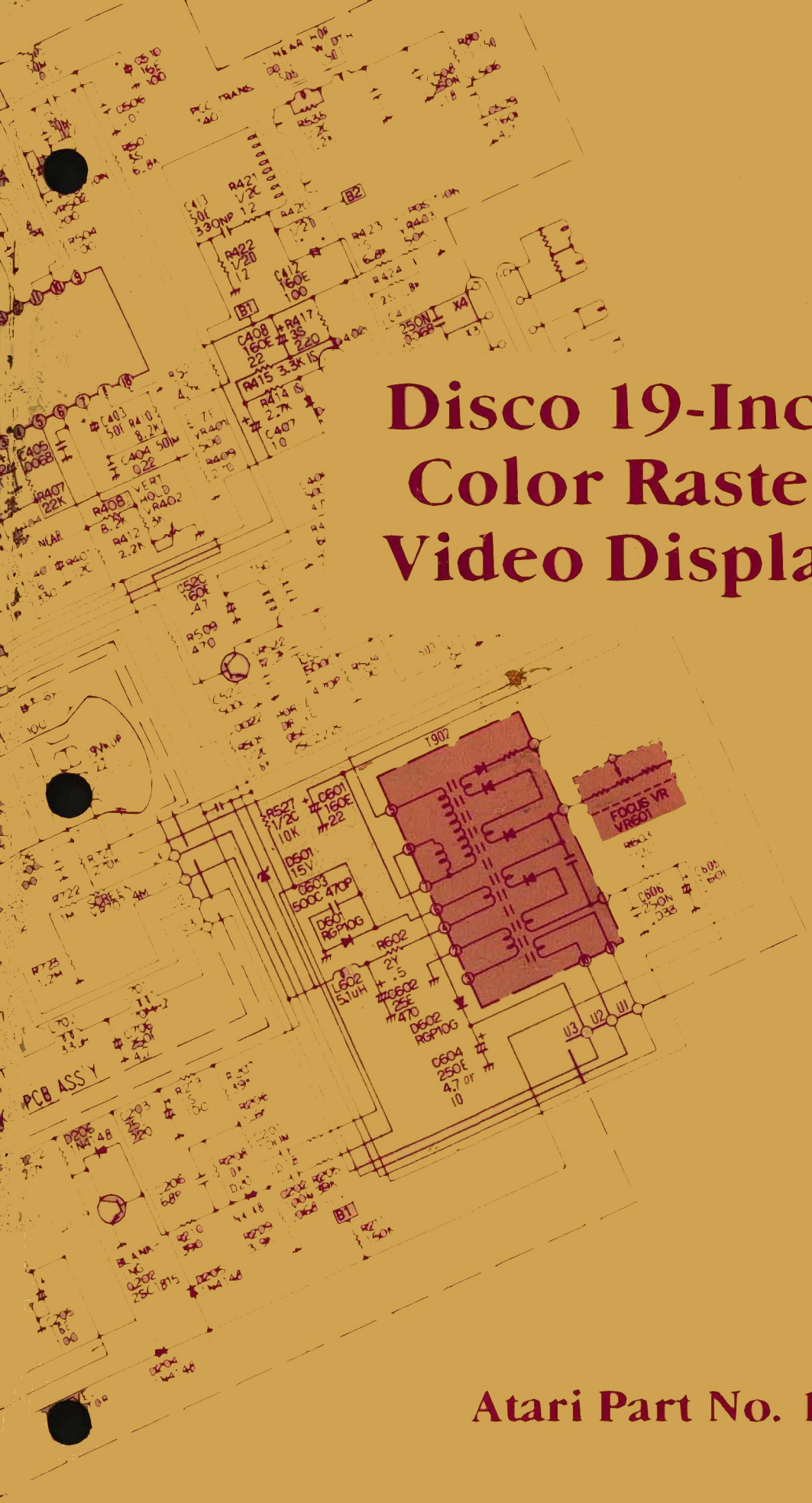
TM-210
2nd printing



Disco 19-Inch Color Raster Video Display

Service Manual

Complete with Schematic and Illustrated Parts Lists

Atari Part No. 139003-1006 B

Warranty

Seller warrants that its printed-circuit boards and parts thereon are free from defects in material and workmanship under normal use and service for a period of ninety (90) days from date of shipment. Seller warrants that its video displays (in games supplied with displays) are free from defects in material and workmanship under normal use and service for a period of thirty (30) days from date of shipment. None of the Seller's other products or parts thereof are warranted.

If the products described in this manual fail to conform to this warranty, Sellers' sole liability shall be, at its option, to repair, replace, or credit Buyer's account for such products which are returned to Seller during said warranty period, provided:

(a) Seller is promptly notified in writing upon discovery by Buyer that said products are defective;

(b) Such products are returned prepaid to Sellers' plant; and

(c) Seller's examination of said products discloses to Seller's satisfaction that such alleged defects existed and were not caused by accident, misuse, neglect, alteration, improper repair, installation or improper testing.

In no event shall Seller be liable for loss of profits, loss of use, incidental or consequential damages.

Except for any express warranty set forth in a written contract between Seller and Buyer which contract supersedes the terms of this order, this warranty is expressed in lieu of all other warranties expressed or implied, including the implied warranties of merchantability and fitness for a particular purpose, and of all other obligations or liabilities on the Seller's part, and it neither assumes nor authorizes any other person to assume for the Seller any other liabilities in connection with the sale of products under this order.

The use of any non-Atari parts may void your warranty, according to the terms of the warranty. The use of any non-Atari parts may also adversely affect the safety of your game and cause injury to yourself and others. Be very cautious in using non-Atari-supplied components with our games, in order to insure your safety.

Atari distributors are independent, being privately owned and operated. In their judgment they may sell parts or accessories other than Atari parts or accessories. Atari cannot be responsible for the quality, suitability or safety of any non-Atari part or any modification including labor which is performed by such distributor.

Disco 19-Inch Color Raster Display Service Manual

Atari Part No. 139003-1006 B

Complete with Schematic and Illustrated Parts Lists

Display manufactured by
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Taipei, Taiwan R.O.C.

Published by:
ATARI, INC.
790 Sycamore Drive
P.O. Box 906
Milpitas, California 95035

Lithographed in the U.S.A. **8M**

Notice Regarding Non-ATARI Parts

WARNING

Use of non-ATARI parts or modifications of your ATARI game circuitry may adversely affect the safety of your game, and injure you or your players.

You may void the game warranty (printed on the inside back cover of this manual) if you do any of the following:

- substitute non-ATARI parts in the game
- modify or alter any circuits in the game by using kits or parts *not* supplied by Atari.

Table of Contents

6 Repair

7 Adjustments and Testing

8 Illustrated Parts Lists

Appendix

List of Illustrations

1 Warnings and Cautions

This color raster display has been built to Atari specifications by Disco Electronics Corp. This display is contained within a separate chassis inside the game cabinet. The Main printed-circuit board (PCB) is mounted to the display chassis under the cathode-ray tube (CRT). The CRT PCB is attached to the neck pins of the CRT.

Input signals for the display are supplied through a 6-pin harness connector on the Main PCB.

Before You Start

Never attempt to work on a display until you are familiar with servicing precautions and procedures necessary for high-voltage equipment. Remember, any video display has at least three sources of possible danger:

- Strong electrical shock, due to high voltage or alternating current (AC) line voltage
- X-ray radiation (if the display is out of adjustment)
- Implosion

Therefore, never modify any circuit in this display.

Perform servicing on a video display only after you are thoroughly familiar with all warnings and safety measures given in this chapter.

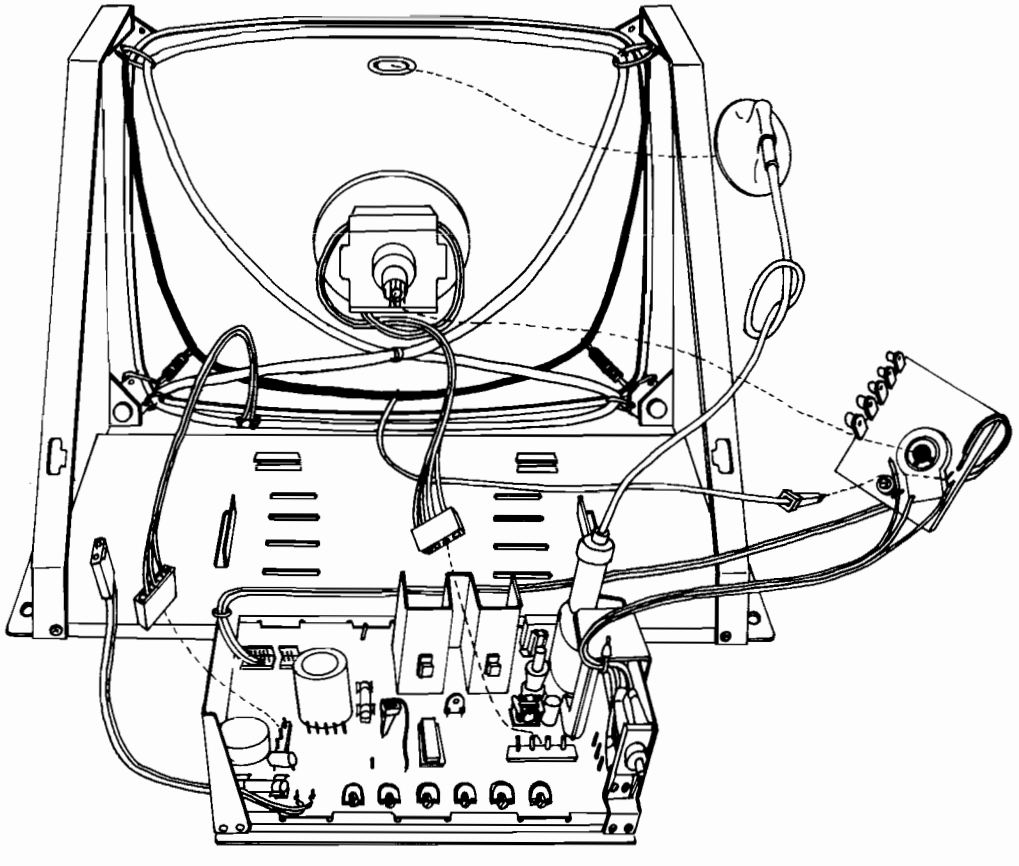


Figure 1 Overview of Disco 19-Inch Color Raster Display

⚠ WARNINGS ⚠

High Voltage

This display contains lethal high voltages. To avoid danger, do not attempt to service the chassis until you take all precautions necessary for working on high-voltage equipment.

X-Radiation

This chassis has been designed to minimize X-radiation hazard. However, to avoid possible exposure to soft X-radiation, never modify the high-voltage circuitry.

Implosion Hazard

If you drop the display and the cathode-ray tube breaks, it may implode! Shattered glass and the yoke assembly can fly 6 feet or more from the implosion site. Use care when replacing any display.

Safety Measures

Good safety habits will allow you to automatically take the proper precautions, even if you are rushed. Whenever you work on a display, always ground the chassis first. Also, use only one hand. This avoids the possibility of carelessly putting one hand on the chassis or ground and the other on an electrical connection. Doing so could cause a severe electrical shock.

If you service the Disco 19-Inch Color Raster Display on a test bench, use an isolation transformer or the power supply that came with the game. (Refer to the Power Supply Assembly parts list in the game manual for the Atari part number of the isolation transformer.) Do not use line voltage or a power supply from a black-and-white game, because the voltages produced by those sources will damage this display. This display will not accept direct current (DC) line voltages.

To prevent fire or shock hazard, never expose this display to moisture.

Periodically check for frayed insulation on wires. If frayed wires are found, replace them with the same gauge, insulation type, thickness, length, and rating of wire. Always observe the original routing and length of harness wires.

Use extra precaution in the high-voltage circuitry areas of the display. If a short circuit occurs, replace any components that indicate they may have overheated.

Handling the Cathode-Ray Tube

Wear safety goggles and heavy gloves for protection whenever you handle a cathode-ray tube. Keep other people away if they are not wearing safety goggles. Never lift the cathode-ray tube by the neck; the neck should only be used to guide the lifting process.

Use extreme care when handling the cathode-ray tube! Rough handling may cause it to implode. Do not nick or scratch the glass or subject any undue pressure upon the tube at any time.

When servicing the cathode-ray tube, discharge the high voltage on the anode connection to chassis ground—not to the cabinet or other mounting parts. When discharging the anode, go from ground to the anode connection with a well-insulated 18-gauge jumper wire in one hand. Allow two minutes to pass and discharge the anode again.

Replace with Proper Components

Maintain the specified values of all components within the display. If you change the values of components, you may cause a rise in the high voltages.

The cathode-ray tube of this display employs integral implosion protection. For continued safety, replace it only with a tube of the same type number. Refer to the parts lists in Chapter 8 of this manual. For continued product safety, use only exact replacement parts, especially for those parts identified in the parts lists with the ⚠ symbol and on the schematic diagrams with shading.

Final Testing Before Reinstalling Display

Before reinstalling this color display into the game, you must perform the following procedures:

1. Inspect all harness wiring within the display area. Be sure no wires or cables are pinched between the cabinet and other parts in the display.
2. Replace any protective device such as insulating fishpaper.

2 Specifications

Power Input and Consumption

Line Voltage	120 VAC, within +10% and -15%
Line Frequency	47–63 Hz
Power Consumption	110 W maximum

Temperature and Humidity

Ambient Air Temperature	0° to +55°C (+32° to +151°F)
Environmental Humidity	10–90%, noncondensing

Current and Voltages

CRT Anode Current (Average)	Less than 700 μA
High Voltage	25–27 kV
B1	+115 V, within ±0.5 V (adjustable)
B2	+18 V, within ±2.0 V

CRT Specifications

Convergence Tolerance Within 11.25-Inch Diameter:

At Screen Center	0.027-inch (0.7 mm) maximum misconvergence
At Screen Edges	0.047-inch (1.2 mm) maximum misconvergence
Color Purity:	Practically uniform throughout the screen area after degaussing
Scan Rates:	
Horizontal	15.750 kHz, within ±500 Hz
Vertical	60 Hz, within ±5 Hz
CRT Type:	#19VKUP22, 19-inch, 90°
Tilt of Video Yoke:	Declination of a horizontal video line is within 0.10-inch (2.54 mm) of CRT center markers

Connectors

6-Pin Connector for Video Signals:

Pin 1 (E6)	+Horizontal Sync
Pin 2 (E5)	+Vertical Sync
Pin 3 (E4)	Input Ground
Pin 4 (E3)	Blue Input
Pin 5 (E2)	Green Input
Pin 6 (E1)	Red Input

2-Pin Connector for Power:

Pin 1	120 VAC
Pin 2	120 VAC

3-Pin Connector for Video Signals:

Pin 1 (E10)	-Horizontal Sync
Pin 2 (E9)	-Vertical Sync
Pin 3 (E8)	Ground

Display CRT Input Signals

RGB Video Input Signals

The red, green, and blue input signals are at test points 7A, 7B, and 7C of the cathode-ray tube (CRT) PCB. Wave shape and polarity are shown in Figure 2.

