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Technical Manual

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Abstract:

This manual contains a complete reprint of the OEM service manual applicable to MON592.

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SERVICE MANUAL

TTL DATA DISPLAY
120/150

5-017-1024

REV. A

July, 1978

Ball Electronic Display Division

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PART I

OPERATING DATA

This section of the Service Manual provides data concerning the specifications, installation and operation of the TTL120/150 Data Monitor.

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SECTION 1

GENERAL INFORMATION

1.1 MONITOR DESCRIPTION

The TTL 120/150 Data Monitor is a solid state raster scan display for data terminal application. The Monitor is designed for high quality display of alphanumeric dot characters.

The Data Monitor is available with either a 12 inch or a 15 inch diagonal screen size CRT and each monitor uses a CRT with 110° deflection angle which results in a very dense package.

The Data Monitor requires three separate TTL compatible input signals for operation, they are 1) vertical drive, 2) horizontal drive and 3) video. These three separate TTL input signals eliminate costly redundancy associated with the mixing and stripping operation required in a composite (single input) monitor.

The unit is available with the following factory installed options. The TTL compatible skip scan option provides for variable spacing between character rows while using only one scan line per space. The dynamic focus PWA option is available to provide an overall focus improvement from the conventional static focus control. The horizontal frequency can be altered from 15.25kHz to 21kHz. The main PWA is available with or without a brightness control, with or without contrast control and the video termination can be changed.

1.2 CUSTOMER INPUT SIGNAL REQUIREMENTS

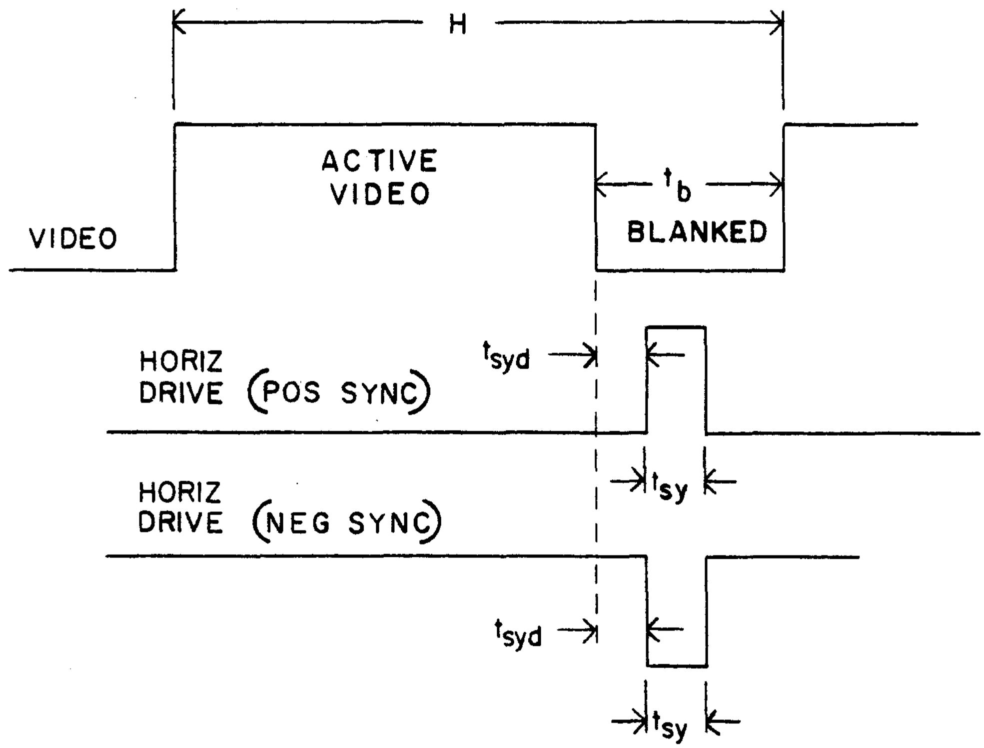
1.2.1 PWA Signal Edge Connector (Customer Supplied)

Viking	No. 2VK10S/1-2
Amphenol	No. 225-21031-101
Cinch	No. 250-10-30-170
Ball EDC	No. 1-039-0119

(Refer to Figure 2.1 for wiring detail of this connector)

1.2.2 Video

Amplitude: High - 4.0V ±2.0V into an external 500Ω or less contrast control.
2.0V max at J101-8 to prevent video amplifier saturation.
Low - 0.0V ±0.4V
Polarity: White High
Pulse Width: 40ns min
Rise and Fall Time: Less than 12ns (10% to 90%)
Video Blanking: Refer to Figures 1.1 and 1.2



H = time from start of one line to the start of the next line

$$\frac{1}{21\text{kHz}} \leq H \leq \frac{1}{15.25\text{kHz}}$$

t_{syd} = sync delay time: $-1\mu s \leq t_{syd} \leq 3\mu s$

t_{sy} = sync pulse width (per 1.2.3): $2.5\mu s \leq t_{sy} \leq 30\mu s$

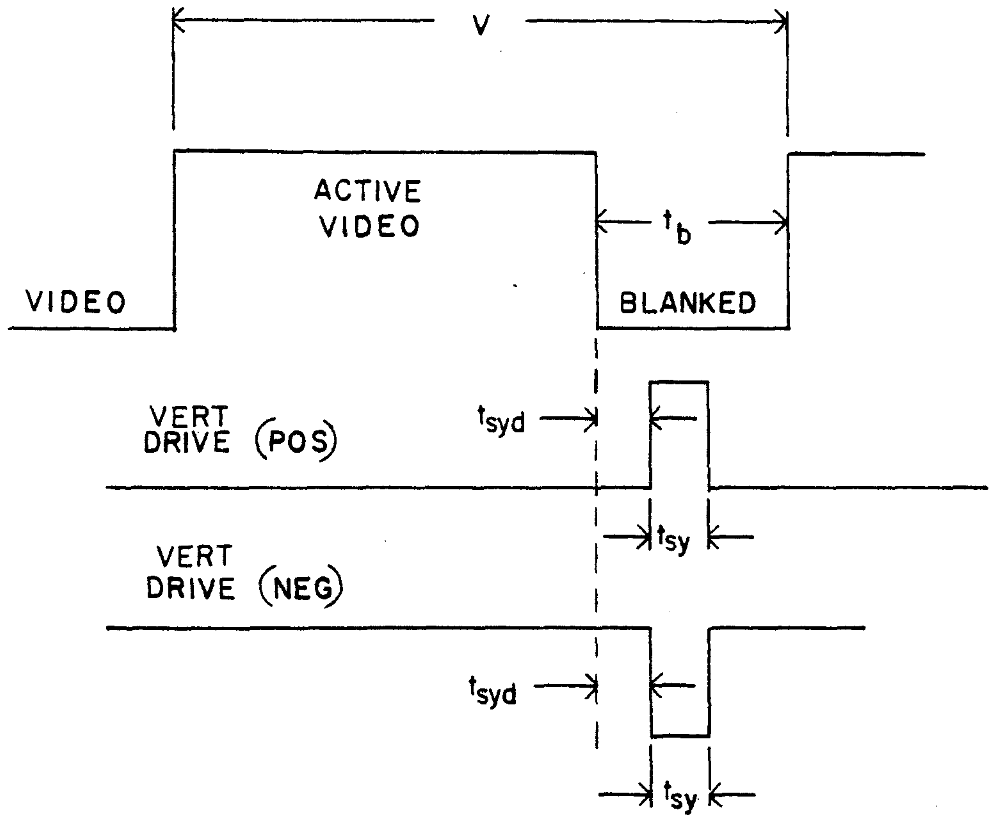
t_b = total blanking time = 12.7µs nom
10µs min

NOTE

PREFERABLY THE SYNC PULSE WIDTH SHOULD FALL WITHIN THE TOTAL BLANKING TIME IN ORDER TO MINIMIZE CROSSTALK BETWEEN HORIZONTAL DRIVE AND ACTIVE VIDEO.

EXAMPLE: $t_{syd} \geq 0$
and
$t_{syd} + t_{sy} \leq t_b$

Figure 1.1 Horizontal/Video Timing



V = time from start of one field to the start of the next field

$$\frac{1}{63Hz} \leq V \leq \frac{1}{46Hz}$$

t_{sy} = sync pulse width per 1.2.4: $75\mu s \leq t_{sy} \leq 1.4ms$

t_b = total blanking time = 2ms nom
900µs min

t_{syd} = should be selected for best video centering within the raster according to:

$$t_{syd} = \frac{t_b - 900\mu s}{2}$$

Example: t_b = 2ms
t_{syd} = 550µs

Figure 1.2 Vertical/Video Timing

1.2.3 Horizontal Drive

Horizontal Frequency: (f_H): 15,250Hz min to 21,000Hz max
15,750Hz ±500Hz (Standard)
Amplitude: High - 4.0V ±1.5V
Low - 0.0V ±0.4V
Polarity: Standard - Positive edge triggering
Optional - Negative edge triggering
Pulse Width (t_{SY}): 2.5µs min to 30µs max
Rise and Fall Time: Less than 100ns (10% to 90%)
Horizontal/Video Timing: Refer to Figure 1.1

1.2.4 Vertical Drive

Vertical Frequency (f_V): 46Hz min to 63Hz max
Amplitude: High - 4.0V ±1.5V
Low - 0.0V ±0.4V
Polarity: Standard - Negative edge triggering
Optional - Positive edge triggering
Pulse Width (t_{SY}): 75µs min to 1.4ms max
Rise and Fall Time: Less than 100ns (10% to 90%)
Vertical/Video Time: Refer to Figure 1.2

1.2.5 Skip Scan

Amplitude: High - 4.0V ±1.5V
Low - 0.0V ±0.4V
Polarity: Skip High
Pulse Width (t_{SS}): 3µs min to 10µs max
Rise and Fall Time: Less than 100ns (10% to 90%)
Skip Scan/Horizontal Timing: Refer to Figure 1.3

1.3 INPUT POWER REQUIREMENT

1.3.1 AC Input Power Requirement

1.3.1.1 Input Power Connector

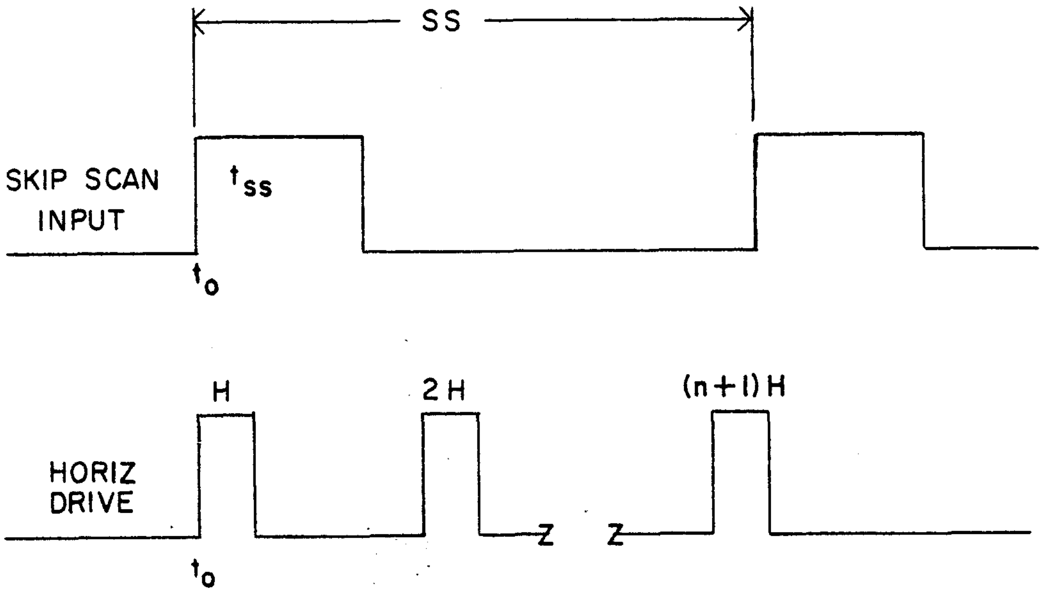
A 9 pin male connector shell (Molex 03-06-1092) with female contacts (Molex 4529) is required to mate with J1 of the AC power supply. Refer to Figure 2.2 for wiring detail of the J1 mating connector.

1.3.1.2 Input Voltage

120V Nominal: 105V RMS min to 130V RMS max
220V Nominal: 198V RMS min to 242V RMS max
240V Nominal: 210V RMS min to 264V RMS max

1.3.1.3 Input Power

Nominal Wattage: 50 watts @ 120VAC, 220VAC or 240VAC
Maximum Wattage: 65 watts @ 120VAC, 220VAC or 240VAC



SS = Time between skip scan pulses nH which will conform to the number of lines (n-1) in the character matrix plus one line (H) for vertical setting

t_{ss} = Skip scan pulse width (per 1.2.5) $3\mu s \leq t_{ss} \leq 10\mu s$

The leading edges of the skip scan input and horizontal drive should be coincident at time t_o.

Figure 1.3 Skip Scan/Horizontal Timing

1.3.1.4 Input Frequency

49Hz min to 61Hz max

1.3.2 DC Input Power Requirements (Optional)

1.3.2.1 Input Power Connector

The DC input voltage is applied through pin 7 of J101 on the main PWA.

1.3.2.2 Input Voltage

+55VDC ±2%, with line, load and temperature.

1.3.2.3 AC Ripple

100mV p-p max for refresh synchronous with power frequency
35mV p-p max for refresh non-synchronous with power frequency

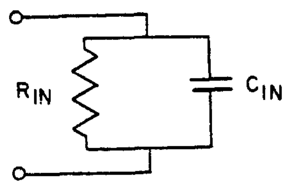
1.3.2.4 Input Current

Average Current Nominal: 0.5A
Average Current Maximum: 0.7A
Maximum Peak Current
from Horizontal and
Vertical AC Components: 1A

1.4 DISPLAY MONITOR ELECTRICAL CHARACTERISTICS

1.4.1 Video Amplifier

Input Impedance: Refer to Figure 1-4



R_{IN} (Unterminated) = 5k typ; 3K min
C_{IN} = 20pF typ; 30pF max

Figure 1.4 Video Amplifier Input Impedance

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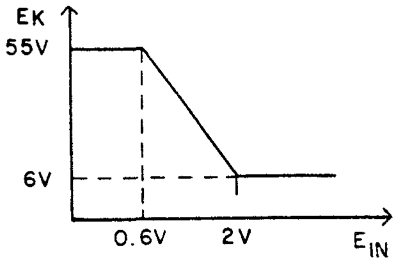
Input Transfer Function (typ): Refer to Figure 1.5

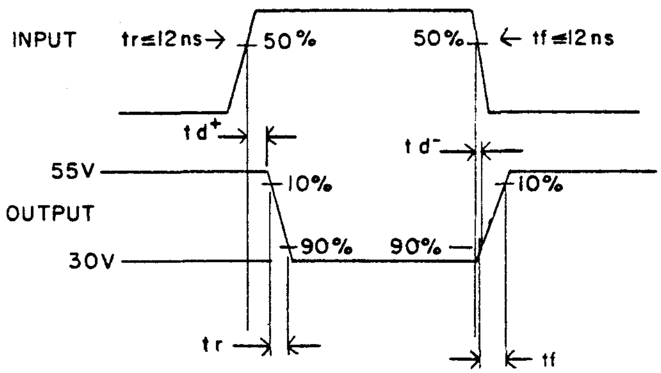


EK = Cathode Voltage
E_{IN} = Video Signal at J101-8

Figure 1.5 Video Amplifier Input Transfer Function

Bandwidth: DC 22MHz @ -3db typ; 20MHz @ -3db min

25V Pulse Response: Refer to Figure 1.6



$t_d^+ = t_d^- = 10ns$ typ , 12ns max
$t_r = 18ns$ typ, 20ns max
$t_f = 28ns$ typ, 35ns max
$t_f = 18ns$ typ, 20ns max
90%-30%

Figure 1.6 25V Pulse Response

1.4.2 Horizontal Electronics

Input Impedance: Refer to Figure 1.7

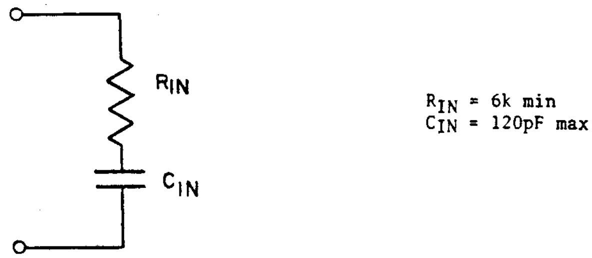


Figure 1.7 Horizontal Input Impedance

Retrace Time: 8.2µs typ; 9.0µs max

Horizontal Centering: Adjustment range is equal to $*t_{CTRG}$ = 1.1(R153+R159)C153 which translates to 8µs min to 28µs max

*t = Time *CTRG = Centering

1.4.3 Vertical Electronics

Vertical Input Impedance: Refer to Figure 1.8

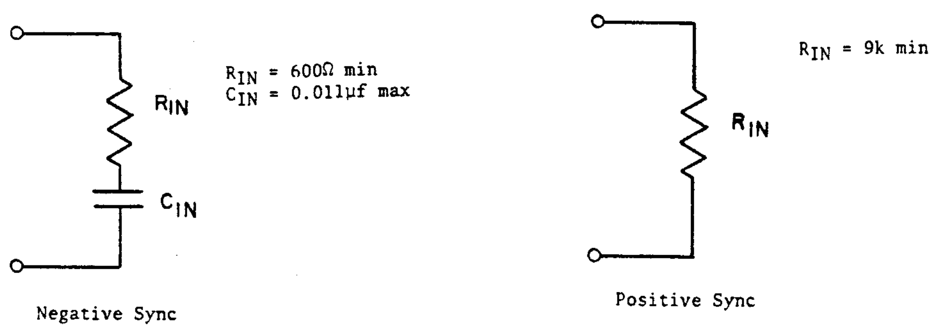
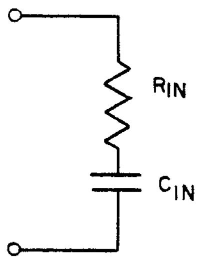


Figure 1.8 Vertical Input Impedance

Retrace Time: 700µs typ; 820µs max

1.4.4 Skip Scan Electronics

Input Impedance: Refer to Figure 1.9



R_{IN} = 900Ω min
C_{IN} = 1100pF max

Figure 1.9 Skip Scan Input Impedance

Vertical Amplifier Delay Plus Settling Time: 60µs max to 90% of final value

1.5 CRT DISPLAY CHARACTERISTICS

1.5.1 CRT Resolution (without bonded panel)

	*Resolution (TV Lines)	
Phosphor	Center	Corner
P4	1000 @ 30fL	900 @ 30fL
P39	1000 @ 15fL	900 @ 15fL

*Resolution is measured in accordance with EIA RS-375 except Burst Modulation (or depth of modulation) is adjusted for 100%.

