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Find the *Sencore CM2000* at our website: *Click HERE*

Testing Switching Transformers

Switching transformers are used in power supply circuits to step voltages up or down. They are much different from conventional power transformers in both appearance and operation. Power transformers usually operate at 60 Hz, and therefore contain a laminated iron core which is often visible. Because the iron core is low Q and absorbs all ringing energy, power transformers cannot be tested with the CM2000.

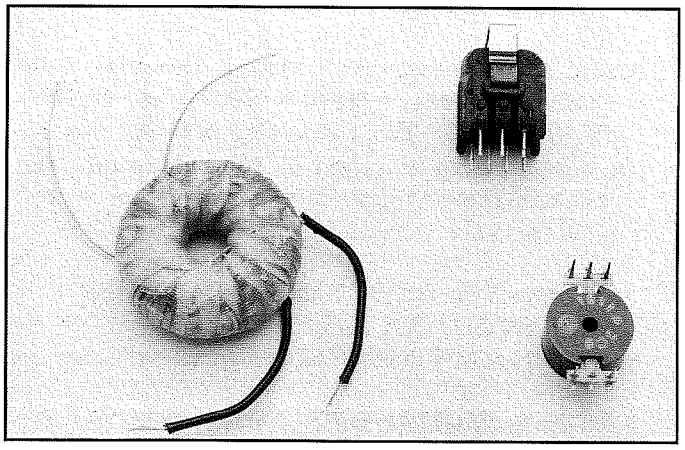


Fig. 45 The toroid (left) and PC mount are two common types of switching transformers.

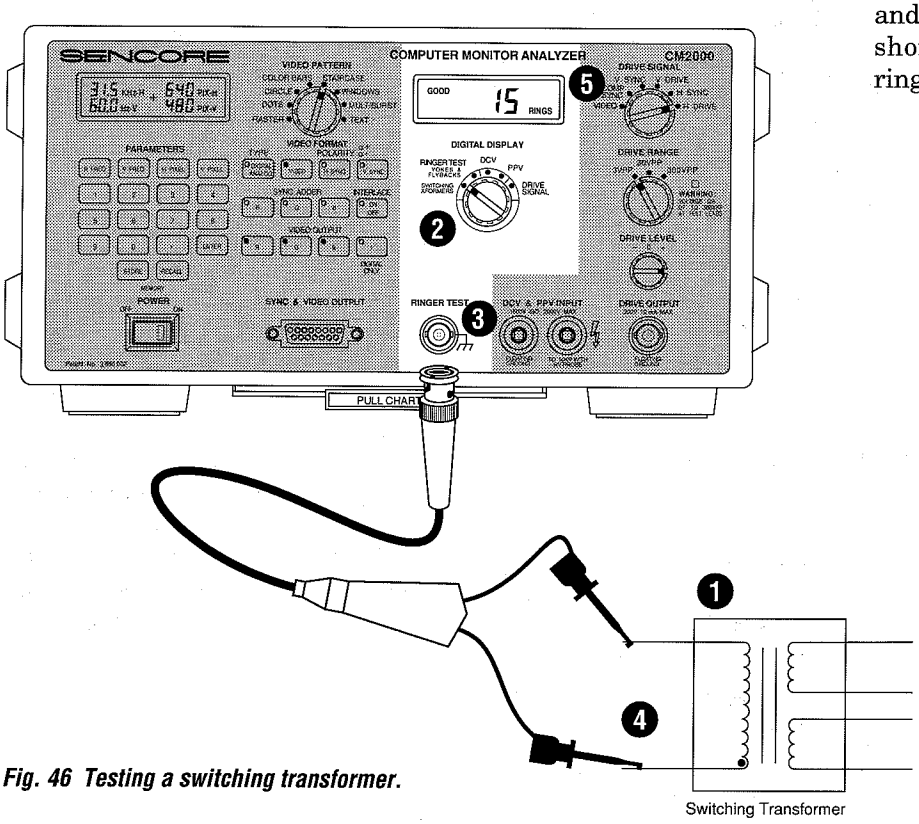


Fig. 46 Testing a switching transformer.

Switching transformers, on the other hand, are much smaller and lighter than power transformers. They are wound around a ferrite core which easily rings when good. Switching transformers operate at much lower currents and much higher frequencies than power transformers.

Example: Testing a switching transformer with the CM2000.

1. Remove the switching transformer from the circuit.
2. Set the DIGITAL DISPLAY Switch to RINGER TEST "Switching Transformers."
3. Connect the DIRECT TEST LEADS to the RINGER TEST Jack.
4. Connect the DIRECT TEST LEADS to the switching transformer.
5. Read the test result in the DIGITAL DISPLAY Readout.

What to expect: Readings of 10 rings or more are accompanied by a "Good" display and indicate that the winding does not have a shorted turn. "Bad" readings, less than 10 rings, indicate a shorted turn.

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Troubleshooting Horizontal Sync Problems

The horizontal sync pulses control the timing of the horizontal oscillator. Many monitors receive horizontal sync directly. Other monitors have a composite sync, or "sync on video" input and require the use of sync separators. Sync pulses that are low in amplitude, the wrong frequency, or are missing cause the monitor to lose horizontal hold.

Some monitors do not have a horizontal oscillator. Instead, they use the incoming sync signal to drive the deflection stages. These monitors will not power up if the sync signal is too low in amplitude, or is missing. This is because they use a scan derived power supply in which the horizontal output stage supplies the operating voltages.

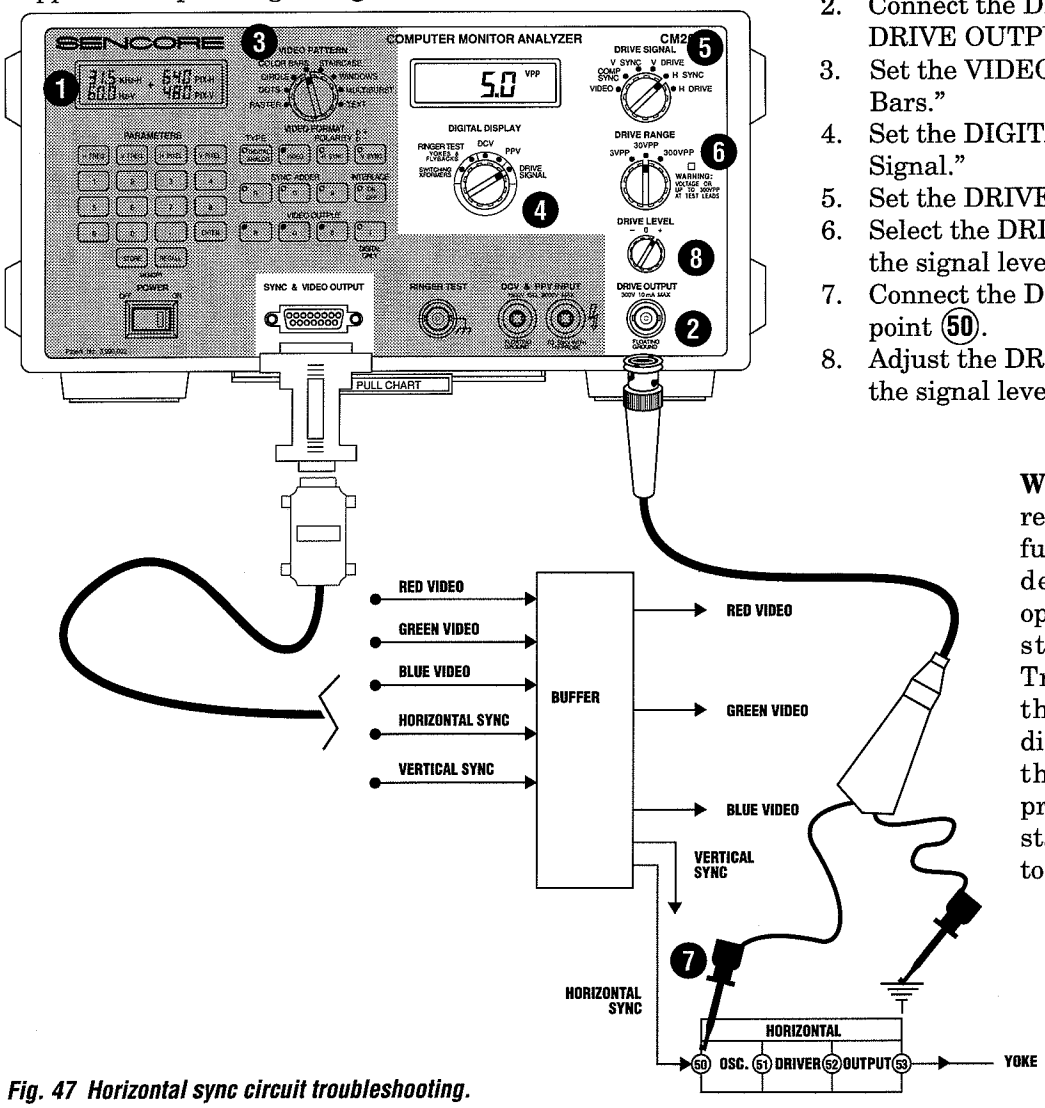


Fig. 47 Horizontal sync circuit troubleshooting.

Use the "H Sync" Drive Signal to inject a good signal into the horizontal oscillator. This will determine whether the problem is in the stages before the oscillator, or in the sweep circuits.

Example: Troubleshooting a monitor with a horizontal hold problem.

