SERVICE MANUAL

TV-50/90/120

Data Display Monitor

5-017-1035

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Ball Electronic Display Division

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CONTENTS

CONTENTS (Cont.)

ILLUSTRATIONS

TABLES

PART 1

OPERATING DATA

This section of the service manual provides data concerning the specification, installation and operation of the TV 50, 90, and 120 Data Display Monitor.

Section 1

GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The TV 50, 90 and 120 series monitor is a raster scan display designed specifically for data terminals. They are designed for high quality display of alphanumeric dot characters.

The data monitor accepts video, horizontal drive and vertical drive as separate TTL level signals, eliminating stripping circuits in the data display unit as well as mixing circuits in the external logic interface.

The 100% solid state silicon circuitry of the PWA provides cool operation and high reliability. The electronic package has been miniaturized for compatibility with small volume requirements.

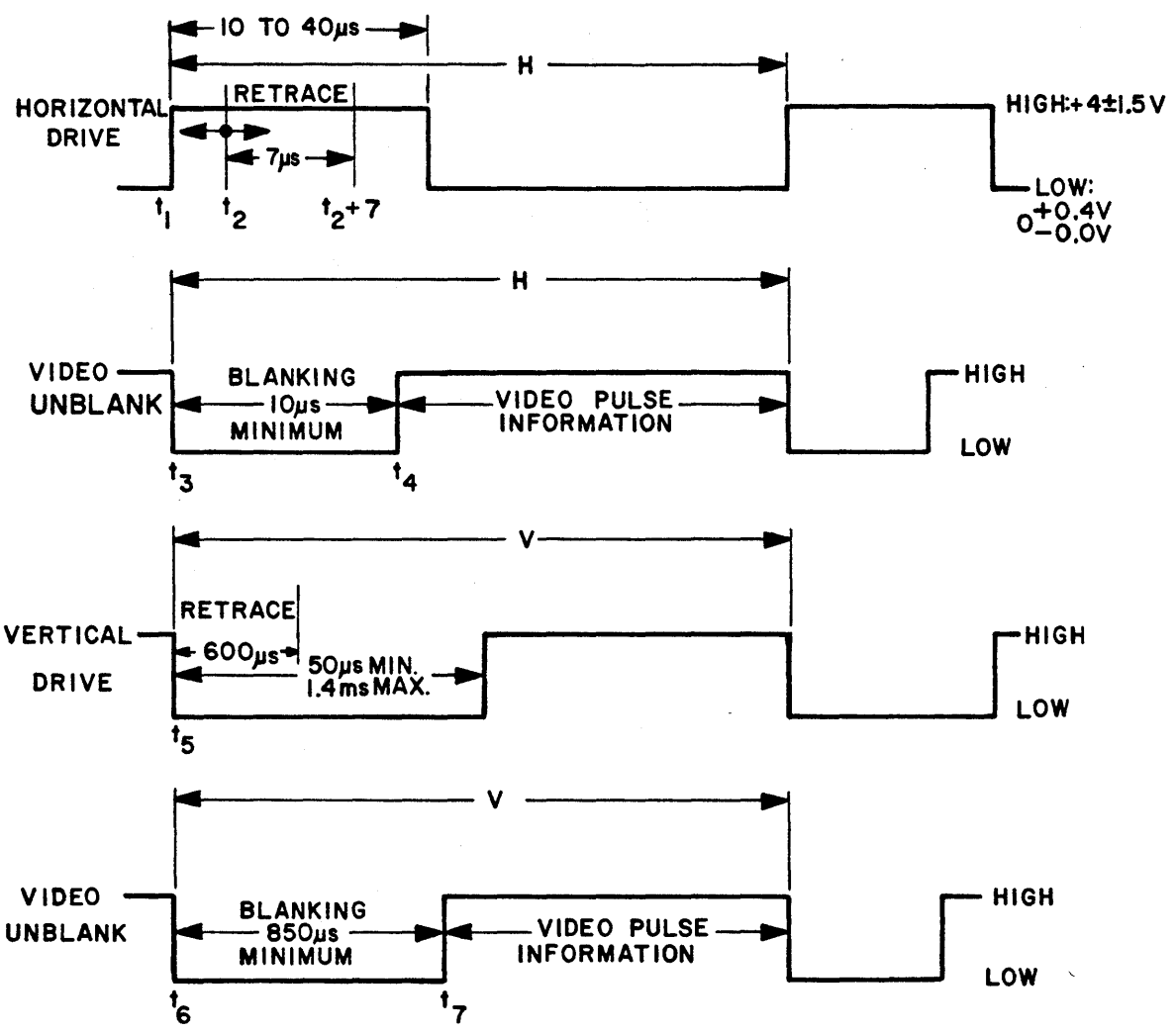
1.2 ELECTRICAL SPECIFICATIONS

1.2.1 Input Data Specification

PWB Edge Input Connector:	Viking	- 2VK10S/1-2
	Amphenol	- 225-21031-101
	Cinch	- 250-10-30-170
	BBRC No.	- 1-039-0119
Video Input Amplitude :	Low	0.0 + 0.4 - 0.0 volts
	High	4.0 ± 1.5 volts
Video Pulse Width :	50ns or greater	
Vertical Drive Rate :	49 to 61 Hz	
Horizontal Drive Rate :	15,250 to 16,250 Hz	
Rise and Fall Times :	Video	Less than 20ns
	Vertical	Less than 100ns
	Horizontal -	Less than 50ns
Input Signal Format :	Refer to figure 1-1	

