

WY-120 Maintenance Manual

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2

Troubleshooting

BEFORE YOU START

Read the following safety information carefully before you attempt to troubleshoot your unit.

Safety

This terminal contains high voltage. Don't attempt to service the terminal without taking the following precautions:

- Turn the terminal off and disconnect the power cable.
- Remove jewelry from your hands and wrists.
- Avoid wearing clothing made of synthetic fabrics.
- Use insulated or nonconductive tools.
- Handle circuit boards only by their edges.
- Don't reconnect the power cable or turn the terminal on unnecessarily while the terminal enclosure is removed.
- Whenever you connect or disconnect the anode from the anode lead, make sure to discharge the anode as directed in Section 1.

⚠ Warning The CRT/yoke assembly has high voltages. Only qualified service personnel should adjust it.

- If you need to remove or replace the CRT/yoke assembly, remember that it can implode if you drop it or break the neck. The flying glass can injure anyone within a radius of ten feet.
- Always use the manufacturer's replacement components. Especially critical components as indicated on the circuit schematics should not be replaced with any component other than the manufacturer's. Where a short circuit has occurred, replace those components that indicate evidence of overheating.

Required Tools

Before you start to repair the terminal, make sure you have the following tools and materials:

- No. 2 Phillips screwdriver
- 3/16-inch flat-blade screwdriver
- Digital multimeter (DMM) or a voltmeter
- Test connectors for the MAIN and AUX1 ports
- Nonconductive video alignment tool
- 100-MHz oscilloscope

PRIMARY TROUBLESHOOTING PROCEDURES

Begin troubleshooting by preparing the terminal properly and running the power-on self-test and the diagnostic self-test.

Diagnostic Self-Test

The terminal diagnostic self-test starts in setup mode. This procedure includes communications circuitry tests, memory read/write tests, EPROM tests, and nonvolatile RAM tests. Two special test connectors allow the diagnostic test to function. After starting, the diagnostic test will run until you terminate it. If the test detects an error, an error code and message display on the screen. Error codes are defined in Table 2-1. See Figure 3-4 in Section 3 for component locations on the terminal PCB.

Table 2-1 Error Codes

Code	Failure Message	Location
0	Character RAM Chip	U3
1	Attribute RAM Chip	U9
2	Font RAM	U2
P	Code PROM Checksum	U5
K	Setup Lost (Battery)	BATT1
d	AUX1 Port D0, D1-ACK	U11 or U12
b	AUX1 Port D2, D3-BUSY	U11 or U12
C	AUX1 Port D4, D5-PE	U11 or U12
a	AUX1 Port D6, D7-ERROR	U11 or U12
A	MAIN Port RTS-CTS	U10 or U7
c	MAIN Port DTR-DCD	U10 or U7
X	MAIN Port TxD-RxD	U10 or U7

Follow these steps to run the diagnostic self-test:

- 1 Turn off the terminal. Unplug it from its AC power source and disconnect any communications cables.
 - 2 Attach loopback diagnostic test connector LB1 to the MAIN port and the EVEN or ODD loopback diagnostic test connector to the AUX1 port on the terminal's rear panel. Loopback connector pin numbers and signals for the ports are shown in Table 2-2.
 - 3 Plug in the terminal and turn it on. The test screen fills with a "walking" RAM character pattern for about 90 seconds, then the screen changes to a "walking" attribute pattern.
- ☐ **Note** To fully test the terminal, let the diagnostic self-test run five minutes.
- 4 If the test stops, the terminal beeps, and a letter or number appears on the screen, refer to Table 2-1 for an interpretation of the error codes before proceeding to the appropriate troubleshooting flowchart.
 - 5 After completing the test, turn the terminal off. Remove the test connectors and reattach the communications cables.

Table 2-2 Loopback Test Connector Pin Assignments

Loopback Port	Pin	Signal
MAIN	2-3	TXD → RXD
	4-5	RTS → CTS
	8-20	DCD → DTR
AUX1 (Even Parallel)	2-10	D0 → ACK
	4-11	D2 → BUSY
	6-12	D4 → PE
	8-15	D6 → ERROR
	1-LED-17	STB → Ground
AUX1 (Odd Parallel)	3-10	D1 → ACK
	5-11	D3 → BUSY
	7-12	D5 → PE
	9-15	D7 → ERROR
	1-LED-17	STB → Ground

Troubleshooting Quick Reference Guide

Table 2-3 is a troubleshooting quick reference guide. Once you discover the major symptoms, this table can quickly direct you to the most likely problem area. However, don't automatically replace the suggested modules until you've studied the problem and checked related details in the troubleshooting flowcharts.

Table 2-3 Module-Level Troubleshooting Quick Reference Guide

Symptom	Terminal PCB	CRT/Yoke	Possible Problem Area				Adjustment	Test Conn.
			Keyboard Cable	Setup Parameter	Comm. Cable			
No video	■	■					■	
Poor display	■						■	
Fails diagnostic test	■							■
No keyboard response	■		■	■	■			
Communication problems/host	■			■	■			

Table 2-4 provides suggestions for actions to take depending on the symptom exhibited. The flowcharts (Figures 2-1 through 2-13) give detailed directions and waveforms, where applicable, for corrective actions.

Table 2-4 Troubleshooting by Symptom

Symptom	Possible Problem Area
Single vertical line on the display	<ol style="list-style-type: none"> 1. Power supply voltages: +5, +12, -12, +15, +30, and +55 2. Dot clock circuitry 3. Custom IC H-Sync 4. Horizontal control circuitry 5. Yoke connection and horizontal signals
Single horizontal line on the display	<ol style="list-style-type: none"> 1. Power supply voltages: +5, +12, -12, +15, +30, and +55 2. Dot clock circuitry 3. Custom IC V-Sync 4. Vertical controller circuitry 5. Yoke connection and vertical signals
No video	<ol style="list-style-type: none"> 1. Power cord, power switch, and fuse 2. Operator brightness and contrast control knobs setting 3. Power supply voltages: +5, +12, -12, +15, +30, and +55 4. Reset circuitry 5. Dot clock circuitry 6. Custom IC H-Sync, V-Sync, video 0, and video 1 7. Horizontal controller circuitry 8. Vertical controller circuitry 9. CRT driver 10. Voltage entering the yoke
Dim video	<ol style="list-style-type: none"> 1. Operator brightness and contrast control knobs setting 2. Power supply voltages: +5, +12, -12, +15, +30, and +55 3. VR204 setting (see Section 3, Adjustments and Alignments) 4. Adjustment of VR402 on the CRT driver (see Section 3, Adjustments and Alignments)
No beep	<ol style="list-style-type: none"> 1. Power cord and switch, fuse 2. +5V and +12V power supply voltages 3. Reset circuitry 4. Beeper circuitry
No keyboard response	<ol style="list-style-type: none"> 1. Power supply voltages: +5, +12, -12, +15, +30, and +55 2. Keyboard connector 3. Custom IC U4 4. Keyboard buffer U13 5. Keyboard PCB 6. 8032 IC U6
Raster but no video	<ol style="list-style-type: none"> 1. Operator brightness and contrast control knobs setting 2. Power supply voltages: +5, +12, -12, +15, +30, and +55 3. Custom IC video signal 4. CRT driver IC301 and Q402
Communication problems	<ol style="list-style-type: none"> 1. Power cord and communications cables 2. Setup information incorrect for the host computer's requirements 3. Run the diagnostic test and look for error codes
Vertical linearity	<ol style="list-style-type: none"> 1. Power supply voltages: +5, +12, -12, +15, +30, and +55. 2. Custom IC V-Sync 3. Vertical adjustment VR303* 4. Vertical controller circuitry*

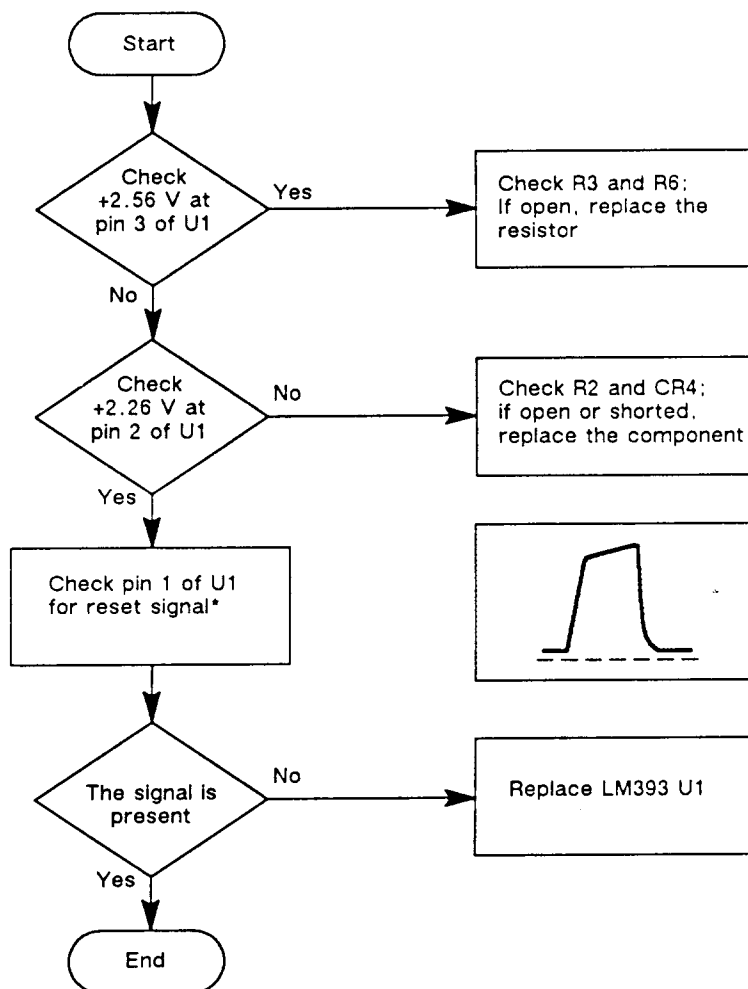
* See Table 3-2 for an illustration of this problem area.

**TROUBLESHOOTING
FLOWCHARTS**

Match the problem symptom with the suggested solutions in the troubleshooting flowcharts (Figures 2-1 through 2-13). The schematics in Section 6 will help you interpret the flowcharts.

- ☐ **Note** All flowcharts are based on terminal operation in 60-Hz mode.

Figure 2-1 Reset Circuitry IC U1
Flowchart



* This signal is only generated at power on. To observe it, set your oscilloscope to a very slow sweep rate (5 ms/sweep), put a probe on Pin 1, then turn on power. Observe a ≈ 1 ms pulse.

