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VR14 and VR20 troubleshooting procedures

laboratory data products

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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 transistors.
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 and 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

The fuse and the 2N4399 transistor do not malfunction without a reason. The 2N4399 normally shorts out because it becomes 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.

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

Step	Procedure
1	Replace the fuse and defective transistor(s). Power transistors must be replaced in pairs. If the 2N4399 is shorted, replace the 2N5302 on the same side also. Use plenty of white thermal compound; ensure that the transistor insulating washer is not left off. **CAUTION** **Use only Motorola transistors and either Dow Corning #340 or Wakefield #120 thermal compound. NEVER USE CLEAR GREASE.**
2	Check the fan.
3	Carefully measure the power supply voltages at pins A01-U (+22V) and A01-K (-22V). If either of these voltages exceeds 22V, even if only by 1V, a power supply problem is indicated. If these voltages drift while diagnostics or any other patterns are running, it indicates a power supply problem. **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 220 ohms, *not* 1K. b. R10 and R27 should be 10 ohms, *not* 150 ohms. c. R2 and R17 should be 1.78K, 1% resistors, *not* 1.62K, 1%. This lowers the ±24V to ±22V. If power supply voltages drift or wander, change Q2 (2N4920), 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.
5	Make certain that the A225 boards have ECOs 2, 4, 5, and 6 incorporated (Figure 2). ECO #2 R29 and R30 (22 ohms) replaced by wires. ECO #4 R1 and R2 are 10K 1/4W. ECO #5 C12 is 100 pf. ECO #6 R19 is 200 ohms 1W.
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.**

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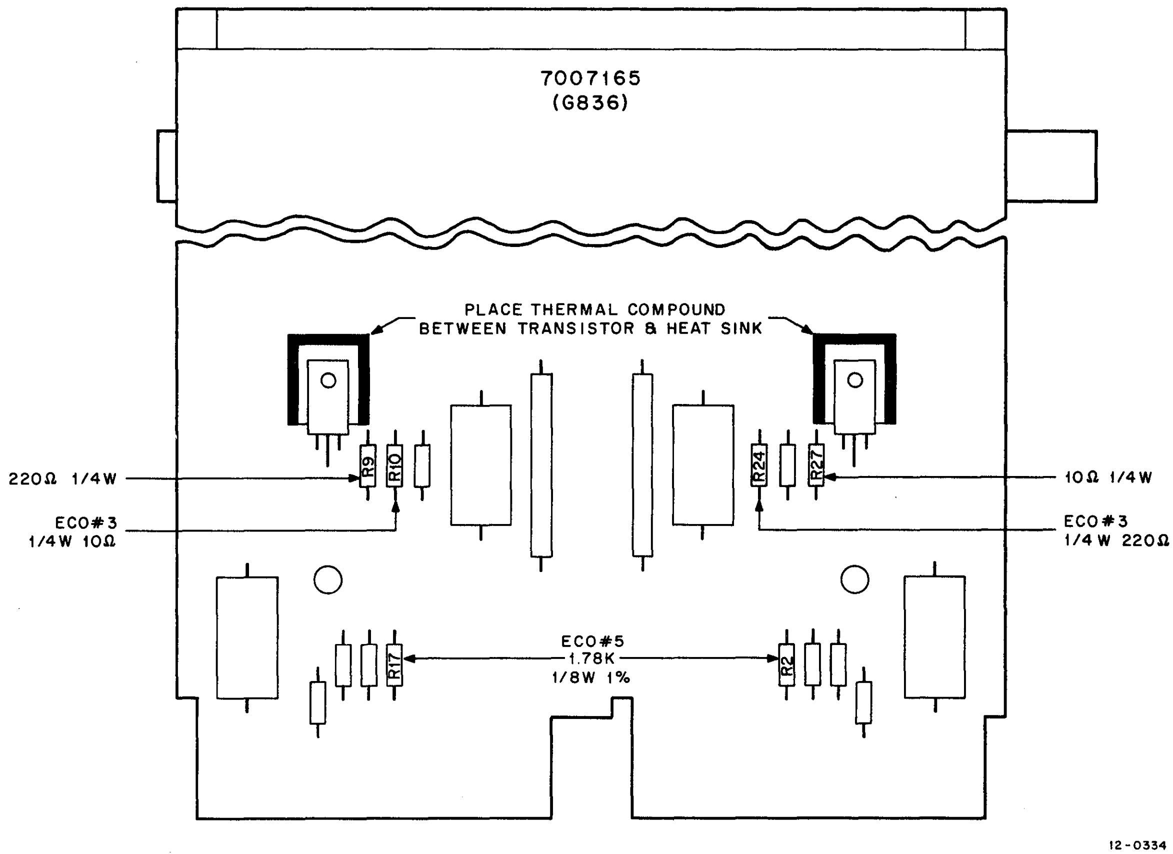