1.2.2 Data Display Specifications

Input Impedance:	Min Shunt Resistance	Max Shunt Capacitance
Video Input (Class A)	4k	40-60pF
Vertical Drive Input	1.2k	40pF
Horizontal Drive Input	510Ω	40pF



NOTES:

1. HORIZONTAL RETRACE IS INITIATED AT t_2 (1.5 TO 7.0μs AFTER t_1, DEPENDING ON SETTING OF A103).
2. VERTICAL RETRACE IS INITIATED AT t_5 WITHOUT DELAY.
3. H=PERIOD OF ONE LINE: 63.5μs ±3%.
4. V= PERIOD OF ONE FIELD: 16.4ms MIN. TO 20.4ms MAX.
5. VIDEO PULSE WIDTH SHOULD BE 50ns MIN.

TABLE 1. t_3 VS t_1 TIMING FOR CENTERED HORIZONTAL VIDEO AS FUNCTION OF H. BLANKING WIDTH.

HORIZONTAL VIDEO BLANKING	
WIDTH	LEAD / LAG
$t_4 - t_3$	$t_1 - t_3$
10μs	−5.5 TO 0μs
12μs	−4.5 TO 1μs
14μs	−3.5 TO 2μs
16μs	−2.5 TO 3μs
18μs	−1.5 TO 4μs
20μs	−0.5 TO 5μs

TABLE 2. t_6 VS t_5 TIMING FOR CENTERED VERTICAL VIDEO AS FUNCTION OF V. BLANKING WIDTH.

VERTICAL VIDEO BLANKING	
WIDTH	LEAD / LAG
$t_7 - t_6$	$t_5 - t_6$
850μs	125μs
900μs	150μs
1000μs	200μs
1200μs	300μs
1400μs	400μs

Figure 1-1 Synchronization and Blanking Generator Waveform

Video Amplifier:

Bandwidth	12 MHz - 3db (Class A mode)
Rise and Fall Time (10 to 90% amplitude)	Less than 35ns (linear mode)
Storage Time	15ns max (linear mode)

Retrace Time:

Vertical	600µs
Horizontal	7µs

1.2.3 Display Specifications

CRT Display (without bonded panel) Horizontal Resolution @ 15,750 Hz

Nominal Diagonal Measurement Inches/mm	Phosphor	*Resolution (TV lines)	
		Center	Corner
5/127	P4	650 @ 60 fL**	550 @ 60 fL**
9/229	P4	800 @ 40 fL	650 @ 40 fL
12/305	P4	900 @ 40 fL	750 @ 40 fL
12/305	P39	900 @ 20 fL	750 @ 20 fL

*Resolution is measured in accordance with EIA RS-375A except burst modulation is adjusted for 100% and burst frequency is then increased to the point where resolution of the lines is just discernible.

**Set reference black to visual cutoff with brightness control and reference white to the indicated fL with contrast control.

1.2.4 Geometric Distortion Specifications

On-Axis Scan Non-Linearities - No picture elements displaced from true position by more than 2% of active raster height. Measurement made using "EIA Linearity Chart" in accordance with RS-375A.

If measured on a field of characters, the character height and width are within 10% of that for any adjacent character and within 20% of that for any character on screen

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

1.2.5 Power Requirements

AC Models	120V	220V/240V
Voltage:	105-130 VRMS ±10%	220 or 240 VRMS ±10%
Frequency:	49-61Hz	49-61Hz
Power:	24 Watts Nominal	24 Watts Nominal
Fuse:	2A	2A

DC Models	12VDC	15VDC
Voltage:	12±0.2 VDC	15± 0.2 VDC
Ripple:	100 mV p-p for refresh synchronous with power freq.	
	10 mV p-p for refresh non-synchronous with power freq.	
Current:	750 mA DC nominal	900mA DC nominal
	1.0 A DC maximum	1.5 A DC maximum
Fuse:	2A	2A

MATING CONNECTORS REQUIREMENTS

Power (AC models only): 4-contact male connector shell (Molex 03-06-1041) with female contact (Molex 4529T).

Signal (and power for DC models): 10-contact board edge connector (Refer to paragraph 1.2.1 for details.)

> WARNING
> ANY POWER TRANSFORMER MUST BE WELL REMOVED FROM CRT AND/OR BE OF LOW EXTERNAL FLUX FIELD DESIGN

1.3 MECHANICAL SPECIFICATIONS

Table 1-1 and figure 1-2 lists the mechanical specifications for the TV 50/90/120 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

1.4 ENVIRONMENTAL SPECIFICATIONS

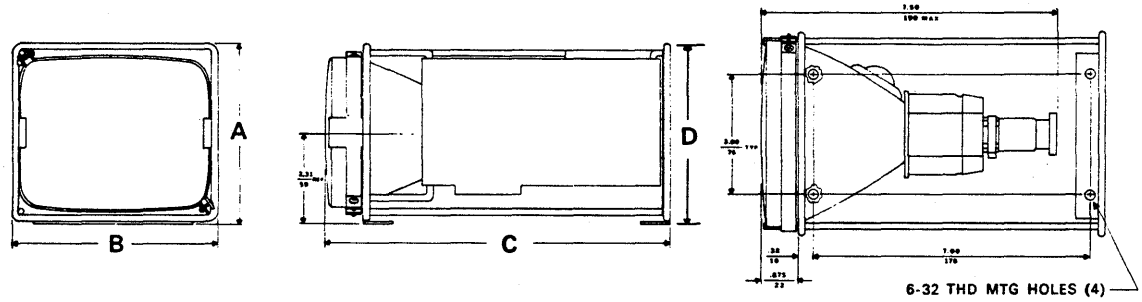
	OPERATING RANGE	STORAGE RANGE
Temperature (Ambient)	$5^{o}C$ to $55^{o}C$	$-40^{o}C$ to $65^{o}C$
Humidity (Non-Condensing)	5 to 80%	5 to 90%
Altitude	Up to 10,000 ft/ 3048m	Up to 30,000 ft/ 9144m

