You will need the following equipment:

- Completed CM-1 Video Monitor Homework Assignment
- CM-1 Service Manual
- Model 2000 Computer with High Resolution Color Graphics option
- Radio Shack Model 2000 Diagnostic Diskette
- Oscilloscope — Dual trace, 35 MHz minimum bandwidth
- Oscilloscope probes — 10x attenuation setting
- Digital Voltmeter (DVM) — A high impedance (greater than 20,000 ohms/volt) or FET input analog voltmeter may be used, but a DVM is suggested for greatest accuracy.
- Voltmeter probes
- High voltage probe — contains its own meter
- Isolation transformer or variac
- Various assembly, disassembly, and adjustment tools

PRELIMINARY SETUP

The CM-1 should be connected to the AC line through the isolation transformer or variac. While this does not appear to be absolutely necessary and is not required by the service manual, there is a possibility of damage to the CM-1, oscilloscope, or the technician. If a variac is used it must be set for 117 volts AC line voltage output. This voltage should be verified inside the monitor to guarantee proper alignment.

NOTE: The turn-on current surge of the CM-1 may be sufficient to blow the fuse in some variacs. If a variac is used the following procedure must be followed.

1) Make sure that both variac and monitor are OFF. Set the variac to zero volts.
2) Plug the monitor into the variac. Plug the variac into the 120 VAC
3) Turn the monitor ON. It will not activate because the variac is OFF.
4) Turn the variac ON. The monitor will not activate because the variac is set to zero volts.
5) Turn the set the variac for 117 VAC output. The monitor should activate and begin to perform properly.

Many of these measurements, and those required to actually service the CM-1, may require that the monitor be placed on its side rather than setting upright. The bottom of the PC board is labeled with component markings to assist in servicing.

SECTION 1: POWER SUPPLY

OBJECTIVES:

1) To measure and adjust the various power supply voltages in the CM-1
2) To locate the sources and destinations of the supply voltages to aid future troubleshooting.

PROCEDURES:

1) Locate the AC line connections on the bottom of the main PC board. Using the DVM, measure the AC line voltage at between the two pins of the connector.

If you are using a variac, adjust the variac until the AC line voltage measured above reads 117 - 120 VAC.

If you are using an isolation transformer simply note the AC line voltage reading.

118.0

2) Locate the B4 adjustment procedure on page 13 of the CM-1 Service Manual. Perform this adjustment as indicated in the manual. For proper operation of this adjustment the controls on the monitor must be set exactly as indicated.

After the adjustment is finished, adjust the front panel BRIGHTNESS and CONTRAST controls to a normal viewing level. Activate the diagnostic program to return to the main menu.

QUESTIONS:

A) Where is the B4 test point located?

changed to 120 V as per Gary's wish

Between C953 & R507 B4 = 111.4 V (within 112 ± 1V)
at the end of R507 (labeled B4 - middle of PC board towards rear).

B) Why does the B4 adjustment procedure require a white screen and maximum contrast and brightness?

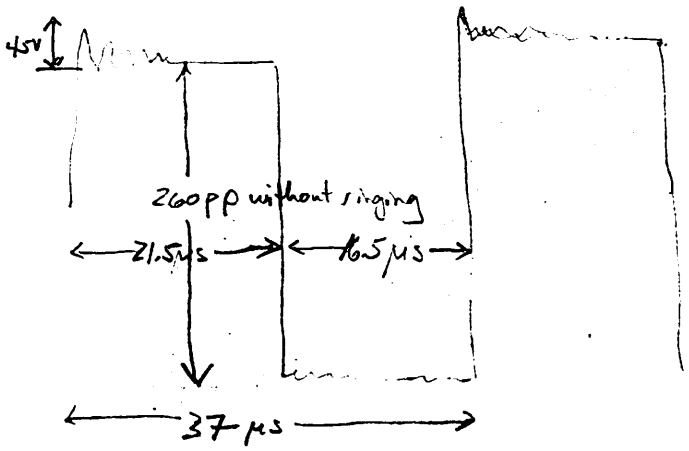
A white screen and max brightness & color implies the highest number of electrons hitting the screen, which translates to the highest current draw. It is necessary to provide the maximum load on the circuit to accurately adjust the voltage at B4

C) Using the schematic diagram contained in the CM-1 Service Manual, name five (5) major circuit areas supplied by the 112 volt B4 voltage.

