MOTOROLA

SERVICE MANUAL

MODELS*

M3000-140, 240, 340
M3003-140, 240, 340
M4000-140, 240, 440
M4003-140, 240, 440

*INCLUDES StepScan™ MOTOROLA

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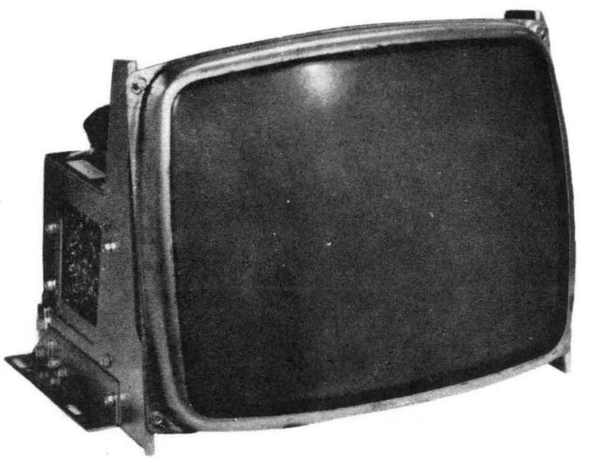
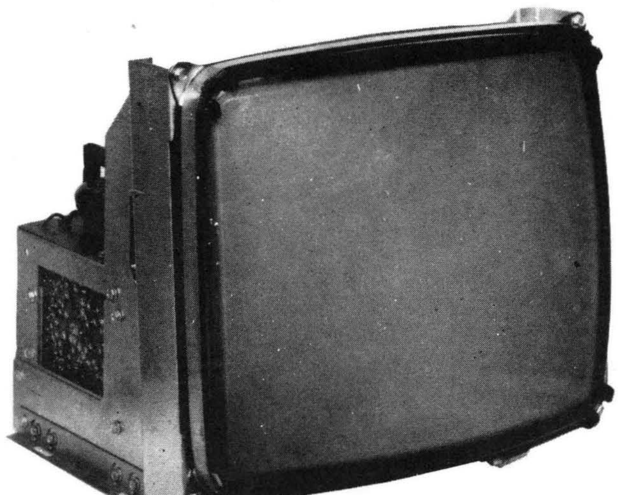


Model M3000/M3003 (12" – CRT)



FAEPC–00169

Model M4000/M4003 (15" – CRT)

CAUTION
NO WORK SHOULD BE ATTEMPTED ON ANY EXPOSED MONITOR CHASSIS BY ANYONE NOT FAMILIAR WITH SERVICING PROCEDURES AND PRECAUTIONS.

MOTOROLA INC.
Data Products
CAROL STREAM, ILLINOIS 60187

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SAFETY WARNING

CAUTION: NO WORK SHOULD BE ATTEMPTED ON AN EXPOSED MONITOR CHASSIS BY ANYONE NOT FAMILIAR WITH SERVICING PROCEDURES AND PRECAUTIONS.

1. SAFETY PROCEDURES should be developed by habit so that when the technician is rushed with repair work, he automatically takes precautions.

2. A GOOD PRACTICE, when working on any unit, is to first ground the chassis and to use only one hand when testing circuitry. This will avoid the possibility of carelessly putting one hand on chassis or ground and the other on an electrical connection which could cause a severe electrical shock.

3. Extreme care should be used in HANDLING THE PICTURE TUBE as rough handling may cause it to implode due to atmospheric pressure (14.7 lbs. per sq. in.). Do not nick or scratch glass or subject it to any undue pressure in removal or installation. When handling, safety goggles and heavy gloves should be worn for protection. Discharge picture tube by shorting the anode connection to chassis ground (not cabinet or other mounting parts). When discharging, go from ground to anode or use a well insulated piece of wire. When servicing or repairing the monitor, if the cathode ray tube is replaced by a type of tube other than that specified under the Motorola Part Number as original equipment in this Service Manual, then avoid prolonged exposure at close range to unshielded areas of the cathode ray tube. Possible danger of personal injury from unnecessary exposure to X-ray radiation may result.

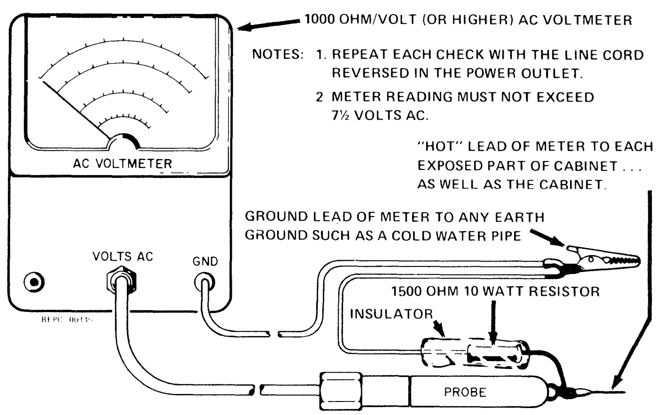
4. An ISOLATION TRANSFORMER should always be used during the servicing of a unit whose chassis is connected to one side of the power line. Use a transformer of adequate power rating as this protects the serviceman from accidents resulting in personal injury from electrical shocks. It will also protect the chassis and its components from being damaged by accidental shorts of the circuitry that may be inadvertently introduced during the service operation.

5. Always REPLACE PROTECTIVE DEVICES, such as fishpaper, isolation resistors and capacitors and shields after working on the unit.

6. If the HIGH VOLTAGE is adjustable, it should always be ADJUSTED to the level recommended by the manufacturer. If the voltage is increased above the normal setting, exposure to unnecessary X-ray radiation could result. High voltage can accurately be measured with a high voltage meter connected from the anode lead to chassis.

7. BEFORE RETURNING A SERVICED UNIT, the service technician must thoroughly test the unit to be certain that it is completely safe to operate without danger of electrical shock. DO NOT USE A LINE ISOLATION TRANSFORMER WHEN MAKING THIS TEST.

In addition to practicing the basic and fundamental electrical safety rules, the following test, which is related to the minimum safety requirements of the Underwriters Laboratories should be performed by the service technician before any unit which has been serviced is returned.



Voltmeter Hook-up for Safety Check

A 1000 ohm per volt AC voltmeter is prepared by shunting it with a 1500 ohm, 10 watt resistor. The safety test is made by contacting one meter probe to any portion of the unit exposed to the operator such as the cabinet trim, hardware, controls, knobs, etc., while the other probe is held in contact with a good "earth" ground such as a cold water pipe.

The AC voltage indicated by the meter may not exceed 7½ volts. A reading exceeding 7½ volts indicates that a potentially dangerous leakage path exists between the exposed portion of the unit and "earth" ground. Such a unit represents a potentially serious shock hazard to the operator.

The above test should be repeated with the power plug reversed, when applicable.

NEVER RETURN A MONITOR which does not pass the safety test until the fault has been located and corrected.

ELECTRICAL SPECIFICATIONS *

	MODEL M3000/M3003	MODEL M4000/M4003
PICTURE TUBE:	12" measured diagonally (305 mm); 74 sq. in. viewing area (477 sq. cm); 110° deflection angle; integral implosion protection; M3000/3003–140: P4 phosphor <u>without</u> anti-reflective faceplate M3000/3003–240: P4 phosphor <u>with</u> anti-reflective faceplate M3000/3003–340: P31 phosphor <u>without</u> anti-reflective faceplate	15" measured diagonally (381 mm); 100 sq. in. viewing area (645 sq. cm); 110° deflection angle; integral implosion protection; M4000/4003–140: P4 phosphor <u>without</u> anti-reflective faceplate M4000/4003–240: P4 phosphor <u>with</u> anti-reflective faceplate M4000/4003–440: P31 phosphor <u>with</u> anti-reflective faceplate
POWER INPUT:	115/230V AC, 60 watts (nominal), or 70V DC	
FUSES:	0.8 Amp Slo-Blo	0.8 Amp Slo-Blo
LOW VOLTAGE POWER SUPPLY:	Electronically regulated over AC inputs from 107V to 135V, or 214V to 270V	
INPUT SIGNALS:	TTL SEPARATE HORIZONTAL, VERTICAL, VIDEO:	2.5V to 5.0V P-P, video drive, sync positive at input (input impedance: 75 ohms to 250 ohms video termination, > 2K ohms vertical and horizontal)
PULSE RISE TIME (TYPICAL):	30V rise in less than 20 nSec	
RESOLUTION (TYPICAL):	800 lines center, 600 lines corners	
VIDEO RESPONSE (TYPICAL):	Within –3 dB, 10 Hz to 22 MHz	
LINEARITY:	Within 2% as measured with standard EIA ball chart and dot pattern	
HIGH VOLTAGE:	14kV nominal at 20 uAmp beam current	17kV nominal at 20 uAmp beam current
HORIZONTAL RETRACE TIME:	11.0 uSec maximum at 15.72 kHz – M3000/M4000 Models 11.0 uSec maximum at 18.72 kHz – M3003/M4003 Models	
SCANNING FREQUENCY:	Horizontal: 15.72 kHz ± 500 Hz; Vertical: 50/60 Hz – M3000/M4000 Models Horizontal: 18.72 kHz ± 500 Hz; Vertical: 50/60 Hz – M3003/M4003 Models	
ENVIRONMENT:	Operating temperature: 0°C to 50°C Storage temperature: –40°C to +65°C Operating altitude: 10,000 feet maximum (3048 meters) Designed to comply with applicable DHEW rules on X-Radiation Designed to enable listing under UL Specification 478	
TYPICAL DIMENSIONS:	9.12" H, 11.40" W, 8.84" D (232 x 290 x 225 mm)	10.94" H, 12.84" W, 10.22" D (278 x 326 x 260 mm)

*** Specifications and descriptions subject to change without notice.**

GENERAL INFORMATION

The monitors described herein are fully transistorized (except CRT) and applicable for displaying alphanumeric characters. The M3000/M3003 series monitors use a 12-inch CRT and the M4000/M4003 series monitors use a 15-inch CRT. All monitors utilize a non-composite video signal with separate TTL horizontal and vertical sync pulses. (See Schematic diagram.)

The CRT's employed are of the magnetic deflection type with integral implosion protection. An operating voltage of +70 volts DC is required from the regulated power supply for both models. A universal power transformer permits operating the monitor from either 115 or 230 volts AC, 50/60 Hz.

Input and output connections for the monitor are made through a 10-pin edge or header connector on the vertical/video circuit card. Inputs consist of video, horizontal/vertical sync, and signal ground. One additional input, TTL level StepScan, is also connected to the monitor via the 10-pin edge connector. Output connections are provided for an optional remote brightness control.

Circuitry consists of two stages for video amplification, five stages for vertical sync and deflection processing, five stages for horizontal sync and deflection processing, and a regulated +70 volt power supply. Both models also have dynamic focusing and StepScan amplifier. (See Schematic diagram.)

Three etched circuit cards are utilized, containing the vertical/video circuit, horizontal circuit, and power supply circuit. An optional low voltage logic power supply is available when a remote power source is required for logic interface circuitry. Components are mounted on the top of the circuit cards and plating copper foil on the bottom. Schematic reference numbers are printed on the top and bottom of each circuit card to aid in the location and identification of components for servicing. All standard operating/adjustment controls are mounted in a convenient manner on the three circuit cards. Refer to Motorola Service Manual VP20, Part No. 68P25253A40 for complete service information on the low voltage logic power supplies.

SERVICE NOTES

CIRCUIT TRACING

Component reference numbers are printed on the top and bottom of the three circuit cards to facilitate circuit tracing. In addition, control names and circuit card terminal numbers are also shown and referenced on the schematic diagram in this manual.

Transistor elements are identified as follows:

E – emitter, B – base, and C – collector.

COMPONENT REMOVAL

Removing components from an etched circuit card is facilitated by the fact that the circuitry (copper foil) appears on one side of the circuit card only and the component leads are inserted straight through the holes and are not bent or crimped.

It is recommended that a solder extracting gun be used to aid in component removal. An iron with a temperature controlled heating element would be desirable since it would reduce the possibility of damaging the circuit card foil due to over-heating.

