RON

DEC-12-HVRTP-A-D

VR14 and VR20 troubleshooting procedures

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1. INTRODUCTION

When servicing a VR14 or VR20 Display, it is relatively easy to replace a faulty component and obtain a display on the screen. However, this method of maintenance usually fails to eliminate the problem that caused the component failure. Until the cause is found and corrected, fuses and transistors may have to be replaced almost on a weekly basis. The purpose of this document is to provide procedures to determine the cause of a component failure.

The three most frequent causes of VR14/VR20 failure are:

a. Overheated power transistor.

b. Faulty construction (bad connector crimps, faulty pins, insufficient thermal compound).

c. Arcing of the CRT.

The remainder of this document provides procedures used for determining and correcting the cause of VR14/VR20 failure. There is a specific procedure for each one of the three symptoms listed below:

Procedure	Paragraph No.	Symptom
A	2	Fuse blown and 2N4399 or 2N5302 transistors shorted between collector and emitter.
B	3	The W682 or W683 intensity board fails to produce intensity pulses. Also, the equipment may have both power transistors and fuses blown and/or the ±22V at a ±40V level.
C	4	Blown fuse only; no other component failure.

Procedure A includes a method for reworking the deflection heat sink to provide better heat dissipation. A more detailed explanation of this rework is presented in Paragraph 5.

2. PROCEDURE A

Fuses and transistors do not malfunction without a reason. Transistors normally short out because they become overheated. This overheating occurs if:

a. There is insufficient *thermal compound* under the power transistor.

b. The power supply voltages are higher than normal, thereby overdriving the power transistor.

c. The deflection or input signals have high frequency oscillations which overheat the transistors.

d. The fan fails to reach proper operating speed.

e. The beam is deflected off the screen for an extended period of time.

f. The transistor is improperly mounted to the heat sink due to a loose or broken socket, or loose transistor hold-down screw threaded insert.

g. The emitter protection resistor has drifted.

The following procedure is to be used for replacing the transistors and for correcting the cause of the malfunction:

1. Replace the fuse and defective transistors.

   NOTE

   POWER TRANSISTORS MUST BE REPLACED IN PAIRS. If the 2N4399 is shorted, the 2N5302 on the same side must also be replaced. Use an ample amount of white thermal compound; be sure that the transistor insulating washer is not left off.

   CAUTION

   Use only Motorola transistors and either Dow Corning No. 340 or Wakefield No. 120 thermal compound, DEC part number 90-08268. DO NOT USE CLEAR SILICON COMPOUND!

   CAUTION

   Do not overtorque the mounting screws when replacing transistors. To do so will strip the socket and render the heat sink totally useless. The screws should be firm, but not excessively tight. If one of the mounting inserts become loose, replace the socket, DEC part number 12-01200, or the entire assembly, DEC part numbers 70-7082 (Deflection) and 70-7080 (Power Supply).

2. Check the 0.1Ω emitter resistors mounted on the transistor sockets for burns, cracks, or discoloration. If they show evidence of overheating or do not measure exactly 0.1Ω, replace them. (Check both the deflection and power supply heat sinks.)

3. Remove the X and Y deflection boards and carefully measure the power supply voltages at pins A01-U (+22V) and A01-K (-22V). If either of these voltages exceeds 22V ± 1.0V, a power supply fault is indicated. Also, if these voltages shift while diagnostic programs or test patterns are being run, a power supply fault is indicated.

   CAUTION

   If a power supply problem exists and is not corrected, the power transistors will probably fail again in the near future.

4. Check the G836 regulator card on the 7007165 to ensure all ECOs have been incorporated (See Figure 1).

   a. R9 and R24 should be 220Ω, *not* 1K.

   b. R10 and R27 should be 10Ω, *not* 150Ω.

   c. R2 and R17 should be 1.78K, 1% resistor, *not* 1.62K, 1%. This lowers the +24V to +22V.

