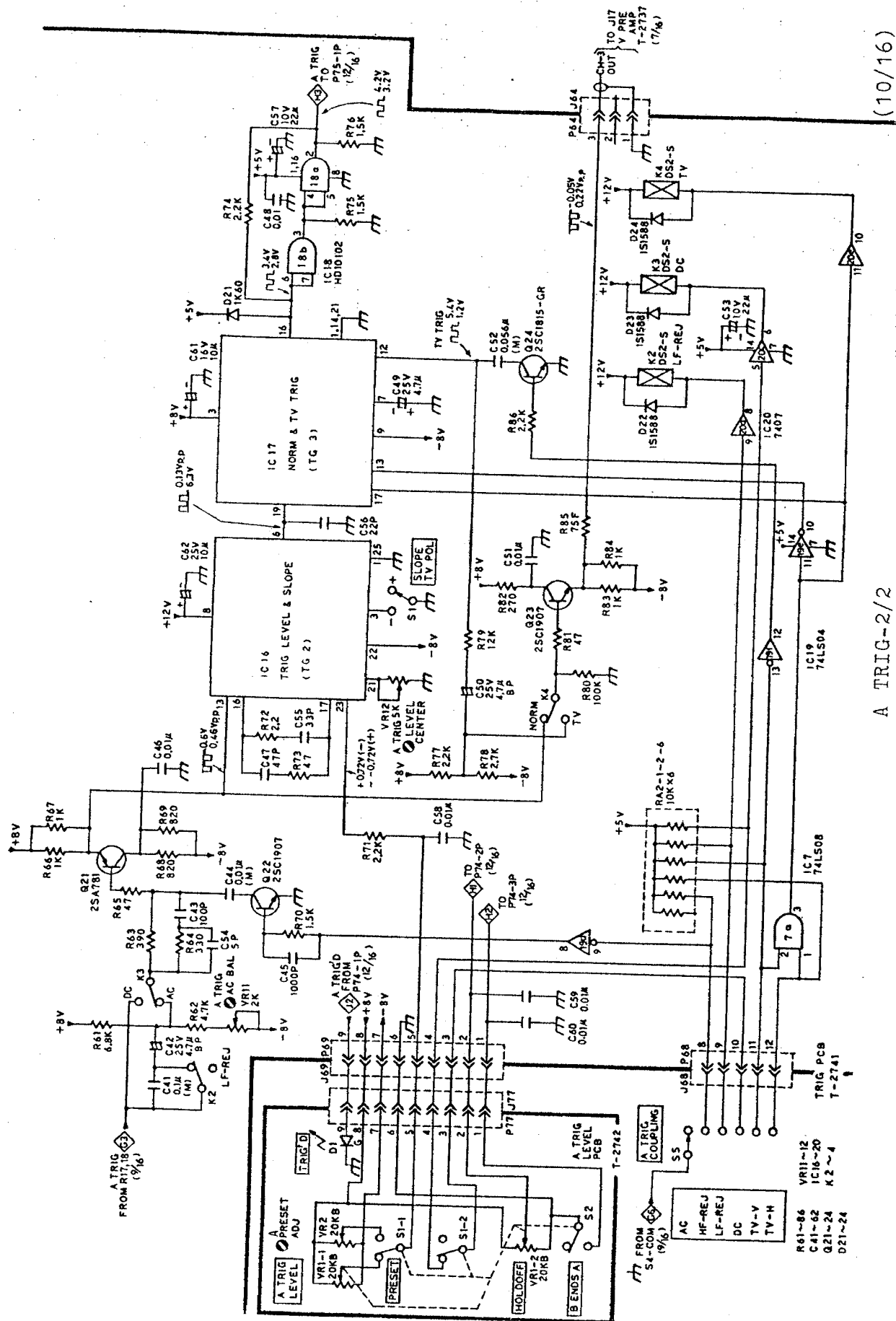
(7/16)





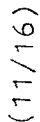
(8/16)



