Data
Systems

PHILIPS

Field Support Manual
Video Display Unit P5020

A PUBLICATION OF
PHILIPS DATA SYSTEMS
APELDOORN, THE NETHERLANDS

PUB. NO. 5122 991 32801

DATE Januari 1982

Great care has been taken to ensure that the information contained in this handbook is accurate and complete. Should any errors or omissions be discovered, however, or should any user wish to make a suggestion for improving this handbook, he is invited to send the relevant details to:

PHILIPS DATA SYSTEMS
SERV. DOC. AND TRAINING DEPT.
P.O. Box 245, APELDOORN,
THE NETHERLANDS.

VIDEO DISPLAY UNIT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1: GENERAL DESCRIPTION

1.1. INTRODUCTION

The model M15P110B/2001 Display Unit, shown in Figure 1-1, contains a CRT assembly, a PCB assembly, and a deflection assembly. The display consists of 495 scan lines per video frame with a frame refresh rate of 40.4 Hz. Each frame consists of two fields. The CRT has a 15-inch diagonal screen, the screen is non-glare, and green characters are produced on a black background.

1.2. PHYSICAL DESCRIPTION

The Display Unit measures 10.905 inches high by 12.913 inches wide by 11.2 inches deep (277.0 x 328.0 x 284.5 mm). All external connections are made via two connectors, J1 and J7. Connector J1 provides for connecting the DC supply (88 Vdc ±8%). Connector J7 provides for connecting the video, horizontal and vertical drives, and a brightness control. The PCB has adjustments for the B+ voltage, field interlacing, linearity, height and width, centring, brightness preset, and static focus.

Figure 1-1 DISPLAY UNIT

1.3. TECHNICAL DATA

1.3.1. DIMENSIONS

Length:	11.2" (284.5 mm)
Width:	12.913" (328.0 mm)
Height:	10.905" (277.0 mm)

1.3.2. ELECTRICAL REQUIREMENTS

Voltage:	88 Vdc ±8%
Ripple:	1 Vp-p maximum

1.3.3. EXTERNAL INPUTS

Refer to Table 1.1

1.3.4. CRT SPECIFICATIONS

CRT Diagonal Measure	15"
Deflection Angle	110°
Implosion Protection	T. Band
Visible Screen Area	11.47" x 8.94" (292 x 227 mm)
Anti-reflective Face Plate	55% Transmission
CRT Phosphors	P39
High Voltage (Nominal)	16.5 KV

1.3.5. RETRACE TIMES

Vertical:	450 us maximum
Horizontal:	8.5 us maximum

1.3.6. VIDEO AMPLIFIER

Rise and Fall Times:	22 ns maximum
Overshoot:	10%
Bandwidth (-3 dB):	21 MHz

1.3.7. GEOMETRIC DISTORTION

Horizontal/Vertical Linearity:	±10%
Pincushion and Barrel:	Arc radius of 2540 mm (100") minimum for top and bottom, and 1905 mm (75") minimum for sides.
Trapezoid:	Deviation from ideal rectangle not to exceed ±3.175 mm (±0.125") maximum horizontally and ±2.54 mm (±0.100") maximum vertically.
Raster Position:	±3.2 mm (±0.125") from geometrical centre.

1.3.8. SETUP CONTROLS ON PCB

B+ Adjustment (R9)
Interlace (R34)
Vertical Linearity (R43)
Vertical Height (R47)
Horizontal Centring (R77)
Brightness Preset (R97)
Static Focus (R103)
Horizontal Linearity (L73)
Horizontal Width (L74)

1.3.9. EXTERNAL CONTROL

Brightness Potentiometer:	120 Kohm, $\geq$ 0.25W

1.3.10. X-RADIATION

Complies with DHEW Radiation Performance Standards 21 CFR subchapter J, and DHW Radiation Emitting Devices Act.

1.3.11. ENVIRONMENTAL

Temperature	
Operating:	+5°C to +55°C (41°F to 131°F)
Storage:	-40°C to +65°C (-40°F to 149°F)
Humidity:	90% maximum (non-condensing)
Altitude:	3000 meters maximum

1.4. INTERFACES

The Display Unit interface with external devices via J1 and J7. Pin assignments are shown in Tables 1.1 and 1.2.

1.5. APPLICATION NOTES

The Display Unit is used in the M3003 Word Processor System, which consists of a desk-top console with a detachable keyboard and which supports a serial daisy wheel printer.

1.6. INSTALLATION DATA

Refer to the adjustment instructions included in Chapter 5.

Table 1.1 CONNECTOR J1 PIN ASSIGNMENTS

PIN	DESCRIPTION
1 2 3	Pins 1, 2 and 3 connect to a transistor mounted on the Display Unit frame.
4	Not used.
5	88 Vdc ±8% input.
6	Ground

Table 1.2 CONNECTOR J7 PIN ASSIGNMENTS

PIN	DESCRIPTION	PULSE RATE	RISE/FALL TIMES	INPUT IMPEDANCE
1	Horizontal and Power Supply Ground	-	-	-
2	Brightness Control High	-	-	-
3	Brightness Control Low	-	-	-
4	Brightness Control Variable	-	-	-
5	Not Used	-	-	-
6	Horizontal Drive	20.0 ±0.75 KHz	50 ns max.	≥2KΩ ≤40pF
7	B+ (75V). Not used.			
8	Video In	45 ns min.	20 ns	≥200Ω ≤40pF
9	Vertical Drive	80.8 ±10 Hz	100 ns max	≥2KΩ ≤40pF
10	Vertical and Video Ground			

Signal Amplitudes Low: 0V, +0.5V, -0.0V
High: 4.0V ±1.5V

Refer to Figure 2-19 for horizontal and vertical waveforms.

Chapter 2: CIRCUIT DESCRIPTION

2.1. INTRODUCTION

This chapter provides a detailed circuit description of the Display Unit. The Display Unit consists of three subassemblies:

- PCB Assembly;
- Deflection Assembly;
- CRT Assembly.

A simple block diagram of the Display Unit is shown in Figure 2-1. Also refer to Figure 5-1 for example waveforms. Figure 2-19 shows horizontal and vertical timing.

2.2. PCB ASSEMBLY

The PCB contains the following circuitry:

- +75V Regulator;
- Video Output Amplifier;
- Vertical Deflection Drive;
- Horizontal Deflection Drive;
- CRT Bias Network;
- Overvoltage Protection.

2.2.1. +75 REGULATOR (Figure 2-2)

An external DC supply of 88 Vdc $\pm$8% is applied to J1-5. Resistor R1 is a bypass resistor which reduces loading on the regulator (it passes about 64 mA of current). Transistor Q2 is a driver, Q3 is a reference amplifier and VR1 provides a reference voltage. The pass transistor is mounted on the metal frame of the Display Unit.

Resistor R7 limits current through the regulator transistor in case the +75V at the junction of R7 and C3 is shorted to ground. Resistors R8, R9 and R10 form a voltage dividing network, with the voltage at the centre tap of R9 providing the reference for Q3. Any change in the output voltage is sensed as a change in the reference voltage, which is used to control Q2 and the external pass transistor to provide regulation. Resistor R12 improves line regulation.

2.2.2. VIDEO OUTPUT AMPLIFIER (Figure 2-3)

The video output amplifier consists of driver Q22 connected in a common-emitter configuration and output amplifier Q21 connected in a common-base configuration. This common-base, common-emitter configuration provides for a high bandwidth (21 MHz). Resistors R23 and R26 determine the gain of the amplifier (R26 is a wire-wound resistor and must be replaced by the same type, otherwise, the video response will deteriorate).

The external video source is applied to pin 8, and R21 and R22 provide input termination. One peaking network is formed by C23/R24 and a second network is formed by L21. Resistor R23 is a feedback resistor and R26 is a load resistor. Resistor R27 is used for arc protection of Q21, which is biased by the +12V supply.

Driver Q22 operates in class B mode, thus, with a no signal condition, both Q21 and Q22 are cut off. As Q21 is forward biased by the +12V, as soon as a positive video signal is applied to the base of Q22, inverted video appears at the collector of Q21. The video is DC coupled to the CRT cathode via peaking coil L21 and R110.

Resistor R110 is in the lead to the CRT socket and it protects Q21 in case of CRT arcing (each pin of the CRT socket has a spark gap).

There is a provision for an optional contrast control (R28), which changes the feedback resistance, thus, increasing or decreasing the video gain.

2.2.3. VERTICAL DEFLECTION DRIVE

The vertical deflection drive circuitry consists of three parts:

- Vertical Interlace or Sync Shaping;
- Vertical Oscillator;
- Vertical Driver.