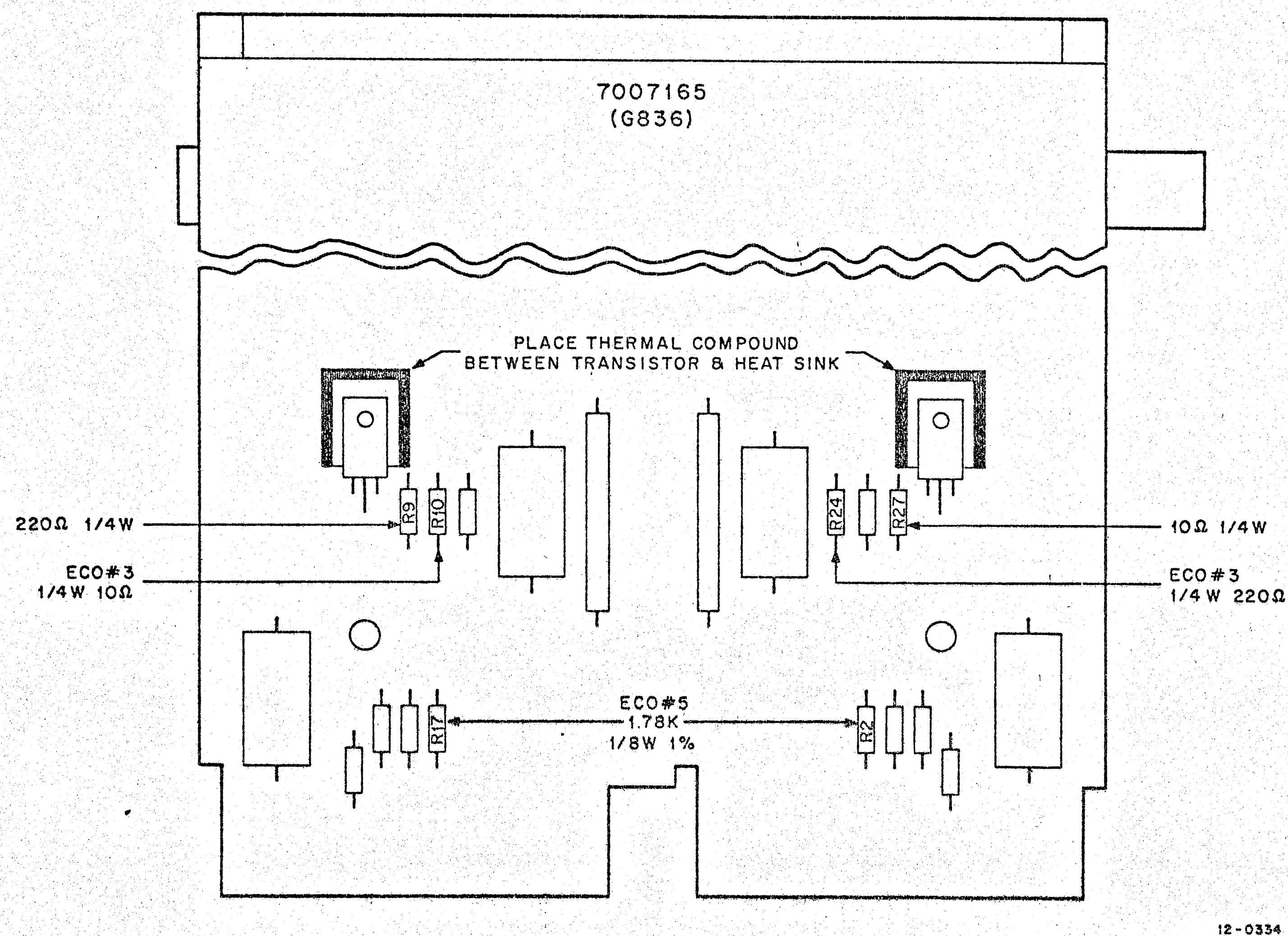

Figure 1 7007165 Power Regulator Assembly

5. If power supply voltages drift or wander, change Q2 (2N4920), or Q4 (2N4923), E1 (709), and E2 (709) or obtain a new 7007165 regulator. Make certain that the board (G836) in the new regulator is *revision D* or higher. Reworked revision B boards with a decal are acceptable. Make certain that the A225 boards have ECOs 2, 4, 5, and 6 incorporated (Figure 2).