Sync Signal

This display is capable of accepting separate horizontal and vertical sync pulses. Connector J101 (6-pin) accepts +horizontal and +vertical signals. Connector J102 (3-pin) accepts -horizontal and -vertical signals. A composite sync (+ or -) will also be accepted by connection to both horizontal and vertical inputs of the appropriate connector. Separate horizontal and vertical levels are 2–4 volts peak-to-peak (+ or -) in amplitude.

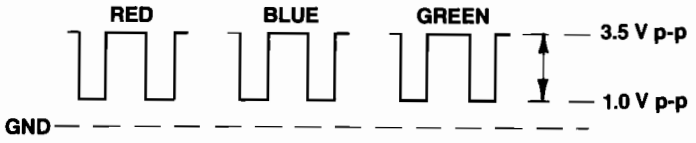


Figure 2 RGB Video Input Signals to CRT

Pattern Size

You should be able to reproduce the patterns as shown in Figure 3.

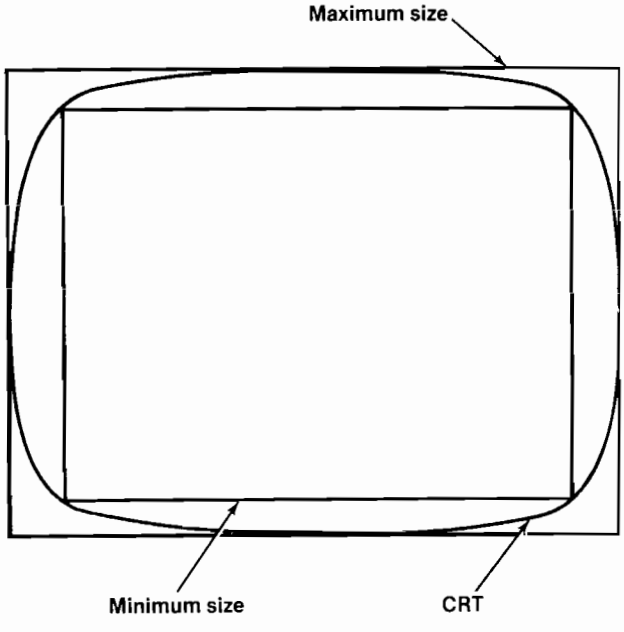


Figure 3 Display Pattern Sizes

3 Control Adjustments

WARNING

Remember to observe the precautions regarding high voltages when making adjustments to this display!

NOTE

Before making any of the following adjustments, turn on the display and allow it to warm up for at least 5 minutes.

Brightness

Do not attempt at this time to adjust the SCREEN control, VR707 (see Figure 4); first, adjust the BRIGHT control, VR201 (see Figure 5). The BRIGHT (brightness) control should be adjusted if the picture image is either too bright or too dark. Figure 5 shows the location of the BRIGHT control on the Main PCB.

1. Place the game in the attract or play mode.
2. Using the BRIGHT control, adjust the display for a pleasing level of brightness.

The SCREEN control, VR707, should *only* be adjusted if the correct brightness is not obtained from adjustment of the BRIGHT control.

NOTE

Too high a brightness level will cause the retrace lines to show; too low a level will cause the entire screen to be dark and obscure.

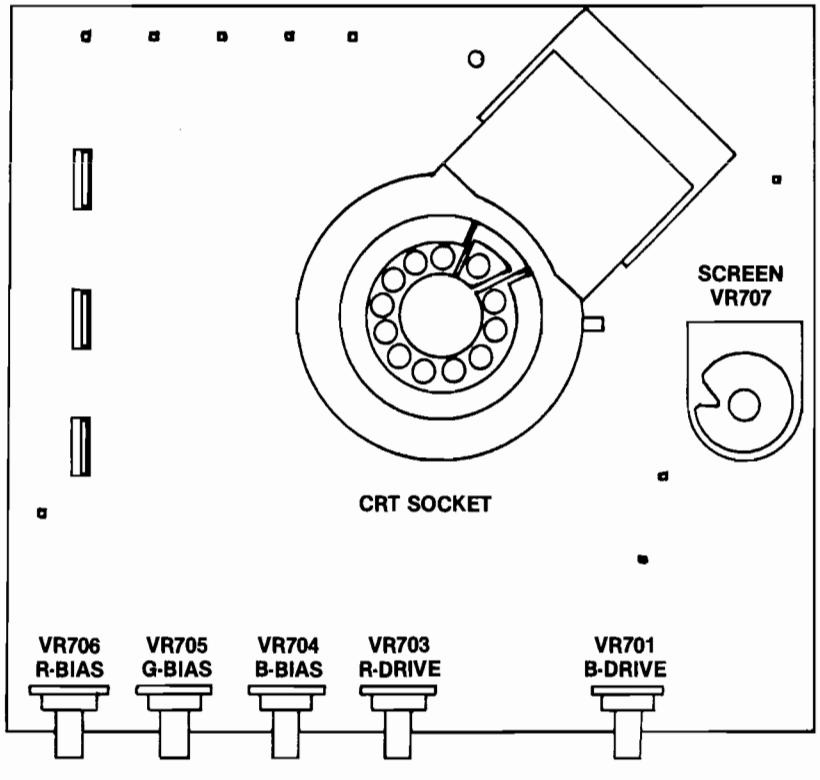


Figure 4 Adjustable Controls on CRT PCB

Horizontal Hold

The H HOLD control should be adjusted if the picture is tearing sideways across the screen. Figure 5 shows the location of H HOLD control VR501 on the Main PCB. Adjust this control until the black lines no longer slant sideways and you obtain a normal screen image.

Vertical Hold

The V HOLD control should be adjusted if the picture drifts straight up or down on the screen. Figure 5 shows the location of V HOLD control VR402 on the Main PCB. Adjust this control until the picture no longer drifts up or down on the screen.

Horizontal Positioning

The H CENTER control should be adjusted if the picture is not centered across the screen, as indicated by a black area at either the left or the right edge of the screen. Figure 5 shows the location of H CENTER control VR502 on the Main PCB. Adjust this control until you obtain a normal screen image.

Vertical Positioning

The V CENTER control should be adjusted if the picture is not vertically centered on the screen. Figure 5 shows the location of the V CENTER control VR403 on the Main PCB. Adjust this control until you obtain a normal screen image.

Horizontal Size

The H WIDTH coil should be adjusted if the screen raster is either too wide or narrow. Figure 5 shows the location of H WIDTH control L507 on the Main PCB. Adjust the H WIDTH control as follows:

1. Set the game for the self-test diagnostic pattern that displays the convergence grid and dots. (Refer to the game manual for detailed procedures on selecting the self-test patterns.)
2. Use only a non-metallic Allen wrench (commonly called a "tweaking tool") to adjust the H WIDTH coil until the right and left grid lines run along the edges of the screen. These grid lines should not be positioned off the screen, which would indicate overscanning.

Vertical Size

The V SIZE control should be adjusted if the screen image is either not filling the screen vertically, or if it is overscanning the screen vertically. Figure 5 shows the location of V SIZE control VR401 on the Main PCB. Adjust the V SIZE control as follows:

1. Set the game for the self-test diagnostic pattern that displays the convergence grid and dots. (Refer to the game manual for detailed procedures on selecting the self-test patterns.)
2. Slowly adjust V SIZE control VR401 until the top and bottom grid lines are along the top and bottom edges of the screen. These grid lines should not disappear off the edges of the screen, which would indicate overscanning.

Focus

The FOCUS control should be adjusted if the CRT screen image is not sharply defined. The FOCUS control, VR601, is mounted at the rear corner of the Main PCB, as shown in Figure 5. Turn this control until you get optimum screen sharpness.

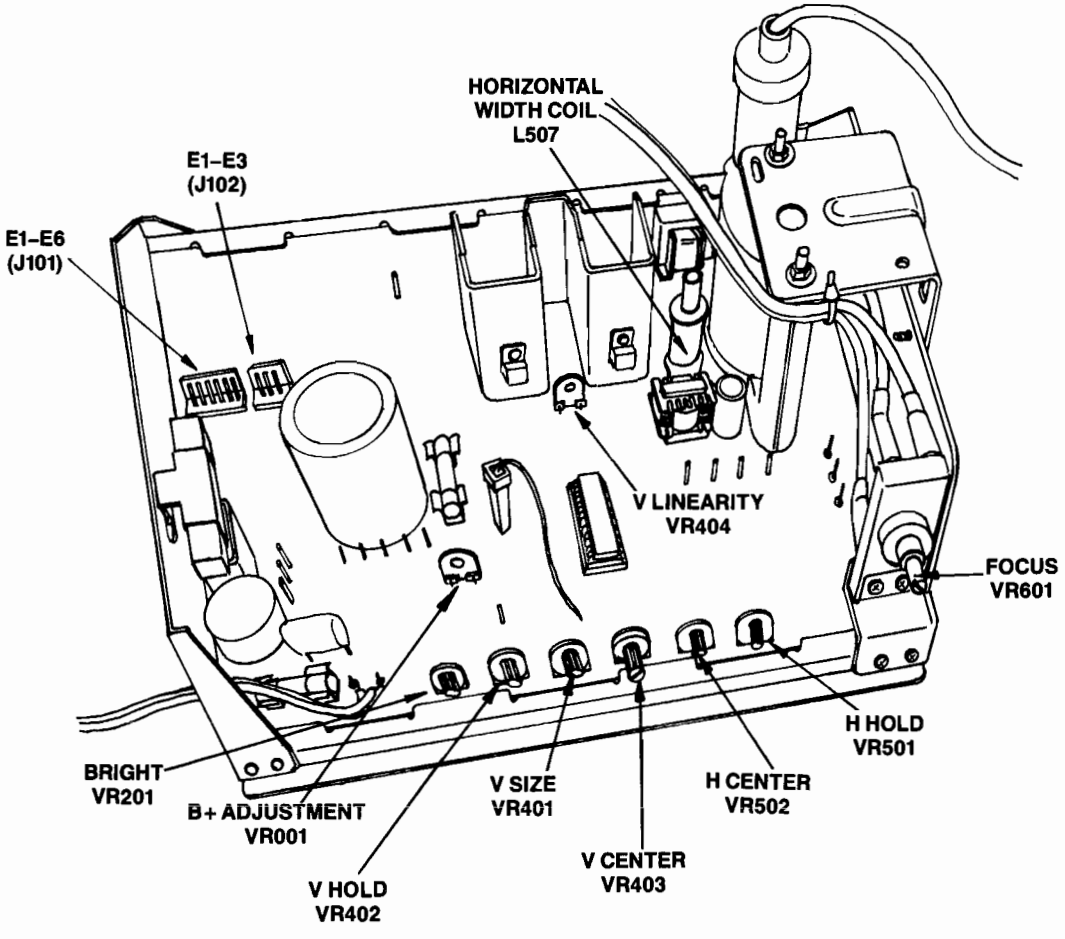


Figure 5 Adjustable Controls and Test Points on Main PCB

4 Signal Test Points

For illustrations of 22 waveforms, see Appendix A in this manual.

RGB Signals

The red (E1), green (E2), and blue (E3) signals can be checked at input connector J101 (see Figure 5). Table 1 illustrates the location of the signals and their corresponding pins on the Main PCB.

Table 1 Signal Locations

Silkscreened Designation	Signal	Location
E1	RED	Pin 6 of J101
E2	GREEN	Pin 5 of J101
E3	BLUE	Pin 4 of J101
E4	INPUT GND*	Pin 3 of J101
E5	V+	Pin 2 of J101
E6	H+	Pin 1 of J101
E8	GND	Pin 3 of J102
E9	V-	Pin 2 of J102
E10	H-	Pin 1 of J102

*INPUT GND (E4) and GND (E8) are not at the same potential as the chassis ground for the display. When making measurements, use the GND test point at pin 3 of J102 (0-volt reference).

You may also test for the presence of the red, green, and blue input signals at pins 7A, 7B, and 7C near the edge of the CRT PCB. The red, green, and blue input signal waveforms are illustrated in Figure 2.

Sync Signal

The following discussion applies only to the positive sync inputs on the 6-pin connector, J101. However, the same theory applies to the negative inputs on the 3-pin connector, J102.

The separate positive or negative synchronization (sync) signals can be checked at input connectors J101 and J102 (see Figure 5). For example, to measure the H- signal level at pin 1 of J102, measure pin 1 near the silkscreened marking E10 on the Main PCB (see Table 1). You may also test for the presence of this sync signal at pin 10 of IC401.

The typical horizontal amplitude is 2.4 volts peak-to-peak with a negative polarity at pin 10 of IC401. The horizontal sync signal at pin 10 of IC401 is always negative. When a positive sync signal is applied through pin E6 of connector J101, amplifier Q105 reverses the signal polarity. Pulse width for the horizontal sync component is 3 to 5 μs; pulse width for the vertical sync component is greater than 190.5 μs.

The vertical sync signal at pin 8 of IC401 is always positive. When a negative vertical sync signal is applied through pin E9 of connector J102, amplifier Q104 reverses the signal polarity.

5 Details of Operation

A basic block diagram of the circuitry within this display is shown in Figure 6. Refer to this figure and the schematic diagram given in Figure 7 throughout the following discussion. In addition, refer to Appendix A for illustrations of 22 waveforms.

