# Model MD1000–190 Specfications*

## (PRELIMINARY)

| | |
|---|---|
| **Cathode Ray Tube** | 5-Inch Measured Diagonally (127 mm) |
| | **Display Size:** 3.80 in. X 2.54 in. |
| | **Video Ampl. Voltage Gain:** 10 min. with a 2.5V P-P min. |
| | **Deflection Angle:** 55° |
| **Video Performance** | **Resolution:** 650 lines, center; 500 lines, corner |
| | **Bandwidth:** Within 3dB, 10Hz to 12MHz |
| **Synchronization** | **Horizontal:** 15.75 kHz ($\pm$ 500 Hz) |
| | **Vertical:** 50/60Hz |
| | **Horizontal Blanking:** 11 $\mu$Sec min. (time includes retrace and delay) |
| | **Vertical Blanking:** 900 $\mu$Sec min. (time includes retrace and video display) |
| **Input Signal** | **Vertical Sync Drive:** 50$\mu$Sec. to 1.4 mSec. input, TTL compatible, negative (positive optional) pulse; 4.0V P-P $\pm$ 1.0 |
| | **Horizontal Sync Drive:** 4 to 40 $\mu$Sec input. TTL compatible, positive (negative optional) pulse 4.0V P-P $\pm$ 1.0 |
| | **Video:** positive white, input impedance greater than 1k ohm |
| **Power Requirement** | **Operating Range:** +12 VDC ($\pm$ 0.5V) |
| **Controls** | **Internal:** brightness, vertical size, vertical linearity, horizontal size, raster centering, vertical hold, contrast, and focus. |
| | **Optional:** customer supplied brightness control for operator adjustment |
| **Linearity** | **Character Size:** 1. Height and width will not vary more than 10% from the average character size. 2. Adjacent characters will not vary more than 10%. |
| **Operating Environment** | **Operating Temperature:** 0°C to +55°C |
| | **Storage Temperature:** –40°C to +65°C |
| | **Operating Altitude:** 10,000 ft. max. |

NOTE

CRT's with bonded etched panels should not be subjected to storage or operating temperatures above 50°C

**PERFORMANCE STANDARD:**

THIS EQUIPMENT IS DESIGNED TO COMPLY WITH DHHS X-RADIATION PERFORMANCE STANDARDS, U.L. AND C.S.A. SPECIFICATIONS PROVIDING B+ TO THE MONITOR DOES NOT EXCEED 14VDC.

* IN A CONTINUAL EFFORT TO UPGRADE OUR STANDARD PRODUCT AS NEW TECHNOLOGICAL ADVANCES ARE MADE. SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

## SERVICE NOTES

### GENERAL SERVICING PRECAUTIONS

**– CAUTION –**

Before attempting to service the monitor, disconnect (or turn off) the external power supply; then, as an added precaution, discharge the CRT 2nd anode before handling any high voltage components. In addition, be sure to observe all safety warnings and service notes in the front of this manual.

When it is necessary to disconnect the deflection yoke, and/or CRT socket leads, pull their small female pins straight out without any back and forth rocking motion. This will prevent, or at least minimize deforming male pins and/or breaking their solder connections.

Use caution around the heat sink of the horizontal output transistor. The heat sink is at the same potential as the transistor collector. During normal operation with signal input present, the horizontal heat sink has 165 volt P-P pulses (with respect to system ground).

### GENERAL SUBSTITUTION OF PARTS

When components need be replaced, order Motorola replacement parts only. Avoid using other substitute semiconductor devices as these can cause system performance degradation. In the event of failure, and the need for emergency system restoration, generic substitution of semiconductor devices used are provided as an aid on the Schematic Diagram and Parts List.

### COMPONENT REMOVAL

Due to the nature of solid state devices such as integrated circuits (IC's), and etched printed circuit cards, special desoldering tools and IC removing techniques should be used. Care should be exercised not to damage the printed circuit card, break or lift the copper foil, and create cold solder connections.

Integrated circuits are very reliable components and should not be replaced until all checks have proven definitely that the IC is the defective component. Removal of the IC is time consuming and often careless or sloppy soldering techniques can cause additional problems.

### CIRCUIT TRACING

For ease in troubleshooting, circuit card components are mounted on one side, with foil circuitry on the reverse side of the circuit card. Schematic reference symbols and numbers are screened on both sides of the circuit card to help locate and identify circuit components during troubleshooting.

Familiarize and study the attached Schematic Diagram and hints provided in this Service Manual before attempting to bypass logical troubleshooting sequence of measurements. The Schematic Diagram in this Service Manual contains voltage readings and oscilloscope test patterns at key points of the electrical circuit. These readings are typical for normal operating conditions and should be considered nominal varying slightly from unit to unit. Any considerable variations should be investigated as a possible defective circuit point.

### ROUTINE PERIODIC MAINTENANCE

Routine periodic maintenance service should be performed on the Display Monitors as well as all supporting system equipment to avoid equipment down-time, and make necessary level adjustments to compensate for slow degradation in quality of display due to component changes, which if left unattended could result in costly and extensive repairs.

### ROUTINE PERIODIC INSPECTION

Routine inspection schedules will depend upon the surrounding environment where the system is installed and should include

- Check all controls for proper mechanical and electrical operation.
- Dust and clean optical surfaces. High quality display requires clean viewing surfaces.
- Examine all components for outward signs of damage.
- Repair loose or worn out electrical connections burned or discolored insulation and parts.

### LOCALIZATION OF TROUBLES

Localization of trouble is most frequently accomplished by performing the adjustment procedure as outlined in this Service Manual and noting the results or indications for comparison with normal operating conditions. Refer to the text portion of this manual on alignment procedures and the respective schematic circuit for additional information.

- Visually check for obvious physical defects or broken leads, broken plating, broken or disconnected (unsoldered) components, or overheating parts. If any attempt is made to change a component, the circuit should be checked to insure that the problem causing the original failure has been identified and corrected, otherwise damage to the new part may occur.

- Check voltages for proper levels at the suspected component and proper voltages at the surrounding circuits. Certain defects or broken plating, broken leads, etc., may not be obvious to a visual inspection.
- The isolation of trouble to a defective component is most easily accomplished with the use of a multimeter and observing normal transistor and IC servicing techniques. During the process of isolation, continuous references must be made to the appropriate section of the schematic diagram to determine circuit configuration.