MODEL		TILT	* DIMENSIONS (Inches/Millimeters) A	B	C	D	WEIGHT Lbs/kg	OUTLINE NO
TV50	DC	0°	4.56/116	5.12/130	8.62/219	4.56/116	3.0/1.4	2-030-0319
TV90	DC	0°	7.00/178	9.50/241	9.75/248	6.16/156	6.8/3.1	2-030-0401
TV90	AC	0°	7.00/178	9.50/241	9.75/248	6.16/156	10.1/4.6	2-030-0401
TV90	DC	10°	6.90.175	9.50/241	9.75/248	6.16/156	6.8/3.1	2-030-0401
TV90	AC	10°	6.90/175	9.50/241	9.75/248	6.16/156	10.1/4.6	2-030-0401
TV120	DC	0°	9.06/230	11.40/289	11.84/301	5.75/146	11.0/5.0	2-030-0400
TV120	AC	0°	9.06/230	11.40/289	11.84/301	5.75/146	13.4/6.1	2-030-0400
TV120	DC	5°	9.03/229	11.40/289	11.84/301	5.75/146	11.0/5.0	2-030-0398
TV120	AC	5°	9.03/229	11.40/289	11.84/301	5.75/146	13.4/6.1	2-030-0398
TV120	DC	7½°	9.00/229	11.40/289	11.84/301	5.75/146	11.01/5.0	2-030-0399
TV120	AC	7½°	9.00/229	11.40/289	11.84/301	5.75/146	13.4/6.1	2-030-0399
TV120	DC	10°	8.92/227	11.40/289	11.84/301	5.75/146	11.01.5.0	2-030-0397
TV120	AC	10°	8.92/227	11.40/289	11.84/301	5.75/146	13.4/6.1	2-030-0397
TV120	DC	15°	10.25/260	11.40/289	11.88/302	10.25/260	10.5/4.8	2-030-0396
TV120	AC	15°	10.25/260	11.40/289	11.88/302	10.25/260	12.9/5.9	2-030-0396