Sync

The horizontal sync signal is applied to E6 (pin 1) of connector J101 or E10 (pin 1) of connector J102. Since the sync input to pin 10 of IC401 responds to negative sync pulses, the sync pulses from E10 (pin 1 of J102) are directly connected to pin 10 of IC401. The positive sync pulses from E6 (pin 1 of J101) are inverted by Q105 and then applied to pin 10 of IC401.

The vertical sync signal is applied to E9 (pin 2) of connector J102 or to E5 (pin 2) of connector J101. Since the vertical sync input to pin 7 of IC401 responds to positive sync pulses, the sync pulses from E5 (pin 2 of J101) are directly coupled to pin 7 of IC401 through capacitor C107. The negative sync pulses from E9 (pin 2 of J102) are inverted by Q104 and then applied to pin 7 of IC401.

Vertical and Horizontal Amplifiers

The vertical oscillator at pin 4 of IC401 is synchronized with the sync pulses applied to pin 7 of IC401. V-HOLD control VR402 sets the DC operating level for the vertical oscillator. The output signal from the vertical oscillator (pin 4 of IC401) is modified with the vertical size information from V-SIZE VR407 and V-LINEAR VR404 and then applied to the Vertical Drive Amplifier at pin 2 of IC401. Final amplification for the vertical deflection signal is provided by Q402–Q403. From here the signal is applied to the deflection yoke of the CRT.

The horizontal oscillator at pin 13 of IC401 is synchronized by the output of the phase detector at pin 12 of IC401. H-HOLD control VR501 sets the DC operating level for the horizontal oscillator. The output signal from the horizontal oscillator is applied through the horizontal output amplifier of IC401 to pin 15 of IC401. This signal is then applied across R509 to the base of horizontal drive transistor Q501, which provides drive to the primary of transformer T501. The horizontal signal is coupled into the secondary of T501 and applied across divider network R523-R524 and coils L501-L502 to the base of Q902. After final amplification by Q902, the horizontal deflection signal is applied to the deflection yoke of the CRT.

Z Amplifiers (Red, Green, and Blue)

NOTE

Because the red, green, and blue amplifiers are similar in operation, only the blue will be discussed here.

The blue intensity signal from the game circuitry is applied from pin 4 (E3) of J101 through R101 to the base of blue intensity buffer transistor Q101. From here the blue intensity signal is applied to pin 7A of the CRT PCB and then to the base of common-emitter transistor Q701. Variable resistor VR201, the BRIGHT control and DC level regulator Q201 set the DC operating level for the input transistors of all three Z amplifiers. Transistor Q202 is the blanking transistor for all three Z amplifiers. From the collector of Q701, the blue intensity signal is applied across R716 through pin 11 of the CRT base socket to the blue cathode gun. B-BIAS adjustment VR704 sets the cutoff characteristics of Q701. B-DRIVE adjustment VR701 sets the gain of Q701.

Blanking

The vertical deflection signal from the vertical drive output at pin 2 of IC401 also contains a negative-going vertical blanking signal. This negative-going blanking signal is applied through R205-C202-R209-D201-R210 to the base of Q202. During horizontal retrace, blanking transistor Q202 turns off, which turns off the blue intensity buffer (Q101).

The horizontal deflection signal is derived from the flyback pulse at pin 6 of T902. During vertical retrace, blanking transistor Q202 turns off, which turns off the blue intensity buffer (Q101).

The vertical blanking pulses applied to the base of Q202 turn off buffers Q101-Q102-Q103 and blank the CRT during the horizontal retrace. The horizontal blanking pulses applied to the base of Q202 turn off buffers Q101-Q102-Q103 and blank the CRT during the vertical retrace.

High Voltage

The high-voltage signals are developed across flyback transformer T902. The horizontal deflection signal is applied across the primary of T902 to induce a 15.734-kHz signal into the secondary. The voltage induced into the secondary is stepped up to about +26 kV before it is applied to the anode of the CRT. The FOCUS and SCREEN adjustments are made in the secondary circuit of T902.

Line Input and Degaussing

Line voltage of 120 VAC is applied through AC fuse F001 and line-filter components L001-C007 to both the degaussing network and the rectifier. When cool, POS001 permits current to flow through the degaussing coil. However, after POS001 heats up, current is removed from the degaussing coil, rendering it inoperative.

The full-wave rectifier is composed of D007 through D010. This rectifier converts the AC input voltage into an unfiltered DC voltage. Capacitor C004 and ripple filter Q003 filter out AC ripple.

+ 115 Volt Regulated Supply

The +115 volt regulated supply provides operating power to circuitry throughout the display. The regulator for the +115 volt regulated supply is a feedback amplifier system that operates between ground and the rectified DC voltage. Current to the load is delivered by power regulator Q901. The supply voltage is established by the voltage drop across resistive-divider network R012-R013-VR001-R014 at the base of error amplifier Q002.

Feedback at the base of Q002 is coupled through regulator drive Q001 to Q901. Any variation in the supply output voltage (due to changing load requirements) causes Q002 to modify the biasing current of Q901. This nullifies the change in the supply output voltage.

DC fuse F002 provides circuit protection in the event of an overload or regulator malfunction.

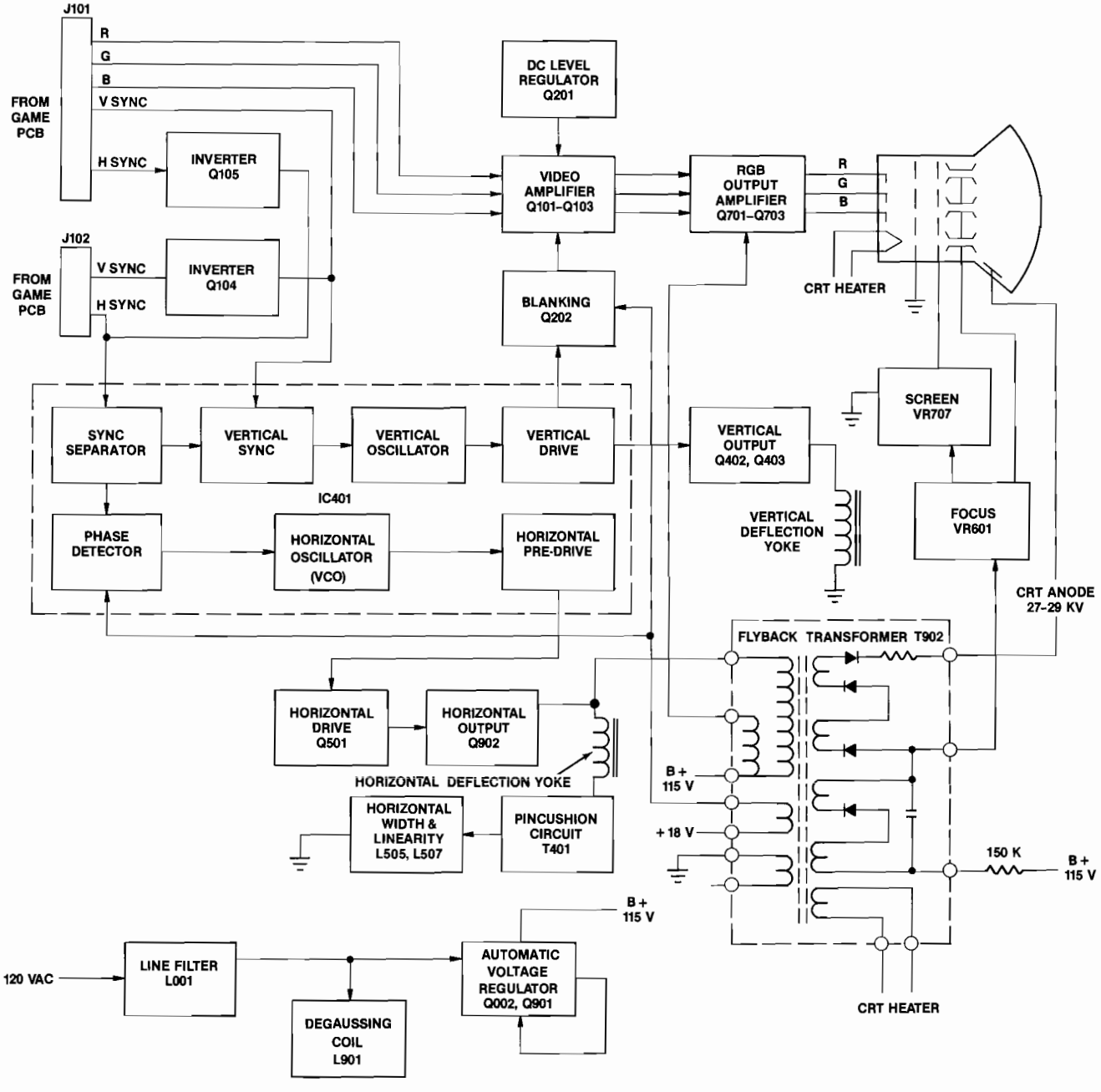
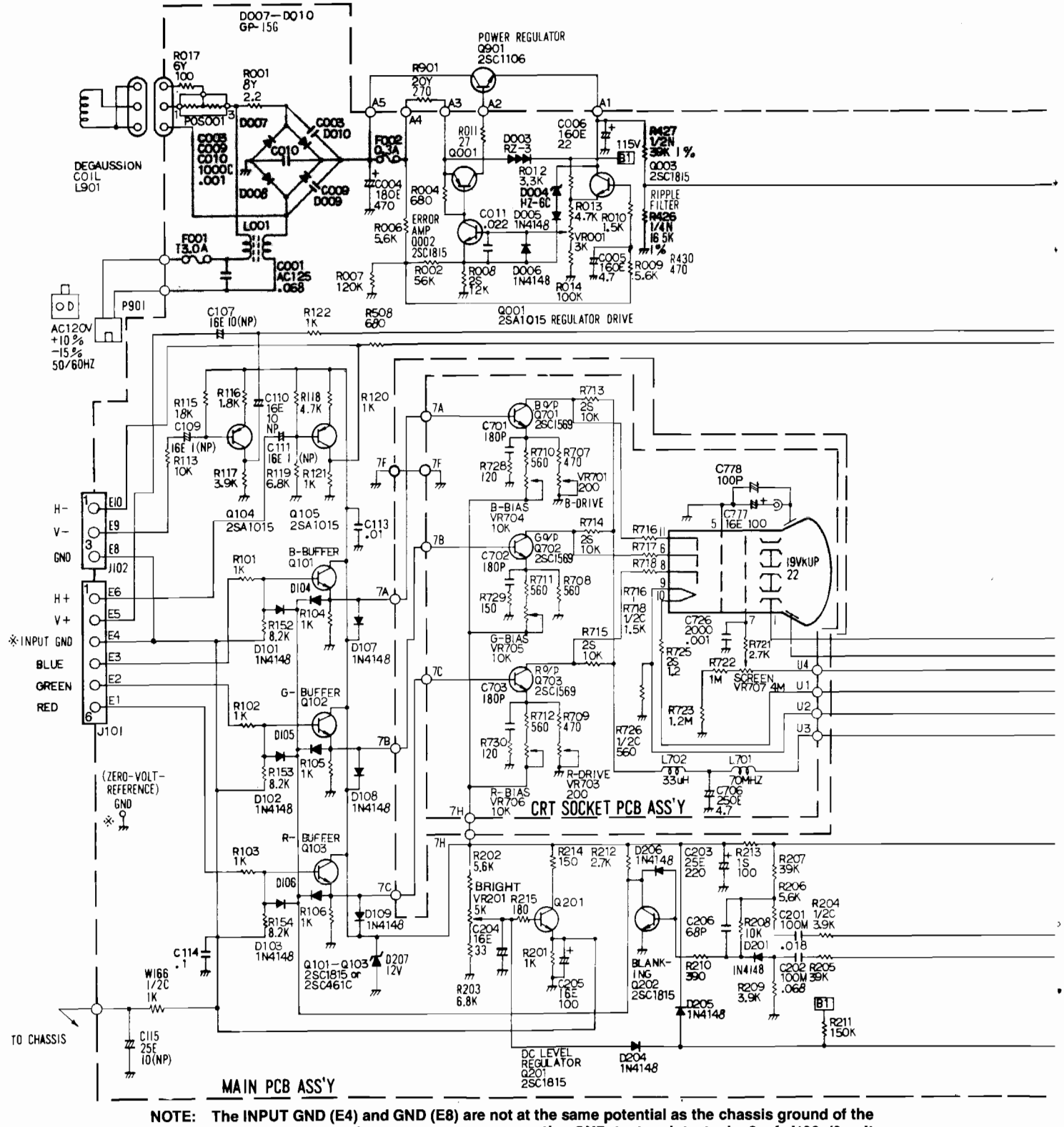


Figure 6 Block Diagram of the Disco 19-Inch Color Raster Display



NOTE: The INPUT GND (E4) and GND (E8) are not at the same potential as the chassis ground of the display. When making measurements, use the GND test point at pin 3 of J102 (0-volt reference). The frame, chassis and CRT coating are at the same potential as INPUT GND (E4).