1) vert. output
2) video gun drivers
3) flyback transformer
4) x-ray protection
5) horizontal osc, TC

3) Using the scope, measure the waveform at IC991 pin 1. Draw what you see. be sure and label the waveform (amplitude, period, pulse width, etc) so that you may refer to it later.

SCOPE SETTINGS
5 μS /div horizontal
5 V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
Auto, channel 1,
DC, trigger chan



QUESTIONS:

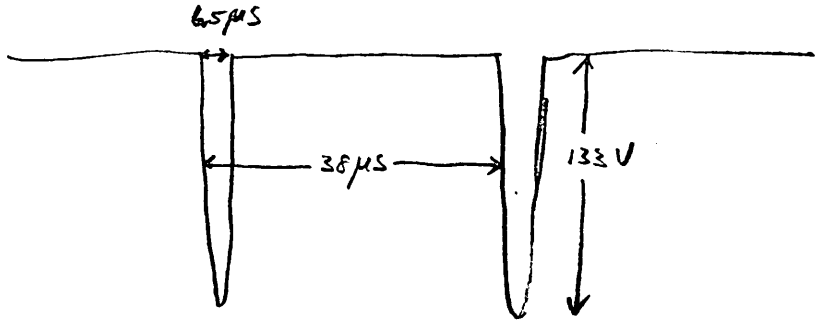
A) What does the above waveform indicate?
Switching → indicates switching power supply is switching.

4) Using the DVM, measure the voltage at TP-9A after the B4 voltage has been properly set. Write the reading here.

TP-9A = 32.5 V (DC) using chassis ground

5) Using the scope, measure the waveform at the anode of D554. Draw it here. Be sure to label the waveform.

SCOPE SETTINGS
10 μS /div horizontal
2 V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
Auto, chan 1 DC



6) Using the DVM, read the voltage at the cathode of D554. Record the reading here.

Cathode of D554 = 14.7 V

QUESTIONS:

A) What is the purpose of this voltage?
scan-derived voltages provide input voltages for the circuitry not powered off the B4 voltage.

7) Using the schematic diagram, follow the voltage measured in (6) above until it passes through L601. Voltage at L601/C608 junction 14.5 V

QUESTIONS:

A) The voltage at the junction of L601 and C608 goes to 7 GENERAL portions of the circuitry. Name them.

1) video amps.
2) vid. gun drivers
3) blanker circuit
4) brightness circuit
5) video buffers
6) contrast circuit
7) horizontal sync
5 V regulator

8) Using the DVM, measure the three leads of Q614. Write their values here.

Q614 base = 5.6 V
Q614 emitter= 5.0 V
Q614 collector = 14.5 V

QUESTIONS:

A) What is the purpose of Q614?

5V Voltage regulator

9) Locate point SC1 on the CRT PC board. Using the DVM, measure it. Write the measurement here.

Point SC1 = 176.9 V

QUESTIONS:

A) What is the function of the voltage at SC1?

Supply voltage for cutoffs.

10) Locate the collector of Q691 on the CRT PC board. Using the DVM, measure it. Write the measurement here.

Collector of Q691 = 112.1 V

QUESTIONS:

A) The voltage at TP-9Z on the CRT PCB serves two functions. Name them.

1) powers the cutoff controls

2) powers the constant current source transistors (RGB Drive 2).

11) Locate D930, the PCB-LED, on the schematic diagram.