### 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.

**– NOTE –**

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

**Procedure:**

Step 1. Remove the CRT socket, and the 2nd anode lead.

Step 2. Remove push-in connectors (4) from both sides of the deflection yoke.

Step 3. Remove (1) ¼-in hex head screw securing the printed circuit card to the chassis.

Step 4. Gently slide the printed circuit card out towards the rear of the monitor. Do not use force as the printed circuit card is secured in place in nylon guiding rails. These guide rails are mounted to the sides of the chassis. When re-inserting the printed circuit card back into position, care should be exercised to first orient the card properly and making sure to align its sides into the nylon guide rails.

Step 5. Loosen the screw on the deflection yoke and remove yoke.

**– NOTE –**

The deflection yoke is secured to the neck of the CRT with hot melt adhesive. Carefully break the adhesive bond before sliding yoke from its position.

Step 6. Remove the grounding spring clipped to the sides of the chassis.

Step 7. Gently grasp the CRT from the rear and remove the (4) hex head screws securing the upper and lower CRT holding bracket. Slide the CRT out from the front.

Step 8. Loosen the copper wire bracket holding screw and slide the bracket assembly off from the CRT.

Step 9. Use Motorola Part No. 11-00131474 adhesive cloth tape to tape the sides of the replacement CRT before installing the CRT mounting brackets.

Step 10. Reverse the procedure/steps to install the new CRT.

## OPERATIONAL CHECK/ADJUSTMENT PROCEDURES

### GENERAL

The following procedures are provided to check the operation of the monitor and perform simple preinstallation adjustments (if required), or readjust after servicing and component replacement.

When reference is made to adjust to a specific size display (vertically and horizontally), refer to original model specifications for correct dimensions by the monitor model number. This also applies to minimum and maximum tolerances when adjusting for correct CRT geometry, linearity, focus, etc.

**– NOTE –**

To assist in understanding more of the preceding terminology, refer to a separate Motorola Manual, "Incoming Inspection Guide" (Motorola part number 68P25253A71).

Perform the procedures in the sequence presented, and allow at least five (5) minutes warm-up before adjusting the monitor. In addition, when instructed to disconnect an input signal, do not ground the signal at the circuit card edge connector (P1). This action could damage the signal source generator. Instead, disconnect the signal at its source.

CCW = Counter Clockwise Rotation, CW = Clockwise Rotation. (As viewed from rear of circuit card.)

### EQUIPMENT REQUIRED

Regulated 12VDC Power Supply

Precision Digital Voltmeter

Non-Metallic Alignment Tool

Test Signals (Bench test signals must be same amplitude, polarity, and frequency as final installed operating signal source. Refer to original specifications for values by monitor model number.)

The following Motorola gauges are required for performing complete and accurate CRT geometry and linearity alignment. Refer to original model specifications for correct gauges to use.

Linearity Gauge  Slot Gauge  Parallelogram Gauge

## SERVICE ADJUSTMENTS

Use a non-metallic tool when performing the following adjustments.

### BRIGHTNESS/CONTRAST ADJUSTMENT

**Procedure:**

Step 1. Disconnect the Video Drive signal, input at pin 8 of edge connector P1.

—or—

If unit is equipped with a customer supplied Contrast control, rotate for minimum signal.

Step 2. Rotate internal Brightness control, R108, to minimum.

Step 3. If unit is equipped with a customer supplied Remote Brightness control, rotate to full maximum position.

Step 4. Rotate R108 to the threshold of the raster.

Step 5. Reconnect Video Drive signal. Adjust customer supplied Contrast control for a desired video level.

Step 6. Adjust the Remote Brightness for the desired brightness level.

### VERTICAL SIZE/LINEARITY ADJUSTMENT

**Procedure:**

Step 1. Connect a test generator whose output is identical to the signal normally used.

Step 2. Rotate the Vert. Size control, R208, until optimum size display is obtained.

Step 3. (Refer to Figure 1.) Adjust the Vert. Linearity control, R211, until extreme top and bottom characters (designated "A" and "B") are equal in height to the center characters (designated "C").

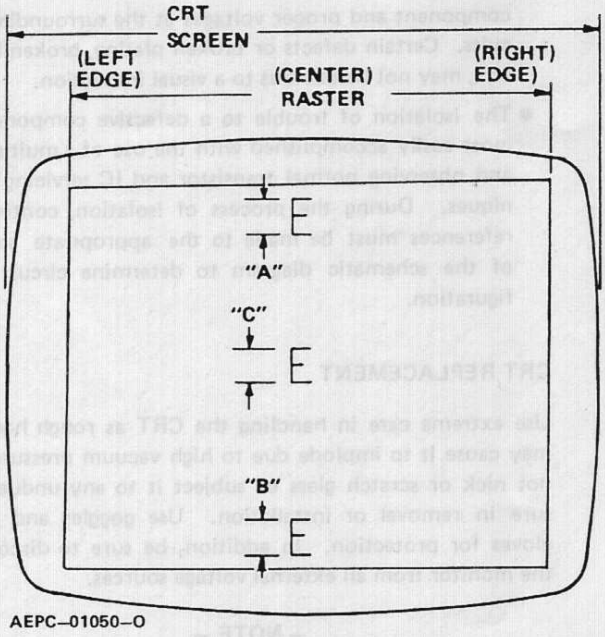



*Figure 1. Partial CRT Display of Characters for Vertical Linearity Adjustment*

Step 4. Readjust R208 until the desired height is obtained.

### FOCUS ADJUSTMENT

**Procedure:**

The optimum focus of the display is obtained by adjusting the focus control, R315, for best focus at a point that is near the center and approximately 1/3 down from the top of the display.

### RASTER CENTERING ADJUSTMENT

**General**

The deflection yoke of these direct drive monitors do not contain magnets; therefore, only raster centering is required whenever the CRT needs to be replaced.

**Procedure:**

Step 1. Adjust Vertical Size Control, R208, so that all edges of the raster are visible.

Step 2. Reposition the Yoke into the CRT for best raster centering.

Step 3. Readjust the Vertical Size Control, R208, to specified dimensions.

Step 4. Secure and bond the Yoke to the neck of the CRT using hot melt adhesive to prevent slippage.

