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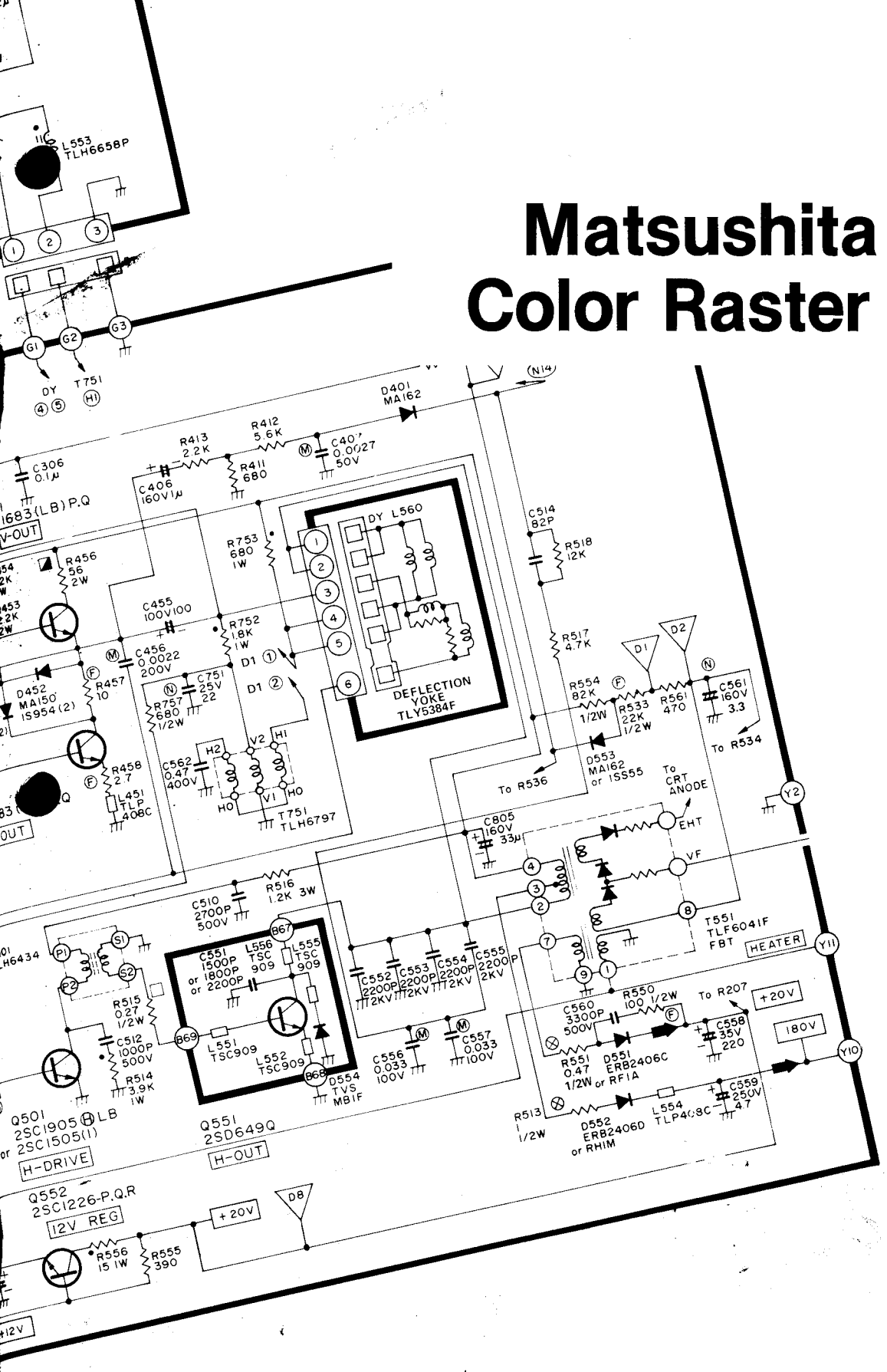
Matsushita 19-Inch Color Raster Display



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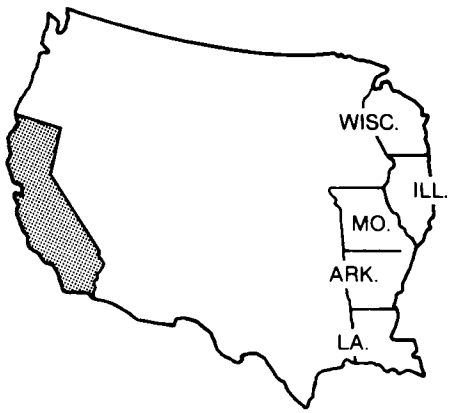

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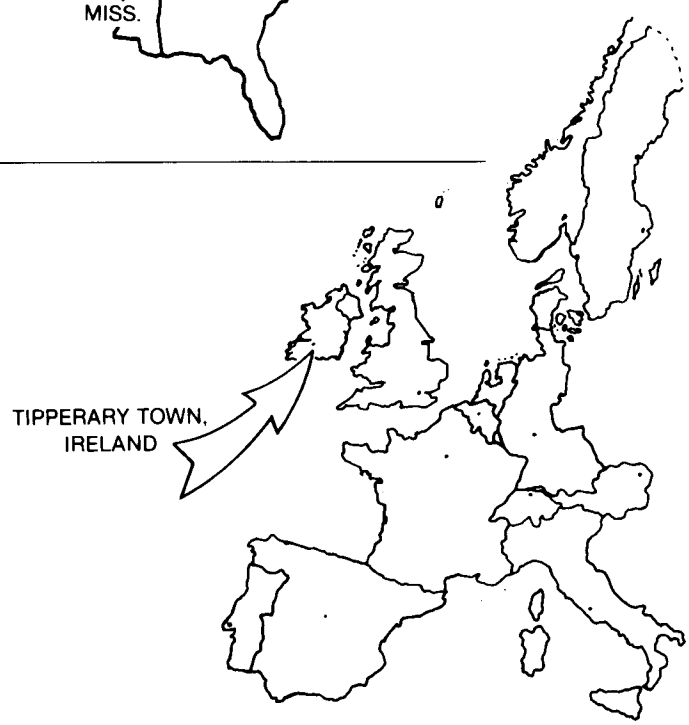

Matsushita 19-Inch Color Raster Display Service Manual

Complete with Schematic and Illustrated Parts Lists

Display manufactured by Matsushita Electric Industrial Co., Ltd.
Television Products Department
Osaka, Japan

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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 may cause injury to you and your players.

The warranty printed on the inside back cover of this manual may be voided, if you do any of the following:

- you substitute non-ATARI parts in your coin-operated game, or
- you modify or alter any circuits in your ATARI game by using kits or parts **not** supplied by Atari.

Not only may the use of any non-ATARI parts void your warranty, but any such alteration may also adversely affect the safety of your game and may cause injury to you and your players.

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1 Warnings and Cautions

This color raster display has been built to Atari specifications by Matsushita Electric Industrial Co., Ltd. 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 Video Amplifier PCB and Deflection PCB are mounted to the rear of the display chassis with the Video Amplifier PCB located above the Deflection PCB. The CRT PCB is attached to the neck pins of the CRT. The Degaussing PCB is mounted to the left side of the CRT neck, just behind the Video Amplifier PCB and Deflection PCB. Input signals for the display are supplied through a 6-pin connector on the Video Amplifier PCB.

A. 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 electric shock, due to high voltage or 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.

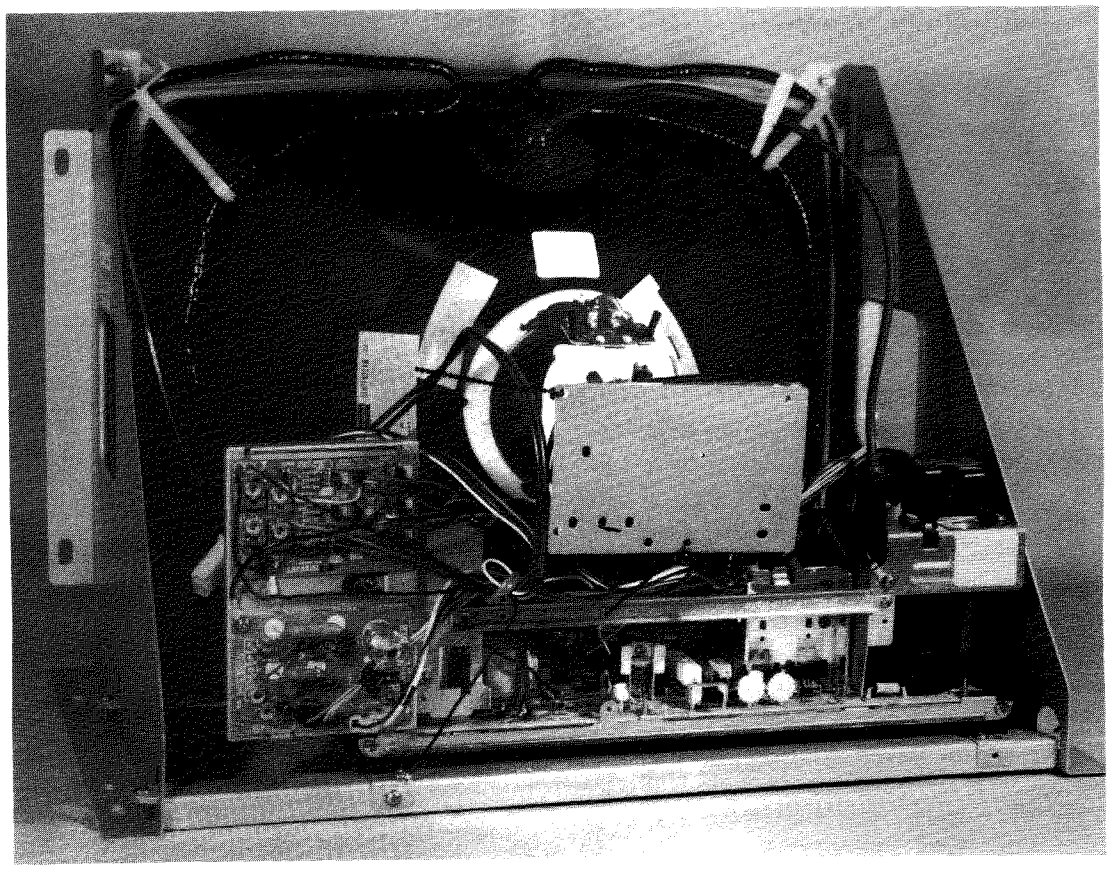


Figure 1 Overview of Matsushita 19-Inch Color Raster Display

WARNINGS

High-Voltage

This display contains high voltages capable of delivering lethal quantities of energy. To avoid danger, do not attempt to service the chassis until you have observed all precautions necessary for working on high-voltage equipment.

X-Radiation

This chassis has been designed for minimum X-radiation hazard. However, to avoid possible exposure to soft X-radiation, it is imperative that you never modify the high-voltage circuitry.

Implosion Hazard

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

B. 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 Matsushita 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 parts lists within the game manual for the Atari part number of the Power Supply Assembly for Color Raster Games.) 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.

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

Periodically check for frayed insulation on the wires within the display. If frayed wires are found, replace them with the same gauge, insulation type, thickness and length of wire. Always observe the original lead dress (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.

C. Cathode-Ray Tube Handling

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

Use extreme care when handling the CRT! 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.

If servicing the CRT, 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 20-kV jumper. Allow two minutes to pass and discharge the anode again.

D. Replace with Proper Components

Maintain the specified values of all components within the display. Failure to do so could cause a rise in the high voltage.

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.

E. Final Testing Before Reinstalling Display

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

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 all protective devices such as insulating fishpaper, compartment covers, and shields.
3. Perform the *Horizontal Oscillator Disable Circuit Test* given in Chapter 7.

2 Specifications

A. Power Input and Consumption

Line Voltage	120 VAC, within +10% and -15%; or 145 VDC, within ±5% (Atari, Inc. will specify the type of input voltage at the time of purchase.)
Line Frequency	47 to 63 Hz
Power Consumption	150 W maximum

B. Temperature and Humidity

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

C. Current and Voltages

CRT Anode Current (Average)	<700 μA
High Voltage	+26.5 kV ±1.5 kV
B+1	+180 V, within ±1.0 V
B+2	+123 V, within ±0.5 V (adjustable)
B+3	+20 V, within ±2.0 V
B+4	+12 V, within ±1.0 V
CRT Heater Voltage	±6.4 V, within ±0.2 VAC (RMS)

D. CRT Specifications

Convergence Tolerance:

At Screen Center	0.25 mm (0.4 mm total) maximum misconvergence
At Screen Edges	0.5 mm (0.7 mm total) maximum misconvergence
Color Purity:	Practically uniform throughout the screen area after degaussing with a hand-held degaussing coil.

Scan Rates:

Horizontal	15.750 kHz, within ±400 Hz
Vertical	60 Hz, within ±5 Hz
CRT Type:	#510TFB22AW, 19-inch, 90°
Tilt of Deflection Yoke:	Declination of a horizontal line is within 0.10 inch (2.54 mm) of CRT center markers.

E. Connectors

6-Pin Connector for Video Signals:

Pin 1	Not Used
Pin 2	Sync (negative composite)
Pin 3	Ground
Pin 4	Blue
Pin 5	Green
Pin 6	Red

2-Pin Connector for Power:

Pin 1	120 VAC
Pin 2	120 VAC

F. Monitor Input Signals

RGB Video Input Signals

The red, green, and blue input signals are at test points N1, N2, and N3 of the Video Amplifier PCB. Waveshape and polarity are as shown in Figure 2.

Sync Signal

The composite synchronization (Sync) signal of horizontal and vertical pulses is at test point D33 of the Main PCB. Sync amplitude is 1–5 volts peak-to-peak with a negative polarity. Pulse width is 3–5 μs horizontally and over 190.5 μs vertically.

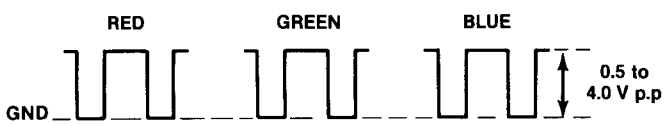


Figure 2 RGB Video Input Signals

G. Pattern Size

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

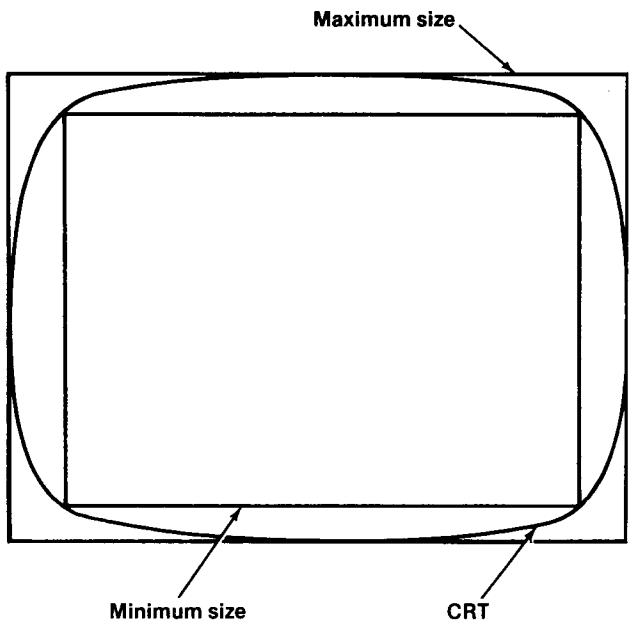


Figure 3 Display Pattern Sizes

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.