Figure 2-2 Beeper Circuitry Flowchart

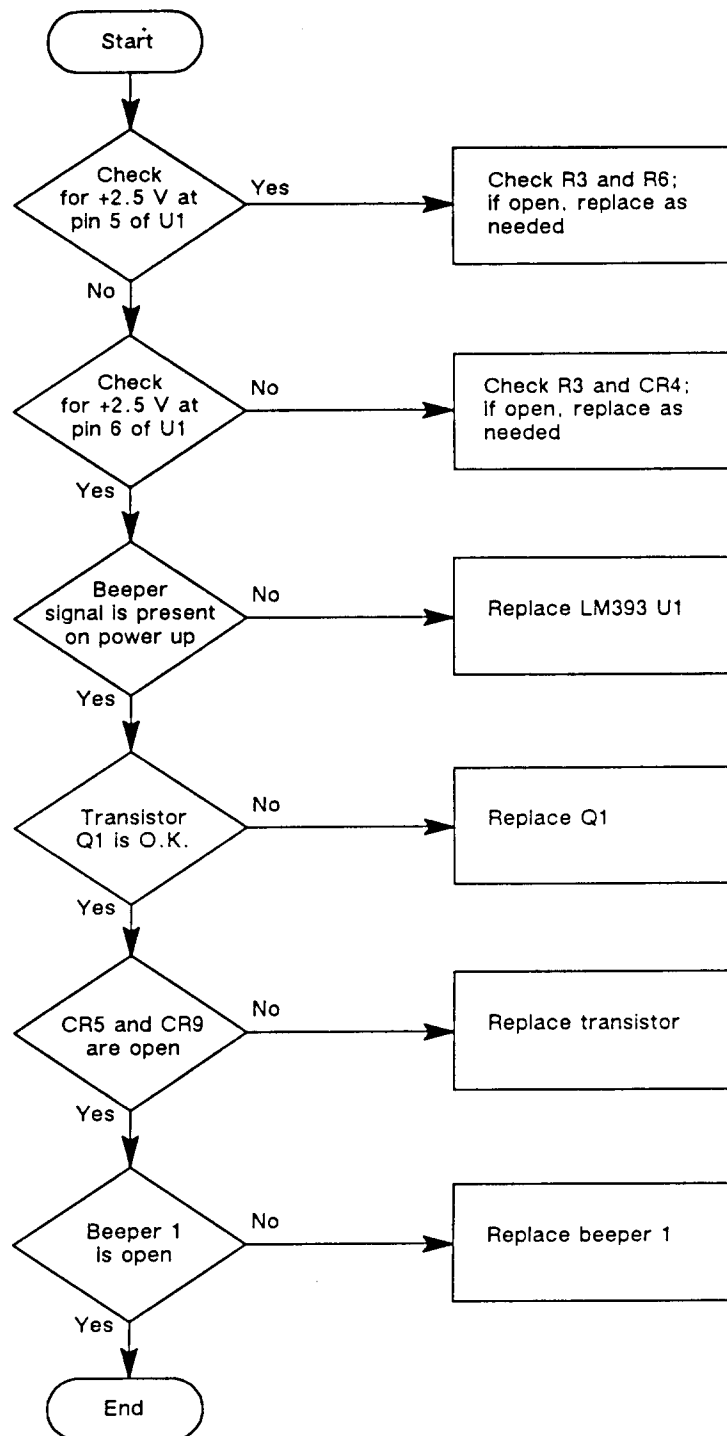


Figure 2-3 8032 IC U6
Flowchart

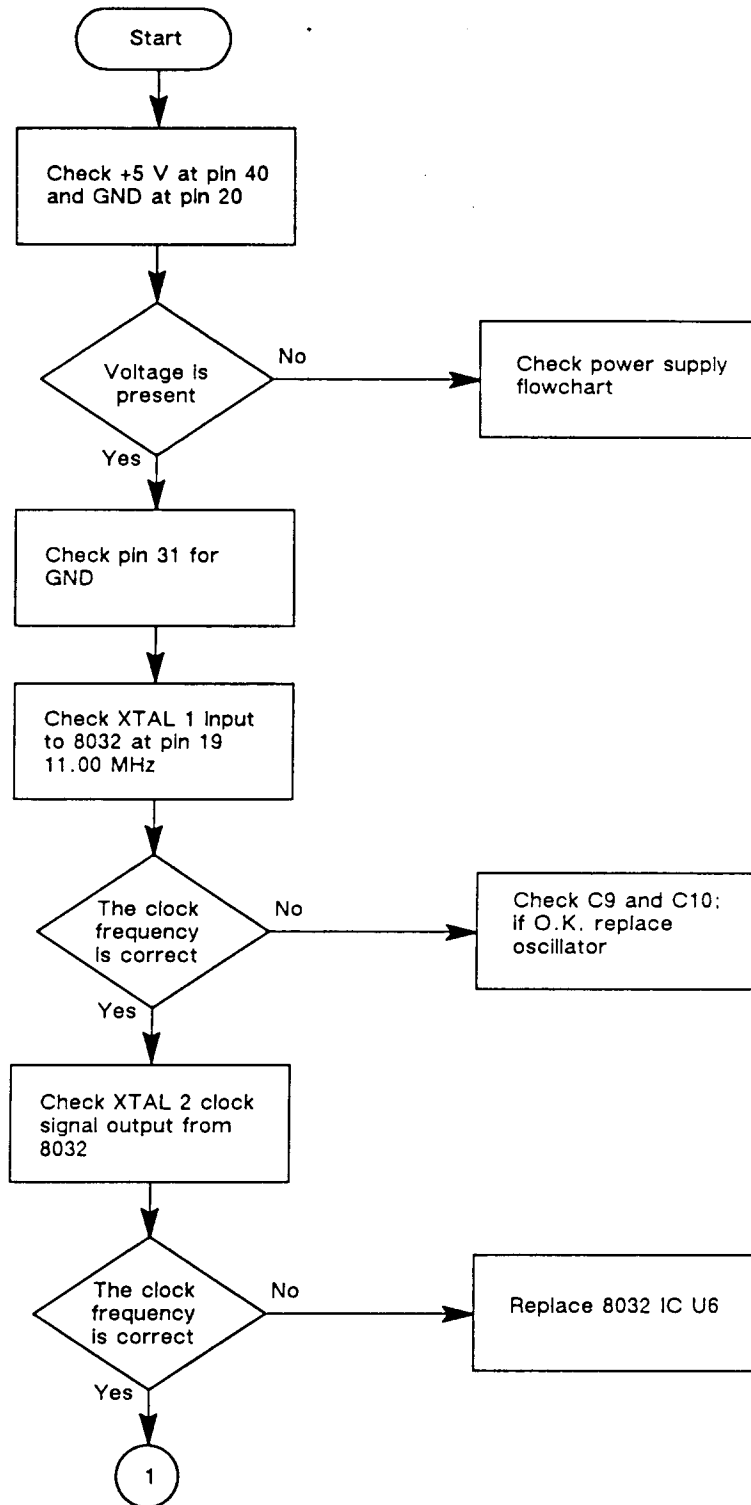


Figure 2-3 8032 IC U6
Flowchart, Continued

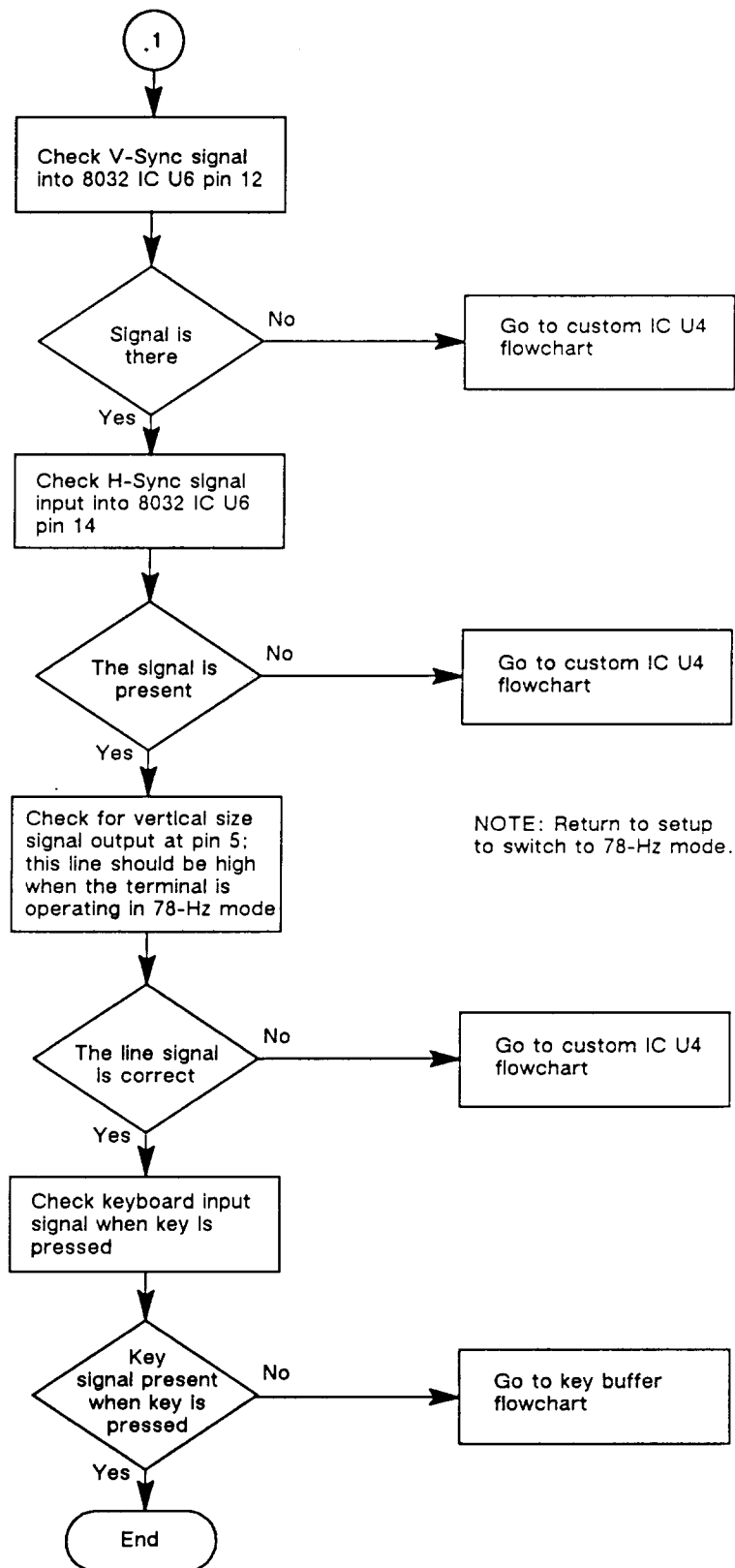


Figure 2-4 Dot Clock IC U8
Flowchart

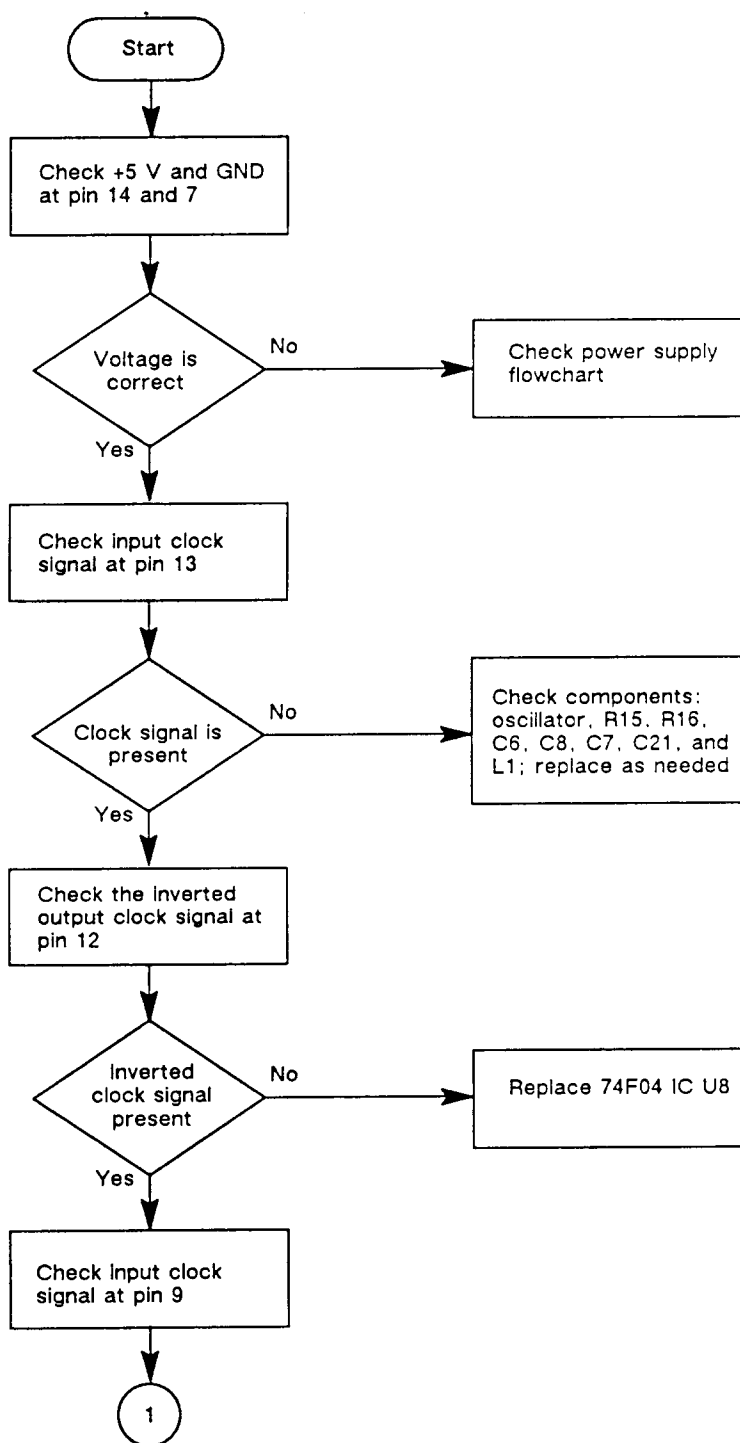
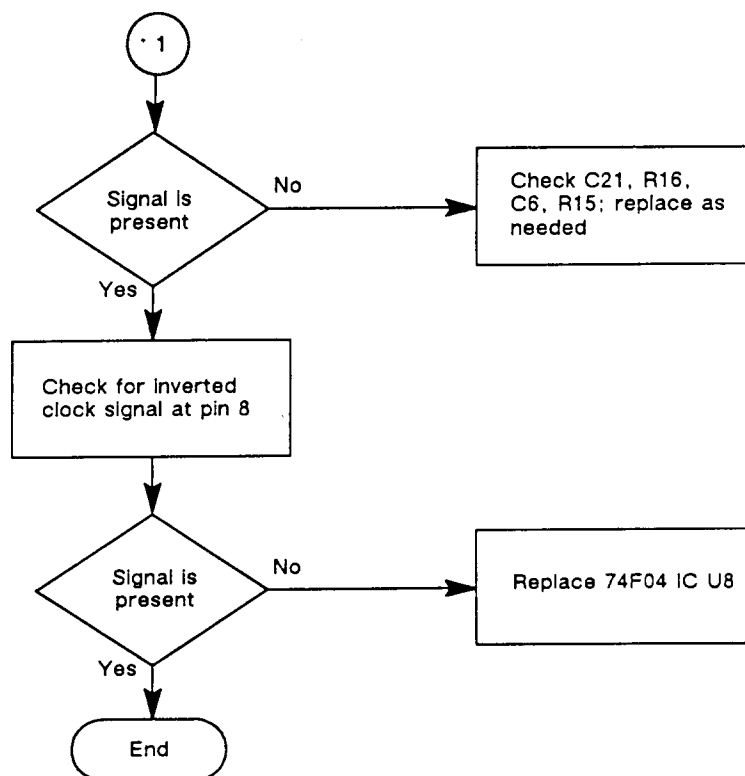
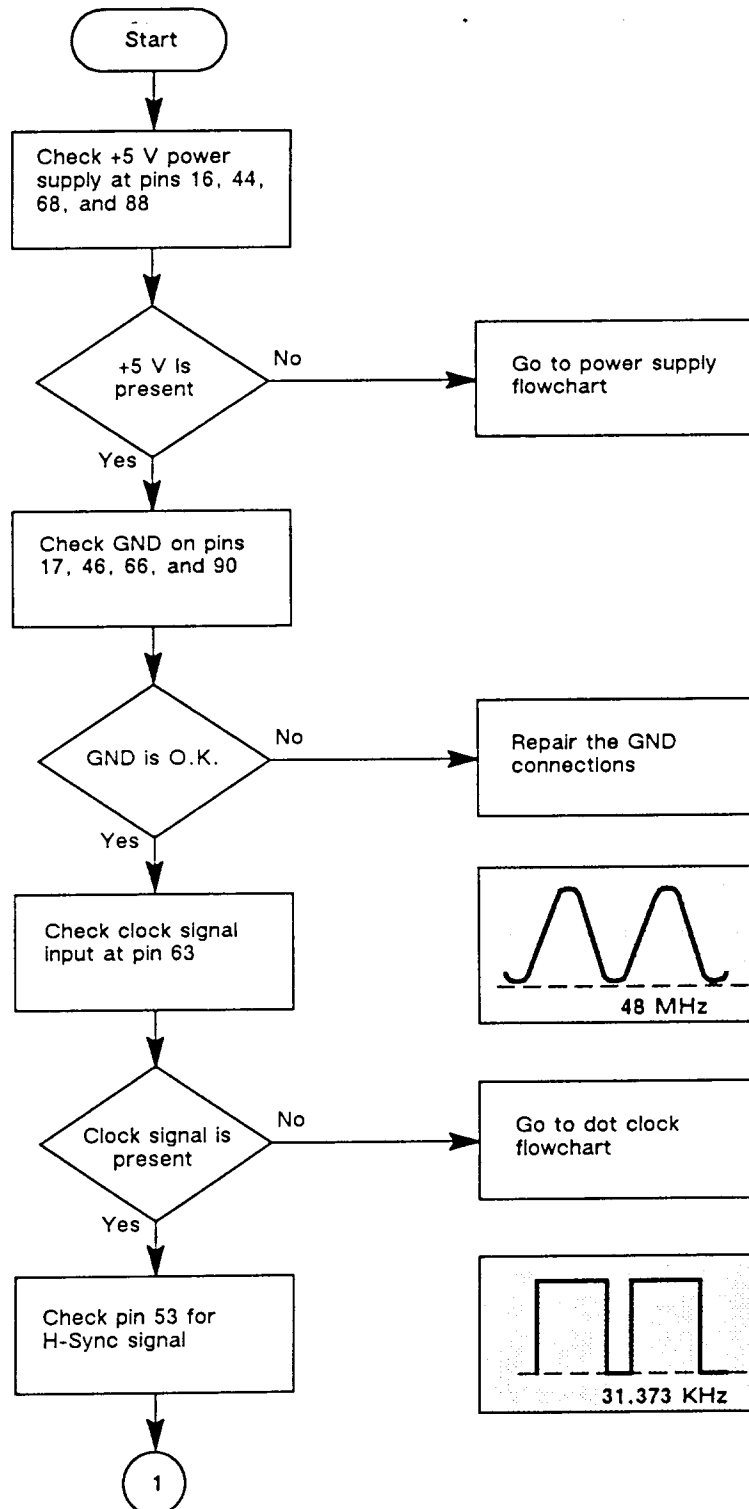
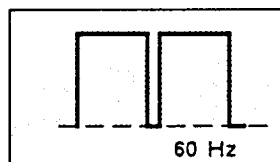
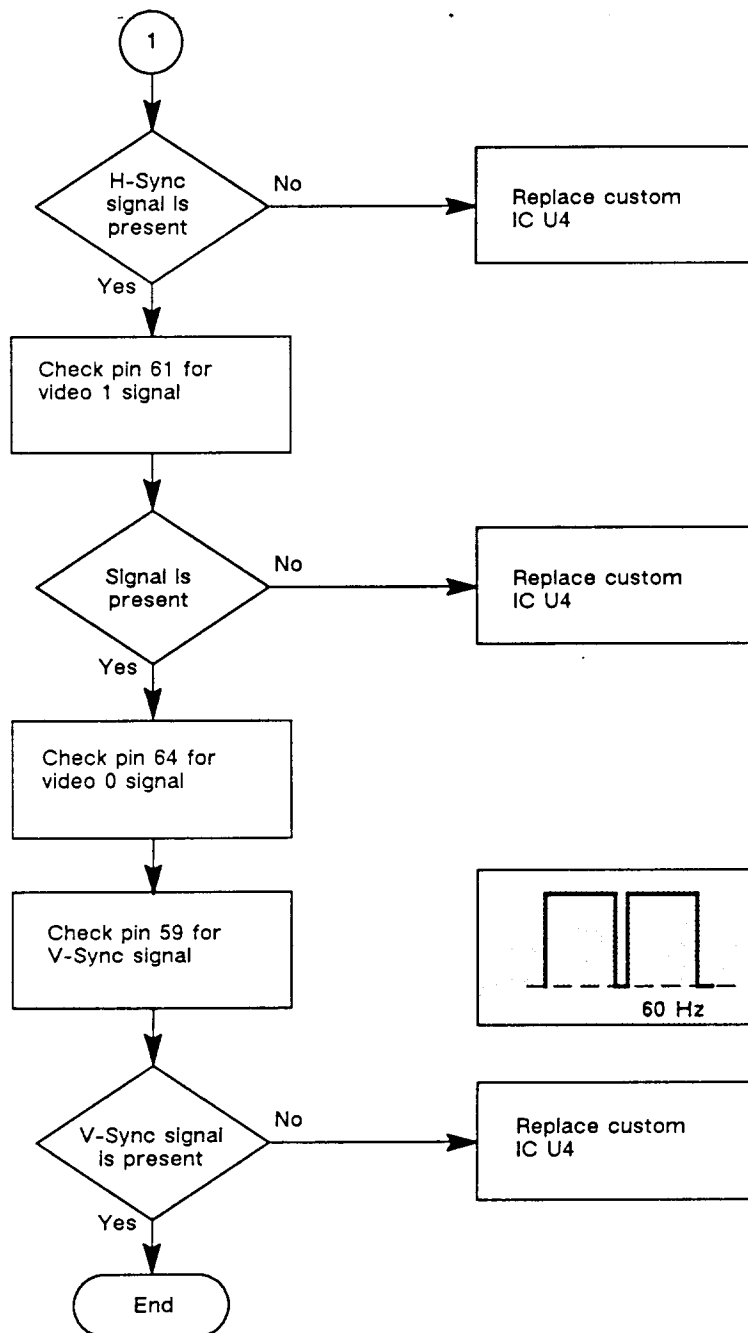