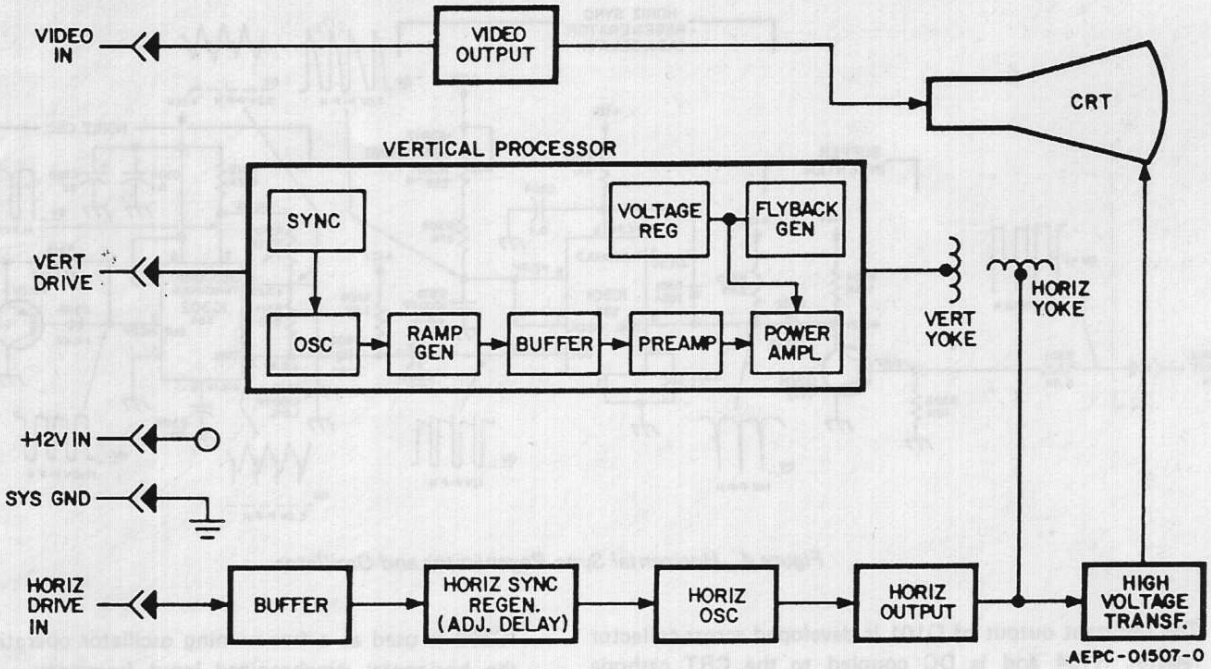



*Figure 2. MD1000–190 Block Diagram*

## THEORY OF OPERATION

### GENERAL

The Model MD1000–190 Series Monitors are direct drive units requiring separate video, horizontal drive and vertical drive inputs. All are TTL compatible. Power is supplied to the monitor from an external +12VDC source.

The monitor consists of a Video Amplifier, a Vertical Processing stage, and five stages of Horizontal Deflection.

### VIDEO AMPLIFIER
**(Refer to Figure 3)**

The linear video amplifier consists of a one stage amplifier, Q101, capable of providing a minimum voltage gain of 10 with a 2.5V PP of signal input.

A TTL compatible non-composite video signal, is DC coupled to the base of Q101 via R103. Capacitor C102 and resistors R105, R106, maintain a flat frequency response whenever Q101 conducts.