ECO #2	R29 and R30 (22Ω) replaced by wires (Reduces runaway)
ECO #4	R1 and R2 are 10K 1/4W. (Reduces gain sensitivity)
ECO #5	C12 is 100 pf. (Prevents internal oscillations)
ECO #6	R19 is 200Ω 1W. (Prevents internal latchup)

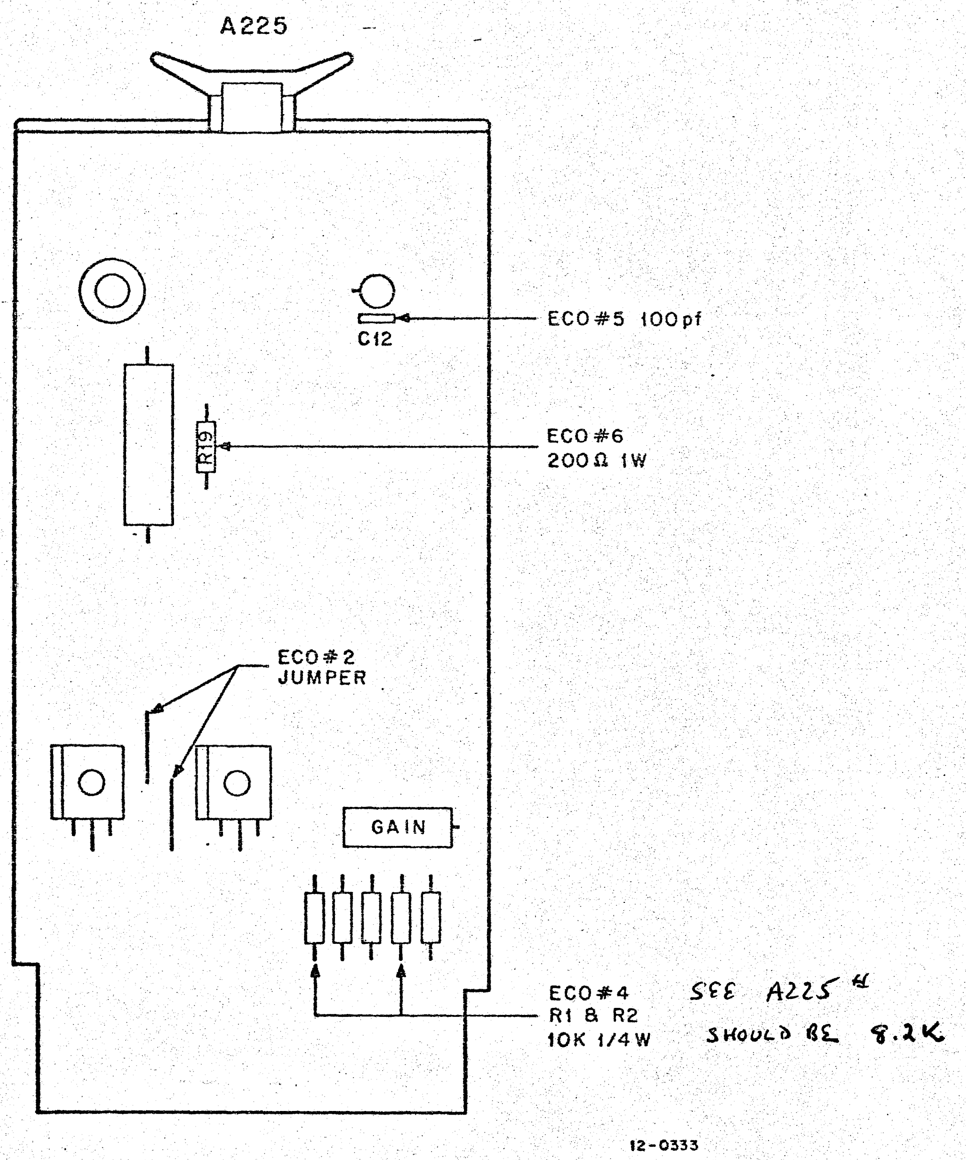

Figure 2 A225 D/A Converter

6. In order to increase heat dissipation for the power transistors, ECO #VR14-15 must be installed. This ECO consists of physically interchanging the inside section (X) of the deflection heat sink assembly with the outside section (Y). This is done because the outside section receives better air flow. Since X generates more heat than Y, X requires more cooling air.

NOTE

The following only represents the basic procedure. The detailed procedure for field rework of the deflection heat sink is given in Paragraph 5 and shown in Figure 3.

NOTE

For 50 Hz units, check for ECO #VR14-15; this ECO requires that 7-bladed fans be installed to insure adequate cooling at lower line frequency.

The interchange is accomplished by unscrewing the end plates of the heat sink assembly, exchanging the heat sinks so that X heat sink is on the outside, and then replacing the end plates.

Before reassembly, remove the thermal cutout on the X heat sink and replace it with a 6-32 screw to hold the terminals on the inside. Place a jumper plug across the thermal cutout leads because the cutout is no longer used and the line circuit must be completed.

7. Heating of the power transistor can also be reduced by decreasing the high voltage, thereby requiring less current for full-scale deflection. The high voltage can be reduced by removing the AC input wires from the 115 Vac transformer tap and connecting them to the 100 Vac tap.

NOTE

This step is valid only for the VR14. Do not change high voltage input wires on the VR20 because the high voltage on a VR20 is already lower than the high voltage on a VR14.

The following method is valid if the VR14 is wired for either 240 Vac or 115 Vac.

Move the red high voltage supply input wires from TB1-1 to TB1-4 and from TB2-1 to TB2-3.

Once the wires have been changed, the X and Y gain must be readjusted to compensate for the lower current requirement.

Note that ECO #G836-5 (see Figure 1) changes the value of resistors ±23/5V to ±21.5V, thereby reducing the deflection heating.

8. Make certain that all power transistors have sufficient thermal compound. If the failed transistor is dry, then the other transistors also probably are dry. All mating surfaces must have 1/32-inch layer of thermal compound applied with a flux brush. No bare metal should show.

9. Check for oscillations and/or "fuzz" on the input signal waveforms. If these are present, overheating of the deflection components may occur.