QUESTIONS:

A) Other than a power on indicator, what purpose does it serve?
It shows that you have scan derived voltages, which implies that you have horizontal output (scan) and the B4 voltage

12) Using the high voltage probe, measure the voltage appearing under the suction cup connector on the bell of the Cathode Ray Tube (CRT). Write the measurement here.

****
** BE EXTREMELY CAREFUL. NEVER USE TWO HANDS. KEEP ONE HAND IN YOUR **
** POCKET AT ALL TIMES WHILE MEASURING THE HIGH VOLTAGE. **
****

High Voltage connector = 22 kV bright
24.5 kV dark

END OF POWER SUPPLY SECTION

SECTION 2: SWEEP CIRCUITS AND SYNCHRONIZING SIGNALS

OBJECTIVES:

1) To view and record signals from a properly operating circuit
2) To locate and use test points given in the service manual

PROCEDURES:

1) Using the DVM, measure the voltage at IC4Ø1 pin 11. Record it here.

IC4Ø1 pin 11 = 12.7V

QUESTIONS:

A) What purpose does this voltage serve?

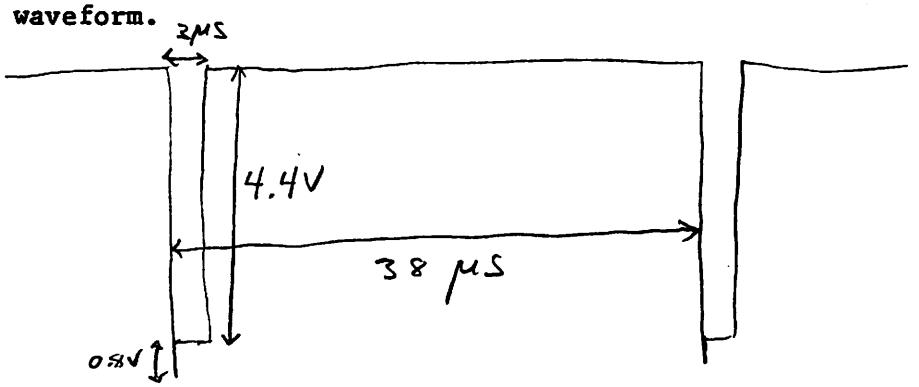
provides power to horizontal oscillator

B) Where does this voltage come from?

B4 dropped across R507

2) Using the scope, view the signal at IC6Ø2 pin 3. Draw what you see on the scope. Be sure to label the waveform.

SCOPE SETTINGS
5μS /div horizontal
.1 /div vertical
Probe: x 10 setting
Other notes (sync, etc):
Recon trigger, DC



QUESTIONS:

A) What is the PERIOD of the signal you are viewing? Milliseconds or microseconds?

38 μS

B) What is the FREQUENCY of the signal you are viewing? Hertz, kilohertz, or megahertz?

26.32 kHz

C) What is the name of the signal you are viewing?

H. sync or H drive

3) Using the scope, view the signal at IC602 pin 3. While viewing the signal, change the position of switch 601 section 4. Note what happens. Look at the display screen. Note what happens. Put switch 601 section 4 back to its original position. low going pulses are now high going - screen shifted to left when viewed from front - folded over on left.

QUESTIONS:

C) What is the function of switch 601?

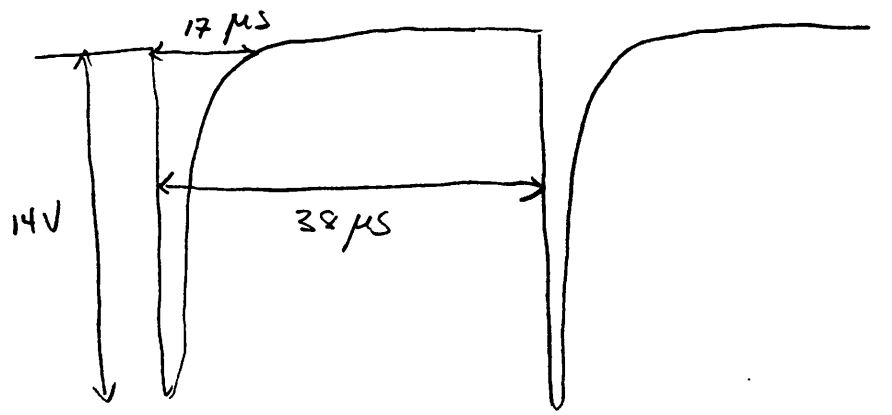
polarity switch

B) What happened to the display screen when the switch was changed?