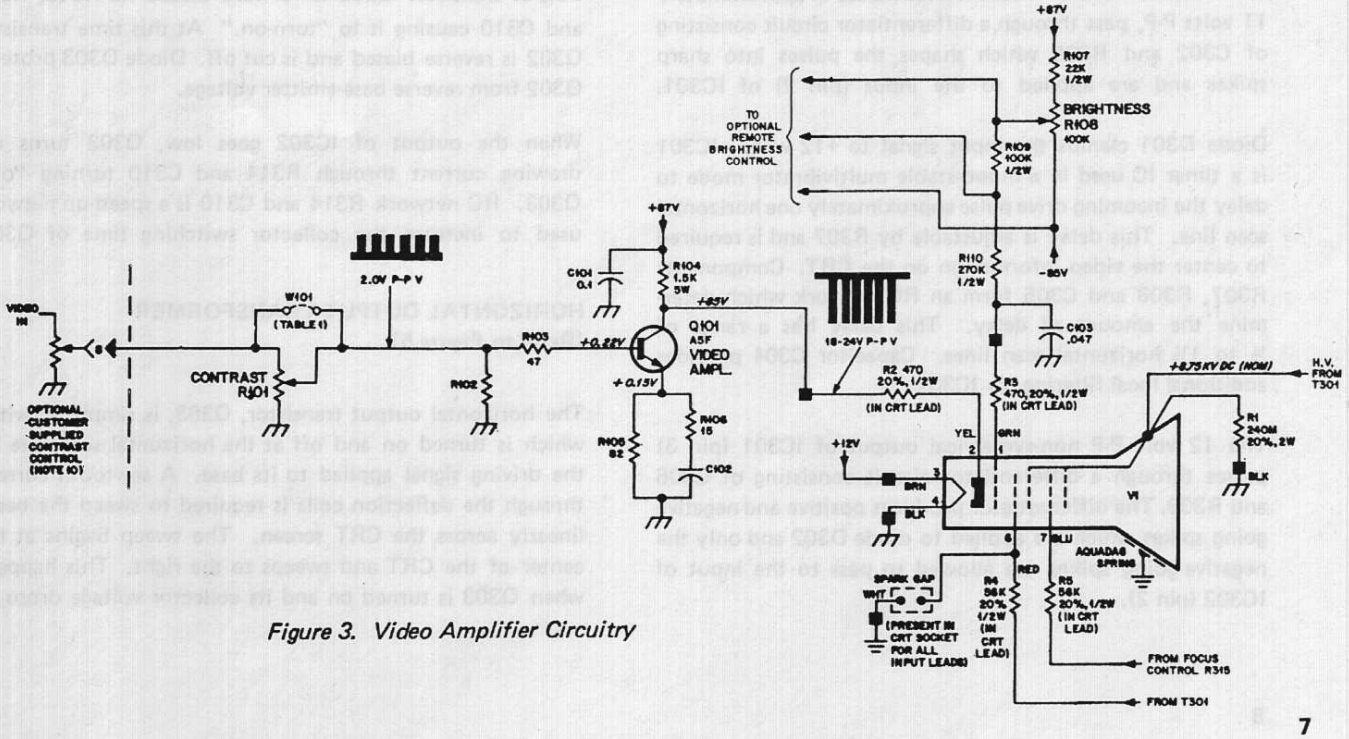



*Figure 3. Video Amplifier Circuitry*

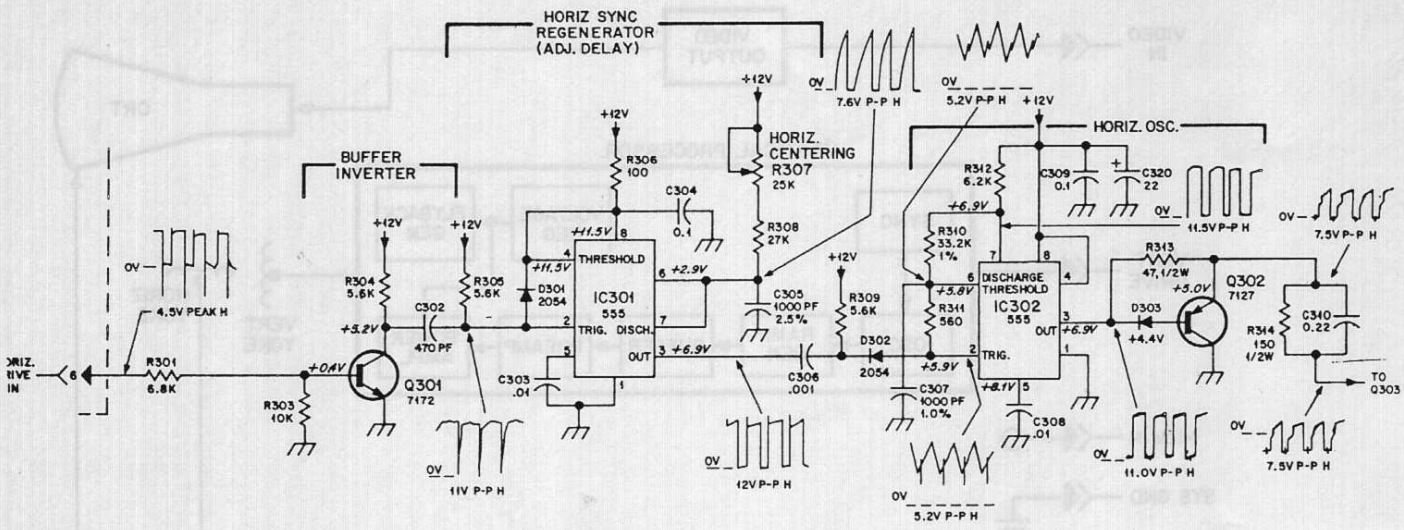



*Figure 4. Horizontal Sync Regenerator and Oscillator*

The resultant output of Q101 is developed across collector resistor R104 and is DC coupled to the CRT cathode via resistor R2. Q101 is protected from the CRT by a spark gap built into the CRT socket and R2 further isolates Q101 from transients.

## HORIZONTAL AMPLIFIER AND OSCILLATOR
**(Refer to Figure 4)**

Transistor Q301 is a single stage buffer/inverter which operates as a switch. During a no-signal condition, Q301 is biased at cut-off. The horizontal drive input is DC coupled to the base of Q301. Positive-going horizontal drive pulses of 2.5 volts P-P will turn Q301 on and cause it to saturate. The inverted output of Q301 is developed across resistor R304. These inverted pulses of approximately 11 volts P-P, pass through a differentiator circuit consisting of C302 and R305 which shapes the pulses into sharp spikes and are applied to the input (pin 2) of IC301.

Diode D301 clamps the input signal to +12 volts. IC301 is a timer IC used in a mono-stable multivibrator mode to delay the incoming drive pulse approximately one horizontal scan line. This delay is adjustable by R307 and is required to center the video information on the CRT. Components R307, R308 and C305 form an RC network which determine the amount of delay. This delay has a range of ½ to 1½ horizontal scan lines. Capacitor C304 provides additional local filtering for IC301.

The 12 volt P-P non-symetrical output of IC301 (pin 3) passes through a differentiator circuit consisting of C306 and R309. The differentiator produces positive and negative going spikes which are applied to diode D302 and only the negative-going spikes are allowed to pass to the input of IC302 (pin 2).

IC302 is used as a free-running oscillator operating above the horizontal synchronized input frequency. If a loss of a horizontal drive signal occurs, the oscillator will free-run at a higher frequency reducing the high voltage developed by the flyback transformer. This prevents any damage to components in the horizontal output circuitry. Components R310, R311, R312 and C307 determine the free-running frequency of the oscillator. The output of IC302 (pin 3) is an 11 volt P-P non-symmetrical square wave.

## HORIZONTAL OUTPUT
**(Refer to Figure 5)**

When the output of IC302 (pin 3) goes high, horizontal output transistor Q303 is forward biased via R313, R314 and C310 causing it to "turn-on." At this time transistor Q302 is reverse biased and is cut off. Diode D303 protects Q302 from reverse base-emitter voltage.

When the output of IC302 goes low, Q302 turns on; drawing current through R314 and C310 turning "off" Q303. RC network R314 and C310 is a speed-up network used to increase the collector switching time of Q303.

## HORIZONTAL OUTPUT TRANSFORMER
**(Refer to Figure 5)**

The horizontal output transistor, Q303, is simply a switch which is turned on and off at the horizontal scan rate by the driving signal applied to its base. A sawtooth current through the deflection coils is required to sweep the beam linearly across the CRT screen. The sweep begins at the center of the CRT and sweeps to the right. This happens when Q303 is turned on and its collector voltage drops to