The nozzle of the solder extracting gun is inserted directly over the component lead and when sufficiently heated, the solder is drawn away leaving the lead free from the copper foil. This method is particularly suitable in removing multi-terminal components.

When replacing "plug-in" transistors, please observe the following precautions:

1. The transistor sockets are not "captive", which means that the transistor mounting screws also secure the socket. When installing the transistor, the socket must be held in its proper position.

2. When replacing a plug-in transistor, silicone grease (Motorola Part No. 11M490487) should be applied evenly to the top of the heat sink and bottom of the transistor. In addition, be sure a mica insulator is positioned properly between the transistor and heat sink.

3. The transistor mounting screws must be tight before applying power to the monitor. This insures proper cooling and electrical connections. NON-COMPLIANCE WITH THESE INSTRUCTIONS CAN RESULT IN FAILURE OF THE TRANSISTOR AND/OR ITS RELATED COMPONENTS.

NOTE

Use caution when tightening transistor mounting screws. If the screw threads are stripped by excessive pressure, a poor electrical and mechanical connection will result.

CRT REPLACEMENT

Use extreme care in handling the CRT as rough handling may cause it to implode due to high vacuum pressure. Do not nick or scratch glass or subject it to any undue pressure in removal or installation. Use goggles and heavy gloves for protection. In addition, be sure to disconnect the monitor from all external voltage sources.

1. Discharge CRT by shorting 2nd anode to ground; then remove the CRT socket, deflection yoke and 2nd anode lead.

2. Remove CRT from the front of the chassis by loosening and removing four screws; one in each corner of the CRT.

REGULATOR ADJUSTMENT

NOTE

Misadjustment of the low voltage regulator, or the horizontal oscillator may result in damage to the horizontal output transistor or pulse limiter diode. The following procedure is recommended to insure reliable operation.

1. Connect the monitor to an AC line supply; then adjust supply to 120 volts (240 volts in some applications).

2. Apply test signal to proper input. Signal should be of same amplitude and sync rate as when monitor is in service.

3. Adjust HOR. SET coil L50 (on the horizontal circuit card) until display is stable.

4. Connect a DC digital voltmeter or equivalent precision voltmeter to the emitter of the regulator output transistor, Q150 (or any +70 volt test point on the power supply circuit card).

5. Adjust the 70V ADJUST. control, R158, on the power supply circuit card for an output of +70 volts. DO NOT rotate the control through its entire range; damage to the monitor may result.

6. When adjustment is complete, the AC line supply can be varied between 105 and 130 volts AC to check for proper regulator operation. With the regulator operating properly, changes in display size should be negligible.

HORIZONTAL HOLD/OSCILLATOR ADJUSTMENT

Adjust the core of HOR. SET coil L50 until the horizontal blanking lines are vertical, or the CRT display is stable (synced).

DYNAMIC FOCUS ADJUSTMENT

The DYNAMIC FOCUS coil is factory set and should not normally require further adjustment. However, if it becomes necessary, use Procedure No. 1 for touching up the overall focus. Procedure No. 2 is provided if the CRT (V1) and/or DYNAMIC FOCUS coil (L52) is replaced in the field.

PROCEDURE NO. 1

1. Adjust FOCUS control R70 (on horizontal circuit card) for best focus in the center of the CRT.

2. Adjust DYNAMIC FOCUS coil L52 for best edge focus.

3. Alternate between adjusting R70 and L52 until overall CRT focus is optimized.

PROCEDURE NO. 2

1. Connect an oscilloscope (DC coupled) between the junction of R71 and C63 (on horizontal circuit card) and signal ground.

CAUTION

High voltage is present.

2. Adjust the oscilloscope controls until one cycle of the horizontal rate sinewave appears as shown in Figure 1.

3. Adjust the DYNAMIC FOCUS coil, L52 for a minimum sinewave amplitude of not more than 125 volts P-P.

NOTE

Be sure that the one cycle appearing on the oscilloscope is not a harmonic of the horizontal rate sinewave. This may occur if the DYNAMIC FOCUS coil, L52, is misadjusted to the extent that L52 will produce the second harmonic. The coil must be adjusted to produce the minimum amplitude of the fundamental frequency only. Confirm the preceding by momentarily connecting the oscilloscope across the primary of T50. Only one cycle or pulse should appear.

4. Observe the center of the CRT display and adjust the FOCUS control, R70, for optimum focus; then record the DC voltage (represented as amplitude "A" in Figure 1) between the DC 0 volt reference and the negative peak of the sinewave.

5. Observe the edges of the CRT display and adjust the FOCUS control, R70, for optimum focus; then record the DC voltage (represented as amplitude "B" in Figure 1) between the DC 0 volt reference and the positive peak of the sinewave .

6. Subtract the negative peak voltage from the positive peak voltage. The difference becomes the voltage value to which the DYNAMIC FOCUS coil, L52, must be adjusted.

7. While observing the sinewave, adjust the DYNAMIC FOCUS coil, L52, until amplitude "C" (see Figure 1) equals the difference voltage value determined in step 6.

8. While observing the oscilloscope, readjust the FOCUS control, R70, until the negative peak of the sinewave is positioned above the DC 0 volt reference line equal to the voltage value recorded in step 4.

Amplitude "A" – Represents adjusting FOCUS control, R70, for best CRT center FOCUS.

Amplitude "B" – Represents adjusting FOCUS control, R70, for best CRT edge FOCUS.

Amplitude "C" – Represents adjusting DYNAMIC FOCUS coil, L52, for final P-P setting that is equal to difference between amplitude "A" and "B".

NOTE: After amplitude "C" is adjusted, amplitude "A" must be reset to the original voltage value that provided best CRT center FOCUS.

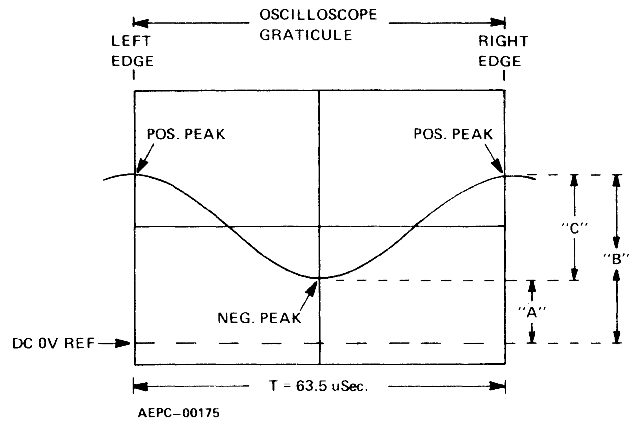
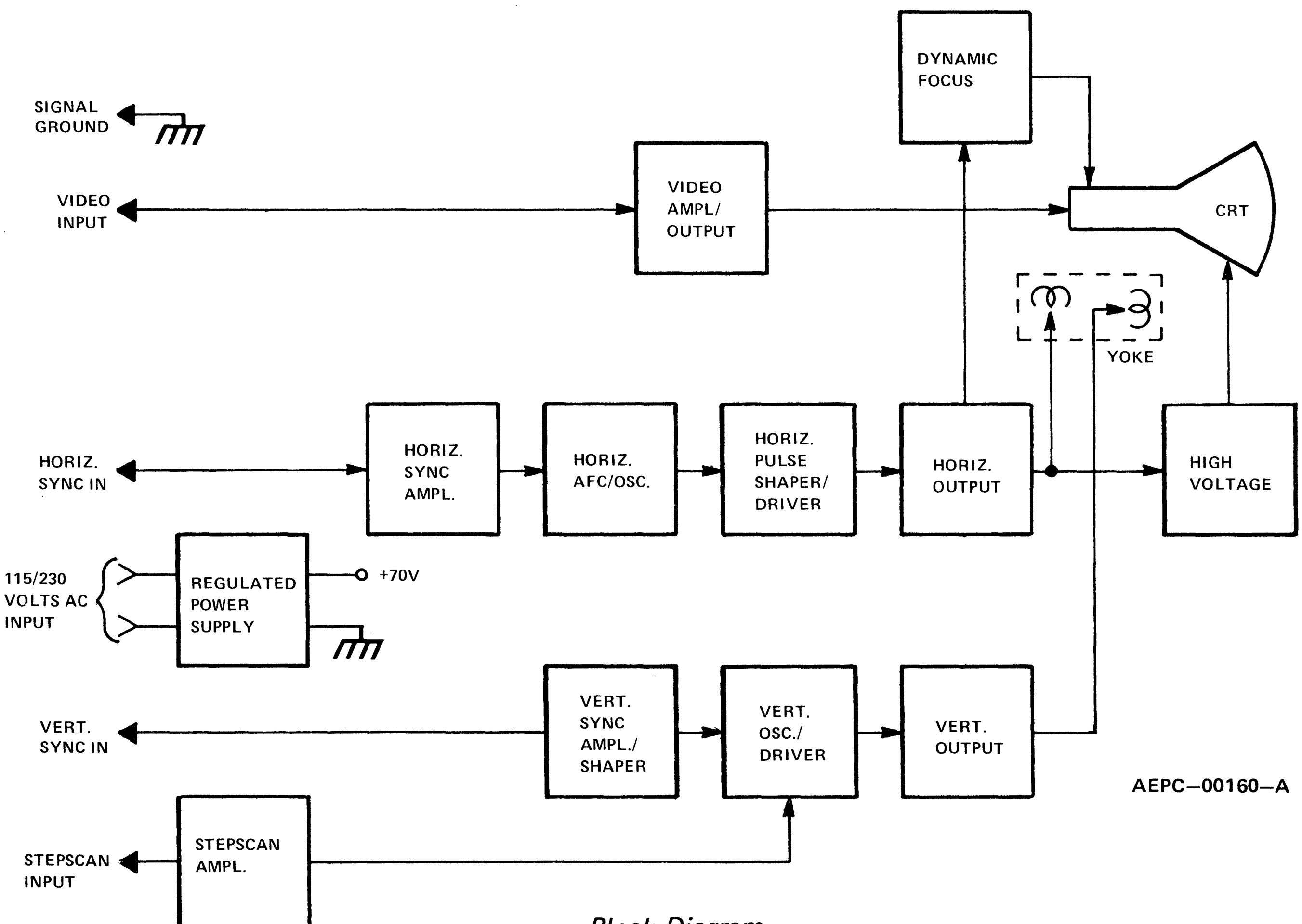


Figure 1. Adjusting Dynamic Focus with an Oscilloscope



Block Diagram

THEORY OF OPERATION

POWER SUPPLY

(Refer to Figure 2.)

The power supply is a transformer operated, full wave, regulated series pass circuit that maintains a constant output voltage with line input variations of ±12.5%. Depending on how connector S2 is wired, operation from 115 or 230 volts, 50/60 Hz is possible. Integrated circuit IC150 is the reference amplifier, transistor Q152 is a regulator buffer, transistor Q151 is the regulated output driver, and Q150 is the series pass transistor.

The output voltage, +70V, appears at the emitter of Q150. This voltage is divided between R157, R158 and R159. The voltage appearing on the arm of potentiometer R158 (70V ADJ. control) is the reference input to the non-inverting input of reference amplifier IC150.