Figure 2-4 Dot Clock IC U8
Flowchart, Continued



**Figure 2-5 Custom IC U4
Flowchart**

NOTE: If the frequency is incorrect, see the 8032 IC U6 flowchart.

**Figure 2-5 Custom IC U4
Flowchart, Continued**

NOTE: If the frequency is incorrect, see the 8032 IC U6 flowchart.

Figure 2-6 Key Buffer IC U13
Flowchart

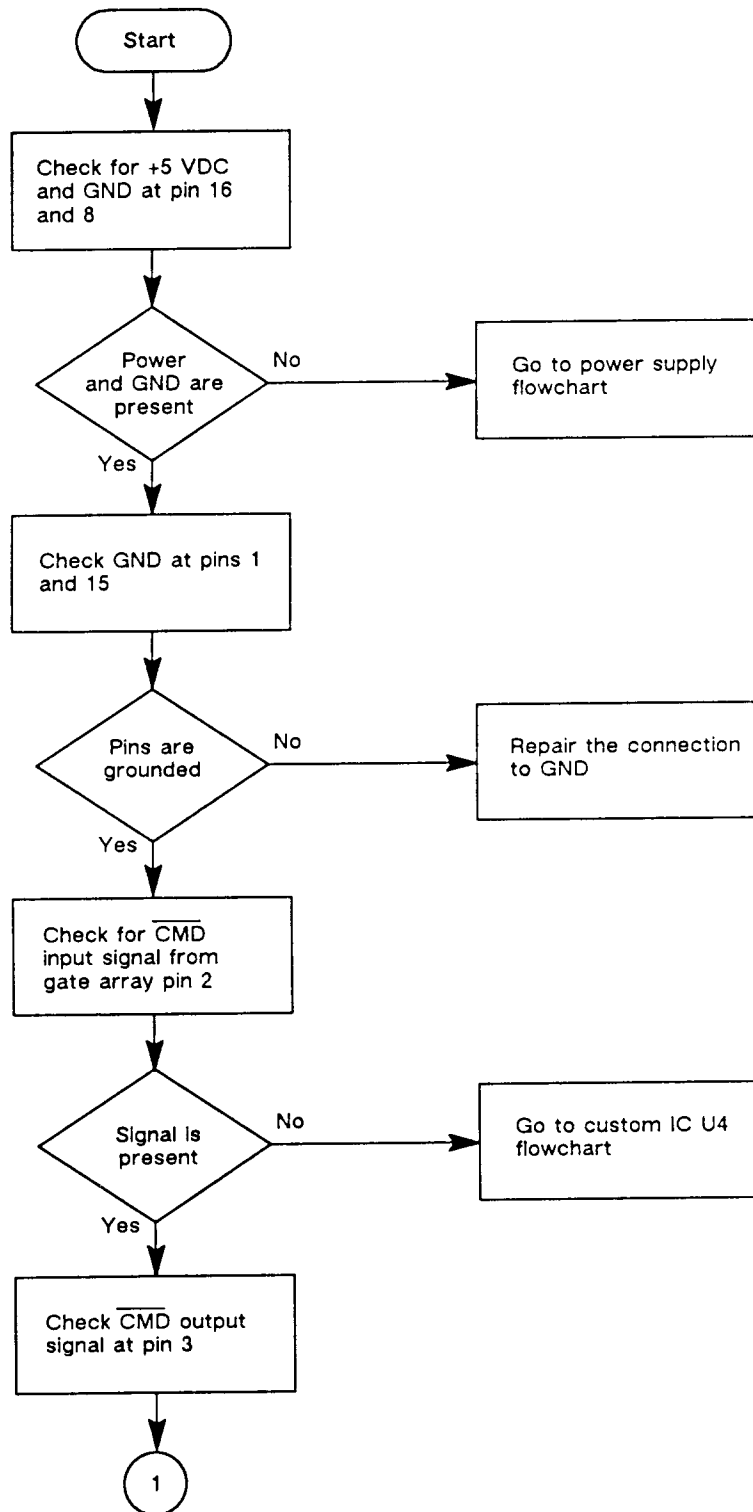


Figure 2-6 Key Buffer IC U13
Flowchart, Continued

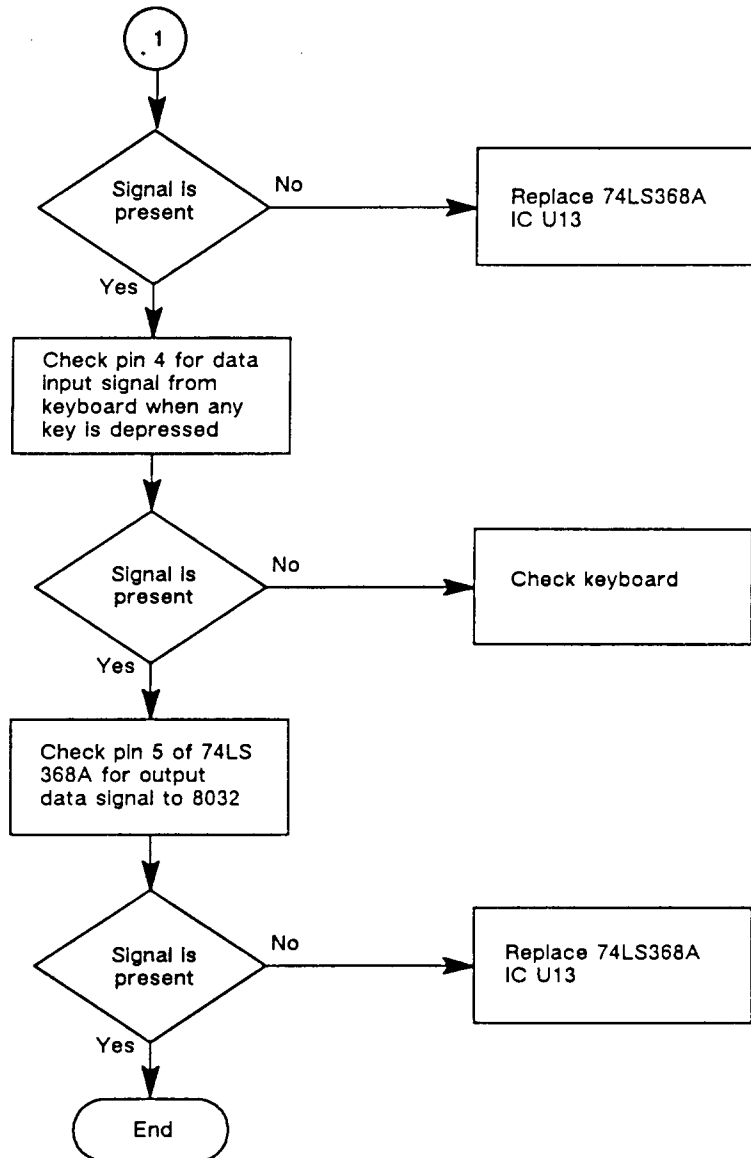
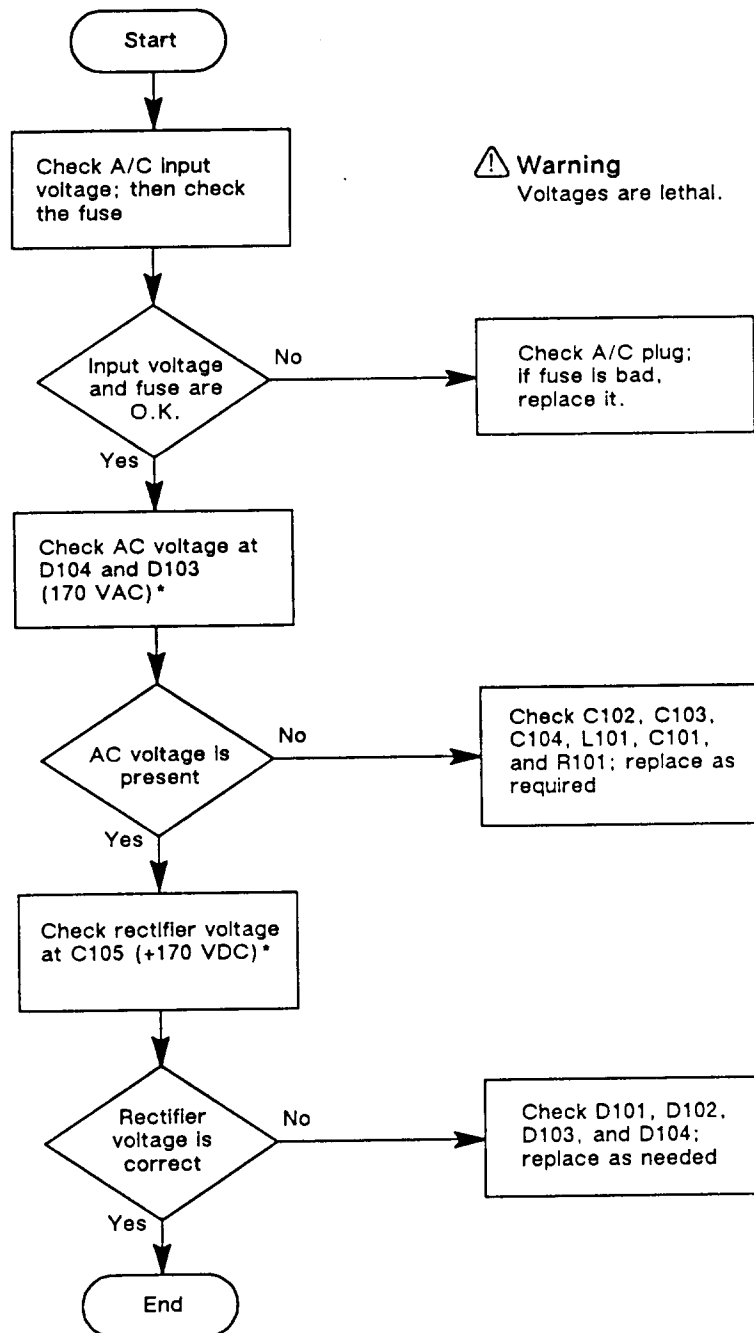
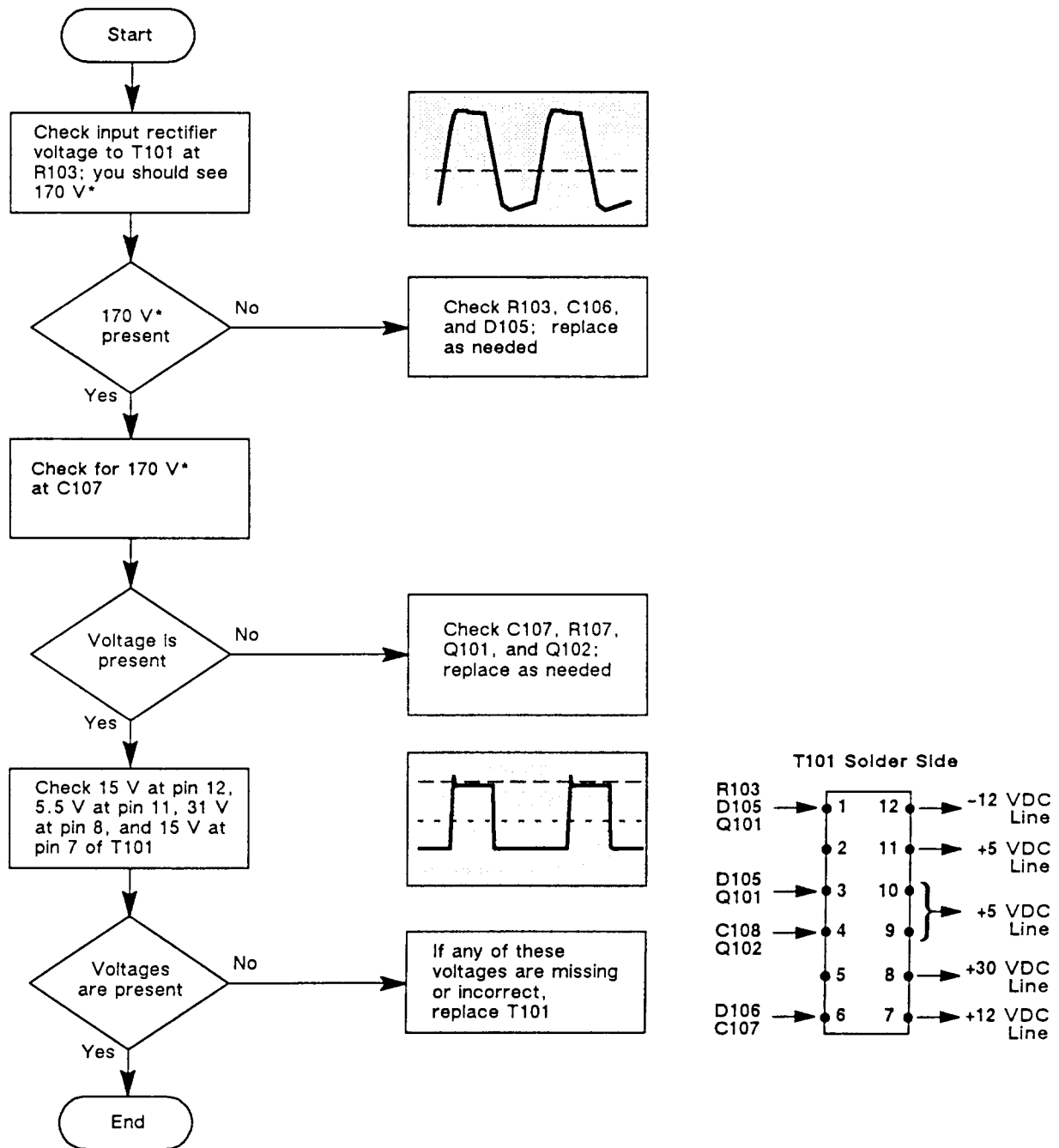