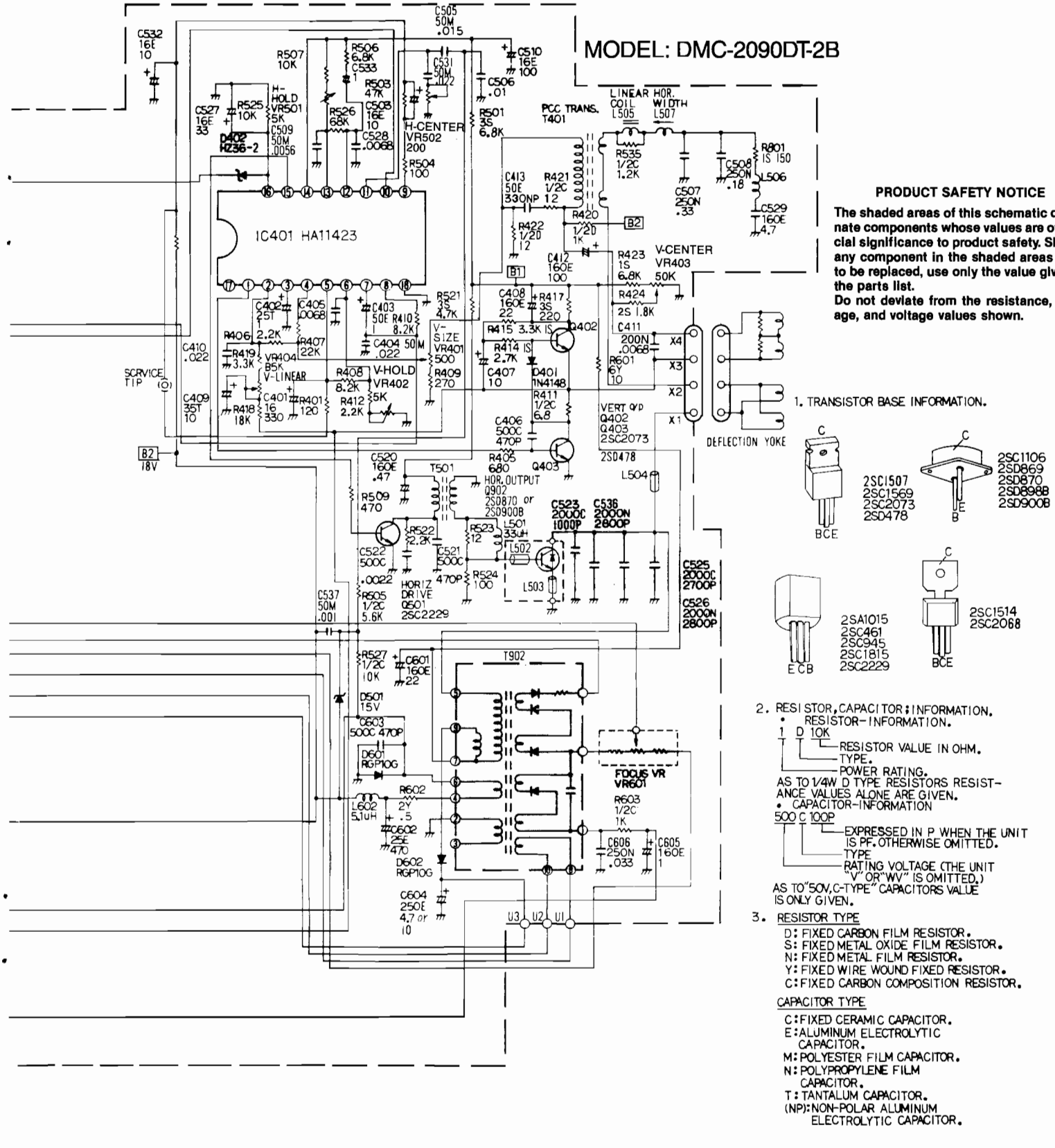


Figure 7 Disco Display Schematic Diagram

6 Repair

⚠ WARNING ⚠

Before removing or installing any component of this display, always disconnect the power source! Observe the precautions regarding high voltages and cathode-ray tube handling when servicing this display.

Cathode-Ray Tube Replacement

NOTE

You must readjust the brightness and perform the purity and convergence adjustment procedures whenever the cathode-ray tube is replaced.

1. Disconnect the 6-pin and 3-pin video-signal connectors from the Main PCB. Disconnect the 2-pin power connector in the harness near the display.
2. Remove the Disco display assembly from the game as described in the game manual.
3. Discharge the high voltage from the CRT as follows:
   a. Using one hand, attach one end of a large, well-insulated, 18-gauge jumper wire to ground.
   b. Momentarily touch the free end of the grounded jumper to the anode by sliding it under the anode cap.
   c. Wait two minutes.
   d. Discharge the anode again.
   e. **Carefully** remove the large high-voltage anode connector from the CRT.
4. Unplug the CRT PCB from the rear of the cathode-ray tube.
5. Unplug the 4-wire connector attaching the yoke wires to the Main PCB.
6. Use a 10-mm hex socket wrench to remove the four screws holding the CRT to the steel chassis.
7. **Carefully** remove the CRT by easing it out the front of the chassis.
8. Place the CRT on a soft mat in a protected location.
9. To install a CRT, reverse the order of this procedure.

Yoke Replacement

NOTE

You must reconverge the picture and readjust the color purity whenever the yoke is replaced.

1. Disconnect the 6-pin and 3-pin video-signal connectors from the Main PCB. Disconnect the 2-pin power connector on the harness near the display.
2. Remove the Disco display assembly from the game as described in the game manual.
3. Discharge the high voltage from the CRT using the procedure given in step 3 under *Cathode-Ray Tube Replacement.*
4. Unplug the CRT PCB from the neck pins of the CRT.
5. Remove the cloth tapes securing the three rubber wedges beneath the yoke collar.
6. Use a thin knife or a single-edged razor blade to carefully loosen the three rubber wedges from the CRT surface.
7. Use a Phillips-head screwdriver and your fingers to loosen the screws that secure the two neck clamps around the CRT.
8. Slide the magnet assembly and the yoke assembly off the end of the CRT.
9. To replace a yoke assembly, reverse the order of this procedure.

Main PCB Replacement

1. Disconnect the 6-pin and 3-pin video-signal connectors from the Video Amplifier PCB. Disconnect the 2-pin power connector in the harness near the display.
2. Remove the Disco display assembly from the cabinet as described in the game manual.
3. Discharge the high voltage from the CRT as described in step 3 under *Cathode-Ray Tube Replacement.* Unplug the red anode wire from the CRT.
4. Gently pull the CRT PCB from the neck pins of the CRT.
5. Unplug the 3-pin and 4-pin connectors on the Main PCB.

6. Use a Phillips-head screwdriver to remove the two screws securing the PCB holder to the chassis.
7. Unsolder all wires on the Main PCB that would prevent the PCB from being removed from the PCB holder.
8. Remove the screws at the left front and rear edges of the Main PCB. Remove the two hex nuts on top of the flyback transformer.
9. Slide back the rubber cap on the beige wire connected to the focus assembly above the Main PCB. Note: You may have to use a flat tool (such as a thin screwdriver) to loosen the rubber cap, since the cap is held by glue. Unsolder this wire from the focus assembly.
10. Gently pull the Main PCB out of the PCB holder.
11. To replace the Main PCB, reverse the order of this procedure.

Flyback Transformer Replacement

1. Remove the Main PCB as described under *Main PCB Replacement*.
2. Using a ¼-inch hex socket wrench, remove the two screws that secure the flyback transformer to the metal bracket. Then remove the four screws on the side of this bracket. Tilt the bracket away from the flyback transformer.
3. Unsolder the transformer connections on the bottom side of the Main PCB. Lift the transformer off the Main PCB.
4. Replace the transformer by reversing this procedure. Be sure to check the picture for sharpness after the transformer is replaced. If appropriate, readjust the FOCUS control as described in Chapter 3.

CRT PCB Replacement

1. Disconnect the 6-pin and 3-pin video-signal connectors from the Main PCB. Disconnect the 2-pin power connector in the harness near the display.
2. Remove the Disco display assembly from the cabinet as described in the game manual.
3. Discharge the high voltage from the CRT as described in step 3 under *Cathode-Ray Tube Replacement*.
4. Unplug the 1-pin connector (ground) on the CRT PCB. Gently pull the CRT PCB from the neck pins of the CRT.
5. Remove the wires from the square-pin connectors on the CRT PCB.
6. Pry off the white square cap on the CRT PCB.
7. Unsolder the large black wire that is attached to the white connector.
8. To replace the CRT PCB, reverse the order of this procedure.

7 Adjustments and Testing

WARNING

Remember to observe the precautions regarding high voltages when making adjustments on this display!

Before adjusting the display, remove the display assembly from the game using the procedure given in the game manual.

Video B+ Adjustment

1. Set SCREEN control VR707 on the CRT PCB for maximum brightness and BRIGHT control VR201 to mid-range. Refer to Figure 4 for the location of the SCREEN control.
2. Remove power from the display.
3. Set a DC voltmeter to the 0-volt to +150-volt range.
4. Connect the plus lead of the voltmeter to test point A1, which is shown in Figure 8.
5. Apply power to the display.
6. Adjust VR001 on the Main PCB, shown in Figure 8, for a voltmeter reading of +115 volts.
7. Return SCREEN control VR707 and BRIGHT control VR201 to their normal settings.

Purity Adjustments

NOTE

The convergence adjustments must be performed after completion of the purity adjustments.

1. Set up the display for the purity adjustments as follows:
   a. Remove power from the display.
   b. Loosen the screws that are used to tighten the deflection yoke and convergence-magnet assembly clamps to the neck of the CRT.
   c. Remove any glue that may be holding the purity magnets in place.
   d. Remove the cloth tapes securing the three rubber wedges beneath the deflection yoke of the CRT. Use a razor blade or thin knife to loosen any glue holding the rubber wedges to the CRT surface. Remove these wedges.
   e. Position the display so that the CRT faces either north or south. Degauss the CRT with a handheld degaussing coil.
   f. Apply power to the display.

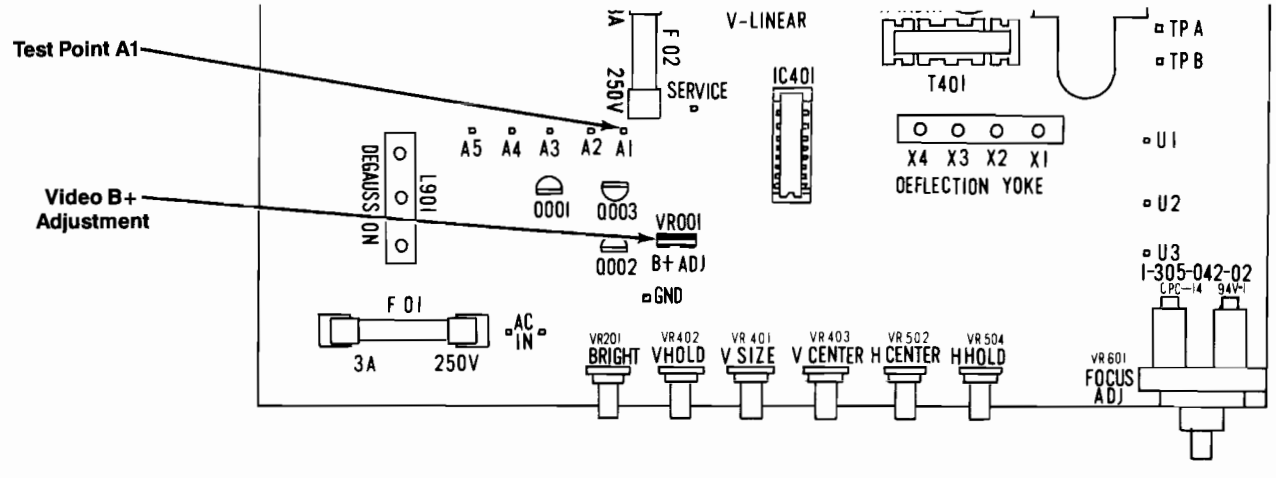


Figure 8 Locations of Video B+ Adjustment VR001 and Test Point A1

2. Position the convergence-magnet assembly so that the purity rings shown in Figure 9 are positioned directly over the gap in the cathode-ray tube gun assembly. This is about two inches forward from the start of the neck glass.
3. Secure the convergence-magnet assembly in position by tightening the neck-clamp mounting screw.
4. Set the game to display the self-test diagnostic pattern that shows a vertical and horizontal crosshatch with all three colors. This may appear as a white crosshatch pattern on the screen. (Refer to the Self-Test Procedure in the game manual for the details on selecting self-test diagnostic patterns.)
5. Preset the convergence magnets to superimpose the red, blue, and green lines at the center of the screen.
6. Set the game so it displays only the green crosshatch diagnostic pattern. If the game does not produce a green-only crosshatch pattern, turn off R-DRIVE VR703 and B-DRIVE VR701 of the display CRT PCB. Refer to Figure 10 for the locations of the Drive controls.
7. Slide the deflection yoke toward the magnet assembly to produce a vertical green band within the center of the crosshatch pattern.
8. Adjust the purity rings of the magnet assembly shown in Figure 9 to center the green band horizontally on the face of the CRT.

NOTE

The purity rings must only affect the horizontal centering of the display. If they have a vertical or a diagonal centering effect, rotate the entire magnet assembly so that the purity rings affect *only* the horizontal centering.

9. Slowly slide the deflection yoke forward until the crosshatch pattern is all green. Tighten the yoke-mounting screw.
10. Set the game to display the self-test diagnostic pattern that shows a crosshatch pattern of all three colors. If you turned off the R-DRIVE and B-DRIVE controls of the display, return them to their normal settings.
11. Check the display for good overall purity.
12. Perform the convergence adjustments.

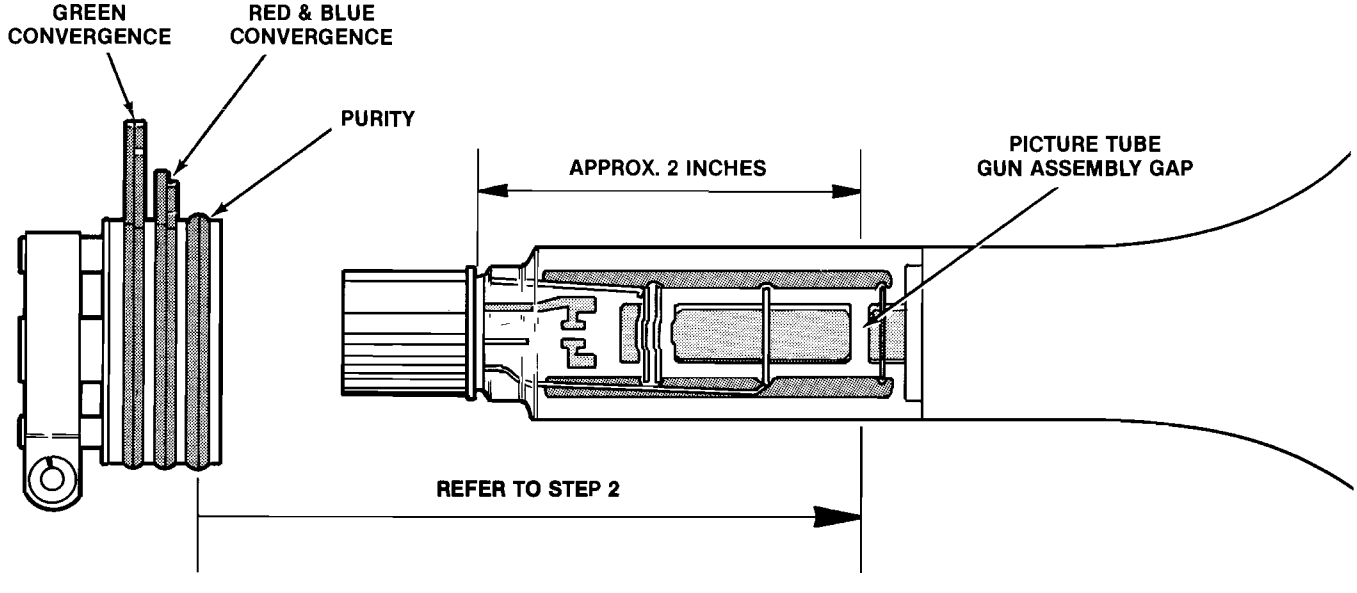


Figure 9 Purity and Convergence Adjustments

Convergence Adjustments

NOTE

If the purity adjustments have been performed, you must also perform the entire convergence adjustments procedure.

