The CM-1 high resolution video monitor is designed to operate on 120 VAC, 60Hz power input. It consumes no more than 78 watts.

The display is driven by standard TTL level signals. These signals are:

Horizontal sync - TTL level, negative going
Vertical sync - TTL level, negative going
Red drive - TTL level, positive going (1 = ON)
Green drive - TTL level, positive going (1 = ON)
Blue drive - TTL level, positive going (1 = ON)
Intensity - TTL level, positive going (1 = active)

This makes the CM-1 an RGB type of monitor. The raster is 848 dots by 440 lines, with an active display area of 640 dots by 400 lines centered in the display face.

Given the above inputs, the CM-1 can display up to 15 colors, actually 8 colors with two intensity levels each.

THE DC POWER SUPPLY

The CM-1 uses a switching type power supply to obtain complete isolation from the AC line, and produce a tightly regulated DC supply voltage.

The CM-1 is isolated from the AC line by transformer T931, and in a minor sense by transformer T932. T931 is also the main feedback component of the switching power supply.

Noise on the AC line is filtered by L905, L906, C913, C914, and C917. Overcurrent protection is supplied by F901. The AC line voltage is rectified by a diode bridge consisting of D901, D902, D903, and D904 and filtered by C905. R901 protects the diodes from from a sudden high current draw if C905 is completely discharged. Noise from the switching power supply is kept from going back out to the AC line by C906, L901, and L902.

IC991 is designed as a switching power supply regulator. It contains most of the components necessary to build a complete switching power supply. Part of T931 acts as the collector load for IC 991. Another part of T931, along with C910 and R904, form the tank circuit in the base of the transistor inside IC991. This particular configuration is known as a BLOCKING OSCILLATOR. It is designed to operate at approximately 26.4 KHz. It is locked on to this frequency by a pulse obtained through T932 from IC401. T932 serves to isolates the regulator from the remainder of the CM-1 circuitry.

D907, C911, VR901, and part of T931 form a DC feedback system to allow IC991 to monitor the current drawn through T931. AS more current is drawn through T932 the pulses produced in T932 change in amplitude. A sample of these pulses is rectified and filtered to DC by D907 and C911. This DC voltage is feed into the regulator network inside IC991. As more or less current is drawn through T931 the DC voltage fed to the regulator inside IC991 will change. The regulator will supply more or less drive to the transistor to compensate for changes in the current drawn, thereby keeping the pulses at a steady height and the DC level into the regulator steady.

The remaining part of T931, D951, and C953 make up the output side of the switching regulator. The pulses produced in T931 are rectified and filtered here to produce a DC voltage at TP B4. Since the pulses appearing across the output of T931 are proportional to the pulses appearing in the DC feedback side of T931, it follows that VR9Ø1 can be used to control both. VR9Ø1 is the DC voltage adjustment for the switching regulator. It should be adjusted so that TP B4 reads 112 VDC +/- 1 volt on a Digital Voltmeter (DVM)

The 112 VDC B4 voltage has limited use. It is first sent to Q4Ø1, one of the vertical output transistors. It is also sent to the flyback transformer (FBT). It is also sent to Q581 and Q582, the X-ray protection circuit. The 112 VDC leaves the board at TP98 to become the collector voltage for the gun driver transistors on the CRT PC board.

The 112 VDC is divided and sent to the system oscillator IC, IC4Ø1. IC 4Ø1 must have a source of DC since it must oscillate to eventually produce the remaining supply voltages.

SCAN DERIVED SUPPLIES

All other DC voltages in the CM-1 are derived from the horizontal flyback transformer pulses. It can be seen that the CM-1 will appear almost completely dead if the horizontal circuitry fails. Only the 112 VDC will be present.

Due to the flyback action of the FBT several voltages are produced. The first is the high voltage for the CRT. This value is 22.5 kilovolts (KV). The high voltage diode is physically part of the FBT. This voltage is also divided to become the SCREEN and FOCUS voltage for the CRT.