Screen shifted left - folded over on left when viewed from front.

4) Using the oscilloscope, measure the collector of Q615. Draw what you see. Label the waveform.

SCOPE SETTINGS
10 μs /div horizontal
0.2V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
norm, DC



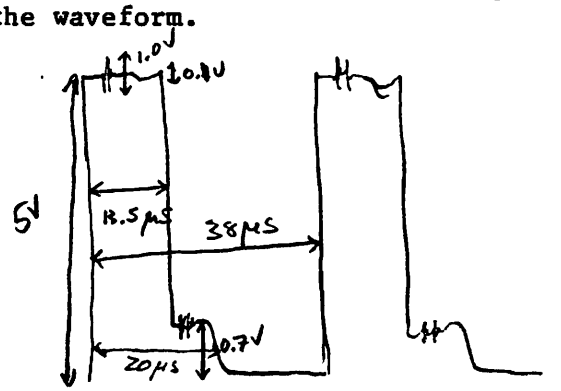
QUESTIONS:

A) What is the function of Q615?

h. sync amplifier

5) Using the scope, view the signal appearing at IC 401 pin 10. Draw it here. Don't forget to label the waveform.

SCOPE SETTINGS
10 μs /div horizontal
0.1V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
norm, chan 1, DC



QUESTIONS:

A) What is the PERIOD of the waveform at IC401 pin 10?

38 μs

B) What is the signal appearing at IC401 pin 10?

h. oscillator output.

6) Using the DVM, measure the voltages on Q551. Write them down.

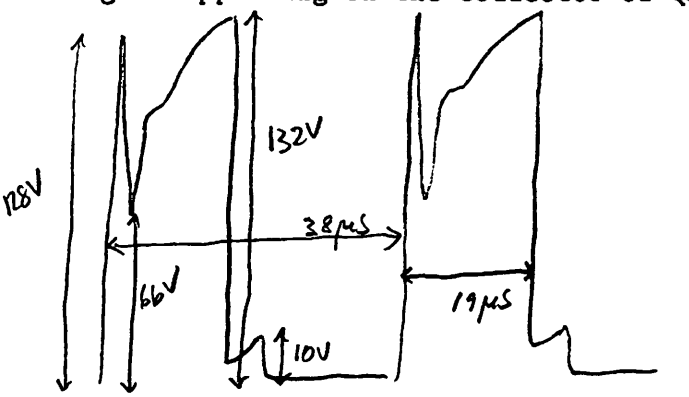
Q551 base = 0.37 V (DC)

Q551 emitter= 0

Q551 collector = 53.8 V

7) Using the scope, measure the signal appearing on the collector of Q551. Draw and label what you see.

SCOPE SETTINGS
10μS /div horizontal
2 V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
norm, chan 1, DC



QUESTIONS:

A) How does this signal compare frequency-wise with the signal at IC401 pin 10?

Same frequency.

8) Refer back to the measurement you made in step 5 of the power supply section, measuring the anode of D554. If you wish, measure it again.

QUESTIONS:

A) What is the cause of the waveform appearing at the anode of D554?

flyback spikes - diode acts to catch them and convert them to scan derived voltages

B) If the waveform at the collector of Q551 is present and appears normal, but the waveform at the anode of D554 is missing or of extremely low amplitude, in what GENERAL circuit area would you expect to find the problem?