1.5.2 Geometric Distortion

The perimeter of a full field of characters approaches an ideal rectangle of 4 by 3 aspect ratio to within ±1.5% of rectangle height.

1.5.3 Linearity

Character height or width shall be within 10% of that of any adjacent character and within 20% of that for any character on the screen.

1.5.4 Jitter

Display jitter as a function of magnetic interference from the power transformer is:

60Hz - 0.006 inch p-p max
50Hz - 0.008 inch p-p max

1.6 MECHANICAL SPECIFICATIONS

Table 1-1 and Figure 1.10 lists the mechanical specifications for the TTL-120/150 Data Monitor. For further information, contact our General Sales Offices. They are:

Addison, Illinois (312) 279-7400
Ocean, New Jersey (201) 922-2800
Santa Clara, California (408) 244-1474
Upland, California (714) 985-7110
Lewisville, Texas (214) 436-2383

1.7 ENVIRONMENTAL SPECIFICATIONS

	Operating Range	Storage Range
Ambient Temperature	5°C to 55°C	-40°C to 65°C
Humidity (Non-Condensing)	5% to 80%	5% to 90%
Altitude	Up to 10,000Ft. (3048M)	Up to 30,000Ft. (9144M)

1.8 RELIABILITY

The calculated MTBF excluding CRT at 55°C is 24,500 hours. The calculations are based on MIL 217A assuming the military K Factors are "ground base equipment."

1.9 X-RAY RADIATION

The TTL 120/150 Data Monitor complies with the Federal Regulation for Radiation Control as required by the radiation Control for Health and Safety Act of 1968, and as implemented by Title 21, Subchapter J of the Code of Federal Regulation.

These regulations place certain requirements upon manufacturers of products which can emit x-rays under some conditions of operation or failure. This includes CRT data display monitors.

Certification of compliance with radiation regulations is shown by a label attached to each monitor. The user is responsible for labeling his product in a similar fashion or in making the DHEW label easily visible from the outside of the enclosure. The regulations state that "This (certification) information shall be provided in the form of a tag or label permanently affixed or inscribed on such product so as to be legible and readily accessible to view when the product is fully assembled for use..." Each monitor is supplied with an extra label attached to the CRT. The user will remove this label and use it as stated above.

DIMENSION (Inches/Millimeters)

MODEL		TILT (°)	A (in/mm)	B	C	Weight (Lbs/Kg)	OUTLINE DWG
TTL-120B	AC	0	4.51/115	4.72/120	9.03/229	15/6.8	2-030-0394
TTL-120B	AC	7½	4.70/119	4.11/104	8.95/227	15/6.8	3-030-0391
TTL-120A	AC	0	4.58/116	2.97/75	9.09/231	14.5/6.6	2-030-0388
TTL-120A	AC	5	4.72/120	2.57/65	9.06/230	14.5/6.6	2-030-0403
TTL-120A	AC	7½	4.78/121	2.37/60	9.01/229	14.5/6.6	2-030-0406
TTL-120A	AC	10	4.80/122	2.16/55	8.95/227	14.5/6.6	2-030-0390
TTL-120D	AC	0	4.66/118	5.30/135	9.20/234	15.5/7.0	2-030-0393
TTL-120D	AC	10	4.90/124	4.78/121	9.02/229	15.5/7.0	2-030-0392
TTL-150A	AC	0	5.33/135	2.38/60	10.66/271	18.5/8.4	2-030-0395
TTL-150A	AC	5	5.42/138	1.91/48	10.62/270	18.5/8.4	2-030-0389
TTL-150A	AC	7½	5.47/139	1.67/42	10.57/268	18.5/8.4	2-030-0405
TTL-150D	AC	0	5.30/135	5.40/137	10.62/270	19.75/9.0	2-030-0387
TTL-150D	AC	5	5.92/150	4.58/116	11.03/280	19.75/9.0	2-030-0387

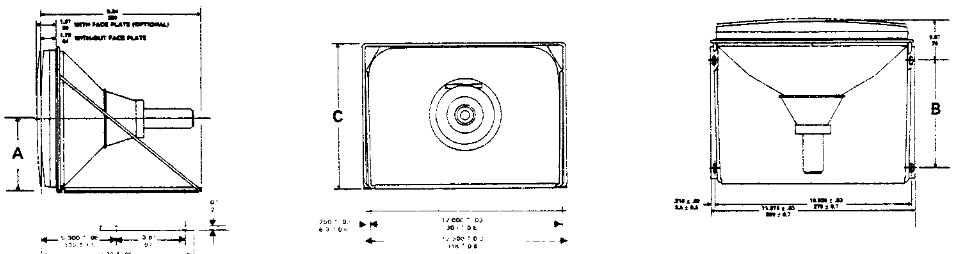
NOTES:

1. For DC models subtract 4 lbs/1.8kg
2. Dimensions based on standard unit with plain face CRT.

Table 1-1 Mechanical Specifications

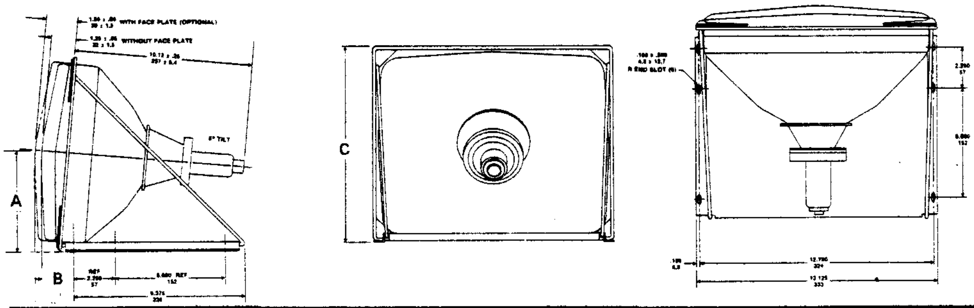
DIMENSIONS FIGURE 1-12

TTL-120 12-INCH DIAGONAL A

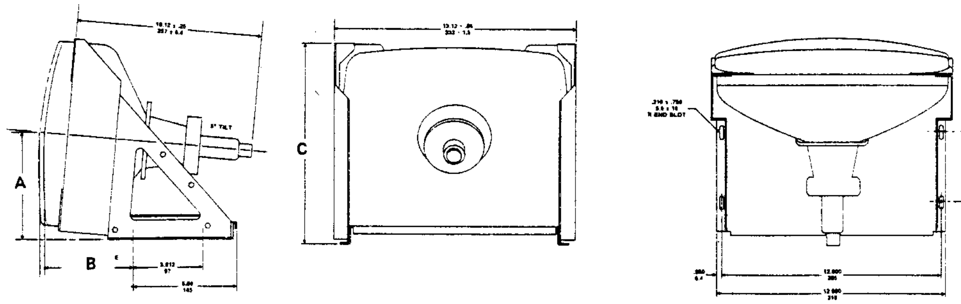


Alternate 12-inch mounting.

TTL-150 15-INCH DIAGONAL A



TTL-150 15-INCH DIAGONAL* D



*Alternate 15-inch frame style.

Figure 1.10 TTL 120, 0^{o} and TTL 150 5^{o} Tilt Dimensions

1.10 USER OPERATING CONTROLS

1.10.1 External Controls

The only external control required for operation of the standard TTL 120/150 display unit is a contrast control. The impedance level of this control shall be no greater than 500Ω to keep frequency response limitations to a minimum.

An option is available where the contrast control can be placed on the PWA.

Another option is available, where the brightness control is removed from the PWA. A remote brightness control supplied by the customer is used and is connected to the PWA via J101.

1.10.2 Internal Controls

The following controls are mounted on the main PWA:

- Width
- Horizontal Video Centering
- Vertical Sync
- Vertical Linearity
- Height
- Skip Height (Optional)
- Internal Contrast (Optional)
- Brightness
- Focus
- Dynamic Focus (Located on Dynamic Focus PWA)

Section 2

INSTALLATION

2.1 MECHANICAL

Refer to Table 2-1 for the Display Monitor mounting data and to Section 1.6 for its mechanical specifications.

MODEL	MOUNTING DATA
TTL120B	4 Clinch Nuts
TTL120A	4 .188X.500 radius end slots
TTL120D	4 .218X.750 radius end slots
TTL150A	6 .188X.500 radius end slots

Table 2-1 Mounting Data

2.2 ELECTRICAL

2.2.1 AC Input

The TTL120/150 Data Monitor with a internal AC power supply operates from either a 120VAC or 220/240VAC source depending on the wiring of the AC mating connector (customer supplied) for J1. Refer to Figure 2.2 for wiring data of J1 mating connector.

2.2.2 DC Input

The TTL120/150 Display Monitor without an internal AC power supply is operated from an external +55VDC source. The DC input voltage of +55V is applied to pin 7 of J101.

2.3 LOCATION

The Display Monitor shall not be located in an area such that the operating ambient temperature exceeds +55°C.

2.4 GROUND TECHNIQUES

The Display Monitor is normally mounted in a system where the frame and chassis plate is an integral part of the system ground. The vertical/video ground and horizontal ground (located on pins 1 and 10 of J101) are tied to the chassis plate through a #6 tapping screw located at one corner of the PWA. Ground connections to the Display Monitor can then be made through the chassis mounting plate or via connections to pins 1 and 10 of J101. Refer to Figure 2.1 for Interface Connections.

2.5 VIDEO LEAD IN CONSIDERATIONS

For the best display, the video input line requires special consideration.

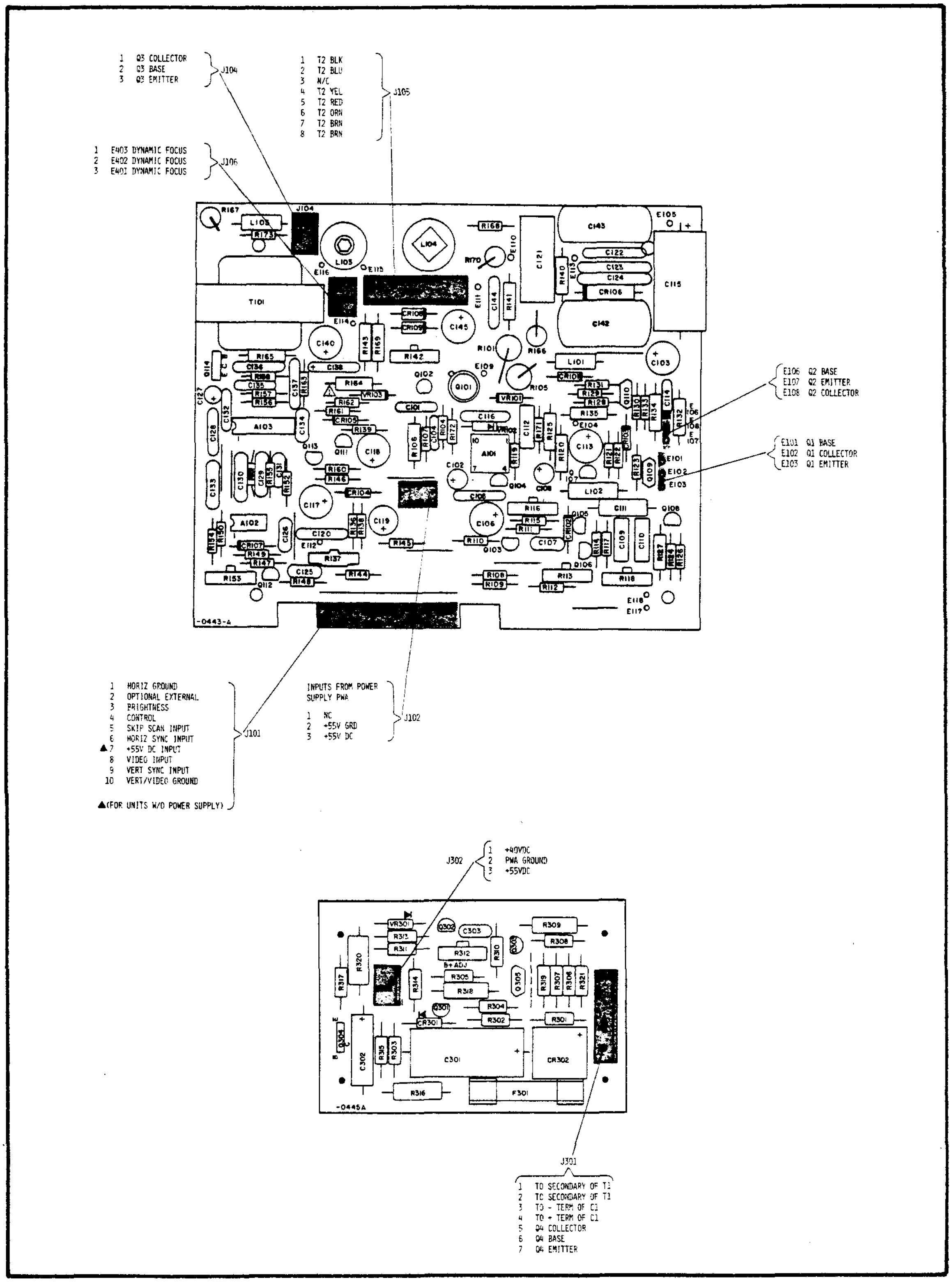


Figure 2.1 PWA Interface Connection and Signal Output

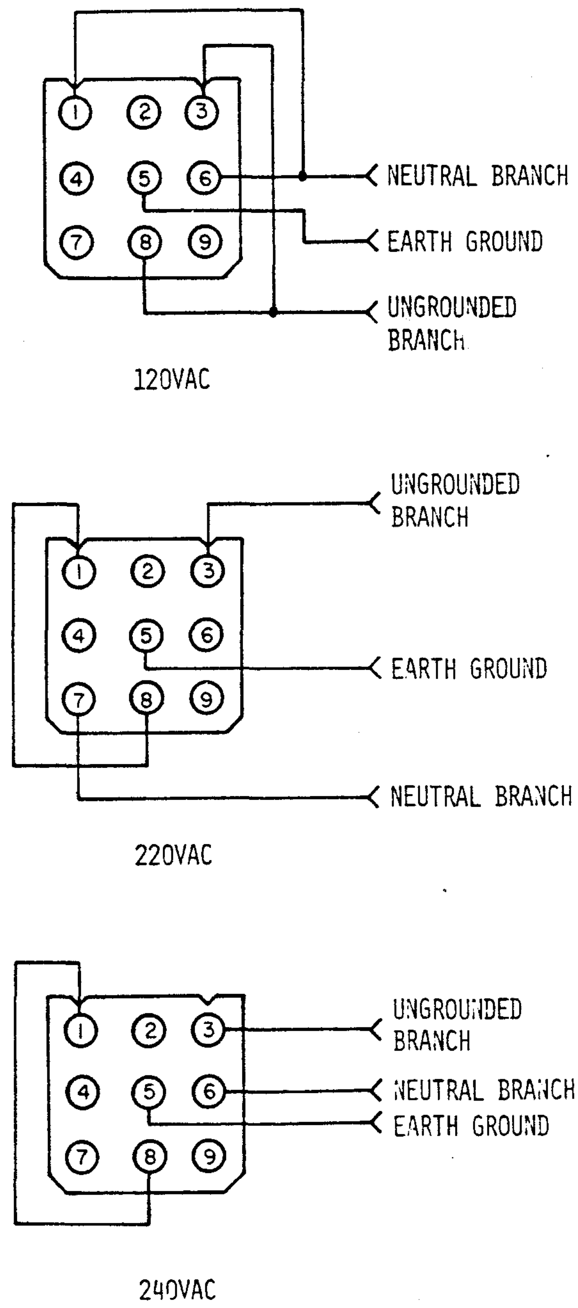


Figure 2.2 Wiring Data for J1 Mating Connector

1. To avoid capacitive coupling from adjacent lines, the video leads should be routed away from all other wiring and the horizontal sync width should not extend into the active video area (Refer to Figure 1.1).