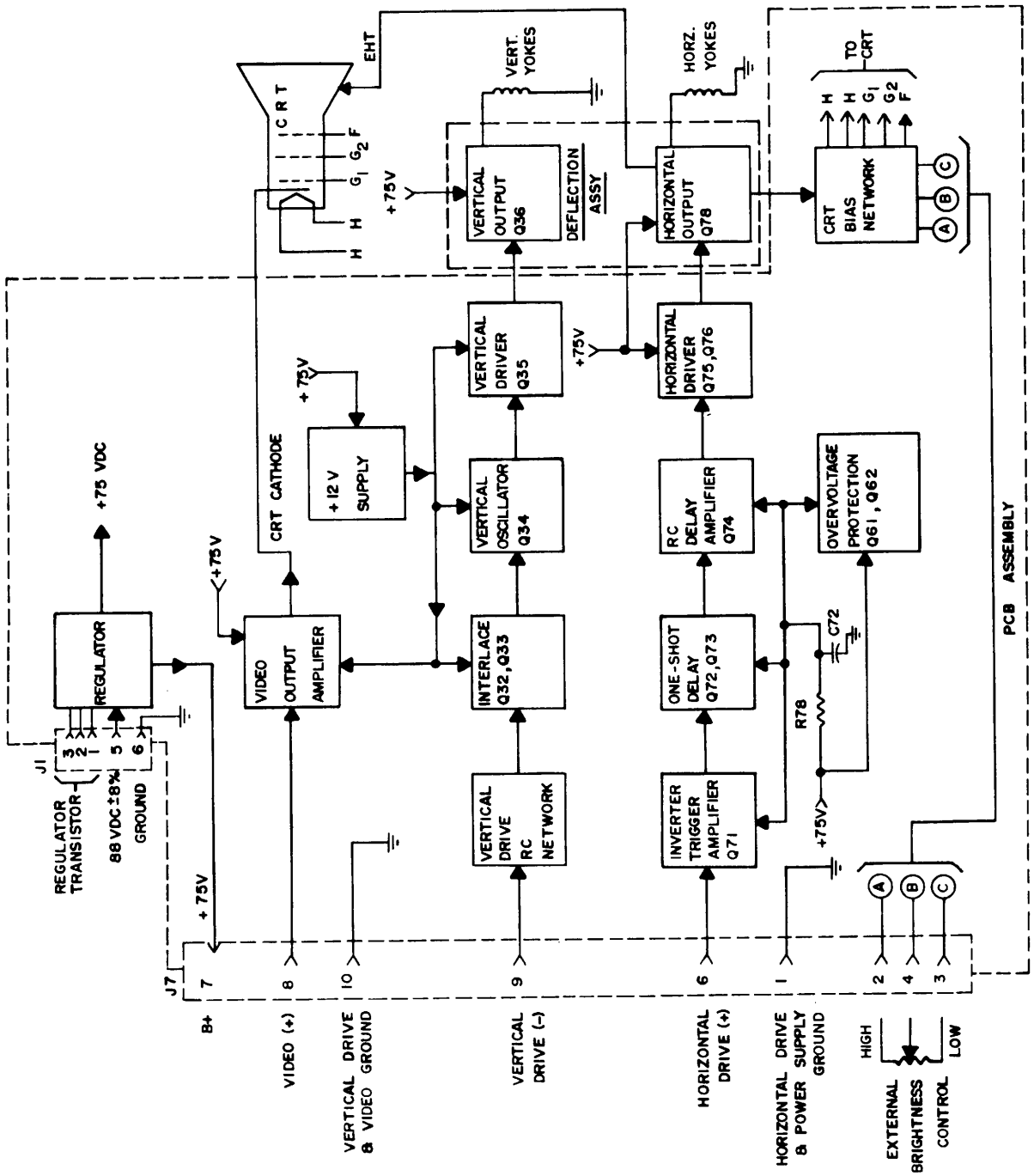


Figure 2-1 DISPLAY UNIT BLOCK DIAGRAM

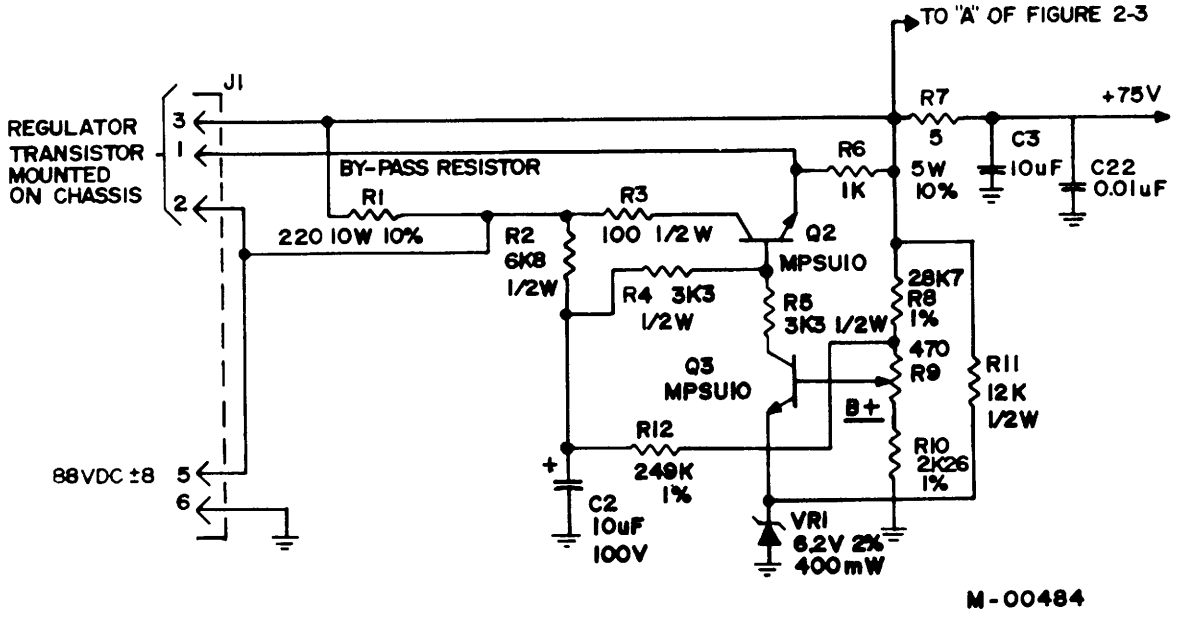


Figure 2-2 +75V REGULATOR

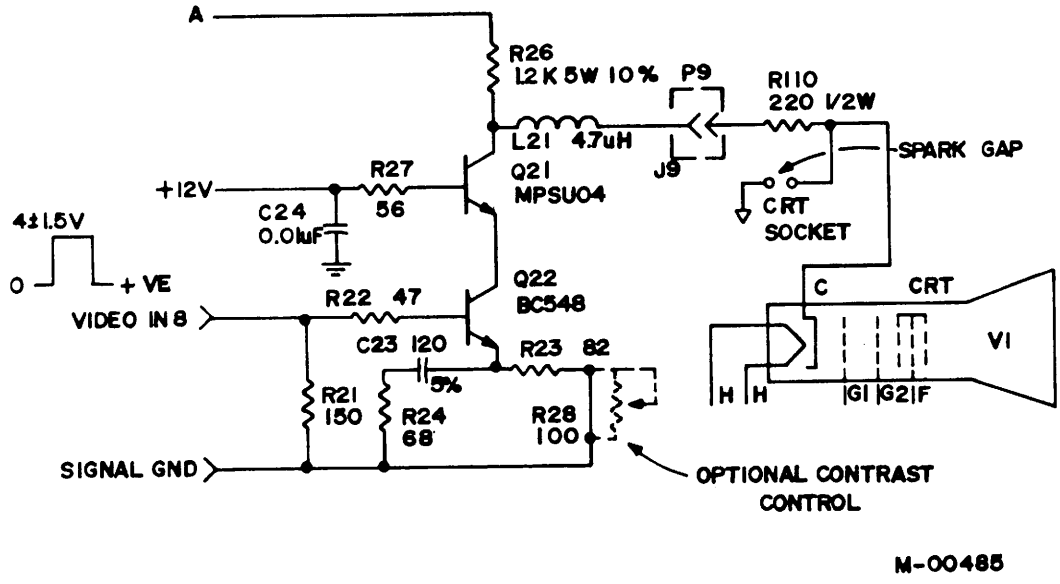


Figure 2-3 VIDEO OUTPUT STAGE

2.2.3.1. VERTICAL INTERLACE (Figure 2-4)

This circuit is used only when drive requirements are for an interlace mode of operation. When a non-interlacing mode is used, the vertical drive input signal is directly AC coupled to the junction of R38 and CR33 (see Figure 2-5).

This is a conventional one-shot delay multivibrator. In the steady state, Q32 is saturated and Q33 is cut off. Resistor R38 is the collector load for Q33 and also provides biasing for the vertical oscillator (programmable unijunction transistor Q34).

When the vertical drive signal is high, Q32 is conducting and Q33 is cut off, and C33 charges to 6V. The negative-going vertical drive pulse is differentiated and AC coupled to Q32, causing Q32 to cut off and Q33 to conduct. Capacitor C33 discharges through R33, R34 and Q33, with the setting of R34 setting the discharge rate and thus setting the pulse width at the collector of Q33. The negative-going pulse at the collector of Q33 is used to trigger Q34 of the vertical oscillator, and the width of the pulse (set by R34) gives proper triggering of Q34 for correct interlacing.

2.2.3.2. VERTICAL OSCILLATOR (Figure 2-5)

The vertical oscillator is formed by programmable unijunction transistor (PUT) Q34 and the associated circuitry. The PUT normally acts as an open circuit, and acts as a short circuit when the anode voltage is 0.6V more positive than the gate voltage. The gate is biased at 5.6V by resistors R38, R40 and R42. The cathode is biased at 0.6V by R42/C34.

When Q34 is cut off, C35 and C36 charge through R41 and, as soon as the anode voltage is 0.6V more positive than the gate voltage, Q34 conducts to discharge C35 and C36. Thus, a positive-going sawtooth voltage is produced at the anode of Q34. Diode CR33 prevents C35 and C36 from discharging through the input RC network when the negative pulse is applied to the gate of Q34.

2.2.3.3. VERTICAL DRIVER (Figure 2-5)

The positive-going sawtooth voltage from Q34 is directly coupled to the input of driver Q35, which operates as an emitter follower, providing a high input impedance to buffer the oscillator stage and a low output impedance to drive the vertical output stage. Resistor R44 is for protection of Q35 and C41 is a high

frequency bypass capacitor. The sawtooth voltage to drive the vertical output stage is developed across potentiometer R47. This is the sawtooth voltage that is applied to the vertical deflection coils. Diode CR34 provides biasing as well as temperature compensation. The output of Q35 is also routed to the junction of C35 and C36 via R45 and R43, and is used for waveform shaping to provide a linear vertical display.

The supply voltage for the interlace circuit, vertical oscillator and vertical driver is derived from the +75V supply. Resistor R46, zener VR31 (12V) and capacitor C37 form a power supply circuit. The +12V supply is also connected to the video output amplifier where it is used for biasing Q21 (Figure 2-3).

2.2.4. HORIZONTAL DEFLECTION DRIVE

The horizontal deflection drive circuitry develops a suitable drive voltage waveform to drive the horizontal output stage. For proper video centring on the raster, it is necessary that the drive waveform be delayed from the horizontal drive pulses which are applied to the Display Unit. The delay is provided by a one-shot delay multivibrator and an RC delay amplifier (Figure 2-1). The horizontal deflection drive circuitry consists of four parts:

- Inverting Trigger Amplifier;
- One-shot Delay Multivibrator;
- RC Delay Amplifier;
- Horizontal Drive Multivibrator.

2.2.4.1. INVERTING TRIGGER AMPLIFIER (Figures 2-6 and 2-7)

The horizontal input drive pulses are applied to pin 6 of the PCB. The pulses are differentiated by C71, R71 and R72 and are applied to the base of Q71, which operates in class B mode. Normally, Q71 is cut off. The positive edge of the differentiated pulse causes Q71 to conduct, providing a negative-going pulse at the collector of Q72. This pulse is used to trigger one-shot delay multivibrator Q72/Q73.

There is also a provision on the PCB to feed part of the horizontal flyback pulse through a resistor to derive trigger pulses for Q71, thus sustaining horizontal drive once it has been initiated by an input horizontal drive pulse.

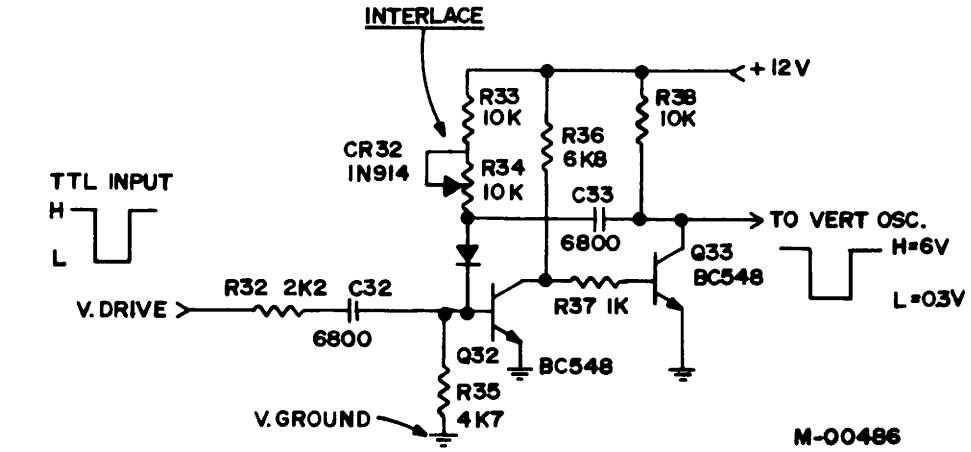


Figure 2-4 VERTICAL INTERFACE CIRCUIT

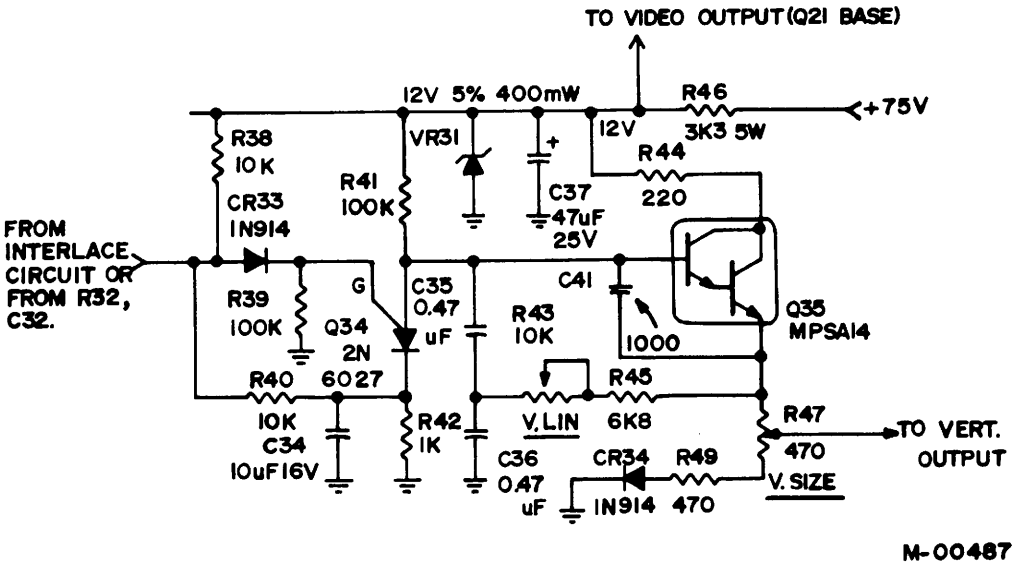


Figure 2-5 VERTICAL OSCILLATOR AND DRIVER

2.2.4.2. ONE-SHOT MULTIVIBRATOR

The multivibrator is formed by Q72, Q73 and the associated circuitry. Normally, Q73 is saturated, Q72 is cut off, and C73 is charged to the horizontal B+ voltage via R73, CR71 and Q73.

When a horizontal drive pulse produces the negative-going pulse at the collector of Q72, the pulse causes Q73 to cut off and regenerative feedback keeps Q72 conducting. This quasi state remains until capacitor C73 discharges to the point where the base voltage of Q73 is sufficient to cause it to conduct again. When Q73 conducts again, it cuts off Q72 and the circuit stays in this condition until the next horizontal drive pulse is received, which causes the process to be repeated. The pulse width at the collector of Q73 is 15 usec (set by the values of C73 and R75), and the pulse frequency is that of the horizontal drive pulses applied to pin 6.

2.2.4.3. RC DELAY AMPLIFIER (Figures 2-8 and 2-9)

This circuit consists of inverting amplifier Q74, which is normally biased at saturation and which can be cut off by applying a negative pulse to the base. The positive-going edge of the pulse from the collector of Q73 charges C75 to +15V via CR72 and Q74 (Q74 remains conducting). When Q73 conducts and the waveform goes negative, CR72 causes Q74 to cut off and C75 begins to discharge through R79, R80 and Q73. The discharge time of C75, hence the length of the positive-going pulse at the collector of Q74, can be set by potentiometer R80 (horizontal phase).

2.2.4.4. HORIZONTAL DRIVE MULTIVIBRATOR (Figures 2-10 and 2-11)

The horizontal driver monostable multivibrator consists of Q75, Q76, drive transformer T71, and the associated circuitry. Normally, Q75 is saturated and Q76 is cut off. The positive pulse from Q74 is differentiated by C76 and R84, and the negative edge triggers the multivibrator. This causes Q75 to cut off and Q76 to conduct, and C77 begins to discharge, keeping Q75 cut off. After approximately one-half a line duration, when C77 is discharged, Q75 conducts again and Q76 cuts off. This cycle repeats each time a pulse is applied to the base of Q75. Resistor R90 is a voltage dropping resistor, C79 provides DC filtering, and R88 and C78 form the tuning network for T71.