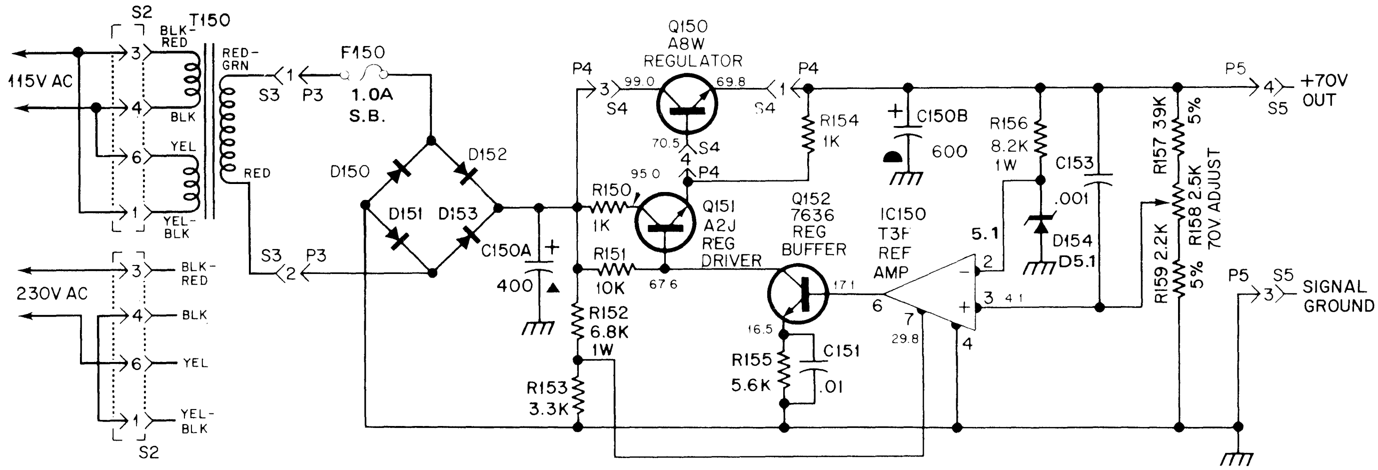


Figure 2. Power Supply Circuit

A temperature compensated zener diode, D154, establishes a fixed reference voltage at the inverting input to IC150. Resistor R156 provides a bias current for D154, which establishes its operating point. Capacitor C153 is a high frequency filter. Operating voltage for IC150 is derived from a voltage divider consisting of R152 and R153. Components R155 and C151 set the voltage gain of Q152.

An increase in output voltage will result in an increase of voltage at the base of Q152 via the non-inverting input of IC150. The change in base voltage will turn Q152 on harder, reducing its collector voltage. This reduces the forward bias to Q151, which results in less emitter current for Q150. With Q150 conducting less, the output voltage will be lowered.

VIDEO AMPLIFIER
(Refer to Figure 3.)

The linear video amplifier consists of two stages, Q100 and Q101, which are connected in a cascode configuration. This common emitter-common base arrangement greatly reduces the effect of Miller capacity (when compared to a conventional single transistor video amplifier/output stage).

A TTL compatible non-composite video signal, approximately 4.0 volts P-P, is DC coupled to the base of Q100 via R100. Resistor R112 provides proper termination for the high frequency input video signal. Capacitor C100 provides high frequency compensation to maintain a flat response when Q100 and Q101 conduct.

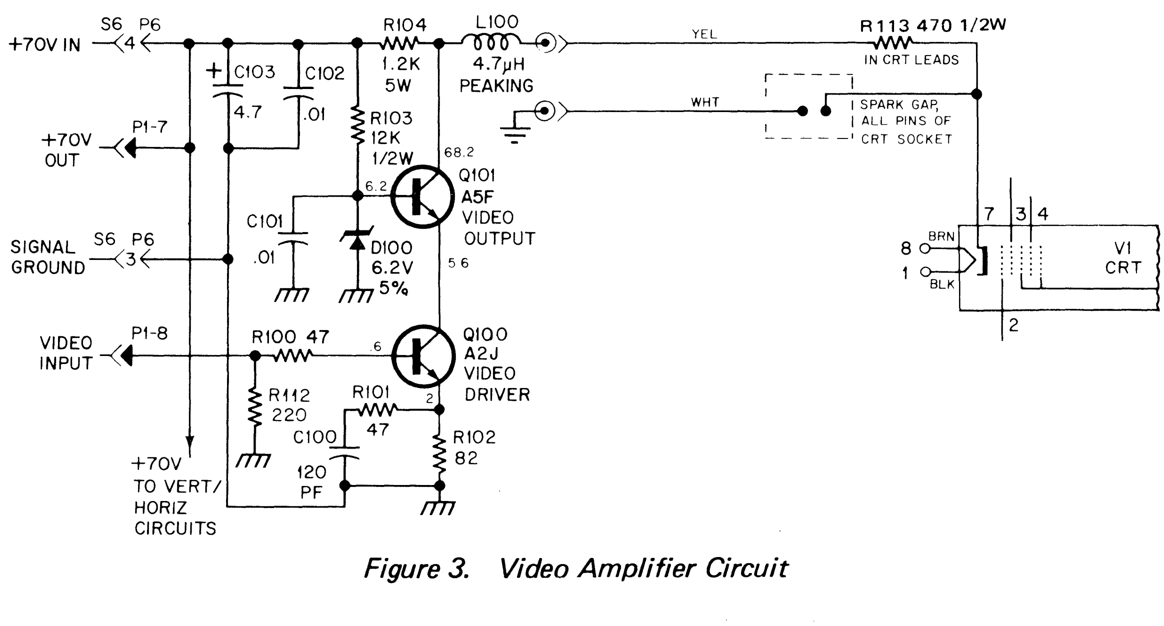


Figure 3. Video Amplifier Circuit

During no-signal conditions, Q100 is off. Transistor Q101, however, is forward biased by the 6.2 volts on its base, which is established by zener diode D100. When a video signal is applied to the base of Q100, it conducts, which causes forward biased Q101 to conduct. The resultant output is developed across R104 at the collector of Q101; then DC coupled to the cathode of V1 (CRT) via peaking coil L100 and R113. Resistor R113 isolates Q101 from transients that may occur as a result of CRT arcing. Capacitor C101 shunts to ground high frequency video that may appear on the base of Q101. Peaking coil L100 boosts the high frequencies of the video signal. Capacitor C103 provides additional filtering of the +70V, while C102 is a high frequency AC bypass capacitor.

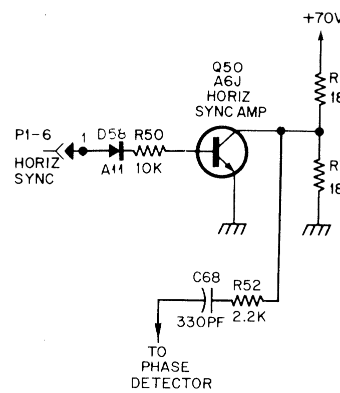


Figure 4. Horizontal Sync Amplifier Circuit

HORIZONTAL SYNC AMPLIFIER
(Refer to Figure 4.)

The horizontal sync amplifier consists of one stage, Q50, which operates as a switch. During a no-signal condition, Q50 is off. When a positive-going horizontal sync signal, approximately 4.0 volts P-P, is applied (DC coupled) to the base of Q50, it goes into saturation. The amplified output is developed across load resistor R51, approximately 35V, which forms a voltage divider with R77. The negative-going horizontal sync pulses are AC coupled to the phase detector circuit via the R-C network consisting of R52 and C68, a high frequency pass filter.

PHASE DETECTOR
(Refer to Figure 5.)

The phase detector consists of two diodes (D50 and D51) in a keyed clamp circuit. Two inputs are required to generate the required output, one from the horizontal sync amplifier, Q50, and one from the horizontal output circuit, Q54. The required output must be of the proper polarity and amplitude to correct phase differences between the input horizontal sync pulses and the horizontal time base. The horizontal output (Q54) collector pulse is integrated into a sawtooth by R56 and C69. During horizontal sync time, diodes D50 and D51 conduct, which shorts C69 to ground. This effectively clamps the sawtooth on C69 to ground at sync time. If the horizontal time base is in phase with the sync (waveform A), the sync pulse will occur when the sawtooth is passing through its AC axis and the net charge on C69 will be zero (waveform B). If the horizontal time base is lagging the sync, the sawtooth on C69 will be clamped to ground at a point negative from the AC axis. This will result in a positive DC charge on C69 (waveform C). This is the correct polarity to cause the horizontal oscillator to speed up to correct the phase lag. Likewise, if the horizontal time base is leading the sync, the sawtooth on C69 will be clamped at a point positive from its AC axis. This results in a net negative charge on C69, which is the required polarity to slow the horizontal oscillator (waveform D). Components R55, C52, R58 and C53 comprise the phase detector filter. The bandpass of this filter is chosen to provide correction of horizontal oscillator phase without ringing or hunting. Capacitor C50 times the phase detector for correct centering of the picture on the raster.

HORIZONTAL OSCILLATOR
(Refer to Figure 5.)

The horizontal oscillator consists of Q51, which is employed as a modified type of Hartley oscillator. The

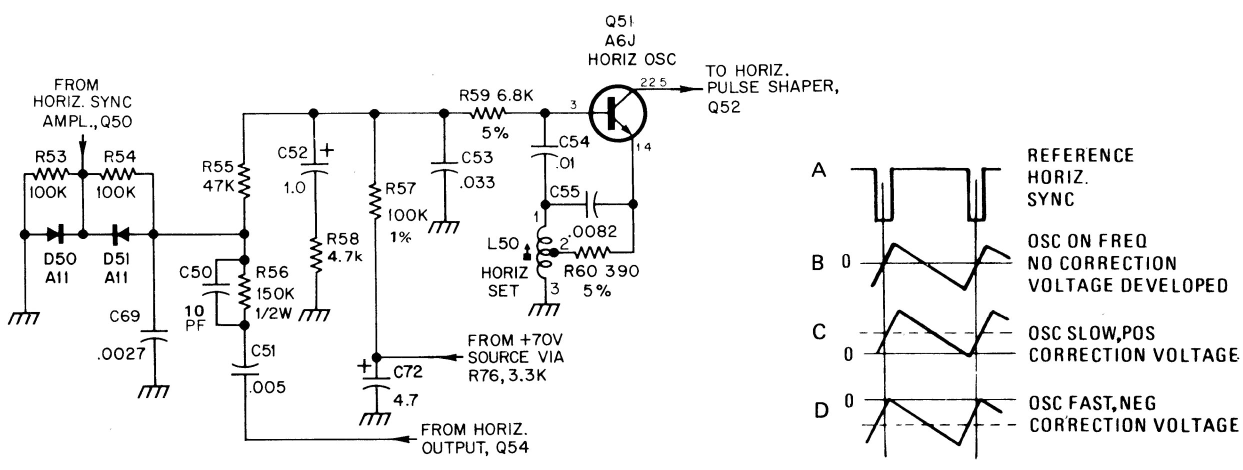


Figure 5. Phase Detector and Horizontal Oscillator Circuits

operating frequency of this oscillator is sensitive to its base input voltage. This permits control by the output of the phase detector. Resistor R57 provides DC bias to turn on Q51 and start the oscillator. The free-running horizontal frequency is adjusted with the HORIZ. SET coil, L50, which along with C54 are the frequency determining components. Capacitor C55 and resistor R60 are feedback components for the oscillator circuit.

HORIZONTAL PULSE SHAPER & DRIVER

(Refer to Figure 6.)

Transistor Q52 is a buffer stage between the horizontal oscillator and horizontal driver. It provides isolation for the horizontal oscillator as well as a low impedance drive for the horizontal driver. Components R62 and C56 form a time constant that shapes the oscillator output to the required duty cycle, approximately 50%, to drive the horizontal output circuitry. The horizontal driver stage, Q53, operates as a switch to drive the horizontal output transistor (Q54) through T50. Because of the low impedance drive and fast switching times furnished by Q52, very little power is dissipated in Q53. Components R66 and C57 provide damping to suppress ringing in the primary of T50 when Q53 goes into cutoff. (Reference Figure 8 – Resistor R68 provides current limiting for Q53 while C58 is an AC bypass capacitor.)

HORIZONTAL OUTPUT

(Refer to Figure 7.)