1. Adjust for static convergence, which aligns the registration of all three colors over the entire screen area, as follows:
   a. Set the game to display the self-test diagnostic pattern that shows a crosshatch of all three colors. This may appear as a white crosshatch pattern. (Refer to the Self-Test Procedure in the game manual for the details on selecting self-test diagnostic patterns.)
   b. Adjust the angle of the tabs of the red and blue convergence magnets to superimpose the red and blue vertical lines in the center of the screen area. This will produce magenta vertical lines at screen center. These magnets are shown in Figure 9.

NOTE

Do not attempt to adjust the convergence of the outer areas of the screen at this time.

   c. Keeping their angles the same, rotate both tabs of these magnets to superimpose the red horizontal lines on the blue horizontal lines in the center of the screen area. This produces magenta horizontal lines at screen center.
   d. Adjust the angle between the tabs of the green convergence magnets to superimpose the green vertical lines on the magenta vertical lines already converged in the center of the screen.
   e. Keeping the tab angles the same, rotate these rings to superimpose the green horizontal lines on the magenta horizontal lines already converged in the center of the screen.
2. Adjust for dynamic convergence, which aligns the registration of all three colors at the outer areas of the screen, as follows:
   a. If not already done as part of the purity adjustments, loosen the screw securing the deflection yoke assembly to the neck of the CRT. Remove the cloth tapes holding the three rubber wedges beneath the yoke. Use a razor blade or thin knife to loosen any glue securing the three rubber wedges to the CRT. Remove these wedges.
   b. Tilt the deflection yoke in a vertical direction to superimpose the red horizontal lines on the blue and green horizontal lines at the 3 o'clock and 9 o'clock positions of the screen. This produces white horizontal lines.
   c. While maintaining the vertical position of the yoke, tilt it in a horizontal direction to superimpose the red crosshatch on the blue and green crosshatch patterns at the 6 o'clock and 12 o'clock positions of the screen. This produces a white crosshatch pattern.
   d. Install the three rubber wedges firmly beneath the yoke collar to hold the yoke in position. Recheck the convergence of the display. If necessary, repeat parts b and c of this step and the static convergence adjustments of step 1.
3. Secure the rings of the convergence-magnet assembly and the rubber yoke wedges with white glue. Replace the cloth tapes over the rubber wedges.
4. Tighten the deflection-yoke mounting screw.

Tracking Adjustments

1. Remove power from both the game and the display.
2. Disconnect the 6-pin and 3-pin video-signal connectors, which are wired to the Main PCB. Disconnect the 2-pin power connector in the harness near the display.
3. On the CRT PCB, set the R-DRIVE, B-DRIVE, and the R-, G-, and B-BIAS controls to their mechanical centers. Turn the SCREEN control VR707 to minimum (fully counterclockwise). Figure 10 shows the location of all the tracking adjustments on the CRT PCB.
4. On the Main PCB, set the BRIGHT control VR201 to its mechanical center.
5. Apply power to the display.
6. Slowly adjust SCREEN control VR707 until the CRT screen shows the first hint of color. Do not adjust the bias control for the color which first appeared on the CRT screen. Slowly adjust the bias controls for the other two colors until the CRT screen is a faint grey. Now reduce the SCREEN setting until the color just disappears.
7. Remove power from the display. Reconnect the 6-pin and 3-pin video-signal connectors between the game and the display. Reconnect the 2-pin power connector.
8. Reapply power to both the game and the display.
9. Set the game to display the self-test diagnostic pattern that shows a white crosshatch. (Refer to the Self-Test Procedure in the game manual for detailed procedures on selecting the self-test diagnostic patterns.)
10. Adjust R-DRIVE and B-DRIVE for a neutral white crosshatch pattern. If necessary, readjust the SCREEN control on the CRT PCB for a proper black level.

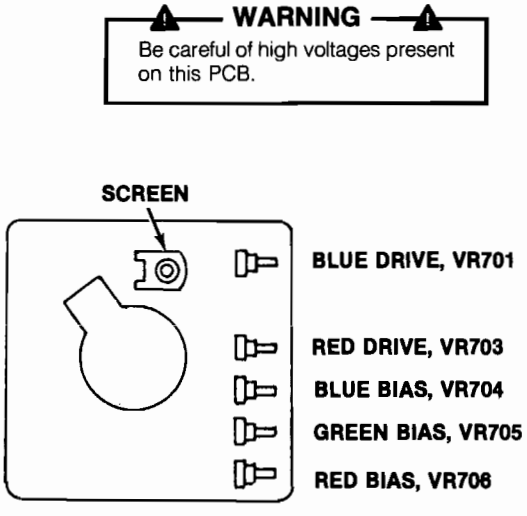


Figure 10 Locations of Tracking Adjustments on the CRT PCB

8 Illustrated Parts Lists

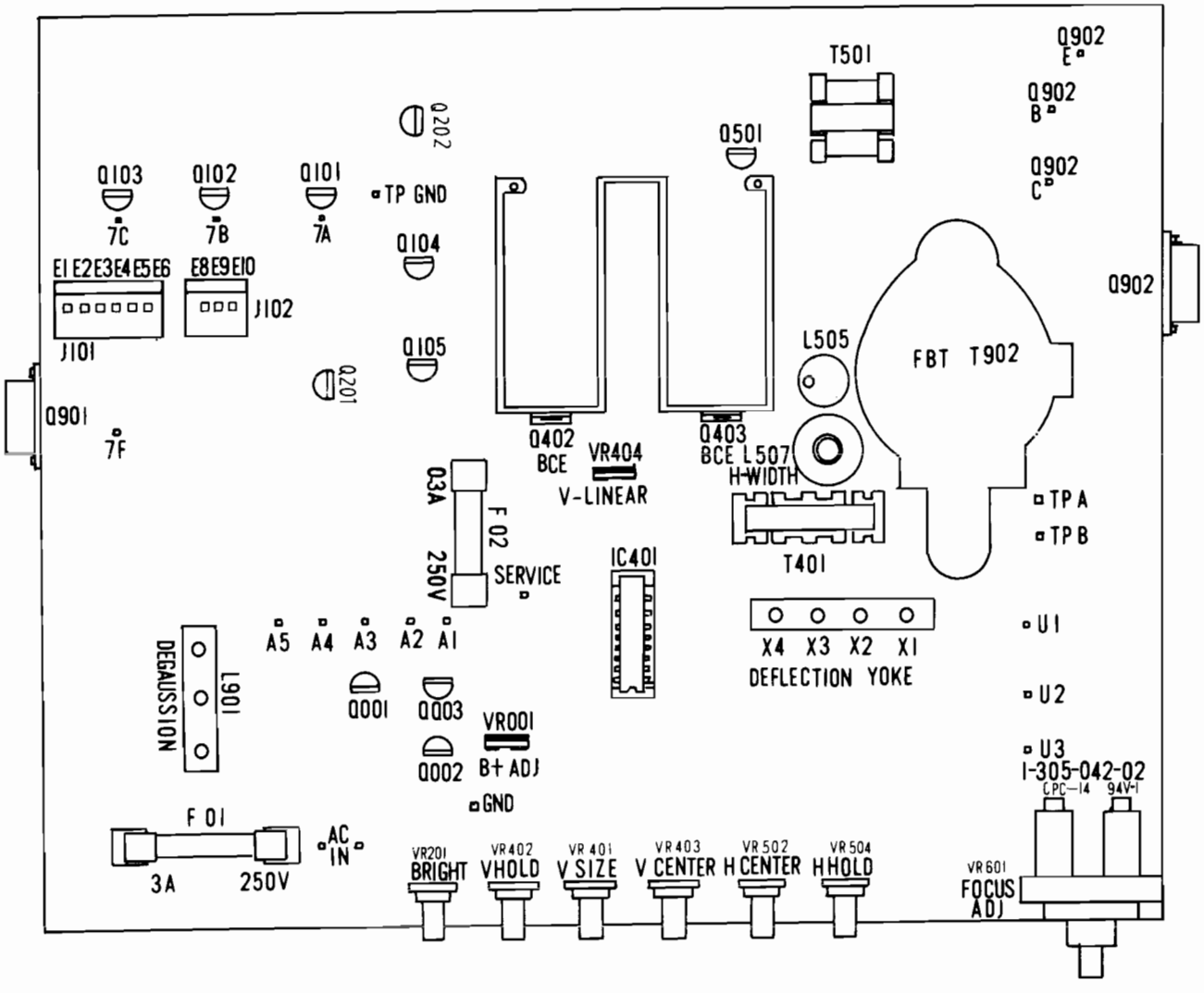


Figure 11 Main PCB Assembly
99-170161 B

Main PCB Assembly
Parts List

⚠ WARNING ⚠

Components identified by ⚠ have special characteristics important to safety and should be replaced only with identical types.

Designator	Description	Part No.
	Capacitors	
C001	⚠ 0.068 µF, ±10%, 125 V, Poly-Film Capacitor	99-170110
C003	1000 pF, ±10%, 1 kV , Ceramic Capacitor	99-170096
C004	470 µF, 180 V, Electrolytic Capacitor	99-170089
C005	4.7 µF, 160 V, Electrolytic Capacitor	99-170086
C006	22 µF, 160 V, Electrolytic Capacitor	99-170087
C009, C010	1000 pF, ±10%, 1 kV, Ceramic Capacitor	99-170096
C011	0.022 µF, ±5%, 50 V, Poly-Film Capacitor	99-170108
C107	10 µF, 16 V, Non-Polar Electrolytic Capacitor	99-170267
C109	1 µF, 50 V, Non-Polar Electrolytic Capacitor	99-170268
C110	10 µF, 16 V, Non-Polar Electrolytic Capacitor	99-170267
C111	1 µF, 50 V, Non-Polar Electrolytic Capacitor	99-170268
C115	10 µF, 50 V, Non-Polar Electrolytic Capacitor	99-170264
C113	0.01 µF, 50 V, Ceramic Capacitor	99-170116
C114	0.1 µF, ±10%, 50 V, Ceramic Capacitor	99-170092
C201	0.018 µF, ±10%, 100 V, Poly-Film Capacitor	99-170100
C202	0.068 µF, ±10%, 100 V, Poly-Film Capacitor	99-170101
C203	220 µF, 25 V, Electrolytic Capacitor	99-170079
C204	33 µF, 16 V, Electrolytic Capacitor	99-170076
C205	100 µF, 16 V, Electrolytic Capacitor	99-170077
C206	68 pF, ±5%, 50 V, Ceramic Capacitor	99-170093
C207	0.1 µF, ±10%, 50 V, Ceramic Capacitor	99-170092
C401	330 µF, 16 V, Electrolytic Capacitor	99-170078
C402	1 µF, ±10%, 25 V, Tantalum Capacitor	99-170112
C403	1 µF, 50 V, Electrolytic Capacitor	99-170081
C404	0.022 µF, ±5%, 50 V, Poly-Film Capacitor	99-170108
C405	0.0068 µF, ±5%, 50 V, Poly-Film Capacitor	99-170106
C406	470 pF, ±10%, 500 V, Ceramic Capacitor	99-170094
C407	10 µF, 50 V, Electrolytic Capacitor	99-170082
C408	22 µF, 160 V, Electrolytic Capacitor	99-170087
C409	10 µF, ±10%, 35 V, Tantalum Capacitor	99-170114
C410	0.022 µF, ±5%, 50 V, Poly-Film Capacitor	99-170108
C411	0.0068 µF, ±10%, 200 V, Poly-Film Capacitor	99-170102
C412	100 µF, 160 V, Electrolytic Capacitor	99-170088
C413	330 µF, 50 V, Electrolytic Non-Polar Capacitor	99-170083
C503	10 µF, 16 V, Electrolytic Capacitor	99-170075
C505	0.015 µF, ±5%, 50 V, Poly-Film Capacitor	99-170107
C506	0.01 µF, ±5%, 50 V, Poly-Film Capacitor	99-170109
C507	0.33 µF, ±5%, 250 V, Poly-Film Capacitor	99-170104
C508	0.18 µF, ±5%, 250 V, Poly-Film Capacitor	99-170103
C509	0.0056 µF, ±5%, 50 V, Poly-Film Capacitor	99-170099