Figure 2-7 Power Supply Line
Filter Flowchart



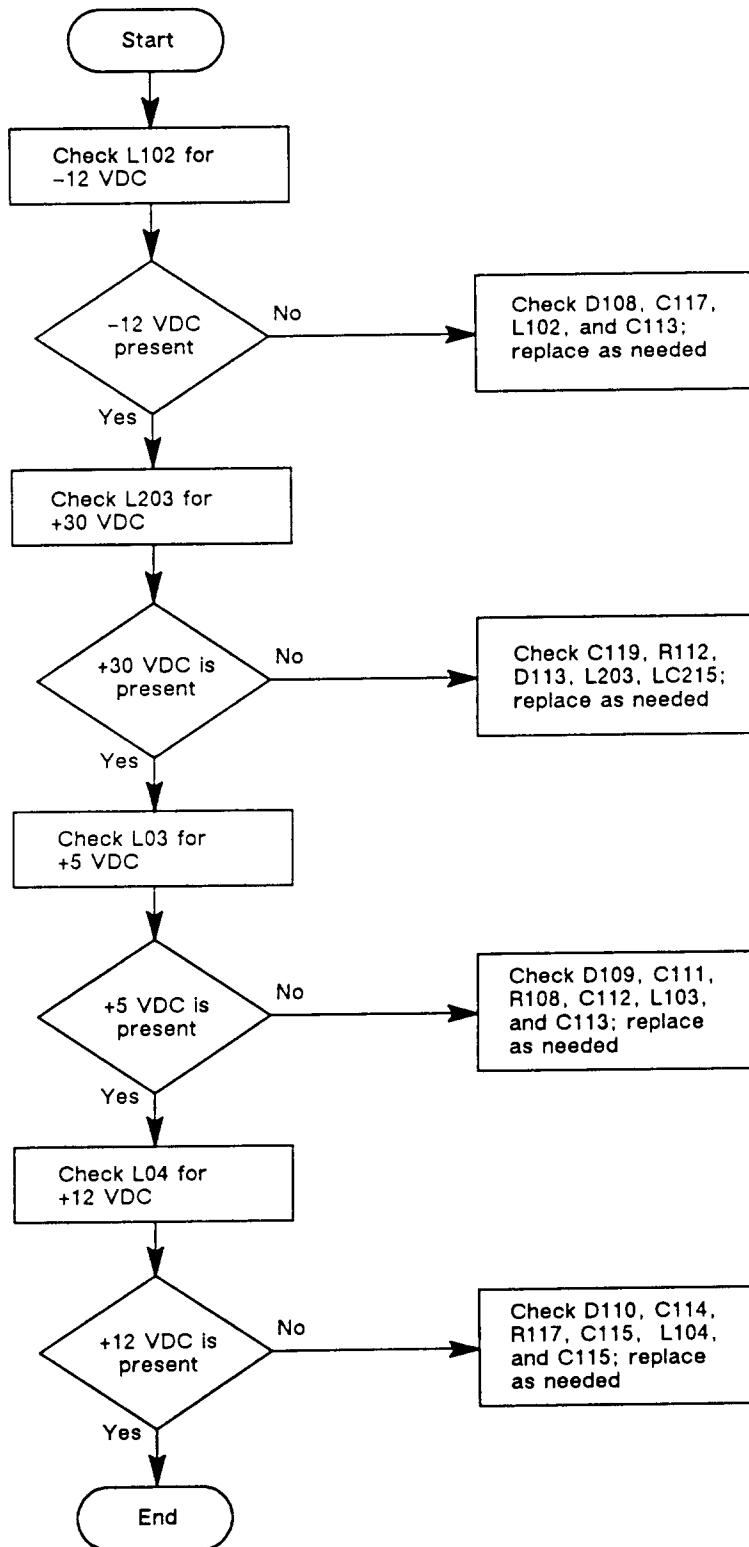
*310 V for 220 V model

Figure 2-8 Transformer Flowchart



* 310 V for 220 V model

Figure 2-9 Power Supply Flowchart



Power Supply Test Points

Voltage	Location
+5.0	C113
+12.0	R110
-12.0	C118
+30.0	R115
+15.0	C116
+55.0	R224