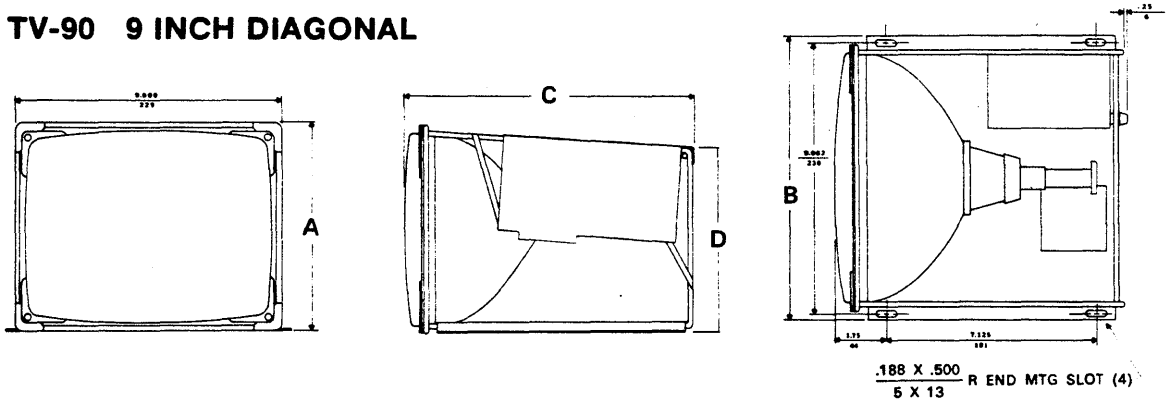
Table 1-1 Mechanical Specifications

DIMENSIONS

TV-50 5 INCH DIAGONAL



TV-90 9 INCH DIAGONAL



TV-120 12 INCH DIAGONAL

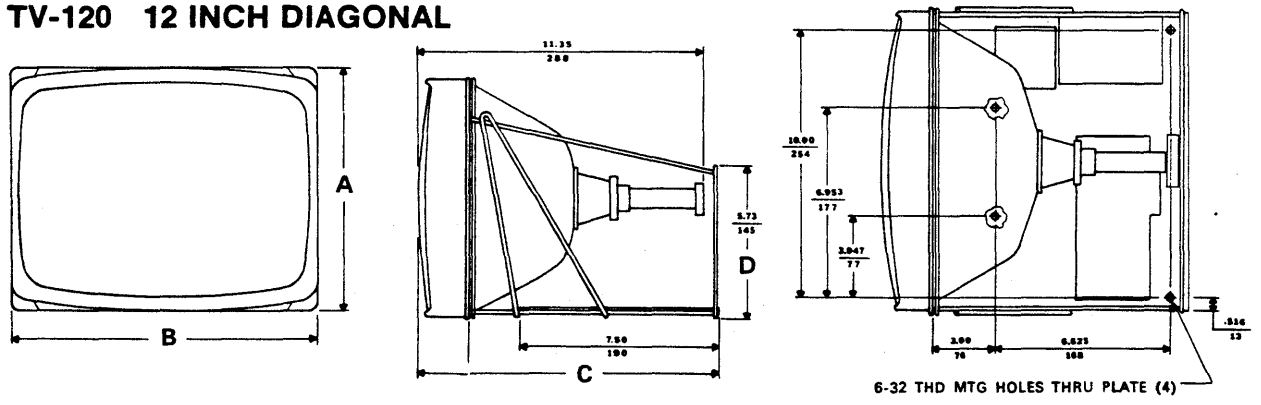


Figure 1-2 TV50, 90, 120 0^{o} tilt with bonded panel dimensions

1.5 HUMAN FACTORS SPECIFICATION

X-Ray Radiation

The TV 50, 90 and 120 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.

Label Visibility

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 face of the CRT. The user will remove this label and use it as stated above.

Power Requirements

The Data monitor is designed to operate and meet radiation requirements when operated within the respective AC or DC input power specifications. Radiation testing is performed at the maximum specified input voltage for AC powered monitors or at 130 VAC for those nominally powered at 110-120 VAC, 60 Hz.

DC powered monitors have an additional requirement because the DC source is usually regulated and subject to failure of the series pass element. This can result in an appreciable increase in the anode voltage and consequent emission of x-rays. This is not a problem for monitors equipped with over voltage protection. For monitors not so equipped, it is necessary for the buyer to ensure that the normal adjustment of his regulator does not exceed the maximum level specified for the particular monitor. Furthermore, he shall ensure that the maximum available voltage from the supply cannot exceed 1.33 times nominal monitor input when the supply has a single failure such as to cause the highest possible output voltage.

User Operating Controls

The only external control required for operation of the TV 50, 90, and 120 display unit is the contrast control. This control is a carbon composition variable resistor, 500Ω±20%; ¼ watt.

The brightness control is mounted on the printed wiring board and is an internal adjustment by the user. An option is available where this control is removed from the board and a remote brightness control supplied by the user is utilized. The remote brightness control is a carbon composition variable resistor, 100kΩ±20%; ¼ watt.

Section 2

INSTALLATION

2.1 MECHANICAL

The TV 50 data monitor has four 6-32 clinch nuts for mounting the unit. The TV 120, 0°, 5°, 7½° and 10° monitors have four 6-32 clinch nuts on the frame for installation purposes. The TV 120, 15° monitor uses three 6-32 clinch nuts for mounting. The TV 90 data monitor has four .188X.500 radius end slots for installation. Refer to figure 1-2

2.2 ELECTRICAL

2.2.1 DC Input

The TV 50/90/120 DC models can be operated from either a 12 VDC or 15 VDC source. Refer to section 1.2.5 for details. The DC input power is applied through the 10 pin edge connector.

2.2.2 AC Input

The TV 90/120 AC models have their own self contained AC power supply. This supply can operate either on 120 VAC or 220/240 VAC depending on which plug of the jumper plug assembly P2 is inserted into the power supply module.

The power transformer is wired to operate on either 120 VAC or 220/240 VAC 50/60Hz. To operate the power supply on 120 VAC, take the connector shell of P2 marked with 120 and insert it in to J2. Conversely, to operate at 220/240 VAC insert the connector shell of P2 marked with 240 into J2.

AC power is supplied to the unit via J1. J1 is a 4 contact female connector shell (Molex #03-06-2041) with male contacts (Molex #45295)

2.3 Location

The TV 50/90/120 models shall not be located in an area that restricts air flow around the unit nor shall it be placed near any heat generating sources, since this may cause the unit to overheat.

2.4 GROUNDING TECHINIQUES

The method of interconnecting and grounding the equipment is a function of the signal frequency. Optimum grounding depends largely on the system in which the equipment is used. The following grounding technique is recommended when installing the monitor. Refer to figure 2-1 for interface connections.

The horizontal, CRT arc and video/vertical board circuit grounds are terminated at J101. The horizontal ground (J101-1) and CRT arc ground (J101-5) is connected together by a jumper wire on the board and they are connected to the frame by a wire from E110.