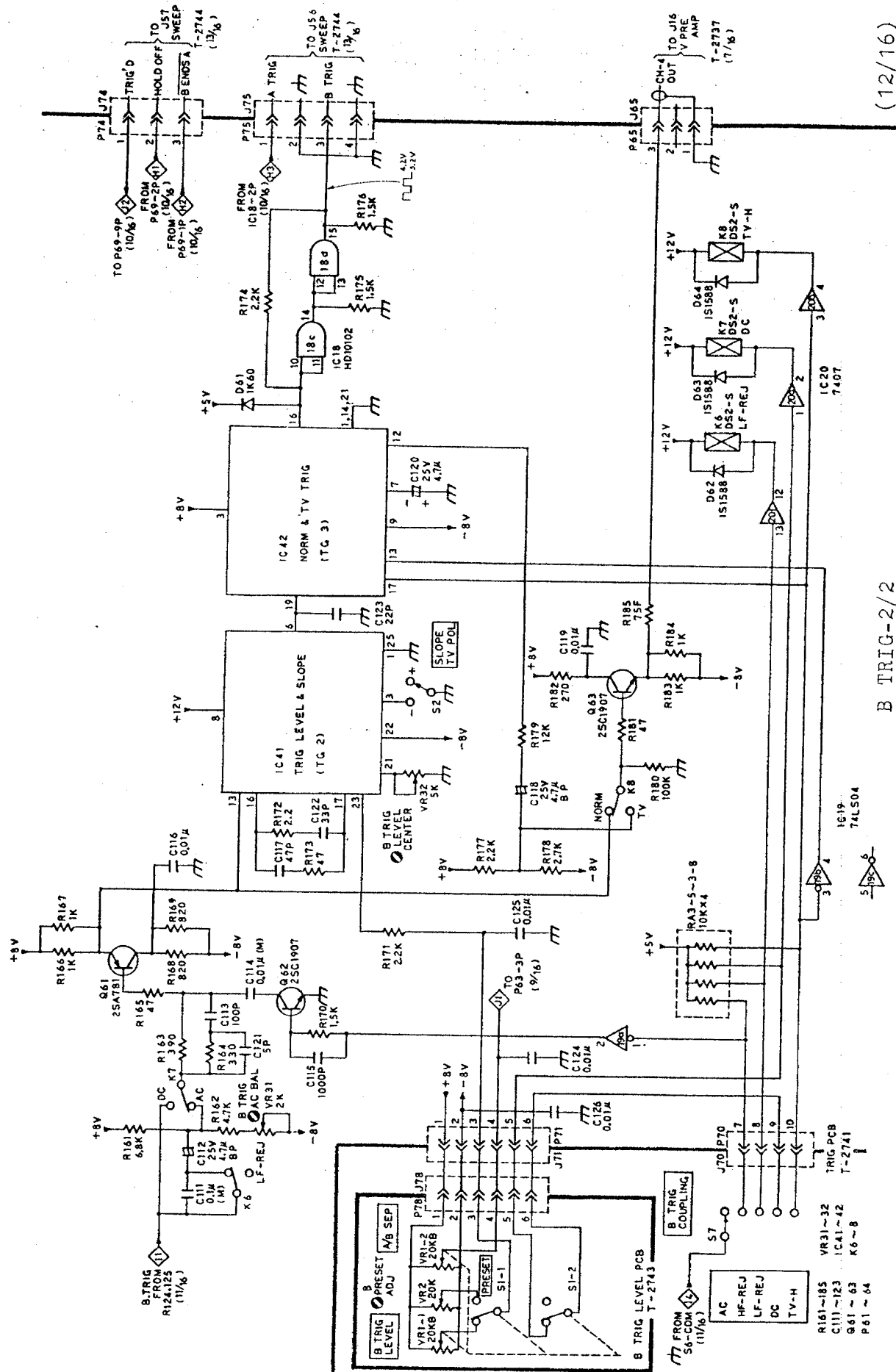


(10/16)