VR 101 will adjust +5.0 Volts and +30.5 Volts

Figure 2-10 Horizontal Controller
IC 201 Flowchart

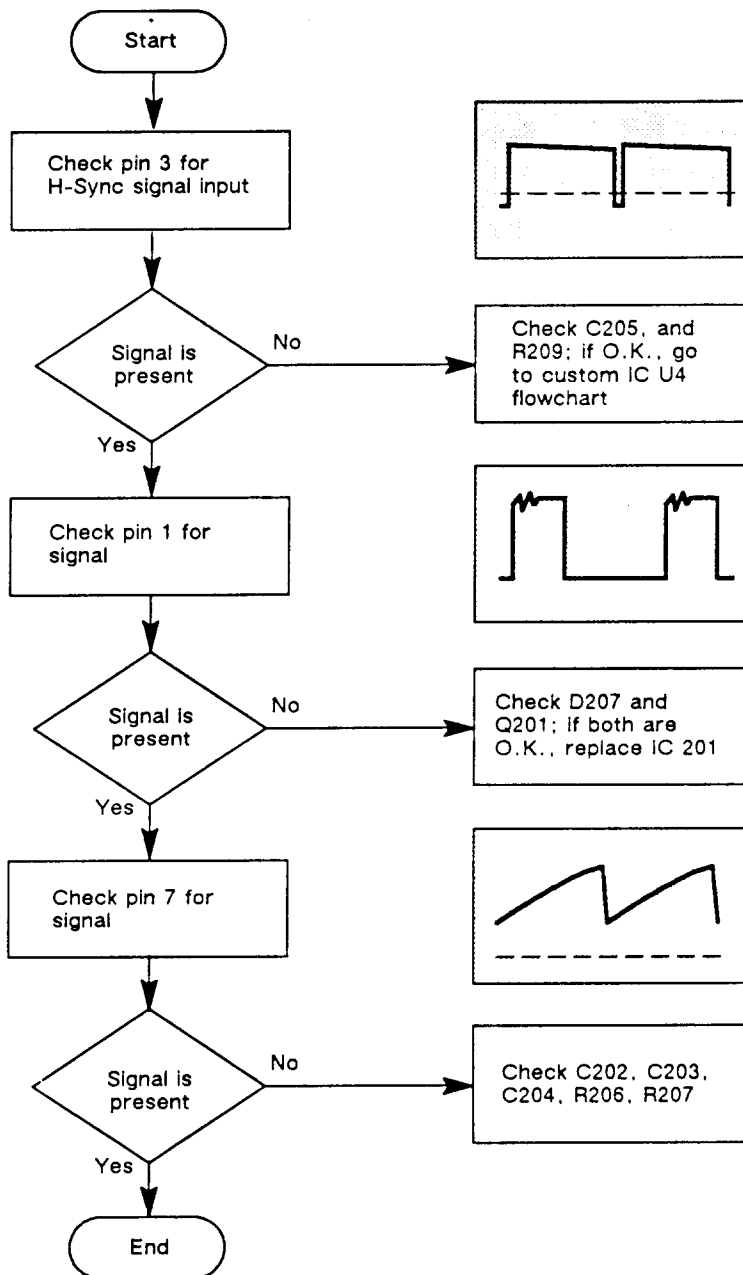


Figure 2-11 Vertical Controller
IC 301 TDA 1170 Flowchart

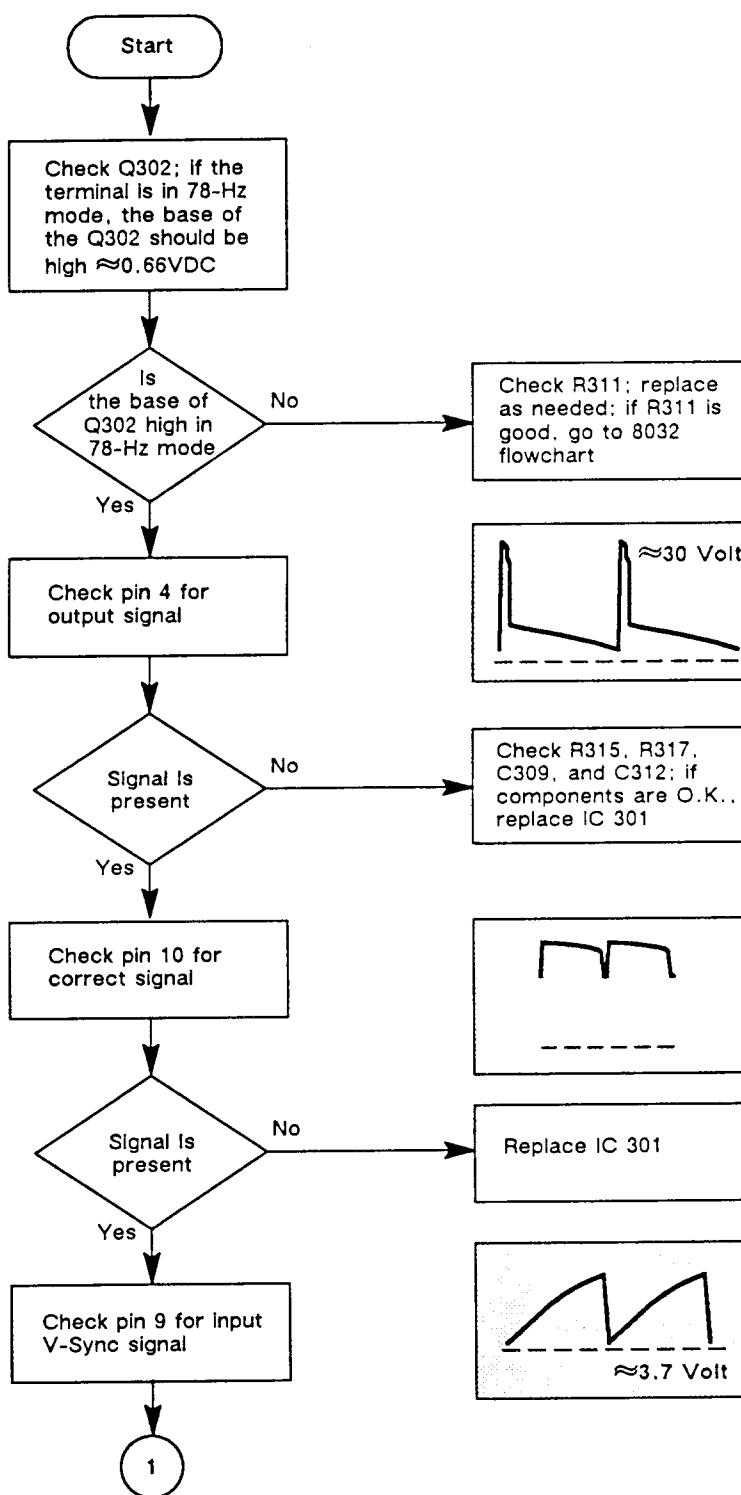


Figure 2-11 Vertical Controller
IC 301 TDA 1170 Flowchart,
Continued

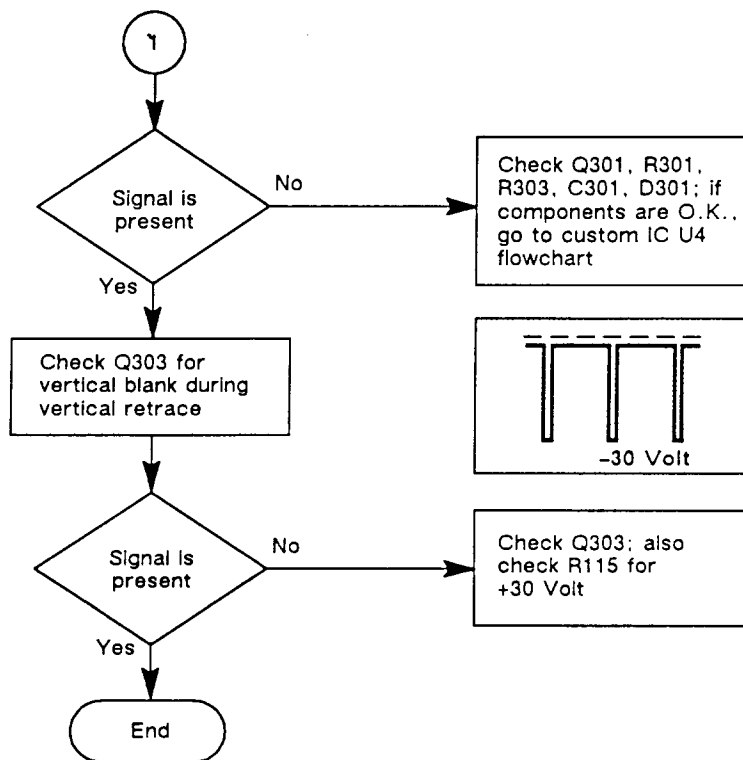
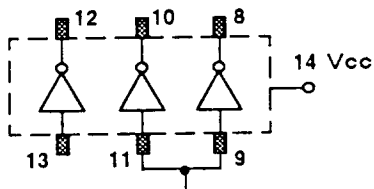
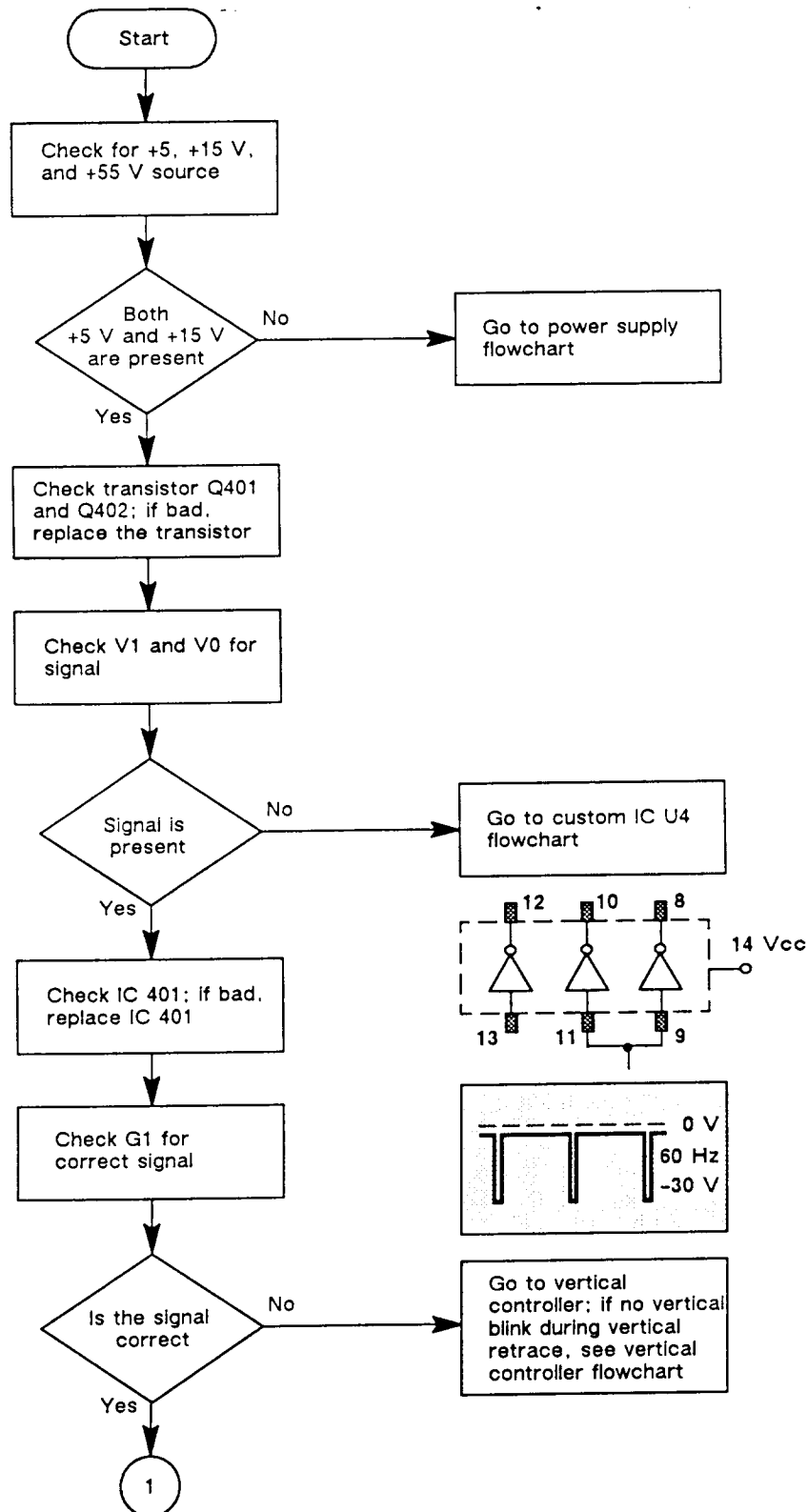


Figure 2-12 CRT Driver Flowchart



V1	V0	Video
0	0	Off
0	1	Dim
1	0	Normal
1	1	Bright

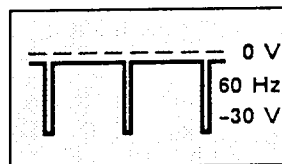


Figure 2-12 CRT Driver
Flowchart, Continued

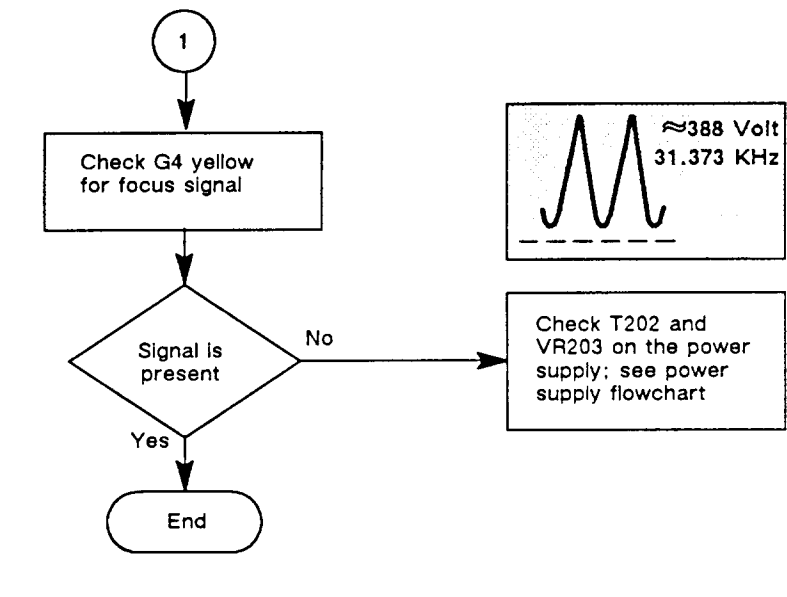
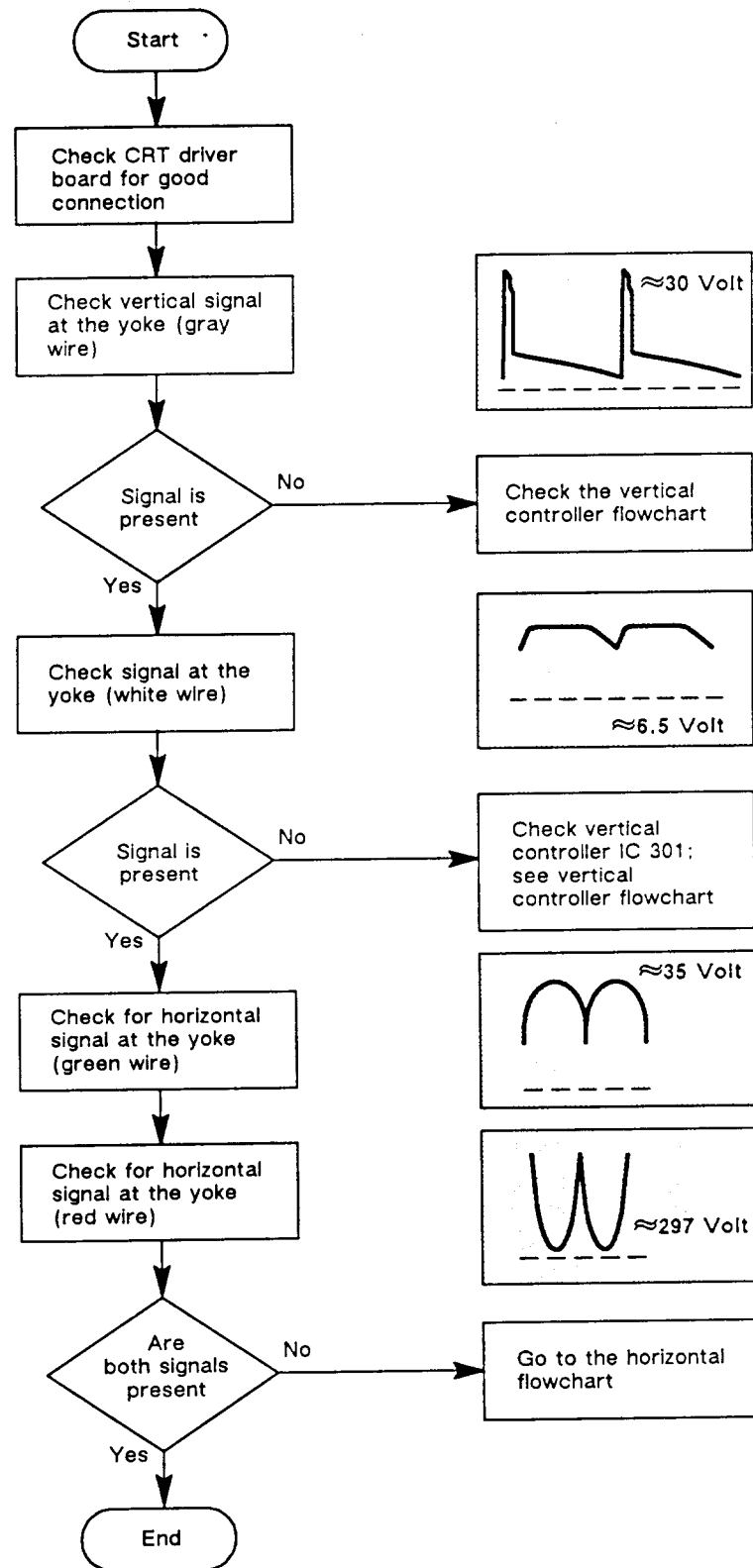


Figure 2-13 CRT Flowchart



3

Adjustments and Alignments


OVERVIEW

This section describes adjustments and alignments for the terminal in the higher-resolution 60-Hz mode (instructions are given for doublechecking in 78-Hz mode). In particular, this section discusses voltage adjustments, full terminal alignment, and individual adjustments. Before you align the terminal, check if the display meets the specification. If it doesn't, follow the set of instructions in the alignment section. You should complete a full terminal alignment whenever you replace the terminal printed circuit board (PCB) or the cathode ray tube (CRT)/yoke assembly.

Safety Summary

This terminal contains high voltage. Don't attempt to service the terminal without taking the following precautions:

- Turn the terminal off and disconnect the power cable.
- Remove jewelry from your hands and wrists.
- Avoid wearing clothing made of synthetic fabrics.
- Use insulated or nonconductive tools.
- Handle circuit boards only by their edges.
- Don't reconnect the power cable or turn the terminal on unnecessarily while the top cover is removed.
- Whenever you connect or disconnect the anode from the anode lead, make sure to discharge the anode as directed in Section 1.

 **Warning** The CRT/yoke assembly has high voltages. Only qualified service personnel should adjust it.

- If you need to remove or replace the CRT/yoke assembly, remember that it can implode if you drop it or break the neck. The flying glass can injure anyone within a radius of ten feet.
- Always use the manufacturer's replacement components. Especially critical components as indicated on the circuit schematics should not be replaced with any component other than the manufacturer's. Where a short circuit has occurred, replace those components that indicate evidence of overheating.

Required Tools

We recommend that you have at least the following tools available before testing the power supply voltages or making any adjustments to the terminal display:

- Flat-blade nonconductive alignment tool
- No. 2 Phillips screwdriver

- Digital voltmeter (DVM)
- Millimeter ruler or reticle (See Appendix A for instructions on how to use the reticle when you check the display.)
- Loopback diagnostic test connectors (provided at the back of this maintenance manual)

SETTING UP THE TEST PATTERNS

- 1 Turn off the terminal. Unplug it from its AC power source, and disconnect any communications cables.
- 2 Attach loopback diagnostic test connector LB1 to the MAIN port and the EVEN loopback diagnostic test connector to the AUX1 port on the terminal's rear panel. Loopback connector pin numbers and signals for the ports are shown in Table 3-1.

Table 3-1 Loopback Test Connector Pin Assignments

Loopback Port	Pin	Signal
MAIN	2-3	TXD → RXD
	4-5	RTS → CTS
	8-20	DCD → DTR
AUX1 (Even Parallel)	2-10	D0 → ACK
	4-11	D2 → BUSY
	6-12	D4 → PE
	8-15	D6 → ERROR
	1-LED-17	STB → Ground
AUX1 (Odd Parallel)	3-10	D1 → ACK
	5-11	D3 → BUSY
	7-12	D5 → PE
	9-15	D7 → ERROR
	1-LED-17	STB → Ground

- 3 Plug in the terminal and turn it on. Let the terminal run for 30 minutes to ensure display stability and to prevent distortion.