10. Reinstall the X and Y deflection boards.

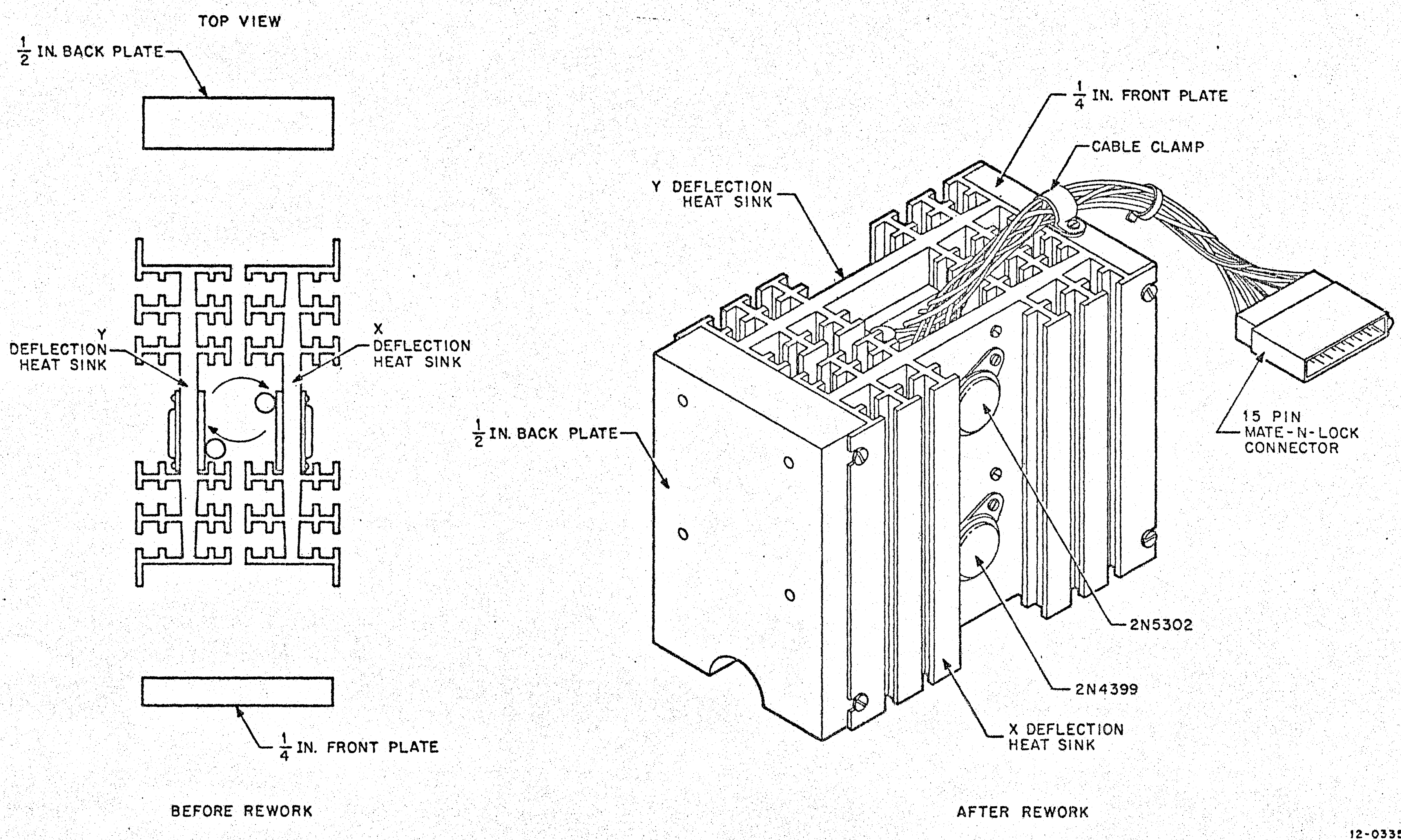

Figure 3 Deflection Heat Sink

11. Measure the yoke sample returns (pins A02-A and A03-A) with no input signals (cable disconnected). They should be approximately +2.5V and +2.0V, respectively. These voltages indicate proper operation for lower left corner deflection for PDP-12 operation. For PDP-8E/PDP-11 operation, the yoke sample return will measure 0.0V on both pins, thus indicating proper center screen deflection. Therefore, adjust the positioning potentiometers for +2.5V and +2.0V to load down the positive power supply.

12. Refer to Figure 4. Measure the base-emitter voltage drop in the power supply heat sink assembly. Because only the positive supply is being used, it should indicate full drop, 1.2V, while the negative supply should indicate only standby drop 0.5V. If the positive supply measurement indicates 2.4V base-to-emitter drop, then one of the 2N4399 transistors is open. Replace both 2N4399 transistors!

13. While measuring the appropriate yoke return, adjust the position potentiometers on the X and Y deflection boards for −2.5V and −2.0V deflection (upper right corner deflection). Then, again measure the base-emitter voltage drop for the negative supply. It should then be 1.2V and the base-emitter drop for the positive supply should be 0.5V. Return the position potentiometers to their original values.

CAUTION

If the position potentiometers are adjusted for a combined voltage of more than ±5V (10 amperes) the respective D.C. fuse will blow.