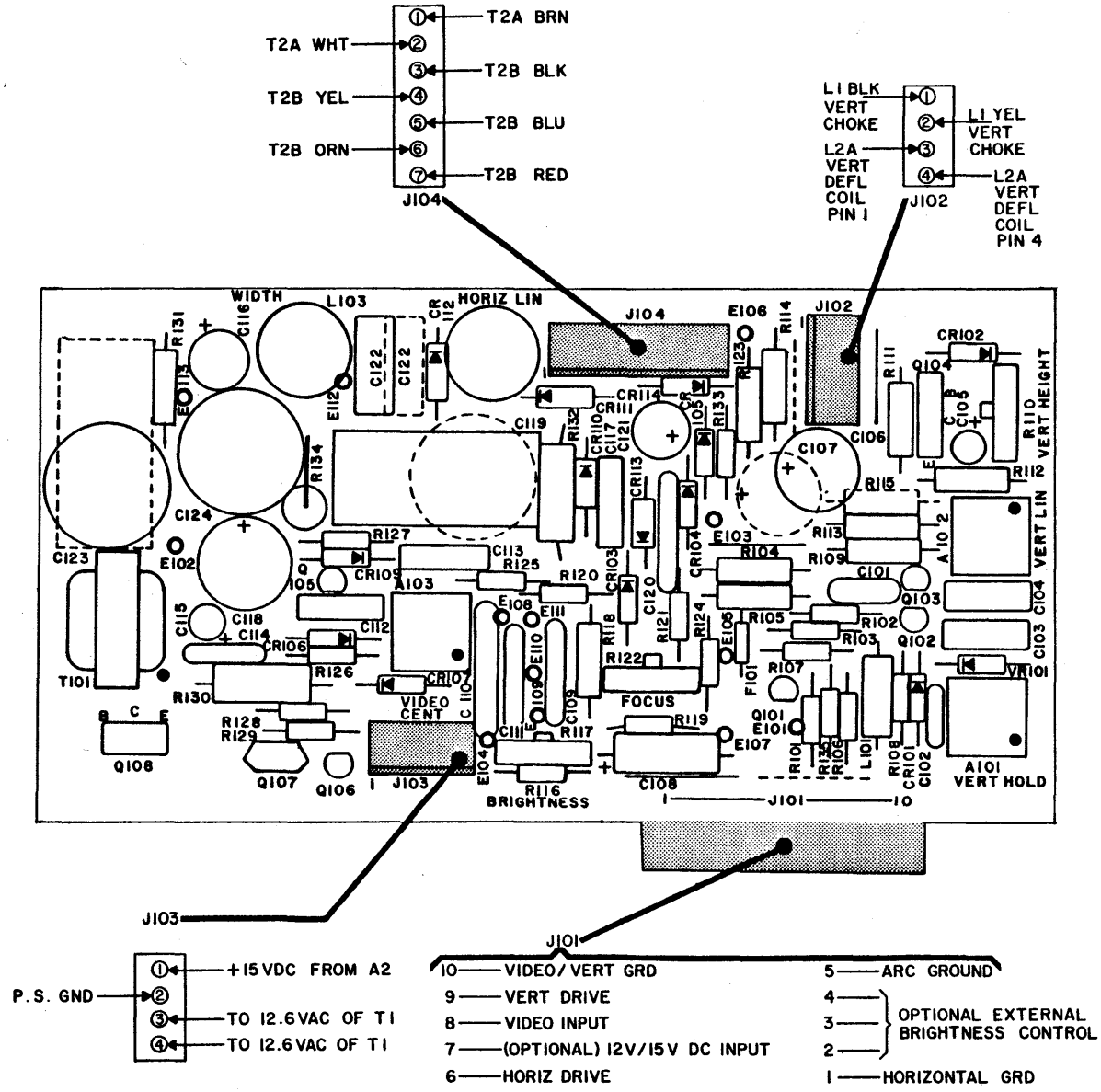


Figure 2-1 Interface Connections

A connection to system ground must be made at both J101-1 and J101-10. When the frame is an integral part of system ground, one of three possible ground configurations can be used.

1. When a good electrical ground connection cannot be made between the monitor frame and system ground, then J101-1 and J101-10 is wired separately to the system ground.

2. When a good ground connection can be made between the monitor frame and system ground, then J101-10 is wired to the system ground and J101-1 is left open.

3. When the ground connection between the monitor frame and the system ground is acceptable and it is desired to omit the wire from J101-10, then add a jumper wire to the board to connect J101-5 and J101-10 together. J101-5 is then wired to the system ground. The monitor is normally supplied without the jumper wire from J101-5 to J101-10 to prevent horizontal circuit ground currents from flowing in the video ground circuit.

In cases of severe arc related problems, the jumper between J101-1 and J101-5 can be removed and J101-5 or E110 can be connected separately to the frame or CRT aquadag ground. J101-1 or E102 must then be connected either to the frame or system ground.

To isolate the frame from system ground, J101-1 and J101-10 should be wired separately to system ground. Add another wire to J101-1 and connect it and J101-5 to the frame (aquadag ground) through a capacitor. The frame cannot be completely isolated, since an AC connection between the signal ground and frame must be maintained to assume a complete circuit for the CRT aquadag capacity.

When the video is routed in by a long cabling, shielded cable should be used. To avoid a ground loop, only one end of the shield should be grounded.

2.5 INPUT SIGNAL LEAD ROUTING

The input signal leads probably will carry high frequency signals and should be given the following considerations:

A. To minimize distributed capacity and capacitive pickup of nearby radiated fields, route the video leads separately and away from all other wiring.

B. Make the lead length as short as possible, consistent with the packaging requirements.

C. Ideally, the video line should meet the requirements of a terminated coaxial system; i.e., the video line should exhibit a constant impedance from source load.

Section 3

OPERATION

3.1 GENERAL

After power, video and drive signals have been applied to the monitor, the contrast and brightness controls may be adjusted to provide the optimum display.

3.2 BRIGHTNESS ADJUST

The monitor is used to display alphanumeric information. The video polarity is usually white characters on a black background. The brightness control should then be adjusted for visual cutoff of the raster. A maximum contrast ratio can now be obtained when video is applied.

3.3 CONTRAST ADJUST

The video amplifier is designed to operate linearly from +.65 to +2.5 V signal input. The contrast control should be adjusted to the point where defocusing sets in and then backed down slightly. This occurs at a 15-20V p-p video swing at the CRT cathode for the TV90/120, and at a 12-15V p-p swing for the TV50. In no case should contrast be adjusted to cause saturation of Q101, as this impairs the pulse response of the video amplifier.