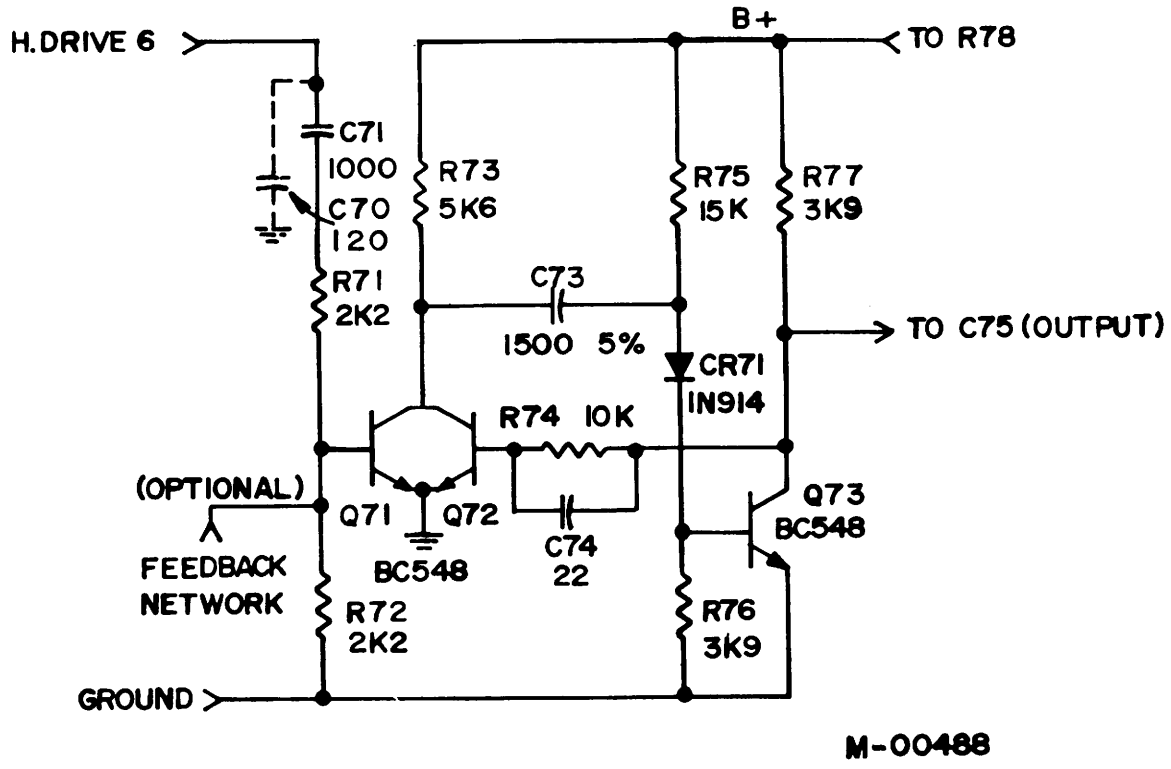


Figure 2-6 ONE-SHOT DELAY MULTIVIBRATOR

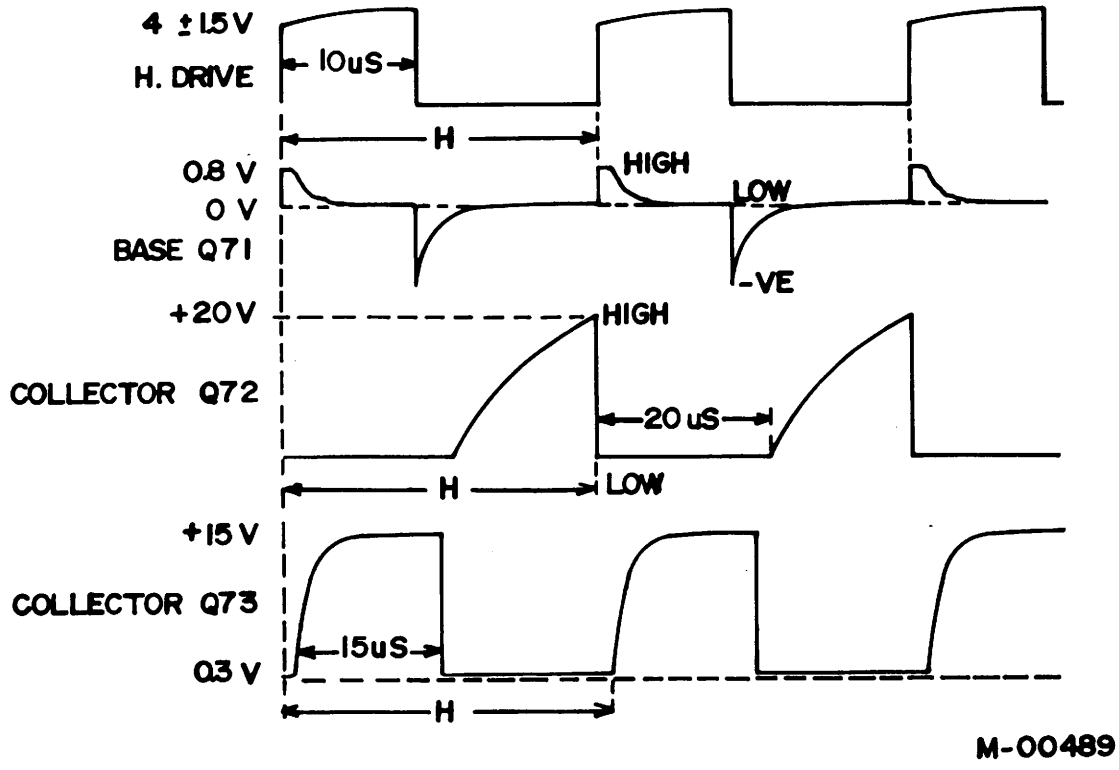


Figure 2-7 MULTIVIBRATOR WAVEFORMS

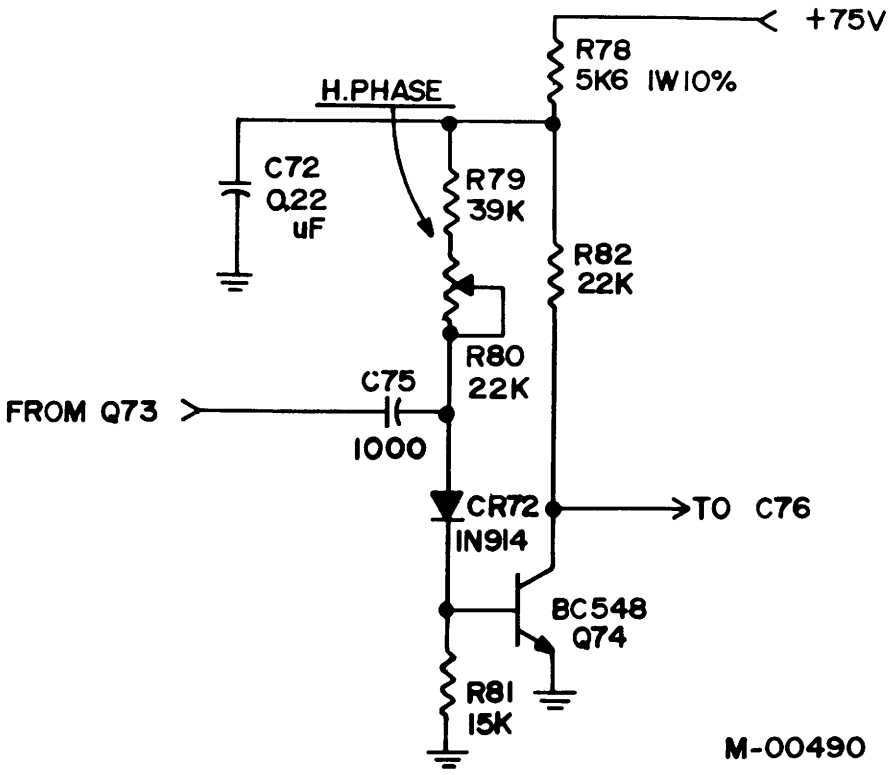


Figure 2-8 RC DELAY AMPLIFIER

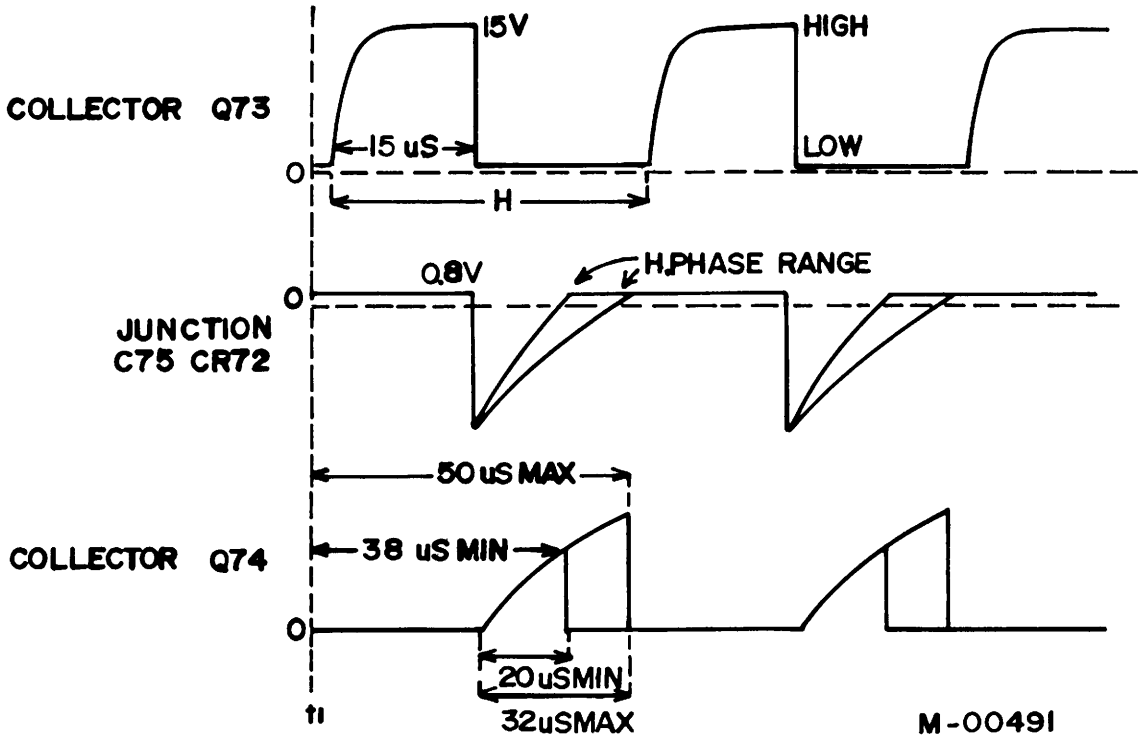


Figure 2-9 RC DELAY AMPLIFIER WAVEFORMS

The pulses developed at the collector of Q76 are coupled to the base of horizontal output transistor Q78 via horizontal driver transformer T71.

2.2.5. CRT BIAS NETWORK (Figures 2-12 and 2-13)

On the CRT, G1 is biased to -59.6V with respect to the cathode. With no video present, the CRT cathode voltage is 77V. Thus, the -15.4V difference required for G1 is obtained from the voltage divider of R93 and R94. Diode CR77 and C80 are used to speed up the CRT discharge during switch-off.

An external potentiometer can be connected to points A, B and C (pins 2, 4 and 3 of J7). The external potentiometer varies the G1 voltage, thus changing the CRT cut-off bias and acting as a brightness control. Capacitor C86 and CR74 develop a -130V voltage from positive 130V pulses from the flyback transformer.

The G2 and focus voltages are derived by rectifying horizontal flyback pulses. Diode CR75 provides rectification and C85 provides filtering. The G2 voltage is obtained from the voltage divider network of R99, R97 and R98, with R97 acting as a preset brightness control when no external brightness control is used. The G2 voltage should be set for a spot cut-off when the CRT cut-off voltage is set for -59.6V.

2.2.6. OVERVOLTAGE CIRCUIT (Figure 2-14)

The function of the overvoltage circuit is to shut down the horizontal drive circuit when the B+ voltage exceeds +80V. This is to prevent the high voltage from reaching a dangerous level should the B+ voltage exceed +80V.

Resistors R61 and R63 bias zener diode VR61 such that is does not conduct until the B+ voltage reaches +80 ±3.0V. When the zener conducts, the voltage developed across R65 triggers the circuit and the horizontal drive B+ (+75V) is shorted through R64, effectively shutting down the horizontal drive circuit.

Capacitor C62 provides a slight switching delay, and R66 and CR61 prevent premature switching with the absence of horizontal drive pulses.