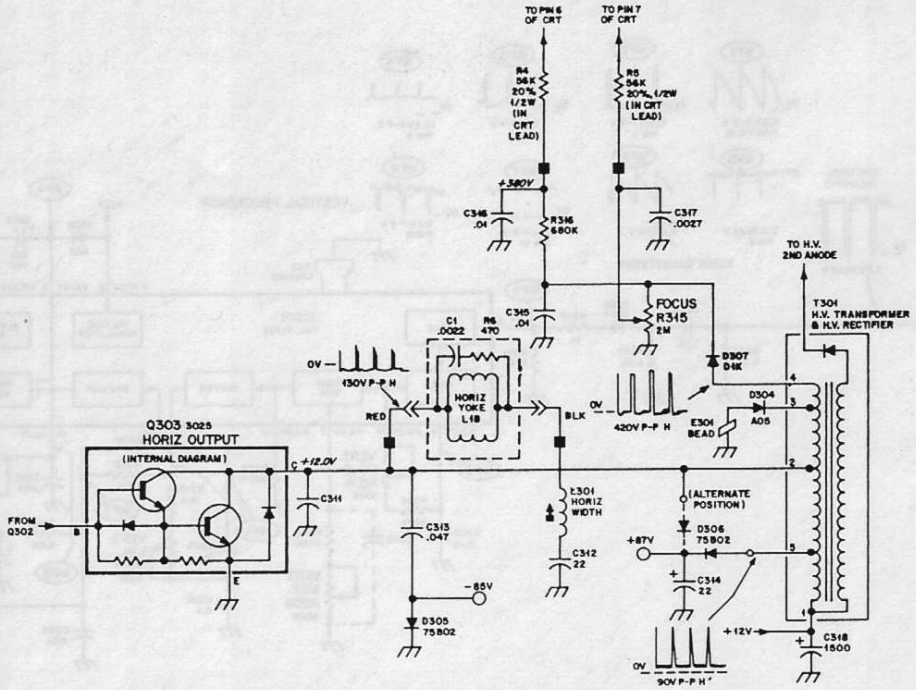



*Figure 5. Horizontal Output Circuitry*

near zero. C311 begins discharging through the deflection coils which deflect the beam to the right of the CRT. At this time, Q303 cuts off and C311 ceases to supply current to the deflection coils. However, an induced voltage appears across the deflection coil as the magnetic field collapses and oscillations then occurs between the deflection coils and C311.

During the first half cycle of this oscillation, the induced voltage is felt across the collector of now cut off Q303, C311, and the primary of T301 - the flyback transformer. This voltage is stepped up by T301 and rectified to produce the required high voltage applied to the 2nd anode of the CRT. The electron beam is also deflected to the left edge of the CRT due to the collapsing magnetic field of the deflection coils.

During the second half cycle of the oscillation, Q303 is still cut off. At this time, damper diode D304 becomes forward biased and begins conduction. The deflection coil current gradually decreases to zero during damper conduction allowing the beam to sweep linearly to the center of the screen.

**FOCUS (Refer to Figure 5)**

Focus voltage for the CRT is derived from the auto-transformer action of T301. D307 and C315 form a positive voltage source. This voltage is reduced by R316 and filtered by C316 to supply the second grid, G2, of the CRT. During auto-transformer action time, D305 conducts, charging 313 negative to positive. When the yoke field collapses, C313 discharges. This creates the -85 volt source for the brightness circuit.

**VERTICAL DRIVE**
**(Refer to Figure 6)**

The vertical deflection circuit consists of one stage, IC201, which accomplishes all active vertical drive functions. Vertical input pulses are differentiated by C201 and R202. This allows IC201 to be edge sensitive. R201 provides proper input loading. Diode D201 couples only the negative-going spikes from the differentiator circuit to the sync input of IC201 (pin 8). R203 and R204 provide input current limiting. The sync input (pin 8) performs several functions. It strips away any random noise that may be present on the input line and conditions the vertical pulses for processing. It also converts the input voltage pulses to current to control the internal oscillator. The oscillator generates a non-symetrical square wave with a short duty cycle approximately 60Hz. Components R205, R206 and C202 determine the frequency. This square wave signal is applied to a ramp generator whose slope and amplitude is determined by R207, R208, and C203. The ramp voltage signal is applied to a buffer stage which isolates the ramp generator from the output stages and reduces any loading effect on the previous stages. Components R209, R210, R211, C204, and C205 reshapes the ramp voltage to make it extremely linear.

The output signal from the buffer stage is applied to a preamp stage for amplification and then to a power amp stage which drives the vertical deflection coils directly via coupling capacitor C210. Components R216 and C209 provide damping to prevent any oscillations in the output circuit. R213, R314, R215, R217, R218, C206, C207 and C208 provide AC and DC feedback for the output stage to maintain proper gain and linearity.