The main DC voltages for the main PC board in the CM-1 are derived from the flyback through D554. This tap on the flyback is responsible for the power supply to the video amplifiers, the gun drivers, the blanker circuit, the brightness circuits, and the signal buffers. If this part of the circuitry, or the horizontal sweep circuitry, fails there will be no power supply to most of the CM-1, making it appear dead. The voltage developed is monitored by the LED D93Ø. If this LED is not lit then there is a failure in the derived power supplies or in the horizontal circuitry.

The voltage developed through D554 is first applied to the junction of R411 and L6Ø1. The voltage is current limited by R411 and Zener regulated by D4Ø1 to become the main supply voltage for the vertical oscillator section of IC4Ø1.

The original voltage is also passed through L6Ø1 and is further filtered by C6Ø8. The resulting voltage then becomes the supply voltage for red, green, and blue signal amplifiers and the red, green, and blue drivers on the CRT PC board. This same voltage is also supplied to the brightness and contrast amplifiers, and is picked off by the brightness and contrast pots to be used as a control voltage.

This voltage is also sent to blanker circuit, the H SYNC amplifier, and the +5 volt regulator. The +5 volt regulator is a simple pass transistor with a Zener in the base. This circuit provides +5 volts to the TTL level ICs on the main PC board.

THE HORIZONTAL OSCILLATOR

The HORIZONTAL SYNC pulses (H SYNC) are applied to the connector jack on the rear of the CM-1. The H SYNC signal is first applied to IC6Ø2. D632 limits the H SYNC signal to approximately 5 volts in amplitude to prevent a stronger signal from destroying IC6Ø2. IC6Ø2 can either be an inverting or non-inverting buffer, depending on the setting of SW6Ø1. As shown on the schematic, the CM-1 is expecting a negative going sync pulse. The pulse if further buffered by IC6Ø2 and is applied to Q615. After passing through Q615 the H SYNC pulse is passed through C5Ø1 and into the AFC section of IC4Ø1.

The power supply for the horizontal oscillator/driver circuitry is derived from the 112 VDC B4 supply. This supply should be active while the CM-1 is turned on, meaning that the horizontal oscillator section should be always active.

The main components of the horizontal oscillator are IC4Ø1, C5Ø7, and VR5Ø2. VR5Ø2 controls the frequency of the horizontal oscillator, and is therefore the horizontal hold control.

The main oscillator output is on Pin 1Ø of IC4Ø1. Pin 1Ø is a pulse wave of 26.4 KHz frequency and approximately 5.2 volts in amplitude. This pulse is applied to the base of Q551, the horizontal output driver. This transistor drivers the bas of Q591, the horizontal output transistor.

Q591, while listed as a transistor, is actually a specialized IC. It main component is a high power output transistor which is used to drive the horizontal yoke assembly and the FBT. Q591 also contains some biasing for the output transistor, and the damper diode used to protect the transistor from the Counter electro-motive forces (EMF) spike produced when the currents in the FBT collapse, or "fly back".

We have already seen that the pulses produced in the FBT can be tapped off to produce different supply voltages. These pulses can also be tapped off but not rectified into DC, and used as timing references. The syncronization of the horizontal oscillator to the horizontal synch pulse from the computer is one such case. A pulse is taken from pin 1Ø of the FBT (This same pulse goes through D554 to become the system supply voltages) and is sent through R559, The horizontal position control, R5Ø4, and C5Ø4 to the AFC circuit inside IC4Ø1. The phase of this signal is compared with the H SYNC pulse from the computer, and the frequency of the horizontal oscillator is adjusted until the oscillator is locked in sync with the sync pulse.