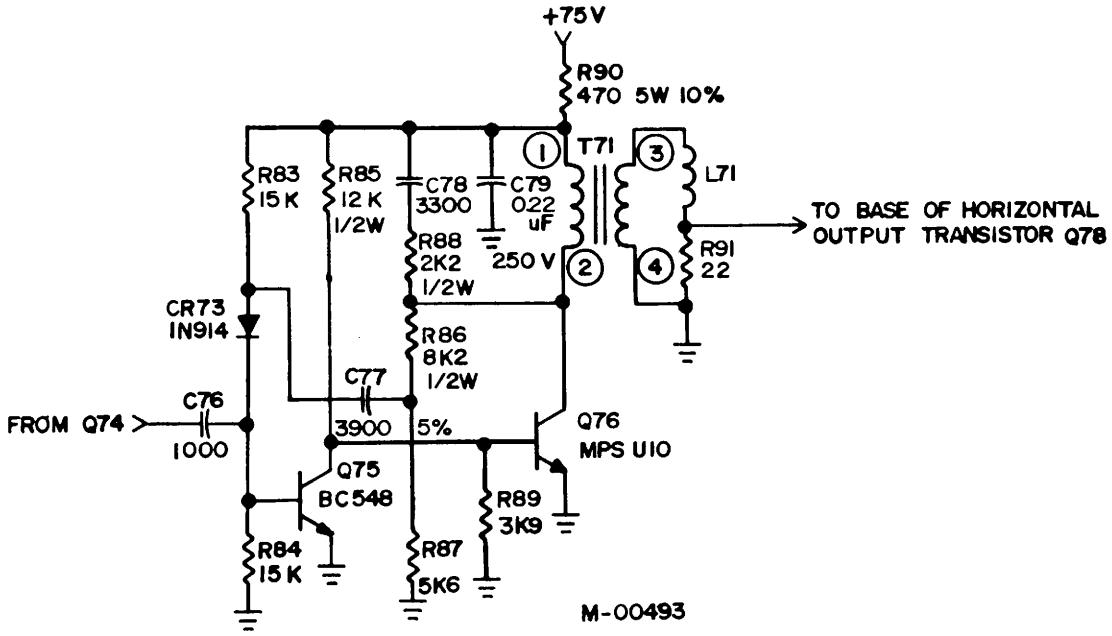


Figure 2-10 HORIZONTAL DRIVE MULTIVIBRATOR

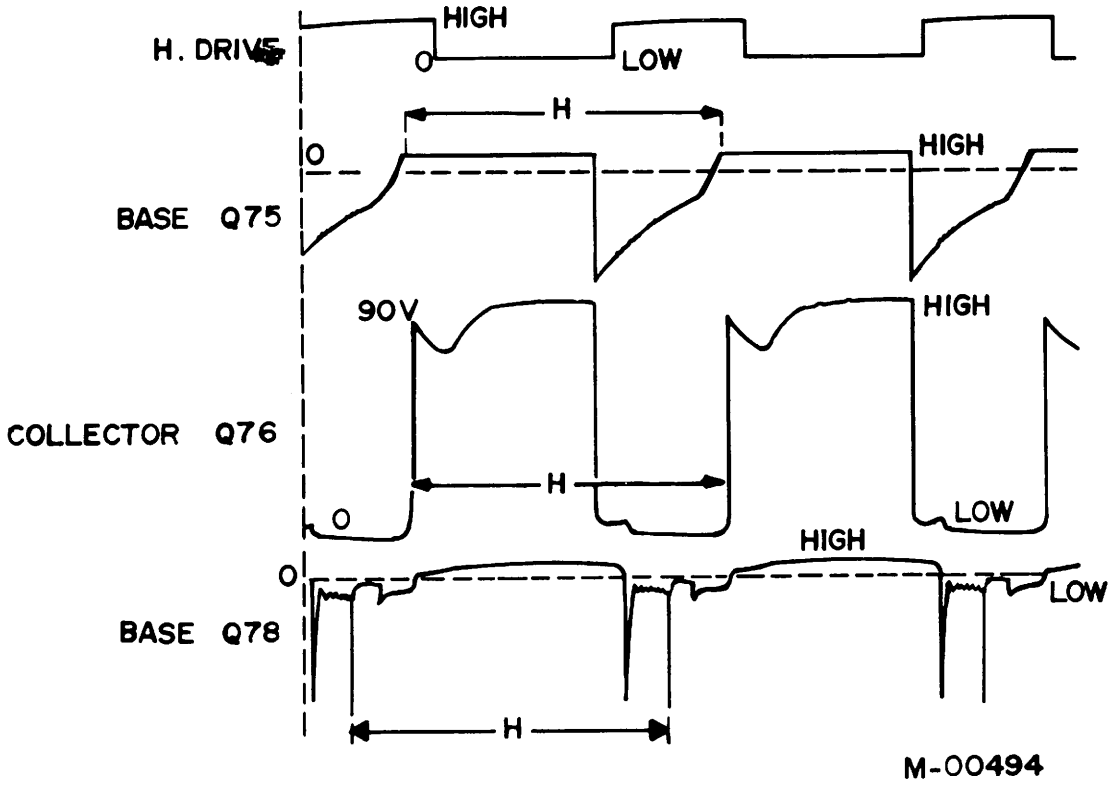


Figure 2-11 HORIZONTAL DRIVE WAVEFORMS

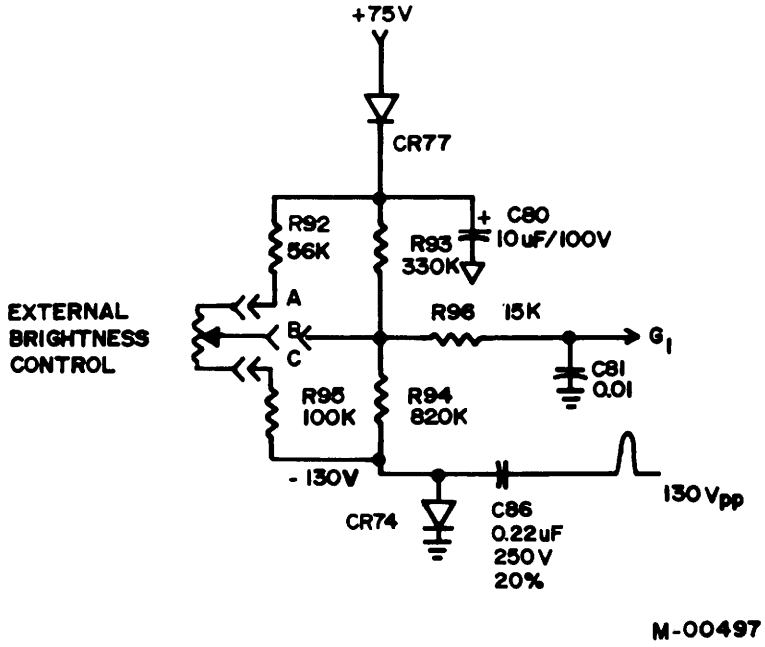


Figure 2-12 CRT G1 BIAS NETWORK

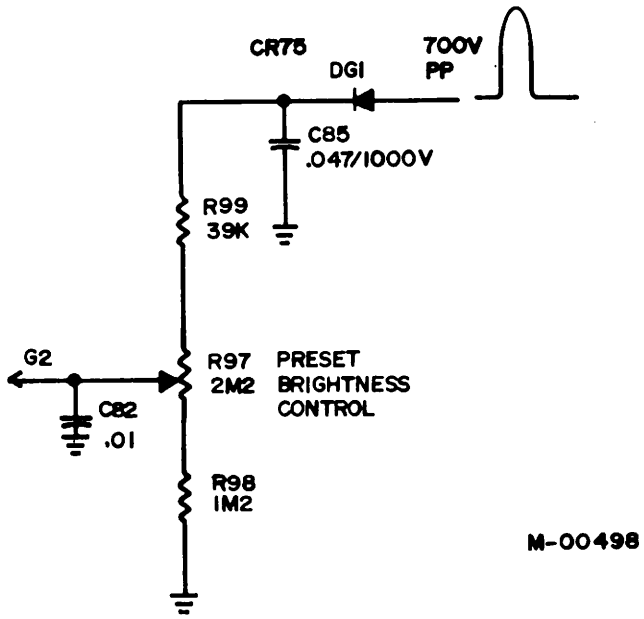


Figure 2-13 CRT G2 AND FOCUS BIAS NETWORK

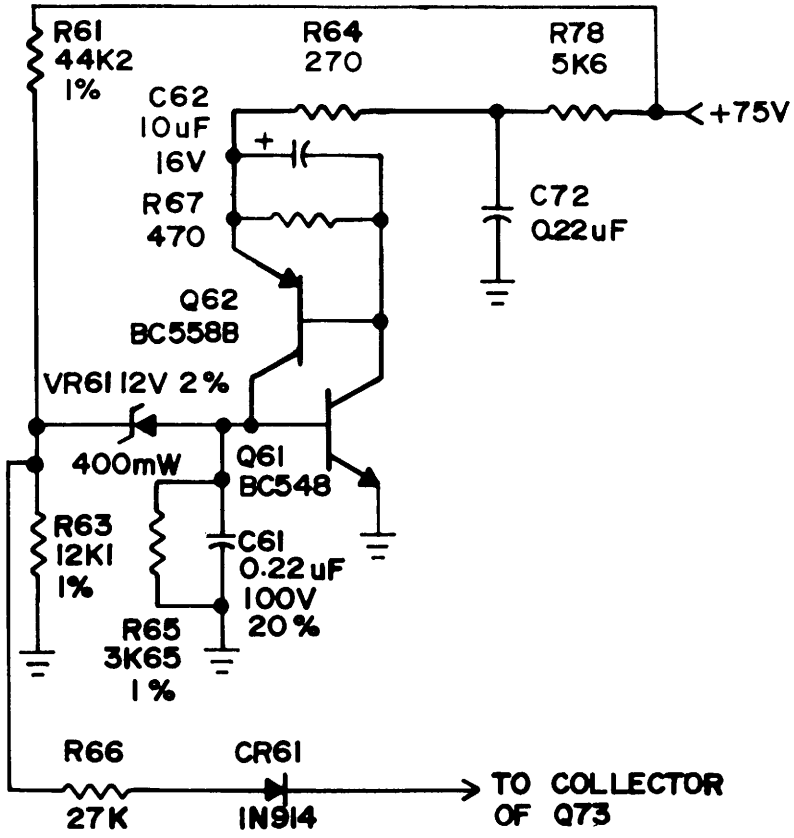


Figure 2-14 OVERVOLTAGE PROTECTION CIRCUIT

2.3. DEFLECTION ASSEMBLY

The deflection assembly consists of vertical output transistor Q36, vertical output choke L31, horizontal output transistor Q78, horizontal output transformer T72, the horizontal width coil, and the associated wiring harness (see Figure 2-1).

2.3.1. VERTICAL OUTPUT STAGE (Figures 2-15 and 2-16)

The positive-going sawtooth waveform from driver Q35 is DC coupled to the base of output transistor Q36, which produces an inverting ramp at the collector. During the scanning time the deflection yoke presents an almost purely resistive load, thus, the inverted ramp produces a sawtooth of current through the yoke. At the end of the scan, the drive voltage reverses direction and the collector current falls rapidly. During the retrace period the load appears inductive due to the short fall time. As Q36 moves toward cut-off, the yokes and the stray capacitance ring for one-half cycle of the self-resonant frequency. Half way through this cycle the voltage reaches a peak value. This is the vertical retrace pulse.

Since the output stage operates in class A, this provides some damping and limits the peak voltage value during retrace. As it also increases the retrace time, conduction during retrace is mimimized, but is never cut off, as this would cause poor linearity at the start of a scan. Resistors R50 and R48 provide damping of the retrace pulse, R51 is a feedback resistor, and R53 provides temperature compensation.

2.3.2. HORIZONTAL OUTPUT STAGE (Figures 2-17 and 2-18)

The horizontal output stage:

- Develops a sawtooth current in the horizontal deflection yokes;
- Develops high voltage for the CRT anode;
- Develops a voltage to bias G2 and G4 of the CRT;
- Develops the CRT heater voltage;
- Develops pulses for the dynamic focus circuit. These pulses are also used to develop the B- voltage for CRT biasing.

The drive pulses coupled through T71 switch Q78 on and off. From the time Q78 turns on, yoke current starts increasing and the electron beam is deflected from the centre of the screen to the right edge of the screen. As soon as Q78 cuts off, a high voltage pulse of about 700 Vp-p is produced at the collector. During this pulse yoke current decreases, reaching zero when the pulse amplitude is maximum and going to a negative value when the pulse drops low. The pulse on the collector of Q78 is rectified by CR75 and is used to provide the G2 and G4 voltages.

During the time Q78 is cut off the yoke current is negative. Damper diode CR76 maintains yoke current until Q78 conducts again. The shape and amplitude of the flyback pulse is determined by C89, the horizontal width coil, the linearity coil, and flyback inductances.

Width coil L74 sets the horizontal size of the display and linearity coil L73 is a polarized inductor for horizontal display linearity. Components R105, C87, R106, and C88 are for damping. Capacitor C92 is an S-correction capacitor and also provides AC coupling.

The pulses produced at the collector of Q78 during retrace are stepped up in the high voltage winding of T72 to produce the high voltage (diode CR78 provides rectification). The CRT filament voltage is developed in winding 1-2. The

pulses produced by winding 1-4 are used by the dynamic focus circuit and to produce the B- voltage.

2.4. CRT ASSEMBLY

Refer to Figure 2-1. This assembly consists of the CRT and the yoke assembly. The yokes are factory set for correct geometry of the CRT display. If yokes or the CRT are changed, the geometry of the display may deteriorate.