The secondary of T50 provides the required low drive impedance for Q54. Components R67 and C59 form a time constant for fast turn-off of the base of Q54. Once during each horizontal period, Q54 operates as a switch that connects the supply voltage across the parallel combination of the horizontal deflection yoke and the primary of the high

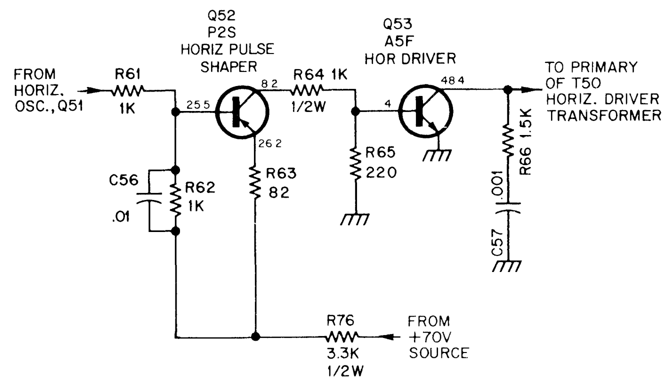


Figure 6. Horizontal Pulse Shaper and Driver Circuits

voltage transformer. The required sawtooth deflection current (through the horizontal yoke) is formed by the L-R time constant of the yoke and primary winding of the H.V. transformer, T51. The horizontal retrace pulse charges C62 through D54 to provide operating voltage for G2 of the CRT. Momentary transients at the collector of Q54, should they occur, are limited to the voltage on C62 since D54 will conduct if the collector voltage exceeds this value.

The damper diode, D53, conducts during the period between retrace and turn on of Q54. Capacitor C65 is the retrace tuning capacitor, while C61 blocks DC from the

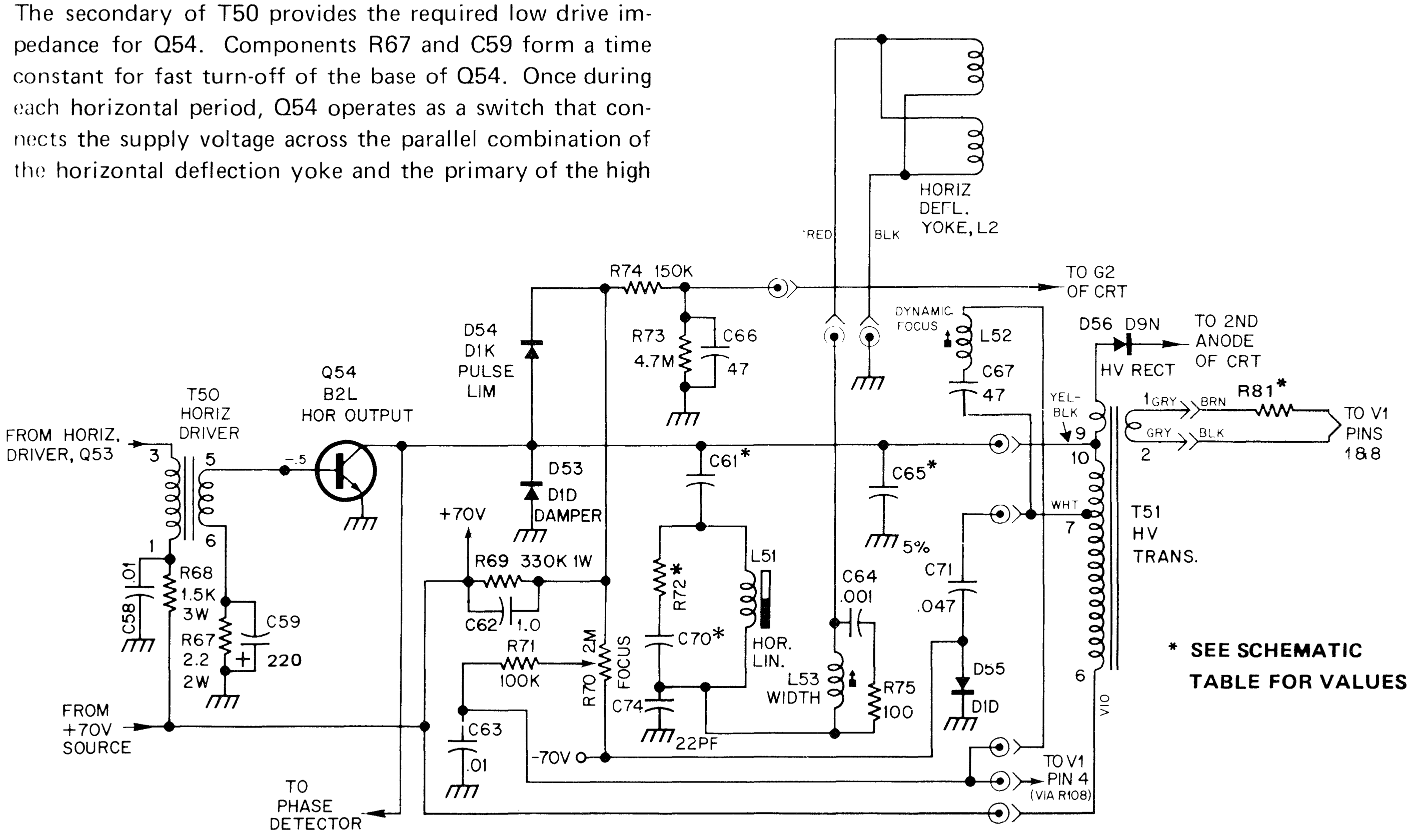


Figure 7. Horizontal Output Circuit

deflection yoke. Coil L51 is a magnetically biased linearity coil that shapes the deflection current for optimum trace linearity. Coil L53 is a series horiz. width control. Components R72 and C70, C64 and R75 are damping network components for the horizontal linearity (L51) and width (L53) controls. Capacitor C71 couples horizontal sync pulses from pin 7 of T51 to diode clamp D55, which maintains the −70V reference voltage.

DYNAMIC FOCUS

(Refer to Figure 8.)

Due to the geometry of a CRT, the electron beam travels a greater distance when deflected to a corner as compared to the distance traveled at the center of the CRT screen. As a result of these various distances traveled, optimum focus can be obtained at only one point. For general applications, an adequate adjustment can be realized by setting the focus while viewing some point mid-way between the center of the CRT screen and a corner, thus optimizing the overall screen focus. When an application requires a tighter specification, one of the simplest methods for improvement is to modulate the focus voltage at a horizontal sweep rate. Now optimum focus voltage is made variable on the horizontal axis of the CRT, which compensates for the beam travel along this axis.

The AC component focus voltage is developed by a series resonant circuit consisting of L52 and C63. This voltage is an 80V P-P horizontal rate pulse coupled from a tap on the horizontal output transformer, T51, via C67. The normal DC component of the G4 focus voltage is set by adjusting the FOCUS control, R70. When the DYNAMIC FOCUS coil, L52, is optimized for best edge focus, a sinusoidal voltage of approximately 200V P-P is developed across C63. This mixed AC and DC voltage results in a waveform of proper phase and amplitude, which is coupled through isolating resistor R108 to the CRT focus anode.

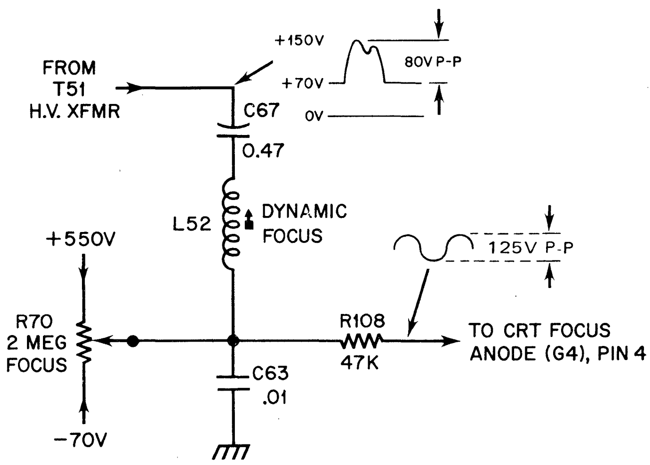


Figure 8. Simplified Dynamic Focus Circuit Diagram

VERTICAL SYNC AMPLIFIER

(Refer to Figure 9.)

The vertical sync amplifier consists of one stage, Q1, which operates as a switch. During no-signal conditions, Q1 is off. When a positive-going vertical sync signal, approximately 4.0 volts P-P, is applied (direct coupled) to the base, Q1 goes into saturation. The amplified output is developed across load resistor R3 to approximately 11 volts.

SYNC SHAPER

(Refer to Figure 9.)

The negative-going vertical sync pulses (from Q1) are direct coupled to the non-inverting input of the sync shaper stage, IC1. The combined action of an integrating network, consisting of C1, C2, C3, R5, R6, and R7, removes high frequency noise from the vertical sync pulses. Capacitor C3 performs the actual integrating, while resistors R5—R7 provide biasing for IC1. Capacitors C1 and C2 provide a bypass function.

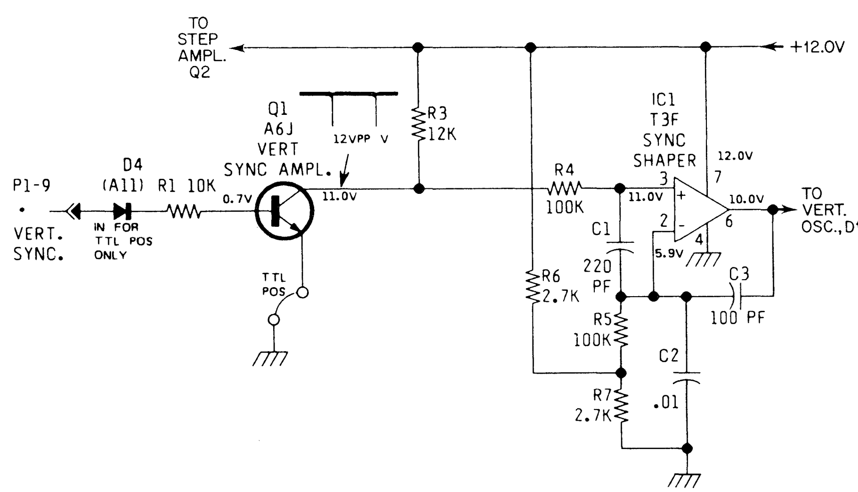


Figure 9. Vertical Sync Amplifier and Sync Shaper Circuits

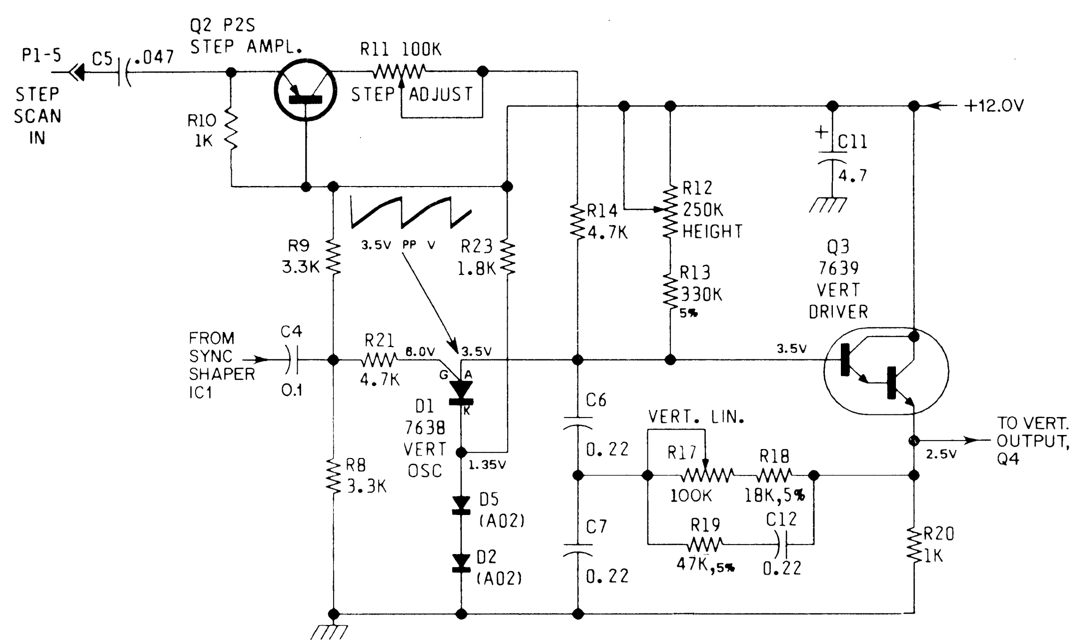


Figure 10. Vertical Oscillator/Driver and StepScan Amplifier Circuits

VERTICAL OSCILLATOR

(Refer to Figure 10.)