H. output section

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** WARNING WARNING WARNING WARNING WARNING WARNING WARNING WARNING **
****
**
** NEVER ATTEMPT TO TAKE ANY READING DIRECTLY ON THE COLLECTOR **
** OF Q591, OR THE COLLECTOR OF ANY HORIZONTAL OUTPUT TRANSISTOR. **
** THE ELECTROMOTIVE FORCES DEVELOPED BY THE COLLAPSE OF THE MAGNETIC **
** FIELD IN THE FLY-BACK TRANSFORMER HAVE SUFFICIENT ENERGY TO DAMAGE **
** MOST ELECTRONIC TEST EQUIPMENT, INCLUDING METERS AND SCOPES. **
**
****

9) Referring to the schematic diagram, there is an unlabeled component coil attached to the collector of Q591. The component is inside a dotted box. Pin 1 of this coil is attached to the collector, pin 2 attaches to T553.

QUESTIONS:

A) What is this component called?

horizontal yoke

B) What does the dotted box indicate?

component found off-board

10) Using a jumper clip, short TP-8A to TP-8B. While watching the display screen, vary VR502. Try to make the display remain steady by adjusting VR502. Remove the jumper short between TP-8A and TP-8B. Reset VR502 until the display locks into position again.

QUESTIONS:

A) What effect does VR502 have on the circuit?

Varies frequency of horizontal osc.

B) What is the name for control VR502?

horizontal hold

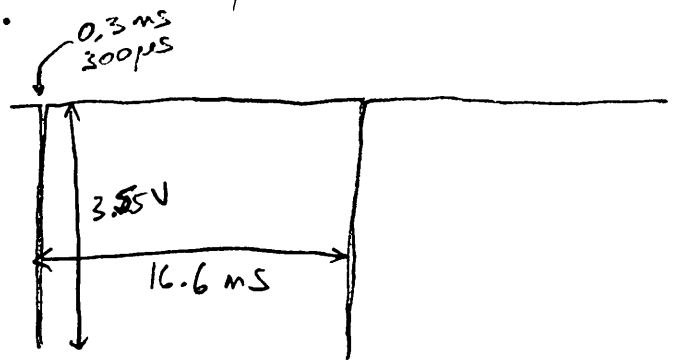
11) There are two other controls in this part of the circuit that you should be familiar with. You can get familiar with them by playing with them. When you figure out what they do, make a note here.

S591 = controls (toggles) horizontal centering

L552 = h. width

12) Using the scope, measure the signal appearing at IC602 pin 6. Draw what you see. Label the waveform.

SCOPE SETTINGS
5 ms /div horizontal
0.1 V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
norm, DC



[QUESTIONS ABOUT THIS MEASUREMENT ARE ON THE NEXT PAGE]

QUESTIONS:

A) What is the PERIOD of the signal you are viewing? Milliseconds or microseconds?

16.6 mS

B) What is the name of the signal you are viewing?

V. drive (or V sync)

13) Note that IC6Ø2 pin 4 connects to switch 6Ø1 section 3.

QUESTIONS:

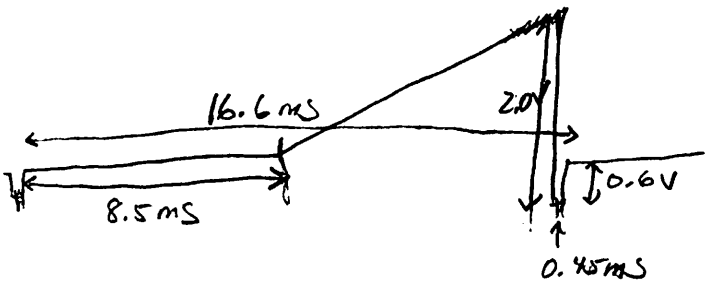
A) What effect will changing switch 6Ø1 section 3 have on the signal at IC6Ø2 pin 6? It will change the polarity – change low going pulses to hi going and move the display up.