PART II

SERVICE DATA

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

The TV 50, 90, 120 has no end user serviceable parts inside. Refer service to qualified service personnel.

Section 4

THEORY OF OPERATION

4.1 VIDEO AMPLIFIER

The video amplifier consists of Q101 and its associated circuitry. The incoming video signal is applied to the monitor through J101-8 and R101 to the base of Q101.

Transistor Q101 has a nominal gain of 15, and operates as a class B amplifier. Q101 remains cutoff until a DC coupled, positive-going signal arrives at its base and turns it on. R103 provides series feedback which makes the terminal to terminal voltage gain relatively independent of transistor parameters and temperature variations. R102 and C101 provide emitter peaking to extend the bandwidth to 12MHz.

The negative going signal at the collector of Q101 is direct coupled to the CRT cathode. The class B biasing of Q101 allows a large video output signal to modulate the CRT's cathode and results in a maximum available contrast ratio.

The overall brightness at the screen of the CRT is also determined by the negative potential at its grid which is varied by the brightness control.

4.2 VERTICAL DEFLECTION

Q102 is a thyristor used as programmable unijunction and together with its external circuitry forms a relaxation oscillator operating at a vertical rate. The sawtooth forming network consists of A101, C103 and C104. These capacitors charge exponentially until the voltage at the anode of Q102 exceeds its gate voltage at which time Q102 becomes essentially a closed switch, allowing a rapid discharge through L101. The rate of charge or frequency is adjustable by A101. The oscillator is synchronized by a negative pulse coupled to its gate from the vertical drive pulse applied externally at J101-9.

A divider network internal to A101 sets the free running frequency by establishing a reference voltage at the gate. This programs the firing of Q102 and amounts to resistive selection of the intrinsic standoff ratio. The frequency is controlled by passive components only. CR101 provides temperature compensation for Q102 while controlling the gate impedance to allow easy turn on and off of Q102. L101 forms a tuned circuit with C103 and C104 during conduction of Q102 which provides a stable control on the drop-out time of Q102 to assist in maintaining interlace. Q103 collector to base forward diode clamping action prevents the voltage from swinging too far negative during this flywheel action.

The sawtooth at the anode of Q102 is direct coupled to the base of Q103. This stage functions as a darlington pair emitter follower driver for the output stage Q104. It presents an extremely high impedance in shunt with A101 and prevents the Beta dependent input impedance of Q104 from affecting the frequency of the

sawtooth forming network.

Linearity control of the sawtooth is accomplished by coupling the output at Q103 emitter resistively back into the junction of C103 and C104. This provides integration of the sawtooth and inserts a parabolic component. The slope change rate of the sawtooth at Q103 output is controlled by the setting of A102. The output at Q103 is coupled into a resistive divider..

Height control R110 varies the amplitude of the sawtooth voltage applied to the base of Q104 and controls the vertical raster size on the CRT. C105 is used to limit the amplitude of the flyback pulse at Q104 collector.

The vertical output stage Q104 uses an NPN power transistor operating as a class AB amplifier. The output is capacitively coupled to the yoke. L1 provides a DC connection to B+ for Q104; it has a high impedance compared to the yoke inductance which causes most of the sawtooth current of Q104 to appear in the yoke. R114 prevents oscillations by providing damping across the vertical yoke coils.

4.3 HORIZONTAL DEFLECTION

4.3.1 Low Level Stages (Figure 4-1)

The purpose of Q105 and Q106 is basically to process the incoming horizontal drive signal into a form suitable to drive the output stage Q108. The duty cycle of Q108 becomes essentially independent of the amplitude and pulse width of the drive pulse. This is a necessary condition to assure stability and reliability in the output stage. In adddition, these stages provide a horizontal video centering adjustment by delaying retrace with respect to the horizontal drive pulse.

The drive pulse is presented to Q105 via J101-6. The base circuit of Q105 includes a clamp and a differentiator which makes Q105 output insensitive to drive pulse amplitude and width changes. The only requirement is that pulse amplitude be of 2.5 volts minimum and pulse width should be 10-40μs. Q105 together with Q106 functions as a monostable multivibrator with Q107 being a slave that provides a positive feedback. Specifically, when Q105 is turned on by the drive pulse, it discharges C112 at a rate determined by the setting of A103. When C112 is discharged to 2.75 volts, Q106 turns off. This change of state turns Q107 on and the base drive to Q106 from R128 is shunted thru Q107. Q106/Q107 remains in this state for nominally 25μs until C112 recharges through A103 to 8.25 volts. At this time, Q106 is biased on again by the current through A103. The multivibrator is now in a state that Q106 is on and Q105/Q107 is off. It will remain in this state until the next drive pulse occurs or power is turned off. C112 is the only timing capacitor in the circuit and has two time constants associated with it. Primarily, the charge path between pin 1 and pin 3 of A103 determines the on time of Q107 while the discharge path through the video centering control and Q105 determines the delay between application of the drive pulse and start of retrace (turn on of Q107).