   If this is not possible, a shielded or twisted pair video lead may become necessary.

2. The video line should be kept as short as possible in order to minimize line capacitance and the bandwidth limitation this capacitance imposes. Unfortunately low line capacitance is contradictory to a shielded or twisted pair line mentioned in item 1 above. To resolve this contradiction, a terminated system may have to be used, where by the video line is terminated in the characteristic impedance of the shielded (coaxial) or twisted pair line generally $50 \leq Z_o \leq 120\Omega$. This termination resistor is available on the Main PWA as an optional component.

Section 3

OPERATION

3.1 GENERAL

After power, video and drive signals have been applied to the Display Monitor, the contrast and brightness controls are adjusted for the best looking display.

3.2 BRIGHTNESS ADJUST

The brightness control is used to adjust the raster just beyond visual cutoff; in this manner, maximum contrast ratio is obtained when video is applied.

3.3 CONTRAST ADJUST

The contrast control is used to vary the data brightness level as dictated by ambient lighting conditions.

PART II

SERVICE DATA

Section 4 through 6 and the supplement are for qualified service personnel.

The TTL 120/150 has no end user serviceable parts inside. Refer service to qualified service personnel.

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Section 4

THEORY OF OPERATION

4.1 VIDEO AMPLIFIER

Video amplification is provided by Q101 and Q102. Q101 and Q102 are connected in a cascode arrangement; Q102 operates as an emitter follower and Q101 operates in the common base configuration. This minimizes the Miller effect input capacitance and the defining breakdown parameter for Q101 becomes B_VCBO as opposed to B_VCEO for the common emitter configuration. This enables selection of a higher speed/lower breakdown transistor to be used in the video amplifier.

The video amplifier is normally off. That is, in the absence of a video input signal or with a signal level of less than 0.6V at J101-8, the CRT cathode voltage at the collector of Q101 will be at +55V. When the input signal exceeds 0.6V, the amplifier begins operation in the linear region and the CRT cathode voltage starts to decrease with a nominal voltage gain of 35 V/V.

The dynamic range capability of the amplifier is 48V which provides more than adequate head room to meet the normal viewing brightness requirement of 18 to 30 volts of modulation. Emitter degeneration resistor R106 stabilizes the gain against hfe variations and V_{BE} temperature variations. High frequency peaking is provided by C104 and L101 resulting in a nominal bandwidth of 22MHz. CR101 provides arc protection for Q101 by clamping the collector voltage to a maximum value of 55V.

Optional resistors R102, R103 and R174 (Refer to Figure 4.1) are used to tailor the video amplifier characteristics to meet certain performance requirements. R102 is a termination resistor used for those applications where the frequency limiting effects of the input cable capacitance must be minimized. R103 is a contrast control which can be provided as an internal adjustment while R174 is used to convert the video amplifier to a normally on Class A amplifier. R174 eliminates the initial 0.6V dead zone which normally exists and modifies the amplifier transfer characteristic (Refer to Figure 1.5) for compatibility with competitive monitors with Class A video amplifiers.

4.2 VERTICAL ELECTRONICS

The vertical electronics circuit consists of a positive sync inverter, a vertical oscillator, an emitter follower, a vertical output amplifier and the vertical deflection coil of the yoke. Refer to figure 4.2.

Q105 is a programmable unijunction transistor and operates as a relaxation sawtooth oscillator. The free running frequency range of 40Hz to 65Hz is governed by R115, C109, C110 and the voltage at the gate of Q105. CR102 provides temperature compensation for the free running frequency. Q105 operates like a switch; in the off condition, a ramp voltage is produced at the anode of Q105 (TP104). This ramp voltage will increase until the anode voltage exceeds the gate voltage and turns Q105 on to rapidly discharge the voltage across C109 and

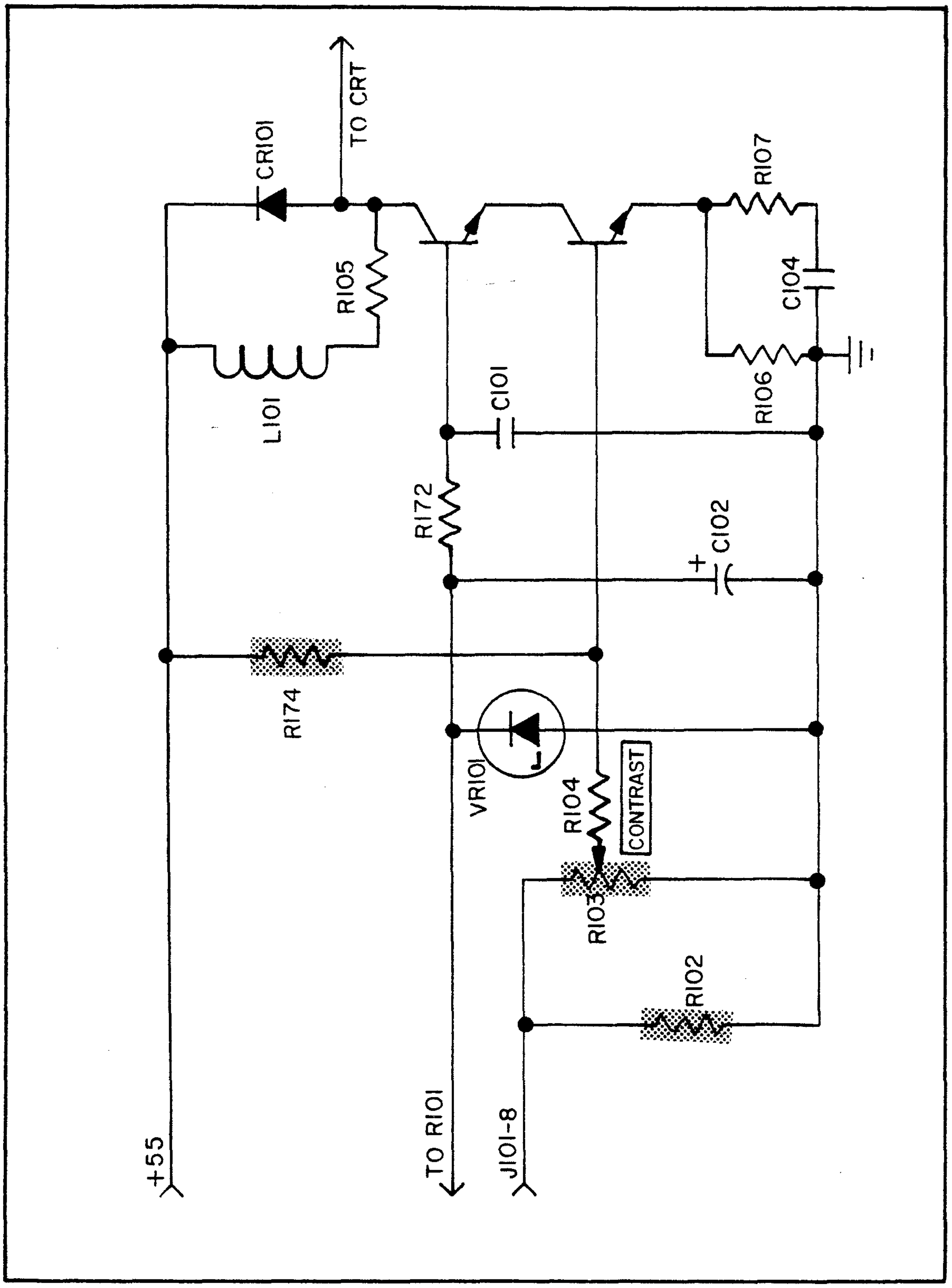


Figure 4.1 Optional Video Amplifier Schematic

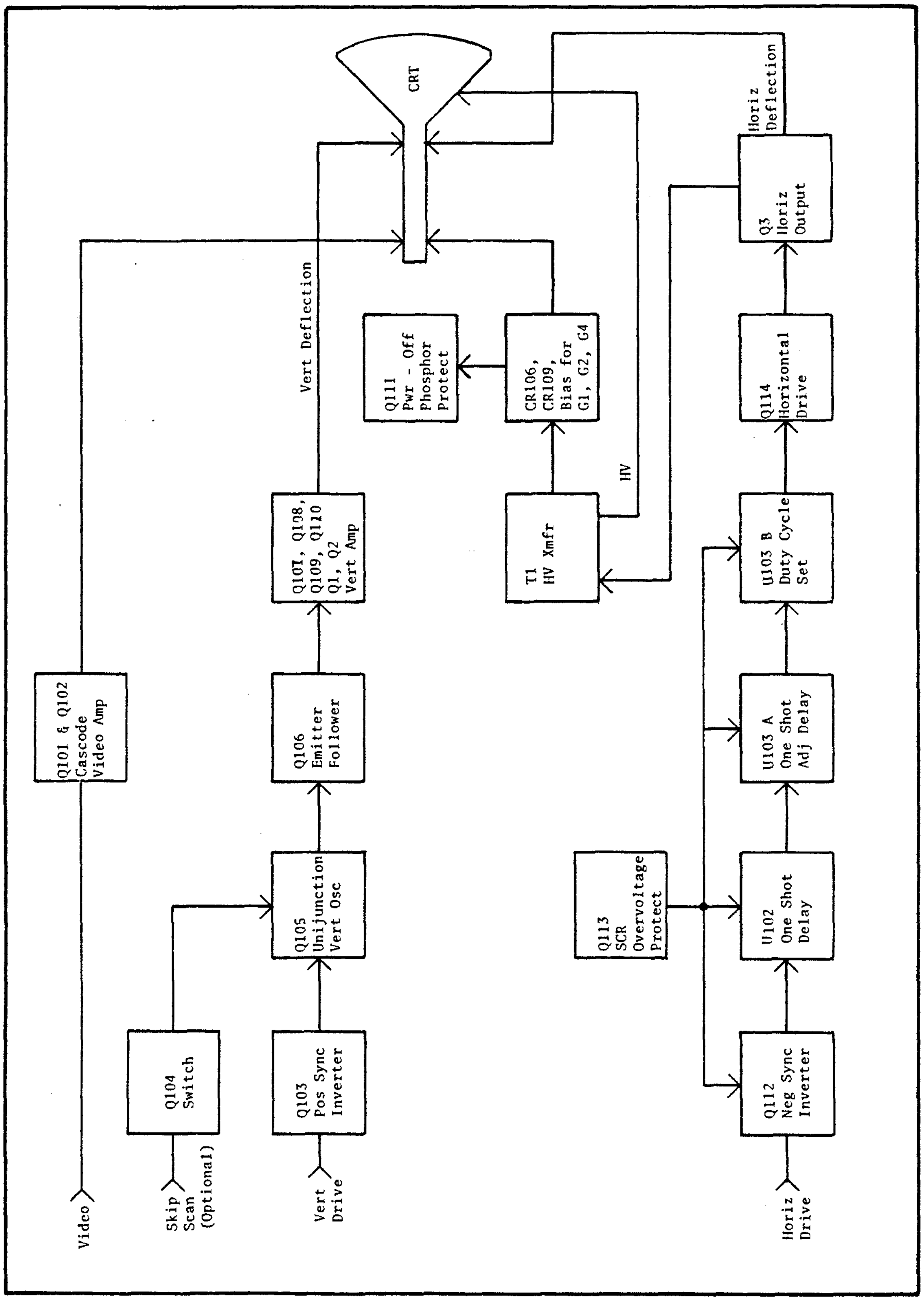


Figure 4.2 TTL120/150 Block Diagram

C110 through L102. The decay time is governed by the resonant frequency of the tuned circuit consisting of L102, C109 and C110.

The oscillator is synchronized by the application of a negative pulse at the gate of Q105. Negative sync at J101-9 is standard but positive sync can be accommodated with inverter Q103 by removing the negative sync jumper wire between R109 and C107 and adding the positive jumper wire between the collector of Q103 and C107. The negative sync pulse lowers the gate voltage and forces the oscillator to run at the incoming frequency as long as the vertical sync control R113 is adjusted to produce a free running frequency slightly lower than the incoming frequency.

Height control R116 varies the amplitude of the sawtooth voltage and subsequent raster height by controlling the effective B+ voltage applied to R115. The B+ voltage is established through the voltage divider action between R111, R112, R113, R116 and R119.

If a true sawtooth current waveform (linear ramp) is supplied to the yoke, the displayed video would be stretched at the top and bottom of the CRT because of the large difference between the faceplate radius curvature and the yoke center of deflection. As such, the sawtooth waveform must be modified to produce the classic "S" shaped yoke current waveform as shown in Figure 4.3.

Figure 4.3 Yoke Current Waveform

The required "S" shaping is produced by linearity electronics Q106, R117, R118 and C110 in combination with the low frequency response limitation of the vertical amplifier. The linearity electronics modifies the sawtooth waveform at the emitter of Q106 by integrating this waveform through R117, R118 and C110 and inserting the resultant parabola in series with the ramp. Q106 is a darlington emitter follower which provides excellent isolation between the vertical oscillator and output amplifier.

The output amplifier consists of Q106 through Q110 and chassis mounted transistors Q1 and Q2. As indicated by Figure 4.4, the amplifier is of the closed loop variety which makes the input to output transfer function independent of the transistor parameters. The Class AB push-pull output stage eliminates the requirement for an output transformer or choke which is required for a Class A output amplifier. If one neglects the finite open loop gain, the input to

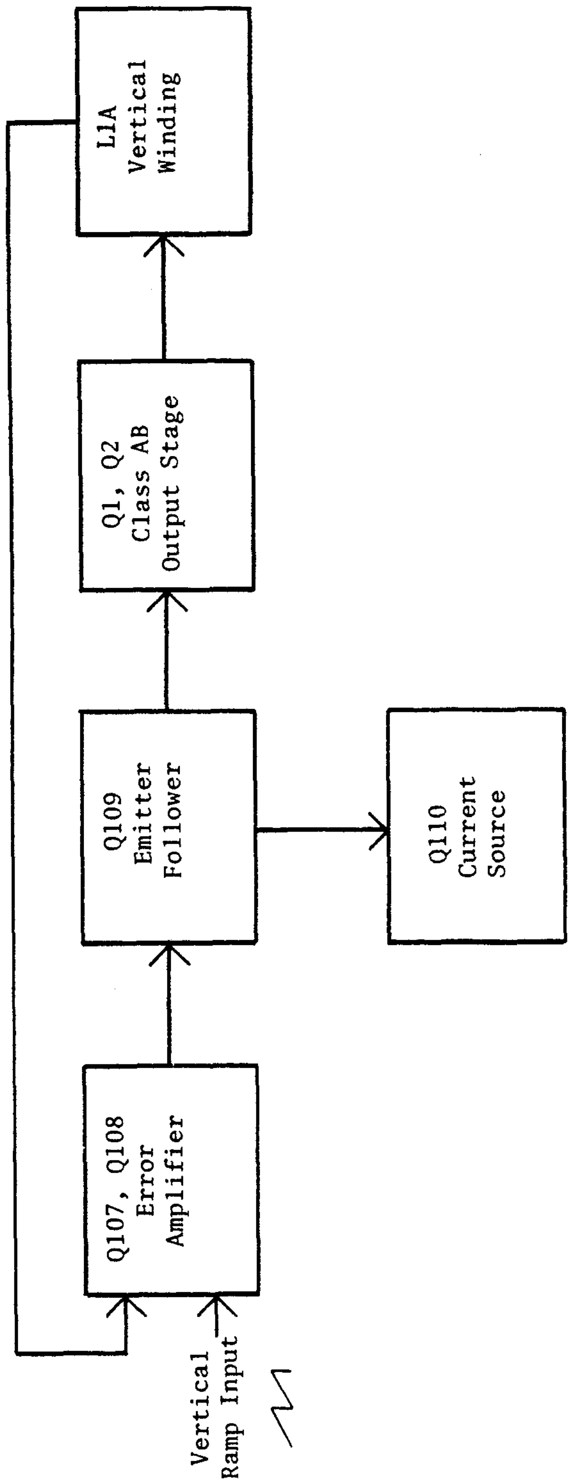


Figure 4.4 Block Diagram of Vertical Amplifier

output transfer function (voltage at the base of Q108 to the yoke current) is defined by:

$$\frac{I_{out}}{E_{IN}} = \frac{R125}{R127} \times \frac{1}{R135}$$

This insures that the output yoke current becomes an exact replica of the input ramp voltage.