1. Set the CM2000 to match the monitor type being serviced (see "Connecting To A Monitor" page 10-19).

Note: *If the monitor operates correctly when connected to the CM2000 SYNC & VIDEO OUTPUT Jack without injecting a Drive Signal, the signal being supplied by the video adapter circuits in the computer is generating horizontal sync pulses at the wrong frequency or amplitude.*

2. Connect the DIRECT TEST LEAD to the DRIVE OUTPUT Jack.
3. Set the VIDEO PATTERN Switch to "Color Bars."
4. Set the DIGITAL DISPLAY Switch to "Drive Signal."
5. Set the DRIVE SIGNAL control to "H Sync."
6. Select the DRIVE RANGE that is closest to the signal level in the circuit.
7. Connect the DIRECT TEST LEAD to test point (50).
8. Adjust the DRIVE LEVEL Control to match the signal level found in the circuit.

What to expect: If the monitor regains horizontal hold and gives full horizontal deflection, or if a dead monitor returns to operation, the Driver and Output stages work properly. Troubleshoot the oscillator and the sync path. If the monitor displays the same symptoms with the Drive Signal applied, the problem is in the Driver or output stages. Use the "H Drive" signal to inject into the output stages.

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Troubleshooting Horizontal Output & High Voltage Problems

The horizontal output circuits are the heart of the monitor. The quickly-changing current in the output stages provides a practical, efficient source of operating voltages for use throughout the monitor. The horizontal output circuits are directly responsible for: 1) horizontal scanning; 2) CRT high voltage; 3) CRT focus voltage; 4) "Scan derived" low voltage supplies; and 5) feedback gating signals.

Components that make this happen are the horizontal output transistor, B+ supply, flyback transformer, high voltage multiplier and the startup and safety shutdown circuits. The horizontal yoke is not responsible for generating high voltage, but it is tied directly into the output circuits and may affect the output voltages if it is defective.

Failures in the horizontal output stages are common because the components are subjected to constant high current and high voltage stress. Without good troubleshooting procedures and test equipment, horizontal output problems can be difficult to isolate because the components interact so closely and the failure of any components often creates the same symptom: a dead monitor.

Several features of the CM2000 help simplify troubleshooting horizontal output problems. These are the Ringer Test, the Horizontal Drive Signal, and the DCV and PPV meter.

Testing Flyback Transformers

A flyback transformer can develop one of three common failures. Following is a brief explanation of each and the troubleshooting procedure to locate the failure.

First, a winding may develop an open or shorted turn. An open winding is usually easy to detect. Measure the DC or PPV output with the CM2000's DVM if the chassis is operational, or check for continuity with an ohmmeter. A shorted turn, however, can only be detected using the CM2000's Ringer Test. The change in resistance that it causes is too small to be detected with an ohmmeter.

A second failure is common only to flybacks that contain a high voltage multiplier. These flybacks are called integrated high voltage transformers, or IHVTs. If the multiplier portion of an IHVT fails, the high voltage and/or focus voltage will be low or missing. Test for this failure by driving the IHVT with the Horizontal Drive Signal and measuring the resulting output.

A third failure occurs when a flyback transformer develops a leakage path between two windings, or between a winding and the transformer's core or mounting bracket. A high resistance leakage path often pulls down the B+ supply, even if the horizontal output transistor is disconnected from the circuit. Usually the leakage path goes unnoticed until operating voltages are applied to the flyback. Use a "Hi Pot" test, such as the Sencore "Z-Meter" Leakage test, to isolate leakage between windings.

Note: *Leakage between windings is different than a shorted turn. The Hi Pot test will find leakage between windings, but not a shorted turn. The Ringer test will find the more common shorted turn, but will not find leakage or shorts between windings.*

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Example: Ringing a flyback transformer for a shorted or opened winding.

1. Remove AC power from the monitor.
2. Set the DIGITAL DISPLAY Switch to RINGER TEST "Yoke & Flybacks."
3. Connect the DIRECT TEST LEAD to the CM2000 RINGER TEST Jack.
4. Connect the DIRECT TEST LEAD to the flyback's primary winding. *(The primary winding connects between the B+ supply and the collector of the horizontal output transistor).*
5. Read the test results in the DIGITAL DISPLAY Readout.

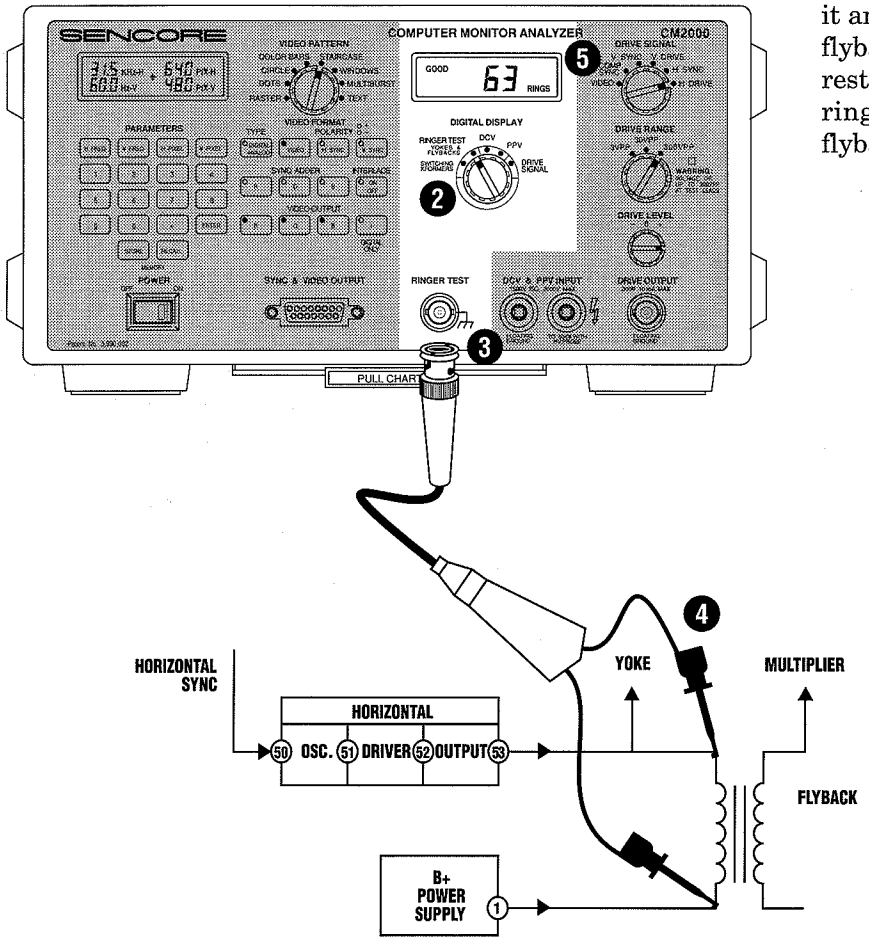


Fig. 48 Ringing a flyback transformer.

What to expect: A "Good" reading of "10" rings or more means that none of the windings in the flyback are shorted. You do not need to ring any other winding. A shorted turn in any other winding will cause the primary to ring bad.

A "Bad" reading, less than 10 rings, may be caused by a circuit connected to the flyback that is loading the Ringer test. Disconnect the most likely circuits in the following order: 1) Yoke; 2) CRT filament (unplug the CRT socket); 3) horizontal output transistor collector; 4) scan derived supplies. Retest the flyback after you disconnect each circuit. If the flyback now rings "good," it does not have a shorted winding.

If the flyback still tests bad after you've disconnected each of the above circuits, unsolder it and completely remove it from the circuit. If the flyback primary still rings less then 10, ring the rest of the windings. If one of the other windings rings above 10, the flyback is good. If not, the flyback is bad and must be replaced.

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Testing The Multiplier In An Integrated High Voltage Transformer (IHVT)

Example: Testing the multiplier section of an IHVT

Note: *It is only necessary to do this test if* ***all*** *of the following conditions are met: 1) Symptom is low or missing high voltage or focus voltage, 2) The B+ and PPV voltages at the horizontal output transistor are normal and 3) The flyback passes the Ringer test.*

1. Remove AC power from the monitor.
2. Discharge the CRT high voltage and remove the HV lead.
3. Remove the IHVT from the circuit or disconnect the IHVT from the circuit as needed to get a "Good" Ringer test.
4. Set the CM2000 as follows:
   a. DIGITAL DISPLAY Switch to "Drive Signal."
   b. DRIVE SIGNAL Switch to "H Sync."
   c. DRIVE RANGE Control to "30 VPP."
   d. DRIVE LEVEL Control to "+ 25 VPP."
   e. DIGITAL DISPLAY Switch to "DCV."
   f. Connect the DVM TEST LEAD to the DCV & PPV INPUT Jack.
   g. Connect the DIRECT TEST LEAD to the DRIVE OUTPUT Jack.
5. Turn off the CM2000.
6. Connect the CM2000 to the IHVT as follows:
   a. DIRECT TEST LEAD to the primary winding.
   b. Black DVM TEST LEAD to the low side of the high voltage secondary winding ("HV resupply").
   c. Place the TP212 on the Red DVM TEST LEAD.
   d. Connect the Red DVM Lead & TP212 to the high voltage lead.
7. Turn on the CM2000.
8. Read the voltage in the DIGITAL DISPLAY Readout and multiply the reading by 10 to compensate for the TP212.