Continued on next page

Main PCB Assembly, continued
Parts List

Designator	Description	Part No.
C510	100 µF, 16 V, Electrolytic Capacitor	99-170077
C520	0.47 µF, 160 V, Electrolytic Capacitor	99-170084
C521	470 pF, ±10%, 500 V, Ceramic Capacitor	99-170094
C522	2200 pF, ±10%, 500 V, Ceramic Capacitor	99-170095
C523	⚠ 1000 pF, ±10%, 1 kV, Ceramic Capacitor	99-170096
C525	⚠ 2700 pF, ±10%, 2 kV, Ceramic Capacitor	99-170098
C526	2800 pF, ±5%, 2 kV, Poly-Film Capacitor	99-170105
C527	33 µF, 16 V, Electrolytic Capacitor	99-170076
C528	0.0068 µF, ±5%, 50 V, Poly-Film Capacitor	99-170106
C529	4.7 µF, 160 V, Electrolytic Capacitor	99-170086
C531	0.022 µF, ±5%, 50 V, Poly-Film Capacitor	99-170108
C532	10 µF, 16 V, Electrolytic Capacitor	99-170075
C533	1 µF, 50 V, Electrolytic Capacitor	99-170081
C536	2800 pF, ±5%, 2 kV, Poly-Film Capacitor	99-170105
C537	0.001 µF, ±5%, 50 V, Poly-Film Capacitor	99-170115
C601	22 µF, 160 V, Electrolytic Capacitor	99-170087
C602	470 µF, 25 V, Electrolytic Capacitor	99-170080
C603	470 pF, ±10%, 500 V, Ceramic Capacitor	99-170094
C604	4.7 µF, 250 V, Electrolytic Capacitor	99-170090
C605	1 µF, 160 V, Electrolytic Capacitor	99-170085
C606	0.033 µF, ±10%, 250 V, Poly-Film Capacitor	99-170266
	Coils and Ferrite Lead Beads	
L001	⚠ Line Filter	99-170139
L501	3.3 µH Inductor	99-170140
L504	0.2 µH Ferrite Bead	99-170141
L505	Linearity Coil	99-170143
L506	3.3 µH, 75 MHz Series Resonant Frequency Choke	99-170145
L507	Horizontal Width Coil	99-170142
L602	5.1 µH Filter Coil	99-170144
	Connectors and Miscellaneous Hardware	
J101	6-Pin Connector	99-170155
J102	3-Pin Connector	99-170236
P901	2-Pin Power Connector	99-170151
VR601	⚠ Focus Control Variable Resistor	99-170200
	High-Voltage Bushing	99-170156
	CRT Ground Spring	99-170157
	1-Pin Connector Assembly	99-170149
	Plastic Wire Tie	99-170158
	GT Pin	99-170150
	Square Pin	99-170163
	3 × 8 Screw	99-170159
	1-Pin Connector	99-170152

Continued on next page

Main PCB Assembly, continued
Parts List

Designator	Description	Part No.
	Diodes	
D003	Type-RZ-3 Diode	99-170124
D004	⚠ Type-HZ6C Zener Diode	99-170129
D005, D006	Type-1N4148 Diode	99-170125
D007–D010	⚠ Type-GP-15G Diode	99-170123
D101–D109	Type-1N4148 Diode	99-170125
D201	Type-1N4148 Diode	99-170125
D204–D206	Type-1S1555 Diode	99-170126
D207	Type-BZX85C12 12 V Zener Diode	99-170227
D402	⚠ Type-HZ36-2 Zener Diode	99-170132
D501	Type-EQA01-15R 15 V Zener Diode	99-170131
D601, D602	Type-RGP10G Diode	99-170128
	Fuses and Fuse Holders	
(F001)	Fuse Holder	99-170165
F001	⚠ Slow-Blow 3A Fuse	99-170160
F002	⚠ 0.3 A Fuse	99-170164
(F002)	Fuse Holder	99-170165
	Integrated Circuits and Sockets	
(IC401)	20-Pin IC Socket	99-170162
IC401	Type-HA11423 Integrated Circuit	99-170117
	Resistors	
POS001	Type-PTH451B02 Posistor	99-170058
R001	2.2 Ω, ±5%, 8 W, Wire-Wound Resistor	99-170057
R002	56 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170028
R004	680 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170011
R006	5.6 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170019
R007	120 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170031
R008	12 kΩ, ±5%, 2 W, Metal-Oxide Resistor	99-170051
R009	5.6 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170019
R010	1.5 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170013
R011	27 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170002
R012	3.3 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170016
R013	4.7 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170018
R014	100 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170030
R017	100 Ω, ±5%, 6 W, Wire-Wound Resistor	99-170056
R101–R106	1 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170012
R113	10 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170022
R115	18 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170024
R116	1.8 kΩ, ±5%, ¼ W, Carbon Resistor	99-170259
R117	3.9 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170017
R118	4.7 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170018
R119	6.8 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170020
R120–R122	1 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170012
R152-R154	8.2 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170021
R201	1 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170012

Continued on next page

Main PCB Assembly, continued
Parts List

Designator	Description	Part No.
R202	5.6 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170019
R203	6.8 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170020
R204	3.9 kΩ, ±10%, ½ W, Carbon-Composition Resistor	99-170039
R205	39 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170026
R206	5.6 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170019
R207	39 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170026
R208	10 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170022
R209	3.9 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170017
R210	390 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170009
R211	150 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170032
R212	2.7 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170015
R213	100 Ω, ±5%, 1 W, Metal-Oxide Resistor	99-170044
R214	150 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170005
R215	180 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170006
R401	120 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170004
R405	680 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170011
R406	2.2 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170014
R407	22 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170025
R408	8.2 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170021
R409	270 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170007
R410	8.2 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170021
R411	6.8 Ω, ±5%, ½ W, Carbon-Deposit Resistor	99-170033
R412	2.2 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170014
R414	2.7 kΩ, ±5%, 1 W, Metal-Oxide Resistor	99-170046
R415	3.3 kΩ, ±5%, 1 W, Metal-Oxide Resistor	99-170047
R417	220 Ω, ±5%, 3 W, Wire-Wound Resistor	99-170261
R418	18 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170024
R419	3.3 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170016
R420	1 kΩ, ±5%, ½ W, Carbon-Deposit Resistor	99-170036
R421, R422	12 Ω, ±5%, ½ W, Carbon-Deposit Resistor	99-170035
R423	6.8 kΩ, ±5%, 1 W, Metal-Oxide Resistor	99-170048
R424	1.8 kΩ, ±5%, 2 W, Metal-Oxide Resistor	99-170260
R426	⚠ 16.5 kΩ, ±1%, ¼ W, Metal-Film Resistor	99-170042
R427	⚠ 39 kΩ, ±1%, ½ W, Metal-Film Resistor	99-170043
R430	470 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170010
R501	6.8 kΩ, ±5%, 3 W, Metal-Oxide Resistor	99-170052
R503	47 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170027
R504	100 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170003
R505	5.6 kΩ, ±10%, ½ W, Carbon-Composition Resistor	99-170040
R506	6.8 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170020
R507	10 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170022
R508	680 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170011
R509	470 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170010
R521	4.7 kΩ, ±5%, 2 W, Metal-Oxide Resistor	99-170049

Continued on next page

Main PCB Assembly, continued
Parts List

Designator	Description	Part No.
R522	2.2 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170014
R523	12 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170001
R524	100 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170003
R525	10 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170022
R526	68 kΩ, ±5%, ¼ W, Carbon-Deposit Resistor	99-170029
R527	10 kΩ, ±10%, ½ W, Carbon-Composition Resistor	99-170041
R535	1.2 kΩ, ±10%, ½ W, Carbon-Composition Resistor	99-170038
R601	10 Ω, ±5%, 6 W, Wire-Wound Resistor	99-170055
R602	0.5 Ω, ±5%, 2 W, Wire-Wound Resistor	99-170053
R603	1 kΩ, ±5%, ½ W, Carbon-Deposit Resistor	99-170036
R801	150 Ω, ±5%, 1 W, Metal-Oxide Resistor	99-170045
VR001	3 kΩ, B+ Adjustment Variable Resistor	99-170073
VR201	5 kΩ, V-Hold, Variable Resistor	99-170064
VR401	500Ω, V-Size, Variable Resistor	99-170061
VR402	5 kΩ, V-Hold, Variable Resistor	99-170064
VR403	50 kΩ, V-Center, Variable Resistor	99-170067
VR404	5 kΩ, V-Linearity, Variable Resistor	99-170071
VR501	5 kΩ, H-Hold, Variable Resistor	99-170064
VR502	200 Ω, H-Center, Variable Resistor	99-170070
W128	470 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170010
W166	1 kΩ, ±10%, ½ W, Carbon-Composition Resistor	99-170037
	Transformers	
T401	Side Pincushion-Correction Transformer	99-170146
T501	Horizontal-Drive Transformer	99-170147
T902	⚠ Flyback Transformer	99-170148
	Transistors	
Q001	Type-2SA1015Y Transistor	99-170121
Q002	Type-2SC945P Transistor	99-170120
Q003	Type-2SC945P Transistor	99-170120
Q101–Q103	Type-2SC1815(Y) Transistor	99-170119
Q104, Q105	Type-2SA1015Y Transistor	99-170121
Q201, Q202	Type-2SC1815(GR) Transistor	99-170276
Q402, Q403	Type-2SC2073-T(D) Transistor	99-170280
Q501	Type-2SC2229Y Transistor	99-170277

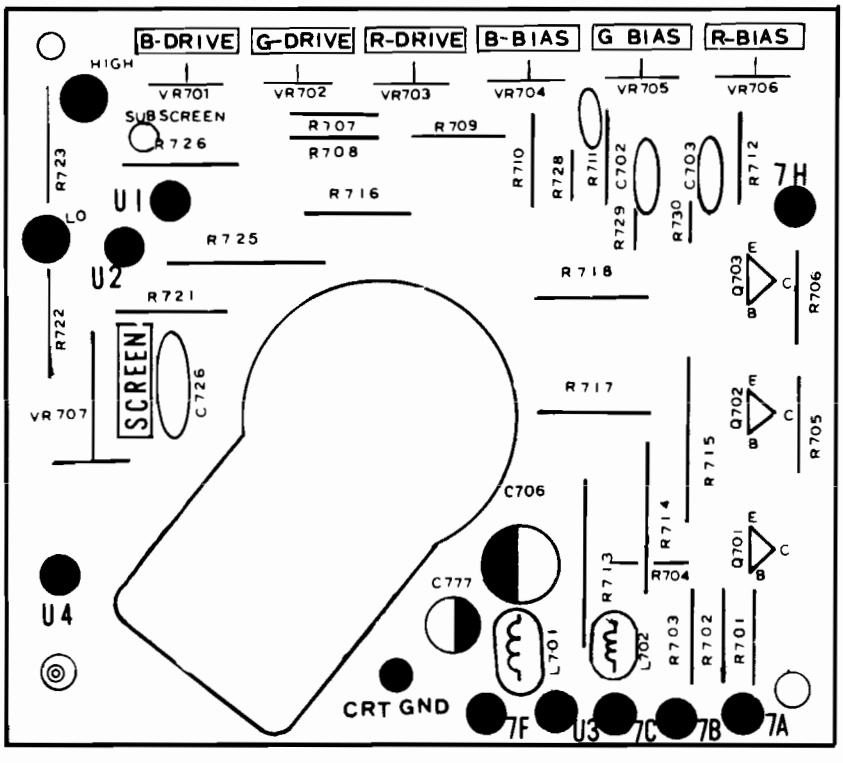


Figure 12 CRT PCB Assembly
99-170190 B

CRT PCB Assembly
Parts List

⚠ WARNING ⚠

Components identified by ⚠ have special characteristics important to safety and should be replaced only with identical types.

Designator	Description	Part No.
	Capacitors	
C701–C703	180 pF, ±5%, 50 V, Ceramic Capacitor	99-170182
C706	4.7 μF, 250 V, Electrolytic Capacitor	99-170090
C726	1000 pF, ±10%, 2 kV, Ceramic Capacitor	99-170183
C777	100 μF, 16 V, Electrolytic Capacitor	99-170077
C778	0.1 μF, 50 V, Ceramic Capacitor (located on circuit side of PCB)	99–170247
	Coils	
L701	70 MHz, Series Resonant Frequency Filter Coil	99-170188
L702	33 μH Peaking Coil	99-170189
	Resistors	
R707	470 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170010
R708	560 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170166
R709	470 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170010
R710–R712	560 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170166
R713–R715	10 kΩ, ±5%, 2 W, Metal-Oxide Resistor	99-170172
R716–R718	1.5 kΩ, ±10%, ½ W, Carbon-Deposit Resistor	99-170170
R721	2.7 kΩ, ±10%, ½ W, Composition Resistor	99-170241
R722	1 MΩ, ±10%, ¼ W, Carbon-Deposit Resistor	99-170167
R723	1.2 MΩ, ±10%, ½ W, Carbon-Deposit Resistor	99-170168
R725	1.2 Ω, ±5%, 2 W, Metal-Oxide Resistor	99-170173
R726	560 Ω, ±5%, ½ W, Carbon-Deposit Resistor	99-170169
R728	120 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170004
R729	150 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170005
R730	120 Ω, ±5%, ¼ W, Carbon-Deposit Resistor	99-170004
VR701	200 Ω Blue Drive Variable Resistor	99-170180
VR703	200 Ω Red Drive Variable Resistor	99-170179
VR704	10 kΩ Blue Bias Variable Resistor	99-170174
VR705	10 kΩ Green Bias Variable Resistor	99-170174
VR706	10 kΩ Red Bias Variable Resistor	99-170174
VR707	4 MΩ Screen Variable Resistor	99-170181
	Sockets	
	⚠ CRT Socket	99-170191
	Transistors	
Q701–Q703	Type-2SC1569 Transistor	99-170185