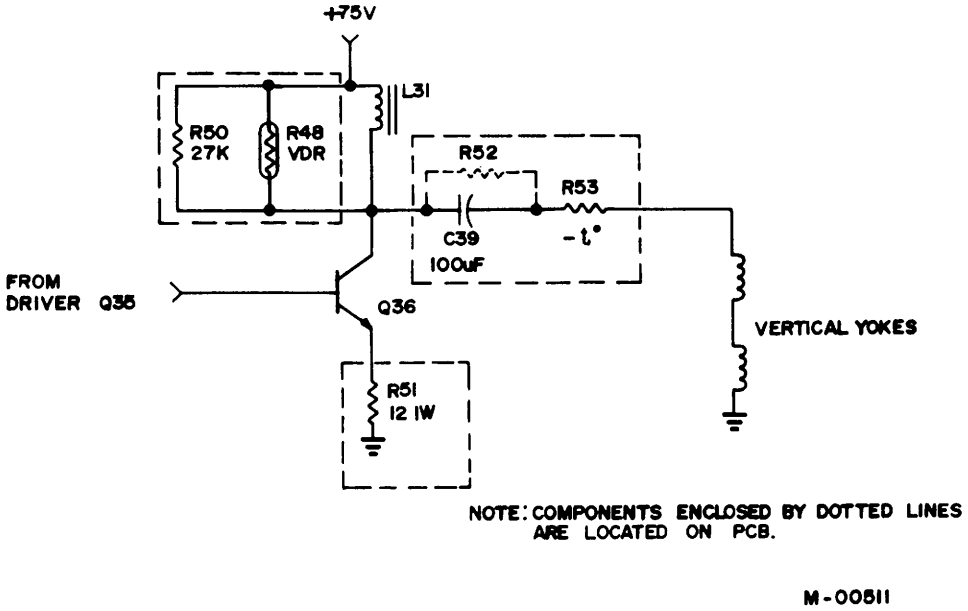


Figure 2-15 VERTICAL OUTPUT STAGE

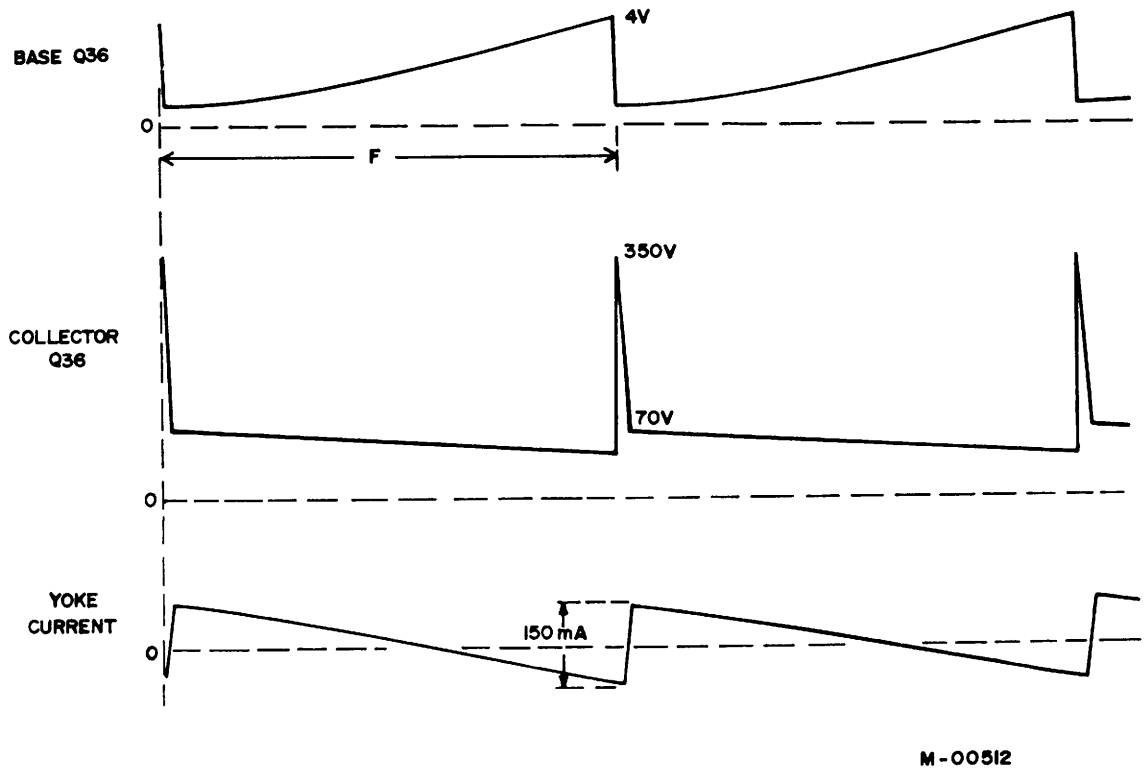


Figure 2-16 VERTICAL OUTPUT WAVEFORMS

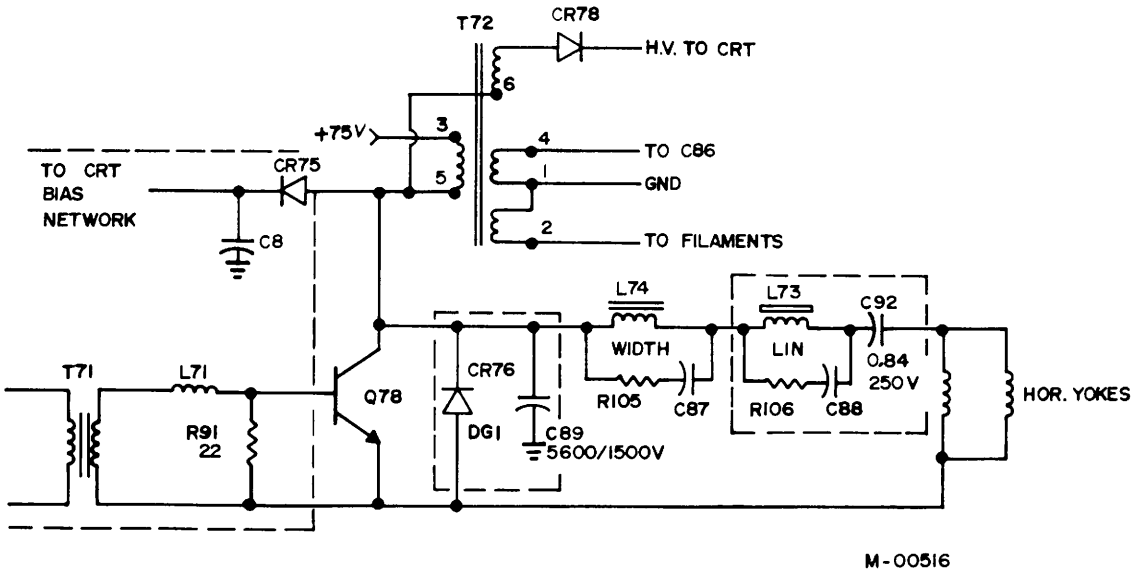


Figure 2-17 HORIZONTAL OUTPUT STAGE

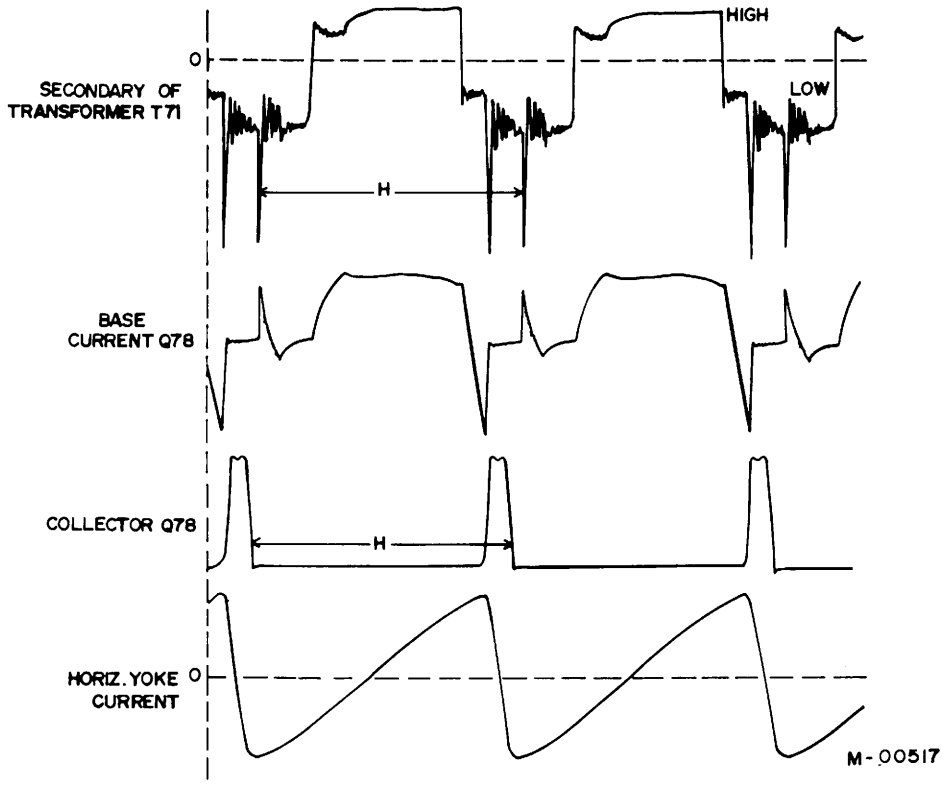


Figure 2-18 HORIZONTAL OUTPUT WAVEFORMS

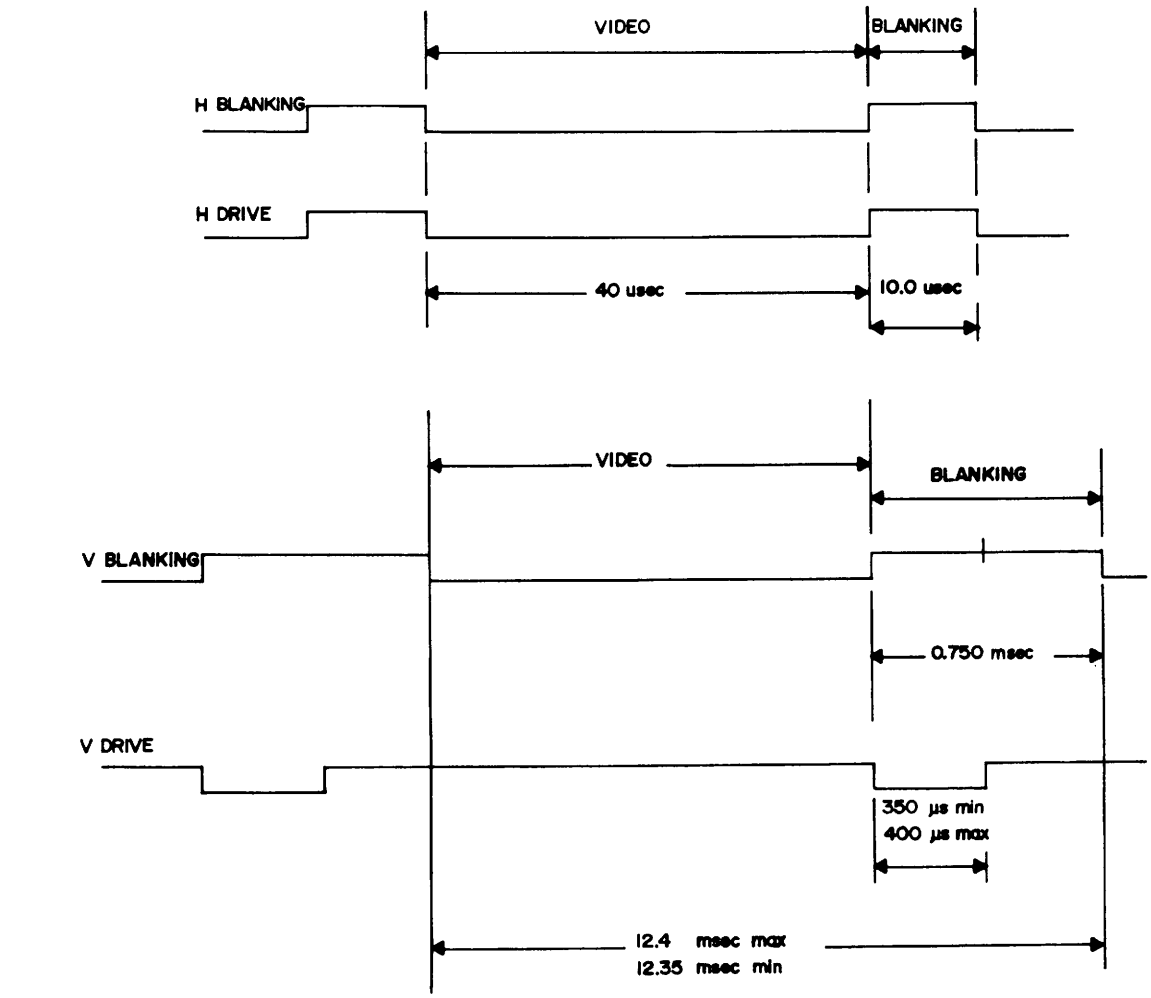


Figure 2-19 HORIZONTAL AND VERTICAL TIMING

Chapter 3: DIAGRAMS

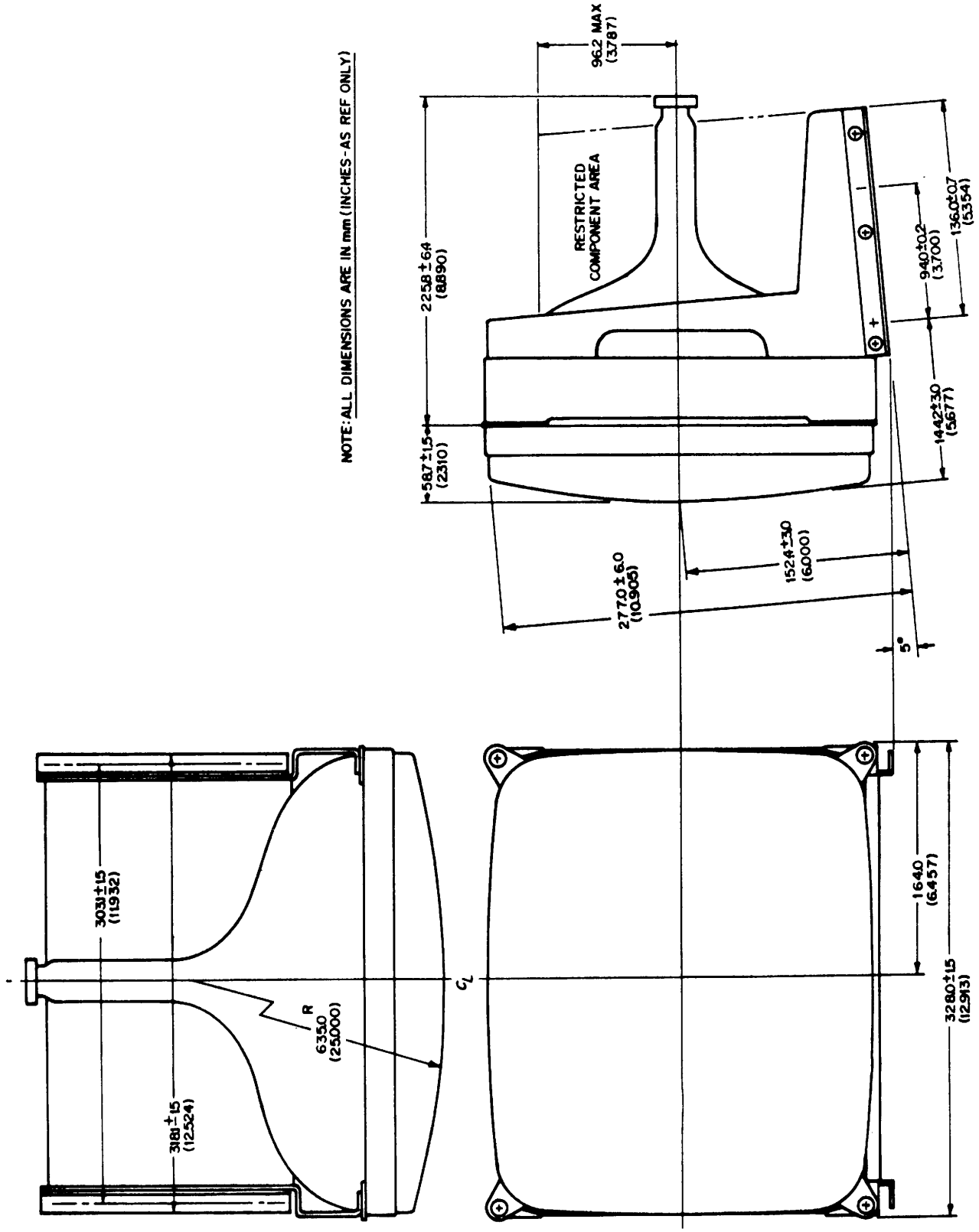


Figure 3-1 DISPLAY UNIT LAYOUT

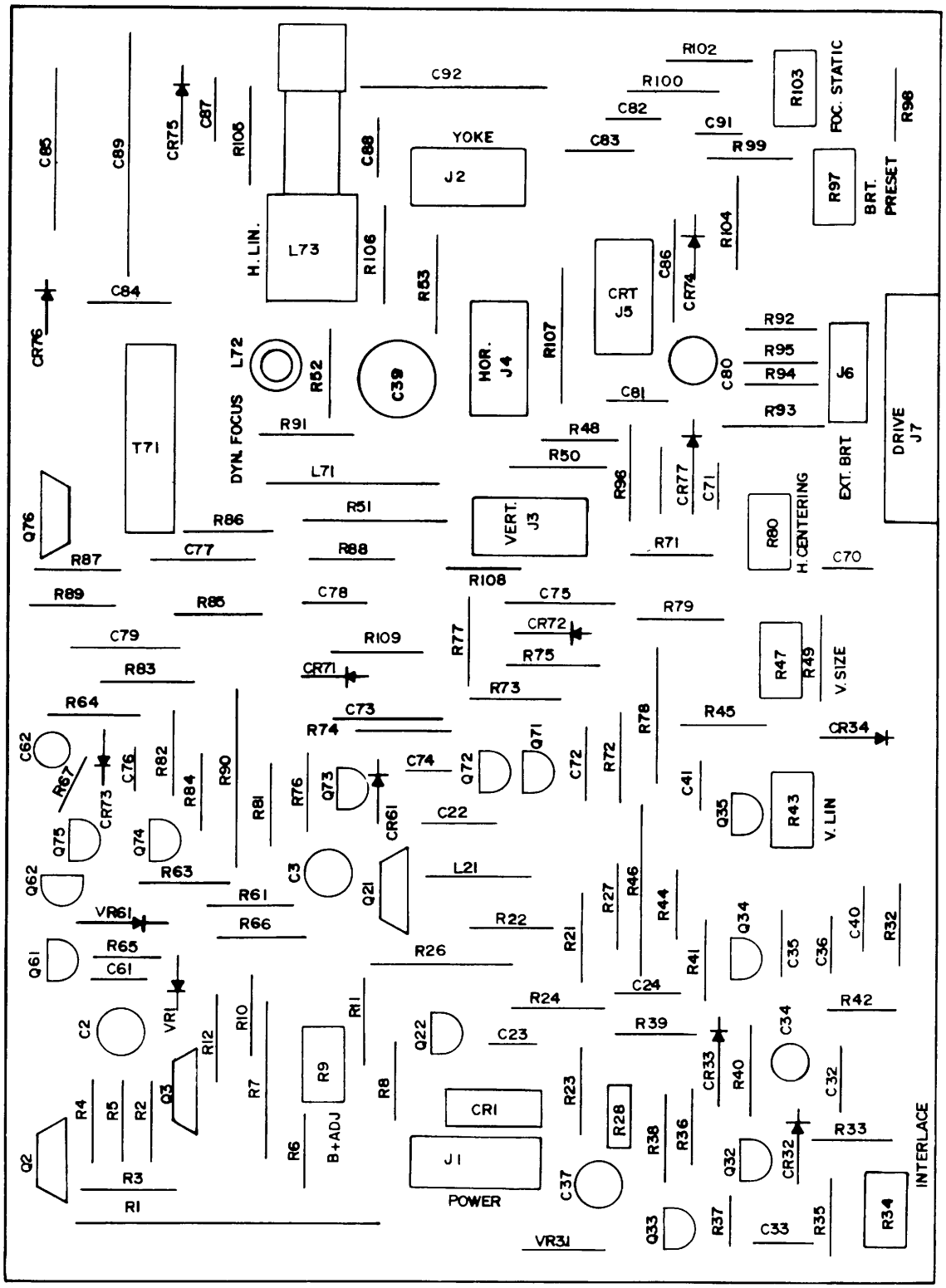
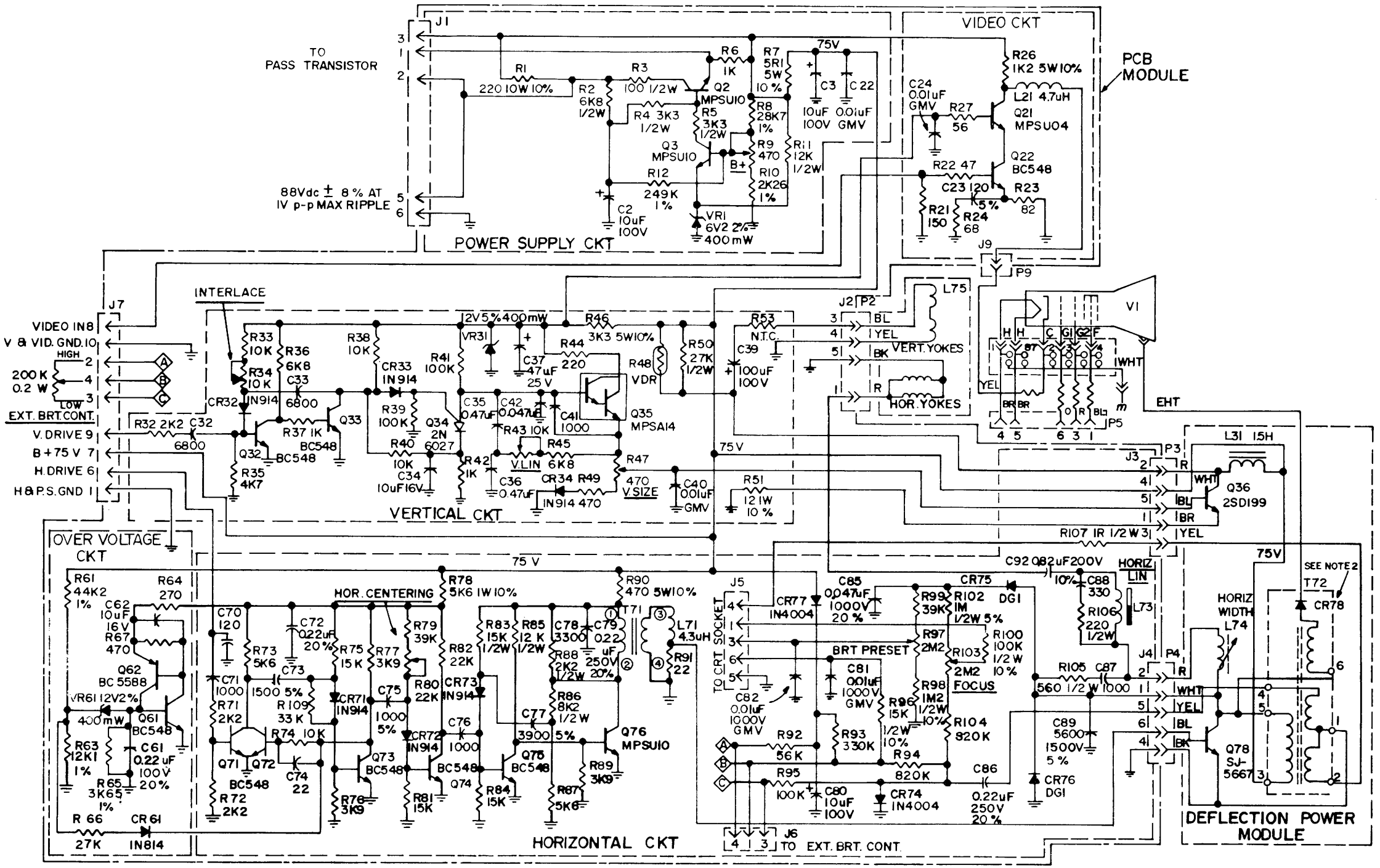


Figure 3-2 PCB LAYOUT

NOTE: 1. UNLESS OTHERWISE SPECIFIED:
RESISTOR VALUES IN OHMS,
WATTAGE RATING IS 1/4 W AND TOLERANCE IS 5%.
CAPACITOR VALUES IN pF AND TOLERANCE IS 10%.

2. H.V. RECTIFIER MAY BE PART OF FLYBACK IN SOME UNITS.



M-00466

IMPORTANT SAFETY NOTICE

COMPONENTS SHOULD ONLY BE REPLACED WITH THOSE SPECIFIED IN THE PARTS LIST.
THE USE OF ANY OTHER PARTS WHICH DO NOT HAVE THE SAME SAFETY CHARACTERISTICS MAY CREATE SHOCK, FIRE, X-RADIATION AND OTHER HAZARDS.

Figure 3-3 SCHEMATIC DIAGRAM

Chapter 4: REPLACEABLE PARTS

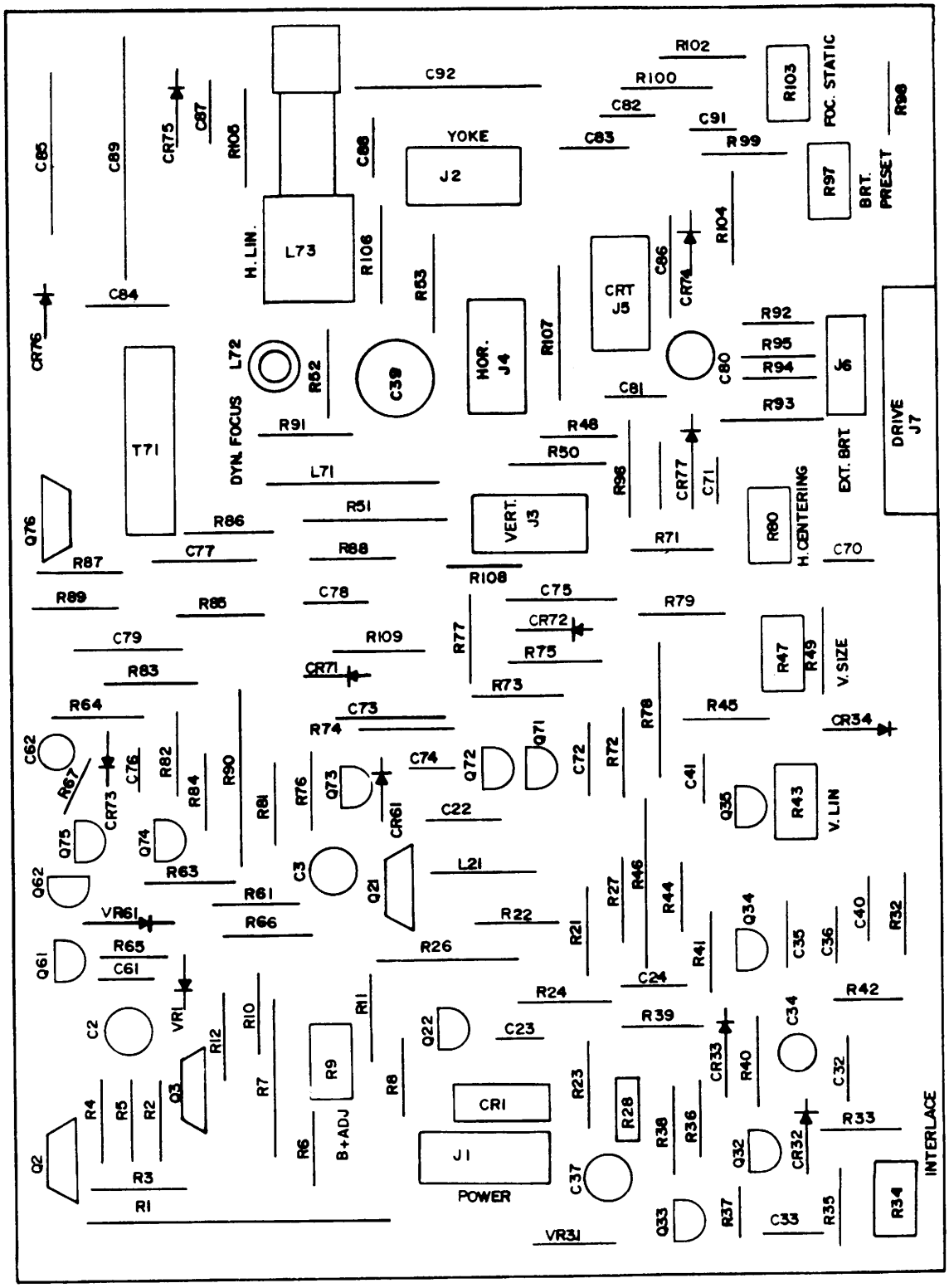


Figure 4-1 PCB ASSEMBLY

4.1. INTRODUCTION

This chapter provides a list of replaceable parts for the Display Unit. For component locations on the PCB, refer to Figure 4-1.

Table 4.1 DISPLAY UNIT REPLACEABLE PARTS

ITEM	DESCRIPTION	PART NUMBER
	ASSEMBLIES	
	PCB Assembly	5107 190 00861
	Deflection Assembly	5107 190 00851
V1	CRT, 15ST4730P39N	9300 836 00862
	CAPACITORS	
C2,C3,C80	Electrolytic, 10 uF, 100V	2222 035 59109
C22,C24,C40	Ceramic, 0.01 uF, 500V GMV, Z5U	514 10305
C23	Ceramic, 120 pF, ±2%, NPO, 100V	2222 642 10121
C32,C33	M.F., 6800 pF, ±10%, 250V	2222 352 48682
C34,C62	Electrolytic, 10 uF, 16V	2222 035 90008
C35,C36	M.F., 0.47 uF, ±10%, 63V	2222 344 15474
C37	Electrolytic, 47 uF, 25V	2222 035 90015