A. Brightness

BRIGHT control, R344, should be adjusted if the picture image is either too bright or too dark. Figure 4 shows the location of the BRIGHT control on the Video Amplifier printed-circuit board (PCB).

1. Place the game in the attract or play mode.
2. Using the BRIGHT control shown in Figure 4, adjust the display for a pleasing level of brightness.

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.

Do not use the SCREEN control to adjust the display brightness.

B. Contrast

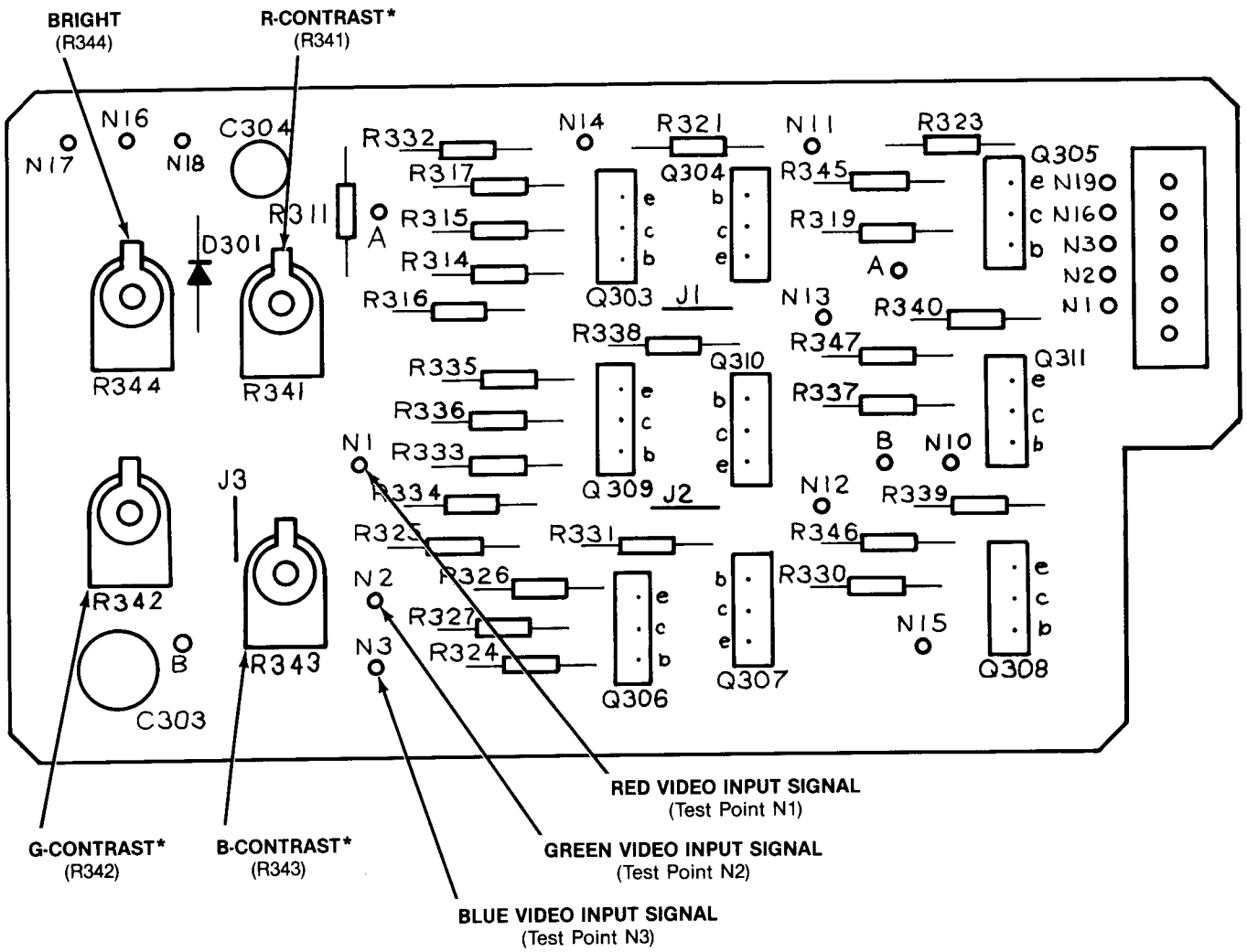
R-CONTRAST R341, G-CONTRAST R342, or B-CONTRAST R343 are not operator-adjustable controls. These controls are set at the factory.

C. Horizontal Hold

The H-HOLD control should be adjusted if the picture is drifting sideways across the screen. Figure 5 shows the location of H-HOLD control R505 on the Main PCB. Adjust this control until the black lines no longer slant sideways and a normal screen image is obtained.

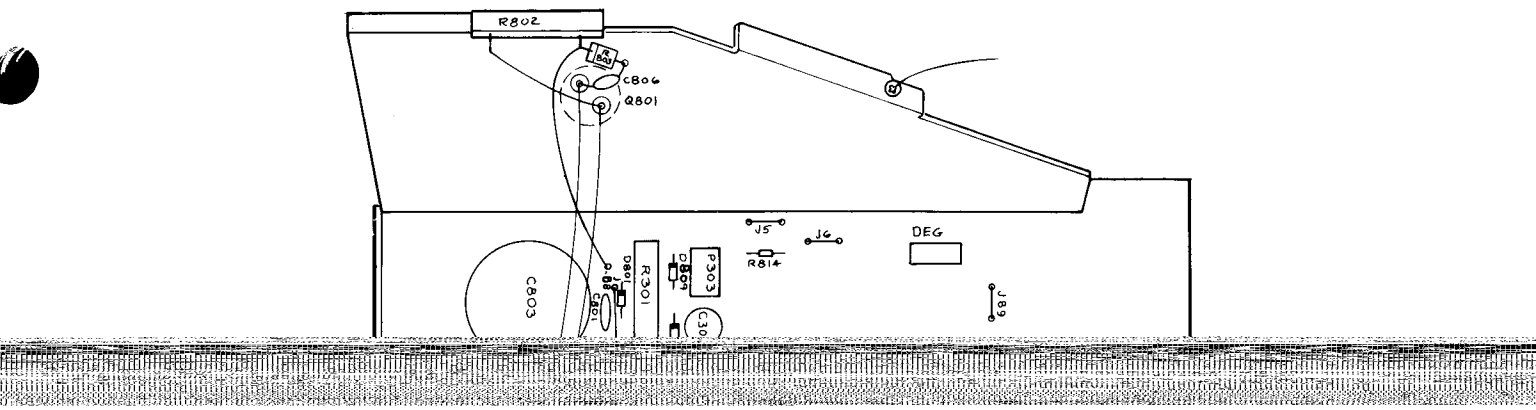
D. Vertical Hold

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 R402 on the Main PCB. Turn this control until the picture no longer drifts up or down on the screen.



*NOTE: The contrast controls are not operator adjustable.

Figure 4 Adjustable Controls and Test Points on Video Amplifier PCB


R802
C806
Q801
J5
J6
DEG
R814
P303
C803
R301
C30
J89

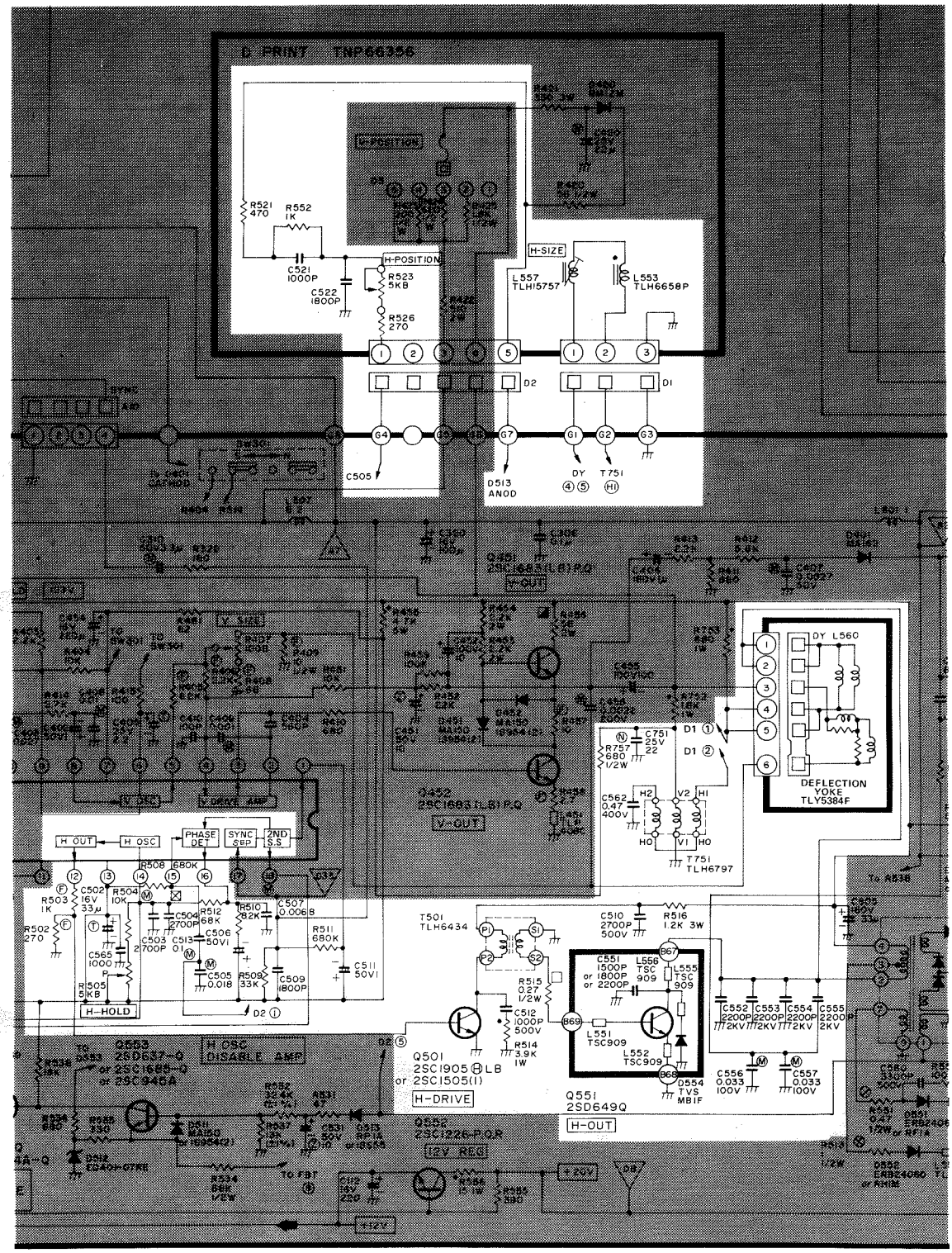


Figure 10 Horizontal Amplifier Schematic Diagram

C. Horizontal Oscillator Disable Circuit

The horizontal oscillator disable circuit turns off the horizontal oscillator within IC401 if the CRT heater voltage rises above + 10 volts. (Refer to Figure 11 for a schematic diagram of the horizontal oscillator disable circuitry.) The CRT heater voltage at Y11 of the Main PCB is rectified by diode D513 and applied through R531-R532 to the base of Q553. When the CRT heater voltage rises above + 10 volts, Q553 will conduct. This turns on Q554 and kills the horizontal oscillator via pin 14 of IC401.

D. 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 of the 6-pin connector to pin N3 of the Video Amplifier PCB. (Refer to Figure 12 for a schematic diagram of the blue Z amplifier.) From here the blue intensity signal is applied across B-CONTRAST control R343 and resistor R334 to common-base transistor Q309. Variable resistor R344, the BRIGHT control, sets the DC operating level for the input transistors of all three Z amplifiers. Transistor Q310 is the blanking transistor for the blue input amplifier. From the collector of Q309, the blue intensity signal is buffered by Q311 and applied across R347 to the base of blue output amplifier Q351 on the CRT PCB. After final amplification by Q351, the signal is applied through R354 to control the blue-cathode gun of the CRT. B-LOW LIGHT adjustment R360 sets the cutoff characteristics of Q351. B-DRIVE adjustment R363 sets the gain of this stage.

E. Blanking

Positive-going vertical and horizontal blanking pulses are derived from the vertical and horizontal deflection signals. (Refer to Figure 13 for a schematic diagram of the blanking circuitry.) The vertical blanking pulse is AC coupled from the vertical output stage through C406. The horizontal blanking pulse is derived from the horizontal output stage through resistors R518 and R517. During retrace, the blanking pulses turn on blanking transistors Q304, Q307, and Q310. The voltage drops at the bases of buffer transistors Q305, Q308, and Q311 are transfered to the RGB output amplifiers on the CRT board. These voltage drops turn off the RGB output amplifiers.

F. High Voltage

The high voltage is developed by horizontal output transistor Q551 and high-voltage transformer T551. (Refer to Figure 14 for a schematic diagram of the high-voltage circuitry.) When Q551 is turned off, an 800-volt pulse is developed across the primary of T551. This pulse is stepped-up in the secondary and rectified by the internal tripler to produce 26 kilovolts for the anode of the CRT.

Other voltages are also produced by the transformer. Theses are the Video B + (180 volts), the low voltage (20 volts), and the CRT filament voltage (6.4 VAC).

G. Line Input and Degaussing

Line voltage of 120 VAC is applied through AC fuse F001 and line-filter L801 to both the degaussing network and the rectifier. When cool, D808 permits current to flow through the degaussing coil. However, after D808 heats up, current is removed from the degaussing coil, rendering it inoperative.

The rectifier is composed of D801. This rectifier converts the AC input voltage into an unfiltered DC voltage. Capacitor C803 filters out AC ripple.

H. + 123-Volt Regulated Supply

The + 123-volt regulated supply provides operating power to circuitry throughout the display. (Refer to Figure 16 for a schematic diagram of the + 123-volt regulated supply.) The regulator for the + 123-volt regulated supply is a feedback amplifier system that operates between ground and the rectified DC voltage. Current to the load is delivered by series-pass transistor Q801. The supply voltage is established by the voltage drop across resistive-divider network R811-R812-R813-R815 at the base of Q802.

Feedback at the base of Q802 is immediately coupled to Q801. Any variation in the supply output voltage (due to changing load requirements) causes Q802 to modify the biasing current of Q801. This nullifies the change in the supply output voltage.