The same pulse from FBT pin 1Ø is also sent through T932 and D9Ø5 to the blocking oscillator in the switching power supply. This locks the frequency of the switching power supply to the horizontal frequency, which is itself locked to the horizontal sync pulse. The result is that possible beat frequencies produced by the horizontal oscillator and the switching power supply are eliminated. Otherwise, these beat frequencies may show up as a wavering or shimmering of the display.

X-RAY PROTECTION CIRCUIT

The phosphors on the face of the CRT are much less active than their black-and-white counterparts. To make the screen bright enough to see it is necessary to boost the available high voltage on the CRT. While monochrome monitors generally use a high voltage of about 12 KV, the typical color monitor will use a high voltage of around 23 KV. With this higher voltage comes the danger of excessive X-ray emissions. The amount of emissions is strongly regulated by the government. The schematic in the CM-1 Service Manual indicates parts which effect the X-ray emissions. ALWAYS USE EXACT REPLACEMENT PARTS IN THESE AREAS. NEVER SUBSTITUTE PARTS IN ANY CIRCUIT WHICH MAY EFFECT X-RAY EMISSIONS.

The amount of X-ray emissions will increase with any increase in the high voltage. This could be caused by a failure in the horizontal sweep circuit, or failure of the switching supply to regulate properly.

A pulse from the FBT is sampled, rectified, and filtered by D581 and C583. When this DC voltage is strong enough to overcome the bias on Q582, Q582 will turn OFF. The only source for bias on Q581 is then R583. This will turn Q581 ON.

CUrrent flowing through Q581 will bring Q551, the horizontal drive transistor, into saturation. The drive pulses can not overcome this bias, so the horizontal output stage is effectively disabled and all voltages developed from the FBT, including the 22 KV high voltage, are stopped.

However, once the output stage is disabled the pulses through D581 are stopped. You would expect that Q582 would now turn ON and deactivate the X-ray shutdown. However, once the system is shut down there is still enough current flowing through R581 from the 112 VDC source to keep Q582 OFF and the X-ray protection active. Once the X-ray protection has activated it can be deactivated only by turning the CM-1 OFF, then ON again.

THE VERTICAL OSCILLATOR

The VERTICAL SYNC (V SYNC) pulses are also buffered by IC6Ø2, However, the V SYNC pulse is sent directly to the vertical oscillator section of IC4Ø1 through R4Ø2.

The main components of the vertical oscillator are IC4Ø1, C4Ø2, C4Ø6, R4Ø5, and VR4Ø1. The frequency of the oscillation can be controlled by VR4Ø1, so it is the VERTICAL HOLD control. The vertical synch pulses are applied to the oscillator through R4Ø2 into IC4Ø1 pin 8. Note that some of of vertical output is tapped from T553 and fed back to the oscillator through R4Ø3 into IC4Ø1 pin 4.

The output of the vertical oscillator appears on IC4Ø1 pin 2 and is applied to Q4Ø1 and Q4Ø2. Note that the high voltage necessary for operation of the vertical output is taken from the 112 VDC switching regulator output.

THE VIDEO CIRCUITS

The four video signals, R, G, B, and I, are all buffered by IC6Ø1. Note that these buffers can also selectively invert the signal according to the setting of SW6Ø1. The CM-1 is expecting positive going video signals. D6Ø2, D6Ø4, D6Ø6, and D6A2 all limit the video signals to 5 volts in amplitude.

The three color signals, R, G, and B are all treated identically, so only one will be discussed. The other two are identical.

After buffering by IC6Ø1 the video signal is sent through the video amplifiers (Q616, Q617, Q618), through the video buffers (Q6Ø7, Q6Ø8, Q6Ø9), and to the video drivers on the CRT PC board. Note that power for the video sections is obtained by rectifying and filtering a pulse from the FBT.

The video output circuits are known as a SINGLE ENDED PUSH PULL circuit. This circuit has advantages of high frequency response and low output impedance. Note that the drive signal from the video buffer is input into the emitter of drive transistor.