The negative-going vertical sync pulses are AC coupled (C4) to the gate of a programmable unijunction transistor device, D1. This device turns on with each negative-going sync pulse applied to its gate. This action permits C6 and C7 to discharge very rapidly; then recharge slowly during the period that a sync pulse is not applied to the gate. The recharge path for C6 and C7 is through R12 and R13. As soon as the next sync pulse is applied to the gate of D1, C6 and C7 discharge very rapidly again. This sequence of events produces a positive-going ramp or sawtooth waveform at the anode of D1.

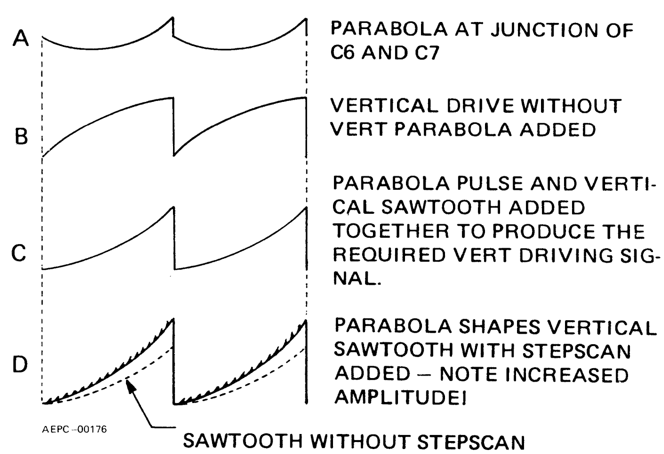
When no vertical sync pulses are connected to the monitor, vertical oscillator D1 is kept free-running to maintain a raster on the CRT. This is accomplished by biasing the gate of D1 in conjunction with the charge and discharge action of C6 and C7. Resistors R9 and R8 provide the proper bias for D1, which also determines the repetition rate for the charge and discharge action of C6 and C7.

In addition, during no-signal conditions, components D5 and D2 (in conjunction with D1), provide a small incremental voltage above ground to compensate for the base-emitter voltage drop of the vertical driver, Q3. This is necessary to keep the vertical output stage, Q4, from being driven into cutoff, which could result in distorted vertical linearity.

VERTICAL DRIVER

(Refer to Figure 10.)

The positive-going sawtooth waveform, from the anode of D1, is direct coupled to the base of vertical driver Q3, which operates as an emitter follower. The sharp fall time of the sawtooth is a result of the rapid discharge of C6 and C7 through D1. The amplitude of the sawtooth is varied with the HEIGHT control, R12.



The output sawtooth from the emitter of Q3 is direct coupled to the base of vertical output stage, Q4. Part of this sawtooth waveform, however, is also coupled back to the junction of C6 and C7 via R18 and VERT. LIN. control R17 for proper shaping. Since this path is resistive, the waveform will be integrated into a parabola waveform by C7 (waveform A). This results in a predistortion of the drive sawtooth (waveform C). (Waveform B illustrates the drive sawtooth without parabola shaping.) Parabola shaping is necessary to compensate for the non-linear charging of C6 and C7. An additional path for phase compensation is provided through C12 and R19.

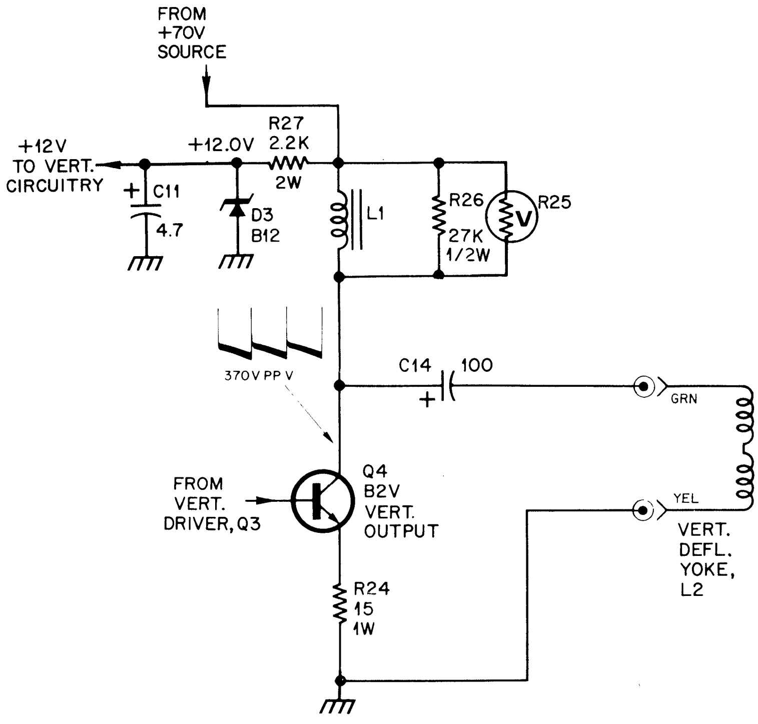


Figure 11. Vertical Output Circuit

VERTICAL OUTPUT

(Refer to Figure 11.)

The positive-going sawtooth waveform from the emitter of Q3 is applied to the base of vertical output stage, Q4, which conducts only during the ramp, or rise time, of the sawtooth waveform. The inverted ramp output (collector current) is the vertical trace period, which is AC coupled (via C14) to the vertical deflection yoke winding. The same collector current output is also applied to L1, which builds up a large electromagnetic field. This field will collapse very rapidly when Q4 turns off during the retrace time of the waveform applied to the base of Q4. The back EMF is in the form of a high voltage positive pulse, whose duration represents the vertical retrace period. To limit this pulse to a safe value, a varistor is connected across L1, with R26 providing damping.

Except for the vertical output stage, Q4, the vertical circuitry operates from a +12 volt source, which is derived from the +70 volt source. Resistor R27 drops the +70 volt source to the required +12V. Zener diode D3 holds the +12V constant while C11 provides additional filtering.

STEPSCAN FUNCTION

With existing logic, the number of characters that can be displayed is limited by logic speed. Anything that increases the speed at which the logic must work, will allow an increase in the number of characters displayed.

When a video monitor is used as a data display, the system bandwidth required (and logic speed) increases in direct proportion to the number of scan lines displayed. Since no data is written in the blank spaces between character rows, a method is required to speed up vertical deflection in the blank spaces to decrease bandwidth requirements. This makes the blank space height less dependent on scan time, allowing time to display more characters. This is accomplished by "stepping" the reference sawtooth between character rows so that a row to row space of from 3 to 5 horizontal lines equivalent height can be displayed in the time it takes to deflect one horizontal line. This is illustrated in Figure 12.

STEPSCAN CIRCUIT

(Refer to Figure 10.)

This circuit requires an external (approximately 4.0 volts P-P) TTL positive-going pulse. These pulses are applied to the emitter of the StepScan Amplifier, Q2, which is turned on when the emitter voltage exceeds the base voltage. The +12 volts stored on C5 is applied through Q2, R11 and R14, to the sawtooth forming capacitors C6 and C7. This momentarily increases the charge rate of C6 and C7, and the resultant action produces the stepping sawtooth shown as waveform D. The rate at which the vertical oscillator steps is determined by the repetition rate of the incoming StepScan pulses. The slope (charge rate) of the stepped portion of the sawtooth is adjustable with the STEP ADJ. control, R11, which varies the spacing from 3 to 5 horizontal scan lines. With the vertical sawtooth thus modified, the collector current of Q4 and, therefore, the yoke vertical deflection current will be "stepped" during the line between character rows chosen.

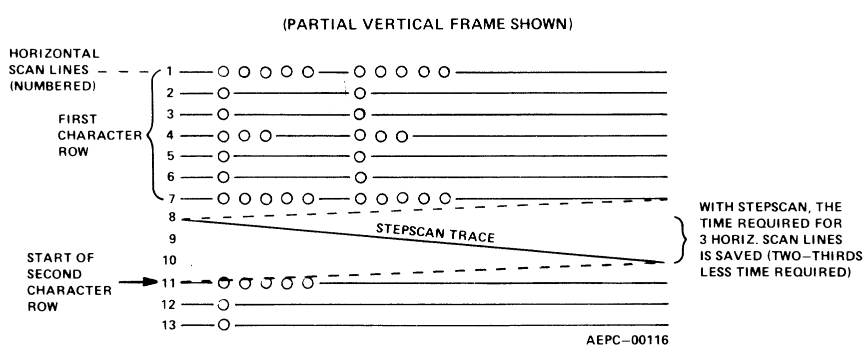
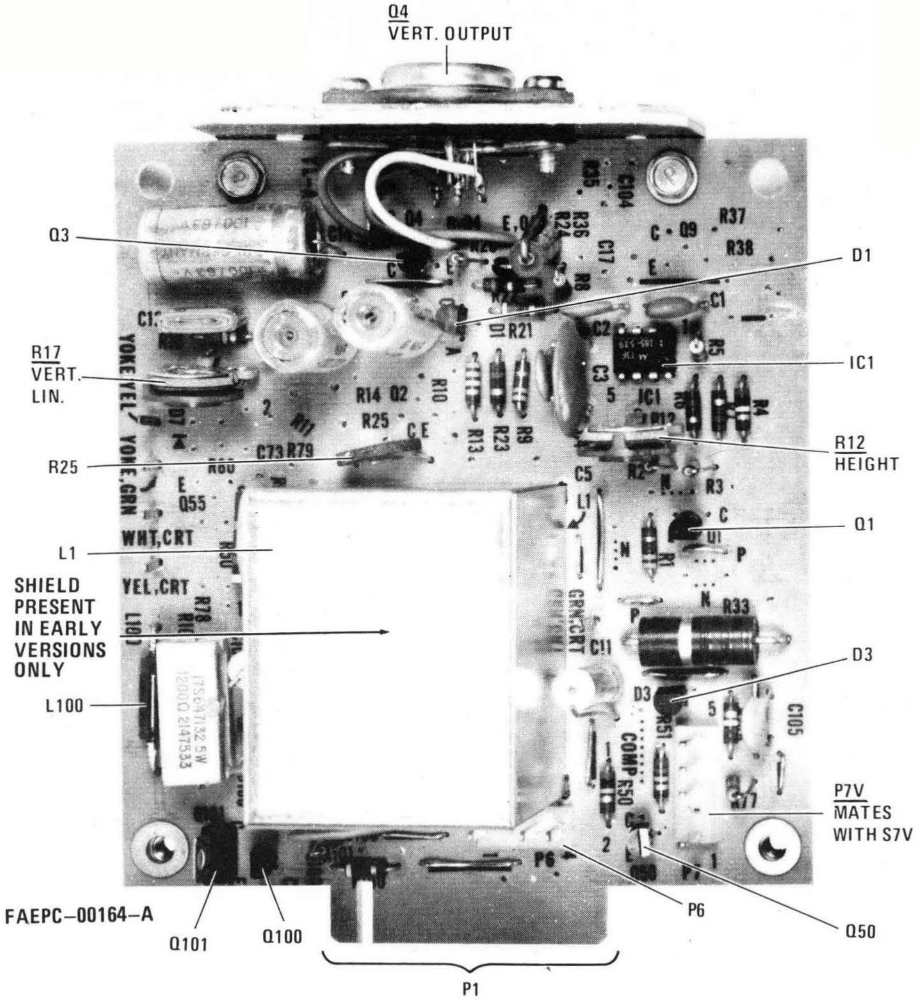
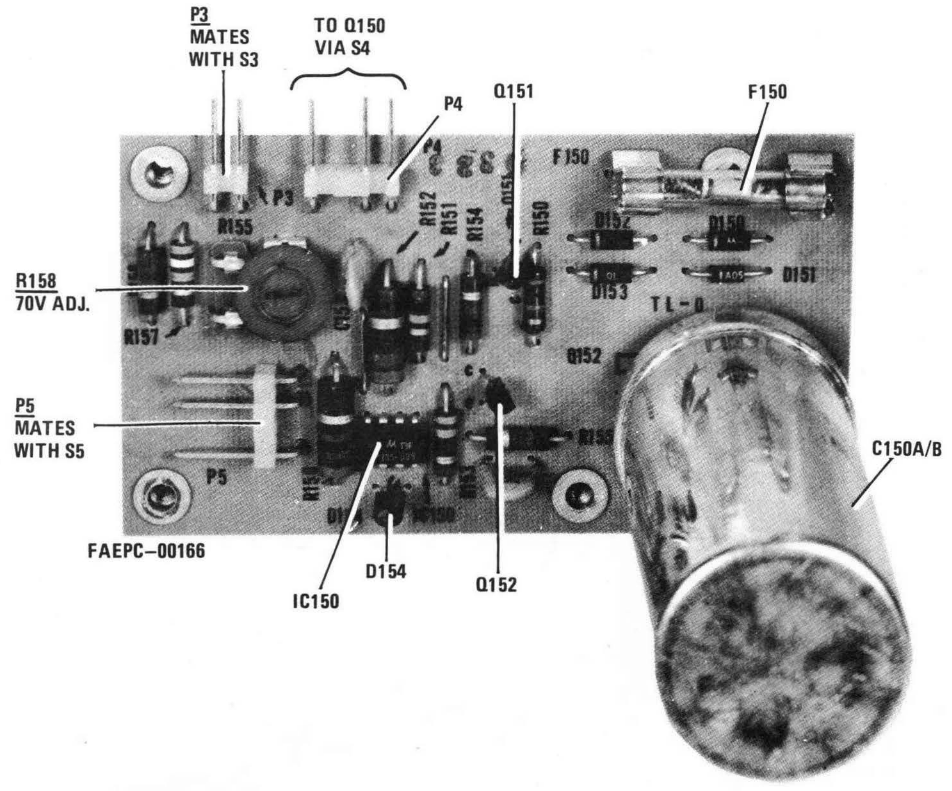