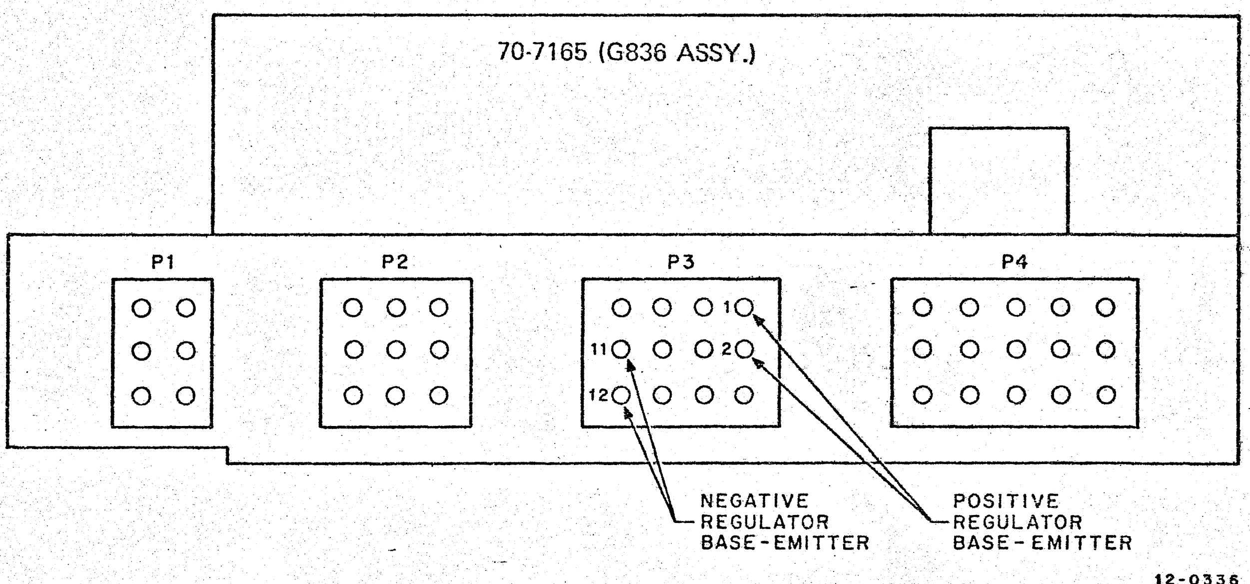

Figure 4 Base-Emitter Voltage Drop, Test Point Location

3. PROCEDURE B

When a display CRT arcs, the cathode, and thus the W682 intensity board, receives the overvoltage surge. The G836 regulator can also receive the overvoltage. This condition is indicated by blown electrolytic capacitors and regulators that no longer function properly. It is also possible for power transistors to short from collector to emitter because of an overvoltage condition.

The most difficult part of troubleshooting a VR14 that has malfunctioned because of an arcing CRT is finding all of the components that have failed or become damaged. Sometimes these failures are very subtle. For example, the MC1709 operational amplifier on the G836 regulator can become partially damaged but appear to function correctly. However, in reality, the ±22V is not regulated and eventually climbs to 40V, thereby overdriving the deflection power transistor which then fails.

The following procedure is to be used when troubleshooting a VR14 that has failed because of an arcing CRT:

1. Replace fuses, power transistors, and any other components that have obviously failed. Use only Motorola transistors and use sufficient thermal compound (refer to Procedure A, Step 1).

2. Replace the 709 operational amplifiers on the G836 regulator board.

3. Replace the CRT when the specific VR14 being repaired has a previous history of failures due to CRT arcing.

4. PROCEDURE C

When a dc fuse has blown, it is usually because the power supply has been subjected to a current overload. However, if a fuse blows but not as a result of failure of internal components (transistors), then the problem is due to an externally generated overload, faulty connections in the VR14, or a power latch-up problem.

The following procedure is to be used in these cases:

1. Replace the fuse and obtain a picture on the display.

2. Remove the top screen on the VR14 and, while a picture is displayed, shake and wiggle the four cables and associated connectors coming into the G836 regulator.

   If the picture breaks up under this condition, it indicates a faulty pin or connection that must be repaired.