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

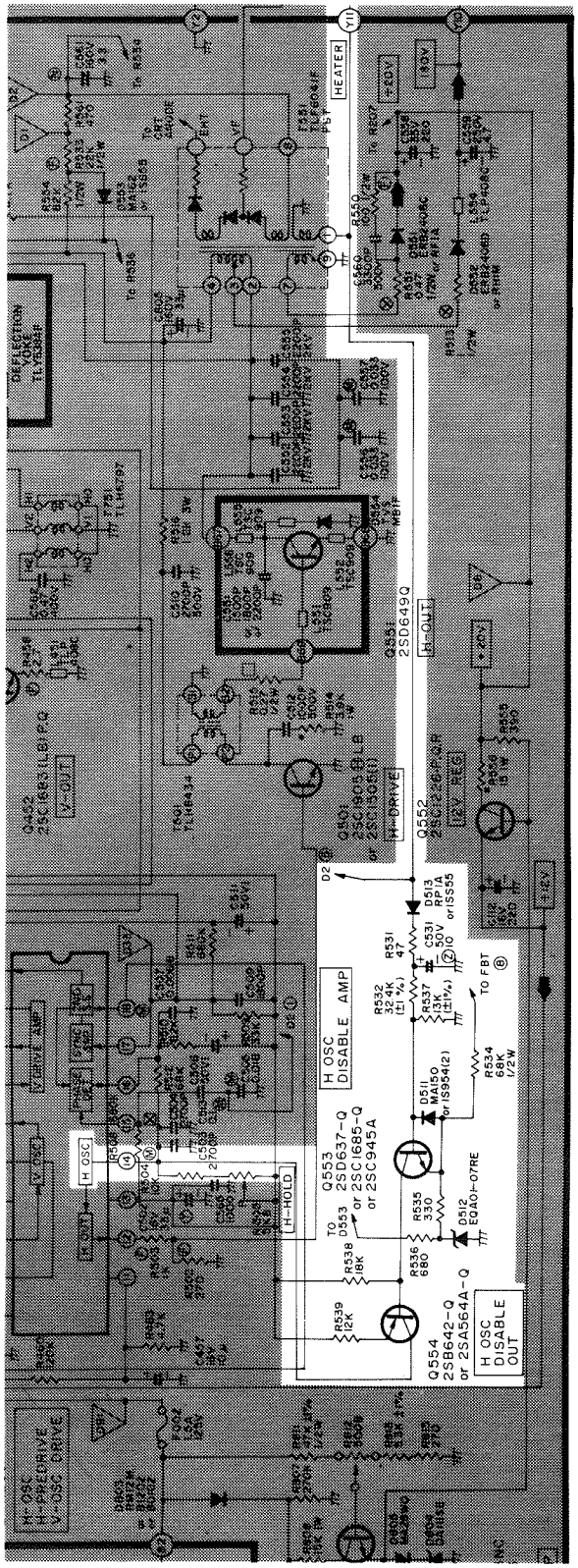


Figure 11 Horizontal Oscillator Disable Circuit Schematic Diagram

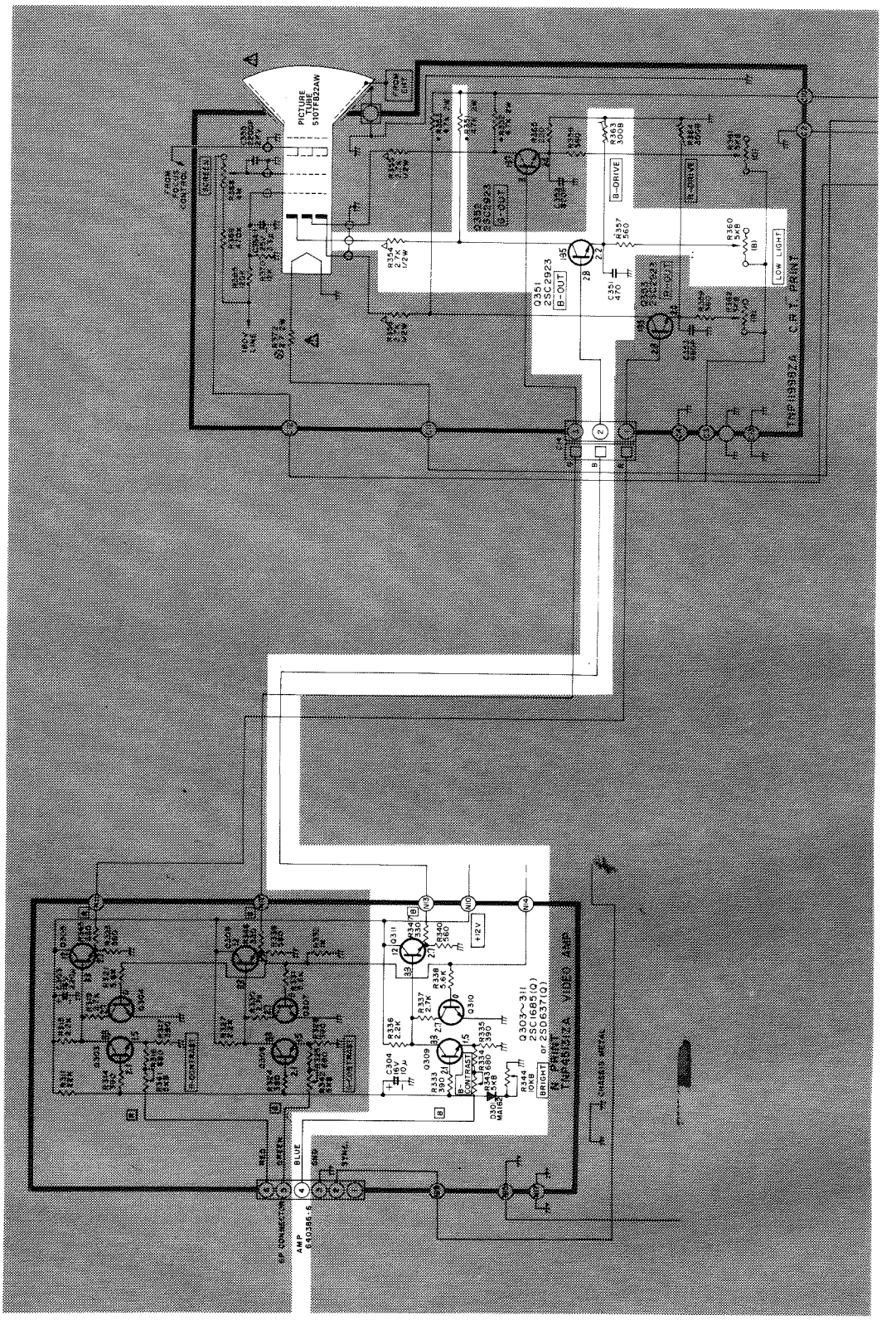


Figure 12 Blue Z Amplifier Schematic Diagram

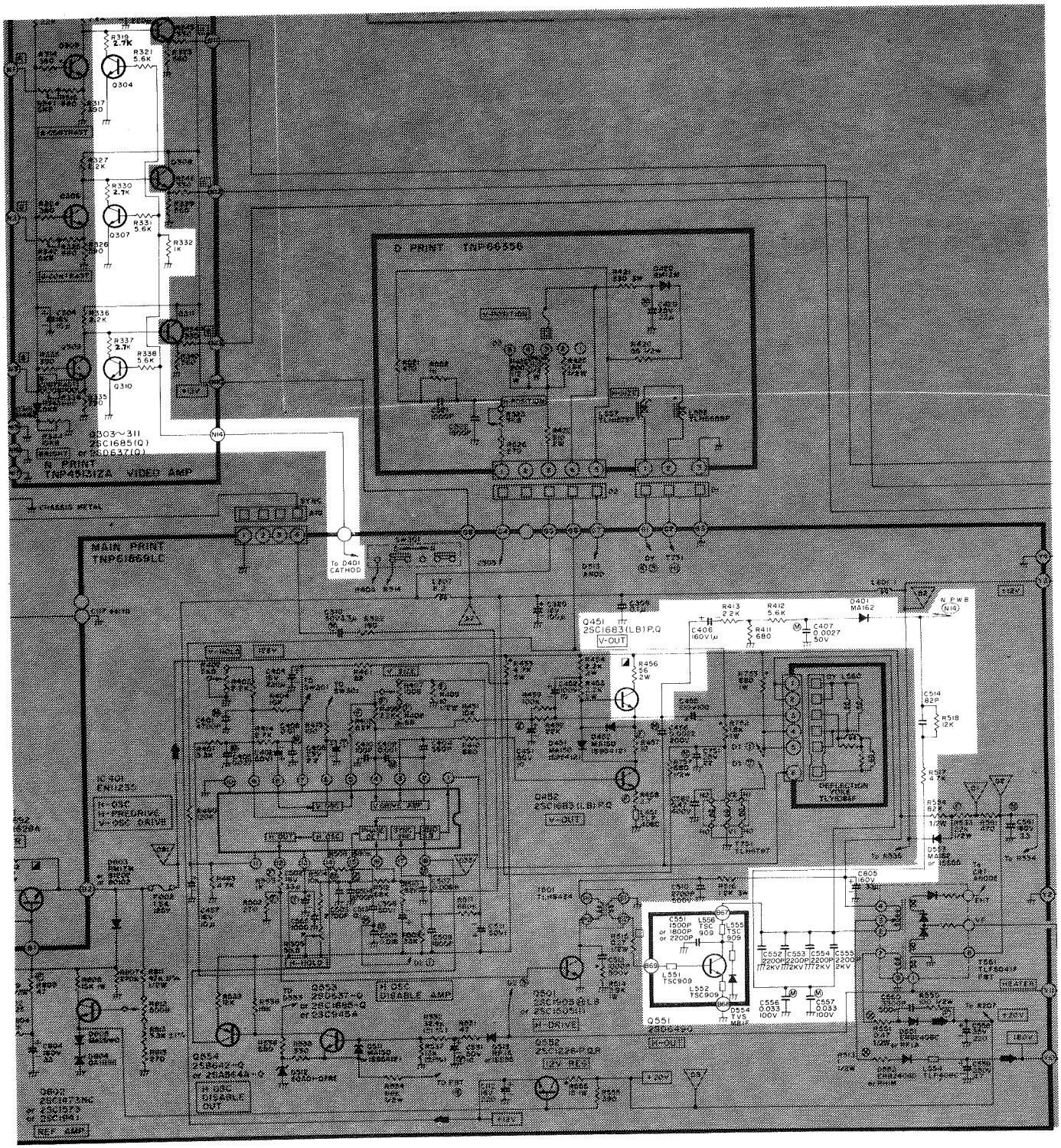


Figure 13 Blanking Schematic Diagram

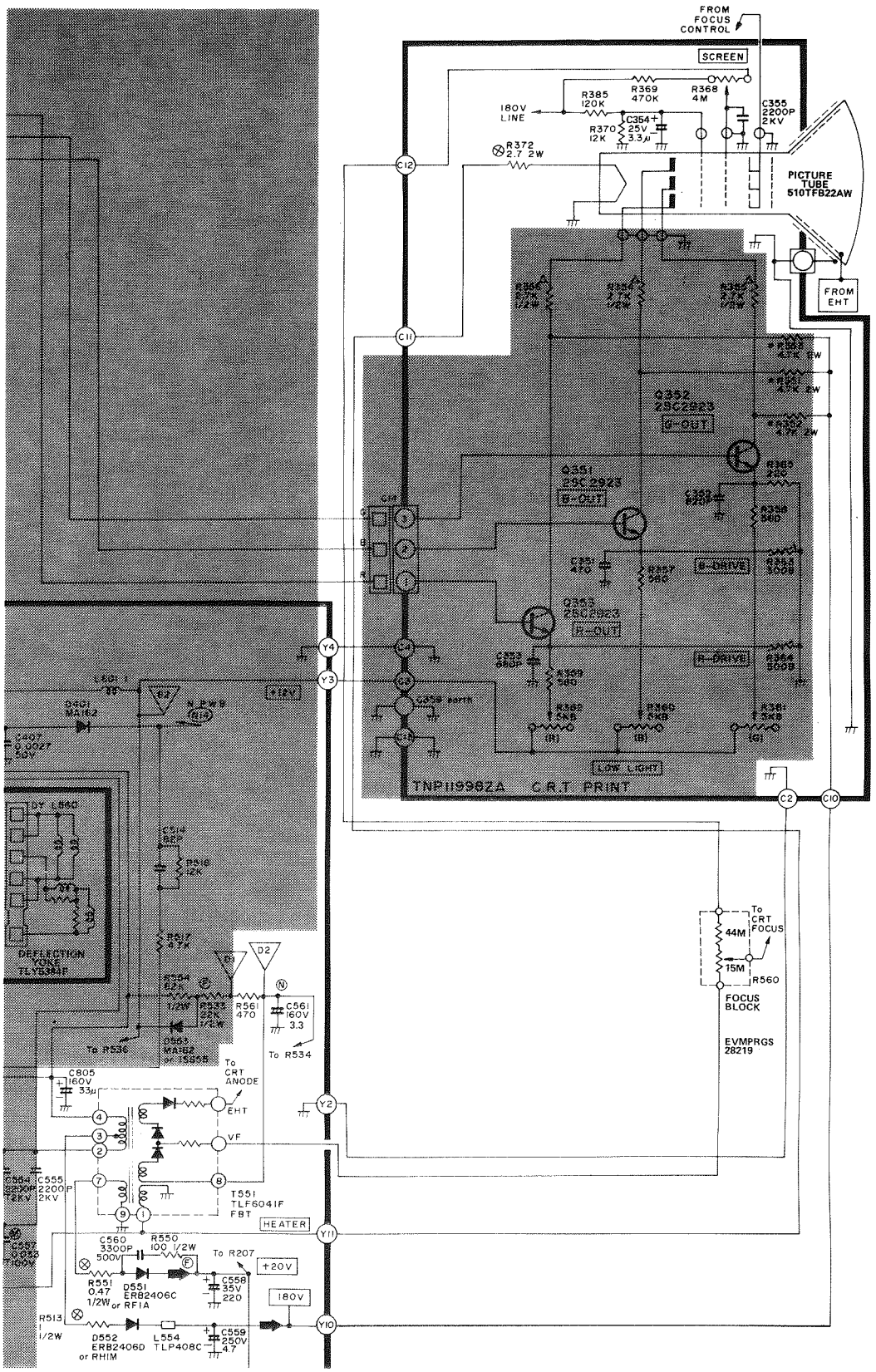


Figure 14 High-Voltage Schematic Diagram

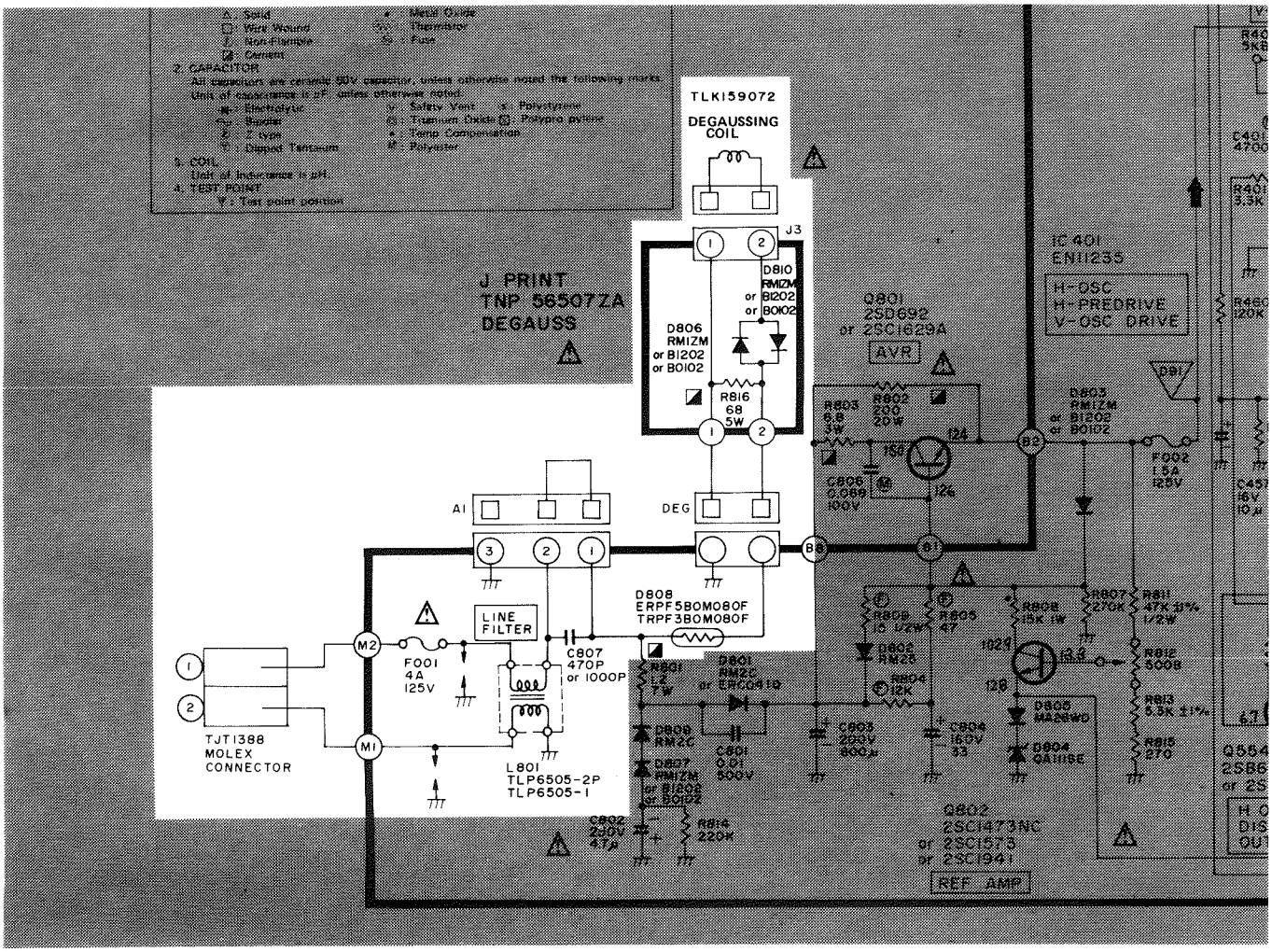


Figure 15 Line Input and Degaussing Schematic Diagram

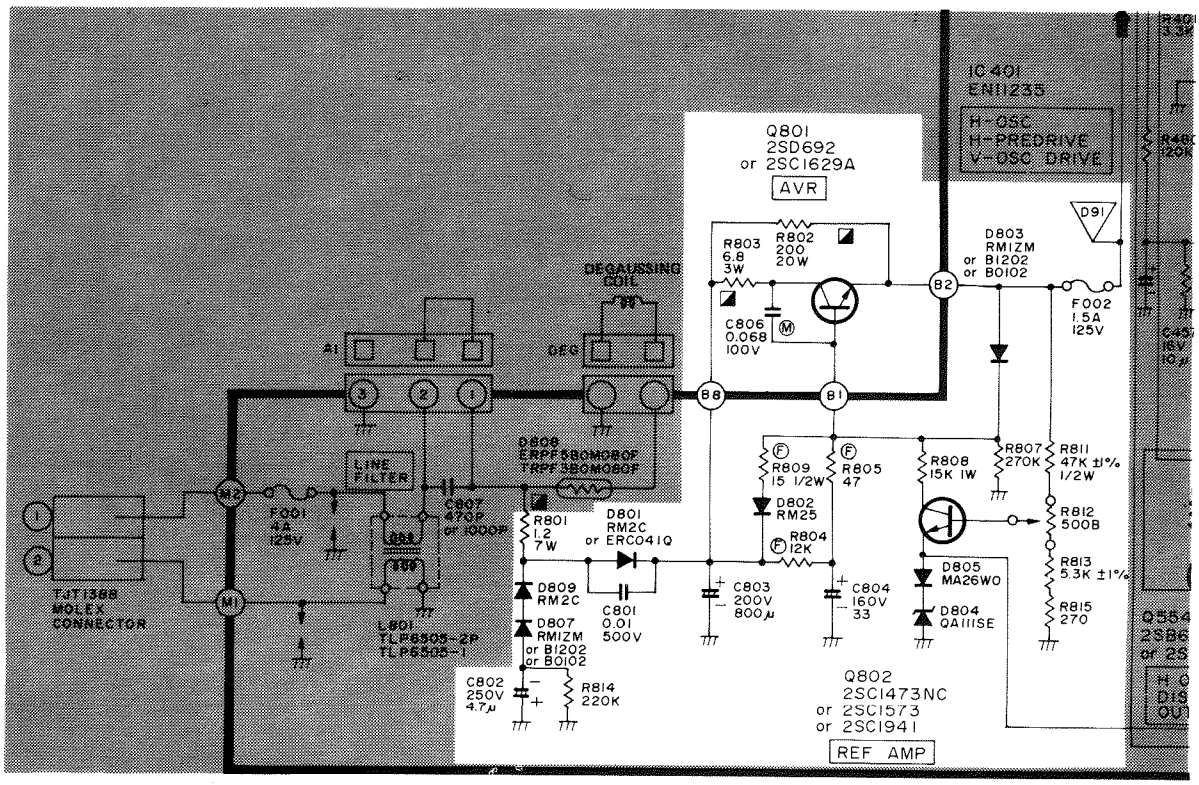
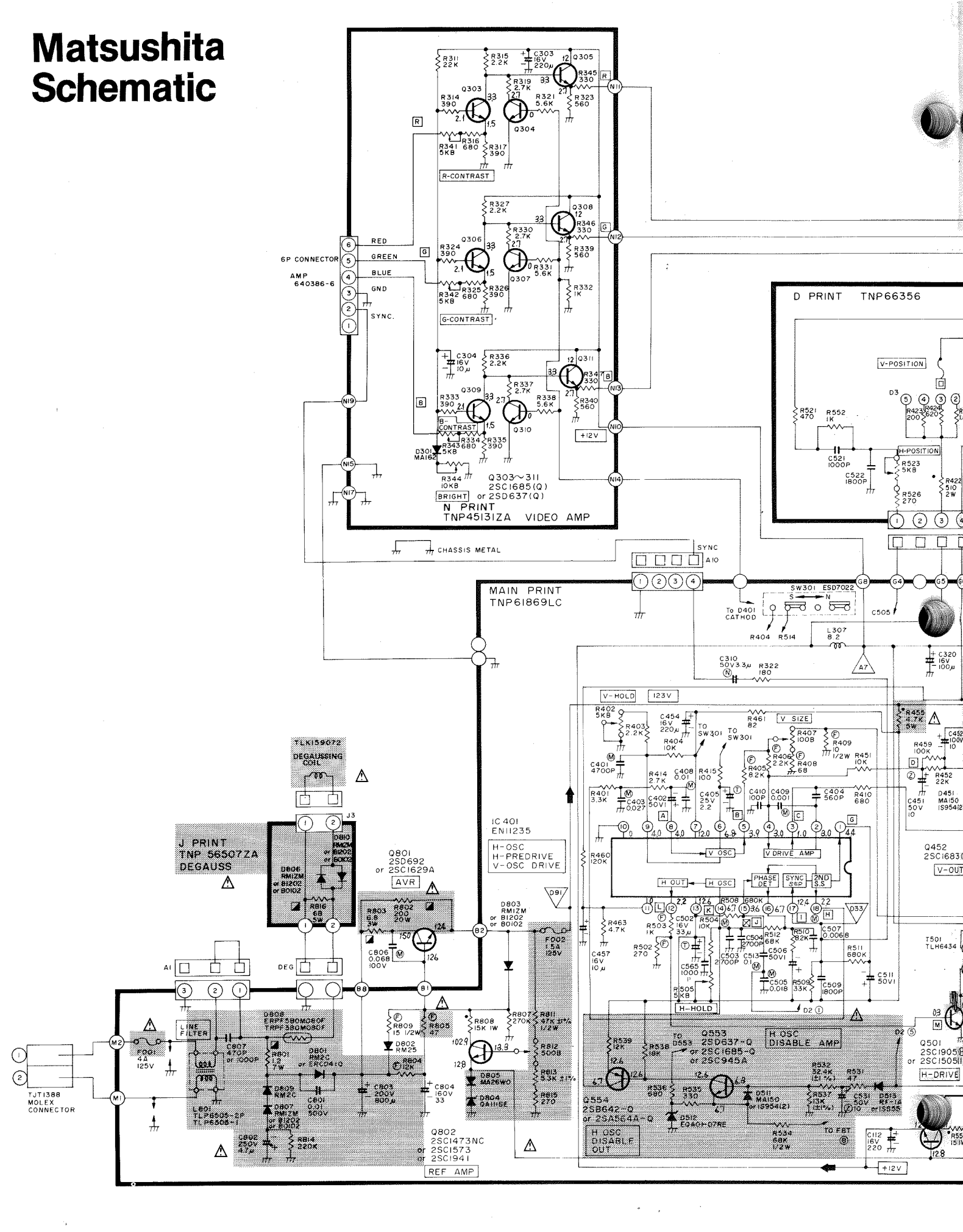


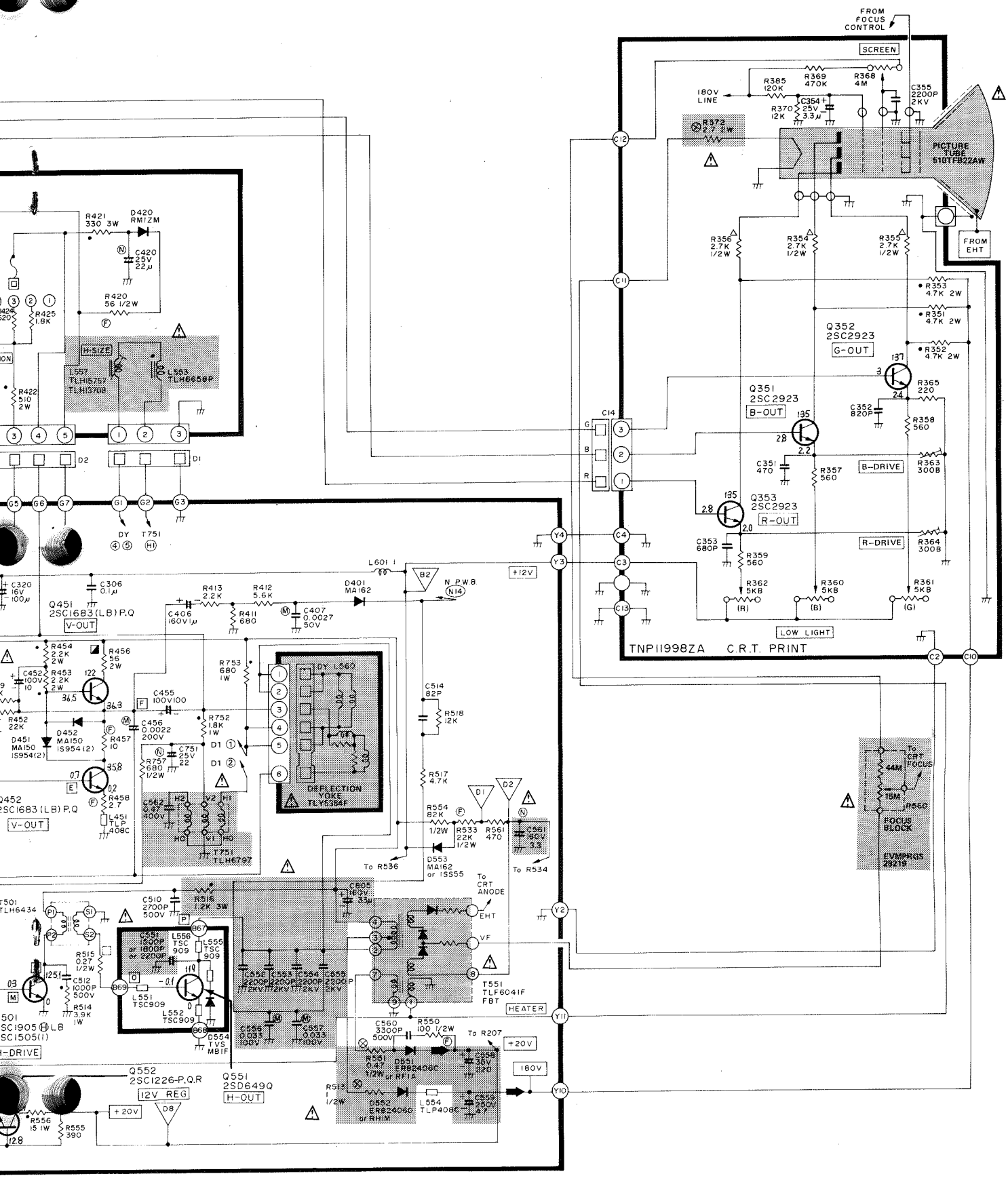
Figure 16 +123-Volt Regulated Supply Schematic Diagram

Matsushita Schematic



⚠ WARNING ⚠

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



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.

Tools Required to Replace These Assemblies: 5/16-inch hex socket wrench, Phillips-head screwdriver, and a soldering iron.

A. 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 video-signal connector from the Video Amplifier printed-circuit board (PCB).
2. Remove the display assembly from the game as described in the game manual.
3. Discharge the high voltage from the cathode-ray tube (CRT) as follows:
   a. Attach one end of a large, well-insulated, 20-kV jumper 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 1-wire connector from pin CRT E of the CRT PCB.
5. Unplug the CRT PCB from the rear of the cathode-ray tube.
6. Unplug the degaussing coil 2-pin connector from the Degaussing PCB.
7. Unplug the 4-wire connector attaching the yoke wires to the Main PCB.
8. Use a 5/16-inch hex socket wrench to remove the four screws holding the CRT to the steel frame chassis.
9. **Carefully** remove the CRT by easing it out the front of the chassis.
10. Place the cathode-ray tube on a soft mat in a protected location.
11. To install a CRT, reverse the order of this procedure.

B. Yoke Replacement

NOTE

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

1. Disconnect the 6-pin video-signal connector from the Video Amplifier printed-circuit board (PCB).
2. Remove the 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 *A. 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 scews 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.