The test screen alternates between a "walking" RAM character pattern and a "walking" attribute pattern.

- ☐ **Note** If the terminal emits a beep and displays an error code, turn to Section 2, "Troubleshooting," for an interpretation of the error codes and more instructions.

- 4 Press **[Spacebar]** to bring up the "m" test pattern.
- 5 Press **[Ctrl]** and **[A]** simultaneously to bring up the pincushion test pattern.
- 6 Simultaneously press **[Ctrl]** and **[S]** to toggle the refresh rate between 60 Hz and 78 Hz.

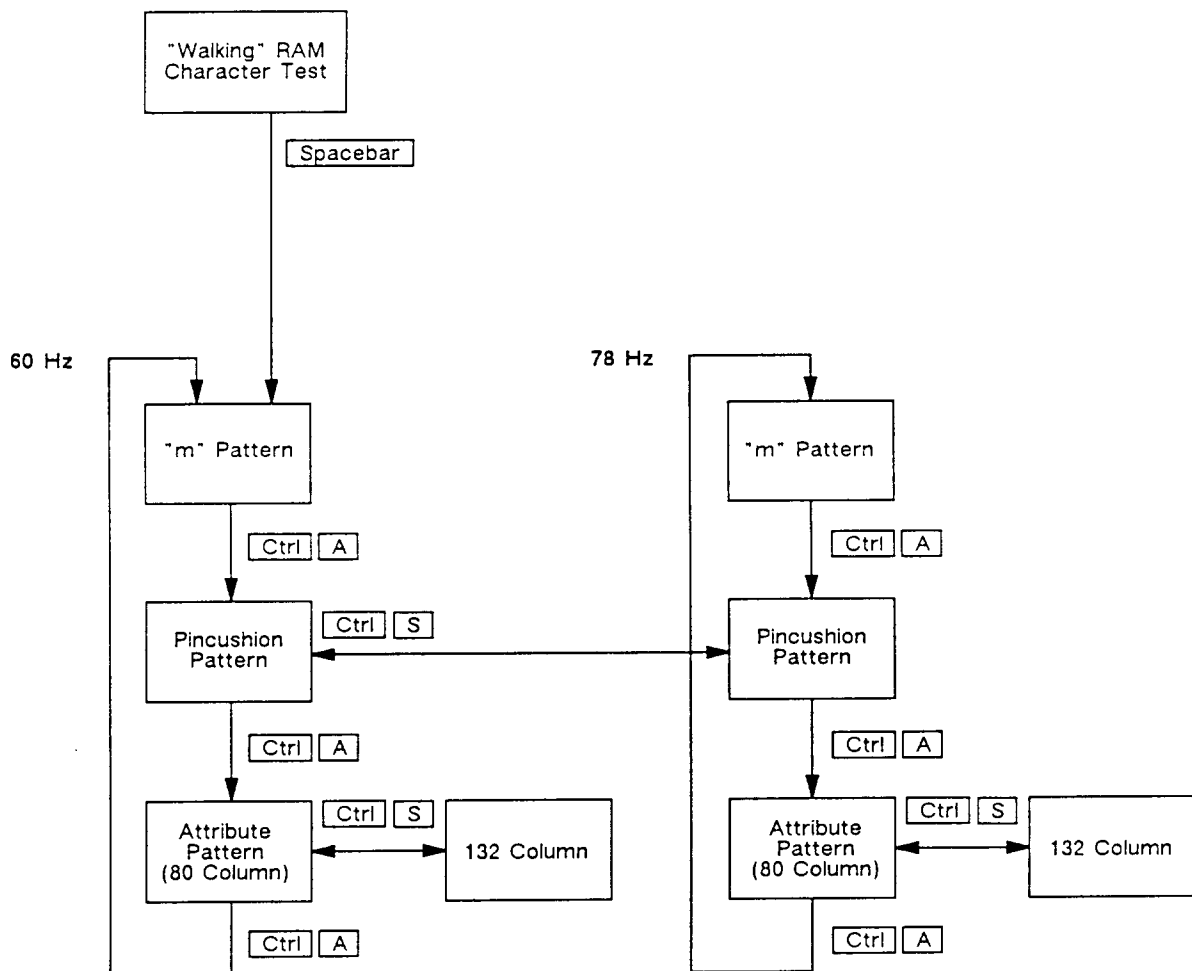
- ☐ **Note** The **[Ctrl]** **[S]** key sequence for 60/78-Hz mode switching works with the pincushion test screen only. Simultaneously pressing **[Ctrl]** and **[A]** displays the next test pattern.

- 7 Call the font size/character attribute test pattern by simultaneously pressing **Ctrl** and **A**.
- 8 Press **Enter** to return to the "walking" RAM character test screen.

Figure 3-1 shows the test pattern sequence for both 60-Hz and 78-Hz modes.

Figure 3-1 Test Pattern Sequence

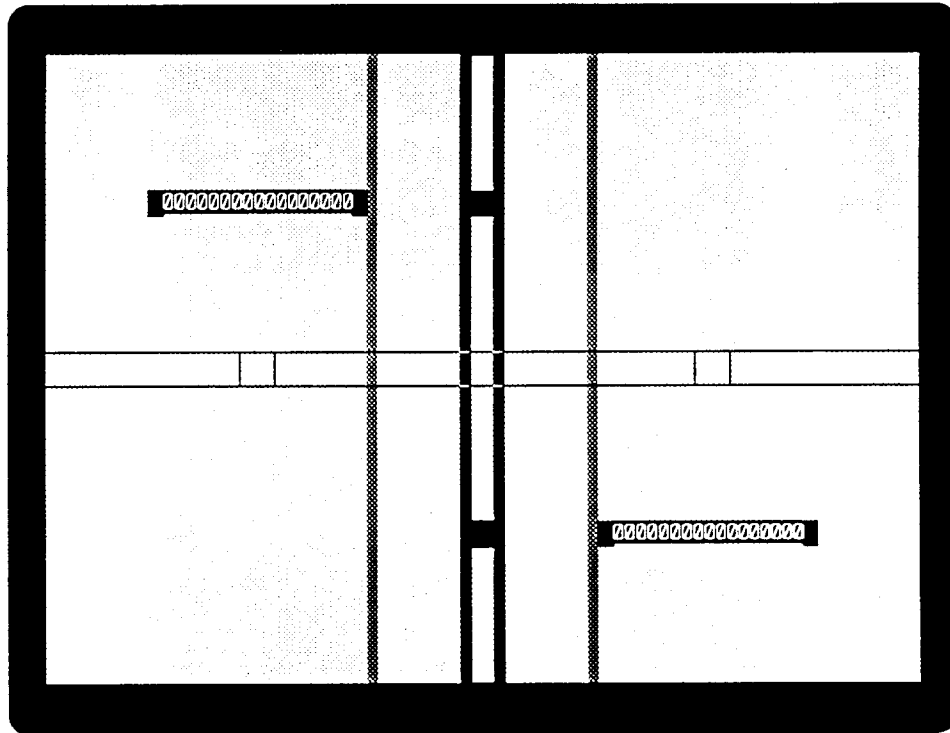
SELF TEST



CHECKING THE DISPLAY SPECIFICATION

- 1 Bring up the pincushion test pattern (Figure 3-2). For instructions, see "Setting Up the Test Patterns."
- 2 Measure the margins on the top, bottom, and both sides of the pincushion test pattern. Each margin should measure 11 mm \pm 2 mm. If you have a reticle, see Appendix A for instructions.

Figure 3-2 The Pincushion Pattern Test Screen



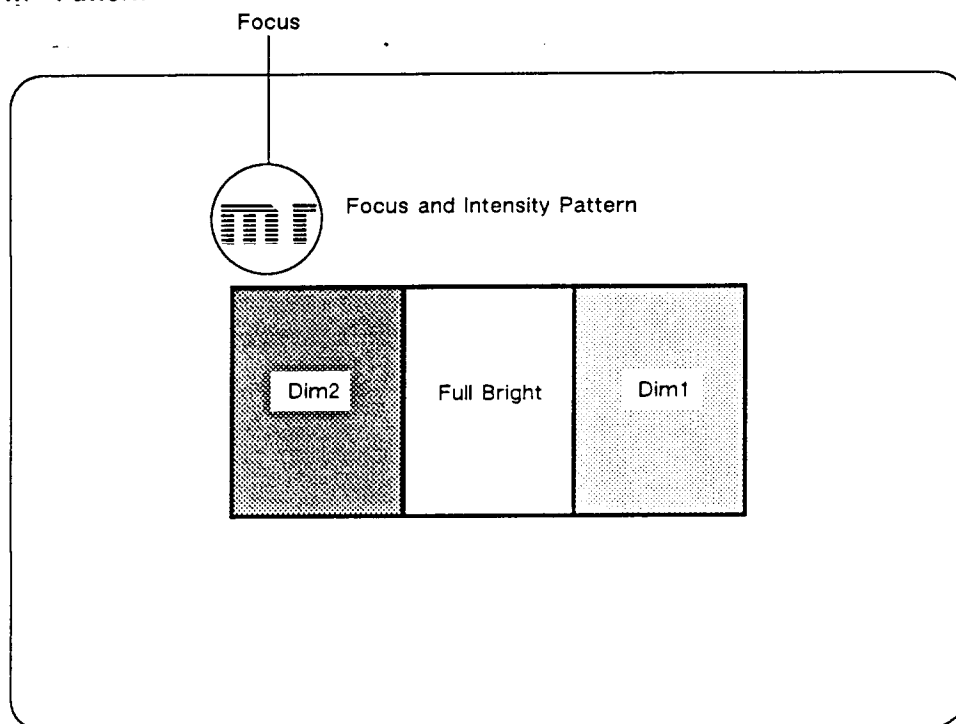
- 3 Check that the display lines are straight across the screen. If the lines aren't straight, go to the display magnets adjustment instructions in this section.
- 4 Bring up the "m" test pattern on the screen (Figure 3-3). Make sure the characters at the top of the screen are the same size as those at the bottom of the screen. If they aren't the same size, turn to the vertical linearity adjustment instructions in this section.
- 5 Check the brightness and contrast blocks for correct balance.

ALIGNING THE TERMINAL DISPLAY

The monitor has several alignments and adjustments. If the terminal display is out of tolerance in one or two areas, correct those problems with the individual adjustments suggested. If you change the CRT, yoke, or terminal PCB, you must perform a full alignment. *Follow these procedures only if the display is out of tolerance and doesn't match the specification.*

- 1 Turn off the terminal. Unplug it from its AC power source, and disconnect any communications cables.
- 2 Remove the terminal enclosure.
- 3 Attach the loopback diagnostic test connectors to the terminal communications ports on the rear panel of the terminal.

Figure 3-3 The "m" Pattern Test Screen



- 4 Plug in the terminal and turn it on. Let the terminal run for 30 minutes to warm up.
- 5 Select the higher-resolution 60-Hz mode for testing, then toggle to the 78-Hz mode (simultaneously press **Ctrl** **S**) from the pincushion pattern to doublecheck the adjustments. For instructions, see "Setting Up the Test Patterns."
- 6 Bring up the pincushion test pattern (see "Setting Up the Test Patterns").

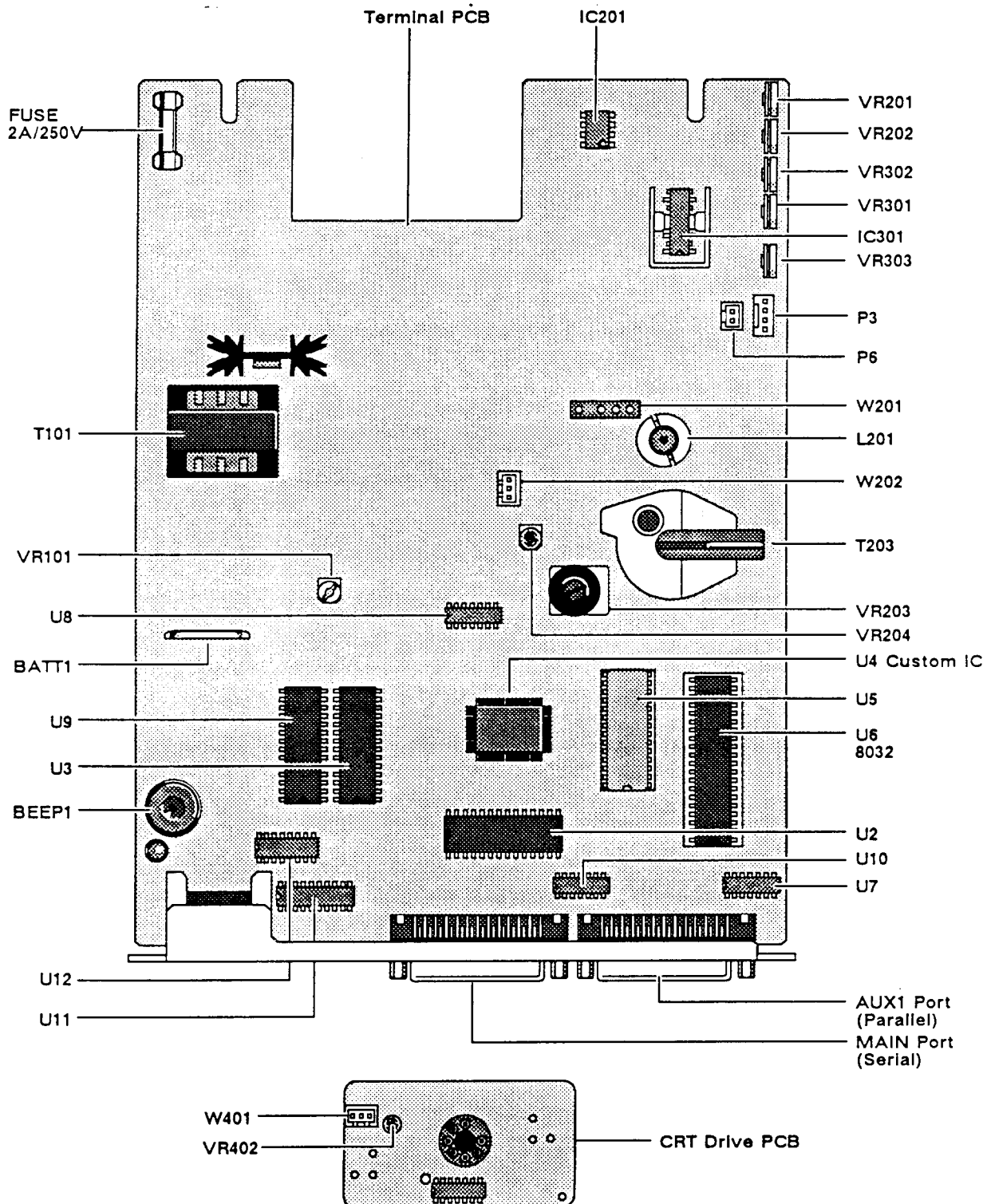
ADJUSTING THE VOLTAGE

☐ **Note** To save time and effort, it's important to adjust the voltage to the correct level before performing any other alignments.