A voltage replica of the yoke current is produced across R135. This voltage is fed back through C113 to the base of Q107. Q107 together with Q108 comprises a high gain error amplifier that amplifies the voltage difference between the two bases. The amplified voltage difference produces the necessary base current for emitter follower Q109. The base current requirement is a function of the current gain (hfe) of Q109, Q1, Q2 and the output yoke current. Q1 and Q2 comprise a class AB emitter follower output stage. Q1 supplies current during the first half of vertical scan (CRT screen top to center) with Q2 supplying current during the last half of scan (CRT screen center to bottom). During vertical retrace, the yoke current is quickly reversed when the peak yoke current is transferred from Q2 to Q1. The retrace time is governed by the flyback voltage which is defined by the natural clamping action of the amplifier at +52V (TP112). Q110 is a current source of sufficient magnitude to handle the peak base current requirement of Q2. The class A bias to eliminate crossover distortion is provided by CR103 and R130. R121, R122, R123, R124 and R133 are DC biasing resistors to insure the amplifier operates within the linear region.

Optional skip scan electronics Q104, U101, C105, C108 and VR102 provides the ability to step the vertical amplifier. Q104 operates as a normally off switch. With the application of a positive pulse at J101-5, Q104 turns on and the collector voltage jumps to 22V as defined by zener VR102. The collector voltage and the 7.5K, 100K resistors in U101 combine to charge C109 and C110 for the duration of the input pulse (as defined in section 1.2.5). The resultant voltage step across C109 and C110 (TP104) is processed by the vertical amplifier to produce a corresponding jump in yoke current. For CRT deflection jumps of <0.16", the settling time of the vertical amplifier is <50µs. Capacitor C108 couples the ramp waveform back to Q104 to provide linearity correction to the skip scan waveform.

4.3 HORIZONTAL ELECTRONICS

4.3.1 Horizontal Deflection

Integrated circuits U102 and U103 are used as one shot delays to perform 2 functions: 1) U102 and one half U103 provide an adjustable one horizontal line sync delay which permits the video to be centered horizontally within the raster and 2) the other half of U103 generates the proper duty cycle for the horizontal output transistor.

The standard main PWA is wired for a positive sync signal applied at J101-6. The input circuit can be modified to accept a negative sync signal at J101-6 by removing the positive sync jumper wire between the collector of Q112 and C126 and inserting a jumper wire connecting R145 to C126.

The positive sync pulse is inverted by Q112 and applied to pin U102-2 to produce a positive going pulse at pin U102-3. The time out of this positive pulse is equal to 1.1(R151 C130). After the pulse times out, the negative going edge applied to pin U103-6 produces another positive pulse at pin U103-5. In this case, the pulse duration is variable according to 1.1(R153+R154)C133. This completes the one line sync delay. The negative going edge of this pulse is coupled to pin U103-8 by C134 to produce another positive pulse at pin U103-9 with a time duration equal to 1.1(R158 C136). This provides a duty cycle consistant with proper operation of the horizontal output transistor.

The complete timing relationship is shown in Figure 4.5.

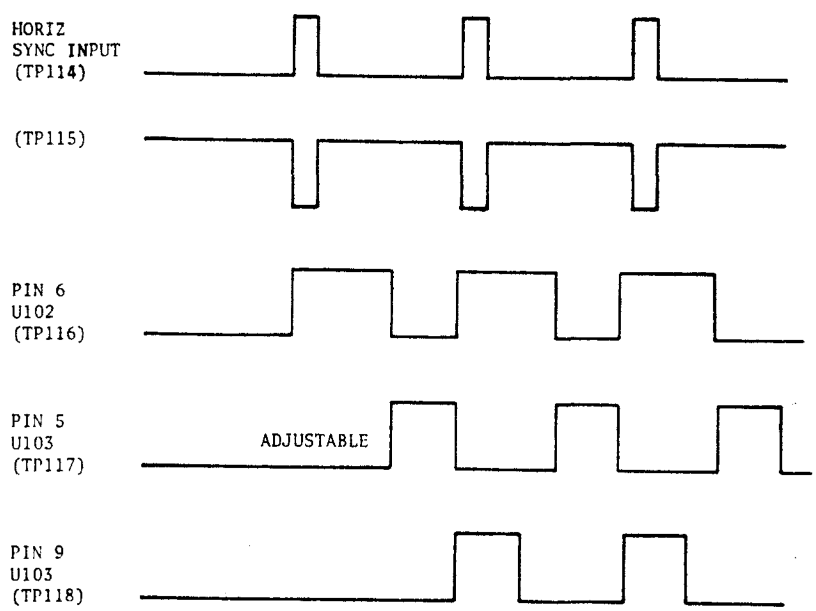


Figure 4.5 Horizontal Timing Diagram of U102 & U103

Horizontal driver Q114 and horizontal output transistor Q3 both operate as switches. The positive pulse at pin U103-9 drives Q114 into saturation. Transformer T101 is phased so that Q3 is turned off during this time. When the primary current of T101 is interrupted by the turn off of Q114, the secondary voltage reverses to turn Q3 on.

The horizontal output stage performs 2 functions: 1) to supply the yoke with the necessary scanning current and 2) develop the CRT anode, G1, G2 and focus voltages. Item 2 will be discussed in section 4.3.2.

Just before horizontal flyback (or when the electron beam moves rapidly from the extreme right side of the CRT screen to the left), maximum yoke current is flowing out of terminal E115 through switch Q3 to ground. Flyback is initiated by the turn off of Q3. With Q3 off, the yoke energy as well as the energy in the flyback primary (T1) is transferred through resonance action to retrace capacitor C142, the yoke distributed capacitance and T1 capacitance. When this energy transfer is complete, the capacitor voltage (TP120) is maximum (400-600V depending upon line rate), the inductive current is zero and the electron beam has returned to screen center. Now the capacitive energy transfers back to inductive energy to produce a yoke current of the same magnitude but of the opposite direction to that just prior to flyback. This completes beam retrace to the left side of the screen.

The capacitor voltage now swings negative but is clamped near ground by damper diode CR108 which results in the inductive current transferring from the capacitor to CR108. Linear scan now begins as a result of the DC voltage on C143 being impressed across the yoke. C143 is charged to the power supply voltage of +55 VDC and prevents any DC currents from flowing through the yoke.

After the electron beam has moved a distance of about 35% across the screen, Q3 is turned on and the yoke current is transferred from CR108 to Q3. Q3 now carries the yoke current for the remainder of the linear scan time.

As discussed in the vertical section, the desired current waveform for a linear scan on the CRT is an "S" shaped ramp. C143 also provides this "S" shaping by impressing a parabolic voltage across the yoke in addition to a DC voltage.

Additional linearity correction is provided by saturable inductor L104. Without L104, the video would be stretched on the left side of the screen because of the R losses present in the yoke, Q3 etc.

L103 is an adjustable coil placed in series with the horizontal yoke winding to provide width control. The coil inductance controls the voltage magnitude available to the yoke and controls the resultant current magnitude and raster width.

4.3.2 CRT Operating Voltages

The DC operating voltages for the CRT with the exception of the filament voltage are all obtained by rectification and filtering of the horizontal flyback pulse. CR106 and C121 rectify and filter the flyback pulse across Q3 to produce a G2 voltage of 400-600 volts depending upon the horizontal operating frequency. This voltage also feeds the focus grid of the CRT through R141 and focus control R142.

The flyback pulse is transformer coupled by T2, rectified and filtered by CR109 and C119 to produce -90V which is used as the source voltage for G1 to control raster brightness. Q111 aids in eliminating CRT spot burn during power turn off by rapidly discharging the CRT aquadag capacitance.

The CRT anode voltage is developed by T2, rectification diode CR1 and the aquadag filter capacitance. The voltage is typically 17kV for the 15" CRT size and 14kV for the 12" CRT size.

The filament voltage of 6.3V RMS is obtained from a 6 turn winding added to T2.

4.4 X-RAY PROTECTION ELECTRONICS

To comply with the DHEW requirements on X-ray radiation, Q113 and VR103 are employed to shut down the high voltage in the event the DC supply voltage exceeds 60V DC. If by misadjustment or failure in the regulator electronics, the input voltage should exceed about 60V DC, zener VR108 will start to conduct and turn Q113 on. With Q113 conducting, the supply voltage for U102 and U103 is reduced to zero; this removes the horizontal drive signal and subsequently the high voltage.

4.5 DYNAMIC FOCUS ELECTRONICS

For optimum electron beam focusing over the complete CRT face, the focus voltage should increase as the deflection angle increases. As such, the focus voltage would be at a minimum in the CRT center and at a maximum in the corners. The optional dynamic focus electronics approximates this requirement by varying the focus voltage as a function of horizontal position from tube center.

The horizontal waveform across Q3 is processed by the C403, L401, C402 tank network to produce the parabolic waveform (See Figure 5.1). L401 provides for amplitude adjustment over the range of 200V to 400V p-p. C401 couples the waveform to the focus electrode.

4.6 LOW VOLTAGE REGULATED SUPPLY

The AC line voltage is applied to transformer T1 (Refer to Figure 4.6). The secondary voltage developed is rectified and filtered by CR302 and C1 to produce a DC voltage for the regulator electronics of 76V DC. The 76V DC input is dropped to +55V DC through the series pass transistor Q4. DC regulation of +55 volts is maintained by tapping down the voltage through the divider network of R311, R312 and R313. The resultant 6.3V DC at the wiper arm of R312 is applied to the base of Q302. Also a DC reference voltage from VR301 is applied to the emitter of Q302. This transistor then develops a DC error current that flows through R310 to the base of emitter follower Q305. Current source Q301 supplies current to the base of Q305 and collector of Q302. This bias current from Q301 will tend to shift the base of Q305 in a positive direction where as the current from Q302 will tend to shift the base in the negative direction. This results in an error current from the collector of Q302 that controls emitter follower Q305 and also the series pass transistor Q4. This enables the DC output voltage to be maintained at +55V DC, independent of the input voltage and output load current.

Foldback current limiting of the +55V DC supply is provided by means of transistor Q303 and resistors R306, R307, R308 bias network. When the load current exceeds about 2 amps, the voltage drop across R309 is of sufficient magnitude to turn on Q303. As Q303 turns on, the base current supplied to Q305 decreases to produce a corresponding decrease in output voltage. In the event of a direct short on the +55V DC bus, the short circuit current will be approximately 100ma. Removing the external short circuit will allow the regulator to resume normal operation.

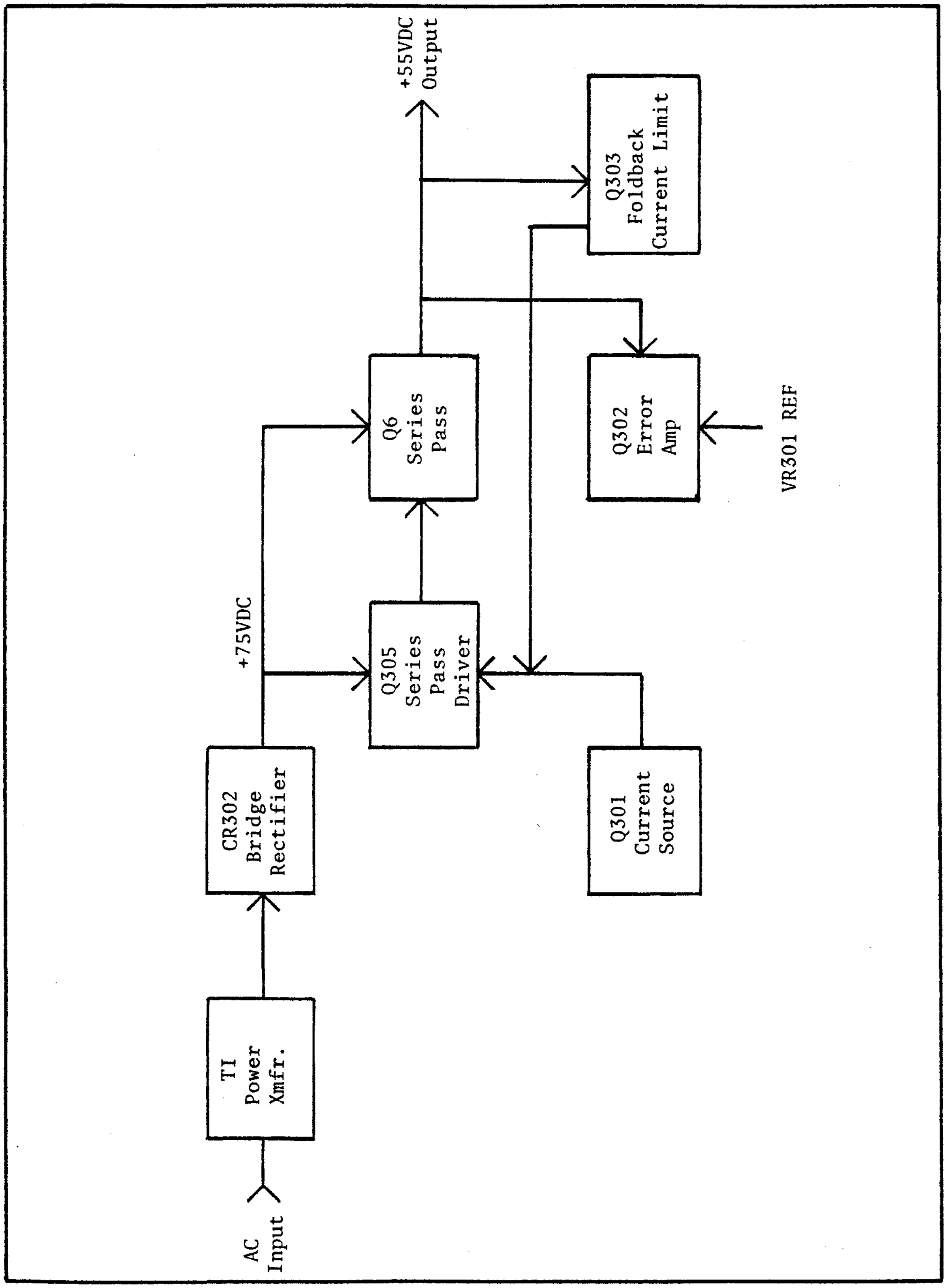


Figure 4.6 Power Supply Block Diagram

Section 5

ADJUSTMENT AND MAINTENANCE

5.1 GENERAL

This section describes the adjustment procedures to be used for set up of the various circuits during routine maintenance or after component replacement.

5.2 INITIAL TURN-ON

Connect the signal input connector to J101 of the main PWA and connect the power input connector to J1 of the power transformer T1. Turn on the Display Monitor and the test equipment; allow 15 minutes for warm-up.

All the horizontal and vertical circuits adjustments can be made using an "E" or "#" character. Adjust the raster brightness to just beyond visual extinction with the brightness control.

5.3 POWER SUPPLY ADJUSTMENT

Connect a DC volt meter to the anode of CR104, located near J102-3 on the main PWA. Adjust the B+ adjust control on the LV regulator PWA for a meter reading of +55V±0.5V.

5.4 VERTICAL ELECTRONICS

5.4.1 Vertical Sync Adjust

The Vertical Sync Adjust control is located on the main PWA. Adjust this control clockwise (as viewed from the rear of the Display Monitor) until the picture just rolls down. Now back off the control (CCW) until the picture snaps back into sync.

5.4.2 Vertical Linearity and Height Adjust

Both of these controls are located on the main PWA. The vertical linearity control R118 is adjusted for the best vertical linearity. The vertical height control R116 is adjusted for the proper vertical height.

5.4.3 Skip Scan Adjust

This adjustment procedure will apply only to the Display Monitor that has the skip scan option.

Apply the skip scan signal and adjust control U101 until the proper skip height is obtained. In general, the proper skip height is obtained by removing the skip scan signal and establishing a given video height as described in Section 5.4.2. The skip scan signal is then applied and the height is increased to the final height requirement with control U101. As the increase from initial height to final height becomes larger there will be interaction between the skip scan control and the vertical sync and linearity controls such that R113 and R118 may have to be readjusted.

5.5 HORIZONTAL ELECTRONICS

5.5.1 Width Adjustment

Adjust the Width Control L103 for the desired picture width.

5.5.2 Horizontal Centering Adjustment

Adjust the Horizontal Centering control R153 to center the video horizontally within the raster.

5.6 RASTER CENTERING

The centering magnets located at the back of the yoke are used to center the raster on the CRT. The magnets should never be used to center the video horizontally as this may cause display focus problems as well as the possibility of neck shadow. The rings may have to be used to center the video vertically since the vertical position of the video within the raster is strictly dependent on customer timing and vertical flyback time. Picture tilt is corrected by rotating the yoke.

5.7 FOCUS

Adjust focus control R142 for the best overall focus on the CRT.

5.8 DYNAMIC FOCUS

Place oscilloscope probe between TP112 and ground. The waveform should look like Figure 5.1.

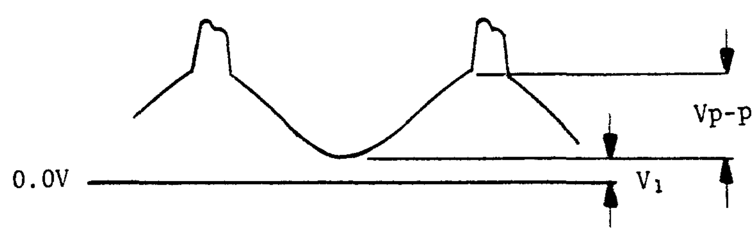


Figure 5.1 Dynamic Focus Waveform

The voltage level at the bottom portion of the waveform (V_1) is controlled with the static Focus control R142 while the peak-to-peak amplitude (Vp-p) is controlled with L401 on the dynamic focus PWA.