C. Flyback Transformer Replacement

1. Disconnect the 6-pin video-signal connector from the Video Amplifier printed-circuit board (PCB).
2. Remove the 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 *A. Cathode-Ray Tube Replacement.*
4. Remove the rubber cap from the white wire connected to the focus assembly on the Main PCB. Unsolder this wire from the focus assembly.

5. Remove the tape from the three wires (red, black, and white) that go to the focus assembly.
6. Open the white twist-and-tie wire holder and remove the white wire.
7. Use a Phillips-head screwdriver to remove the screw securing the focus assembly. Remove the focus assembly.
8. Remove the two screws that secure the housing for the flyback transformer.
9. Remove the Main PCB following the procedure beginning at step 4 of *G. Main PCB Replacement.*
10. Remove the three screws securing the transformer to the Main PCB.
11. Unsolder the eight transformer connections on the bottom side of the Main PCB.
12. Lift the transformer from its housing.
13. 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.

D. Video Amplifier PCB Replacement

1. Disconnect the 6-pin video-signal connector from the Video Amplifier printed-circuit board (PCB).
2. Remove the 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 *A. Cathode-Ray Tube Replacement.*
4. Use a Phillips-head screwdriver to remove the screw securing the Video Amplifier PCB to the chassis.
5. Slide the Video Amplifier PCB toward the Deflection PCB and remove it from the display.
6. To replace the Video Amplifier PCB, reverse the order of this procedure.

E. Deflection PCB Replacement

1. Disconnect the 6-pin video-signal connector from the Video Amplifier printed-circuit board (PCB).
2. Remove the 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 *A. Cathode-Ray Tube Replacement.*
4. Using a Phillips-head screwdriver, remove the two screws securing the Deflection PCB to the chassis.
5. Slide the Deflection PCB toward the Video Amplifier PCB and remove it from the display.
6. To replace the Deflection PCB, reverse the order of this procedure.

F. CRT PCB Replacement

1. Disconnect the 6-pin video-signal connector from the Video Amplifier printed-circuit board (PCB).
2. Remove the 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 *A. Cathode-Ray Tube Replacement.*
4. Gently pull the CRT PCB from the neck pins of the CRT.
5. To replace the CRT PCB, reverse the order of this procedure.

G. Main PCB Replacement

1. Disconnect the 6-pin video-signal connector from the Video Amplifier printed-circuit board (PCB).
2. Remove the 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 *A. Cathode-Ray Tube Replacement.*
4. Unplug the CRT PCB from the neck pins of the CRT.
5. Use a Phillips-head screwdriver to remove the screw securing the black ground wire to the chassis frame at the rear of the display.
6. Use a Phillips-head screwdriver to remove the two screws securing the Main PCB to the black plastic spacers at the rear of the display.
7. Gently pull the Main PCB out the rear of the chassis.

NOTE

The Video Amplifier PCB, Deflection PCB, and Degaussing PCB are mounted on a frame that is attached to the Main PCB; therefore, these circuit boards will come with the Main PCB when the Main PCB is removed.

8. To replace the Main PCB, reverse the order of this procedure.

H. Degaussing PCB Replacement

1. Disconnect the 6-pin video-signal connector from the Video Amplifier PCB.
2. Remove the 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 *A. Cathode-Ray Tube Replacement.*
4. Using a Phillips-head screwdriver, remove the two screws securing the Degaussing PCB to the chassis.
5. To replace the Degaussing 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. Leave connected all cables between the display assembly and other parts of the game.

A. Video B + Adjustment

1. Set BRIGHT control R344 on the Video Amplifier PCB for maximum brightness. Refer to Figure 4 for the location of the BRIGHT 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 D91, which is shown in Figure 17.
5. Apply power to the display.
6. Adjust R812 on the Main PCB, shown in Figure 17, for a voltmeter reading of + 123 volts.
7. Return BRIGHT control R344 to its normal setting.

B. 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 cathode-ray tube (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 hand-held degaussing coil.
   f. Apply power to the display.
2. Position the convergence-magnet assembly so that the purity rings shown in Figure 18 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 Procedures within the game manual for the details on selecting selftest 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 to display only the green crosshatch diagnostic pattern. If the game does not produce a green-only crosshatch pattern, turn off R DRIVE R364 and B-DRIVE R363 of the display CRT PCB. Refer to Figure 19 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 18 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 diagnal centering effect, rotate the entire magnet assembly so that the purity rings affect ONLY the horizontal centering.

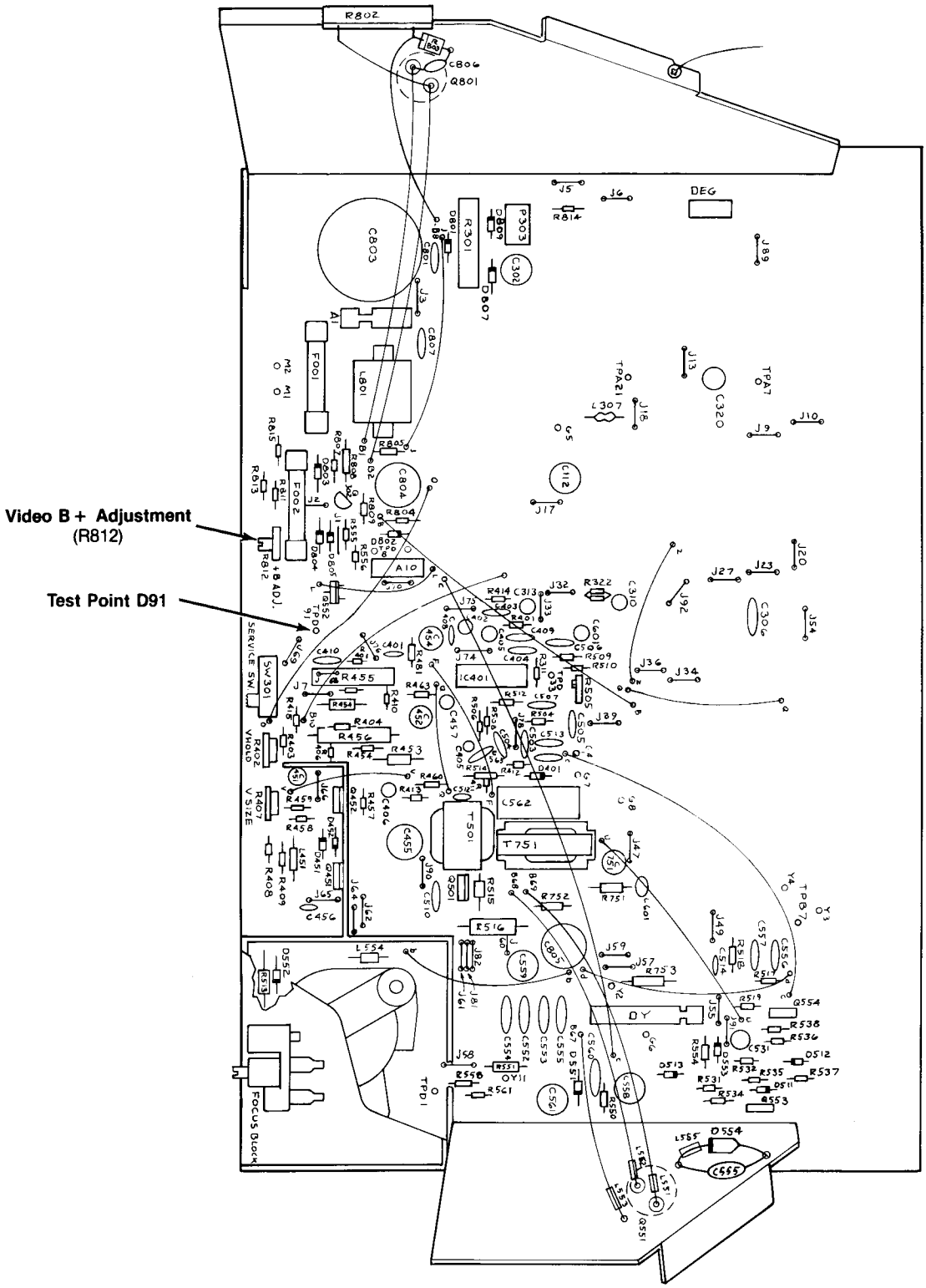


Figure 17 Locations of Video B + Adjustment R812 and Test Point D91

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.

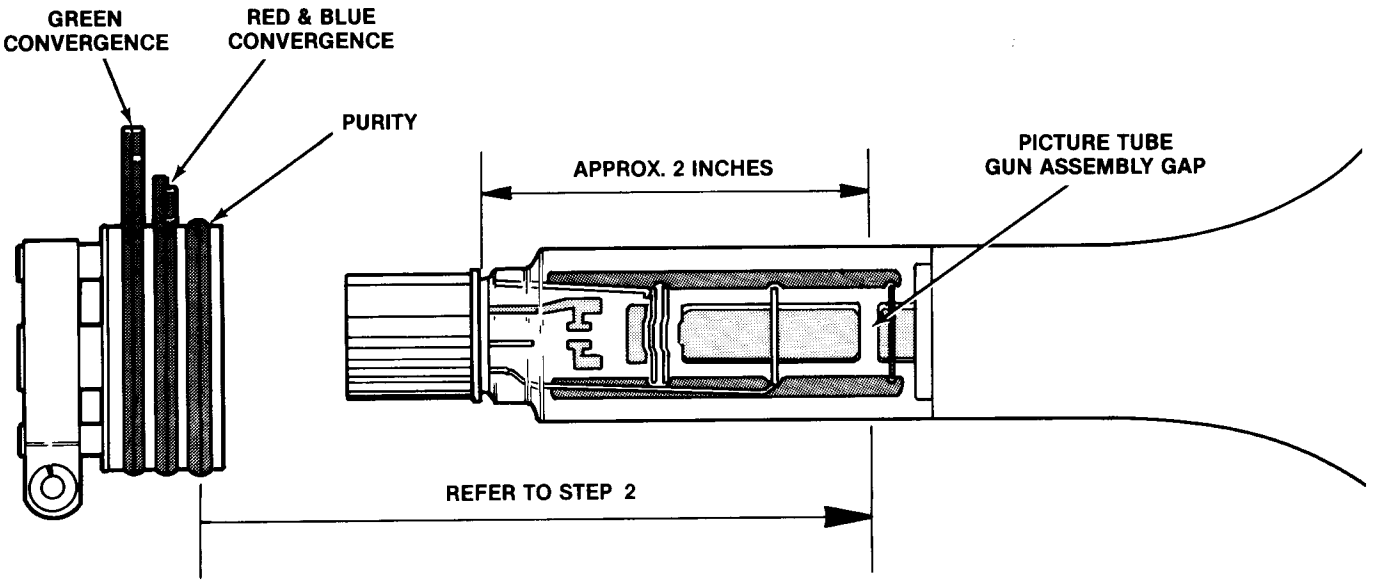


Figure 18 Purity and Convergence Adjustments

C. 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 Procedures within 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 18.

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 with 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 with the magenta vertical lines already converged in the center of the screen.

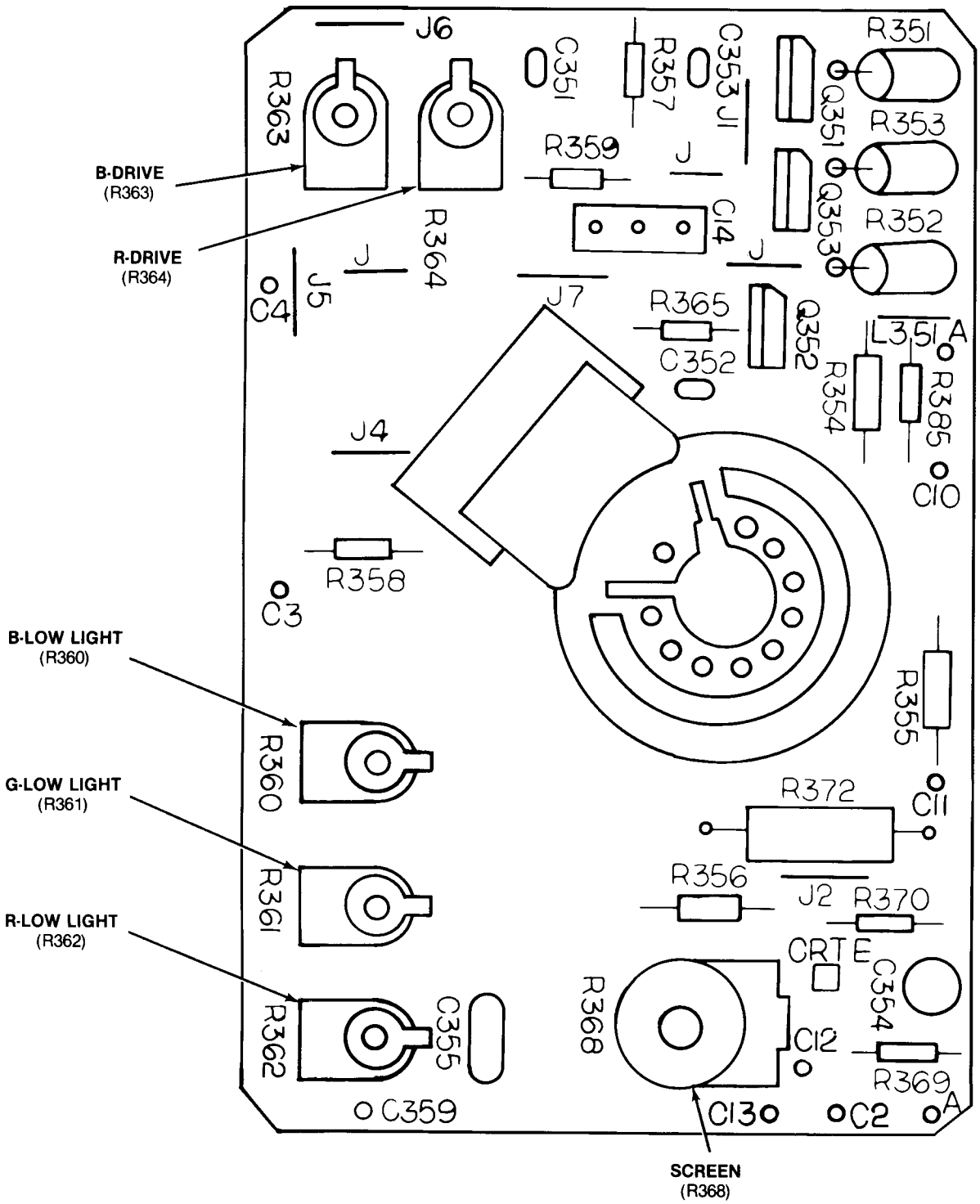


Figure 19 Locations of Tracking Adjustments on the CRT PCB

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 peripheral 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 cathode-ray tube. 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 with 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 with 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.