C39	Electrolytic, 100 uF, 100V	2222 034 59101
C41,C71,C76	Ceramic, 1000 pF, ±10%, 500V	2222 630 06102
C61,C72	M.F., 0.22 uF, ±20%, 100V	2222 352 27224
C70	Ceramic, 120 pF, ±2%, 100V, NPO	2222 638 10121
C73	Polypropylene, 1500 pF, ±5%, 160V	2012 324 01034
C74	Ceramic, 22 pF, ±2%, 100V	2222 642 10229
C75	Polypropylene, 1000 pF, ±5%, 160V	2012 324 00022
C77	Polypropylene, 3900 pF, ±5%, 160V	2012 324 00021
C78	Ceramic, 3300 pF, ±10%, 500V	514 33206
C79,C86	M.F., 0.22 uF, ±20%, 250V	2222 352 47224
C81,C82	Ceramic, 0.01 uF, 1000V, GMV	514 10322
C85	M.F., 0.047 uF, ±20%, 1000V	2222 341 70473
C87	Ceramic, 1000 pF, ±10%, 500V	2222 655 03102
C88	Ceramic, 330 pF, ±10%, 500V	2222 655 03331
C89	P.P., 5600 pF, ±5%, 1500V	2012 325 00049
C92	P.F., 0.82 uF, ±5%, 250V	2222 363 42824

Table 4.1 DISPLAY UNIT REPLACEABLE PARTS (Cont'd)

ITEM	DESCRIPTION	PART NUMBER
	DIODES	
CR32,CR33,CR34,CR61	Signal Diode, IN914	9330 599 50113
CR71,CR72,CR73	Signal Diode, IN4148	9330 839 50113
CR74,CR77	Rectifier Diode, IN4004	9330 544 40113
CR75,CR76	Damper Diode, DG1	9332 898 90113
CR78	H.V. Rectifier Diode, H1802 (used with T72 #5107 140 00053)	9335 136 10682
VR1	Zener Diode, BZX79 B6V2	9331 668 30113
VR31	Zener Diode, BZX79 C12	9331 178 90113
VR61	Zener Diode, BZX79 B12	9331 668 90113
	INDUCTORS	
L21	Video Peaking Coil, 4.7 uH	5107 108 20072
L31	Vertical Output Choke	5107 108 30034
L71	Coil, 4.3 uH	5107 108 20042
L73	Horizontal Linearity Coil (Adj.)	5107 108 20053
L74	Horizontal Width Coil	5107 108 20003
L75	Deflection Yoke Assy	5107 108 50411
	TRANSISTORS	
Q2,Q3,Q76	Transistor, MPSU10	9334 934 90682
Q21	Video Output, MPSU04	9334 728 00112
Q22,Q32,Q33,Q61 Q71,Q72,Q73,Q74 Q75	Transistor, BC548B	9331 976 60112
Q34	PUT, 2N6027	9332 151 50112
Q35	Darlington, MPSA14	9332 883 50112
Q36	Vertical Output, 2SD199	9334 727 90112
Q62	Transistor, BC558B	9331 977 50112
Q78	Horizontal Output SJ5667	5107 010 00021