A TRIG-2/2



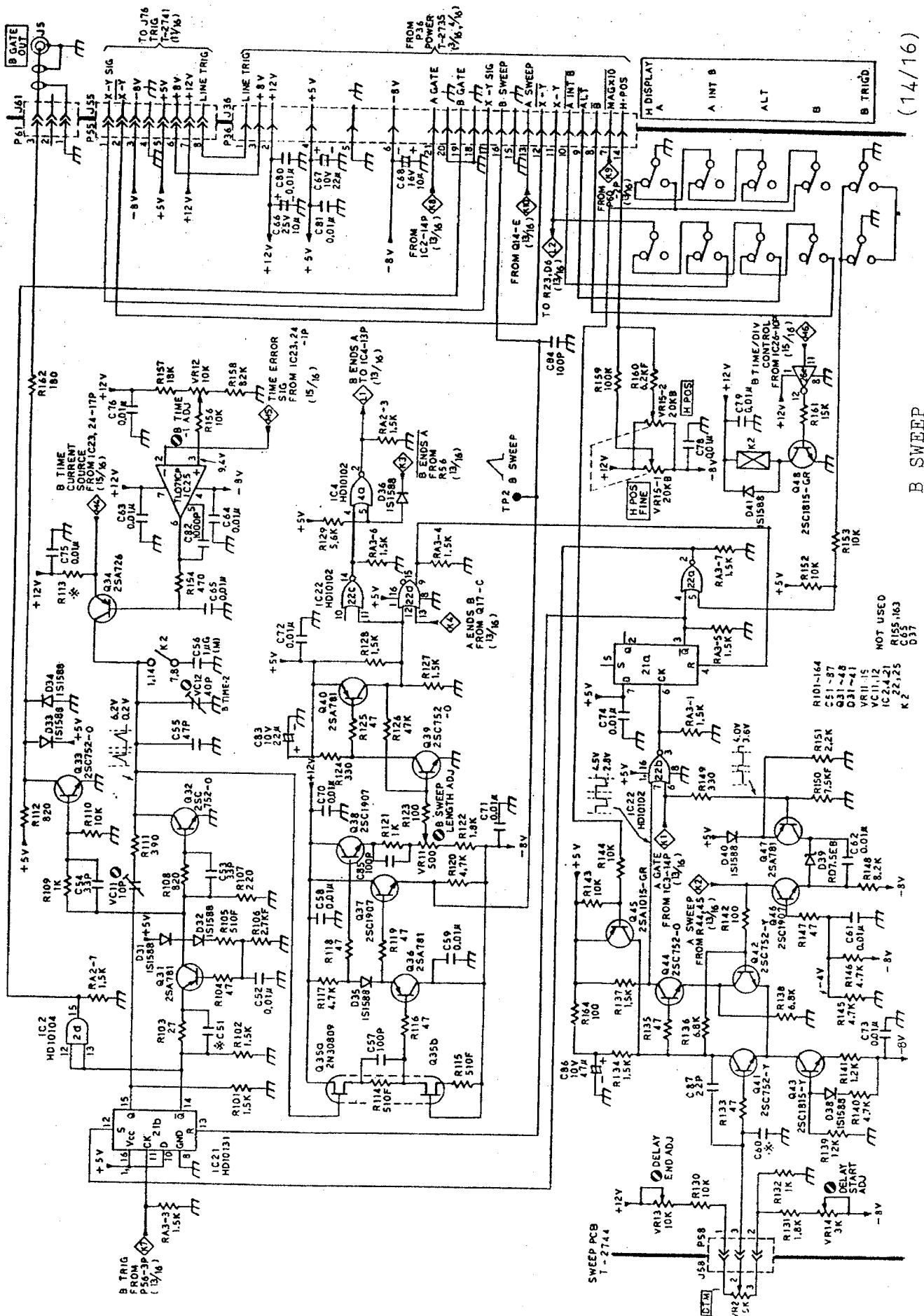
R101 ~ 150  
C71 ~ 106  
Q41 ~ 50  
D41 ~ 49  
NOT USED D47



B TRIG-2/2

(12/16)