14) Using the scope, measure the signal at IC4Ø1 pin 2. Draw what you see. Label the waveform.

SCOPE SETTINGS
2MS /div horizontal

0.1V /div vertical
Probe: x 1Ø setting
Other notes (sync, etc):

norm, DC



QUESTIONS:

A) What is the PERIOD of the signal you are viewing?

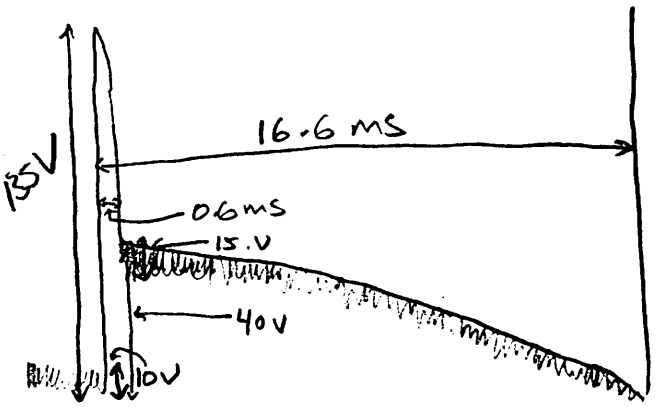
16.6 mS

B) Compare these readings with the readings from step 12 above. Explain what you find.

Periods are the same – which is good since one would hope that V. sync would compare periods favorably with V. osc. – or freq. is same, depending on your point of view.

d5) Using the scope, measure the waveform appearing at the emitter of Q401. Draw and label the waveform.

SCOPE SETTINGS
2mS /div horizontal
2V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
norm, DC



QUESTIONS:

A) What is this signal called?

V. output

B) What will happen to the waveform at the emitter of Q401 if Q401 is open? [HINT: An open transistor would behave much the same as one completely cut off. Try shorting the BASE and EMITTER of Q401 together while watching the waveform]

The smooth curve after the spike goes away - becomes linear and flat - screen loses smooth sweep, gets only part of the display.

16) Referring to the schematic diagram, there is an unlabeled component attached to the emitter of Q401. The component is inside a dotted line box. Pin 4 connects to the emitter of Q401. Pin 3 connects to switch S491.

QUESTIONS:

A) What is this component called?

vertical yoke

17) There are four variable components in this section of the circuitry. You should familiarize yourself with them by adjusting them and noting their effects (if any) on the wave form at the emitter of Q401 and their effects on the visible display.

QUESTIONS:

A) What are the function(s) of these components?

VR401 = vertical hold

VR402 = vertical linearity

VR403 = vertical height

S491 = vertical centering.

END OF SWEEP CIRCUITS AND SYNCHRONIZATION SECTION

SECTION 3: VIDEO AMPLIFIERS AND BRIGHTNESS

OBJECTIVES:

1) To become familiar with the video signals used in the CM-1.
2) To signal trace one video signal from its input to the output of the of the video amplifiers.

PROCEDURES

1) Using the Model 2000 diagnostic diskette, send a CROSS HATCH pattern to the CM-1 screen. Set the BRIGHTNESS and CONTRAST controls to produce a normal display. Using the oscilloscope, view the signals appearing at IC601 pins 1, 4, and 13. Draw what you see at any ONE pin. Label the waveform and indicate which pin has this pattern.