   If a bad connection interrupts a critical voltage, the deflection amplifier deflects the beam off screen and blows the fuse.

3. If shaking fails to isolate the problem than one of two problems exists:

   a. The input deflection signals are intermittently excessive, thereby driving the CRT beam off screen and blowing the fuse.

   b. A power latch-up problem exists.

4. Check the computer D/A converters for intermittent or incorrect outputs. Make certain that there are no oscillations on the D/As.

5. Check for a power latch-up problem.

   When power is turned on, the deflection amplifier settles to its normal operating conditions. However, if power is subsequently turned off and immediately turned on again (within 1/2 second), the deflection amplifier may receive the power supply voltages in such a manner that the deflection amplifier saturates driving the CRT beam off screen. The deflection amplifier is then prevented from recovering unless powered down for one second or longer.

   If a power latch-up problem occurs, it is worse at low line (110 Vac). If the VR14 is left on in this latch-up mode, the deflection amplifier saturates and blows the −22V, 10A fuse. However, no other harm is done.

Make certain that resistor R19 on the A225 is 200Ω rather than 270Ω (see Figure 2). The resistor was changed by ECO #A225-6 to prevent a latch-up problem.

6. If the D/A converters in the computer deliver incorrect analog voltages to the display X and Y inputs, the beam can be deflected off the screen causing a fuse to blow which protects the deflection amplifier.

   This condition may exist in computers that use separate precision ±15V power supplies (such as the PDP-12 computer). Some of these supplies latch-up in current fold-back when turned on, causing the +15 Vdc to go to 0V. This in turn causes the D/A converters to deliver −12V instead of the correct voltage. An ECO (ECO #A615-6) in the PDP-12 places zener diodes on the output to clamp the D/A to a safe value under these conditions. Other D/A subsystems may or may not have this output limit protection; check the appropriate DEC-O-LOG for further information.

5. FIELD REWORK OF DEFLECTION HEAT SINK

The deflection heat sink can be reworked to provide better heat dissipation for the power transistors as described in Step 6 of Procedure A (Paragraph 2). The X heat sink, which generates more heat than the Y heat sink, is physically exchanged with the Y heat sink with the result that the X heat sink is near the outside of the VR14 chassis. In this position it gets better air circulation for cooling. The following procedure provides the method of reworking the heat sink assembly (see Figure 3).

NOTE

If you think that the heat sink may have already been modified, and you wish to check to be sure, adjust the X position to 0V yoke return and feel the outside deflection transistors. They should feel cool. If one remains warm, the X heat sink is on the inside, and must be moved to the outside of the VR14 chassis.

1. Remove deflection heat sink assembly from the VR14.

2. Remove 6-32 X 3/8 screw that secures cable clamp to 1/4-inch front plate.

3. Remove eight 6-32 X 1/4 screws that secure X and Y heat sinks to front and back plates.

4. Remove thermal cutout from X deflection heat sink and place a 6-32 X 1/2 pan head screw in the hole.

5. Place 1/2-inch back plate on a flat surface with the two mounting screws (used for securing heat sink) facing up and half-circle cutout facing the bottom.

6. Secure the X deflection heat sink (identified by grey wire on transistor collectors) to the 1/2-inch back plate, using two 6-32 X 1/4 screws. Make certain the 2N4399 transistor is on the bottom.

7. Place 1/4-inch mounting block on other side of the X deflection heat sink with the cable clamp screw hole facing the top. Secure with two 6-32 X 1/4 screws.

8. Secure the Y deflection heat sink (identified by violet wire on transistor collectors) to the opposite side of the assembly, ensuring that the 2N4399 is on the bottom.

9. Secure the cables from X and Y deflection heat sinks to the top of the 1/4-inch front plate with cable clamp and 6-32 X 3/8 screws.

10. To complete the AC line circuit, place a jumper plug (7007006-3) in the 2-pin connector that was connected to the plug for the thermal cutout.

11. Replace deflection heat sink assembly in the VR14.