V_1 corresponds to CRT center focus and is adjusted for 25V ±75V to give best center focus while the peak-to-peak amplitude is adjusted for 300V ±100V. This will give the best focus compromise at the edges of the display pattern. The adjustments do interact in that increasing the Vp-p will lower the V_1 voltage and vice versa.

5.9 BRIGHTNESS AND CONTRAST

The brightness and contrast controls are adjusted per Section 3 of the manual.

5.10 TROUBLESHOOTING GUIDE

Symptoms/Possible Solutions

1. Screen is dark - Check to see if the +55V is present. A convenient point of measurement is at CR104 on the main PWA. If there is no +55V, disconnect J104 which isolates the horizontal transistor. If the +55V is still not present, disconnect J105 which isolates the remainder of the horizontal output stage. If the +55V now returns to normal, the problem is most likely the damper diode CR108.

   If the +55V is still not present after disconnecting J104 and J105, the problem is either with the +55V power supply or the vertical amplifier. This can be determined by disconnecting J102 and measuring the +55V at the power supply itself. Actual isolation of a fault to a specific transistor stage is best accomplished by the use of an oscilloscope and reference to the typical waveforms in Figure 6.7 in Section 6.

2. Loss of Video - Check Q101, Q102 and VR101.

3. Loss of Brightness Control - Check CR109 and CR106.

Unnecessary delays may be avoided when parts are returned to Ball Electronic Display Division using the following procedures:

(1) Package the unit or part in accordance with the method of shipment. Enclose a list of the material being returned and the reason for returning it.

(2) Send the unit or part, transportation prepaid, to the address stipulated for returning parts.

All equipment and parts described in the warranty will be replaced, provided our examination discloses that the defects are within the limits of the warranty. If damages or defects are not within the limits of the warranty, the customer will be notified of the extent of repairs required and the cost. The unit will be repaired and returned upon agreement.

6.4 WAVEFORMS

The waveforms on the component layout were taken with 1.5V peak-to-peak character signal (Refer to Section 5.2) applied to the Data Monitor. These waveforms can be used as a check point to localize problems to a specific circuit area. The waveform photographs indicate the actual peak amplitude for each test point.

6.5 BOARD ASSEMBLY

The board assembly part number has a 6-002-XXXX prefix. The last four digits of the part number is found under the "use on 6-002" column in the parts list. The last four digits of the board assembly part number is stamped on the component side of the board.

6.6 COMPONENT REPLACEMENT PARTS AFFECTING PRODUCT SAFETY

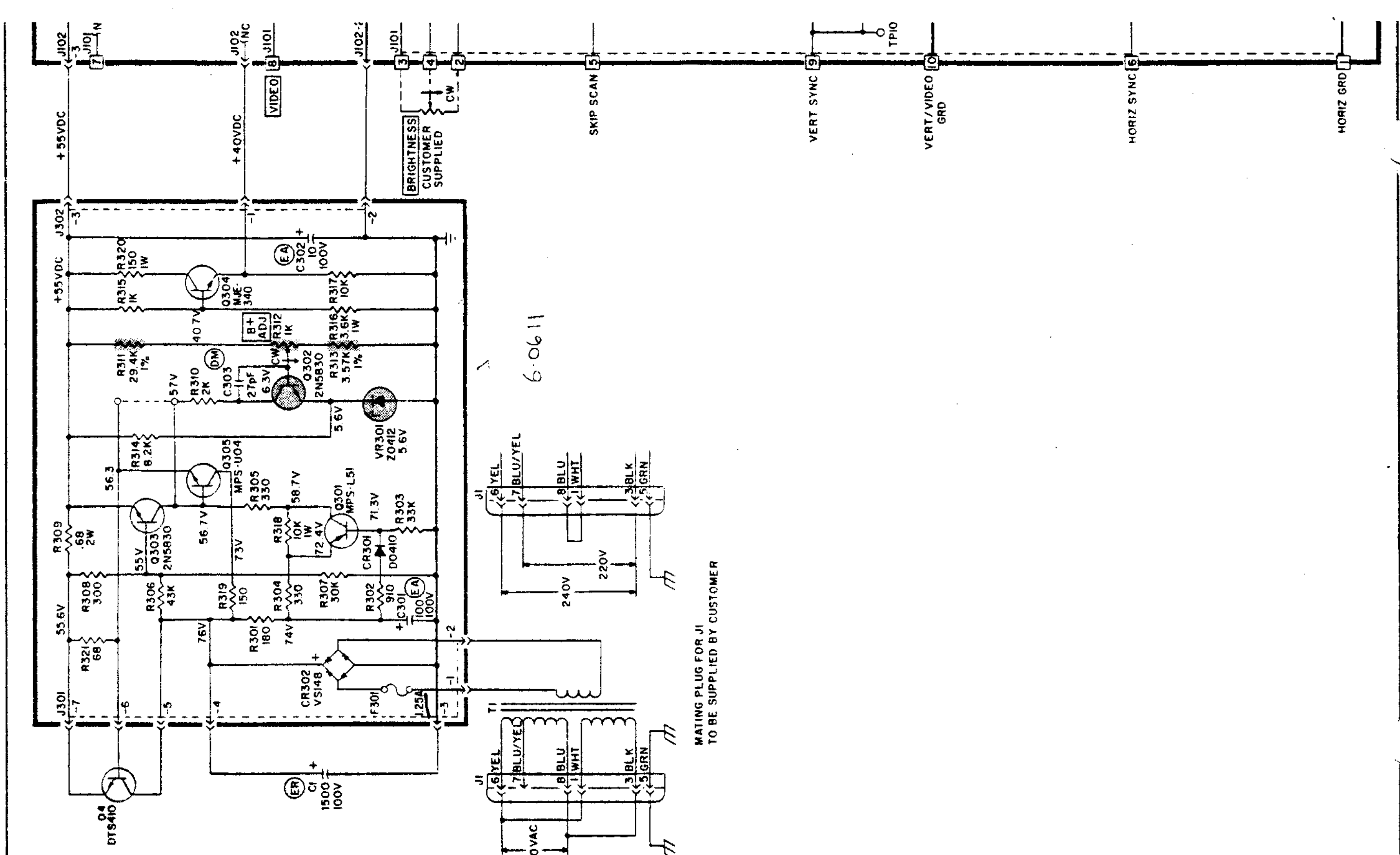
Product safety must be considered when any components is replaced in this monitor. The critical components that affect X-radiation are denoted in the shaded areas on the schematics. Components in the shaded area are to be replaced only with Ball Electronic Display Division approved components.

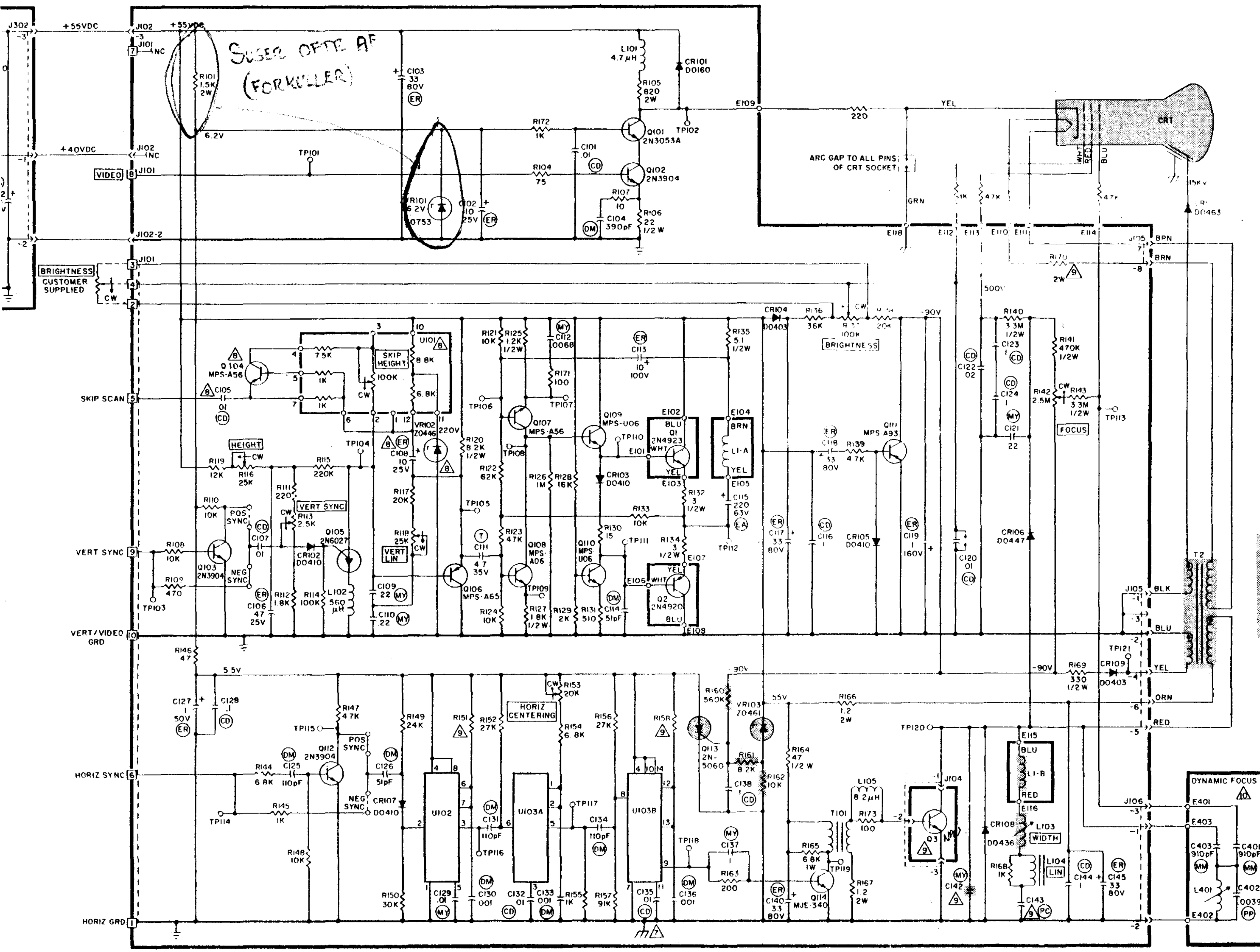
The use of substitute components which do not have the same characteristics as the original components may create excessive X-radiation.

6.7 CHASSIS MOUNTED COMPONENT PARTS LIST

REF SYM	DESCRIPTION	PART NUMBER
C1	Cap, 1500-100, ER	1-012-2186
CR1	Diode, HV, D0463	1-021-0463
J1	Connector Shell, 9 Pin Female	1-034-0313
L1	Deflection Coil - Refer to part number on yoke; i.e. 1-023-XXXX	

		Transistor	
Q1		2N4923	78-85-4923
Q2		2N4920	1-015-1169
Q3		B0402 (15,750)	78-85-0402
	or	B1213 (18,240)	1-015-1213
Q4		DTS410	78-85-0410
		Transformer	
T1		Power	
T2		High Voltage Stamp on Coil Form; i.e. 6-003-XXXX - Refer to last four digits of part number.	


+55VDC
+40VDC
VIDEO
BRIGHTNESS
CUSTOMER SUPPLIED
SKIP SCAN
VERT SYNC
VERT/VIDEO GRD
HORIZ SYNC
HORIZ GRD
TP10
J101
J102
J301
J302
Q4
DTS410
CR302
VS148
F301
T1
120VAC
240V
220V
C1
1500
100V
R321
68
R308
300
R306
43K
R309
.68
2W
Q303
2N5830
Q305
MPS-U04
R314
8.2K
R310
2K
C303
27pF
Q302
2N5830
R311
29.4K
1%
R312
1K
B+ ADJ
R313
3.57K
1%
R316
3.6K
1W
R315
1K
R320
150
1W
Q304
MJE-340
R317
10K
C302
10
100V
VR301
Z0412
5.6V
Q301
MPS-L51
R318
10K
1W
R303
33K
CR301
D0410
R307
30K
R302
910
C301
100
100V
R319
150
R304
330
R301
180
R305
330
MATING PLUG FOR J1
TO BE SUPPLIED BY CUSTOMER



GENERAL NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS 1/4W, 5%, VALUES IN OHMS.
2. ALL CAPACITOR VALUES IN MICROFARADS. FOR CAPACITOR TYPES SEE NOTE 6.
3. ☐ DENOTES CARD EDGE CONNECTOR.
4. →≻ DENOTES CONNECTION TO OFF BOARD COMPONENT.
5. LAST REFERENCE DESIGNATION USED: R173, C145, CR109, Q114
6. CAPACITOR TYPES
   - (DP) DIPPED MICA
   - (CD) CERAMIC DISC
   - (MY) MYLAR
   - (EA) ELECTROLYTIC AXIAL
   - (ER) ELECTROLYTIC RADIAL
   - (PC) POLYCARBONATE
   - (T) TANTALUM
   - (MM) MOLDED MICA
   - (PP) POLYPROPYLENE
7. SIGNAL TO CHASSIS GROUND CONNECTION MADE THROUGH BOARD MOUNT SCREW.
8. USED ON MODELS WITH SKIP SCAN OPTION.
9. R & C VALUE TABLE

REF SYM	HORIZ FREQUENCY 15750	18240
C142	.006	.01
C143	1.0	1.2
R151	36K	33K
R158	24K	20K
R170	1.2Ω	3.3Ω
Q3	B0402	B1213

10. USED ON MODELS WITH DYNAMIC FOCUS OPTION.

41

PRODUCT SAFETY MUST BE CONSIDERED WHEN ANY COMPONENT IS REPLACED IN THIS MONITOR. THE CRITICAL COMPONENTS THAT AFFECT X-RADIATION ARE DENOTED IN THE SHADED AREAS ON THE SCHEMATIC. COMPONENTS IN THE SHADED AREA ARE TO BE REPLACED ONLY WITH BALL E.O.D. APPROVED COMPONENTS.

THE USE OF SUBSTITUTE COMPONENTS WHICH DO NOT HAVE THE SAME CHARACTERISTICS AS THE BALL E.O.D. ORIGINAL COMPONENTS MAY CREATE EXCESSIVE X-RADIATION.

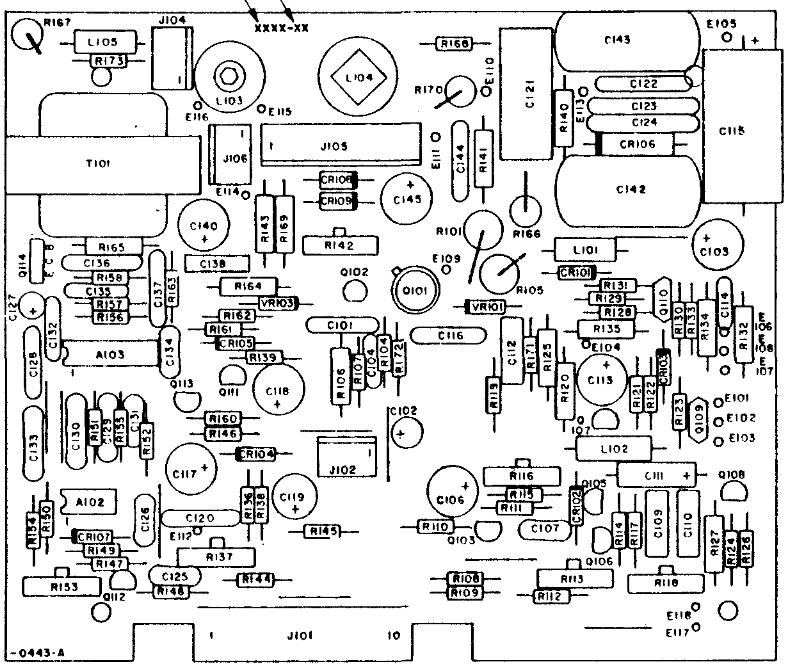
Ball | SCHEMATIC TTL 120 | E | 1-024-0592 | B | SCALE NONE

FIGURE 6.1 TTL 120 SCHEMATIC

B 1182

NOTES:
1 REFERENCE SCHEMATIC 1-024-0592
2. ALL PWA COMPONENTS PRECEDED WITH AN ASTERISK ARE NOT PART OF THE BASIC BOARD 6-200-0002.
3 PWA 6-002-0673 IS 15750 W/BRT
0674 IS 18240 W/BRT
0764 IS 15750 W/O BRT
0766 IS 18240 W/O BRT