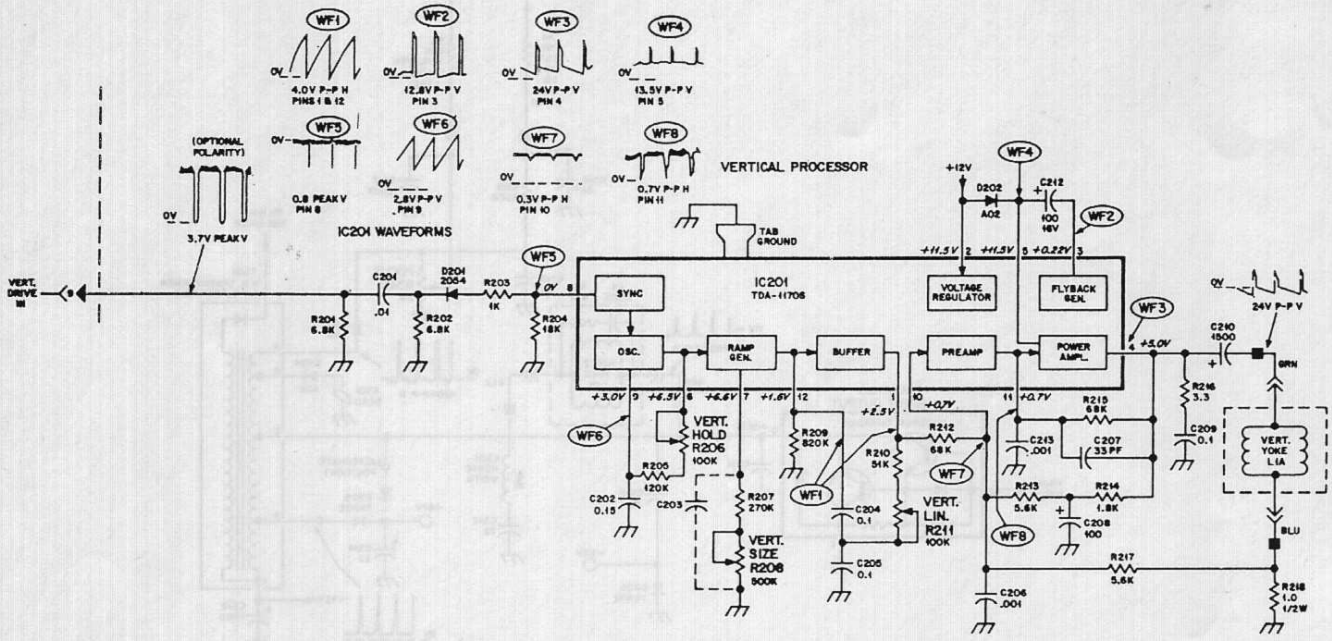



*Figure 6. Vertical Deflection Circuitry*