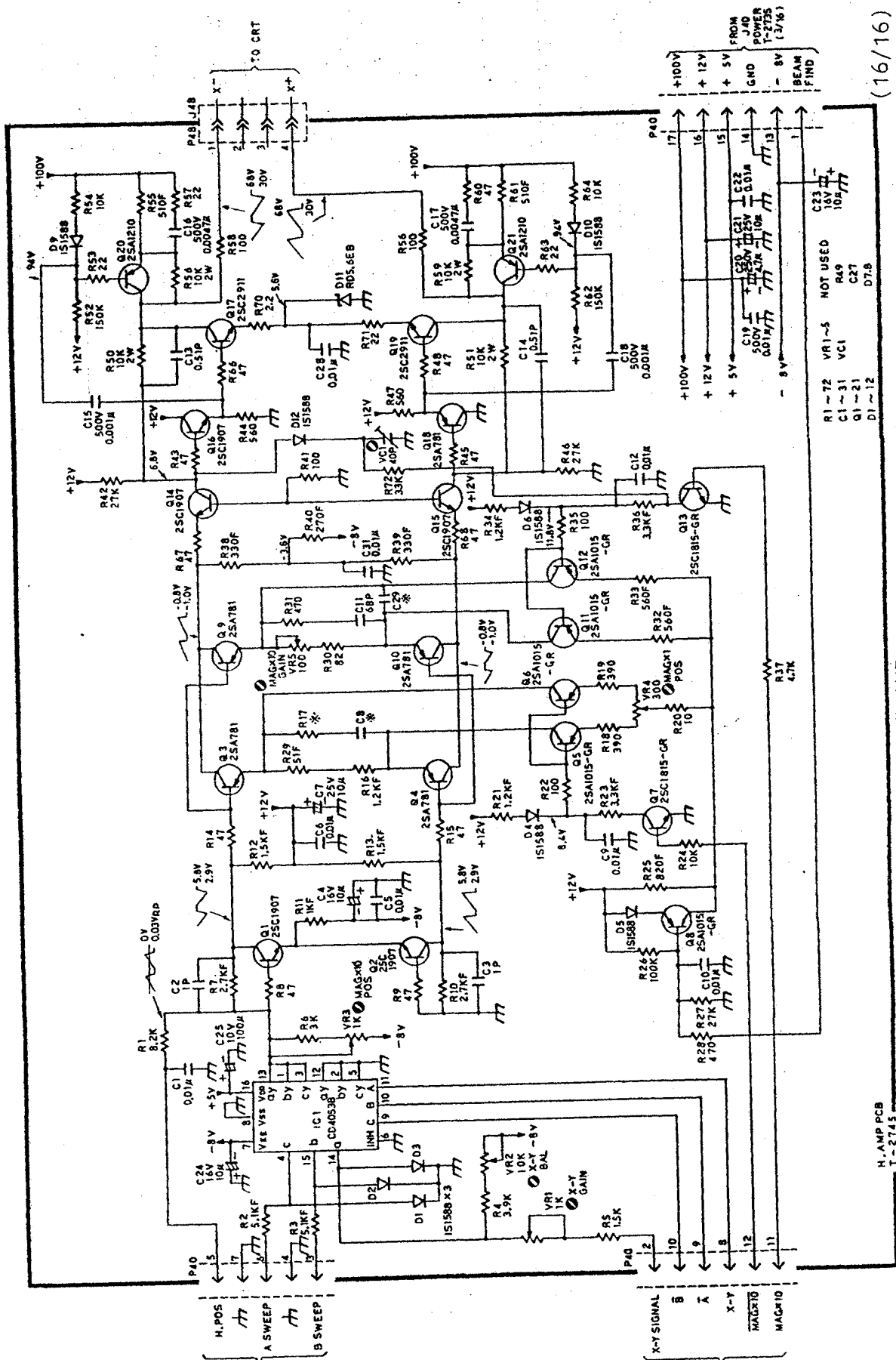
(14/16)

B SWEEP

NOT USED  
R101-164  
C51-87  
Q31-48  
D31-41  
VR11-15  
IC11-12  
IC21-25  
K22,25  
D37







(16/16)

H AMP

H AMP PCB  
T-2745