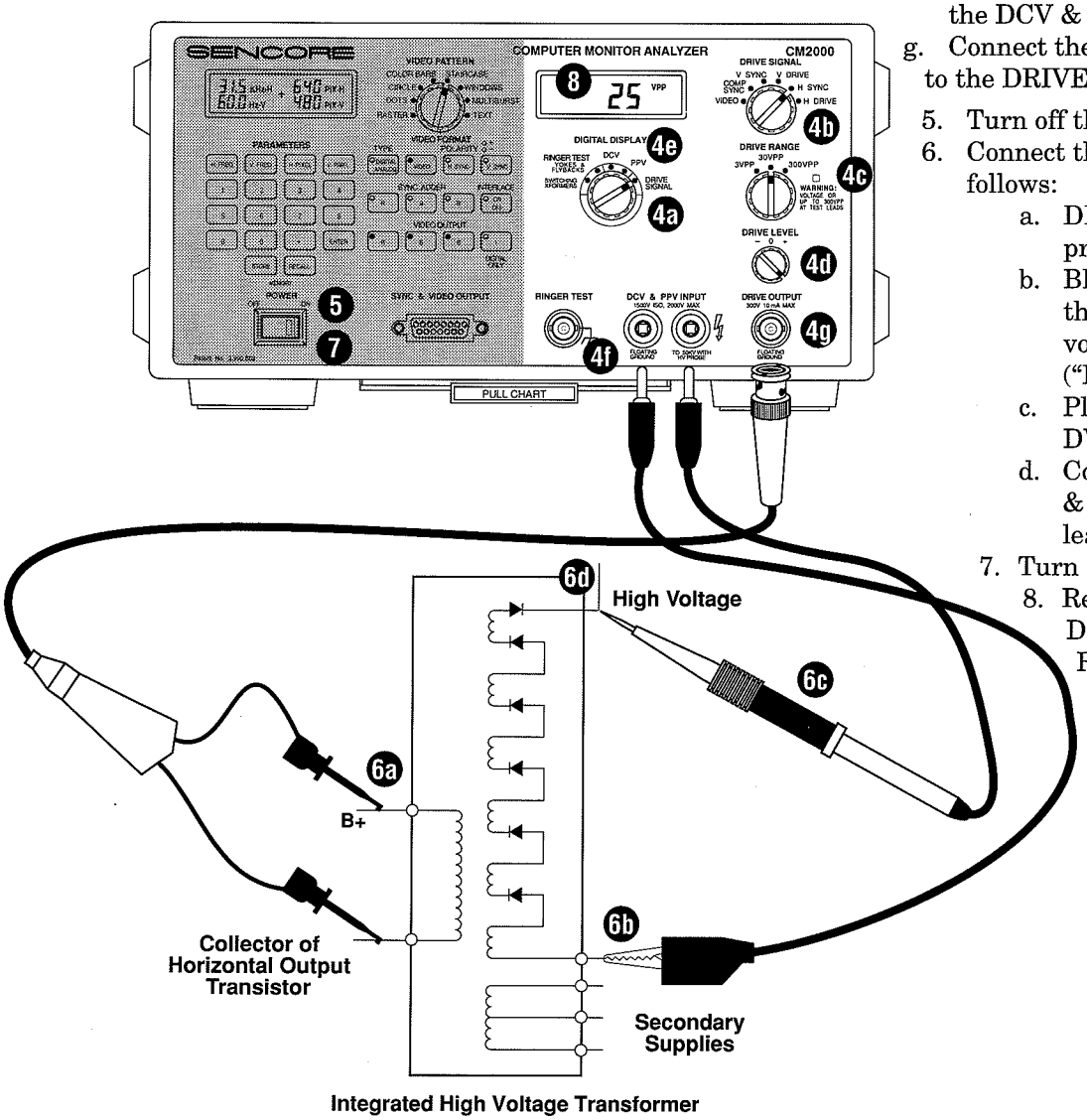


Fig. 49 Testing the multiplier section of an IHVT.

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What to expect: Compare the DC voltage reading to values in Table 3. If the voltage reading is below the value shown, change the DRIVE LEVEL polarity to - 25 VPP. If the reading is still low, the IHVT is bad. If the voltage reading is equal to or above the value shown in the chart, the IHVT is good.

Note: *To test the focus tap, measure the DC voltage on the focus output lead or pin. A good focus supply will produce 20-35% of the voltage measured at the HV lead.*

COLLECTOR	CRT HIGH VOLTAGE					
PPV	10000	15000	20000	25000	30000	35000
100	2500	3750	5000	6250	7500	8750
200	1250	1875	2500	3125	3750	4375
300	833	1250	1667	2083	2500	2917
400	625	938	1250	1563	1875	2188
500	500	750	1000	1250	1500	1750
600	417	625	833	1042	1250	1458
700	357	536	714	893	1071	1250
800	313	469	625	781	938	1094
900	278	417	556	694	833	972
1000	250	375	500	625	750	875
1100	227	341	455	568	682	795

Table 3 Use the ratio between the peak-to-peak voltage of the horizontal output transistor and the normal high voltage to determine the DC voltage for the integrated flyback test.

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Testing High Voltage Multipliers

Some monitors use a high voltage multiplier that is a separate component from the flyback transformer. Typically, high voltage multipliers are doublers, triplers or quadruplers. The procedure for testing these components is similar to testing the high voltage diodes in an IHVT.

Example: Testing discrete high voltage multipliers:

1. Remove AC power from the monitor.
2. Discharge the CRT high voltage and remove the HV lead.
3. Remove the multiplier from the circuit.
4. Set the CM2000 as follows:
    a. DIGITAL DISPLAY Switch to "Drive Signal."
    b. DRIVE SIGNAL Switch to "H Sync."
    c. DRIVE RANGE Control to "300 VPP."
    d. DRIVE LEVEL Control to + 250 VPP.
    e. DIGITAL DISPLAY Switch to "DCV."
    f. Connect the DVM TEST LEAD to the DCV & PPV INPUT Jack.
    g. Connect the DIRECT TEST LEAD to the DRIVE OUTPUT Jack.
5. Turn off the CM2000.
6. Connect the CM2000 to the multiplier as follows:
    a. DIRECT TEST LEAD to the input pins.
    b. Black DVM TEST LEAD to the ground pin.
    c. Place the TP212 on the Red DVM TEST LEAD.
    d. Connect the Red DVM Lead & TP212 to the high voltage lead.
7. Turn on the CM2000.
8. Read the voltage in the DIGITAL DISPLAY Readout and multiply the reading by 10 to compensate for the TP212.

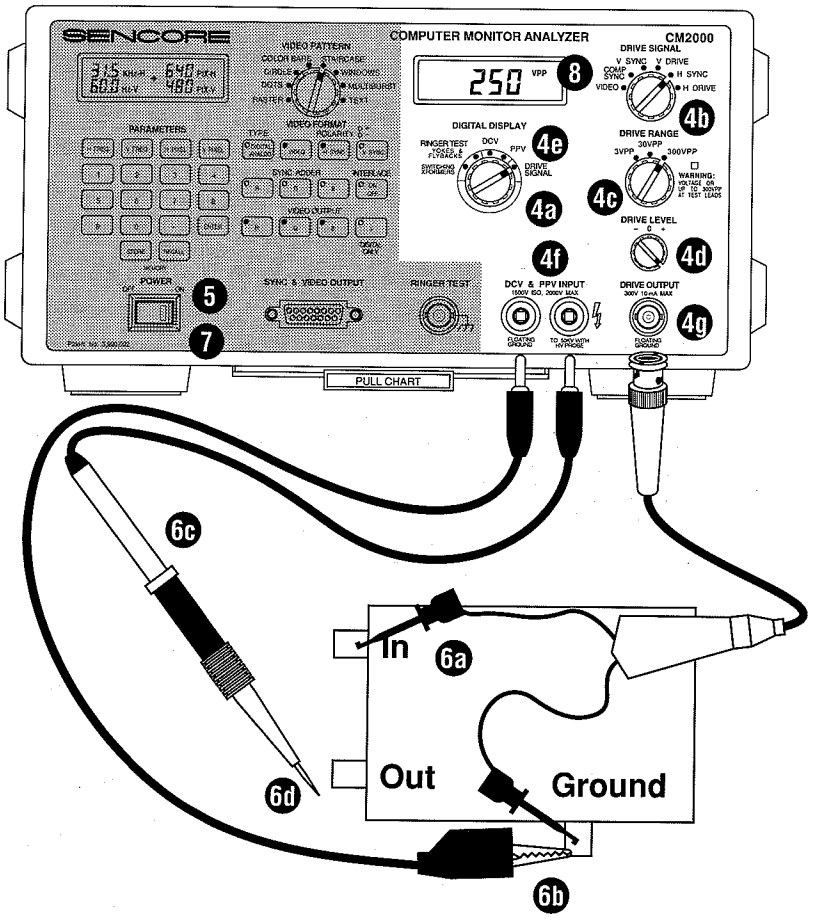


Fig. 50 Testing a high voltage multiplier.

What to expect: Compare the DC voltage reading to the values listed in the table below. If the DC voltage reading is below the amount listed, change the DRIVE LEVEL polarity to -250 VPP. If the reading is still low, the multiplier is bad. If the voltage reading is equal to or above the value shown in the chart, the multiplier is good.

Note: *To test the focus tap, measure the DC voltage on the focus output lead or pin. A good focus supply will produce 25-50% of the voltage measured at the HV lead. If the multiplier has a CTL pin, connect the CTL pin to the ground or common pin before measuring the voltage. In this case, the voltage should be 10-20% of the voltage measured on the HV lead.*

Multiplier Type	Multiply Factor	Output Voltage
Doubler	2	250
Tripler	3	500
Quadrupler	4	750

Table 4 A high voltage multiplier should produce these voltages or higher when supplying 250 VPP to the input.