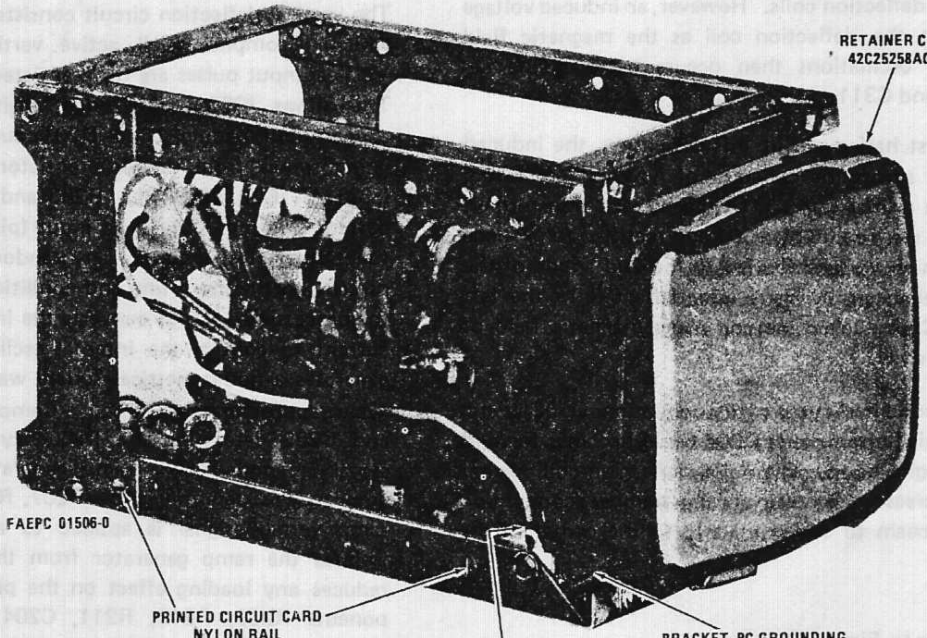
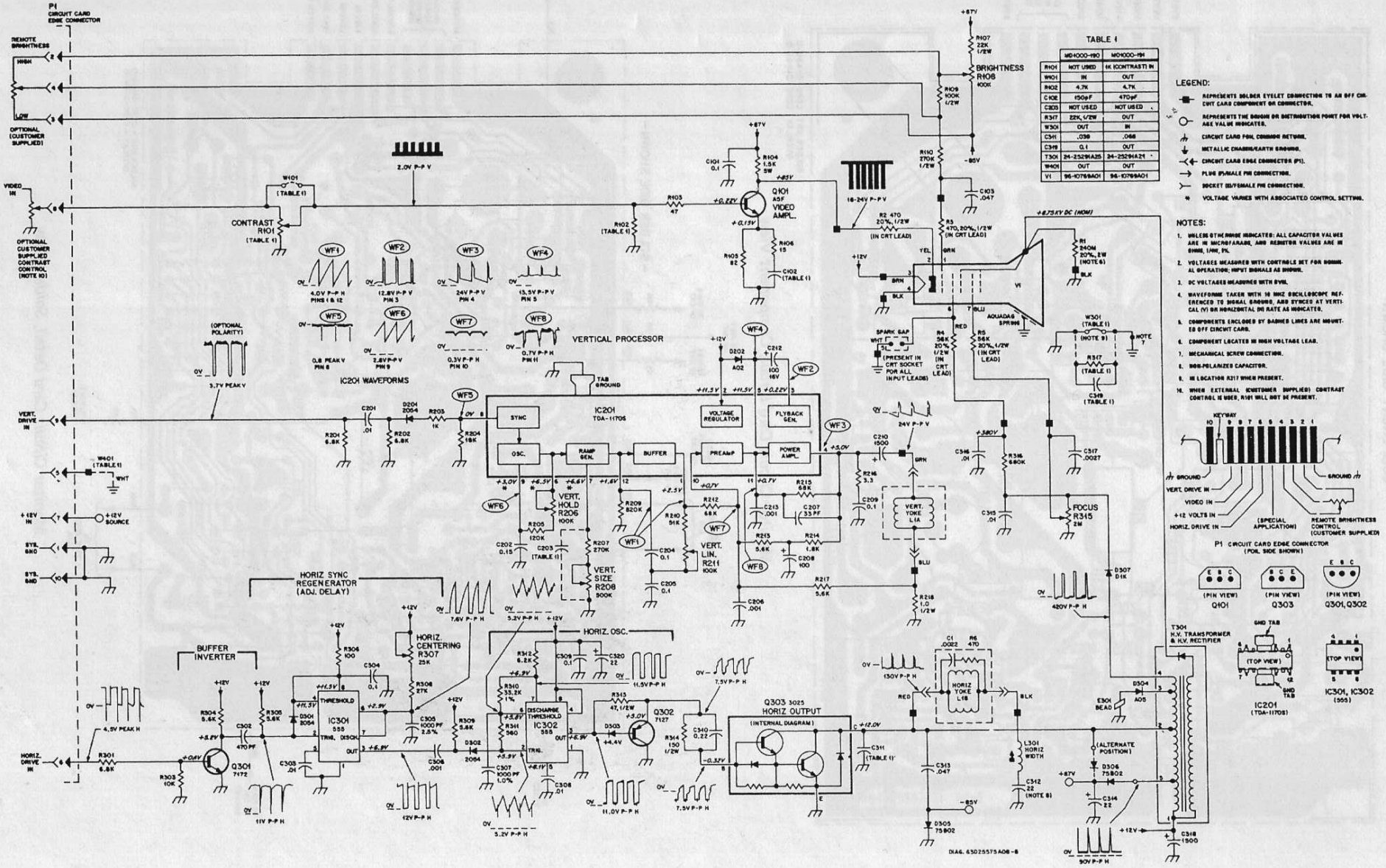
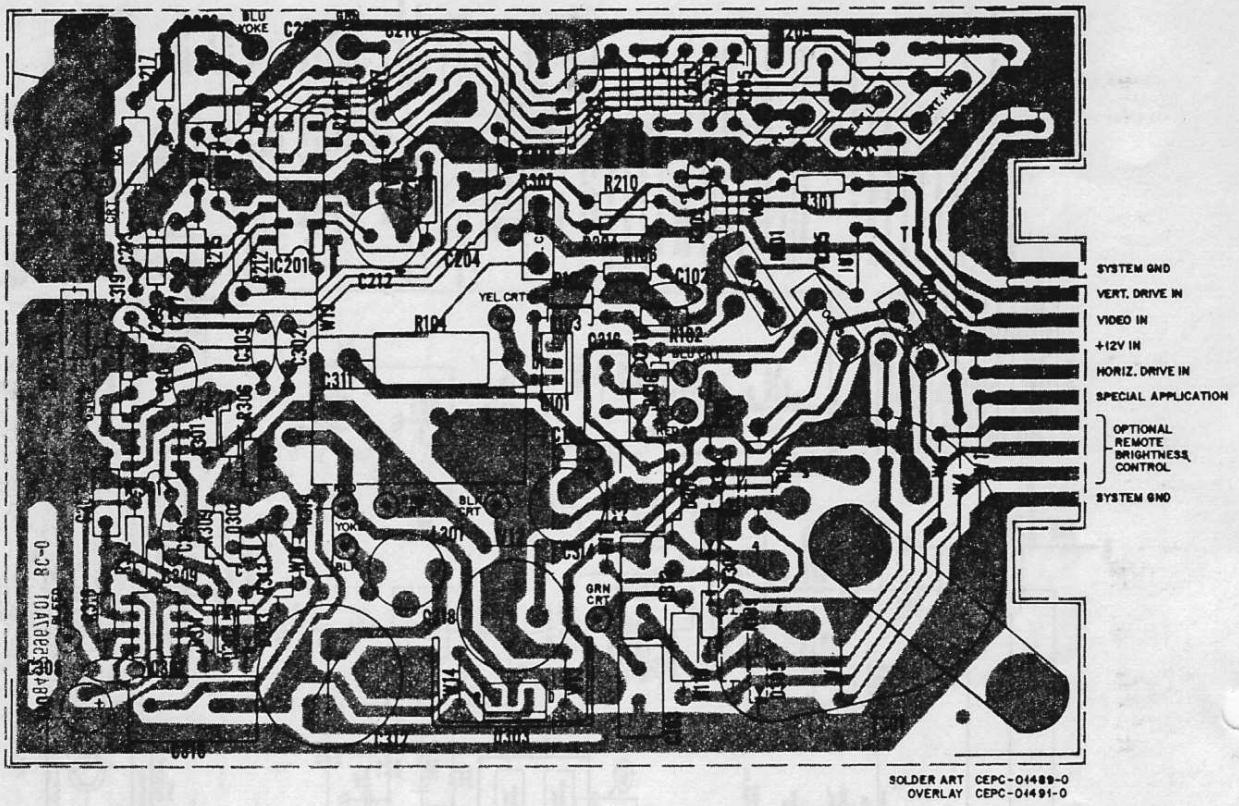