Table 4.1 DISPLAY UNIT REPLACEABLE PARTS (Cont'd)

ITEM	DESCRIPTION	PART NUMBER
	FIXED VALUE RESISTORS	
	(values in ohms unless otherwise specified)	
R1	WW, 220, ±10% 10W	2122 251 00694
R2	CF, 680, ±5%, 1/2W	2322 212 23682
R3	CF, 100, ±5%, 1/2W	2322 212 23101
R4,R5	CF, 3300, ±5%, 1/2W	2322 212 23332
R6,R37,R42	CF, 1000, ±5%, 1/4W	2322 211 23102
R7	WW., 5R1, ±10%, 5W	2122 251 00695
R8	MF, 28k7, ±1%, 1/4W	2322 151 22873
R10	MF, 2K26, ±1%, 1/4W	2322 151 22262
R11,R85	CF, 12k, ±5%, 1/2W	2322 212 23123
R12	MF, 249K, ±1%, 1/4W	2322 151 22494
R21	CF, 150, ±5%, 1/4W	2322 211 23151
R22	CF, 47, ±5%, 1/4W	2322 211 23479
R23	CF, 82, ±5%, 1/4W	2322 211 23829
R24	CF, 68, ±5%, 1/4W	2322 211 23689
R26	WW, 1200, ±10%, 5W	2122 251 00697
R27	CF, 56, ±5%, 1/4W	2322 211 23569
R32,R71,R72	CF, 2200, ±5%, 1/4W	2322 211 23222
R33,R38,R40 R74	CF, 10K, ±5%, 1/4W	2322 211 23103
R35	CF, 4700, ±5%, 1/4W	2322 211 23472
R36,R45	CF, 6800, ±5%, 1/4W	2322 211 23682
R39,R95,R41	CF, 100k, ±5%, 1/4W	2322 211 23104
R46	WW, 3300, ±10%, 5W	2122 251 00698
R48	VDR, 300V	2322 552 03441
R49,R67	CF, 470, ±5%, 1/4W	2322 211 23471
R50	CF, 27K, ±5%, 1/2W	2322 212 23273
R51	CC, 12, ±10%, 1W	2107 218 22129
R53	NTC, 50, ±20%, 1W	2322 610 11509
R61	MF, 44K2, ±1%, 1/4W	2322 151 24423
R63	MF, 12K1, ±1%, 1/4W	2322 151 21213
R64	CF, 270, ±5%, 1/4W	2322 211 23271

Table 4.1 DISPLAY UNIT REPLACEABLE PARTS (Cont'd)

ITEM	DESCRIPTION	PART NUMBER
R65	MF, 3k65, ±1%, 1/4W	2322 151 23652
R66	CF, 27k, ±5%, 1/4W	2322 211 23273
R73,R87	CF, 5600, ±5%, 1/4W	2322 211 23562
R75,R81,R84	CF, 15k, ±5%, 1/4W	2322 211 23153
R76,R77,R89	CF, 3900, ±5%, 1/4W	2322 211 23392
R78	CC, 5600, ±10%, 1W	2107 218 22562
R79,R99	CF, 39k, ±5%, 1/4W	2322 211 23393
R82	CF, 22k, ±5%, 1/4W	2322 221 23223
R83	CF, 15k, ±5%, 1/2W	2322 212 23153
R86	CF, 8200, ±5%, 1/4W	2322 211 23822
R88	CF, 2200, ±5%, 1/2W	2322 212 23222
R90	WW, 470, ±10%, 5W	2122 251 00696
R91	CF, 22, ±5%, 1/4W	2322 211 23229
R92	CF, 56k, ±5%, 1/4W	2322 211 23563
R93	CF, 330k, ±5%, 1/4W	2322 211 23334
R94,104	CF, 820k, ±5%, 1/4W	2322 211 23824
R96	CC, 15k, ±10%, 1/2W	2107 217 22153
R98	CF, 1M2, ±10%, 1/2W	2322 212 22125
R100	CC, 100k, ±10%, 1/2W	2107 217 23104
R102	CF, 1M, ±10%, 1/2W	2322 212 23105
R105	CF, 560, ±5%, 1/2W	2322 212 23561
R106	CF, 220, ±5%, 1/2W	2322 212 23221
R107	WW, 1R0, ±10%, 1W	2322 212 23108
R109	CF, 33k, ±5%, 1/4W	2322 211 23333
	VARIABLE RESISTORS	
	(values in ohms unless otherwise specified)	
R9	B+ Adjust, 470, 1/2W	2122 377 00019
R34	Interlace, 10k, 1/4W	2122 377 00012
R43	V. Linearity, 10k, 1/4W	2122 377 00012
R47	V. Size, 470, 1/4W	2122 377 00019
R80	H. Centring, 22k, 1/4W	2122 377 00022
R97	BRT Preset, 2M2, 1/4W	2122 377 00026
R103	Focus, 2M2, 1/4W	2122 377 00026

Table 4.1 DISPLAY UNIT REPLACEABLE PARTS (Cont'd)

ITEM	DESCRIPTION	PART NUMBER
	TRANSFORMERS	
T71	Horizontal Driver Transformer	3122 138 26060
	Horizontal Driver Transformer	5107 140 00073
T72	Horizontal Output Transformer	5107 140 00061
	Horizontal Output Transformer (with CR78)	5107 140 00053
	Horizontal Output Transformer	5107 108 30021
	MISCELLANEOUS PARTS	
	CRT Socket Assy	5107 190 00141
	Transistor Insulating Cover	3122 104 03502
	Grounding Spring	5107 101 00001
	Terminal, Molex 08-50-0105	2422 034 11432
	Housing, 6-pin	2422 025 01759
	Housing, 5-pin	2422 025 02604
J9	Pin	2422 034 16316
	Socket, Transistor (Q36,Q78)	2422 485 80002
	Insulator, Transistor (Q36,Q78)	2422 487 89036

Chapter 5: TROUBLESHOOTING & REPAIR

5.1. GENERAL

This chapter provides troubleshooting and repair instructions for the Display Unit.

5.2. TOOLS AND MATERIALS REQUIRED

- Standard Tool Kit
- Functional Field Test Program Diskette
- Oscilloscope
- Digital Voltmeter

5.3. TROUBLESHOOTING

These procedures apply when the troubleshooting will be performed with the Display Unit installed in a console. All other assemblies of the console (power supply, Controller PCB, etc.) must be fully operational.

Reference must be made to the schematic diagram and assembly drawing, which are located in Chapter 3.

CAUTION

This Display Unit contains high voltage (15.6 KV).

5.3.1. SERVICE PROCEDURE

The following steps can be used to isolate a fault. Pertinent waveforms are given in Figure 5-1.

- Check the external power supply fuse. If this fuse keeps blowing, it is most likely because Q78 has failed. Plugs P3 and P4 can be disconnected to isolate the horizontal output section from the PCB.

- Check the +75V bus. If it is high, the overvoltage circuit will cut the horizontal circuit off. If it is low, something is loading it. Isolate the horizontal and vertical output stages by disconnecting plugs P3 and P4.

- In the event of vertical or horizontal deflection malfunction, the corresponding B+ for the drive circuits should be checked. For vertical drive, VR31 is the 12V regulator zener. The horizontal drive circuit B+ is 20V after dropping resistor R78.

- If the supply voltage buses are as specified, then the individual circuitry should be checked with an oscilloscope (see Figure 5-1).

5.4. ADJUSTMENTS

5.4.1. B+ ADJUSTMENT

Connect a digital volmeter on the +75V line (jumper on top of CR77). Adjust B+ ADJ. potentiometer R9 for +75V. Now the regulator can be checked for line regulation. Vary the AC input voltage between 105 and 135 VAC RMS; with the regulator operating properly the DC voltage change should be negligible.

5.4.2. HORIZONTAL ADJUSTMENTS

- With the horizontal width coil, located on the deflection output assembly, adjust the required display size (9.75" ±0.25").
- Touch up horizontal linearity coil L73, if required, for proper linearity.
- Touch up width coil L74 for proper size, if required.
- Adjust horizontal centring potentiometer R77 for proper video centring.

5.4.3. CRT SPOT CUT-OFF

With the external brightness control disconnected, adjust Brightness Preset potentiometer R97 so that the raster is just extinguished. It is also possible to use this as brightness preset to limit maximum CRT beam current, if desired.

5.4.4. VERTICAL ADJUSTMENTS

- Adjust the display size to 7.50" ± 0.25" with potentiometer R47 (marked V.Size.)
- Adjust vertical linearity with potentiometer R43.
- If necessary, touch up vertical size potentiometer R47 for the required size.

- Adjust interlace control R34 for proper display interlace.

5.4.5. STATIC FOCUS

Adjust focus potentiometer R103 for best overall focus of the CRT. Generally it is sufficient to set up for the best focus between the centre and the edges of the CRT.

5.4.6. RASTER CENTRING

The ring magnets on the yoke can be used to centre the raster of CRT phosphor. The magnets should not be touched if the raster is already in the centre of the CRT screen, otherwise the CRT resolution and display geometry will deteriorate.

5.5. REPAIR

5.5.1. REPAIR PRECAUTIONS

When repairing the unit the following precautions must be observed.

- Never repair the unit with power applied.
- When soldering, use only a soldering iron which has a properly grounded soldering tip. A soldering iron which has AC on the soldering tip will cause damage to transistors.
- Only use a low-wattage soldering iron.
- A soldering iron must not be held in contact with the solder point any longer than necessary. Excess heat can damage components. Use a "solder sucker" to remove melted solder.
- Perform a visual inspection of all repairs. After soldering, check for solder shorts between pins and tracks adjacent to the repair. Check for cold solder joints.

5.5.2. POST-REPAIR TESTING

After a unit has been repaired, it should be checked for proper operation by running the Display test of the Functional Field Test Program.

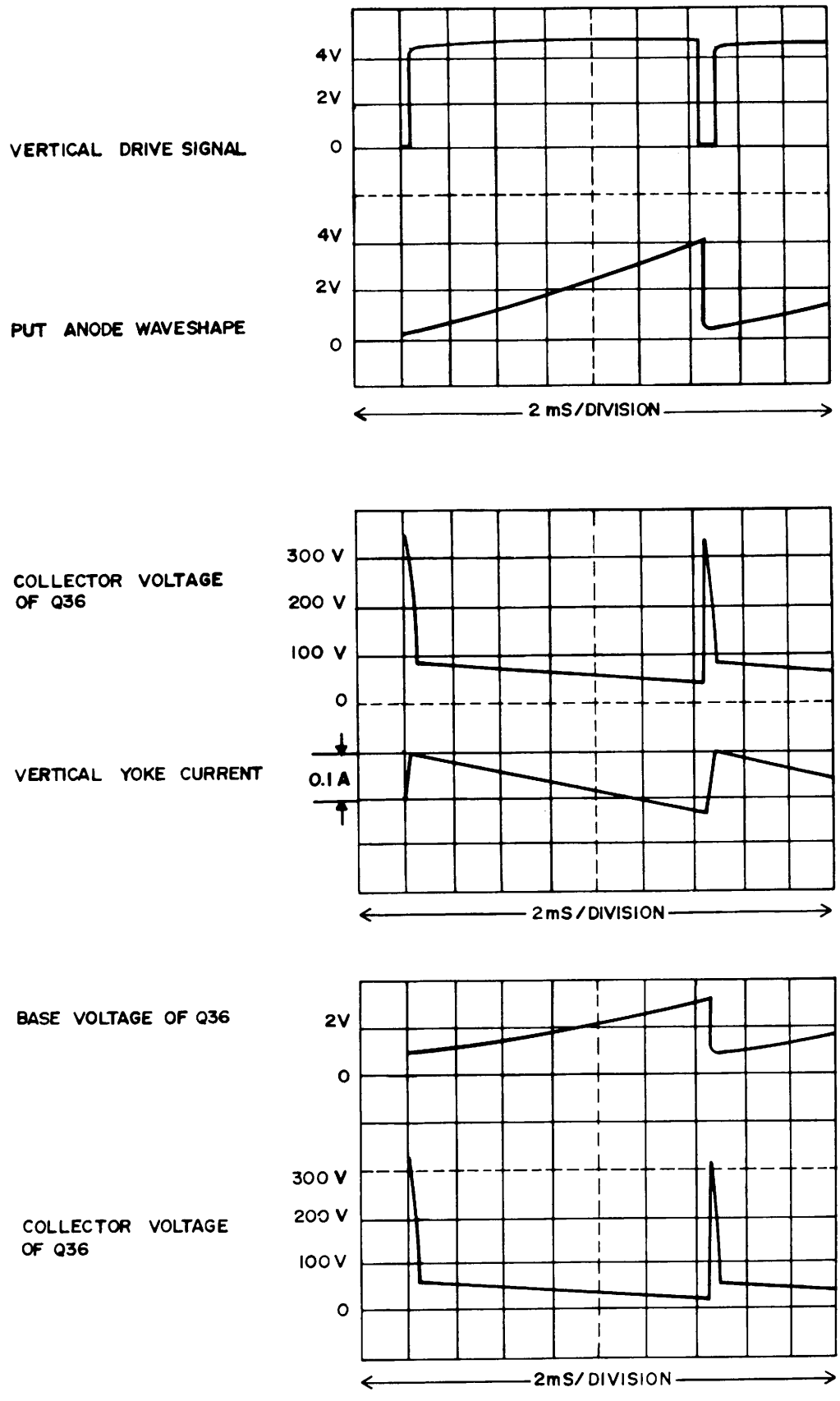
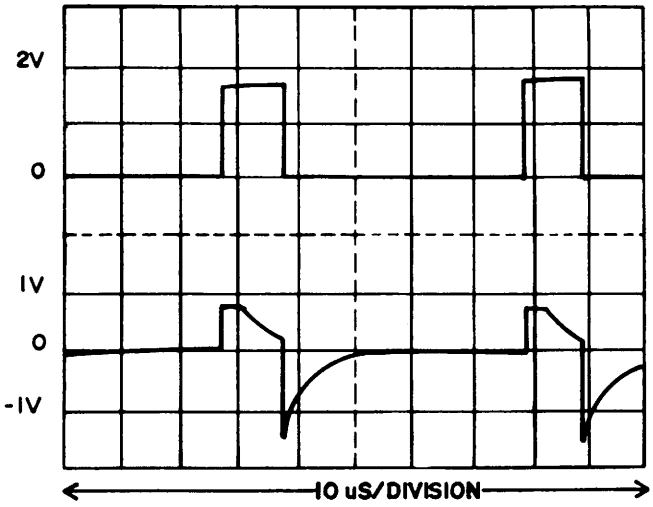