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Testing High Voltage Regulation

The high voltage regulator circuit is responsible for maintaining a constant high voltage at the CRT as the HV load varies. A black raster turns the guns off, so there is minimum beam current and minimum load. The heaviest load is produced by a white raster. Without regulation, the high voltage would vary with displayed image. Poor high voltage regulation creates problems such as blooming, improper brightness variations, poor focus, poor color and a jumpy display.

Use the CM2000's RASTER pattern to dynamically test a monitor's high voltage regulation circuit. Quickly switching the "Video" FORMAT Button between "+" and "-" causes the display to alternate between white (maximum load) and black (minimum load).

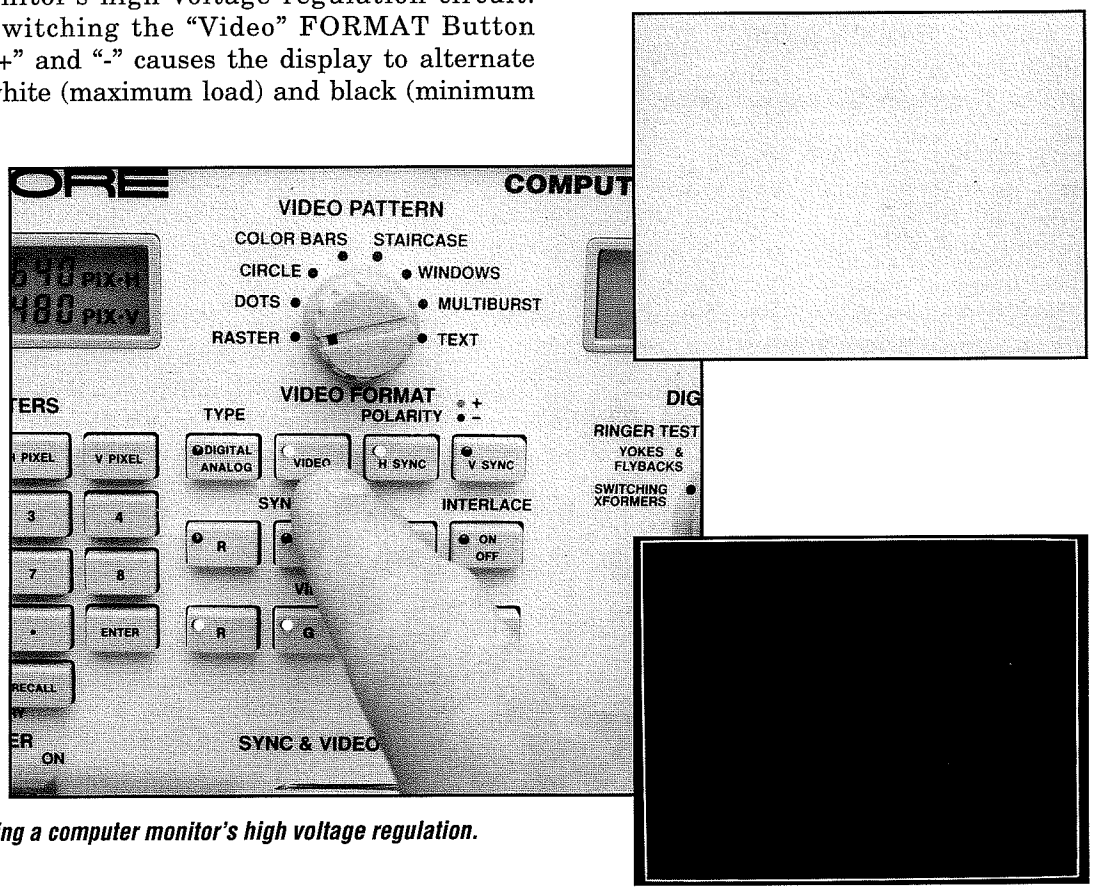


Fig. 51 Testing a computer monitor's high voltage regulation.

Example: Testing a monitor's high voltage regulation.

1. Set the CM2000 to match the monitor type being serviced (see "Connecting To A Monitor" pages 10-19).
2. Set the VIDEO PATTERN Switch to "Raster."
3. Press R G B to "on".
4. Set the monitor's brightness to maximum.
5. Quickly press VIDEO from "+" to "-".

What to expect: The display should remain stable as it is switched between the white raster and black raster. The white border line should remain stable with no signs of bowing or blooming.

If the display shows a regulation problem, measure the peak-to-peak voltage at the collector of the horizontal output transistor while repeating step 5. If the PPV voltage changes widely with the changing video pattern, troubleshoot the B+ regulator circuit. If the PPV voltage remains stable, check the video or sync circuits for changing levels.

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Troubleshooting Horizontal Drive Circuits

If the horizontal yoke, flyback, multiplier, horizontal output transistor, and B+ supply have been tested and found to be good, but the monitor still has no deflection or high voltage, the horizontal driver circuit may be defective. A missing or reduced amplitude horizontal drive signal could prevent the computer monitor from starting up and operating properly. Use the CM2000's "H Drive" to isolate problems in the horizontal drive circuit.

Example: Troubleshooting a "no high voltage" or horizontal deflection problem:

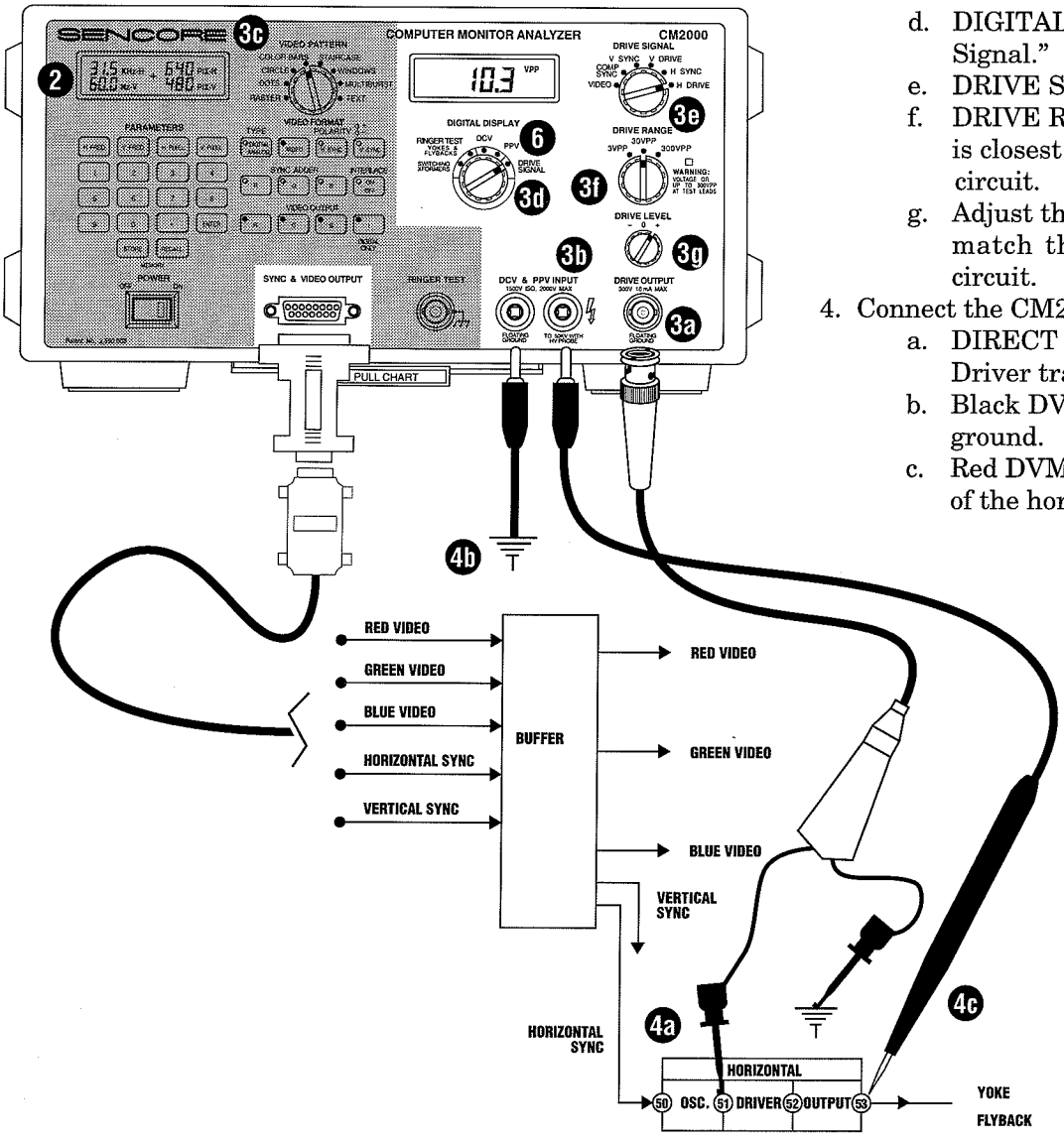


Fig. 52 Horizontal drive circuit troubleshooting.

Notes: *1). Before injecting into the horizontal drive circuit, test the flyback and yoke, the high voltage multiplier, the horizontal output transistor, and the B+ supply and 2). When injecting the H DRIVE signal into the horizontal drive circuit always lower the line voltage to 85 volts AC.*

1. Turn the monitor POWER to "Off."
2. Set the CM2000 to match the monitor type being serviced (see "Connecting To A Monitor" pages 10-19).
3. Set the CM2000 as follows:
   a. Connect DIRECT TEST LEAD to the DRIVE OUTPUT Jack.
   b. Connect DVM TEST LEAD to DCV & PPV INPUT Jack.
   c. VIDEO PATTERN Switch to "Color Bars."
   d. DIGITAL DISPLAY Switch to "Drive Signal."
   e. DRIVE SIGNAL Switch to "H Drive."
   f. DRIVE RANGE Control to range that is closest to the signal level in the circuit.
   g. Adjust the DRIVE LEVEL Control to match the signal level found in the circuit.
4. Connect the CM2000 to the monitor as follows;
   a. DIRECT TEST LEAD to base of the Driver transistor (TP (51)).
   b. Black DVM TEST LEAD to circuit ground.
   c. Red DVM TEST LEAD to the collector of the horizontal output transistor.
5. Set the AC voltage to 85 VAC and turn "On" the monitor POWER.
6. Monitor the PPV level on the DIGITAL DISPLAY Readout as you adjust the DRIVE LEVEL Control.