4.3.2 High Level Stages

These stages consist of Q107 driving the output stage, Q108 and its associated

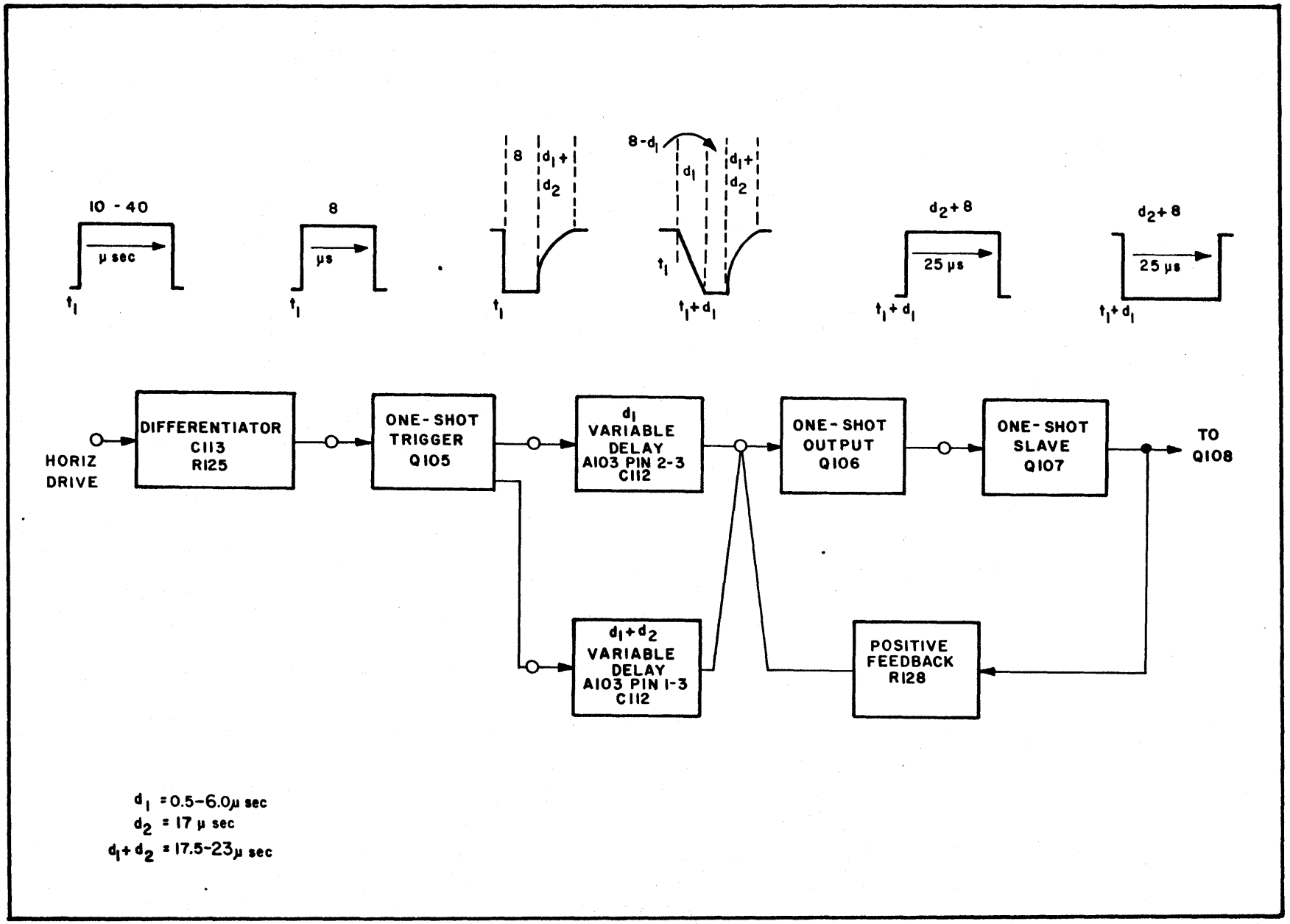


Figure 4-1 Horizontal Drive Processing and Timing Chart

circuitry thru T101. Q107 is an inverting slave of Q106 and is driven alternately into saturation and cutoff as are all stages in the horizontal circuit. Q107 output is transformer coupled to the output stage with phasing of T101 chosen such that Q108 turns off when Q107 turns on. This allows Q108 to turn off quickly, thus minimizing dissipation. A careful review will show that Q108 turns off at a variable delay time after receipt of the drive pulse. This action causes retrace to begin.

During conduction of the driver transistor, energy is stored in the coupling transformer. The polarity at the secondary is then phased to keep Q108 cut off. As soon as the primary current of T101 is interrupted due to the base signal driving Q107 into cut off, the secondary voltage changes polarity. Q108 now saturates due to the forward base current flow. This gradually decreases at a rate determined by the transformer inductance and circuit resistance. However the base current is sufficient to keep Q108 in saturation until the next polarity change of T101.

The horizontal output stage has two main functions: 1) to supply the deflection coil with the correct horizontal scanning currents: 2) to develop high voltage for the CRT anode and DC voltage for the CRT bias, focus and accelerating grids as well as the DC voltage for the video output stage.

Q108 acts as a switch which is turned on or off by the rectangular waveform on the base. When it is turned on, the supply voltage plus the charge on C123 causes deflection current to increase in a linear manner and moves the beam from near the center of the screen to the right side. At this time, the transistor is turned off by a polarity change of T101 which causes the output circuit to oscillate. A high reactive voltage in the form of a half cycle negative voltage pulse is developed by the deflection coil inductance and the primary of T2. The peak magnetic energy which was stored in the deflection coil during scan time is not transferred to C122 and the deflection coil distributed capacity. During this cycle, the beam is returned to the center of the screen.