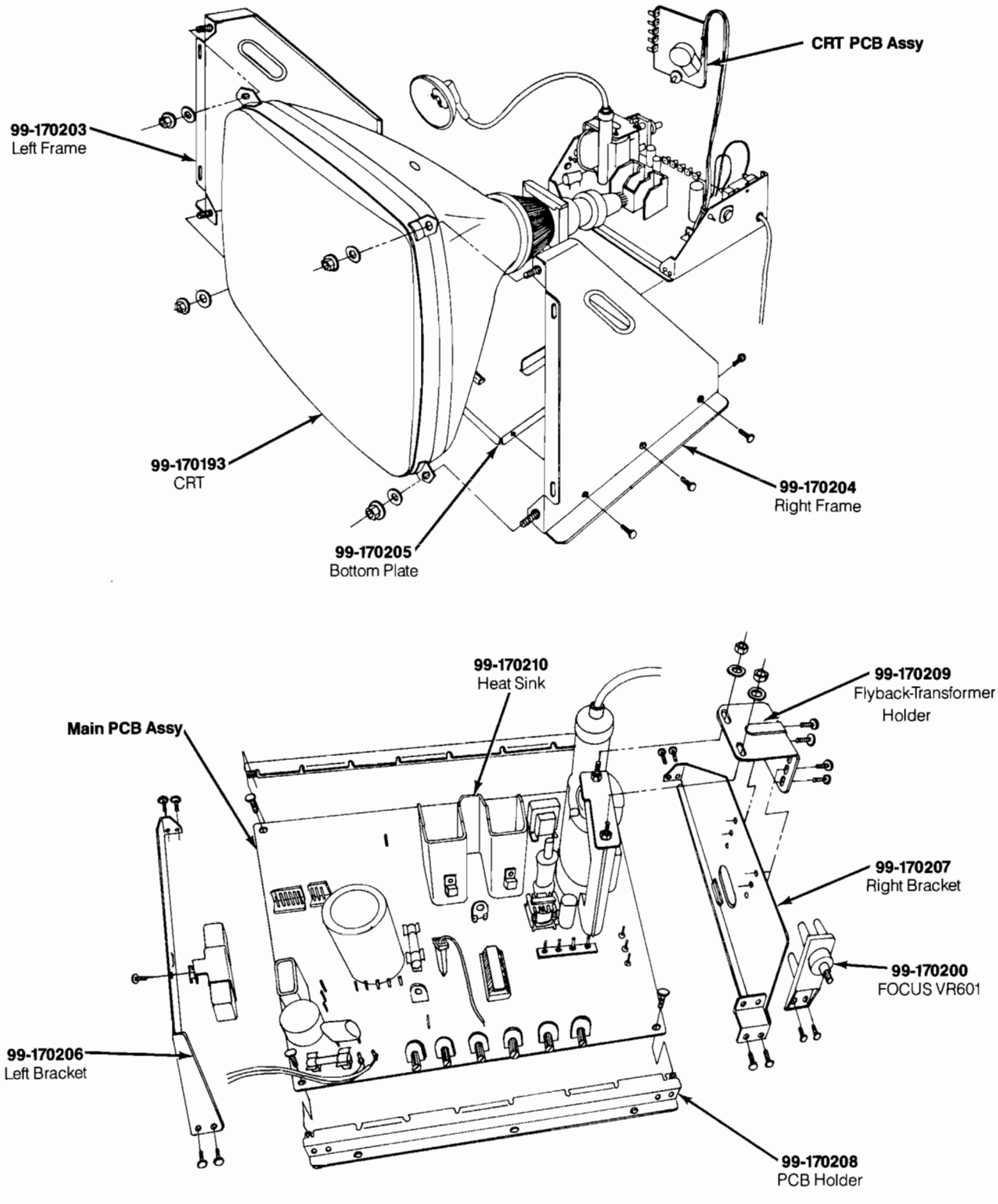


Figure 13 Display Assembly
139003-1006 B

Display Assembly Parts List

⚠ WARNING ⚠

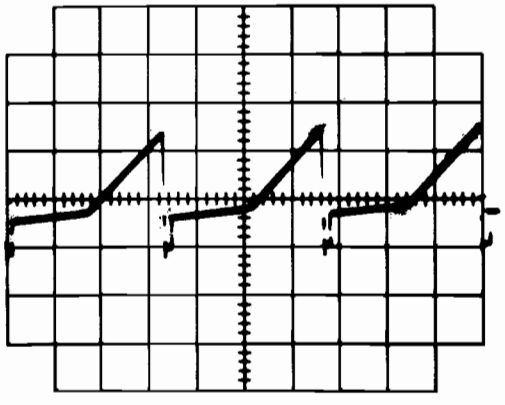
Components identified by ⚠ have special characteristics important to safety and should be replaced only with identical types.

Designator	Description	Part No.
	Main Printed-Circuit Board Assembly—*see Figure 11*	99-170161
	CRT Socket Printed-Circuit Board—*see Figure 12*	99-170190
	Resistors	
R901	270 Ω, ±10%, 20 W, Power Resistor (not shown)	99-170202
VR601	Type-MHF008-06 FOCUS Variable Resistor	99-170200
	Transistors	
Q901	Type-2SC1106 Transistor (not shown)	99-170194
Q902	Type-2SD870 Transistor (not shown)	99-170195
	Miscellaneous Hardware	
	0.2 μH Ferrite Core (not shown)	99-170199
	Type-19VKUP22 Cathode-Ray Tube	99-170193
L901	Degaussing Coil (not shown)	99-170192
	Left Frame	99-170203
	Right Frame	99-170204
	Bottom Plate	99-170205
(Q901)	Left Bracket	99-170206
(Q902)	Right Bracket	99-170207
	PCB Holder	99-170208
	Flyback-Transformer Holder (not shown)	99-170209
(Q402, Q403)	Heat Sink	99-170210
	AC Cord Bushing (not shown)	99-170211
	Handle Bushing (not shown)	99-170212

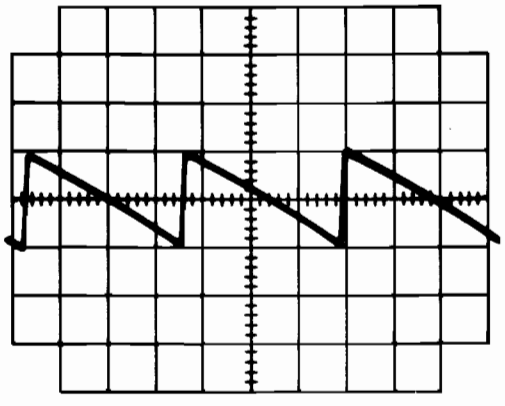
Appendix A Waveforms

NOTE

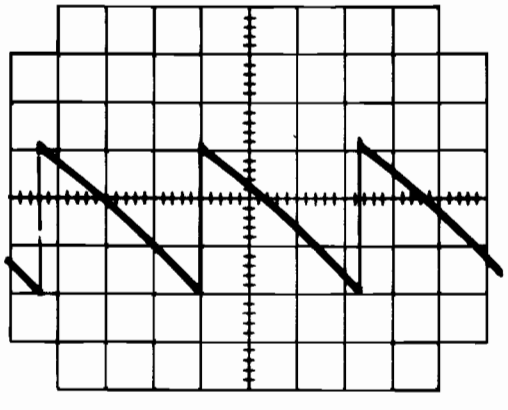
All waveforms were taken using a crosshatch-pattern generator signal.



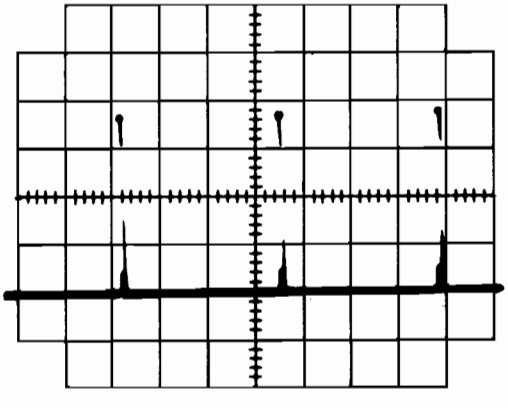
1. VERTICAL DRIVE
   At pin 1 of IC401. H: 5 ms/cm.
   V: 1 V/cm.



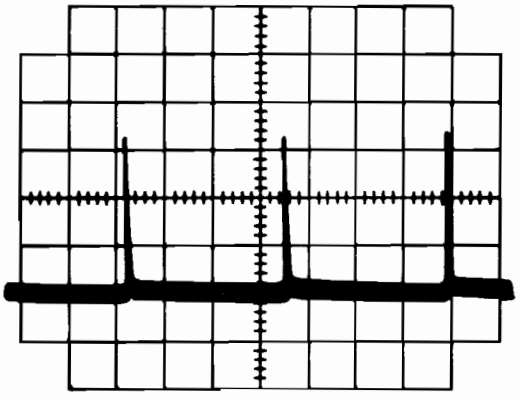
2. VERTICAL FEEDBACK
   At pin 2 of IC401. H: 5 ms/cm.
   V: 1 V/cm.



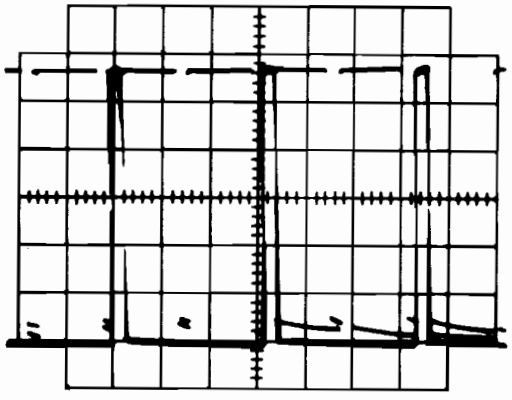
3. VERTICAL OSC 1
   At pin 3 of IC401. H: 5 ms/cm.
   V: 1 V/cm.



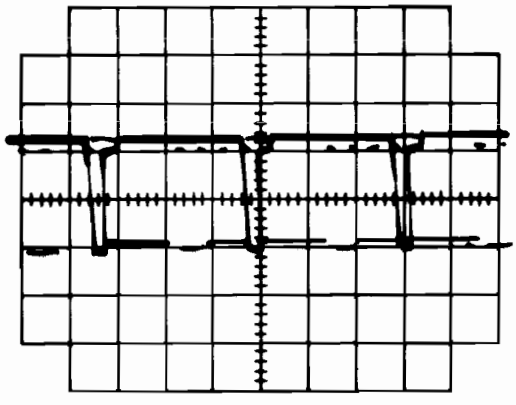
4. VERTICAL OSC 2
   At pin 6 of IC401. H: 5 ms/cm.
   V: 1 V/cm.



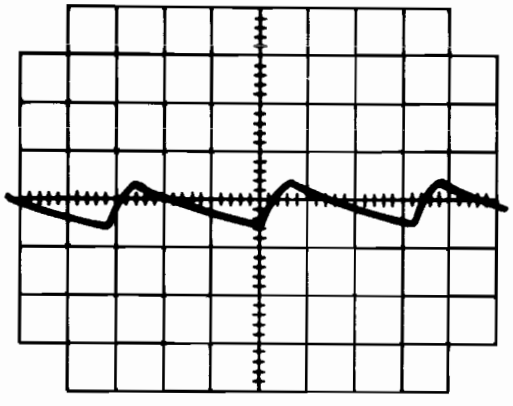
5. VERTICAL TRIGGER
At pin 7 of IC401. H: 5 ms/cm.
V: 1 V/cm.



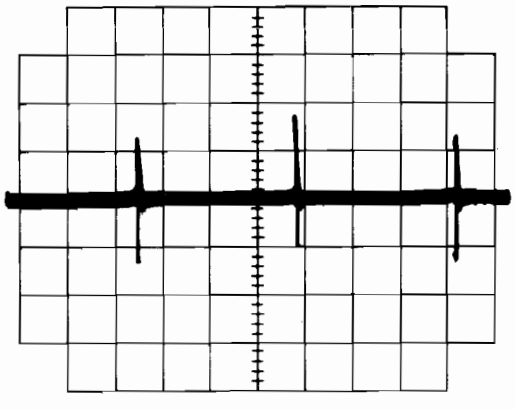
6. SYNC OUTPUT
At pin 8 of IC401. H: 20 μs/cm.
V: 2 V/cm.



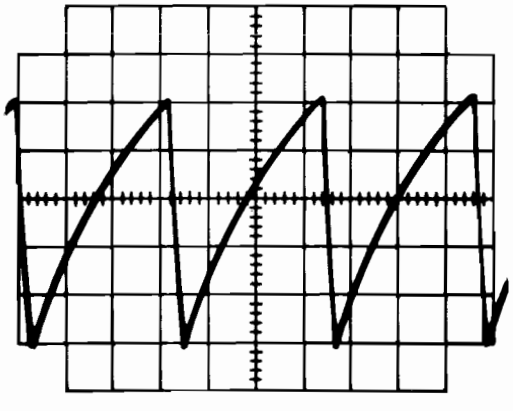
7. SYNC INPUT
At pin 10 of IC401. H: 20 μs/cm.
V: 1 V/cm.



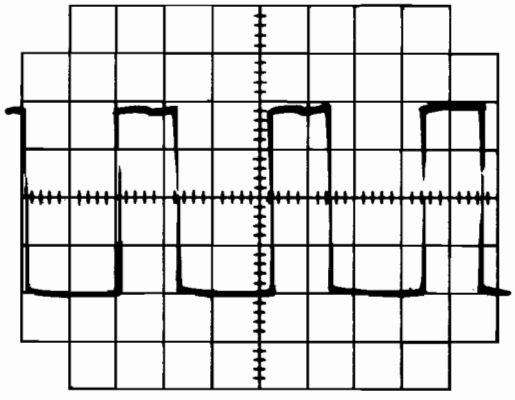
8. FLYBACK INPUT
At pin 11 of IC401. H: 20 μs/cm.
V: 0.5 V/cm.



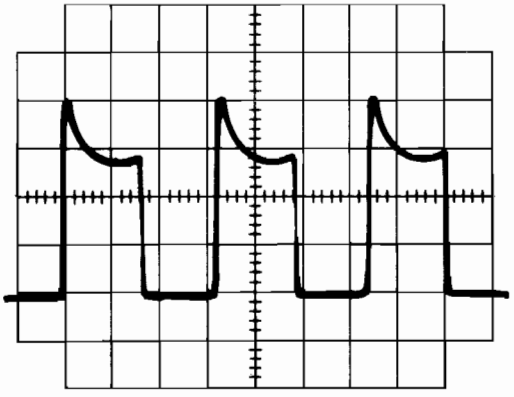
9. AFC FILTER
At pin 12 of IC401. H: 5 ms/cm.
V: 1 V/cm.



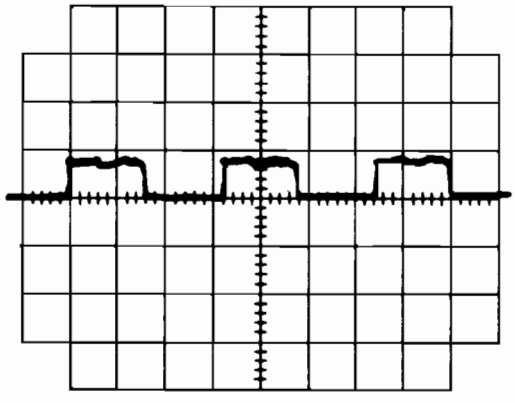
10. HORIZONTAL OSC
At pin 13 of IC401. H: 20 μs/cm.
V: 1 V/cm.