The input signal to the driver circuits is adjustable in the RED and BLUE circuits, but not the GREEN. This is because the GREEN phosphor is less efficient than the other two. The GREEN is used as a reference and the RED and BLUE are adjusted around it.

The actual output transistors themselves are a standard push/pull configuration. Note that the signal developed at the emitters of these transistors is coupled through a capacitor to the pins of the CRT. Because of this it is necessary to set the DC level on the pins by using the CUTOFF controls on the CRT PC board.

THE BLANKER CIRCUIT

At the end of each sweep (horizontal or vertical) the beams must return to their starting position. This is known as RETRACE. If the electron beams are turned ON during this time we will see bright horizontal (or vertical) lines on the screen. These lines are undesirable, so some arrangement must be made to BLANK the beams during retrace time. This circuit is called the BLANKER.

Q61Ø is the main blanking transistor. It receives pulses from the vertical circuit through C471 and D471, and pulses from the horizontal circuit through R571 and D571.

During the actual sweep time Q61Ø is biased OFF. Its collector voltage rises to about 1Ø.5 volts. This voltage is sent to Q66Ø on the CRT PC board and is used to keep Q66Ø turned ON. Q66Ø acts like a switch in the emitter circuits of the driver transistors. With Q66Ø ON the 1.2K resistors connect to ground through Q66Ø and R696.

However, during retrace the flyback pulses are applied to Q61Ø. This will turn Q61Ø ON during the retrace period. The collector of Q61Ø drops to a low voltage, turning OFF Q66Ø. With Q66Ø OFF the emitters of the drivers have no return to ground. This deactivates (BLANKS) the beams during the retrace periods of both vertical and horizontal sweep.

THE BRIGHTNESS AND CONTRAST CONTROLS

The brightness is handled by Q611 and Q602. Q611 is controlled by the BRIGHTNESS CONTROL VR68 and the AUTOMATIC BRIGHTNESS Q612. The range of the brightness control is set by the SUB-BRIGHTNESS CONTROL, VR694. Varying the voltage on the base of Q611 varies the current flowing through the collector. The resulting voltage change across R627 is connected to the base of Q602 to vary the current flow through Q602. The current flowing through Q602 is used to bias the video amplifiers through the 150 ohm resistors R607, R608, and R609.

The automatic brightness control is handled by Q612. Changes in beam current will be reflected in changes in the high voltage. These changes can be monitored through another tap on the FBT, through D552. These changes are detected by Q612 which changes the control on the base of the brightness transistor Q611. If the beam current increases producing a brighter display current flow through Q612 will be increased, decreasing the drive on Q611 and reducing the brightness. If the beam current decreases producing a darker display current flow through Q612 will decrease, increasing the drive on Q611 and increasing the brightness. The result is that the display maintains a constant brightness for most changes in beam current.

Contrast is handled by Q601. Note that the contrast control, VR682, is connected to the brightness control voltage appearing at the base of Q602. This means that the contrast will vary with the brightness.

The action of the contrast circuit is controlled by the "I" signal. The "I" signal is inverted once by the buffer IC 601 and again by the inverter IC603 for a end result of no phase change. However, IC603 is an open collector device. This allows its outputs to act as switches for the contrast control.

If the "I" signal is HIGH (normal or "bright" colors) the outputs of IC603 will be inactive. The RGB signals are sent to the video amplifiers unattenuated. If the "I" signal is LOW ("dark" colors) the outputs of IOC603 are active. The first effect is to add a 47 ohm "load" to the RGB signals through D6A5, D6A6, and D6A7. This lowers the amplitude of the RGB signals, producing the "dark" colors. The second effect is to activate Q601 through D6A3, D6A4, and D6A8. Current can now flow through these diodes and Q601. This will change the bias on the previous three diodes changing the point at which they become active. This will effectively allow the contrast control to change the level of the "dark" video signals and change their brightness level. Note that this means that the contrast control has an effect only on the "dark" colors.