REVISION LEVEL IDENTIFIER
LAST FOUR DIGITS OF PWA NUMBER



REF SYM	DESCRIPTION	PART NUMBER	0673	0674	0764	0766
			USED ON 6-002-			
*U101	NOT USED					
U102	IC MC1455P	1-025-0118	X	X	X	X
U103	IC 556	1-025-0119	X	X	X	X
	CAP, FIXED uF UNLESS NOTED					
C101	.01-500-20, CD	1-012-0740	X	X	X	X
C102	10-25, ER	1-012-2211	X	X	X	X
C103	33-80, ER	1-012-2259	X	X	X	X
C104	390pF-500-5, DM	10-56-5391	X	X	X	X
*C105	NOT USED					
C106	47-25, ER	1-012-2165	X	X	X	X
C107	.01-100-10, CD	10-12-7109	X	X	X	X
*C108	NOT USED					
C109	.22-200-10, MY	1-012-0930	X	X	X	X
C110	.22-200-10, MY	1-012-0930	X	X	X	X
*C111	4.7-35-10, T	1-012-2301	X	X	X	X
C112	.0068-200-10, MY	10-47-7682	X	X	X	X
C113	10-100, ER	1-012-2260	X	X	X	X
C114	51pF-500-5, DM	10-56-5510	X	X	X	X
C115	220-63, EA	1-012-2261	X	X	X	X
C116	.1-100-20, CD	10-12-7104	X	X	X	X
C117	33-80, ER	1-012-2259	X	X	X	X

REF SYM	DESCRIPTION	PART NUMBER	0673	0674	0764	0766
			USED ON 6-002-			
C118	33-80, ER	1-012-2259	X	X	X	X
C119	1-160, ER	1-012-2251	X	X	X	X
C120	.01-1000, CD	1-012-0112	X	X	X	X
C121	.22-630-10, MY	1-012-2287	X	X	X	X
C122	.02-1000-20, CD	1-012-2217	X	X	X	X
C123	.1-500-20, CD	10-16-7104	X	X	X	X
C124	.1-500-20, CD	10-16-7104	X	X	X	X
C125	110pF-500-5, DM	10-56-5111	X	X	X	X
C126	51pF-500-5, DM	10-56-5510	X	X	X	X
C127	1-50, ER	1-012-2189	X	X	X	X
C128	.1-100-10	1-012-2236	X	X	X	X
C129	.01-500-20, CD	1-012-0740	X	X	X	X
C130	.001-500-5, DM	10-57-5102	X	X	X	X
C131	110pF-500-5, DM	10-56-5111	X	X	X	X
C132	.01-500-20, CD	1-012-0740	X	X	X	X
C133	.001-500-5, DM	10-56-5102	X	X	X	X
C134	110pF-500-5, DM	10-56-5111	X	X	X	X
C135	.01-500-20, CD	1-012-0740	X	X	X	X
C136	.001-500-5, DM	10-56-5102	X	X	X	X
C137	.1-100-10, MY	1-012-2236	X	X	X	X
C138	.1-100-20, CD	10-12-7104	X	X	X	X
*C139	NOT USED					
C140	33-80, ER	1-012-2259	X	X	X	X
C141	NOT USED					
*C142	.006-1600-10, MY	1-012-2268	X		X	
	OR .01-1500-10, MY	1-012-2248		X		X
*C143	1.2-200-10, PC	1-012-2233		X		X
	OR 1-100-10, PC	1-012-2220	X		X	
C144	.1-100-20, CD	10-12-7104	X	X	X	X
C145	33-80, ER	1-012-2259	X	X	X	X

REVISIONS
A ENGRG RELEASE
C ECO 3350, 3219 Deleted 4 jumper wires and basic Pwa parts list
D ECO 3370, 3371

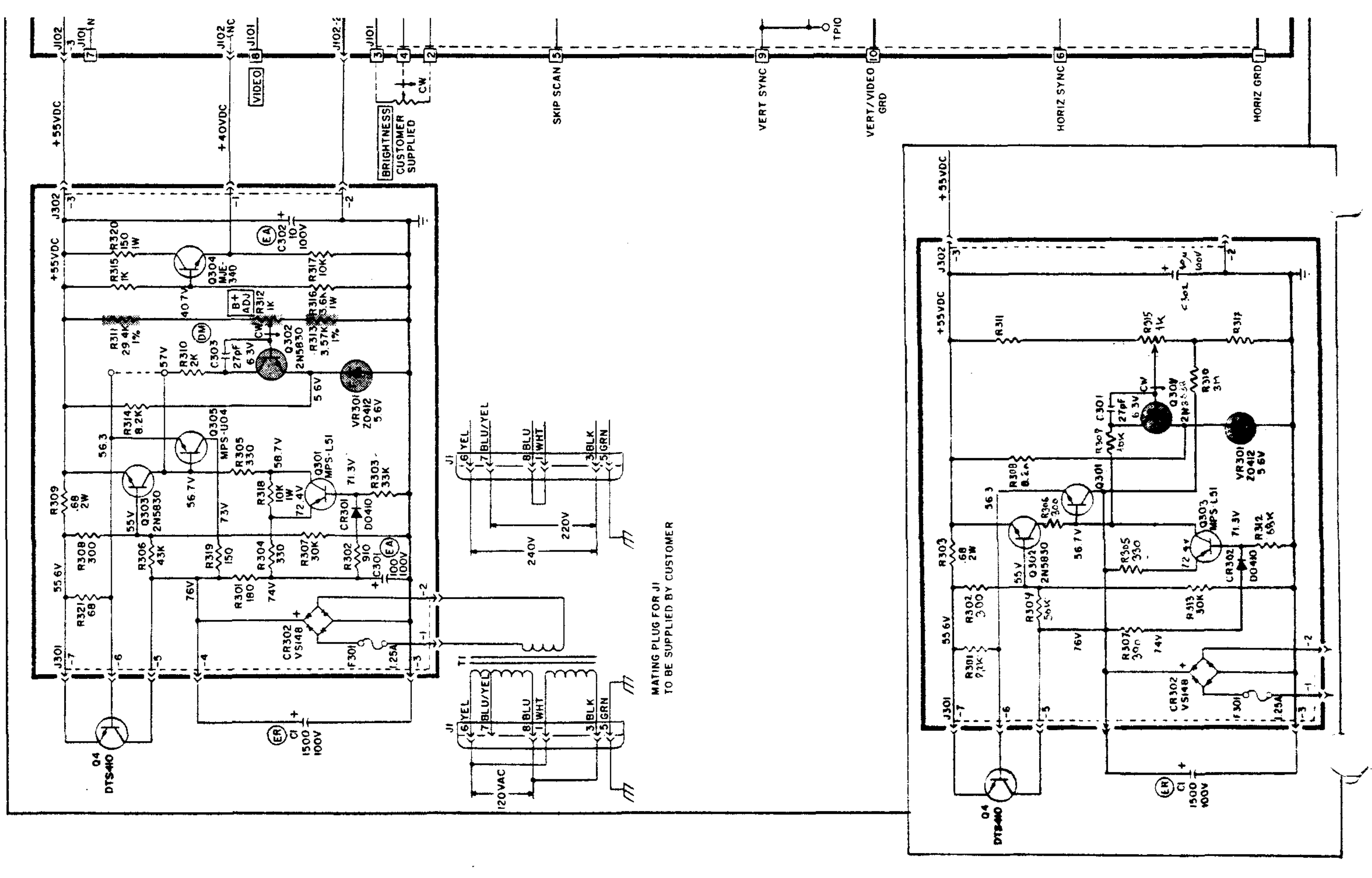
REF SYM	DESCRIPTION	PART NUMBER	USED ON 6-002- 0673	0674	0764	0766
	DIODE					
CR101	D0160	1-021-0160	X	X	X	X
CR102	D0410	1-021-0410	X	X	X	X
CR103	D0410	1-021-0410	X	X	X	X
CR104	D0403	1-021-0403	X	X	X	X
CR105	D0410	1-021-0410	X	X	X	X
CR106	D0447	1-021-0447	X	X	X	X
CR107	D0410	1-021-0410	X	X	X	X
CR108	D0436	1-021-0436	X	X	X	X
CR109	D0403	1-021-0403	X	X	X	X
	CONNECTOR					
J102	CONN, 3 PIN	1-039-0148	X	X	X	X
*J103	NOT USED					
J104	CONN, 3 PIN	1-039-0148	X	X	X	X
J105	CONN, 8 PIN	1-039-0149	X	X	X	X
J106	CONN, 3 PIN	1-039-0148	X	X	X	X
	COIL					
L101	4.7uH	15-13-1479	X	X	X	X
L102	560uH	1-016-0302	X	X	X	X
*L103	WIDTH	1-016-0304	X		X	
	OR WIDTH	1-016-0317		X		X
*L104	LINEARITY	1-016-0331	X		X	
	OR LINEARITY	1-016-0330		X		X
L105	8.2uH	15-13-1829	X	X	X	X
	TRANSISTORS					
Q101	2N3053A	1-015-1205	X	X	X	X
Q102	2N3904	1-015-1144	X	X	X	X
Q103	2N3904	1-015-1144	X	X	X	X
*Q104	NOT USED					
Q105	2N6027	1-015-1157	X	X	X	X
Q106	MPS-A65	1-015-1136	X	X	X	X
Q107	MPS-A56	1-015-1171	X	X	X	X
Q108	MPS-A06	1-015-1165	X	X	X	X
Q109	MPS-U06	1-015-1164	X	X	X	X
Q110	MPS-U06	1-015-1164	X	X	X	X
Q111	MPS-A93	1-015-1202	X	X	X	X
Q112	2N3904	1-015-1144	X	X	X	X
Q113	2N5060	1-015-1168	X	X	X	X
Q114	MJE-340	78-86-0340	X	X	X	X
	RES, FIXED CARBON 1/4W±5%					
R101	1.5K-2-10	1-011-1500	X	X	X	X
*R102	NOT USED					
*R103	NOT USED					
*R104	75	70-16-0750	X	X	X	X
R105	820-2-5	1-011-2422	X	X	X	X
R106	22-1/2-5	1-011-2230	X	X	X	X
R107	10	70-16-0100	X	X	X	X
R108	10K	70-16-0103	X	X	X	X
R109	470	70-16-0471	X	X	X	X
R110	10K	70-16-0103	X	X	X	X
R111	220	70-16-0221	X	X	X	X
R112	1.8K	70-16-0182	X	X	X	X
R113	VAR 2.5K-20	1-011-5636	X	X	X	X
R114	100K	70-16-0104	X	X	X	X
R115	220K	70-16-0224	X	X	X	X
R116	VAR 25K-20	1-011-5325	X	X	X	X
R117	20K	70-16-0203	X	X	X	X
R118	VAR 25K-20	1-011-5325	X	X	X	X
R119	12K	70-16-0123	X	X	X	X
R120	8.2K-1/2-5	1-011-2292	X	X	X	X
R121	10K	70-16-0103	X	X	X	X
*R122	62K	70-16-0623	X	X	X	X
R123	47K	70-16-0473	X	X	X	X
*R124	10K	70-16-0103	X	X	X	X
R125	1.2K-1/2-5	1-011-2272	X	X	X	X
R126	1M	70-16-0105	X	X	X	X
*R127	1.8K-1/2-5	1-011-2276	X	X	X	X
R128	16K	70-16-0163	X	X	X	X
R129	2K	70-16-0202	X	X	X	X
R130	15	70-16-0150	X	X	X	X
R131	510	70-16-0511	X	X	X	X
R132	3-1/2-5	1-011-2478	X	X	X	X
R133	10K	70-16-0103	X	X	X	X

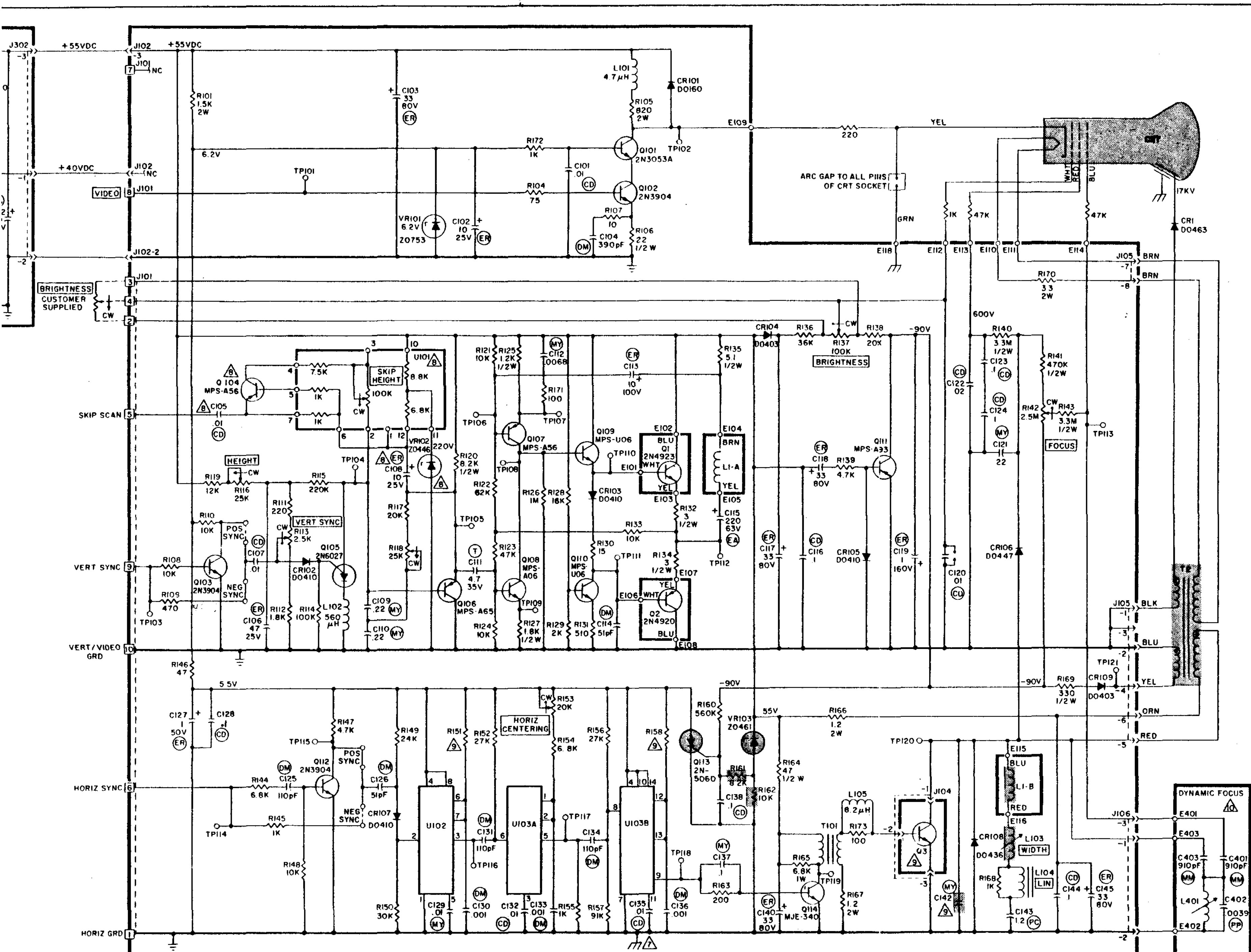
REF SYM	DESCRIPTION	PART NUMBER	USED ON 6-002- 0673	0674	0764	0766
R134	3-1/2-5	1-011-2478	X	X	X	X
R135	5.1-1/2-5	70-17-0519	X	X	X	X
R136	36K	70-16-0363	X	X	X	X
*R137	VAR; 100K-20	1-011-5435	X	X		
R138	20K	70-16-0203	X	X	X	X
R139	4.7K	70-16-0472	X	X	X	X
R140	3.3M-1/2-5	1-011-2354	X	X	X	X
R141	470K-1/2-5	1-011-2334	X	X	X	X
R142	VAR 2.5M-20	1-011-5566	X	X	X	X
R143	3.3M-1/2-5	1-011-2354	X	X	X	X
R144	6.8K	70-16-0682	X	X	X	X
R145	1K	70-16-0102	X	X	X	X
R146	47	70-16-0470	X	X	X	X
R147	4.7K	70-16-0472	X	X	X	X
R148	10K	70-16-0103	X	X	X	X
R149	24K	70-16-0243	X	X	X	X
R150	30K	70-16-0303	X	X	X	X
*R151	36K	70-16-0363	X		X	
	OR 33K	70-16-0333		X		X
R152	27K	70-16-0273	X	X	X	X
*R153	VAR 20K-20	70-89-0203	X	X	X	X
R154	6.8K	70-16-0682	X	X	X	X
R155	1K	70-16-0102	X	X	X	X
R156	27K	70-16-0273	X	X	X	X
R157	91K	70-16-0913	X	X	X	X
*R158	24K	70-16-0243	X		X	
	OR 20K	70-16-0203		X		X
*R159	NOT USED					
R160	560K	70-16-0564	X	X	X	X
R161	8.2K	70-16-0822	X	X	X	X
R162	10K	70-16-0103	X	X	X	X
R163	200	70-16-0201	X	X	X	X
R164	47-1/2-5	1-011-2238	X	X	X	X
R165	6.8K-1-5	1-011-2536	X	X	X	X
R166	1.2-2-10	1-011-1395	X	X	X	X
R167	1.2-2-10	1-011-1395	X	X	X	X
R168	1K	70-16-0102	X	X	X	X
R169	330-1/2-5	1-011-2258	X	X	X	X
*R170	3.3-2-10, WW	1-011-1571		X		X
	OR 1.2-2-10, WW	1-011-1395	X		X	
R171	100	70-16-0101	X	X	X	X
R172	1K	70-16-0102	X	X	X	X
R173	100	70-16-0101	X	X	X	X
*R174	NOT USED					
	TRANSFORMER					
T101	HORIZ DRIVER	1-017-5330	X	X	X	X
	ZENER					
VR101	Z0753	78-15-0753	X	X	X	X
*VR102	NOT USED					
VR103	Z0461	1-021-0461	X	X	X	X
	MISCELLANEOUS					
	*SOCKET, CRT	1-022-0442	X	X	X	X
	PWB	1-029-0443	X	X	X	X
	ASSY CONN Q1 & Q2	1-041-0105	X	X	X	X
	WIRE/CONT BRN	1-043-1210	X	X	X	X
	WIRE/CONT RED	1-043-2210	X	X	X	X
	WIRE/CONT YEL	1-043-4210	X	X	X	X
	WIRE/CONT BLU	1-043-6210	X	X	X	X
	CABLE TIE (2)	2-048-0110	X	X	X	X
	JUMPER WIRE (8) 1/4W LG		X	X	X	X
	JUMPER WIRE (1) 41.3mm LG		X	X	X	X