Check the +30.5VDC ± 2 percent at R115 and ± 5 VDC ± 2 percent at R114 (Figure 3-4). If the voltage is not correct, adjust VR101. If the voltage will not adjust satisfactorily, see the power supply troubleshooting flowchart in Section 2.

Figure 3-4 shows the location of the terminal PCB components.

Figure 3-4 Component Locations
on the Terminal PCB



**ADJUSTING THE TERMINAL
DISPLAY**

Instructions are provided adjacent to each drawing in Table 3-2 for adjustments to the terminal display.

Table 3-2 Display Adjustment Quick Reference Guide

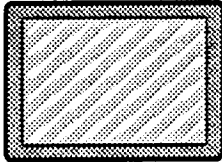
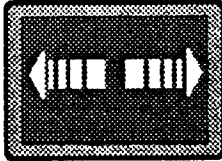
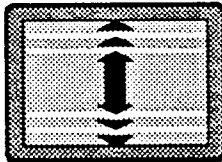
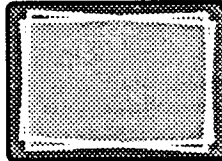
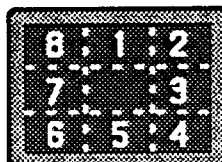
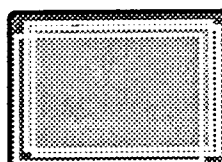
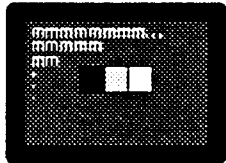
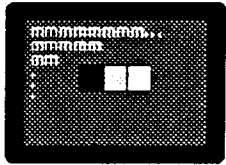
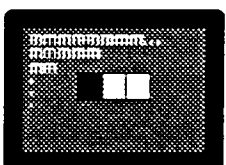
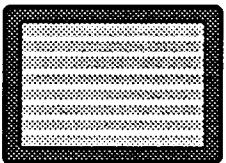
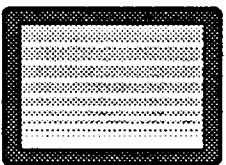
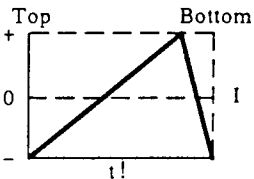
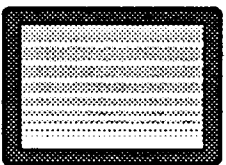
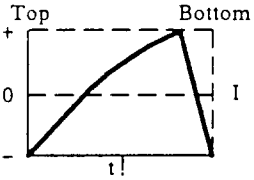
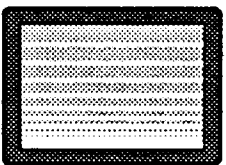
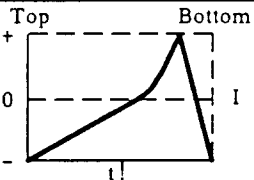
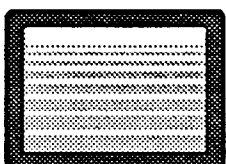
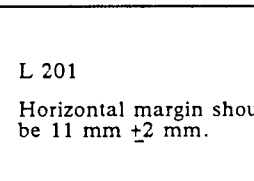
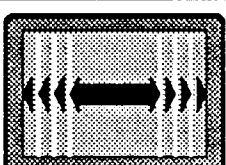
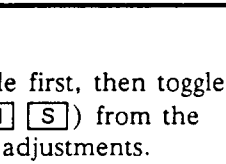
Adjustment	Component	Display
Voltage Adjustment	VR 101	+30.5 VDC \pm 2% + 5.0 VDC \pm 2%
Horizontal Hold	VR 201	
Horizontal Phase	VR 202	
Vertical Size	VR 302	
78 Hz Size	VR 301	
Display Rotation	Rotate the yoke. NOTE: Do not tighten the yoke lock too tightly or the CRT may break.	
Quadrant Adjustment	Rotate the display magnets to adjust the corresponding display quadrant.	
Centering the Display	Rotate the centering rings. Margin should be 11 mm \pm 2 mm on all sides.	

Table 3-2 Display Adjustment Quick Reference Guide, Continued

Adjustment	Component	Display
Sub-Brightness	VR 204	
Sub-Contrast	VR 402	
Focus	VR 203	
Vertical Linearity	VR 303	
Check the following possible problem areas:	Vertical Yoke Currents	
1. Power supply voltage +5, +12, -12, +15, +30, and +55		
2. Custom IC U4 V-Sync		
3. Vertical linearity adjustment VR 303		
4. Vertical controller circuitry		
Horizontal Size	L 201 Horizontal margin should be 11 mm \pm 2 mm.	

☐ **Note** Make adjustments in 60-Hz mode first, then toggle to 78-Hz mode (simultaneously press **Ctrl** **S**) from the pincushion pattern to doublecheck the adjustments.

Vertical Size	<p>The vertical size adjustment potentiometers are labeled VR301 and VR302 on the terminal PCB (Figure 3-4). With the terminal in 60-Hz mode (10x16 character cell), simultaneously press Ctrl A to display the pincushion test pattern.</p> <p>Adjust the vertical size by following these steps:</p> <ol style="list-style-type: none">1 Turn potentiometer VR302 until the top edge and the bottom edge of the display are both 11 mm \pm2 mm from the edge of the bezel.2 Simultaneously press Ctrl S to toggle to 78-Hz mode (10x13 character cell) pincushion display.3 Adjust VR301 to the same specification as VR302.4 Simultaneously press Ctrl S to toggle back to 60-Hz mode.
Horizontal Hold	<p>Adjust VR201 (Figure 3-4) for minimum horizontal tearing.</p>
Linearity	<p>The linearity adjustment is labeled VR303 on the terminal PCB (Figure 3-4). To adjust the linearity,</p> <ol style="list-style-type: none">1 Display the "m" test pattern.2 Adjust VR303 until characters on the bottom of the display are the same height as those on the top.
Horizontal Size	<p>■ Caution Do not use a metal tool to adjust the width coil. The magnetic properties of a metal tool will affect the adjustment.</p> <p>The horizontal size adjustment is labeled L201 on the terminal PCB (Figure 3-4). To adjust the horizontal size,</p> <ol style="list-style-type: none">1 Display the pincushion test pattern.2 Adjust L201 until either side of the display is 11 mm \pm2 mm from the edge of the bezel.
Display Rotation	<p>⚠ Warning The CRT/yoke assembly has high voltages. Only qualified service personnel should service it.</p> <p>The yoke lock, located on the neck of the CRT (Figure 3-5), corrects tilt problems (Figure 3-6). To correct tilt problems,</p> <ol style="list-style-type: none">1 Display the pincushion test pattern.2 Loosen the yoke lock thumbscrew on the neck of the CRT.3 Rotate the yoke until the top and bottom edges of the display are level with the top and bottom of the bezel. <p>⚠ Warning Do not tighten the thumbscrew too much or the neck of the CRT will break, and shoot broken glass for a radius of ten feet.</p> <ol style="list-style-type: none">4 Tighten the yoke lock thumbscrew.

Figure 3-5 Yoke Lock, Centering Rings, and Display Magnets

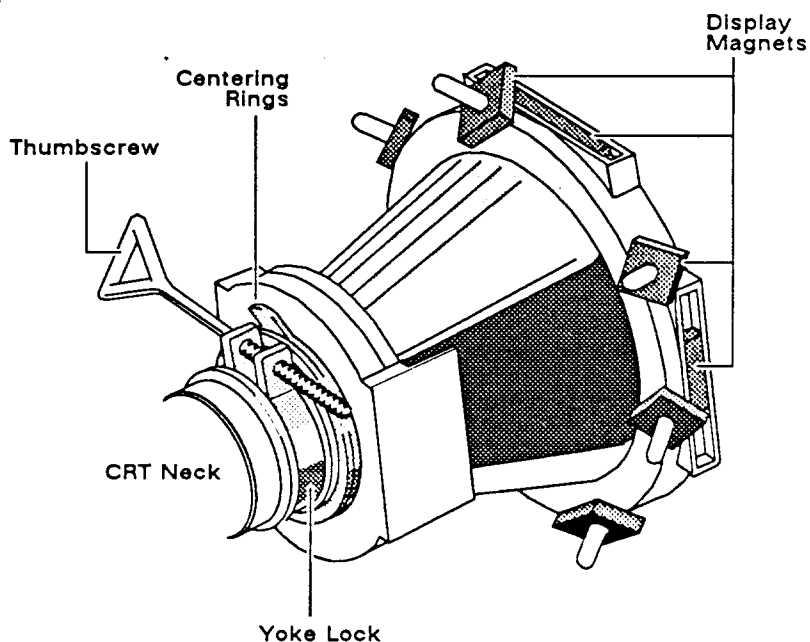
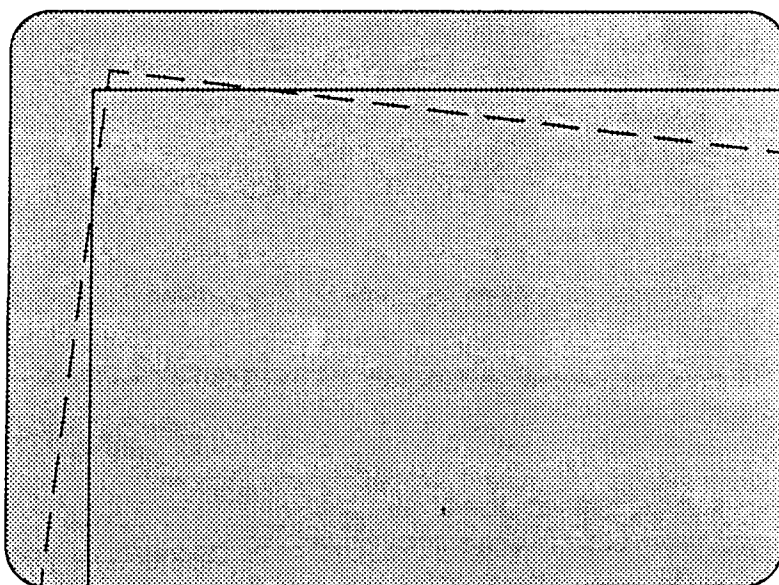


Figure 3-6 Display Tilt



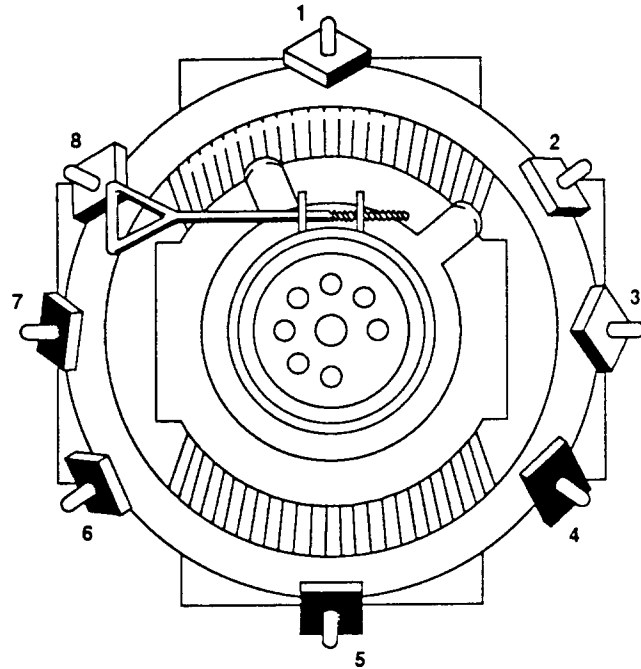
Centering Rings

There are two display centering rings around the yoke (Figure 3-5). When turned, they move the display position on the screen. Gently turn the rings until the display is in the center of the screen.

Display Magnets

There are eight display magnets on a ring around the yoke (Figure 3-7). When turned, they change the corresponding screen area and can also affect adjacent areas (See "Quadrant Adjustment" in Table 3-2).

Figure 3-7 Display Magnets



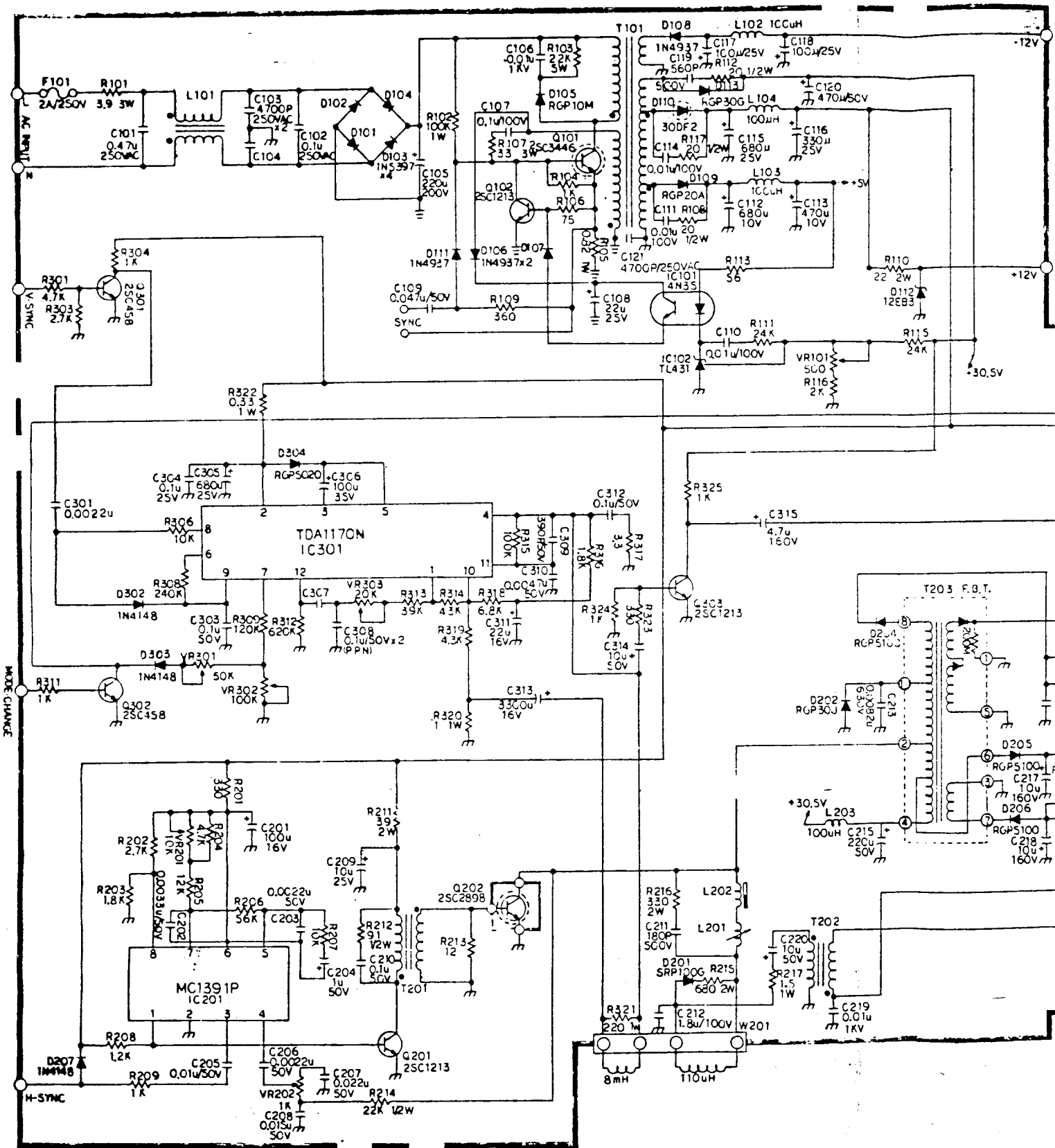
Brightness/Subcontrast Adjustment

Since excessive brightness can shorten tube phosphor life, you may wish to measure the three brightness levels with a correctly calibrated photometer. Perform the following steps to adjust the three degrees of brightness on the "m" test pattern:

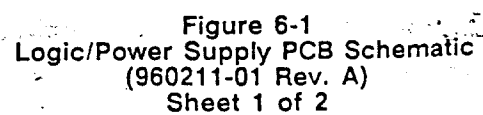
- 1 Turn the operator brightness control knob fully clockwise.
 - 2 Turn the operator contrast control knob fully counterclockwise.
 - 3 Turn SUB-BRI, VR204, until the raster is just visible (2fL).
 - 4 Turn the operator contrast control knob fully clockwise. You'll now see the three brightness blocks (Figure 3-3).
 - 5 Look at the outside brightness blocks. If Dim2 is too bright or Full Bright is too dark, adjust subcontrast VR402 (on the CRT drive PCB) until you correct the problem.
-

Focus

☐ **Note** Don't use the focus control to adjust the outer extremities of the screen. Some focus distortion happens in any CRT. The focus adjustment is labeled FOCUS VR203 on the terminal PCB (Figure 3-4). Display the "m" test pattern. Adjust VR203 until the characters halfway between the center of the display and the bezel are distinct and clear.

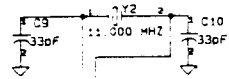
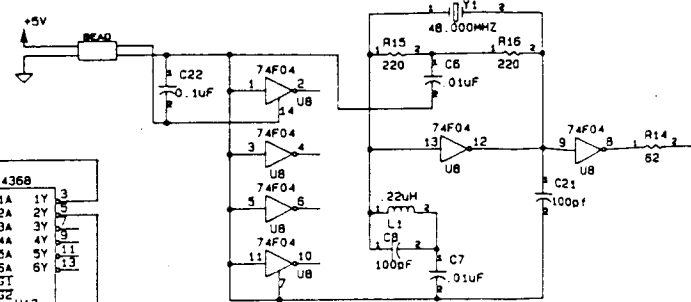
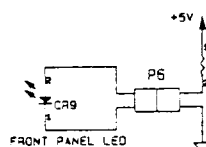
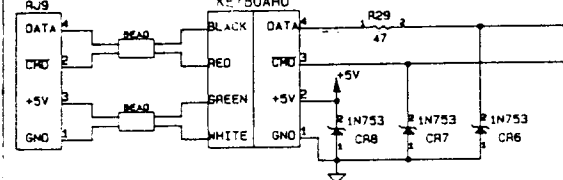


NOTE:
 1. THE UNIT OF RESISTANCE "OHM" IS OMITTED (K=1000 OHMS AND M=1MEG OHM).
 2. ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE NOTED.
 3. THE UNIT OF CAPACITANCE "UFD" IS OMITTED UNLESS OTHERWISE NOTED PF.



KEYBOARD
CONNECTOR
R29

P3
KEYBOARD



8032

BANK SELECT
for 27010
(Pin 21)

U6

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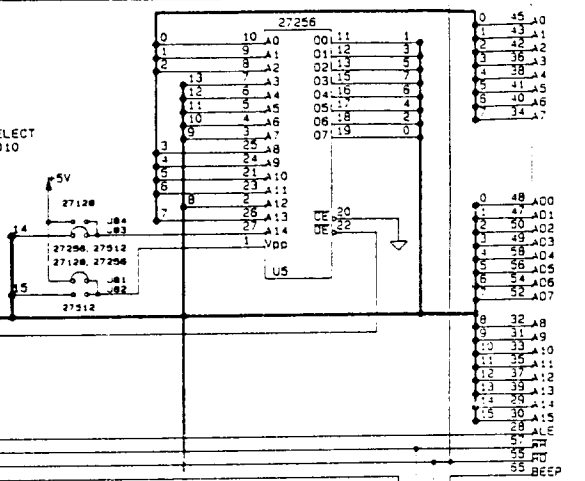
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P1
MAIN
PORT

OB25

RTS

TX

DT

RTS

GND

CTS

FS

DCD

MC1488

MC1488

MC1488

MC1489

MC1489

MC1489

MC1489

MC1489

MC1489

MC1489

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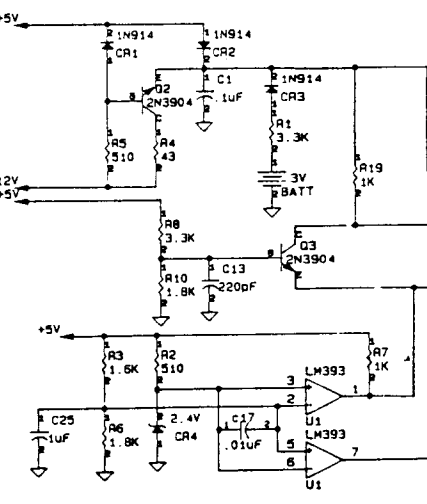
MC1489

MC1489

MC1489

MC1489

MC1489



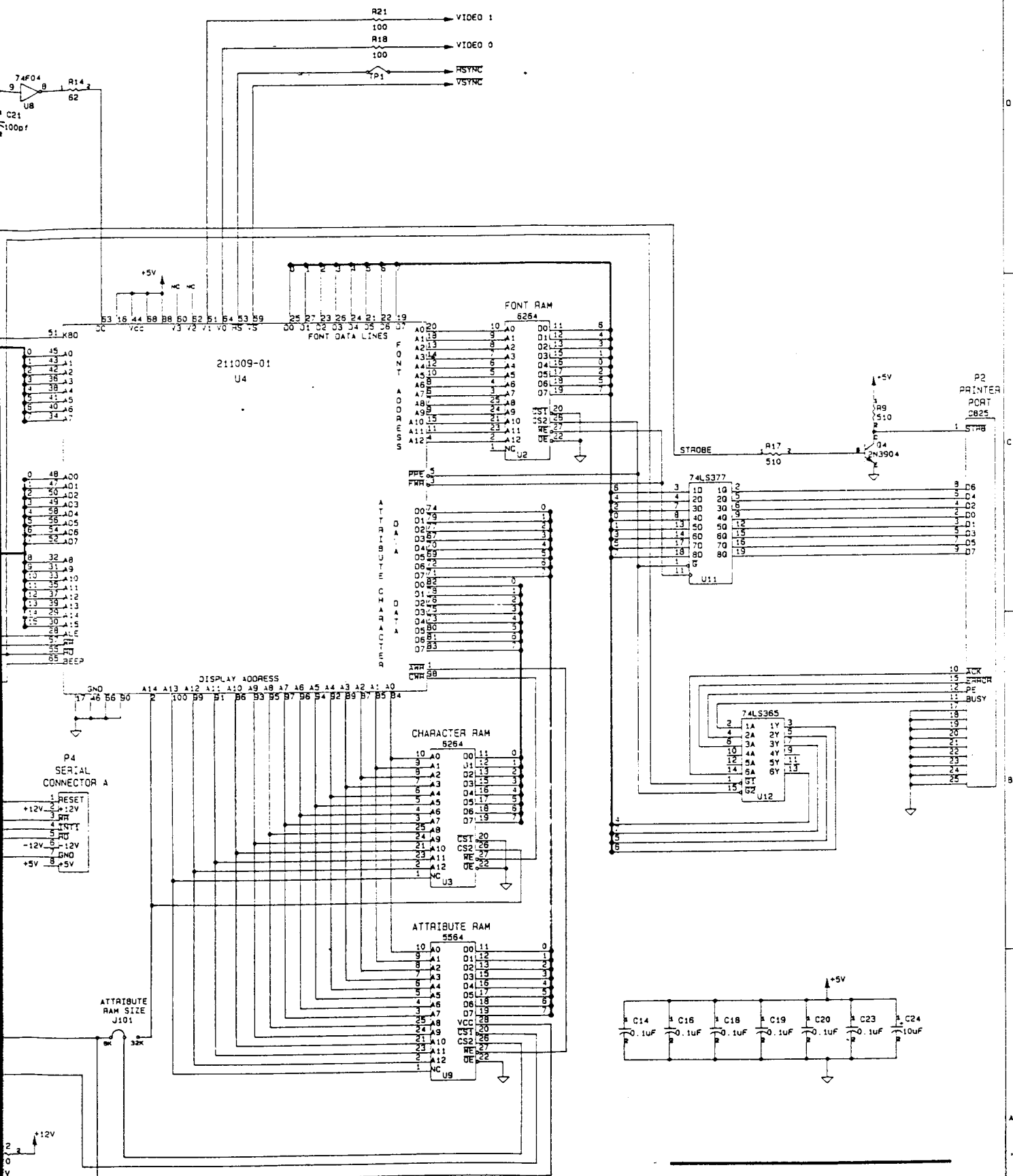
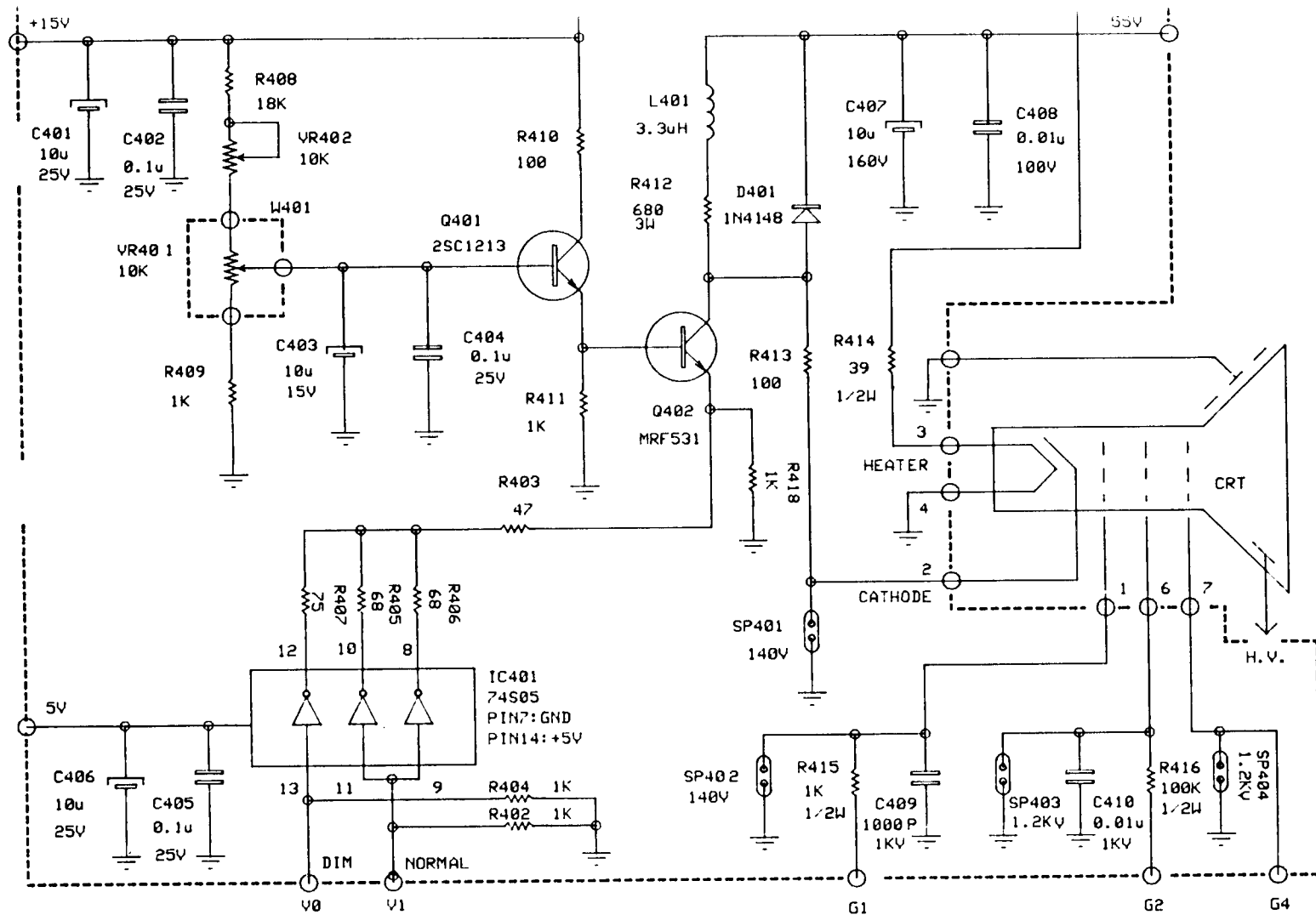


Figure 6-1
Logic/Power Supply PCB Schematic
(960211-01 Rev. A)
Sheet 2 of 2

Figure 6-2 CRT Drive PCB
Schematic (960213-01 Rev. 5A)



NOTE:

1. THE UNIT OF RESISTANCE "OHM" IS OMITTED (K-1000 OHMS AND M-1MEG).
2. ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE NOTED.
3. THE UNIT OF CAPACITANCE "uFD" IS OMITTED UNLESS OTHERWISE NOTED PF.