D. Tracking Adjustments

1. Remove power from both the game and the display.
2. Unplug the 6-pin video-signal connector, which is wired to the Video Amplifier PCB.
3. Set R-DRIVE R364 and B-DRIVE R363 to their mechanical centers. Figure 19 shows the location of the tracking adjustments on the CRT PCB.
4. Set all three Low Light controls (R360, R361, and R362) fully counterclockwise.
5. Set SCREEN control R368 fully counterclockwise.
6. Apply power to the display.
7. Slowly adjust SCREEN control R368 until the CRT screen shows the first hint of color. Do not adjust the Low Light control for the color which first appeared on the CRT screen. Slowly adjust the Low Light controls for the other two colors until the CRT screen is a faint grey. Now back off the SCREEN setting until the color just disappears.
8. Remove power from the display. Reconnect the 6-pin video-signal connector between the game and the display.
9. Reapply power to both the game and the display.
10. Set the game to display the self-test diagnostic pattern that shows a white crosshatch. (Refer to the Self-Test Procedures within the game manual for detailed procedures on selecting the self-test diagnostic patterns.)
11. Adjust R-DRIVE R364 and B-DRIVE R363 for a neutral white crosshatch pattern. If necessary, readjust SCREEN R368 for a proper black level.

E. Horizontal Oscillator Disable Test

1. Apply power to the display and the game.
2. Short across R802, shown in Figure 20, with a well-insulated jumper.
3. Check that the CRT picture is lost and that all high-voltages are lost.

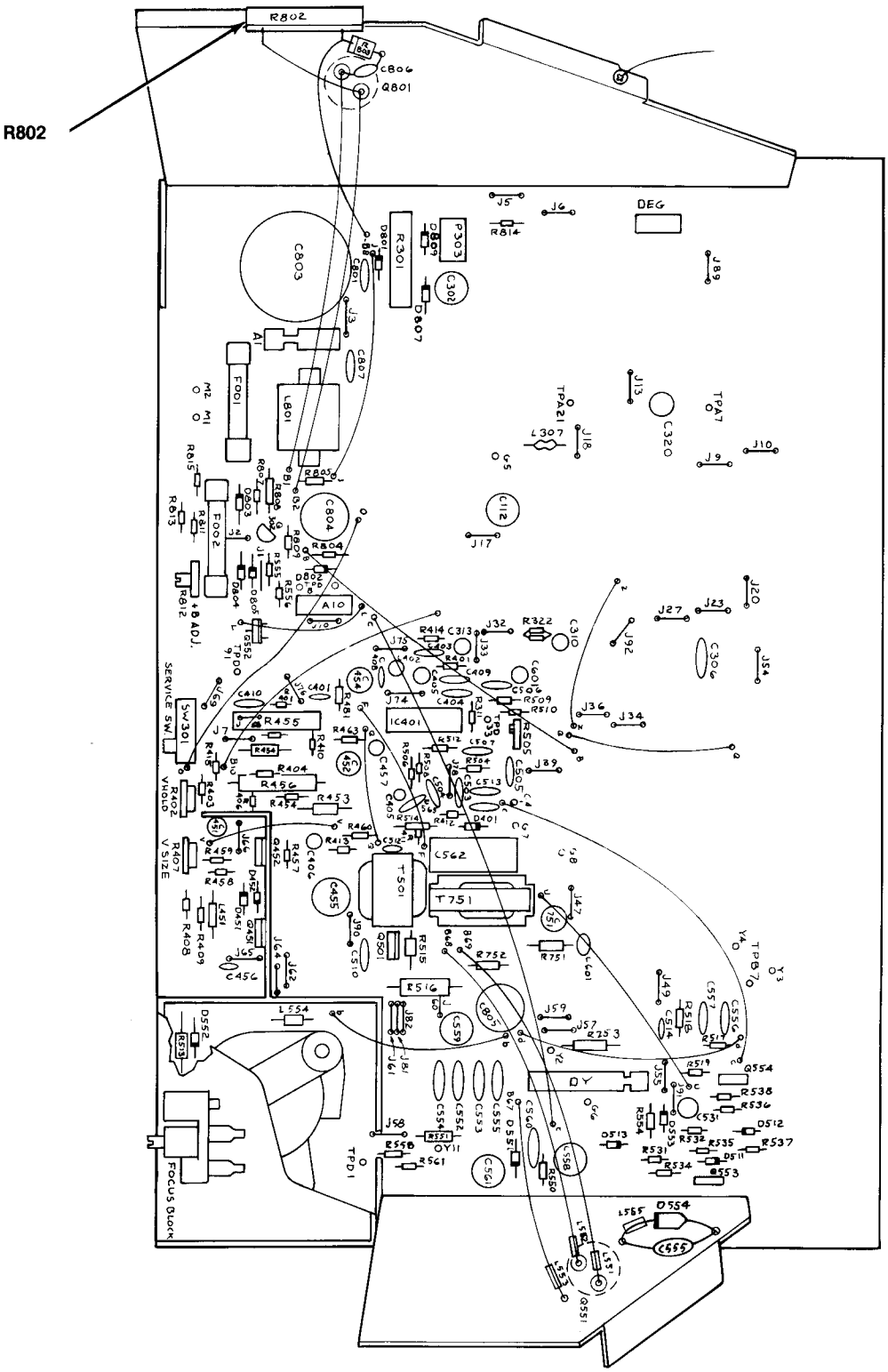


Figure 20 Location of R802 for Horizontal Oscillator Disable Test

8 Illustrated Parts Lists

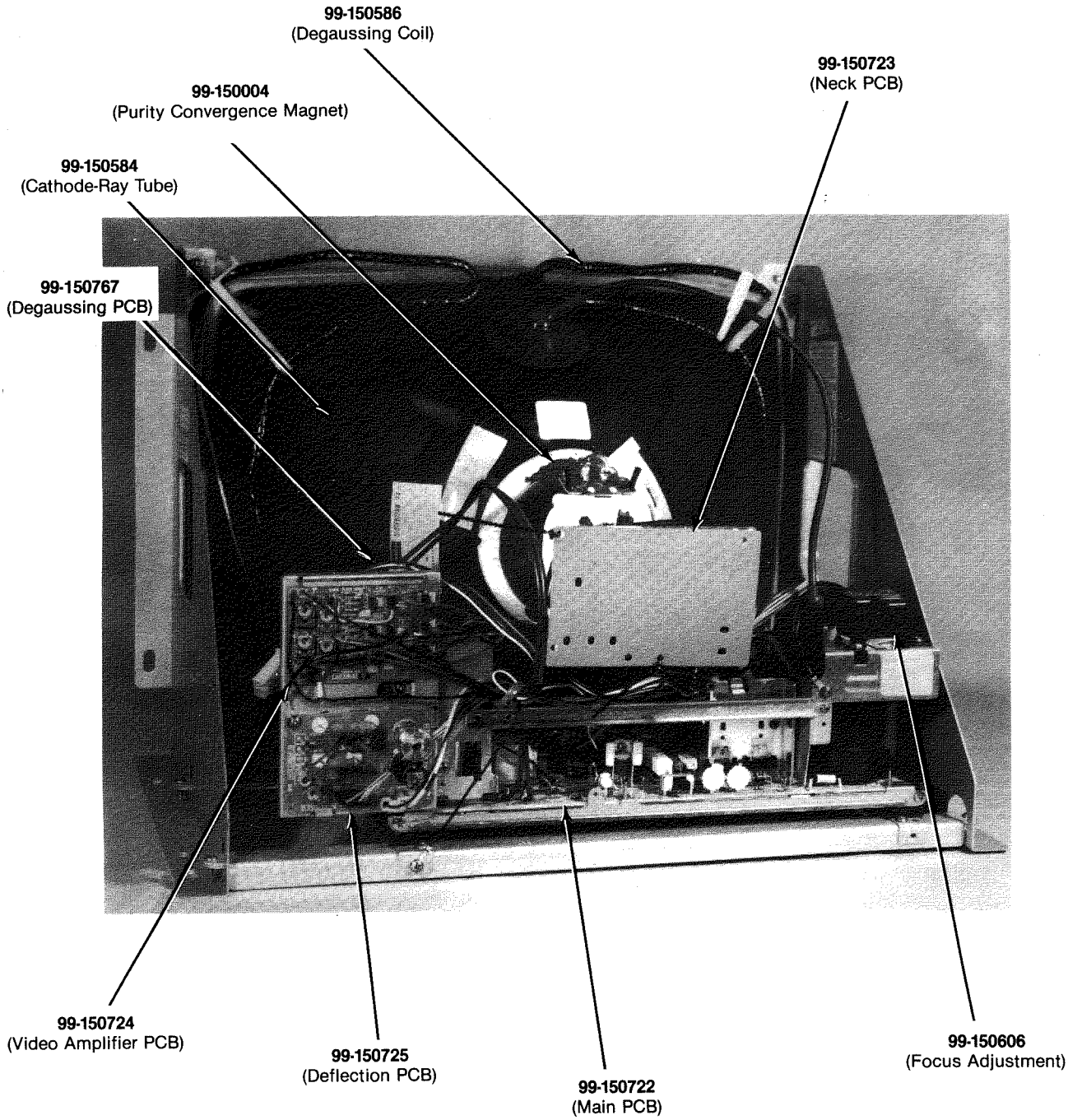


Figure 21 Display Assembly 139003-1004

Figure 21 Display Assembly, continued
Parts List

Components and assemblies listed in this Parts List are shown in Figure 21.

WARNING

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

Designator	*Description*	*Part No.*
	Cathode-Ray Tube Assemblies	
	▲ Purity Convergence Magnet	99-150004
	▲ Type-510TFB22AW 19-Inch Cathode-Ray Tube	99-150584
	▲ Degaussing Coil	99-150586
L560	▲ Deflection Coil	99-150585
	Printed Circuit Boards	
	Main PCB	99-150722
	Neck PCB	99-150723
	Video Amplifier PCB	99-150724
	Deflection PCB	99-150725
	Degaussing PCB	99-150767
	Resistors	
R560	▲ FOCUS Adjustment	99-150606
	Transistors	
Q451, Q452	Type-2SC1683LB Vertical Output Transistor	99-150562
Q551	Type-2SD649Q Horizontal Output Transistor	99-150563
Q801	Type-2SD692 Video B+ Regulator Transistor	99-150568

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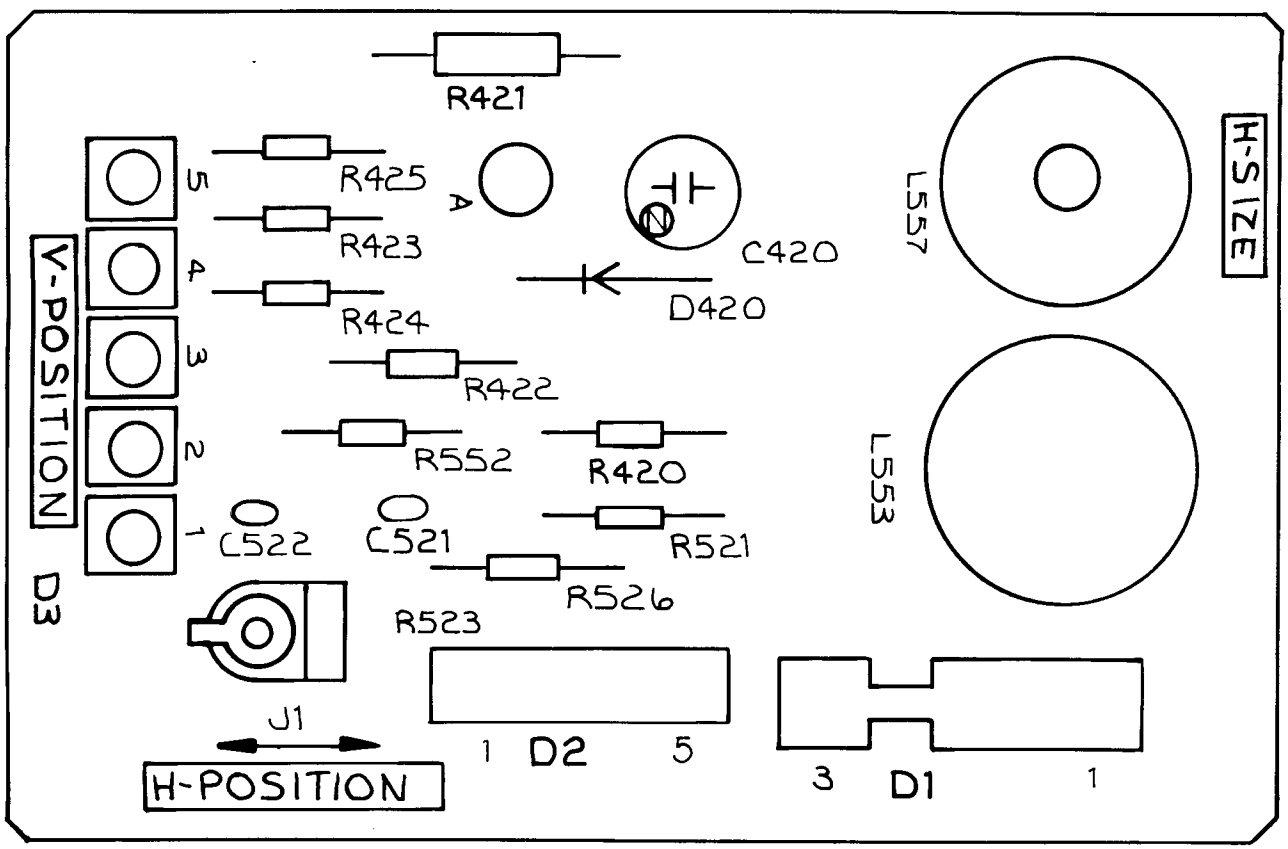

Figure 22 Deflection PCB
99-150725 A

Figure 22 Deflection PCB, continued
Parts List

Components listed in this Parts List are shown on Figure 22.