TOLERANCES UNLESS OTHERWISE SPECIFIED — DO NOT SCALE DRAWING

TITLE: PWA, TTL-120 — SIZE D — DRAWING NO. 5-017-5019 — REV D — SCALE 2-1 — SHEET 1 OF 1

FIGURE 6.2 TTL 120 MAIN PWA COMPONENT LAYOUT AND PARTS LIST


+55VDC
+40VDC
VIDEO
BRIGHTNESS
CUSTOMER SUPPLIED
SKIP SCAN
VERT SYNC
VERT/VIDEO GRD
HORIZ SYNC
HORIZ GRD
TP10
MATING PLUG FOR J1
TO BE SUPPLIED BY CUSTOMER
120VAC
240V
220V



GENERAL NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS 1/4W, 5%, VALUES IN OHMS.
2. ALL CAPACITOR VALUES IN MICROFARADS. FOR CAPACITOR TYPES SEE NOTE 6.
3. ☐ DENOTES CARD EDGE CONNECTOR.
4. —>>— DENOTES CONNECTION TO OFF BOARD COMPONENT.
5. LAST REFERENCE DESIGNATION USED: R173, C145, CR109, Q114
6. CAPACITOR TYPES
   - (DM) DIPPED MICA
   - (CD) CERAMIC DISC
   - (MY) MYLAR
   - (EA) ELECTROLYTIC AXIAL
   - (ER) ELECTROLYTIC RADIAL
   - (PC) POLYCARBONATE
   - (T) TANTALUM
   - (MM) MOLDED MICA
   - (PP) POLYPROPYLENE
7. SIGNAL TO CHASSIS GROUND CONNECTION MADE THROUGH BOARD MOUNT SCREW.
8. USED ON MODELS WITH SKIP SCAN OPTION.
9. R & C VALUE TABLE

REF SYM	HORIZ FREQUENCY 15750	18240
C142	.0056	.0068
R151	36K	33K
R158	24K	20K
Q3	B0402	B1213

10. USED ON MODELS WITH DYNAMIC FOCUS OPTION.

45

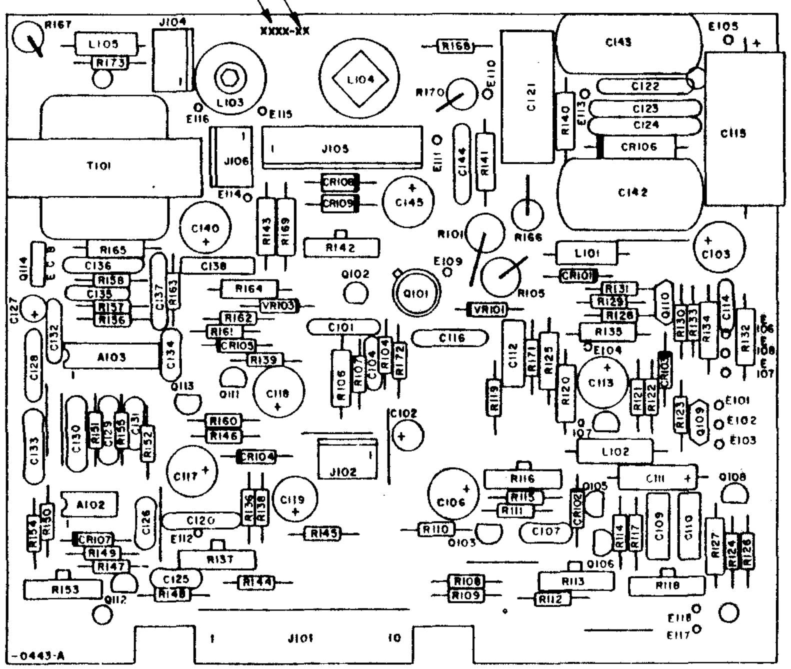
SCHEMATIC

E I-024-0602 A

FIGURE 6.3 TTL150 SCHEMATIC

NOTES: 1. REFERENCE SCHEMATIC: 1-024-0602
2. ALL PWA COMPONENTS PRECEDED WITH AN ASTERISK ARE NOT PART OF THE BASIC BOARD 6-200-0002.
3. PWA 6-002-0671 IS 15750 W/BRT
0672 IS 18240 W/BRT
0763 IS 15750 W/O BRT
0765 IS 18240 W/O BRT

REVISION LEVEL IDENTIFICATION
LAST FOUR DIGITS OF PWA NUMBER



REF SYM	DESCRIPTION	PART NUMBER	USED ON 6-002- 0671	0672	0763	0765
*A101	NOT USED					
A102	IC MC1455P	1-025-0118	X	X	X	X
A103	IC 556	1-025-0119	X	X	X	X
	CAP, FIXED uF UNLESS NOTED					
C101	.01-500-20, CD	1-012-0740	X	X	X	X
C102	10-25, ER	1-012-2211	X	X	X	X
C103	33-80, ER	1-012-2259	X	X	X	X
C104	390pF-500-5, DM	10-56-5391	X	X	X	X
*C105	NOT USED					
C106	47-25, ER	1-012-2165	X	X	X	X
C107	.01-100-10, CD	10-12-7109	X	X	X	X
*C108	NOT USED					
C109	.22-200-10, MY	1-012-9930	X	X	X	X
C110	.22-200-10, MY	1-012-9930	X	X	X	X
*C111	4.7-35-10, T	1-012-2391	X	X	X	X
C112	.0068-200-10, MY	10-47-7682	X	X	X	X
C113	10-100, ER	1-012-2269	X	X	X	X
C114	51pF-500-5, DM	10-57-5510	X	X	X	X
C115	220-63, EA	1-012-2261	X	X	X	X
C116	.1-100-20, CD	10-12-7104	X	X	X	X
C117	33-80, ER	1-012-2259	X	X	X	X
C118	33-80, ER	1-012-2259	X	X	X	X
C119	1-160, ER	1-012-2251	X	X	X	X
C120	.01-1000, CD	1-012-0112	X	X	X	X
C121	.22-630-10, MY	1-012-2287	X	X	X	X
C122	.02-1000-20, CD	1-012-2217	X	X	X	X
C123	.1-500-20, CD	10-16-7104	X	X	X	X
C124	.1-500-20, CD	10-16-7104	X	X	X	X
C125	110pF-500-5, DM	10-57-5111	X	X	X	X
C126	51pF-500-5, DM	10-57-5510	X	X	X	X
C127	1-50, ER	1-012-2189	X	X	X	X
C128	.1-100-10	1-012-2236	X	X	X	X
C129	.01-500-20, CD	1-012-0740	X	X	X	X
C130	.001-500-5, DM	10-57-5102	X	X	X	X
C131	110pF-500-5, DM	10-57-5111	X	X	X	X
C132	.01-500-20, CD	1-012-0740	X	X	X	X
C133	.001-500-5, DM	10-57-5102	X	X	X	X
C134	110pF-500-5, DM	10-57-5111	X	X	X	X
C135	.01-500-20, CD	1-012-0740	X	X	X	X
C136	.001-500-5, DM	10-57-5102	X	X	X	X
C137	.1-100-10, MY	1-012-2236	X	X	X	X
C138	.1-100-20, CD	10-12-7104	X	X	X	X
*C139	NOT USED					
C140	33-80, ER	1-012-2259	X	X	X	X
C141	NOT USED		X	X	X	X
*C142	.0056-2000-10, MY	10-35-7562	X		X	
	OR .0068-1600-10, MY	1-012-2210		X		X
*C143	1.2-200-10, PC	1-012-2233	X	X	X	X
C144	.1-100-20, CD	10-12-7104	X	X	X	X
C145	33-80, ER	1-012-2259	X	X	X	X

REVISIONS
A ENGRG RELEASE
C ECO 3211, 3310, 3219 Deleted 4 jumper wires. Add basic PWA parts list. R165 was 3.9K, C137 was .05, R107 was 33Ω, C107 was .01,500V
D ECO 3371

REF SYM	DESCRIPTION	PART NUMBER	USED ON 6-002- 0671	0672	0763	0765
	DIODE					
CR101	D0160	1-021-0160	X	X	X	X
CR102	D0410	1-021-0410	X	X	X	X
CR103	D0410	1-021-0410	X	X	X	X
CR104	D0403	1-021-0403	X	X	X	X
CR105	D0410	1-021-0410	X	X	X	X
CR106	D0447	1-021-0447	X	X	X	X
CR107	D0410	1-021-0410	X	X	X	X
CR108	D0436	1-021-0436	X	X	X	X
CR109	D0403	1-021-0403	X	X	X	X
	CONNECTOR					
J102	CONN, 3 PIN	1-039-0148	X	X	X	X
*J103	NOT USED					
J104	CONN, 3 PIN	1-039-0148	X	X	X	X
J105	CONN, 8 PIN	1-039-0149	X	X	X	X
J106	CONN, 3 PIN	1-039-0148	X	X	X	X
	COIL					
L101	4.7uH	15-13-1479	X	X	X	X
L102	560uH	1-016-0302	X	X	X	X
*L103	WIDTH	1-016-0304	X		X	
	OR WIDTH	1-016-0319		X		X
*L104	COIL LINEARITY	1-016-0331	X		X	
	OR COIL LINEARITY	1-016-0330		X		X
L105	8.2uH	15-13-1829	X	X	X	X
	TRANSISTORS					
Q101	2N3053A	1-015-1205	X	X	X	X
Q102	2N3904	1-015-1144	X	X	X	X
Q103	2N3904	1-015-1144	X	X	X	X
*Q104	NOT USED					
Q105	2N6027	1-015-1157	X	X	X	X
Q106	MPS-A65	1-015-1186	X	X	X	X
Q107	MPS-A56	1-015-1171	X	X	X	X
Q108	MPS-A06	1-015-1165	X	X	X	X
Q109	MPS-U06	1-015-1164	X	X	X	X
Q110	MPS-U06	1-015-1164	X	X	X	X
Q111	MPS-A93	1-015-1202	X	X	X	X
Q112	2N3904	1-015-1144	X	X	X	X
Q113	2N5060	1-015-1168	X	X	X	X
Q114	MJE-340	78-86-0340	X	X	X	X
	RES, FIXED CARBON 1/4W±5% UNLESS NOTED					
R101	1.5K-2-10	1-011-1500	X	X	X	X
*R102	NOT USED					
*R103	NOT USED					
*R104	75	70-16-0750	X	X	X	X
R105	820-2-5	1-011-2422	X	X	X	X
R106	22-1/2-5	1-011-2230	X	X	X	X
R107	10	70-16-0100	X	X	X	X
R108	10K	70-16-0103	X	X	X	X
R109	470	70-16-0471	X	X	X	X
R110	10K	70-16-0103	X	X	X	X
R111	220	70-16-0221	X	X	X	X
R112	1.8K	70-16-0182	X	X	X	X
R113	VAR 2.5K-20	1-011-5636	X	X	X	X
R114	100K	70-16-0104	X	X	X	X
R115	220K	70-16-0224	X	X	X	X
R116	VAR 25K-20	1-011-5325	X	X	X	X
R117	20K	70-16-0203	X	X	X	X
R118	VAR 25K-20	1-011-5325	X	X	X	X
R119	12K	70-16-0123	X	X	X	X
R120	8.2K-1/2-5	1-011-2292	X	X	X	X
R121	10K	70-16-0103	X	X	X	X
*R122	62K	70-16-0623	X	X	X	X
R123	47K	70-16-0473	X	X	X	X
*R124	10K	70-16-0103	X	X	X	X
R125	1.2K-1/2-5	1-011-2272	X	X	X	X
R126	1M	70-16-0105	X	X	X	X
*R127	1.8K-1/2-5	1-011-2276	X	X	X	X
R128	16K	70-16-0163	X	X	X	X
R129	2K	70-16-0202	X	X	X	X
R130	15	70-16-0150	X	X	X	X
R131	510	70-16-0511	X	X	X	X
R132	3-1/2-5	1-011-2478	X	X	X	X

REF SYM	DESCRIPTION	PART NUMBER	USED ON 6-002- 0671	0672	0763	0765
R133	10K	70-16-0103	X	X	X	X
R134	3-1/2-5	1-011-2478	X	X	X	X
R135	5.1-1/2-5	70-17-0519	X	X	X	X
R136	36K	70-16-0363	X	X	X	X
*R137	VAR; 100K-20	1-011-5435	X	X		
R138	20K	70-16-0203	X	X	X	X
R139	4.7K	70-16-0472	X	X	X	X
R140	3.3M-1/2-5	1-011-2354	X	X	X	X
R141	470K-1/2-5	1-011-2334	X	X	X	X
R142	VAR 2.5M-20	1-011-5566	X	X	X	X
R143	3.3M-1/2-5	1-011-2354	X	X	X	X
R144	6.8K	70-16-0682	X	X	X	X
R145	1K	70-16-0102	X	X	X	X
R146	47	70-16-0470	X	X	X	X
R147	4.7K	70-16-0472	X	X	X	X
R148	10K	70-16-0103	X	X	X	X
R149	24K	70-16-0243	X	X	X	X
R150	30K	70-16-0303	X	X	X	X
*R151	36K	70-16-0363	X		X	
	OR 33K	70-16-0333		X		X
R152	27K	70-16-0273	X	X	X	X
*R153	VAR 20K-20	70-89-0203	X	X	X	X
R154	6.8K	70-16-0682	X	X	X	X
R155	1K	70-16-0102	X	X	X	X
R156	27K	70-16-0273	X	X	X	X
R157	91K	70-16-0913	X	X	X	X
*R158	24K	70-16-0243	X		X	
	OR 20K	70-16-0203		X		X
*R159	NOT USED					
R160	560K	70-16-0564	X	X	X	X
R161	8.2K	70-16-0822	X	X	X	X
R162	10K	70-16-0103	X	X	X	X
R163	200	70-16-0201	X	X	X	X
R164	47-1/2-5	1-011-2238	X	X	X	X
R165	6.8K-1-5	1-011-2536	X	X	X	X
R166	1.2-2-10	1-011-1395	X	X	X	X
R167	1.2-2-10	1-011-1395	X	X	X	X
R168	1K	70-16-0102	X	X	X	X
R169	330-1/2-5	1-011-2258	X	X	X	X
*R170	3.3-2-10, WW	1-011-1571	X	X	X	X
R171	100	70-16-0101	X	X	X	X
R172	1K	70-16-0102	X	X	X	X
R173	100	70-16-0101	X	X	X	X
*R174	NOT USED					
	TRANSFORMER					
T101	HORIZ DRIVER	1-017-5380	X	X	X	X
	ZENER					
VR101	Z0753	73-15-0753	X	X	X	X
*VR102	NOT USED					
VR103	Z0461	1-021-0461	X	X	X	X
	MISCELLANEOUS					
	*SOCKET, CRT	1-022-0422	X	X	X	X
	PWB	1-029-0443	X	X	X	X
	ASSY CONN Q1 & Q2	1-041-0105	X	X	X	X
	WIRE/CONT BRN	1-043-1210	X	X	X	X
	WIRE/CONT RED	1-043-2210	X	X	X	X
	WIRE/CONT YEL	1-043-4210	X	X	X	X
	WIRE/CONT BLU	1-043-6210	X	X	X	X
	CABLE TIE (2)	2-048-0110	X	X	X	X
	JUMPER WIRE (8) 1/4W LG		X	X	X	X
	JUMPER WIRE (1) 41.3MM LG		X	X	X	X