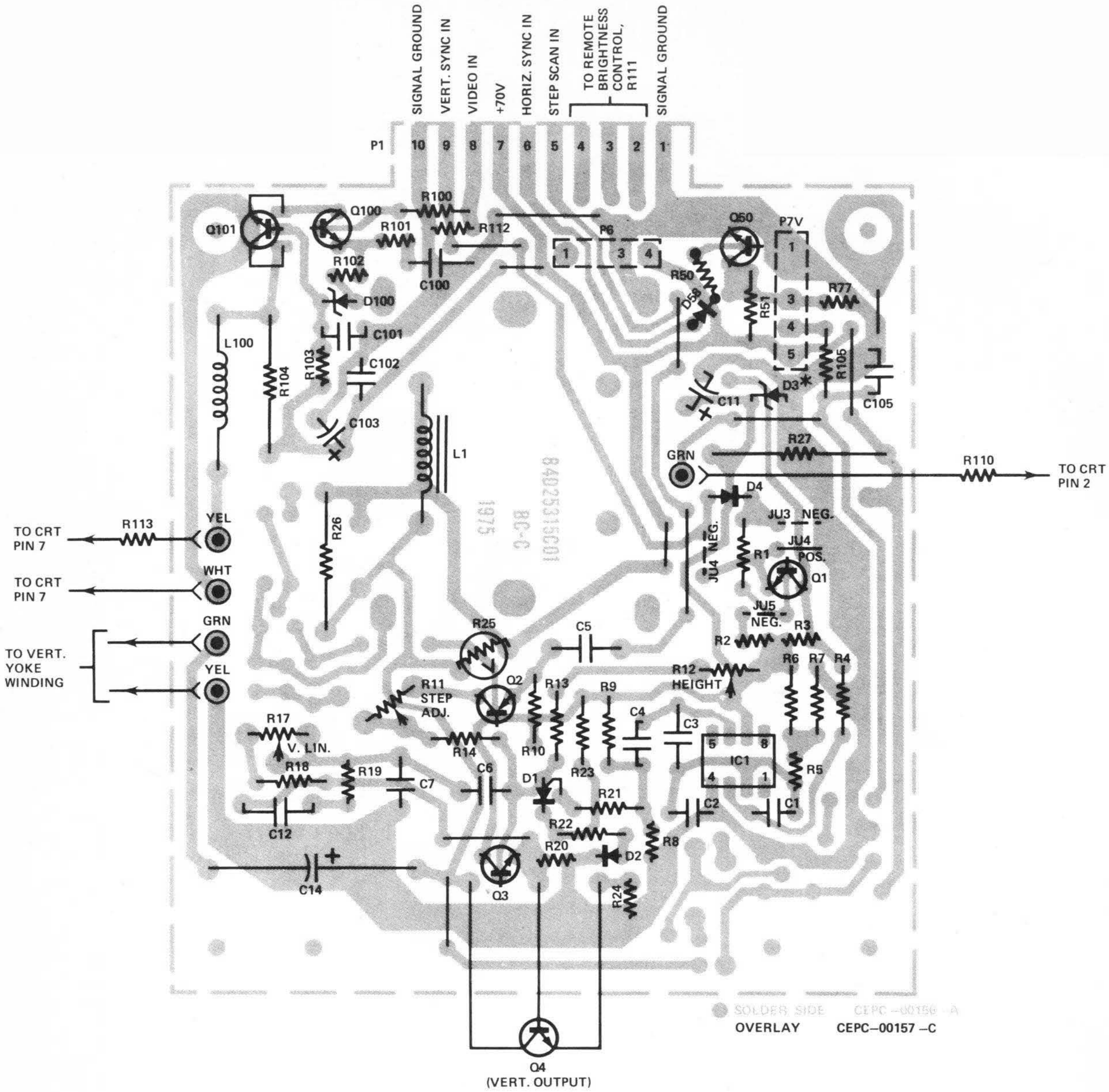
Figure 12. Displaying Characters on a Monitor with StepScan



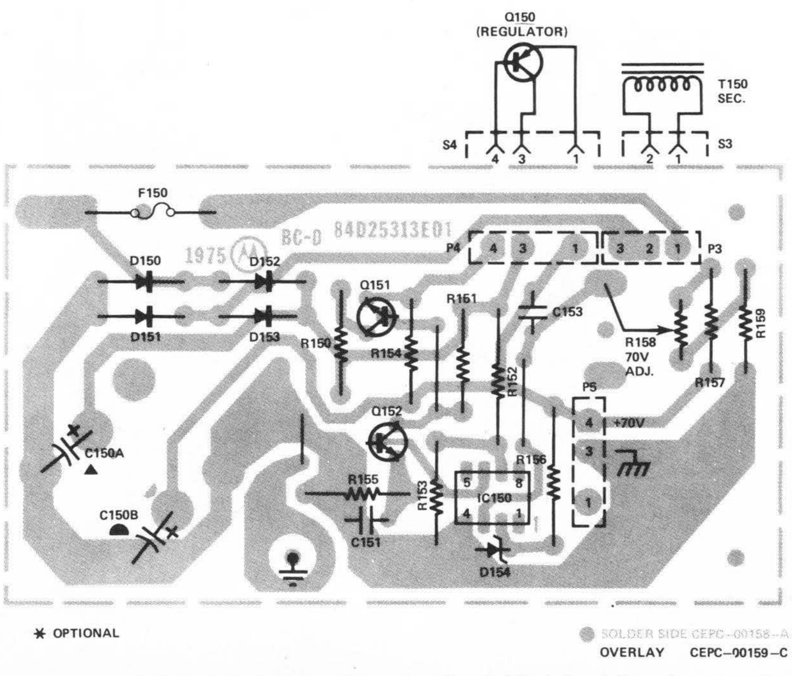
Vertical/Video Circuit Card (Component View)



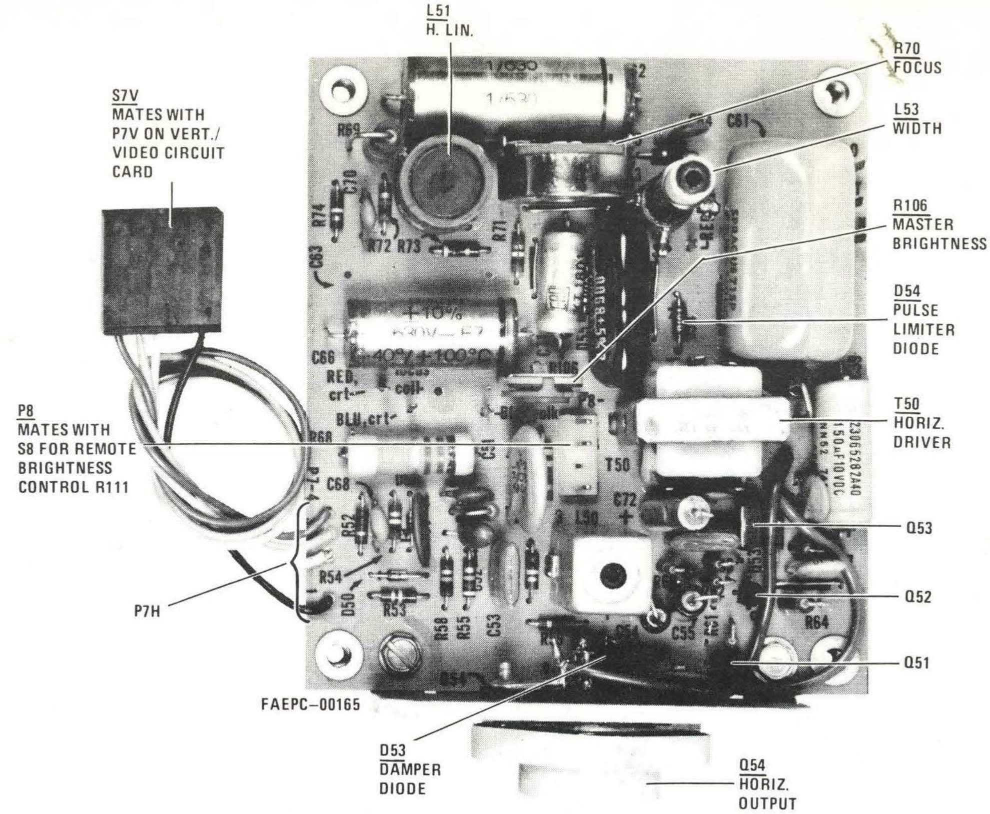
Power Supply Circuit Card (Component View)



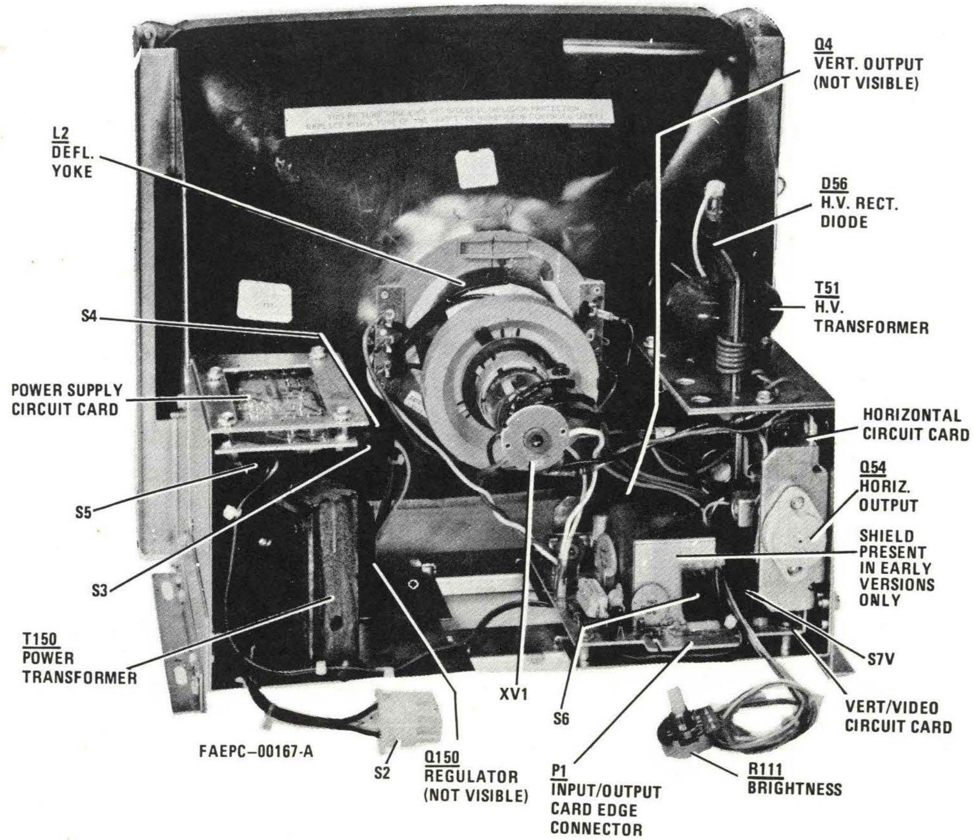
Vertical/Video Circuit Card (Solder View)