Figure 1 7007165 Power Regulator Assembly

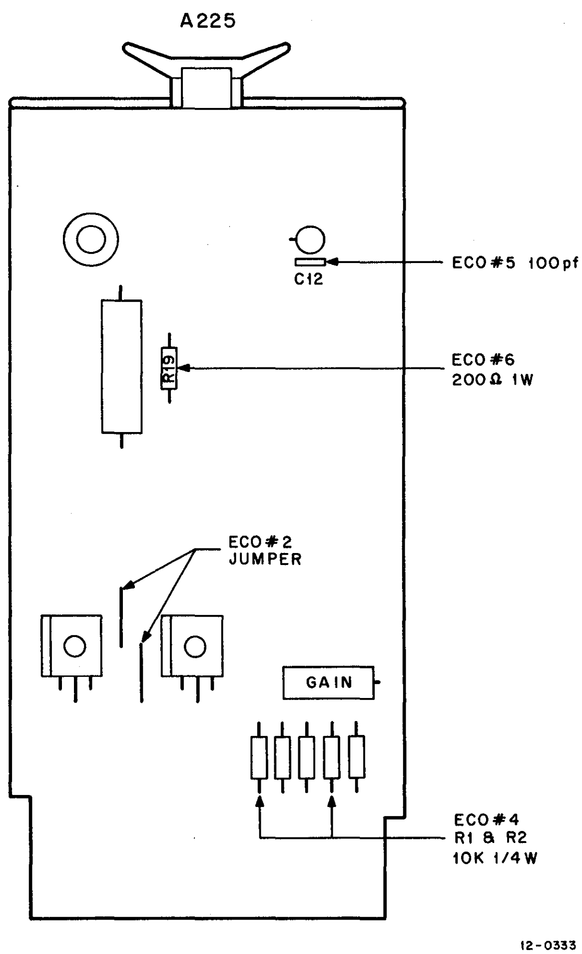

Figure 2 A225 D/A Converter

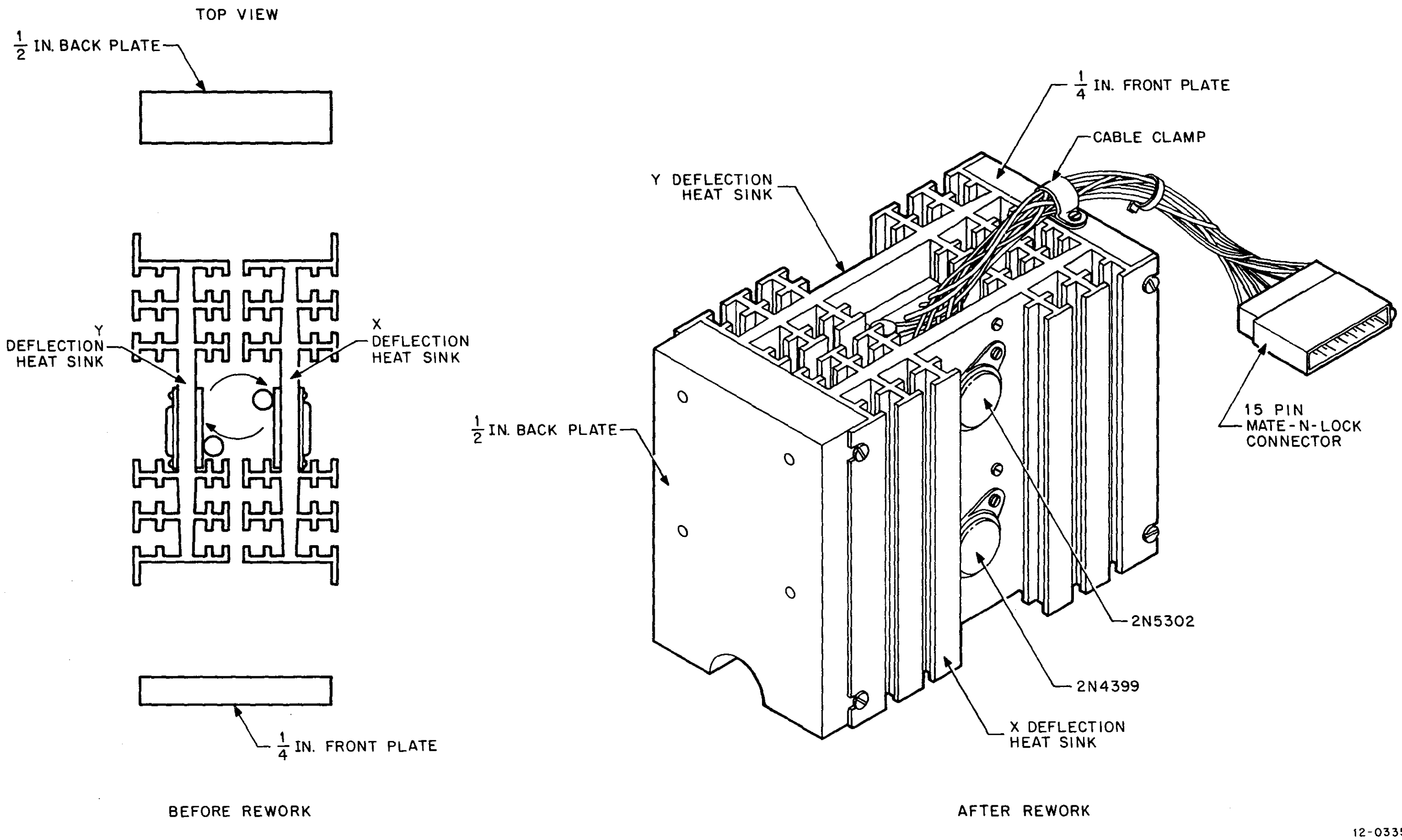

Figure 3 Deflection Heat Sink

Step	Procedure
6 (cont)	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 R2 and R17 from 1.62K to 1.78K. This reduces the supply voltages from ±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. Check the D/A converters in the computer. The A225 modules should have 100 pf capacitors for C12 (this prevents VR14/VR20 oscillations).

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:

Step	Procedure
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:

Step	Procedure
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, then 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 200 ohms rather than 270 ohms (see Figure 2). The resistor was changed by ECO #A225-6 to prevent a latch-up problem.

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Step	Procedure
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.

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 (Parargaph 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).

Step	Procedure
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 screw.
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.