TOLERANCES UNLESS OTHERWISE SPECIFIED — DO NOT SCALE DRAWING

Ball

TITLE: PW ASSY, TTL-150 15.75 KC, 18.24 KC

SIZE D — DRAWING NO 5-017-5015 — REV D — SCALE 2-1 — SHEET 1 of 1

FIGURE 6.4 TTL 150 MAIN PWA COMPONENT LAYOUT AND PARTS LIST

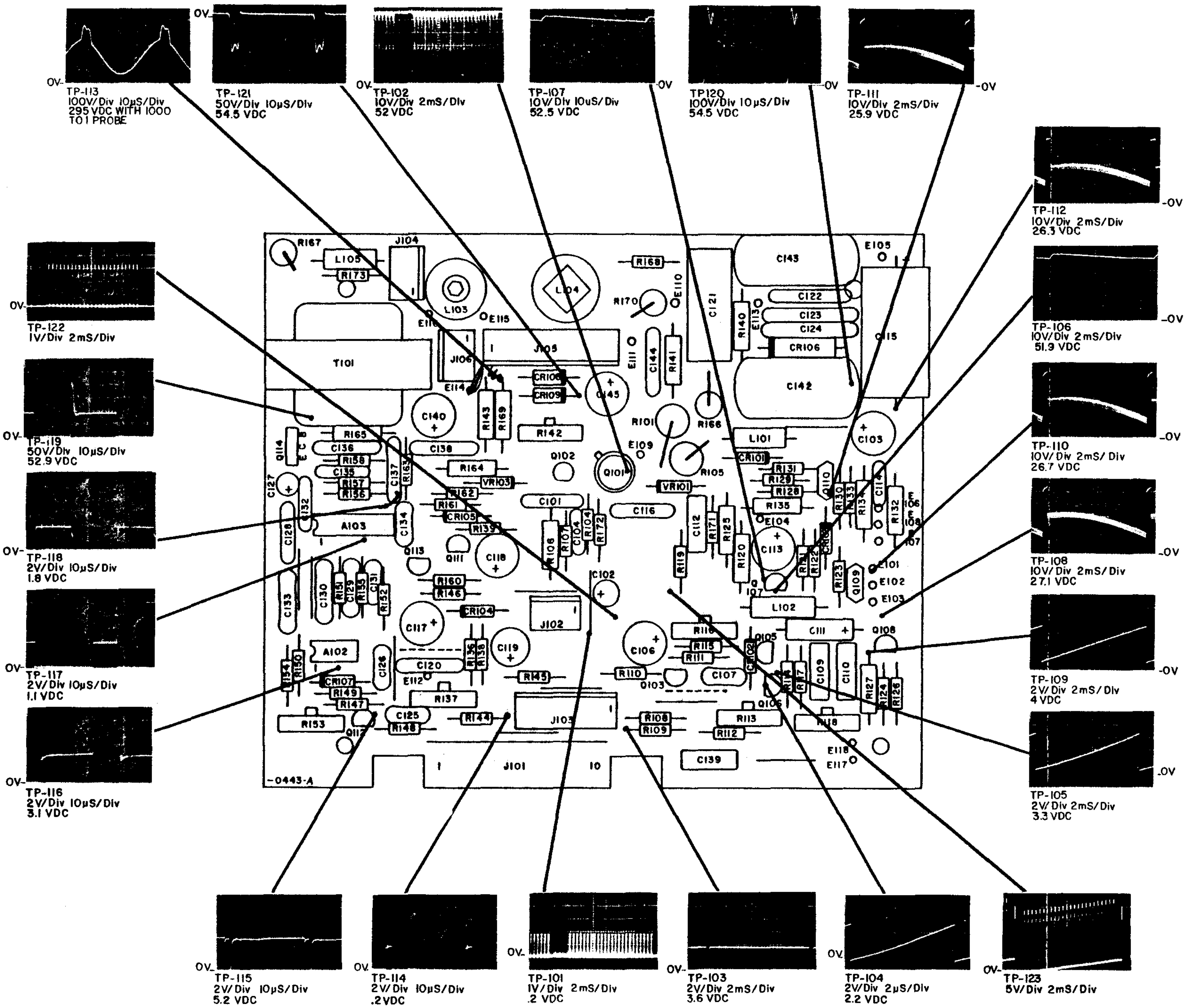
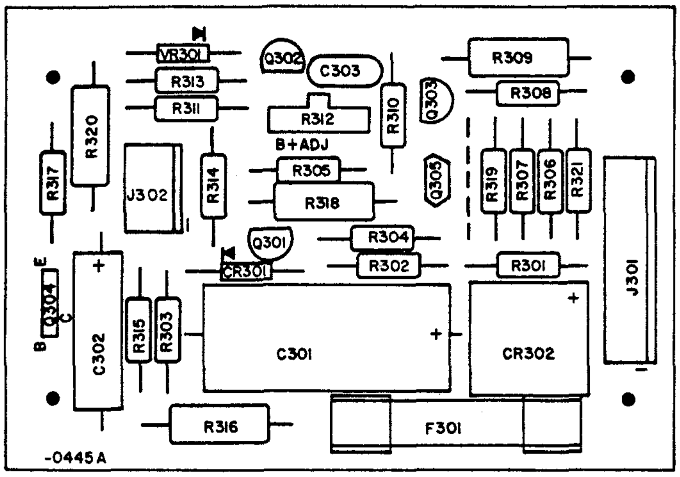


FIGURE 6.5 TTL120/150 WAVEFORMS

IM1024

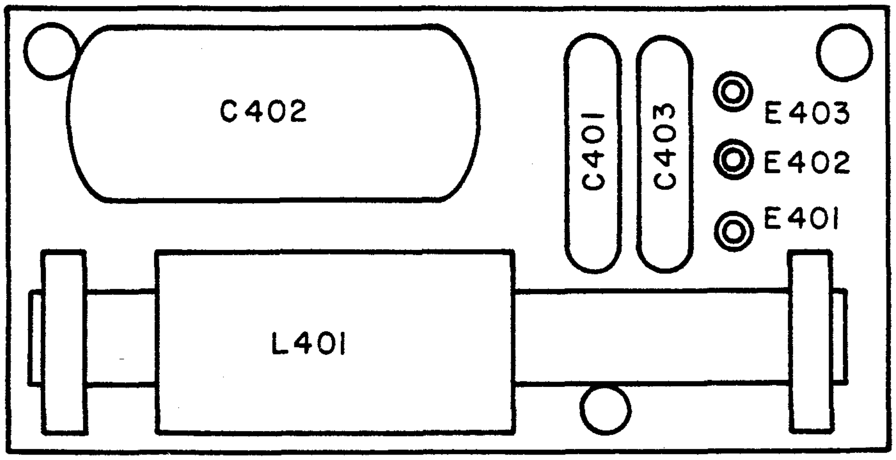


REF SYM	DESCRIPTION	PART NUMBER
	CAP, FIXED uF UNLESS NOTED	
C301	100-100, EA	1-012-2127
C302	10-100, EA	1-012-2115
C303	27pF-500-5, DM	1-012-2161
	CONNECTOR	
J301	CONN 7 PIN MALE	1-039-0145
J302	CONN 3 PIN MALE	1-039-0148
	DIODES	
CR301	D0410	1-021-0410
CR302	VS148 2 AMP	1-021-0413
	FUSE	
F301	FUSE 1.25A-250V	28-13-0125
	RES, FIXED CARBON 1/2W ±5% UNLESS NOTED	
R301	180	1-011-2252
R302	910	1-011-2269
R303	33K	1-011-2306
R304	330	1-011-2258
R305	330	1-011-2258
R306	43K	1-011-2309
R307	30K	1-011-2305
R308	300	1-011-2257
R309	.68-2-10, WW	1-011-2217
R310	2K	1-011-2277
R311	29.4K-1%	1-011-2518

REF SYM	DESCRIPTION	PART NUMBER
R312	VAR 1K-1/4-20%, CO	1-011-5182
R313	3.57K-1%	1-011-2517
R314	8.2K	1-011-2292
R315	1K	1-011-2270
R316	3.6K-1	1-011-2527
R317	10K	1-011-2294
R318	10K-1-10, CO	1-011-2508
R319	150	1-011-2250
R320	150-1-10, CO	1-011-1155
R321	68	1-011-2242
	TRANSISTORS	
Q301	MPS-L51	1-015-1175
Q302	2N5830	1-015-1172
Q303	2N5830	1-015-1172
Q304	MJE340	78-86-0340
Q305	MPS-U04	1-015-1167
	ZENER	
VR301	Z0412	1-021-0412
	MISCELLANEOUS	
	FUSE CLIP (2)	13-14-6008
	PWB	1-029-0445

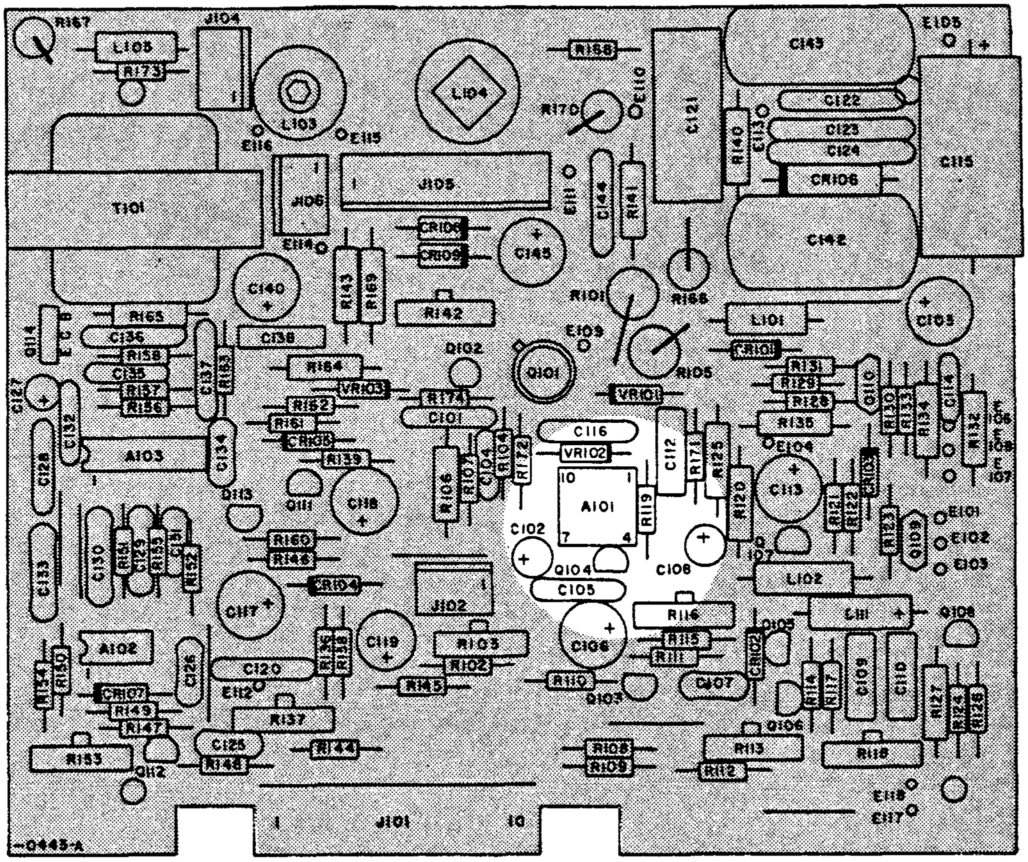
FIGURE 6.6 COMPONENT LAYOUT LOW VOLTAGE REGULATOR PWA

IM1024



REF SYM	DESCRIPTION	PART NUMBER
	CAP, FIXED uF UNLESS NOTED	
C401	910-1000-5, MM	1-012-0523
C402	3900-1600-10, PP	1-012-2262
C403	910-1000-5, MM	1-012-0523
	COIL	
L401	FOCUS	1-016-0249
	MISCELLANEOUS	
	PWB	1-029-0446
	CONN, SHELL, 3 PIN	1-034-0356
E401	WIRE/CONT ORN	1-043-3271
E402	WIRE/CONT BLK	1-043-0270
E403	WIRE/CONT RED	1-043-2271

Figure 6.7 Component Layout for Dynamic Focus PWA



PART NUMBERS FOR PWA'S WITH THE SKIP SCAN OPTION ARE:

6-002-0738	TTL 150, 15,750 W/BRT
6-002-0768	TTL 150, 18,240 W/BRT
6-002-0769	TTL 150, 15,750 W/O BRT
6-002-0770	TTL 150, 18,240 W/O BRT
6-002-0771	TTL 120, 15,750 W/BRT
6-002-0772	TTL 120, 18,240 W/BRT
6-002-0773	TTL 120, 15,750 W/O BRT
6-002-0774	TTL 120, 18,240 W/O BRT

THE BALANCE OF THE COMPONENT PARTS AND PART NUMBERS CAN BE FOUND ON THE APPROPRIATE COMPONENT LAYOUTS WITHOUT THE SKIP SCAN OPTION; FOR EXAMPLE, BALANCE OF THE PARTS USED ON 6-002-0738 TTL150, 15,750, W/BRT CAN BE LOCATED ON FIGURE 6.4.

SKIP SCAN COMPONENT PARTS LIST

REF SYM	DESCRIPTION	PART NUMBER
U101	RES TRIM 100K	1-011-8004
C105	CAP .01uF-500-20, CD	1-012-0740
C108	CAP 10uF-25, ER	1-012-2211
Q104	TRANSISTOR MPS-A56	1-015-1171
VR102	ZENER, Z0446	1-021-0446

Figure 6.8 Skip Scan Component Layout and Parts List

WARRANTY

Ball Electronic Display Division certifies that each monitor will be free from defective materials and workmanship for one year from date of shipment to the original customer. The only exception will be the receiving tubes and solid state devices (transistors, diodes, etc.). Receiving tubes will carry a 90 day warranty, and the picture tube will have the standard one year warranty. With solid state devices, we will reflect the manufacturers' warranty.

Ball Electronic Display Division agrees to correct any of the above defects when the monitor is returned to the factory prepaid. Written authorization must be obtained and confirmed in writing by the Customer Service Department before returning the monitor to the factory.

Under this warranty, Ball Electronic Display Division will provide the necessary components required by the customer to correct the monitor in the field. The components will be shipped, prepaid, on a billing memo which will be cancelled upon receipt of the defective components at the factory. When ordering components for repair or replacement, the model number and serial number must be included on the customer request.

This warranty is invalid if the monitor is subject to mis-use, abuse, neglect, accident, improper installation or application, alteration or negligence in use, storage, transportation or handling and where the serial number has been removed, defaced or changed.

INSTALLATION AND OPERATING MANUAL

MALFUNCTION REPORT

Dear Customer:

We are trying to manufacture the most reliable product possible. You would do us a great courtesy by completing this form should you experience any failures.

1. Type Unit ____________________ Serial No. ____________

   Module (if applicable) ____________________

2. Part failed (Name and Number) ____________________

3. Cause of failure (if readily available) ____________________

   ____

   ____

   ____

4. Approximate hours/days of operation to failure ____________________

5. Failure occurred during:

   Final Inspection   Customer Installation   Field Use

6. Personal Comment:

   ____

   ____

   ____

Customer ____________________

Address ____________________

Signed ____________________

Date ____________________

Ball Electronic Display Division
P.O. Box 43376
St. Paul, Minnesota 55164
Telephone 612-786-8900 TWX 910-563-3552

LOST OR DAMAGED EQUIPMENT

The goods described on your Packing Slip have been received by the Transportation Company complete and in good condition. If any of the goods called for on this Packing Slip are short or damaged, you must file a claim WITH THE TRANSPORTATION COMPANY FOR THE AMOUNT OF THE DAMAGE AND/OR LOSS.

IF LOSS OR DAMAGE IS EVIDENT AT TIME OF DELIVERY:

If any of the good called for on this Packing Slip are short or damaged at the time of delivery, ACCEPT THEM, but only if the Freight Agent makes a damaged or short notation on your Freight Bill or Express Receipt and signs it.

IF DAMAGE OR LOSS IS CONCEALED AND DISCOVERED AT A LATER DATE:

If any concealed loss or damage is discovered, notify your local Freight Agent or Express Agent AT ONCE and request him to make an inspection. This is absolutely necessary. Unless you do this, the Transportation Company will not consider any claim for loss or damage valid. If the agent refuses to make an inspection, you should draw up an affidavit to the effect that you notified him on a certain date and that he failed to make the necessary inspection.

After you have ascertained the extent of the loss or damage, ORDER THE REPLACEMENT PARTS OF COMPLETE NEW UNITS FROM THE FACTORY. We will ship to you and bill you for the cost. This new invoice will then be a part of your claim for reimbursement from the Transportation Company. This, together with other papers, will properly support your claim.

Remember, it is extremely important that you do not give the Transportation Company a clear receipt if damage or shortages are evident upon delivery. It is equally important that you call for an inspection if the loss or damage is discovered later. DO NOT, UNDER ANY CIRCUMSTANCES, ORDER THE TRANSPORTATION COMPANY TO RETURN SHIPMENT TO OUR FACTORY OR REFUSE SHIPMENT UNTIL WE HAVE AUTHORIZED SUCH RETURN.

IMPORTANT

EQUIPMENT RETURN TO BALL ELECTRONIC DISPLAY DIVISION

1. Receive return authorization from the plant unless the unit was sent to you upon evaluation or rental.

2. Return prepaid.

3. Be sure a declared value equal to the price of the unit is shown on the bill of lading, express receipt, or air freight bill, whichever is applicable. This would cover claim for shipping damage on return.

RETURN LETTER

Title: MON592 - Monitor Technical Manual

RCSL No.: 44-RT2051

A/S Regnecentralen af 1979/RC Computer A/S maintains a continual effort to improve the quality and usefulness of its publications. To do this effectively we need user feedback, your critical evaluation of this manual.

Please comment on this manual's completeness, accuracy, organization, usability, and readability:

Do you find errors in this manual? If so, specify by page.

How can this manual be improved?

Other comments?

Name: __________ Title: __________

Company: __________

Address: __________

Date: __________

Thank you

42-i 1288

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