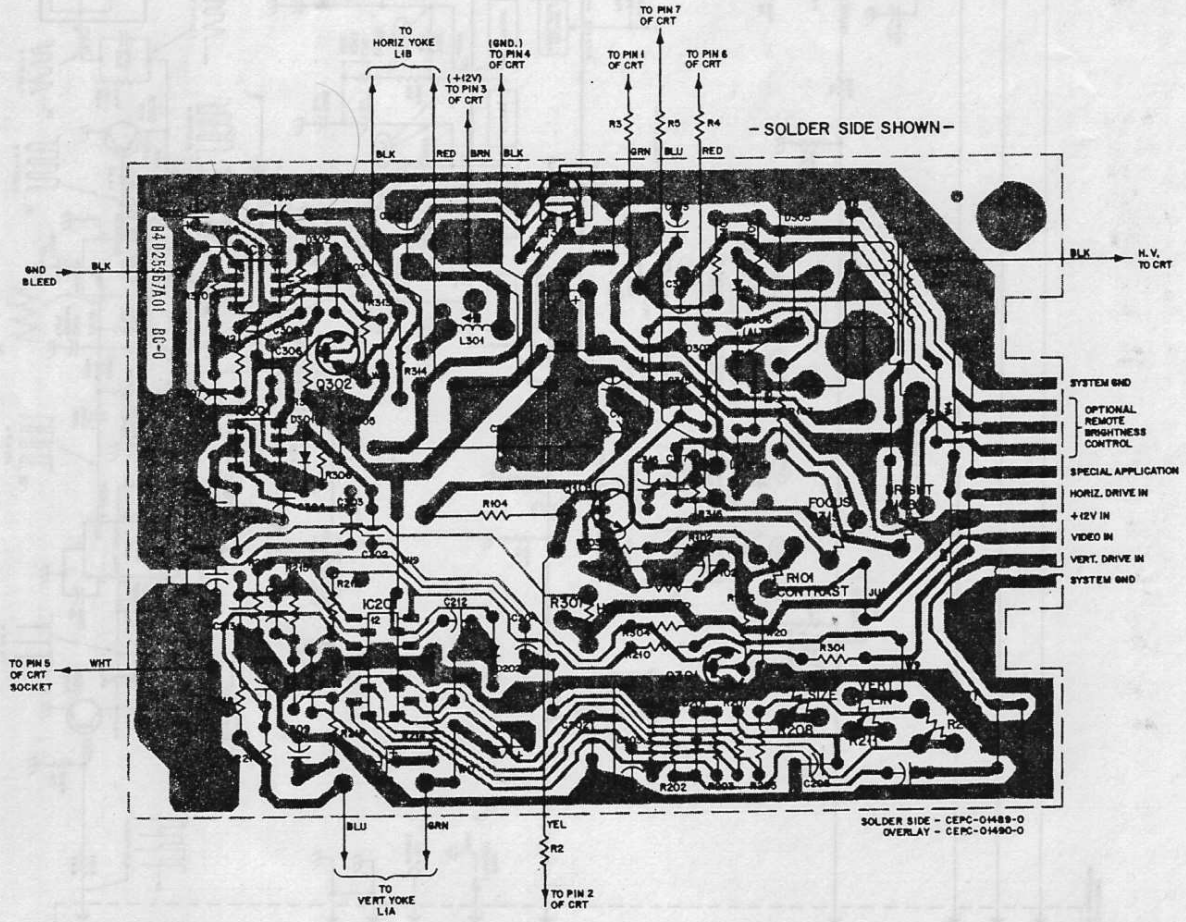

*Figure 7. Model MD1000–190 Series (Side View)*




*Schematic Diagram, Model MD1000–190 Series CRT Monitors*




*Monitor Circuit Card Detail, Component View*




*Monitor Circuit Card Detail, Solder View*

# REPLACEMENT PARTS LIST

| REF. NO. | PART NO. | DESCRIPTION |
|---|---|---|
| | **CAPACITORS: (All Values are in Microfarads Unless Otherwise Noted.)** | |
| C101 | 21R29964A05 | 0.5 +80-20 Z5U 100V Spcl. |
| C102 | 21S180E58 | 150PF 5% NPO 100V (MD1000–190) |
| | 21-S180B53 | 470PF 10% Z5F 100V Disc. (MD1900–191) |
| C103 | 8R29959A65 | 0.047 10% 200V Plystr. |
| C201 | 8R29959A41 | 0.01 10% 200V Plystr. |
| C202 | 8R29967B92 | 0.15 10% 50V Plystr. |
| C204,5 | 8R29967A11 | 0.1 10% 50V Plystr. |
| C206 | 21S180B51 | 0.001 10% X5F 500V Disc. |
| C207 | 21S180B94 | 33PF 10% NPO 500V Disc. |
| C208 | 23R29914A40 | 100 16V PCM lytic |
| C209 | 8R29959A76 | 0.1 10% 100V Plystr. |
| C210 | 23R29914A68 | 1500 25V PCM lytic |
| C212 | 23R29914A40 | 100 16V PCM lytic |
| C213 | 21S180B51 | 0.001 10V X5F 500V Disc |
| C302 | 21S180B53 | 470PF 10% X5F 100V Disc |
| C303 | 21S180B90 | 0.01 20% Z5F 100V Disc |
| C304 | 21R29964A05 | 0.1 +80-20 Z5U 100V Spcl |
| C305 | 8R29970A03 | 0.001 2.5% 100V polyprop. |
| C306 | 21S180B51 | 0.001 10% X5F 500V Disc |
| C307 | 8R29970A02 | 0.001 1% 100V Polyprop. |
| C308 | 21S180B90 | 0.01 20% Z5U 100V Disc. |
| C309 | 21R29964A05 | 0.1 +80-20% Z5U 100V Spcl. |
| C310 | 8R29959A88 | 0.22 10% 100V Plystr. |
| C311 | 8R29956A38 | 0.039 5% 200V Mylar (MD1000–190) |
| | 8R29956A46 | 0.068 5% 200V Mylar |
| C312 | 23R29910A05 | 22 25V Lytic |
| C313 | 8R29959A65 | 0.047 10% 200V Plystr. |
| C314 | 23R29914B49 | 22 100V PCM Lytic |
| C315, 316 | 8R29959A42 | 0.01 10% 400V Plystr. |
| C317 | 21S180C41 | 0.0027 20% Z5F 100V Disc. |
| C318 | 23R29914A66 | 1500 25V Lytic |
| C319 | 21R29964A05 (not used) | 0.1 +80-20% Z5U 100V Spcl (MD1000–191) |
| C320 | 23R29914A77 | 22 35V Lytic |
| | **DIODES/RECTIFIERS** | |
| D201 | 48-02054A00 | DIODE, 2054 |
| D202 | 48-00191A02 | DIODE, A02 |
| D301,302, 303 | 48-02054A00 | DIODE, 2054 |
| D304 | 48-00191A05 | DIODE, A05 |
| D305,306 | 48-02075B02 | DIODE, 75B02 |
| D307 | 48R134978 | DIODE, D1K |

| REF. NO. | PART NO. | DESCRIPTION |
|---|---|---|
| | **TRANSISTORS** | |
| Q101 | 48R137093 | NPN TRANSISTOR A5F |
| Q301 | 48R137172 | NPN TRANSISTOR 7172 |
| Q302 | 48R137127 | PNP TRANSISTOR 7127 |
| Q303 | 48-03025A00 | DARL. TRANSISTOR 3025 |
| | 1V25576A60 | includes heatwink and transistor 3025 |
| | **RESISTORS/CONTROLS** | |
| NOTE: | Only power or special resistors are listed. Use the description when ordering standard values of fixed carbon resistors. | |
| R1 | 6R29978A01 | RES. Fixed 240M |
| R101 | 18D25245A02 | CONTROL, Contrast Var. 1K |
| R108 | 18D25245A15 | CONTROL, Brightness Var. 100K |
| R206 | 18D25245A15 | CONTROL, Var. Vert. Hold 100K |
| R208 | 18D25245A07 | CONTROL, Var. Vert. Size 500K |
| R211 | 18D25904A02 | CONTROL, Var. Vert. Lin. 250K |
| R307 | 18D25245A40 | CONTROL, Var. Horiz. Centering 25K |
| R315 | 18D25245A32 | CONTROL, Var. Focus 2M |
| | **COIL/CHOKES** | |
| L1 A/B | 24D25290A03 | COIL, deflection |
| L301 | 24D25603A03 | COIL, width |
| | **INTEGRATED CIRCUITS (IC)** | |
| IC201 | 51R06015A00 | IC, TDA1170S Vert. Proc. |
| IC301, 302 | 51R06332A00 | IC, 555 Timer |
| | **TRANSFORMERS** | |
| T301 | 24D25291A21 | TRANSF., horiz. output (MD1000–191) |
| T301 | 24D25291A25 | TRANSF., horiz output (MD1000–190) |
| | **MISCELLANEOUS** | |
| V1 | 9610769A01 | CRT, 5-in P4/H |
| | 0725978A01 | BRACKET, PC grounding |
| | 4125268A03 | SPRING, dag. |
| | 5925667A0X | NOTE: For Replacement of magnetic yokes, order replacement by specifying the Model No., description of the unit, and the unique CRT display characteristics. |
| | 1V25576A56 | CRT socket and lugs |
| | 9D25241A11 | SOCKET, CRT |
| | 42D25298A04 | ANODE connector |
| E301 | 76A25809A02 | Ferrite Bead. |