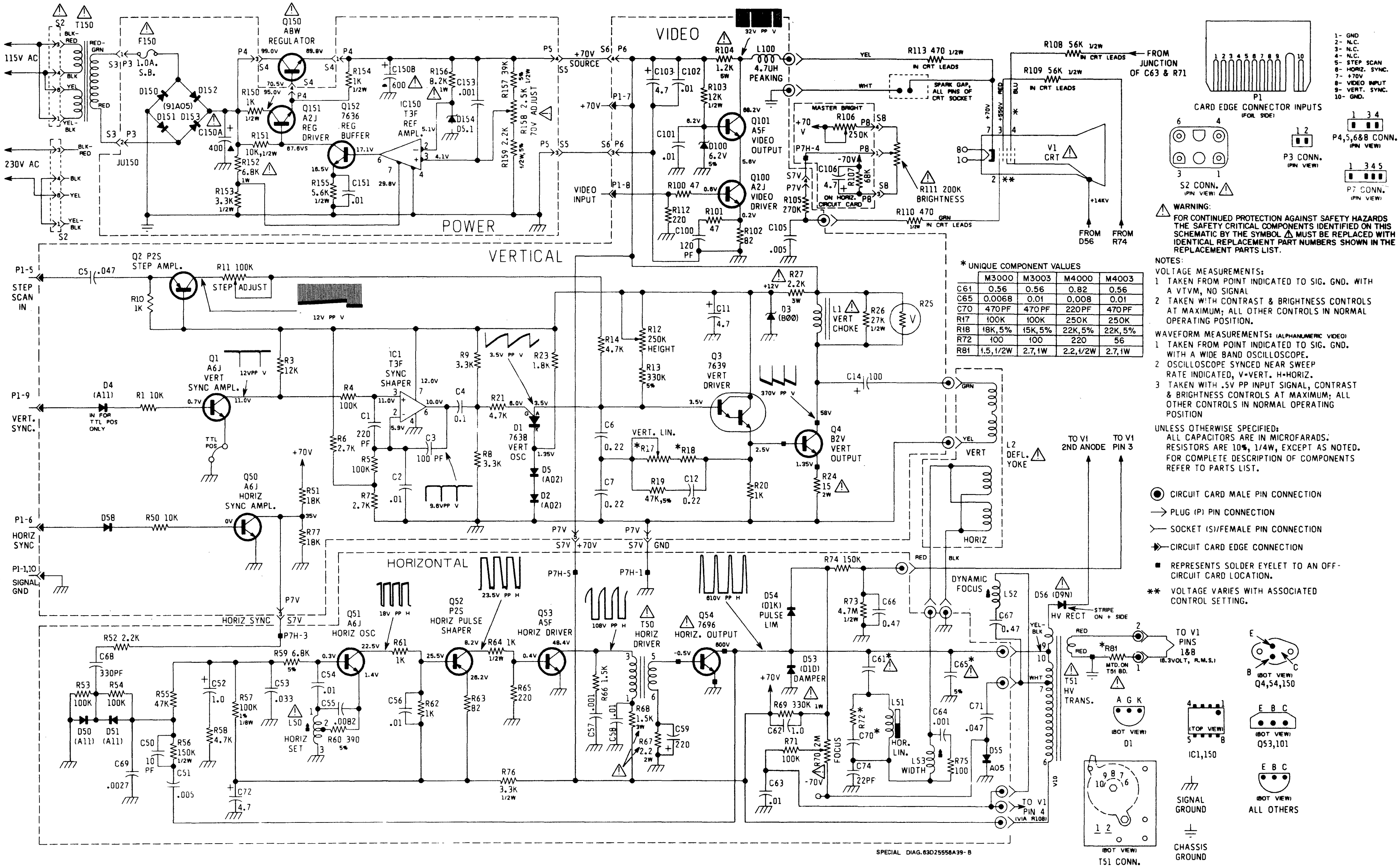
Power Supply Circuit Card (Solder View)



Horizontal Circuit Card (Component View)



Rear Chassis View – Typical of M3000/M4000



* UNIQUE COMPONENT VALUES

	M3000	M3003	M4000	M4003
C61	0.56	0.56	0.82	0.56
C65	0.0068	0.01	0.008	0.01
C70	470PF	470PF	220PF	470PF
R17	100K	100K	250K	250K
R18	18K, 5%	15K, 5%	22K, 5%	22K, 5%
R72	100	100	220	56
R81	1.5, 1/2W	2.7, 1W	2.2, 1/2W	2.7, 1W

⚠ WARNING:
FOR CONTINUED PROTECTION AGAINST SAFETY HAZARDS THE SAFETY CRITICAL COMPONENTS IDENTIFIED ON THIS SCHEMATIC BY THE SYMBOL ⚠ MUST BE REPLACED WITH IDENTICAL REPLACEMENT PART NUMBERS SHOWN IN THE REPLACEMENT PARTS LIST.

NOTES:

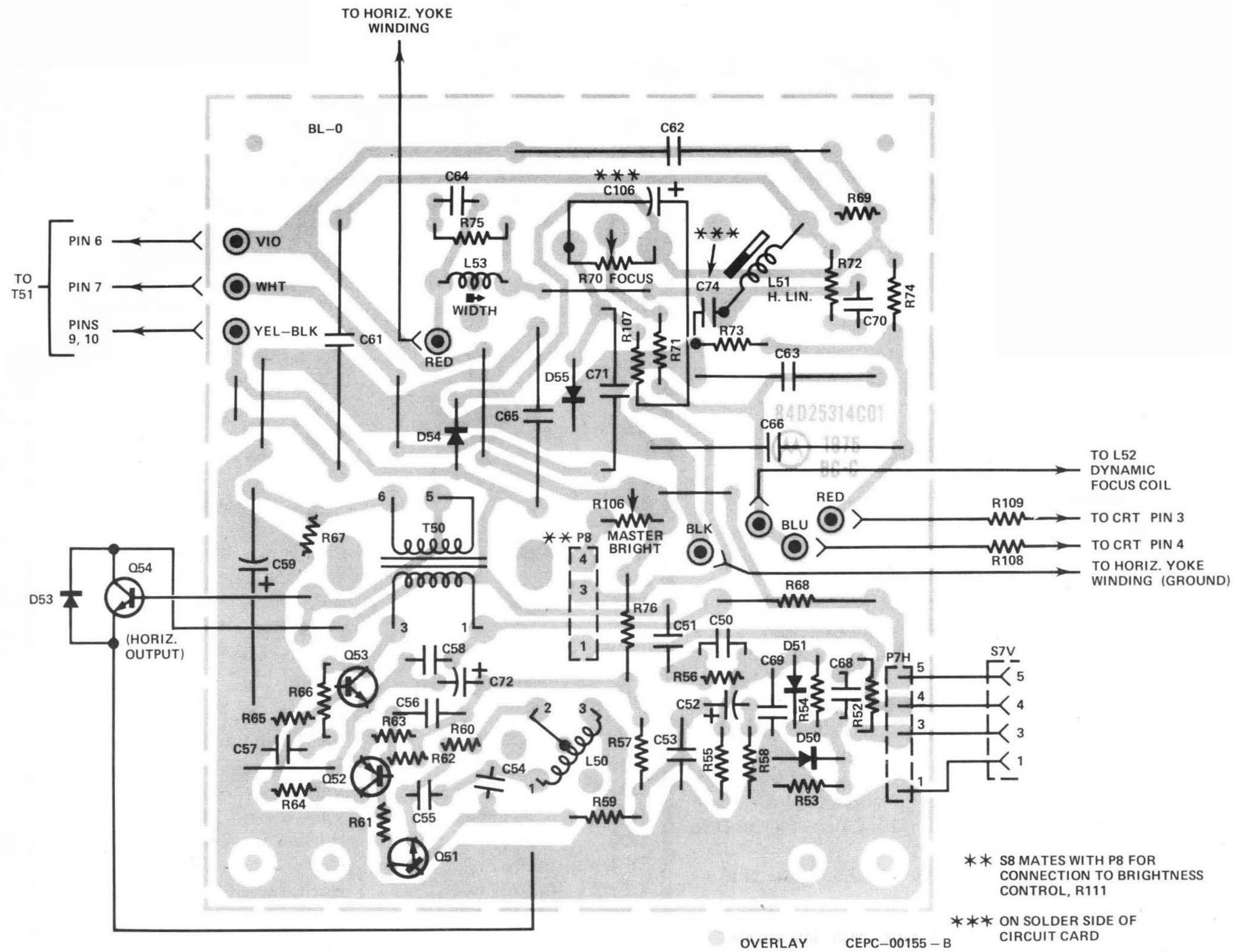
VOLTAGE MEASUREMENTS:
1. TAKEN FROM POINT INDICATED TO SIG. GND. WITH A VTVM, NO SIGNAL
2. TAKEN WITH CONTRAST & BRIGHTNESS CONTROLS AT MAXIMUM; ALL OTHER CONTROLS IN NORMAL OPERATING POSITION.

WAVEFORM MEASUREMENTS: (ALPHANUMERIC VIDEO)
1. TAKEN FROM POINT INDICATED TO SIG. GND. WITH A WIDE BAND OSCILLOSCOPE.
2. OSCILLOSCOPE SYNCED NEAR SWEEP RATE INDICATED, V=VERT. H=HORIZ.
3. TAKEN WITH .5V PP INPUT SIGNAL, CONTRAST & BRIGHTNESS CONTROLS AT MAXIMUM; ALL OTHER CONTROLS IN NORMAL OPERATING POSITION

UNLESS OTHERWISE SPECIFIED:
ALL CAPACITORS ARE IN MICROFARADS. RESISTORS ARE 10%, 1/4W, EXCEPT AS NOTED. FOR COMPLETE DESCRIPTION OF COMPONENTS REFER TO PARTS LIST.

◉ CIRCUIT CARD MALE PIN CONNECTION
→ PLUG (P) PIN CONNECTION
≻ SOCKET (S)/FEMALE PIN CONNECTION
→≻ CIRCUIT CARD EDGE CONNECTION
■ REPRESENTS SOLDER EYELET TO AN OFF-CIRCUIT CARD LOCATION.
** VOLTAGE VARIES WITH ASSOCIATED CONTROL SETTING.