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What to expect: Watch for voltage on the CM2000's PPV meter and for horizontal deflection. If these return, you are injecting after the defective stage. If pulses do not occur at the collector, inject the Drive Signal at the base of the horizontal output transistor.

Note: *When injecting at the output transistor, disconnect the secondary winding of the driver transformer from the base of the output transistor.*

Monitoring The Horizontal Output Transistor Collector

A wealth of troubleshooting information can be gained about the monitor's operation by measuring the DC and peak-to-peak voltage at the collector of the horizontal output transistor. The DC reading tells you if the B+ supply is working correctly, while the peak-to-peak reading tells you if the output circuits are creating the needed high voltage.

Example: Measuring DC and peak-to-peak volts at the collector of the horizontal output transistor.

1. Set the DIGITAL DISPLAY control to "DCV"
2. Connect the DVM TEST LEADS to the DCV & PPV INPUT Jacks.
3. Connect the black DCV & PPV INPUT test lead to ground.
4. Connect the red DCV & PPV INPUT test lead to the collector of the horizontal output transistor.
5. Take the voltage reading.
6. Set the DIGITAL DISPLAY control to "PPV".
7. Take the voltage reading.

What to expect: Compare the voltage readings to those shown on the schematic. If the B+ voltage is low, unload the power supply by disconnecting the collector of the horizontal output transistor from the circuit. Measure the voltage at the output of the power supply regulator again. If the voltage is still low or missing, troubleshoot the power supply. If the voltage goes to its schematic value, something is loading down the supply. Troubleshoot the output transistor, flyback, or yoke.

If the peak-to-peak voltage reading is missing or low, troubleshoot the output transistor, flyback or yoke. If the voltage is high, check the high voltage regulation circuit, or the timing capacitors in the horizontal output circuit.

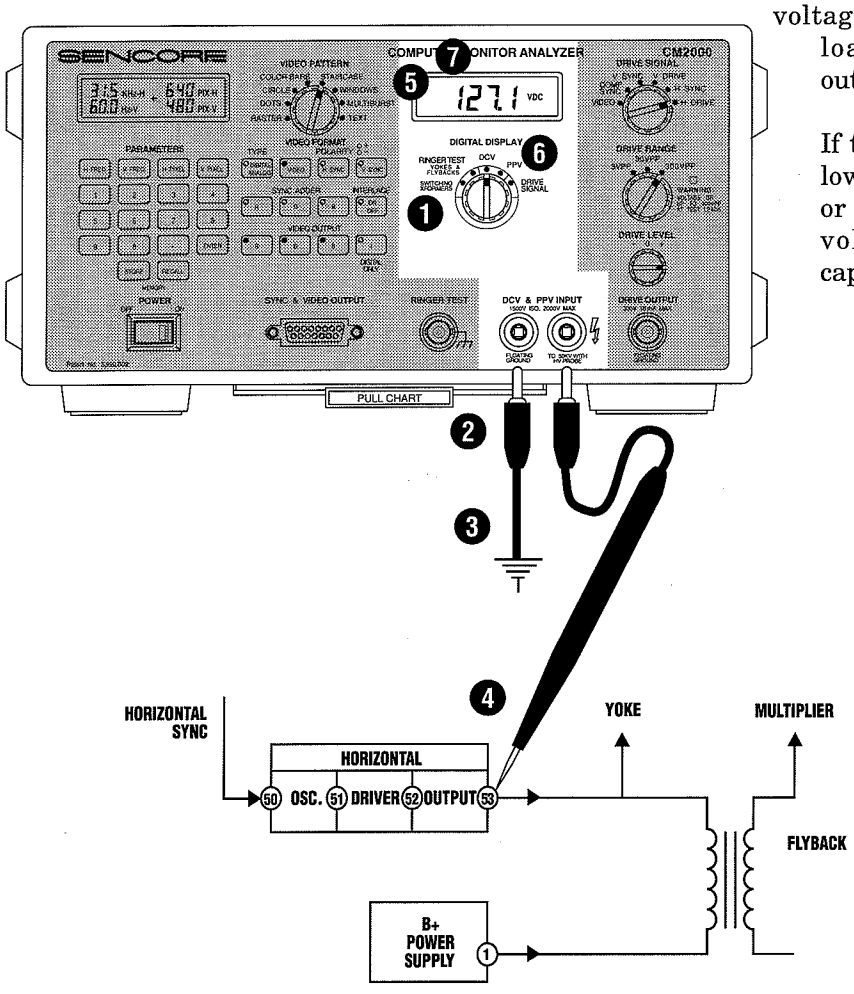


Fig. 53 Monitoring the voltage at the collector of the horizontal output transistor.

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Measuring High Voltage

The CRT requires a very high DC voltage to accelerate the electrons toward the screen. This voltage is developed by the secondary winding of the flyback transformer and is rectified by the integrated diodes in the flyback, or by a separate multiplier circuit.

Measuring the high voltage at the second anode of the CRT lets you know if the output circuit, flyback, high voltage multiplier, and power supply regulation circuits are working correctly. Additionally, some monitors have adjustments to set the high voltage and focus voltage.

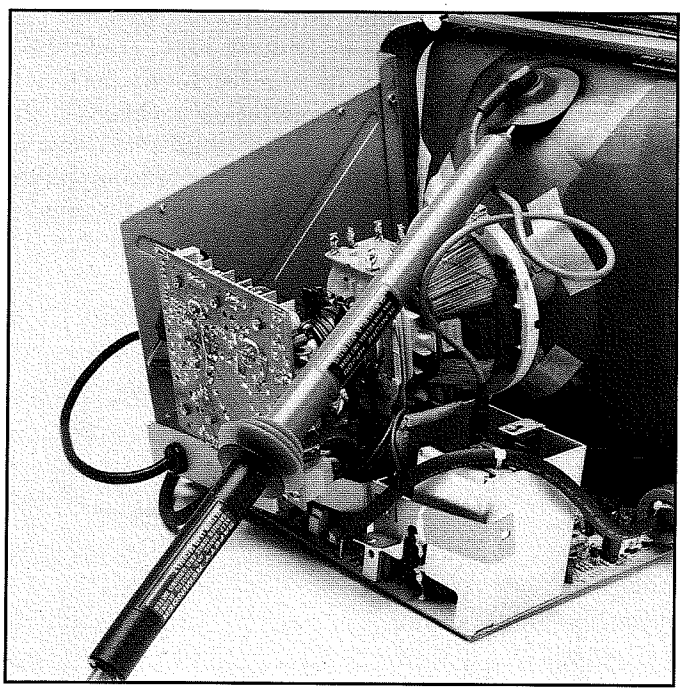


Fig. 54 Use caution when measuring high voltage with the HP200, 50,000 volt high voltage probe.

WARNING

Measuring the high voltage exposes you to the possibility of a severe shock hazard if you do not follow careful test methods. Do not do the high voltage test until you completely read and understand the following warnings and instructions.

1. **Never measure more than 2000 volts without a high voltage probe.** Use the TP212 to measure voltages in the 2,000 to 10,000 volt range. Use the HP200 for voltages near or over 10,000 volts.

2. **Remove power to the circuit before connecting to the test point or before disconnecting the high voltage probe.**

3. **Connect the ground lead so that it cannot become detached during the test.** If the ground lead becomes loose, remove the AC power to the monitor immediately.

4. **Connect to the correct ground point.** Some chassis use a separate ground for the high voltage.

5. **Immediately remove power to the circuit if the high voltage probe comes loose.** Do not touch the high voltage probe until power is removed and the high voltage discharged.

6. **If you must hold the high voltage probe, use extreme caution.** Be sure the connections to the probe and ground lead are firmly attached. Hold the probe behind the molded safety rings to prevent the possibility of contacting the high voltage test point or to prevent arcing across the probe to your body.

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Example: Measuring a monitor's high voltage.

1. Turn off the power to the monitor.
2. Set the CM2000 DIGITAL DISPLAY Switch to "DCV."
3. Connect the DVM TEST LEADS to the DCV & PPV INPUT Jacks.
4. Slide the red DVM TEST LEAD into the HP200 High Voltage Probe.

Note: *Be sure the tip is firmly seated in the connector inside the probe so that it will not detach during the measurement.*

5. Connect black DVM TEST LEAD to the HV ground point.
6. Connect the probe to the test point so that is does not need to be held during the measurement.
7. Turn on the monitor and take the voltage reading.
8. Multiply the reading on the digital display by 100 when using the Sencore HP200.
9. Turn off the monitor before disconnecting the HP200.