WARNING

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

Designator	*Description*	*Part No.*
	Capacitors	
C420	22 μF, 25 V Aluminum Electrolytic Capacitor	99-150689
C521	1000 pF, ± 10%, 50 V Ceramic Capacitor	99-150713
C522	1800 pF, ± 10%, 50 V Ceramic Capacitor	99-150705
	Coils	
L553	▲ Linear Coil	99-150589
L557	▲ H-SIZE Coil	99-150761
	Diodes	
D420	Type-TVSRM1ZM Silicon Diode	99-150570
	Resistors	
R420	56 Ω, ± 5%, ½ W Carbon Resistor	99-150627
R421	330 Ω, ± 5%, 3 W Power Resistor	99-150628
R422	510 Ω, ± 5%, 2 W Power Resistor	99-150629
R423	200 Ω, ± 5%, ½ W Carbon Resistor	99-150630
R424	620 Ω, ± 5%, ½ W Carbon Resistor	99-150631
R425	1.8 kΩ, ± 5%, ½ W Carbon Resistor	99-150632
R521	470 Ω, ± 5%, ¼ W Carbon Resistor	99-150495
R523	5 kΩ H-POSITION Adjustment	99-150599
R526	270 Ω, ± 5%, ¼ W Carbon Resistor	99-150509
R552	1 kΩ, ± 5%, ¼ W Carbon Resistor	99-150488

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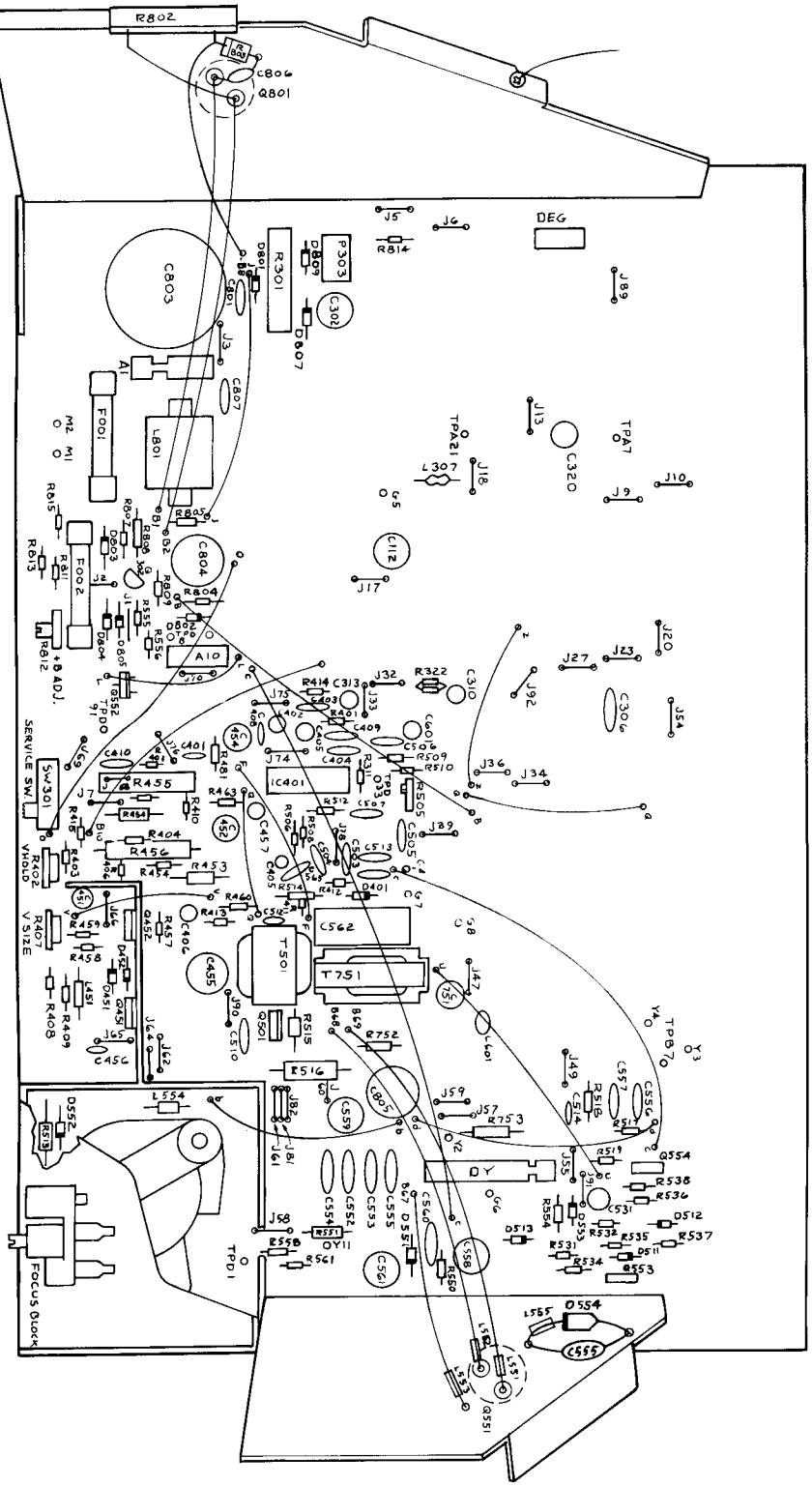

Figure 23 Main PCB
99-150722 A

Figure 23 Main PCB, continued
Parts List

Components listed in this Parts List are shown on Figure 23.

WARNING

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

Designator	*Description*	*Part No.*
	Capacitors	
C112	220 μF, 16 V Aluminum Electrolytic Capacitor	99-150673
C306	0.1 μF, ± 10%, 50 V Poly Capacitor	99-150536
C310	3.3 μF, 50 V Aluminum Electrolytic Capacitor	99-150674
C320	100 μF, 16 V Aluminum Electrolytic Capacitor	99-150675
C401	0.0047 μF, ± 10%, 50 V Poly Capacitor	99-150681
C402	1 μF, 50 V Aluminum Electrolytic Capacitor	99-150313
C403	0.027 μF, ± 10%, 50 V Poly Capacitor	99-150682
C404	560 pF, ± 10%, 50 V Ceramic Capacitor	99-150676
C405	2.2 μF, 25 V Tantalum Capacitor	99-150684
C406	1 μF, 160 V Aluminum Electrolytic Capacitor	99-150685
C407	2700 pF, ± 10%, 50 V Poly Capacitor	99-150719
C408	0.01 μF, ± 10%, 50 V Poly Capacitor	99-150686
C409	1000 pF, ± 10%, 50 V Poly Capacitor	99-150687
C410	100 pF, 50 V Ceramic Capacitor	99-150688
C451	10 μF, 50 V Aluminum Electrolytic Capacitor	99-150690
C452	10 μF, 100 V Aluminum Electrolytic Capacitor	99-150691
C454	220 μF, 16 V Aluminum Electrolytic Capacitor	99-150673
C455	100 μF, 100 V Aluminum Electrolytic Capacitor	99-150692
C456	0.0022 μF, 200 V Poly Capacitor	99-150693
C457	10 μF, 16 V Aluminum Electrolytic Capacitor	99-150694
C502	33 μF, 16 V Tantalum Capacitor	99-150695
C503	2700 pF, ± 10%, 50 V Poly Capacitor	99-150738
C504	0.0027 μF, ± 5%, 600 V Poly Capacitor	99-150697
C505	0.018 μF, ± 10%, 50 V Poly Capacitor	99-150698
C506	1 μF, 50 V Aluminum Electrolytic Capacitor	99-150313
C507	0.0068 μF, ± 10%, 50 V Poly Capacitor	99-150699
C509	1800 pF, ± 10%, 50 V Ceramic Capacitor	99-150700
C510	2700 pF, ± 10%, 500 V Ceramic Capacitor	99-150701
C511	1 μF, 50 V Aluminum Electrolytic Capacitor	99-150702
C512	1000 pF, 500 V Ceramic Capacitor	99-150739
C513	0.1 μF, ± 10%, 50 V Poly Capacitor	99-150536
C514	82 pF, ± 5%, 50 V Ceramic Capacitor	99-150720
C531	▲ 10 μF, 50 V Aluminum Electrolytic Capacitor	99-150690
C551	▲ 1500 pF, ± 10%, 2 kV Ceramic Capacitor	99-150706
C552–C555	▲ 2200 pF, ± 10%, 2 kV Ceramic Capacitor	99-150707
C556, C557	▲ 0.033 μF, ± 10%, 100 V Poly Capacitor	99-150708

[Continued on next page]

Figure 23 Main PCB, continued
Parts List

Designator	*Description*	*Part No.*
	Capacitors, continued	
C558	▲ 220 μF, 35 V Aluminum Electrolytic Capacitor	99-150309
C559	▲ 4.7 μF, 250 V Aluminum Electrolytic Capacitor	99-150709
C560	3300 pF, ± 10%, 500 V Ceramic Capacitor	99-150710
C561	▲ 3.3 μF, 160 V Aluminum Electrolytic Capacitor	99-150711
C562	▲ 0.47 μF, 400 V Poly Capacitor	99-150712
C565	1000 pF, ± 10%, 50 V Ceramic Capacitor	99-150713
C751	22 μF, 25 V Aluminum Electrolytic Capacitor	99-150714
C801	▲ 1000 pF, 500 V Ceramic Capacitor	99-150324
C802	▲ 4.7 μF, 250 V Aluminum Electrolytic Capacitor	99-150709
C803	▲ 800 μF, 200 V Aluminum Electrolytic Capacitor	99-150715
C804	33 μF, 160 V Capacitor	99-150716
C805	▲ 33 μF, 160 V Aluminium Electrolytic Capacitor	99-150551
C806	0.068 μF, ± 10%, 100 V Ceramic Capacitor	99-150717
C807	▲ 470 pF, 200 V Ceramic Capacitor	99-150718
	Coils and Ferrite Lead Beads	
L451	1 μH Ferrite Lead Bead	99-150453
L551, L552	Ferrite Lead Bead	99-150588
L554	1 μH Ferrite Lead Bead	99-150741
L555, L556	Ferrite Lead Bead	99-150588
L601	1 μH Peaking Coil	99-150591
L801	▲ Power Filter	99-150592
	Diodes	
D401	Type-MA162TA5 Silicon Diode	99-150729
D451, D452	Type-MA150TA Silicon Diode	99-150103
D511	▲ Type-MA150 Silicon Diode	99-150571
D512	▲ Type-TVSQA107RE Zener Diode	99-150572
D513	▲ Type-TVSRF1A Silicon Diode	99-150766
D551	▲ Type-TVSB2406C Silicon Diode	99-150574
D552	▲ Type-TVSB2406D Diode	99-150767
D553	Type-MA162TA5 Silicon Diode	99-150729
D554	Type-TVSMB1F Silicon Diode	99-150577
D801	▲ Type-TVSC0410 Diode	99-150578
D802	Type-TVSRM25 Diode	99-150579
D803	Type-TVSRM1ZM Diode	99-150570
D804	▲ Type-TVSQA111SE 11 V Zener Diode	99-150581
D805	▲ Type-MA26W0 Silicon Diode	99-150104
D807	▲ Type-TVSRM1ZM Silicon Diode	99-150570
D809	▲ Type-TVSRM2C Silicon Diode	99-150583

[Continued on next page]

Main PCB, continued
Parts List

Designator	*Description*	*Part No.*
	Fuses	
F001	▲ 125 V, 4 A, Slow-Blowing Fuse	99-150597
F002	▲ 125 V, 1.5 A, Slow-Blowing Fuse	99-150598
	Integrated Circuits	
IC401	Horizontal Oscillator/Vertical Oscillator Integrated Circuit	99-150561
	Resistors	
D808	▲ Type-ERPF5B0M080F Posistor	99-150582
R322	180 Ω, ±5%, ¼ W Carbon Resistor	99-150609
R401	3.3 kΩ, ±5%, ¼ W Carbon Resistor	99-150513
R402	5 kΩ V-HOLD Adjustment	99-150602
R403	2.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150522
R404	10 kΩ, ±5%, ¼ W Carbon Resistor	99-150620
R405	8.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150621
R406	2.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150622
R407	100 Ω V-SIZE Adjustment	99-150603
R408	68 Ω, ±5%, ¼ W Carbon Resistor	99-150623
R409	10 Ω, ±5%, ½ W Carbon Resistor	99-150624
R410, R411	680 Ω, ±5%, ¼ W Carbon Resistor	99-150487
R412	5.6 kΩ, ±5%, ¼ W Carbon Resistor	99-150485
R413	2.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150522
R414	2.7 kΩ, ±5%, ¼ W Carbon Resistor	99-150625
R415	100 Ω, ±5%, ¼ W Carbon Resistor	99-150626
R451	10 kΩ, ±5%, ¼ W Carbon Resistor	99-150497
R452	2.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150484
R453, R454	2.2 kΩ, ±5%, 2 W Power Resistor	99-150633
R455	▲ 4.7 kΩ, ±5%, 5 W Power Resistor	99-150634
R456	56 Ω, ±5%, 2 W Power Resistor	99-150737
R457	10 Ω, ±5%, ¼ W Carbon Resistor	99-150636
R458	2.7 Ω, ±5%, ¼ W Carbon Resistor	99-150637
R459	100 kΩ, ±5%, ¼ W Carbon Resistor	99-150638
R460	120 kΩ, ±5%, ¼ W Carbon Resistor	99-150639
R461	82 Ω, ±5%, ¼ W Carbon Resistor	99-150502
R463	4.7 kΩ, ±5%, ¼ W Carbon Resistor	99-150521
R502	270 Ω, ±5%, ¼ W Carbon Resistor	99-150640
R503	1 kΩ, ±5%, ¼ W Carbon Resistor	99-150641
R504	10 kΩ, ±5%, ¼ W Carbon Resistor	99-150497
R505	5 kΩ H-HOLD Adjustment	99-150604
R508	680 kΩ, ±5%, ¼ W Carbon Resistor	99-150642
R509	33 kΩ, ±5%, ¼ W Carbon Resistor	99-150643
R510	8.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150644
R511	680 kΩ, ±5%, ¼ W Carbon Resistor	99-150498
R512	68 kΩ, ±5%, ¼ W Carbon Resistor	99-150645

[Continued on next page]

Figure 23 Main PCB, continued
Parts List

Designator	*Description*	*Part No.*
	Resistors, continued	
R513	▲ 1 Ω, ±5%, ½ W Carbon Resistor	99-150209
R514	3.9 kΩ, ±5%, 1 W Power Resistor	99-150646
R515	0.27 Ω, ±10%, ½ W Power Resistor	99-150208
R516	▲ 1.2 kΩ, ±5%, 3 W Power Resistor	99-150735
R517	4.7 kΩ, ±5%, ¼ W Carbon Resistor	99-150521
R518	12 kΩ, ±5%, ¼ W Carbon Resistor	99-150721
R531	▲ 47 Ω, ±5%, ¼ W Carbon Resistor	99-150648
R532	▲ 32.4 kΩ, ±1%, ¼ W Power Resistor	99-150649
R534	▲ 68 kΩ, ±5%, ¼ W Carbon Resistor	99-150650
R535	▲ 330 Ω, ±5%, ¼ W Carbon Resistor	99-150651
R536	▲ 680 Ω, ±5%, ¼ W Carbon Resistor	99-150487
R537	▲ 13.0 kΩ, ±1%, ¼ W Power Resistor	99-150652
R538	▲ 18 kΩ, ±5%, ¼ W Carbon Resistor	99-150499
R539	▲ 12 kΩ, ±5%, ¼ W Carbon Resistor	99-150721
R550	100 Ω, ±5%, ½ W Carbon Resistor	99-150654
R551	▲ 0.47 Ω, ±10%, ½ W Carbon Resistor	99-150655
R553	22 kΩ, ±5%, ½ W Carbon Resistor	99-150656
R554	82 kΩ, ±5%, ½ W Carbon Resistor	99-150657
R555	390 Ω, ±5%, ¼ W Carbon Resistor	99-150658
R556	15 Ω, ±5%, 1 W Power Resistor	99-150659
R561	470 Ω, ±5%, ¼ W Carbon Resistor	99-150495
R751	680 Ω, ±5%, ½ W Carbon Resistor	99-150660
R752	1.8 kΩ, ±5%, 1 W Power Resistor	99-150661
R753	680 Ω, ±5%, 1 W Power Resistor	99-150662
R801	▲ 1.2 Ω, ±10%, 7 W Power Resistor	99-150663
R802	200 Ω, ±5%, 20 W Power Resistor	99-150664
R803	6.8 Ω, ±10%, 3 W Power Resistor	99-150665
R804	▲ 12 kΩ, ±5%, ¼ W Carbon Resistor	99-150666
R805	▲ 47 Ω, ±5%, ¼ W Carbon Resistor	99-150667
R807	270 kΩ, ±5%, ¼ W Carbon Resistor	99-150668
R808	15 kΩ, ±5%, 1 W Power Resistor	99-150669
R809	15 Ω, ±5%, ½ W Carbon Resistor	99-150670
R811	▲ 47 kΩ, ±1%, ½ W Power Resistor	99-150671
R812	▲ 500 Ω VIDEO B+ Adjustment	99-150605
R813	▲ 5.3 kΩ, ±1%, ¼ W Power Resistor	99-150672
R814	220 kΩ, ±5%, ¼ W Carbon Resistor	99-150527
R815	▲ 270 Ω, ±5%, ¼ W Carbon Resistor	99-150509
	Switches	
SW301	Service Switch	99-150596