Schematic Diagram



Horizontal Circuit Card (Solder View)

REPLACEMENT PARTS LIST

REF. NO.	PART NUMBER	DESCRIPTION
CIRCUIT CARD ASSEMBLIES:		
	84V25554A88	Horizontal Circuit Card (Cpt.) (M3000–140, 240, 340)
	84V25553A32	Horizontal Circuit Card (Cpt.) (M3003–140, 240, 340)
	84V25552A77	Horizontal Circuit Card (Cpt.) (M4000–140, 240, 440)
	84V25554A68	Horizontal Circuit Card (Cpt.) (M4003–140, 240, 440)
	84V25554A89	Vertical/Video Circuit Card (Cpt.) (M3000–140, 240, 340)
	84V25554A38	Vertical/Video Circuit Card (Cpt.) (M3003–140, 240, 340)
	84V25553A94	Vertical/Video Circuit Card (Cpt.) (M4000–140, 240, 440)
	84V25554A69	Vertical/Video Circuit Card (Cpt.) (M4003–140, 240, 440)
	84V25019A27	Power Supply Circuit Card (Cpt.)
CAPACITORS: (ALL VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.)		
C1	21S180B87	220 pF 10%,X5F, 500V; Cer.Disc
C2	21S180E60	.01 +80–20%,Z5V,50V;Cer. Disc
C3	21S180C50	100 pF 5%, NPO, 500V; Cer.Disc
C4	8S10212D52	0.1 10%, 100V, Mtlz Poly
C5	8S10191B91	.047 10%, 250V, Polyester
C6, 7	8S10191B67	0.22 10%, 250V; Polyester
C11	23S10255B28	4.7, 100V; lytic
C12	8S10212C08	0.22 10%, 100V; Polyester
C14	23S10255A60	100, 63V; lytic
C50	21S180C02	10 pF, NPO, 500V; Cer. Disc
C51	21S180D34	.005 20%, Z5F, 1 kV, Cer.Disc
C52	23S10229A32	1.0 +40–20%, 16V; lytic
C53	8S10191B90	.033 10%, 250V; Polyester
C54	8S10299B28	.01 10%, 100V; Poly Carb
C55	8S10299B29	.0082 10%, 100V; Poly Carb
C56	8S10191B98	.01 10%, 250V; Polyester
C57	21S180B51	.001 10%, X5F, 500V; Cer.Disc
C58	21S180E60	.01 +80–20%, Z5F, 50V;Cer.Disc
C59	23S10255B81	220, 10V; lytic
C61	8S10571A23	0.56 10%, 250V, Polyprop (M3000–140, 240, 340; M3003–140, 240, 340)
C61	8S10299B27	0.82 10%, 400V; Mtlz Poly Carb (M4000–140, 240, 440)
C61	8S10299B37	0.68 10%, 200V; Mtlz. Poly Carb. (M4003–140, 240, 440)
C62	8S10212A11	1.0 10%, 630V; Mtlz Mylar
C63	8S10571A06	.01 5%, 1200V; Polyprop
C64	21S180B51	.001 10%, X5F, 500V; Cer. Disc (All models except M4003-140, 240, 440)

REPLACEMENT PARTS LIST (Cont'd)

REF. NO.	PART NUMBER	DESCRIPTION
C64	21S180C42	560 pF 10%, Z5F, 500V;Cer.Disc (M4003–140, 240, 440)
C65	8S10571A04	.0068 5%, 1200V; Polyprop (M3000–140, 240, 340)
C65	8S10571A06	.01 5%, 1200V; Polyprop (M3003–140, 240, 340; M4003–140, 240, 440)
C65	8S10571A05	.008 5%, 1200V; Polyprop (M4000–140, 240, 440)
C66	8S10212B53	0.47 10%, 630V; Mtlz Mylar
C67	8S10212B53	0.47 10%, 630V; Mtlz Poly
C68	21S131625	330 pF 10%,X5F, 500V;Cer.Disc
C69	21S180C41	.0027 10%, Z5F, 500V; Cer.Disc
C70	21S180B72	470 pF 10%,Z5F, 500V; Cer.Disc (M3000–140, 240, 340; M3003–140, 240, 340)
C70	21S180B87	220 pF 10%, X5F, 500V;Cer.Disc (M4000–140, 240, 440)
C70	21S180C42	560 pF 10%, Z5F, 500V;Cer.Disc (M4003–140, 240, 440)
C71	8S10191B07	.047 10%, 400V; Polyester
C72	23S10255B28	4.7, 100V; lytic
C74	21S180B55	22 pF 15%, NPO, 550V; Cer.Disc
C100	21S180E50	120 pF 5%, NPO; Cer.Disc
C101	21S180E60	.01 +80–20%, Z5V,50V;Cer. Disc
C102	21S132492	.01 +80–20%,Z5V,100V;Cer.Disc
C103	23S10255B28	4.7, 100V; lytic
C105	21S180A62	.005 20%, Z5V,500V; Cer.Disc
C106	23S10255B26	4.7, 63V; lytic
C150A/B	23S10255B71	400/125V, 600/100V; lytic
C151	21S180E60	.01 +80–20%,Z5V,50V; Cer.Disc
C153	21S180B51	.001 10%, X5F,500V; Cer.Disc
DIODES:		
D1	48S137638	Programmable UJT, MPU–6027 Vert. Osc.
D2, 5	48S191A02	Rectifier, Silicon; A02
D3	48R02024B00	Diode, Silicon Zener(2024B)
D4,50,51	48D67120A11	Diode, Low Power; A11
D53	48S134921	Diode, D1D, Damper
D54	48S134978	Diode, D1K; Pulse Lim.
D55	48S191A05	Rectifier, Silicon; 91A05
D56	48S137622	Diode, Silicon, D9N; H.V.Rect.
D58	48D67120A11	Diode, Low Power; A11
D100	48S10813A01	Diode, Zener 6.2V 5% (1N5234B)
D150–153	48S191A05	Rectifier, Silicon; 91A05
D154	48S10813A02	Diode, Zener 5.1V
FUSES:		
F150	65S139424	Fuse, Slow Blow 1.0 Amp.
INTEGRATED CIRCUITS:		
IC1	51S10732A01	Integrated circuit, T3F; Sync Shaper
IC150	51S10732A01	Integrated circuit, T3F;Ref.Ampl.
COILS/CHOKES:		
L1	25D25221A13	Choke, Vert.

REF. NO.	PART NUMBER	DESCRIPTION
L2	24D25261B01	Yoke, Deflection (M3000–140, 240, 340)
L2	24D25687A01	Yoke, Deflection (M3003–140, 240, 340)
L2	24D25687A02	Yoke, Deflection (M4000–140, 240, 440)
L2	24D25261B07	Yoke, Deflection (M4003–140, 240, 440)
L50	24C25448A01	Coil, Horiz. Set
L51	24D25600A06	Coil, Horiz. Lin. (M3000–140, 240, 340; M4000–140,240,440)
L51	24D25600A07	Coil, Horiz.Lin. (M3003–140, 240,340; M4003–140,240,440)
L52	24D25603A06	Coil, Dynamic Focus
L53	24D25603A03	Coil, Horiz. Width (M3000–140, 240,340; M3003–140,240,340)
L53	24D25603B09	Coil, Horiz. Width (M4000–140, 240,440; M4003–140,240,440)
L100	24D25601A02	Coil, Peaking 4.7 uH 10%
TRANSISTORS:		
Q1	48S137172	Vert. Sync Ampl; A6J
Q2	48S137127	Step Ampl; P2S
Q3	48S137639	Vert.Driver; 7639
Q4	48S137596	Vert. Output; B2V
Q50	48S137172	Horiz. Sync Ampl; A6J
Q51	48S137172	Horiz. Osc.; A6J
Q52	48S137127	Horiz. Pulse Shaper; P2S
Q53	48S137093	Horiz. Driver; A5F
Q54	48S137696	Horiz. Output; 7696
Q100	48S134952	Video Driver; A2J
Q101	48S137093	Video Output; A5F
Q150	48S137368	Regulator; A8W
Q151	48S134952	Reg. Driver; A2J
Q152	48S137636	Ref. Ampl; 7636
RESISTORS/CONTROLS:		
NOTE:	Only power or special resistors are listed. Use the description when ordering standard values of fixed carbon resistors up to 2 watts.	
R11	18D25245A15	Control, Step Adjust 100k
R12	18D25245A22	Control, Height 250k
R17	18D25245A15	Control, Vert. Lin. 100 k (M3000–140, 240, 340; M3003–140, 240, 340)
R17	18D25245A22	Control, Vert. Lin. 250k (M4000–140, 240, 440; M4003–140, 240, 440)
R25	6S10201A04	Varistor, VDR 1 mA
R68	17S10130B07	1.5k 10%, 3W
R70	18C25218A14	Control, Focus 2 Meg.
R104	17S647132	1.2k 10%, 5W
R106	18D25245A22	Control, Master Brightness 250k
R111	18D25212A39	Control, Brightness 200k
R158	18D25245A21	Control, 70V Adjust 2.5k
TRANSFORMERS:		
T50	25D25221A05	Transformer, Horiz.Driver
T51	24D25240B11	Transformer, High Voltage (M3000–140, 240, 340)

REPLACEMENT PARTS LIST (Cont'd.)

REF. NO.	PART NUMBER	DESCRIPTION
T51	24D25240B16	Transformer, High Voltage (M3003–140,240,340; M4003–140,240,440)
T51	24D25240C13	Transformer, High Voltage (M4000–140, 240, 440)
T150	25D68164A33	Transformer, Power
MISC. ELECTRICAL PARTS:		
V1	96S233A01	12" CRT; Type CE226–M12P4S (M3000–140; M3003–140)
	96S249A01	12" CRT; Type 12ST5427P4A (M3000–240, M3003–240)
	96S256A01	12" CRT; Type CE226M12P31S (M3000–340; M3003–340)
	96R2500A04	14" CRT; Type ST4730C (M4000–140; M4003–140)
	96R2500A05	14" CRT; Type ST4730D (M4000–240; M4003–240)
	96R2500A07	14" CRT; Type ST4730P31D (M4000–440; M4003–440)
MECHANICAL PARTS:		
	42B25158C01	Clamp, Deflection Yoke
	42S10240A07	Clamp (Mt. C150A/B)
	42S10122A12	Clip, Fuse
	42D25298A03	Connector, Anode
P3	28S10586A56	Connector, 2–Contact(See Fig.13)
P4,5	28S10586A25	Connector, 3–Contact
P6	28S10586A14	Connector, 3–Contact
P7	28S10586A21	Connector, 4–Contact
P8	28S10586A14	Connector, 3–Contact
	14S10550A02	Cover, Transistor (Q54)
S2	15S10183A77	Housing, Receptacle; 6–Contact (Less Contacts)
	39S10184A64	Contact, Receptacle (4 Req'd. for S2)
S3	15S10183A94	Housing, Receptacle; 2–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (2 Req'd. for S3)
S4	15S10183A87	Housing, Receptacle; 3–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (3 Req'd. for S4)
S5, 6	15S10183A87	Housing, Receptacle; 3–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (2 ea. Req'd. for S5 & S6)
S7	15S10183A88	Housing, Receptacle; 4–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (4 Req'd. for S7)
S8	15S10183A87	Housing, Receptacle; 3–Contact (Less Contacts)
	39S10184A72	Contact, Receptacle (3 Req'd. for S8)
	14A25393A01	Insulator, Hi–Voltage Standoff
	14A562353	Insulator, Transistor (Q150, Q54, Q4)
	2S10054A25	Nut, Spring
	3S136050	Screw, 6–20 x ½" Clutch Head (Mt. Q150, Q54, Q4)
	26B25137B01	Shield, Coil (L50)
	9D25470A02	Socket, CRT (Incl. leads and resistors R108–R110, R113
	9S10274A08	Socket, Transistor (Q150,Q54,Q4)
	41D65987A01	Spring, Special; CRT Aquadag Gnd
	66C68497A03	Tool, Adjust

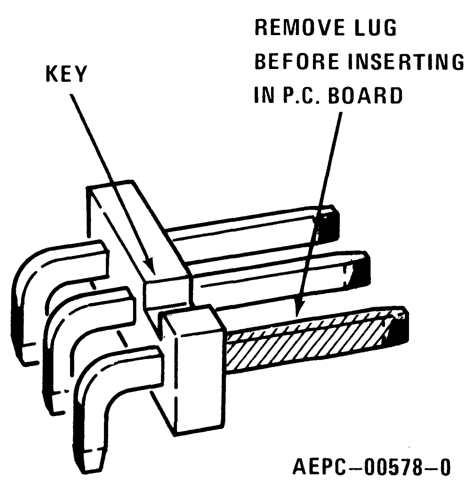


Figure 13. Part No. 28S10586A56