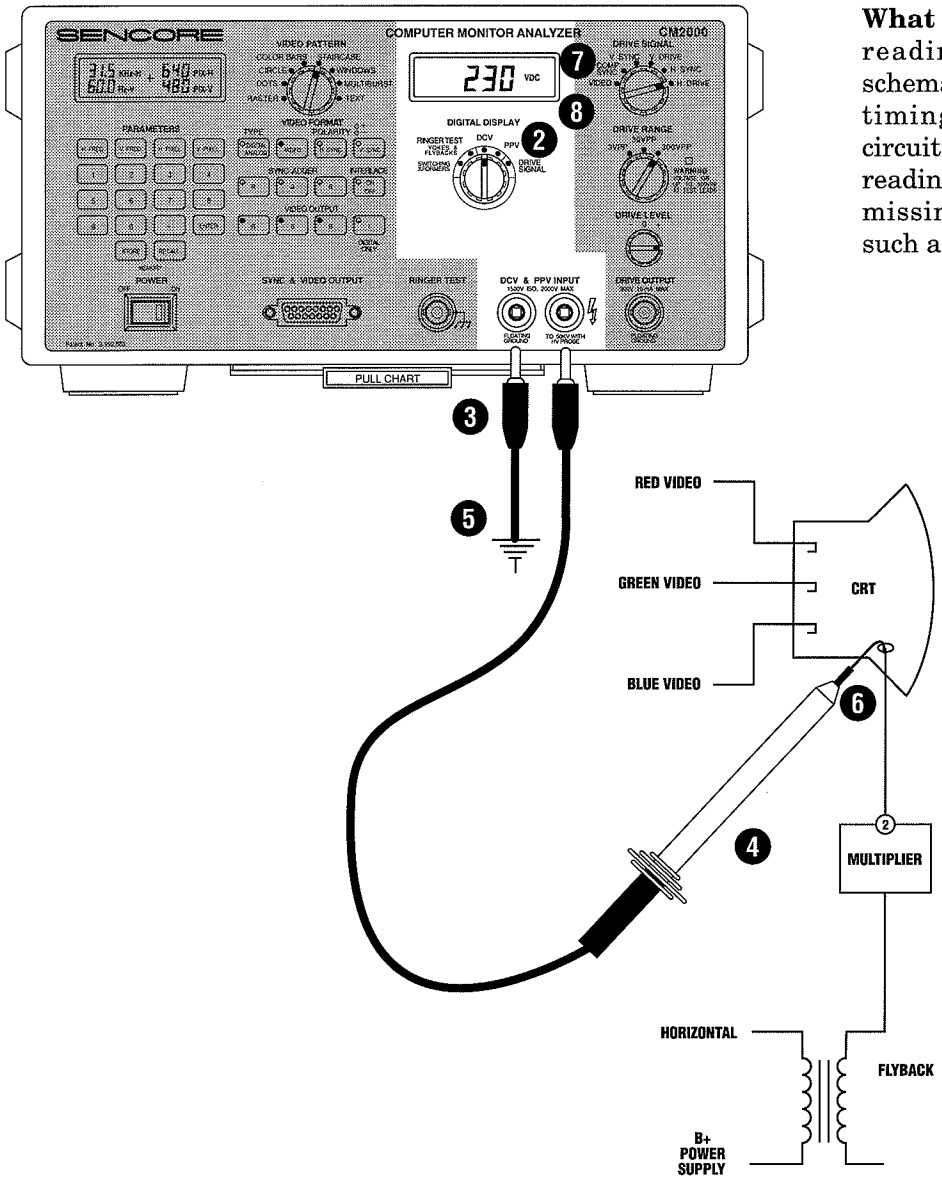


Fig. 55 Measuring the CRT's high voltage.

What to expect: Compare the high voltage reading to the voltage shown on the schematic. If the reading is high, check for a timing problem in the horizontal output circuit, or for a B+ regulation problem. If the reading is low or missing, check for a low or missing B+ supply, or a faulty component such as the IHVT or high voltage multiplier.

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"Burning In" A Monitor

After you've completed a monitor repair you may want to "burn in" the unit for a number of hours to make sure no problems surface. If a monitor displays the same pattern for an extended period of time, you run the risk of burning the phosphor in the CRT. To the avoid the problem, the CM2000 can be programmed to automatically sequence through each of its video patterns. Each pattern is displayed 15 seconds.

Example: Programming the CM2000 to automatically sequence through each of its patterns.

1. Set the CM2000 to match the monitor type being serviced (see "Connecting To A Monitor" pages 10-19).
2. Press RECALL 9 9 ENTER

   To stop the video patterns from sequencing:
3. Press RECALL 9 9 ENTER

Note: The CM2000 will not be in the video pattern sequence mode if it is shut off and turned back on again.

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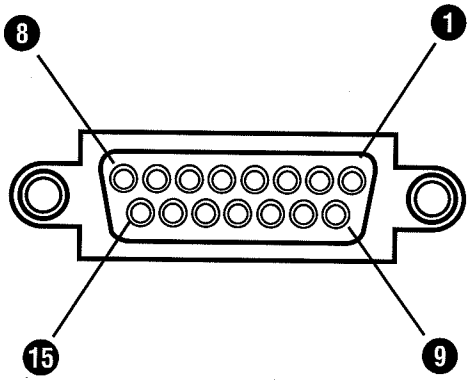
APPENDIX A:

CM2000 Connector Chart	
Connector	**Computer Monitor Type**
1	CGA, MDA, Hercules
2	EGA
3	PGC
4	VGA, PS/2, SVGA, XGA
5	Apple® or Macintosh®
6	BNC Input
Universal	Adapts to match any computer monitor type

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APPENDIX B:

CM2000 Sync & Video Output Pin Configuration

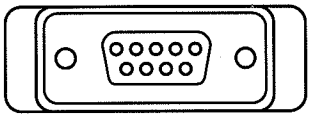


PIN #	OUTPUT
1	RED
2	GREEN
3	BLUE
4	INTENSITY
5	INTENSITY
6	H SYNC
7	COMP SYNC
8	GND
9	RED GND
10	GREEN GND
11	BLUE GND
12	INTENSITY
13	GND
14	V SYNC
15	+5 MODE

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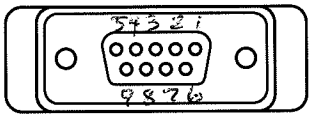
APPENDIX C:

Connector Pin Configurations



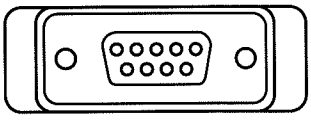
CONNECTOR #1

	CM2000 PIN #	CGA MDA. HERCULES PIN#
RED	1	3
GREEN	2	7, 4
BLUE	3	5
INTENSITY	4	6
INTENSITY	5	NC
H SYNC	6	8
COMP SYNC	7	NC
GND	8	1
RED GND	9	NC
GREEN GND	10	NC
BLUE GND	11	NC
INTENSITY	12	NC
GND	13	2
V SYNC	14	9
+ 5 MODE	15	NC



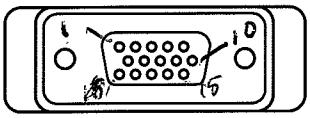
CONNECTOR #2

	CM2000 PIN #	EGA PIN #
RED	1	3
GREEN	2	4
BLUE	3	5
INTENSITY	4	2
INTENSITY	5	6
H SYNC	6	8
COMP SYNC	7	NC
GND	8	1
RED GND	9	NC
GREEN GND	10	NC
BLUE GND	11	NC
INTENSITY	12	7
GND	13	NC
V SYNC	14	9
+ 5 MODE	15	NC



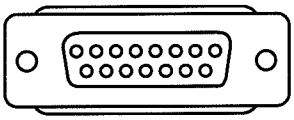
CONNECTOR #3

	CM2000 PIN #	PGC PIN #
RED	1	1
GREEN	2	2
BLUE	3	3
INTENSITY	4	NC
INTENSITY	5	NC
H SYNC	6	NC
COMP SYNC	7	4
GND	8	8
RED GND	9	6
GREEN GND	10	7
BLUE GND	11	8
INTENSITY	12	NC
GND	13	NC
V SYNC	14	NC
+ 5 MODE	15	NC



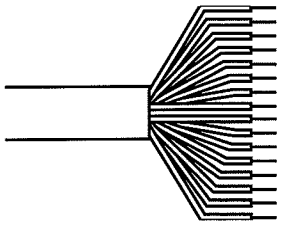
CONNECTOR #4

	CM2000 PIN #	VGA, SVGA PS/2, XGA PIN #
RED	1	1
GREEN	2	2
BLUE	3	3
INTENSITY	4	NC
INTENSITY	5	NC
H SYNC	6	13
COMP SYNC	7	NC
GND	8	4,5
RED GND	9	6
GREEN GND	10	7
BLUE GND	11	8
INTENSITY	12	NC
GND	13	10,11
V SYNC	14	14
+ 5 MODE	15	NC



CONNECTOR #5

	CM2000 PIN #	APPLE, MAC PIN #
RED	1	2
GREEN	2	5
BLUE	3	9
INTENSITY	4	NC
INTENSITY	5	NC
H SYNC	6	NC
COMP SYNC	7	3
GND	8	11
RED GND	9	1
GREEN GND	10	6
BLUE GND	11	13
INTENSITY	12	NC
GND	13	14
V SYNC	14	NC
+ 5 MODE	15	NC



CM2000 UNIVERSAL

	PIN #	COLOR
RED	1	BROWN
GREEN	2	RED
BLUE	3	ORANGE
INTENSITY	4	PINK
INTENSITY	5	YELLOW
H SYNC	6	GREEN
COMP SYNC	7	LIGHT GREEN
GND	8	BLUE
RED GND	9	LIGHT BLUE
GREEN GND	10	PURPLE
BLUE GND	11	SLATE
INTENSITY	12	WHITE
GND	13	BLACK
V SYNC	14	RED/BLACK
+ 5 MODE	15	ORANGE/BLACK

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APPENDIX D:

Computer Monitor Formats

Monitor Type	H FREQ	V FREQ	H PIXEL	V PIXEL	DIGITAL ANALOG	H SYNC	V SYNC	Sync Adder	Interlace
CGA	15.7	60.0	640	200	DIGITAL	+	+	OFF	OFF
NEC DH	16.0	60.3	640	200	DIGITAL	+	-	OFF	OFF
HITACHI 2	17.3	62.4	512	512	ANALOG	+	-	OFF	ON
HERCULES	18.4	50.0	720	350	DIGITAL	+	-	OFF	OFF
MDA	18.4	50.0	720	350	DIGITAL	+	-	OFF	OFF
EGA	21.8	60.0	640	350	DIGITAL	+	-	OFF	OFF
NEC P2	24.8	56.4	640	400	DIGITAL	-	-	OFF	OFF
PGC	30.5	60.0	640	400	ANALOG	COMPOSITE SYNC		OFF	OFF
PGC	30.5	60.0	640	480	ANALOG	COMPOSITE SYNC		OFF	OFF
NEC P1	31.5	59.4	720	480	ANALOG	-	-	OFF	OFF
MCGA	31.5	60.0	640	480	ANALOG	-	-	OFF	OFF
VGA 2	31.5	60.0	640	480	ANALOG	-	-	OFF	OFF
NEC 3D+	31.5	60.1	640	480	ANALOG	+	+	OFF	OFF
MCGA	31.5	70.0	720	400	ANALOG	-	+	OFF	OFF
VGA 1	31.5	70.0	640	350	ANALOG	+	-	OFF	OFF
VGA 3	31.5	70.0	720	400	ANALOG	-	+	OFF	OFF
SUPER VGA	35.2	56.0	800	600	ANALOG	+	+	OFF	OFF
8514A	35.2	87.0	1024	768	ANALOG	+	+	OFF	ON
XGA	35.2	87.0	1024	768	ANALOG	+	+	OFF	ON
MAC II	35.5	67.0	640	480	ANALOG	-	-	GREEN	OFF
HITACHI 1	48.4	60.0	1387*	768	ANALOG	-	-	GREEN	OFF
SUPER MAC	48.8	60.0	1024	768	ANALOG	-	-	GREEN	OFF
8508 2	70.7	82.2	736	828	ANALOG	-	+	OFF	OFF
8508 1	70.7	93.5	736	736	ANALOG	+	-	OFF	OFF

* Program the CM2000 to 1024 horizontal pixels.

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APPENDIX E:

CM2000 Computer Monitor Setup Storage Locations		
Format	**Storage Location**	**Connector**
CGA	0	1
Hercules, MDA	1	1
EGA	2	2
PGC 1	3	3
PGC 2	4	3
MCGA 1, VGA 1	5	4
VGA 2	6	4
MCGA 2, VGA 3	7	4
Super VGA	8	4
8514 A, XGA	9	4
MAC II	10	5
1024 X 768	11	4
1280 X 1024	12	4
Micro VAX	13	6 (BNC)
Sun color 1152 X 900	14	6 (BNC)
IBM RS6000 color 6091, 5081	15	6 (BNC)
HP 98789A, 98754A	15	6 (BNC)
Apollo DN2500, 3000, 3500, 4500	16	6 (BNC)
IBM RS6000 monochrome 8508	17	6 (BNC)
Apollo 19" color	18	6 (BNC)
Radius 1152 X 882	19	6 (BNC)
User Definable	20 - 39	-
Interface Bus Definable	40 - 59	-
15 Second Pattern Sequence	99	-

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APPENDIX F:

VIDEO OUTPUT COLOR COMBINATIONS

DIGITAL MONITORS

COLOR	R	G	B	I
Black	0	0	0	0
Blue	0	0	1	0
Green	0	1	0	0
Cyan	0	1	1	0
Red	1	0	0	0
Magenta	1	0	1	0
Brown	1	1	0	0
White	1	1	1	0
Dark Gray	0	0	0	1
Light Blue	0	0	1	1
Light Green	0	1	0	1
Light Cyan	0	1	1	1
Light Red	1	0	0	1
Lt. Magenta	1	0	1	1
Yellow	1	1	0	1
Intense White	1	1	1	1

ANALOG MONITORS

COLOR	R	G	B
Black	0	0	0
Blue	0	0	1
Green	0	1	0
Cyan	0	1	1
Red	1	0	0
Magenta	1	0	1
Brown	1	1	0
White	1	1	1

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APPENDIX G:

Calculating A Monitor's Bandwidth

A monitor's bandwidth is determined by its ability to display a sharp, crisp picture. The higher the bandwidth, the more resolution and clarity appears in the picture. A monitor's bandwidth is best checked with a pattern that produces lines that are a single pixel wide (a pixel is the smallest picture element possible).

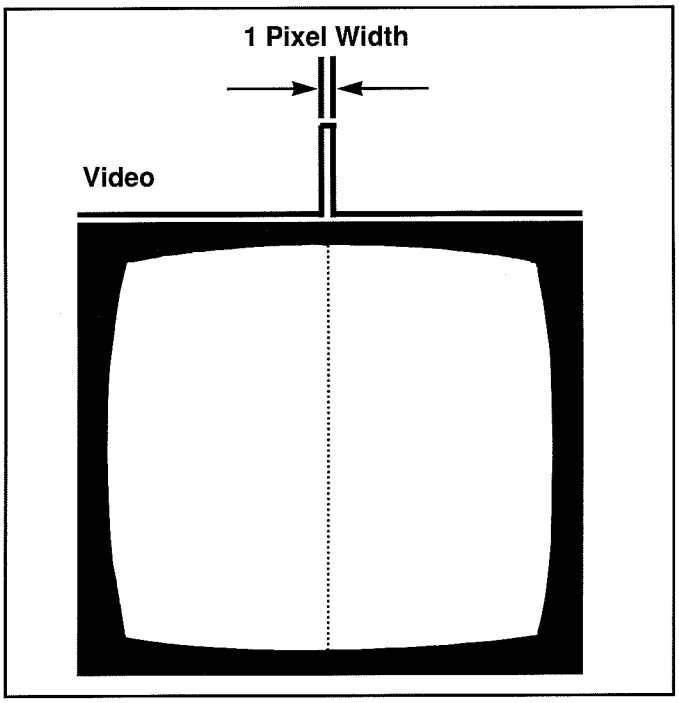


Fig. 55 A one pixel wide line is best suited for testing a monitor's maximum bandwidth. A crisp, distinct line shows that the monitor has the bandwidth needed to "turn on" a single pixel at a time.

For an example let's calculate the required bandwidth of a VGA monitor. The VGA standard has 640 horizontal pixels and the horizontal scanning frequency is 31.5 kHz.

Inverting the horizontal scanning frequency gives a total horizontal scan time of 31.7 micro-seconds. About 80% of this time is active video (what's seen on the monitor) and about 20% is blanking. So 25.4 micro-seconds is active video and 6.3 micro-seconds is blanking.

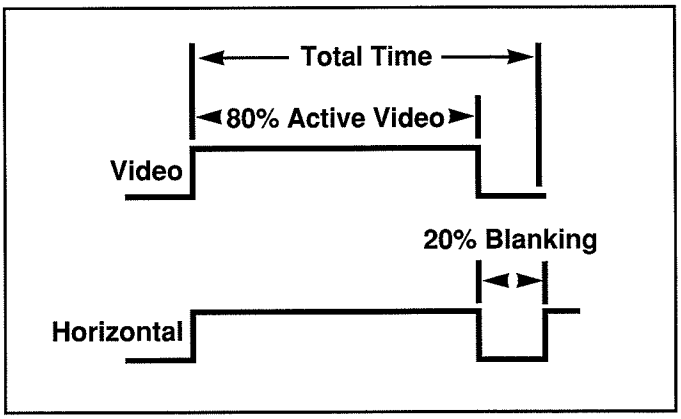


Fig. 56 One scan line is made up of active video and blanking.

If 640 pixels must be fit into the 25.4 micro-second active display time, we can find the amount of time it takes to turn on one pixel by dividing 25.4 micro-seconds by 640 pixels. This shows that each pixel is on for 39.7 nano-seconds (39.7 X 10^{-9} seconds). If we invert 39.7 nano-seconds we get a frequency of 25.2 MHz. So in order to see a crisp, distinct line of one pixel width, the bandwidth of the video amplifiers in a VGA monitor must be 25.2 MHz or greater.

Horizontal Scan = 31.5 kHz

Total Scan Time = 1/31.5 kHz = 31.7 usec.

Active Video Time = (80%) (31.7 usec.) = 25.4 usec.
Note: 640 Pixels will be displayed in 25.4 usec.

Display time per pixel = 25.4 usec./640 pixels = 39.7 nanosec.

Bandwidth required to turn on a single pixel = 1/39.7 x 10^{-9} = 25.2 MHz

Fig. 57 Bandwidth calculation for a VGA monitor.

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APPENDIX H:

Pixel Parameter Errors

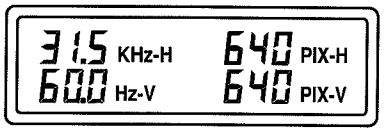
There are two sync and pixel parameter conditions the CM2000 cannot accept: (1) the vertical pixel value exceeds the time allotted by the horizontal and vertical scanning frequencies or (2) the combination of the horizontal pixel value and horizontal scanning frequency exceeds the bandwidth of the CM2000.

When either of these cases occur, the pixel enunciator blinks and the CM2000 automatically determines and displays the maximum allowable pixel value. You can press "ENTER" to accept this value or you can enter a value lower than the one displayed.