[Continued on next page]

Figure 23 Main PCB, continued
Parts List

Designator	*Description*	*Part No.*
	Transformers	
T501	Horizontal Drive Transformer	99-150593
T551	▲ Flyback Transformer	99-150594
T751	▲ Pincushion Transformer	99-150595
	Transistors	
Q501	Type-2SC1905HLB Horizontal Drive Transistor	99-150565
Q552	Type-2SC1226 12 V Regulator Transistor	99-150564
Q553	▲ Type-2SD637 Horizontal Disable Amplifier Transistor	99-150566
Q554	▲ Type-2SB642 Horizontal Oscillator Disable Output Transistor	99-150567
Q802	Type-2SC1473PNC Reference Amplifier Transistor	99-150765

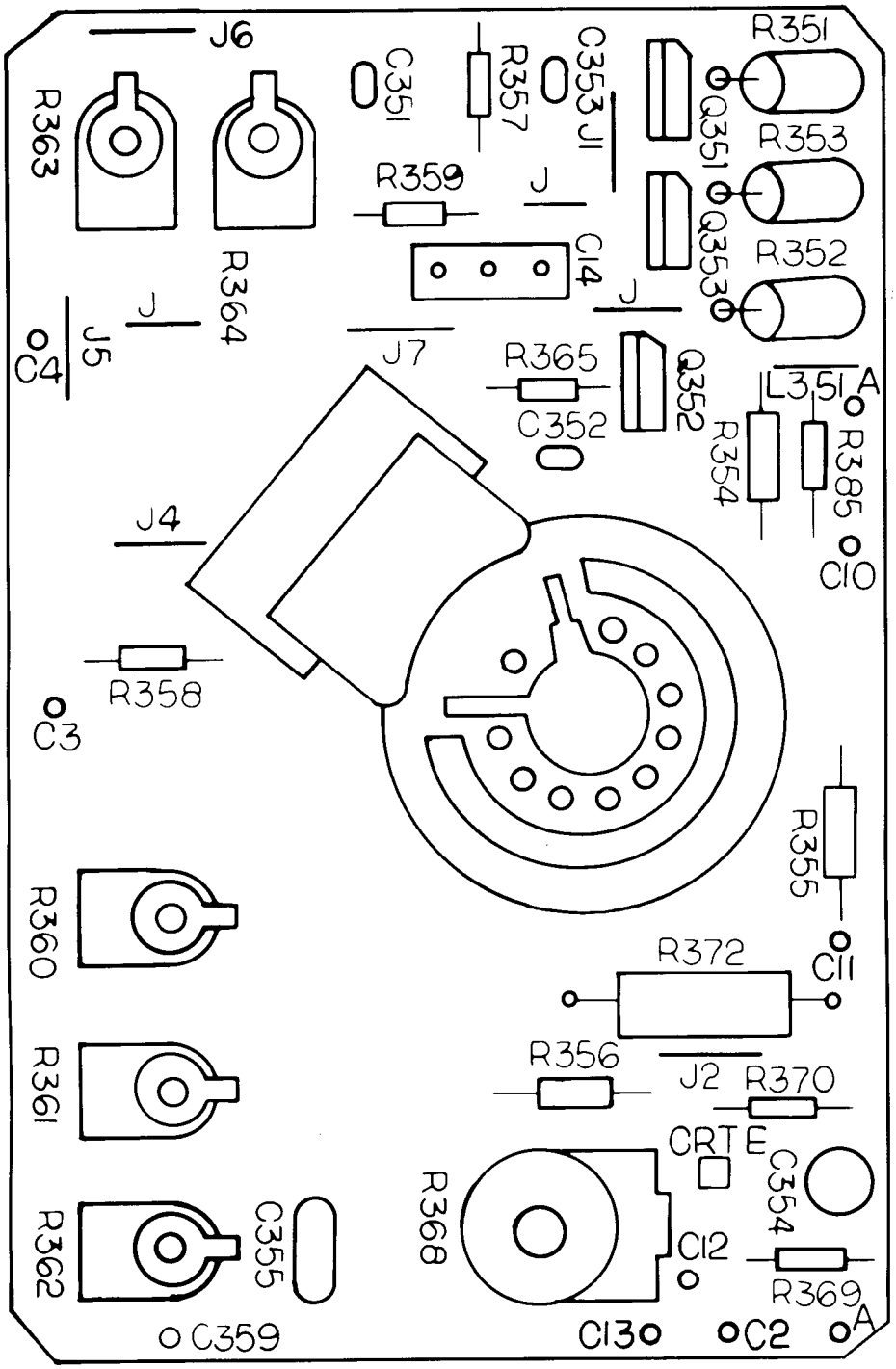

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Figure 24 Neck PCB
99-150723 A

Figure 24 Neck PCB,continued
Parts List

Components listed in this Parts List are shown in Figure 24.

WARNING

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

Designator	*Description*	*Part No.*
	Capacitors	
C351	470 pF, ±10%, 50 V Ceramic Capacitor	99-150677
C352	820 pF, ±10%, 50 V Ceramic Capacitor	99-150680
C353	680 pF, ±10%, 50 V Ceramic Capacitor	99-150678
C354	3.3 μF, 25 V Aluminum Electrolytic Capacitor	99-150304
C355	2200 pF, ±10%, 2 kV Ceramic Capacitor	99-150754
	Resistors	
R351–R353	4.7 kΩ, ±5%, 2 W Power Resistor	99-150752
R354–R356	2.7 kΩ, ±5%, ½ W Carbon Resistor	99-150613
R357-R359	560 Ω, ±5%, ¼ W Carbon Resistor	99-150614
R360	5 kΩ B-LOW LIGHT Adjustment	99-150599
R361	5 kΩ G-LOW LIGHT Adjustment	99-150599
R362	5 kΩ R-LOW LIGHT Adjustment	99-150599
R363	300 Ω B-DRIVE Adjustment	99-150600
R364	300 Ω R-DRIVE Adjustment	99-150600
R365	220 Ω, ±5%, ¼ W Carbon Resistor	99-150607
R368	4 MΩ SCREEN Adjustment	99-150601
R369	470 kΩ, ±5%, ¼ W Carbon Resistor	99-150616
R370	12 kΩ, ±5%, ¼ W Carbon Resistor	99-150617
R372	▲ 2.7 Ω, ±5%, 2 W Power Resistor	99-150618
R385	120 kΩ, ±5%, ¼ W Carbon Resistor	99-150619
	Sockets	
(J4)	CRT Socket	99-150008
	Transistors	
Q351	Type-2SC2923RL CRT Blue Drive Transistor	99-150560
Q352	Type-2SC2923RL CRT Green Drive Transistor	99-150560
Q353	Type-2SC2923RL CRT Red Drive Transistor	99-150560

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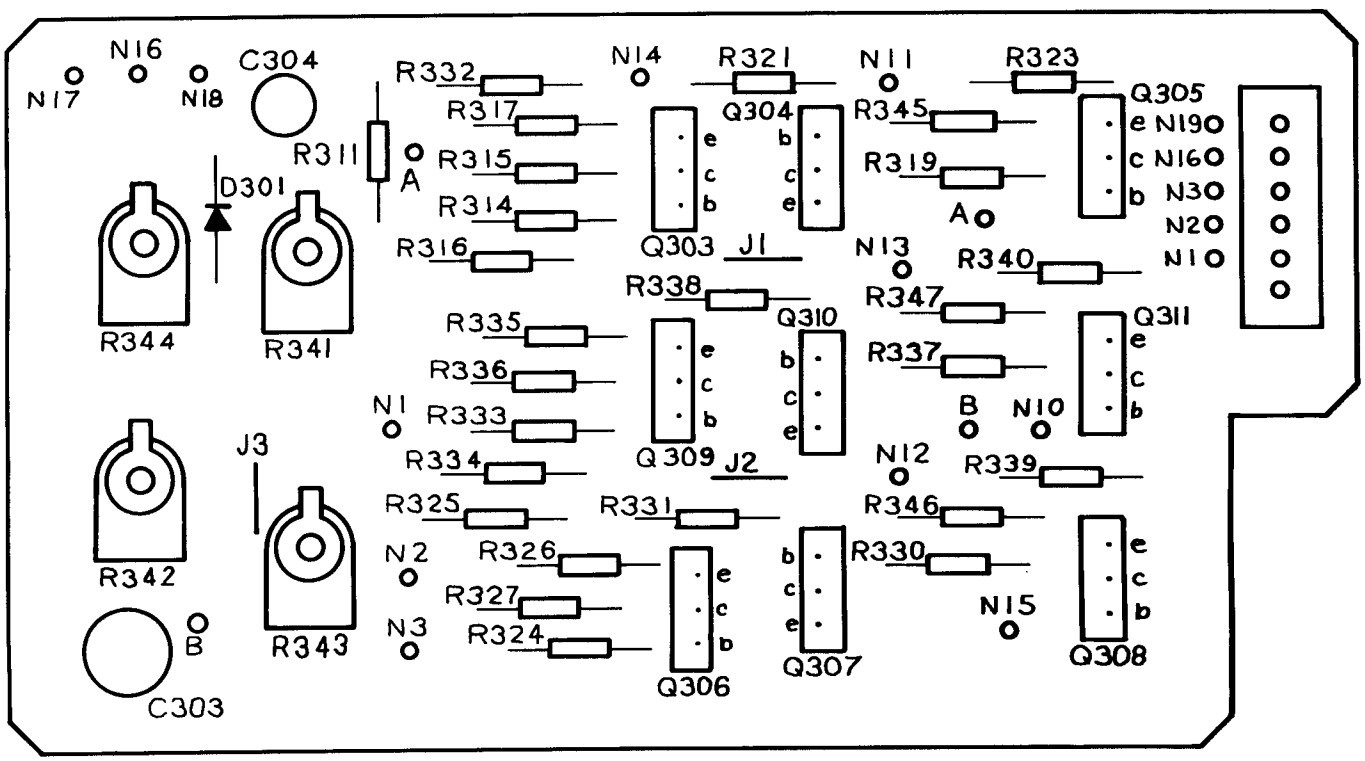

Figure 25 Video Amplifier PCB
99-150724 A

Figure 25 Video Amplifier PCB, continued
Parts List

Components listed in this Parts List are shown in Figure 25.

WARNING

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

Designator	*Description*	*Part No.*
	Capacitors	
C303	220 μF, 16 V Aluminum Electrolytic Capacitor	99-150673
C304	10 μF, 16 V Aluminum Electrolytic Capacitor	99-150530
	Diodes	
D301	Type-MA162TA5 Silicon Diode	99-150729
	Resistors	
R311	22 kΩ, ±5%, ¼ W Carbon Resistor	99-150484
R314	390 Ω, ±5%, ¼ W Carbon Resistor	99-150658
R315	2.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150522
R316	680 Ω, ±5%, ¼ W Carbon Resistor	99-150487
R317	390 Ω, ±5%, ¼ W Carbon Resistor	99-150658
R319	2.7 kΩ, ±5%, ¼ W Carbon Resistor	99-150486
R321	5.6 kΩ, ±5%, ¼ W Carbon Resistor	99-150485
R323	560 Ω, ±5%, ¼ W Carbon Resistor	99-150523
R324	390 Ω, ±5%, ¼ W Carbon Resistor	99-150658
R325	680 Ω, ±5%, ¼ W Carbon Resistor	99-150487
R326	390 Ω, ±5%, ¼ W Carbon Resistor	99-150658
R327	2.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150522
R330	2.7 kΩ, ±5%, ¼ W Carbon Resistor	99-150486
R331	5.6 kΩ, ±5%, ¼ W Carbon Resistor	99-150485
R332	1 kΩ, ±5%, ¼ W Carbon Resistor	99-150488
R333	390 Ω, ±5%, ¼ W Carbon Resistor	99-150658
R334	680 Ω, ±5%, ¼ W Carbon Resistor	99-150487
R335	390 Ω, ±5%, ¼ W Carbon Resistor	99-150658
R336	2.2 kΩ, ±5%, ¼ W Carbon Resistor	99-150522
R337	2.7 kΩ, ±5%, ¼ W Carbon Resistor	99-150486
R338	5.6 kΩ, ±5%, ¼ W Carbon Resistor	99-150485
R339, R340	560 Ω, ±5%, ¼ W Carbon Resistor	99-150523
R341	5 kΩ RED CONTRAST Adjustment	99-150599
R342	5 kΩ GREEN CONTRAST Adjustment	99-150599

[Continued on next page]

Figure 25 Video Amplifier PCB, continued
Parts List

Designator	*Description*	*Part No.*
R343	5 kΩ BLUE CONTRAST Adjustment	99-150599
R344	10 kΩ BRIGHT Adjustment	99-150726
R345–R347	330 Ω, ±5%, ¼ W Carbon Resistor	99-150651
	Transistors	
Q303–311	Type-2SC1685 Video Amplifier Transistor	99-150756

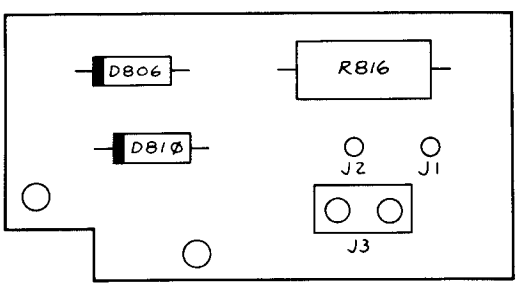

Figure 26 Degaussing PCB
99-150767 A

Degaussing PCB
Parts List

Components listed in this Parts List are shown in Figure 26.

WARNING

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

Designator	*Description*	*Part No.*
	Diodes	
D806	▲ Type-TVSRM1ZM Silicon Diode	99-150570
D810	▲ Type-TVSRM1ZM Silicon Diode	99-150570
	Resistors	
R816	▲ 68 Ω, ±10%, 5 W Wirewound Resistor	99-150749