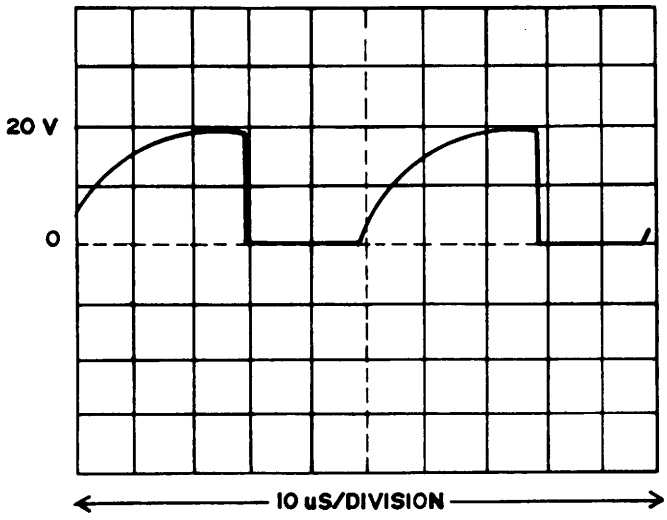
Figure 5-1 TROUBLESHOOTING WAVEFORMS (Sheet 1 of 5)

HORIZONTAL DRIVE SIGNAL



BASE VOLTAGE OF Q71

COLLECTOR VOLTAGE OF Q72



COLLECTOR VOLTAGE OF Q73

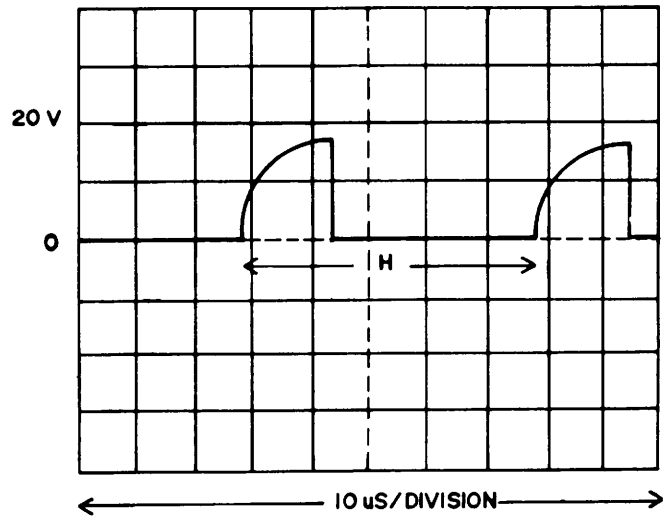
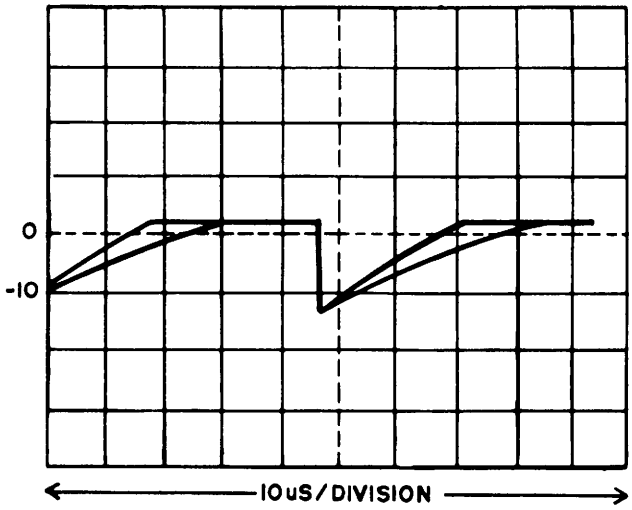
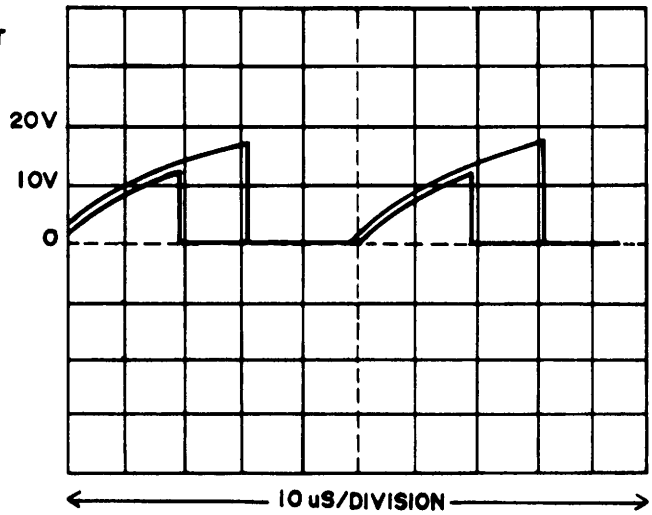


Figure 5-1 TROUBLESHOOTING WAVEFORMS (Sheet 2 of 5)

VOLTAGE WAVESHAPE AT JUNCTION OF C75 AND CR72



VOLTAGE WAVESHAPE AT COLLECTOR OF Q74



HORIZONTAL DRIVE PULSE

VOLTAGE WAVEFORM AT BASE OF Q75

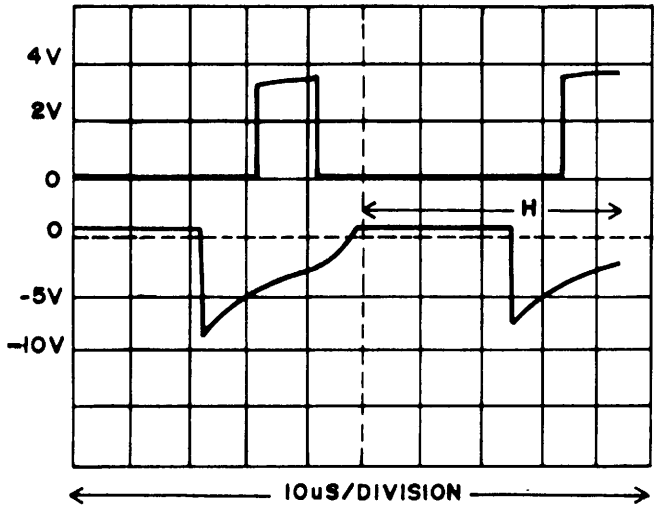
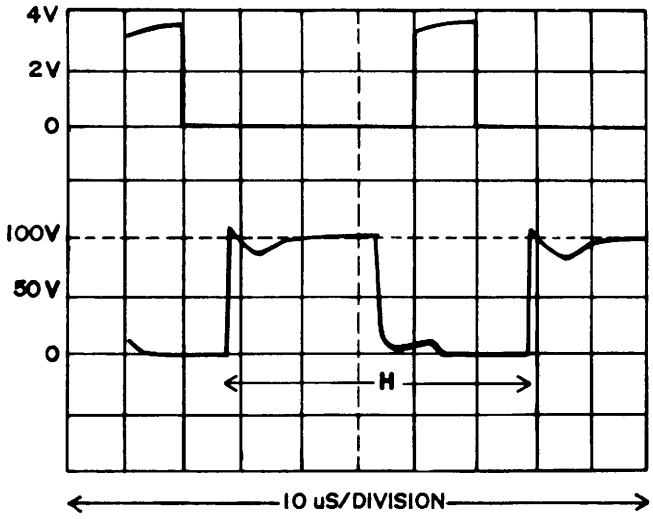


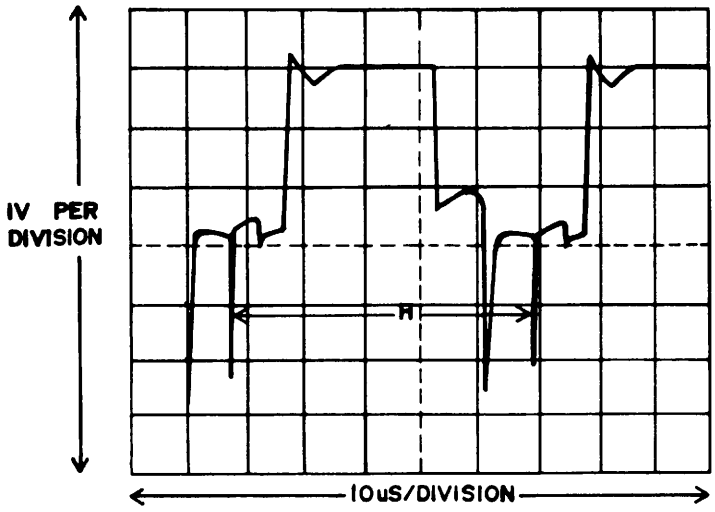
Figure 5-1 TROUBLESHOOTING WAVEFORMS (Sheet 3 of 5)

HORIZONTAL DRIVE PULSE

VOLTAGE WAVESHAPE AT COLLECTOR OF Q78



VOLTAGE WAVESHAPE AT SECONDARY OF HORIZONTAL DRIVE TRANSFORMER



VOLTAGE WAVESHAPE AT BASE OF Q78

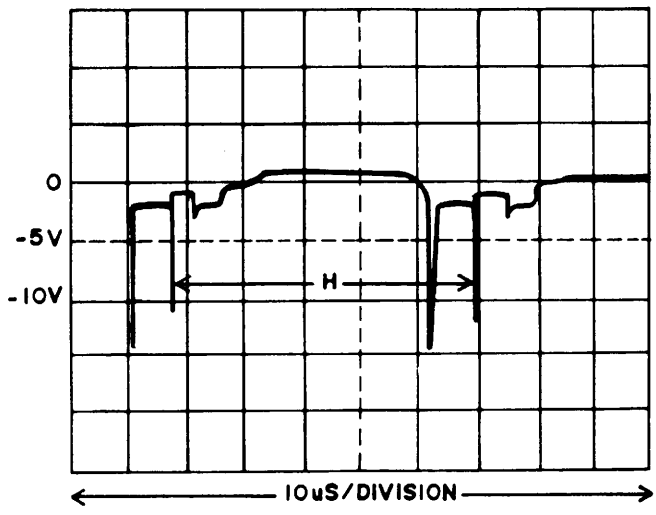
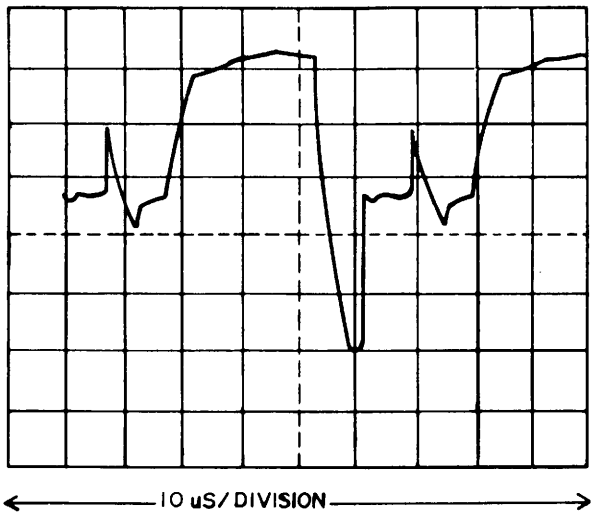


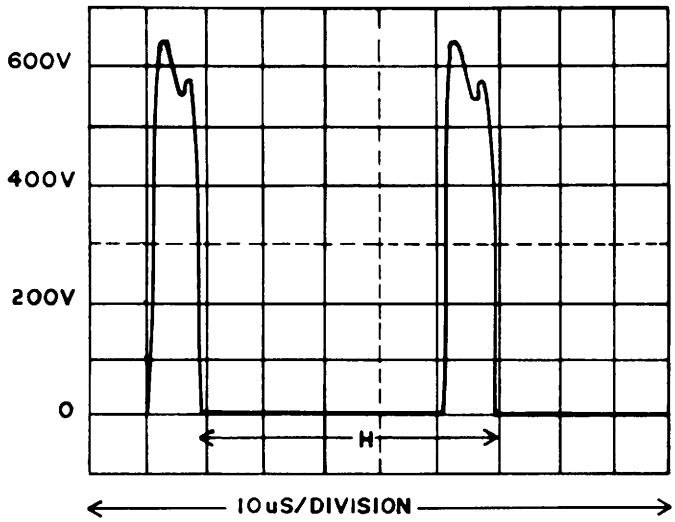
Figure 5-1 TROUBLESHOOTING WAVEFORMS (Sheet 4 of 5)

CURRENT WAVESHAPE AT BASE OF Q78

0.5A PER DIVISION



VOLTAGE WAVESHAPE AT COLLECTOR OF Q78



HORIZONTAL YOKE CURRENT WAVESHAPE

1.0A PER DIVISION

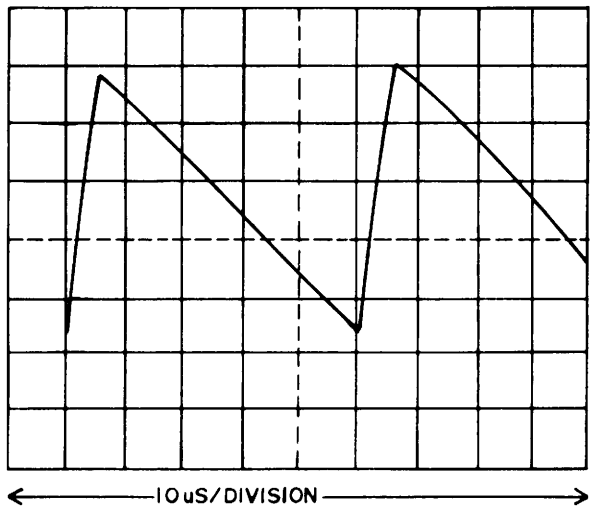


Figure 5-1 TROUBLESHOOTING WAVEFORMS (Sheet 5 of 5)