Here's the explanation for each condition:

Condition (1) the vertical pixel value exceeds the time allotted by the horizontal and vertical scanning frequencies

For example you've programmed these parameters into the CM2000:



The PIX-V enunciator blinks and the vertical pixel value is 521. Here's why:

The total scan time for one full field (raster) is 16.7 mSec

1/ V SYNC = scan time of one field
1/60.0 Hz = 16.667 mSec

The total scan time for one line is 31.7 uSec

1/ H SYNC = scan time of one line
1/31.5 KHz = 31.746 uSec

If we divide the scan time for one field by the scan time for one line we will get the maximum number of lines that can be displayed.

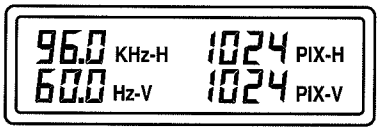
$$\frac{\text{Scan time of one field}}{\text{Scan time of one line}} = \text{maximum number of lines that can be displayed}$$

$$\frac{16.667 \text{ mSec}}{31.746 \text{ uSec}} = 525 \text{ lines}$$

The CM2000 will display 521 PIX-V because four lines are used for vertical sync.

Condition (2) the combination of horizontal pixel value and horizontal scanning frequency exceed the bandwidth of the CM2000

For example you've programmed these parameters into the CM2000:



The PIX-H enunciator blinks and the horizontal pixel value is 653. Here's why:

The total scan time for one line is 96.0 uSec.

1/ H SYNC = scan time of one line
1/96.0 KHz = 10.417 uSec

Approximately 80% of the scan time is displayed video.

(80%)*(scan time of one line) = displayed video time
(80%)*(10.417 uSec) = 8.333 uSec

The CM2000 has been programmed to display 1024 pixels in 8.333 uSec. Dividing the displayed video time by the number of pixels gives the amount of time required for each pixel.

$$\frac{\text{displayed video time}}{\text{horizontal pixels}} = \text{time required for each pixel}$$

$$\frac{8.333 \text{ uSec}}{1024 \text{ pixels}} = 8.13 \text{ nSec}$$

$$\frac{1}{\text{time}} = \text{frequency}$$

$$\frac{1}{8.13 \text{ nSec}} = 123 \text{ MHz}$$

The required 123 MHz bandwidth exceeds the capabilities of the CM2000 (98 MHz). The CM2000 will calculate the pixel rate it can produce and display that value. In this situation the CM2000 will display 653 PIX-H.

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GLOSSARY

Active Scan - Trace time. The part of the vertical or horizontal beam motion when picture information is being drawn on the screen. Typically scan is 80% active and 20% inactive (retrace).

Analog Monitor - Uses a varying voltage (analog) signal. Can produce virtually unlimited gray shades and colors.

Bandwidth - The highest frequency that the video circuits can pass.

Blanking Time - Retrace time. The part of vertical or horizontal beam movement when no picture information is drawn on the screen

CGA - Color Graphics Adapter. Interface standard that provides pixel resolutions from 320 x 200 to 640 x 200

Clarity - A description of how closely the displayed image on the CRT matches the desired image. Clarity depends on pixel aspect ratio, dots per inch, and noise.

Composite Monitor - Monitor that uses composite video input. Offers very limited resolution. Not widely used in computer applications.

Composite Sync - Signal that contains both vertical and horizontal sync information.

Composite Video - Type of signal used in television systems. Consists of an analog luminance (B&W) signal, phase shifted chroma information, and composite sync.

CRT - Cathode Ray Tube. The monitor component that converts electrical signals into the visual image.

Digital Monitor - Uses digital signals that are either "on" or "off". Can produce a maximum of 64 colors and 16 gray shades.

Dot Pitch - The distance between the centers of like holes in adjacent triads of color CRT shadow masks. Example: The distance between the center of one "red" hole and the next "red" hole. Dot pitch determines the smallest pixel size a color CRT can produce.

DPI (Dots Per Inch) - Number of pixels displayed in one inch.

EGA - Enhanced Graphics Adapter. Interface standard that provides maximum 640 x 350 pixel resolution.

Flicker - An apparent flashing of the displayed image. Dependent on vertical scan (refresh rate) and screen size.

Focus - Ability of the electron beam to produce a single, concise, halo-free spot of light.

Graphics Adapter Card - A circuit board located inside a computer that provides the signals to drive the monitor. The adapter card must match the monitor type. Examples of graphic adapter standards are CGA, EGA, PGC and VGA.

Graphic Mode - Subdivision of an interface standard that provides different pixel resolutions or vertical scan frequencies.

Gray Scale - Video pattern of evenly spaced steps from dark (black) to bright (white). (Applies to any phosphor color).

HGC - Hercules Graphics Card. Interface standard for monochrome monitors that provides a maximum 720 x 348 pixel resolution.

High Resolution - Monitors which have horizontal scan frequencies above 50 kHz .

Horizontal Frequency - The rate at which the electron beam makes one scanning cycle across the screen from left to right and back.

Horizontal Pixels - Number of picture elements displayed in one horizontal line across the CRT screen.

Horizontal Resolution - The maximum number of pixels displayed in one horizontal line on the screen. Determined by video bandwidth, dot pitch and focus.

Horizontal Retrace - The time during which the electron beam returns from the right side of the screen to the left side.

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H SYNC - External pulse that locks the horizontal scanning circuits to the incoming video.

Interlace - Scanning method where raster is made up of two sets (fields) of horizontal lines. Odd numbered lines are scanned in first field and even numbered lines are scanned in second field. The refresh rate of an interlaced signal is one half the vertical scan frequency.

Medium Resolution - Monitors operating at frequencies between 20-50 kHz, such as EGA and VGA.

MDA - Monochrome Display Adapter. Interface standard designed for text applications. Provides 720 x 350 resolution.

Mode Select - Circuit inside the monitor that detects the graphics mode by looking at the polarities of the sync pulses and automatically adjusts the scan current to maintain a full-size picture.

Monitor - (video monitor) Electronic device that converts electrical video signals into a visual display. The input signal is usually RGB.

Multiscan - Type of monitor that is capable of locking to a range of vertical and horizontal sync frequencies.

Noise - Electrical interference that produces "snow" on the screen.

Non-Interlace - Vertical scanning method where horizontal lines are scanned consecutively. Produces less flicker and jitter than interlace scan. Refresh rate equals vertical scan frequency.

NTSC - National Television Systems Committee. Standards that define the television video signal.

PGC - Professional Graphics Card. Interface standard that provides pixel resolution of 640 x 400 or 640 x 480.

Pixel - Picture element. One of the dots that makes up the displayed image. A 640 x 200 pixel resolution means there are 640 pixels across the screen (horizontal) and 200 pixels top to bottom (vertical), or 128,000 total pixels.

Pixel Aspect Ratio - Ratio of a pixel's width to its height. A 1:1 ratio is a square pixel.

Raster - The area of brightness that occurs on the CRT screen as the result of vertical and horizontal scanning.

Raster Linearity - Constant vertical and horizontal beam movement.

Refresh Rate - The speed that the screen phosphor is refreshed. Primarily dependant on the vertical scan frequency. Refresh rates below 60 Hz cause flicker.

Reverse Video - Feature found on some monitors that reverses the black and white images.

Resolution - The maximum number of distinct dark-to-light or light-to-dark transitions (pixels) visible on the screen.

RGB - Red, Green, Blue. Video information of the proper form needed to feed the CRT cathodes.

Shadow Mask - A metal grid consisting of hundreds of thousands of holes located directly behind the phosphor screen of a color CRT. It allows the electron beams to strike only their respective colors.

Spot Size - Size of the spot of light produced by the electron beam when it strikes the phosphor. Depends on CRT focus, shadow mask, and phosphor.

Standard Resolution - Monitors operating at 15.75 kHz horizontal scan frequency. This is the lowest resolution and is comparable to a television receiver

Super VGA - Interface standard that is compatible with VGA but provides higher resolution.

Triad - The resulting white dot produced when the red, green and blue electron guns strike their respective phosphors. A pixel in a color monitor. Applies to color CRTs only.

V SYNC - External pulse that locks the vertical scanning circuits to the incoming video.

Vertical Frequency - The rate at which the electron beam makes one scanning cycle from the top of the screen to the bottom and back.

Vertical Pixels - Number of pixels displayed from top to bottom in the CRT display.

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Vertical Resolution - The maximum number of vertical pixels displayed on the screen. Determined by video bandwidth, dot pitch, focus, refresh rate and scanning method.

Vertical Retrace - The time during which the electron beam returns from the bottom of the screen to the top.

VGA - Video Graphics Array. Analog interface standard that provides a maximum of 720 x 400 pixel resolution.

Video Adapter Card - Another name for a Graphics Adapter Card.

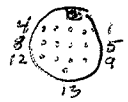
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NOTES

PACKARD BELL PB1272A
Plug 1 — 0 — CGA
NO VIDEO — Replaced IC201
ECG 7406

MAGNAVOX CM8562
Plug 1 — 0 — CGA
BAD Soldier connection FLYBACK

ATARI SC1224
Dead — Burnt spot on Circuit
BOARD NEAR FLYBACK
Cut out circuit BOARD



1 — AUDIO out
2 - Composite Video
3 - General Purpose out
4 - Mono chrome Detect
5 - Audio in
6 - GREEN
7 - RED
8 - +12V Pullup
9 - H. SYNC
10 - BLUE
11 - MonoChrome
12 - V SYNC
13 - GND

SAMSUNG CM4531
Dead 9915 shorted
R221 open 560KΩ

ATARI — VIDEO - VERTICAL
C142 OPEN

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