SCOPE SETTINGS

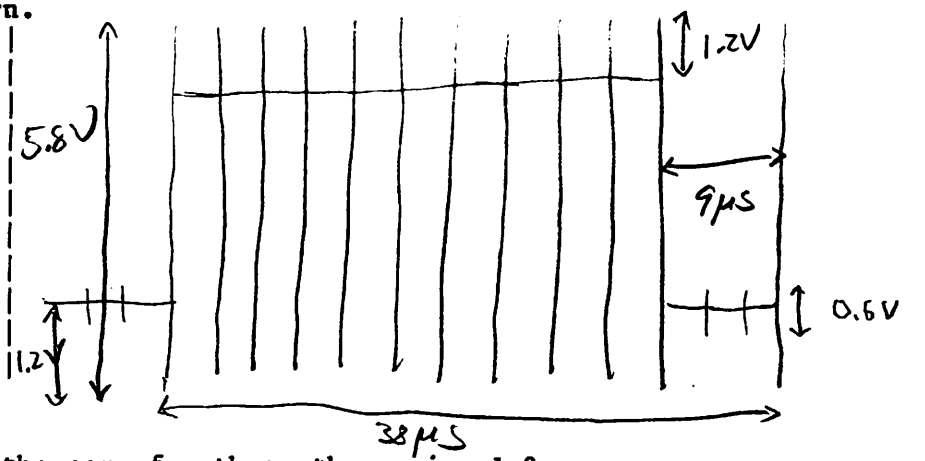
5μs /div horizontal

0.1V /div vertical

Probe: x 10 setting

Other notes (sync, etc):

auto, DC



QUESTIONS:

A) Collectively, what is the name for these three signals?

video data

B) Individually, what signal is found at which pin? [use the schematic]

IC601 pin 1 = red

IC601 pin 4 = green

IC601 pin 13 = blue

2) Using the schematic, trace each located in (1) above to its associated buffer transistor, Q616, Q617, or Q618. Use a pencil, pen, or marker to trace the actual circuit path taken by each signal. Label each transistor below.

Q616 = red [color]

Q617 = green [color]

Q618 = blue [color]

3) Using the DVM, measure the voltage at the collector of Q616. Write it down.

Voltage at Q616 = 14.3 V

Note that each video amplifier channel is identical to the other two.

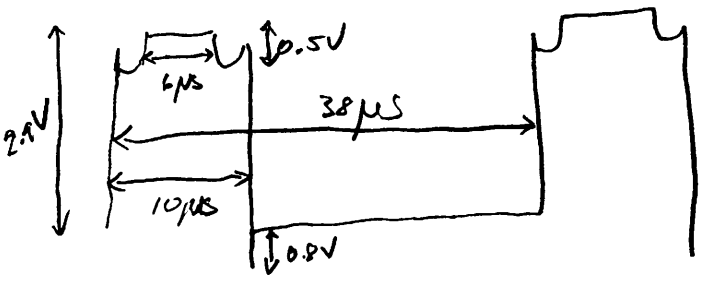
QUESTIONS:

A) Since all three video amplifiers are identical, what assumption can you make about the voltage readings on the collectors of Q617 and Q618?

They should be identical.

4) Using the scope, examine the signal appearing at the emitter of Q608. Make a note of its amplitude. Note that the controls are set for NORMAL VIEWING LEVELS.

SCOPE SETTINGS
10 µS /div horizontal
0.2 V /div vertical
Probe: x 10 setting
Other notes (sync, etc):
auto, DC



Now, turn the BRIGHTNESS control to MAXIMUM. Make a note of signal amplitude at the emitter of Q608.

3.9 V (p-p) [at maximum brightness]

Now, turn the BRIGHTNESS control to MINIMUM. Make a note of the signal amplitude at the emitter of Q608.

0.9 V (p-p) [at minimum brightness]

QUESTIONS:

A) How does the BRIGHTNESS control effect the video signals?

Increases and decreases amplitude of the signal.

5) Using the DVM, measure the voltage at the emitter of Q611.

QUESTIONS:

A) What is the voltage reading at the emitter of Q611 when the brightness control is at MAXIMUM.

Maximum brightness = 2.3V

B) What is the voltage reading at the emitter of Q611 when the BRIGHTNESS control is at MINIMUM.

Minimum brightness = 0.6V

6) Using the scope, measure the signal at the emitter of Q654. While viewing the signal, turn the R-DRIVE CONTROL, VR651.