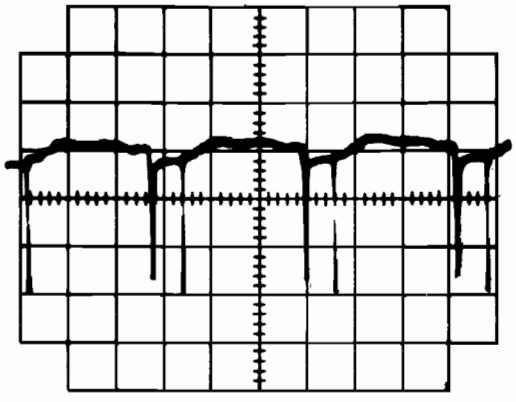
11. HORIZONTAL PRE-DRIVE OUTPUT
At pin 15 of IC401. H: 20 μs/cm.
V: 1 V/cm.



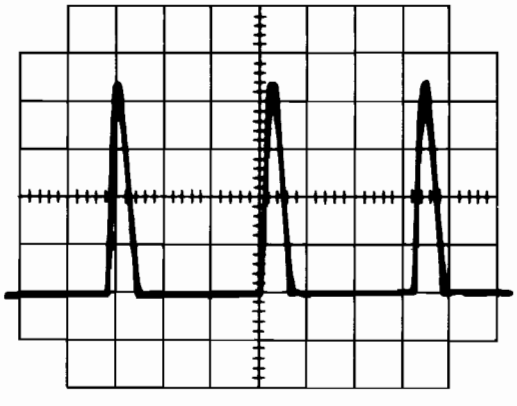
12. HORIZONTAL PRIMARY DRIVE
At collector of Q501. H: 20 μs/cm.
V: 20 V/cm.



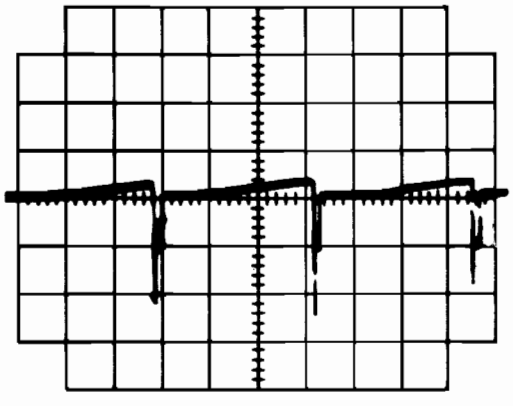
13. HORIZONTAL PRE-DRIVE INPUT
At base of Q501. H: 20 μs/cm.
V: 1 V/cm.



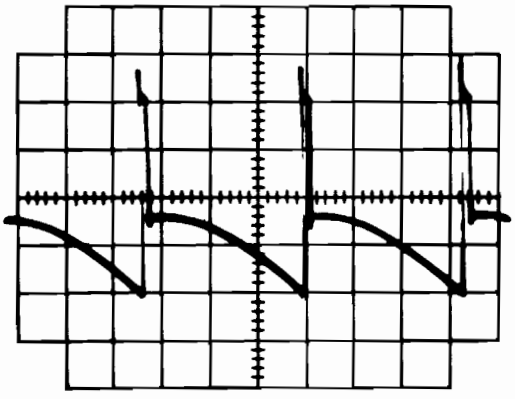
14. HORIZONTAL SECONDARY DRIVE
At base of Q902. H: 20 μs/cm.
V: 5 V/cm.



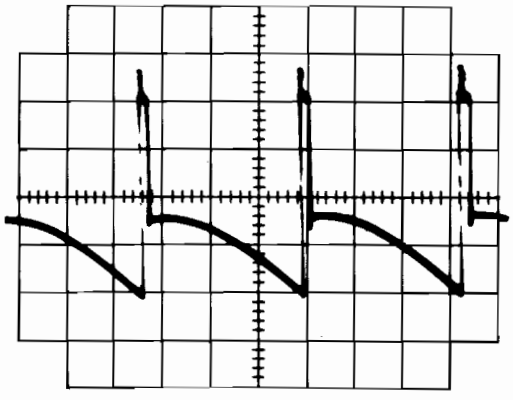
15. HORIZONTAL OUTPUT
At collector of Q902. H: 20 μs/cm.
V: 200 V/cm.



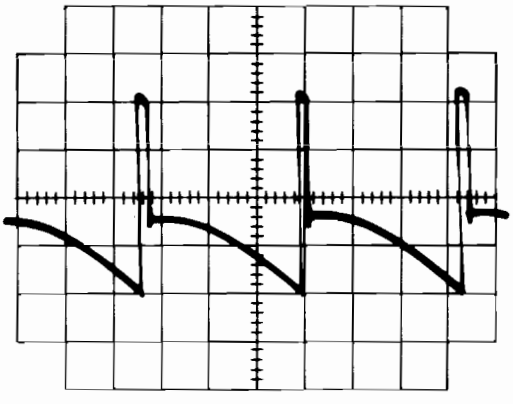
16. VERTICAL DRIVE INPUT-1
At base of Q403. H: 5 ms/cm.
V: 0.5 V/cm.



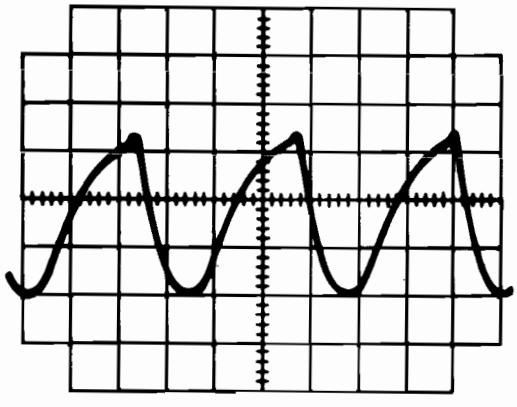
17. VERTICAL OUTPUT-1
At collector of Q403. H: 5 ms/cm.
V: 20 V/cm.



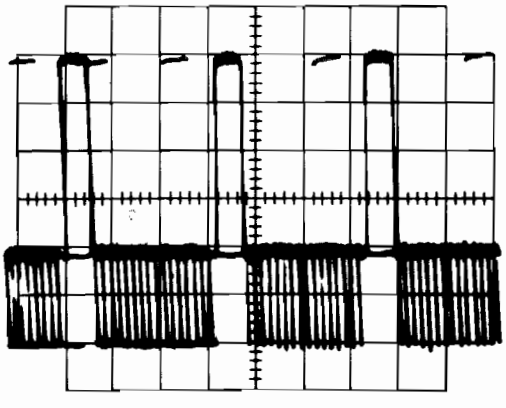
18. VERTICAL OUTPUT-2
At emitter of Q402. H: 5 ms/cm.
V: 20 V/cm.



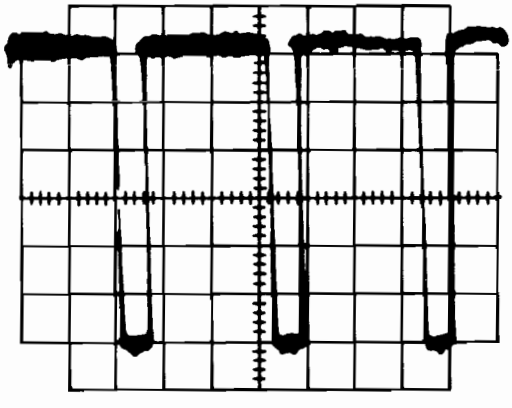
19. VERTICAL DRIVE INPUT-2
At base of Q402. H: 5 ms/cm.
V: 20 V/cm.



20. VERTICAL B +
At collector of Q402. H: 5 ms/cm.
V: 5 V/cm.



21. RGB OUTPUT
At collector of Q701–Q703.
H: 20 μs/cm. V: 20 V/cm.



22. BLANKING OUTPUT
At collector of Q202. H: 20 μs/cm.
V: 1 V/cm.

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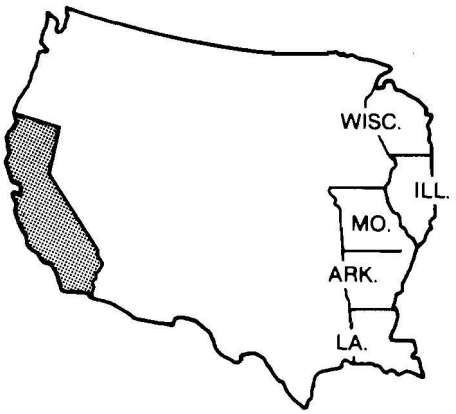

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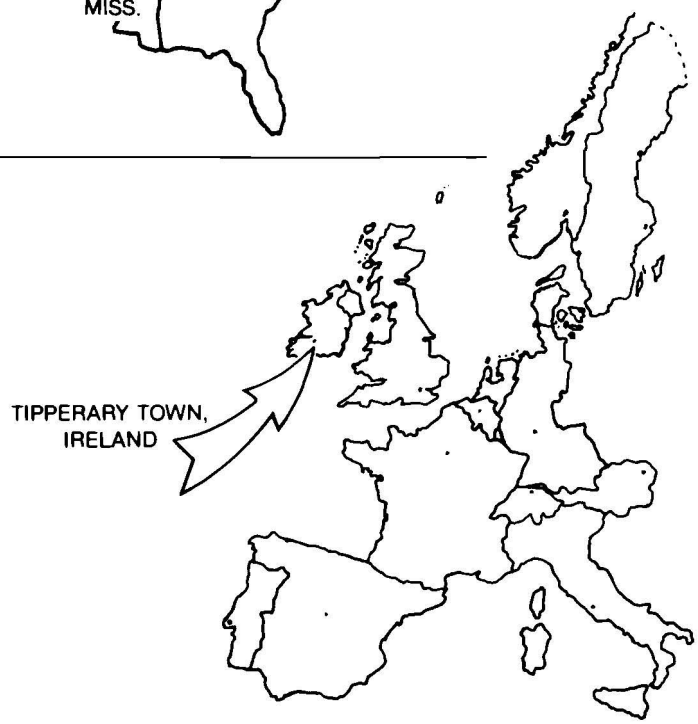

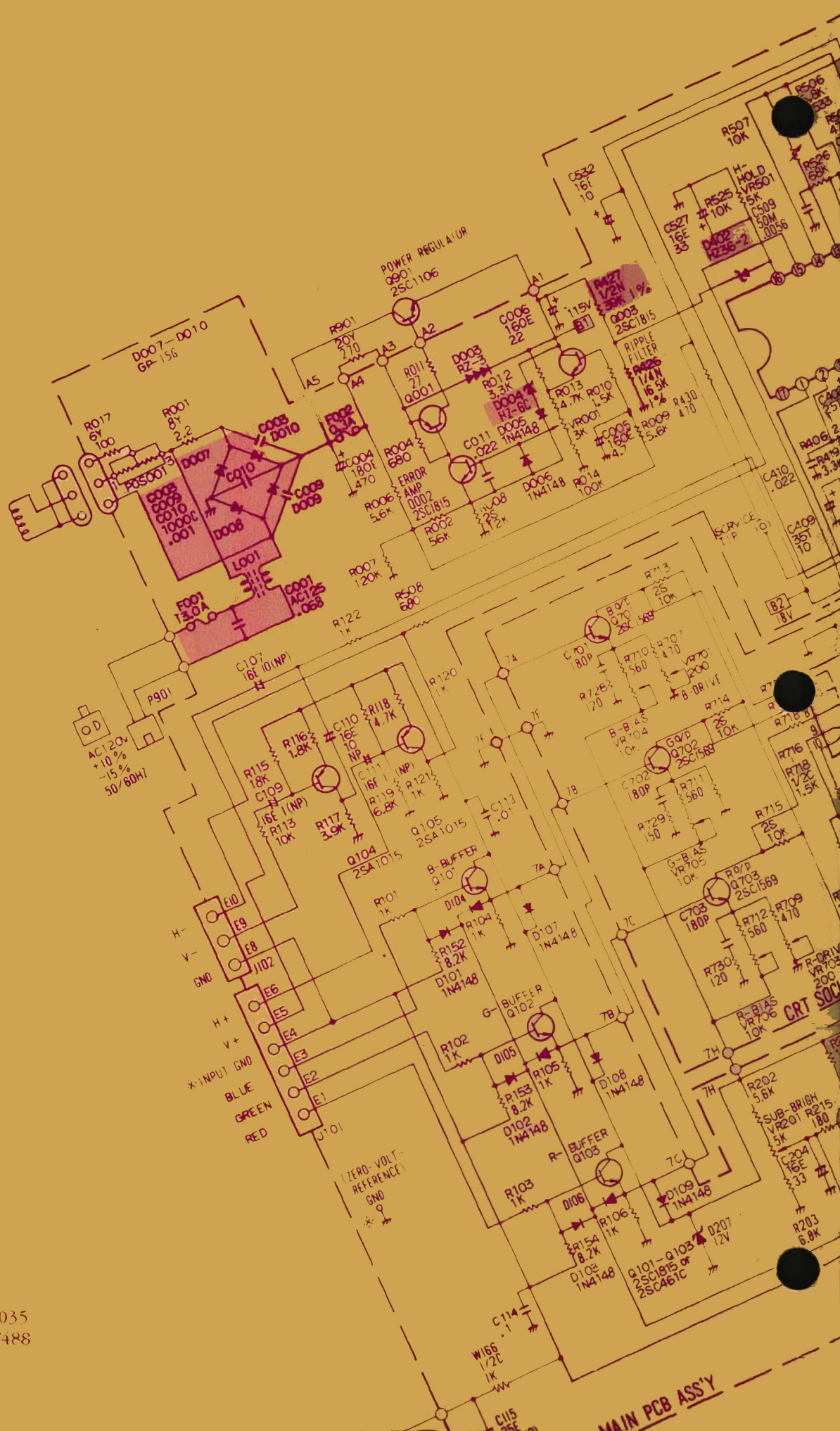

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