QUESTIONS:

A) What effects does the R-DRIVE control have on the signal?
changes amplitude of signal

7) Using the schematic diagram, note that there is also a B-DRIVE CONTROL, VR653, but no G-DRIVE CONTROL.

QUESTIONS:

A) What are the functions of the R-DRIVE and B-DRIVE controls? Why is there no G-DRIVE control?
the green phosphor is "weakest," so it is driven as hard as possible and used as a non-adjustable reference. The red & blue drivers are used to balance the levels of brightness of red & blue with regards to green.

END OF VIDEO AND BRIGHTNESS SECTION

SECTION 4: THE CRT

OBJECTIVE:

1) To locate and measure signals on a properly operating CRT

1) Using the DVM, measure the voltage appearing at all pins of the CRT. Record your reading here.

white screen

Pin 5 =	0.0V VDC	0.0V VAC
Pin 6 =	119.3V VDC	32.8V VAC
Pin 7 =	302.V VDC	0.26V VAC
Pin 8 =	109.0V VDC	40.6V VAC
Pin 9 =	0.002V VDC	3.5V VAC
Pin 10 =	0.000V VDC	0.0V VAC
Pin 11 =	136.1V VDC	24.7V VAC

2) Using the scope, measure any signals appearing on the pins of the tubes. If possible, match these signals to other signals you have already viewed.

Pin 5 = ground (control grid)

Pin 6 = video data (green)

Pin 7 = DC to Screen grid

Pin 8 = video data (red)

Pin 9 = flyback pulses (to heaters)

Pin 10 = ground

Pin 11 = video data (blue)

3) Devise a method to determine which pins on the CRT receive the video signals. Using that method, find the three video pins on the CRT, and to correctly label then RED, GREEN, and BLUE.

QUESTIONS:

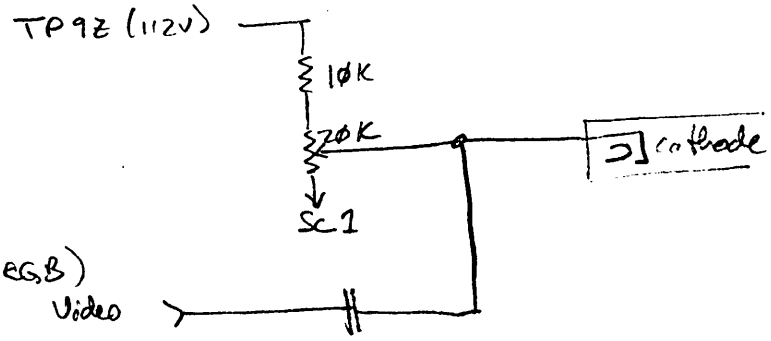
A) Which pins on the CRT accept which video signals?

RED = pin 8

GREEN = pin 6

BLUE = pin 11

4) Using the schematic diagram, locate the CUTOFF CONTROLS (VR654, VR655, VR656) on the CRT PC board. Redraw the circuit for ONE of these controls.



QUESTIONS:

A) The cutoff controls are "between" what two voltages?

TP9Z - 112 V (±1)

SC1 = 176.9V

B) What RANGE of measurements would you expect to see at the WIPER of the cutoff controls [HINT: ohms law]

Max = 176.9V

min = 135.26 V

5) Using the information you gained in #3 above, see if the reading on the CRT pins falls within the range of 9B above.

QUESTIONS:

125.3 V = min

158.7 V = max with dots on screen

A) What is the purpose of the cutoff controls?

To ensure that when the screen is supposed to be off, it is off - without any screen glow,

B) How do the cutoff controls work? How do they effect the CRT and the visible display?

The cutoff controls make the cathode more positive with respect to the control grid, which is grounded. As stated above, when adjusted correctly, the cutoff controls ensure that the screen will be off when required.

through potential → reduce lines

C) Why is a cutoff control necessary?

The DC video signals are stopped by capacitors - the cutoffs are necessary to drive the CRT.

END OF CRT SECTION