The charged capacitances now discharge into the deflection coil and induce a current in a direction opposite to the current of the previous part of the cycle. The magnetic field thus created around the coil moves the scanning beam to the left of the screen.

After slightly less than half a cycle, the decreasing voltage across C122 biases the damper diode CR111 into conduction and prevents the flyback pulse from further oscillation. The magnetic energy that was stored in the deflection coil from the discharge of the distributed capacity is now released to provide sweep for the left half of scan and to charge C123 through the rectifying action of the damper diode. The beam is now at the center of the screen. The cycle will repeat as soon as the base of Q108 becomes positive with respect to its emitter.

C123 serves to block DC current from the deflection coil and to provide "S" shaping of the current waveform. "S" shaping compensates for stretching at the left and right sides of the picture tube because the curvature of the CRT face and the deflected beam do not follow the same arc.

L103 is an adjustable width control placed in a series with the horizontal de-

flection coils. The variable inductance allows a greater or lesser amount of deflection current to flow through the horizontal yoke and varies the width of the horizontal scan.

Linearity control is provided by modifying the deflection coil voltage. During retrace, an auxilliary winding on the flyback transformer supplies a pulse which charges C119 through rectifier diode CR112 and L102. This voltage is then applied in series with the deflection coil when the damper diode turns on at the start of trace. The voltage is sawtooth shaped and has the effect of decreasing the deflection coil current as a function of the sawtooth shape. This compensates for the stretch normally found on the left side of the screen due to the deflection coil and system RL time constant. Linearity is optimized by adjustment of L102 which acts as an impedance to the pulse from T2.

The negative flyback pulse developed during horizontal retrace time is rectified by CR110 and filtered by C117. This produces approximately -130 VDC which is coupled through the brightness control R117 to G1 of the CRT.

This same pulse is transformer-coupled to the secondary of T2 where it is rectified by CR2, CR113 and CR114 to produce rectified voltage of approximately 12KV, 400V and 32V respectively. 12KV is the anode voltage for the CRT, while 32V is used for the video output stage, and the 400V source is used for G2 and G4 voltages for the CRT.

4.4 LOW VOLTAGE SUPPLY

The TV 90/120 models are available with an internal power supply. This supply utilizes an integrated circuit voltage regulator which supplies 15VDC±2.5% to J103-1. It also supplies 12.6 VAC to J103-3 and 4 for the CRT filament.

The 120VAC primary voltage (220/240V optional) is stepped down at the secondary of T1 where it is rectified by CR1 and filtered by C1. A2 functions as a series regulator to drop the rectified voltage down to 15V at pin 2. The regulator maintains a constant output voltage (within 2.5%) with changes in line voltage load or temperature. It is capable of supplying 1.5 amps and features internal current limiting, thermal shutdown and safe over-voltage protection. A hermetically sealed TO-3 case is used for high reliability and low thermal resistance.

If a short circuit is present at the output, the current limiting feature of A2 will cause the output current to fold back to safe levels. The fast limiting action of A2 is very effective in protecting transistors from abnormal loads. The resistor R1, is used to reduce the power dissipation in A2.

Section 5

ADJUSTMENT AND MAINTENANCE

5.1 HORIZONTAL ADJUSTMENTS

With a crosshatch signal applied, adjust video centering control, A103 to center the video within the raster horizontally. Adjust L102 for best horizontal linearity. Do not adjust L102 core out farther than necessary as this causes excessive power to be consumed.

Adjust L103 for desired width.

5.2 VERTICAL ADJUSTMENTS

With the crosshatch signal applied, adjust vertical hold control A101 to lock in the picture.

Adjust vertical linearity control A102 for best overall linearity. This control affects the vertical frequency slightly and might require a readjustment of the hold control. Adjust vertical height control R110 for desired height.

5.3 FOCUS ADJUST

Adjust focus control R122 for best overall focus of the picture. Usually the center and corners of the screen do not focus at the same setting and a compromise must be made.

5.4 CENTERING ADJUST

If the raster is not properly centered, it may be repositioned by rotating the ring magnets behind the deflection yoke. The ring magnets should not be used to offset the raster from its nominal center position because this degrades the focus and resolution of the display and may cause neck shadow.

If the picture is tilted, rotate the entire yoke.

5.5 TROUBLESHOOTING GUIDE

	Symptom	Possible Remedy
1.	Screen is dark	Check 15V bus, Q108, Q107, CR2, CR113
2.	Loss of Video	CR114, Q101
3.	Power consumption is too high	Check horizontal drive waveform; adjust horizontal linearity coil; Q107, Q108

4. Low voltage bus incorrect (for units with a low voltage supply)	A1, A2 NOTE: Low voltage supply will indicate low or "0" volts if an abnormal load is evident on the 15 volt line.

5.6 RASTER SHIFTING

The extra cost factory option of inserting R113 or R115 makes possible a fixed raster shift either down or up by allowing a fixed DC current to flow in the deflection coil. This option precludes the need for using the centering rings for non-standard centering which would result in disturbance of geometry and focus.

1. Raster pull down (Refer to figure 5-1)

   Add R113 from J102-4 to ground in holes provided. Value to be selected for desired amount of pull down.

2. Raster pull up (Refer to figure 5-1)

   Replace C106 with a jumper wire. Remove jumper wire from J102-3 and J102-1 and replace with C107, 470uf, 10v, electrolytic. Add R115 from J102-3 to ground in holes provided. Value of R115 to be selected for desired amount of pull up.

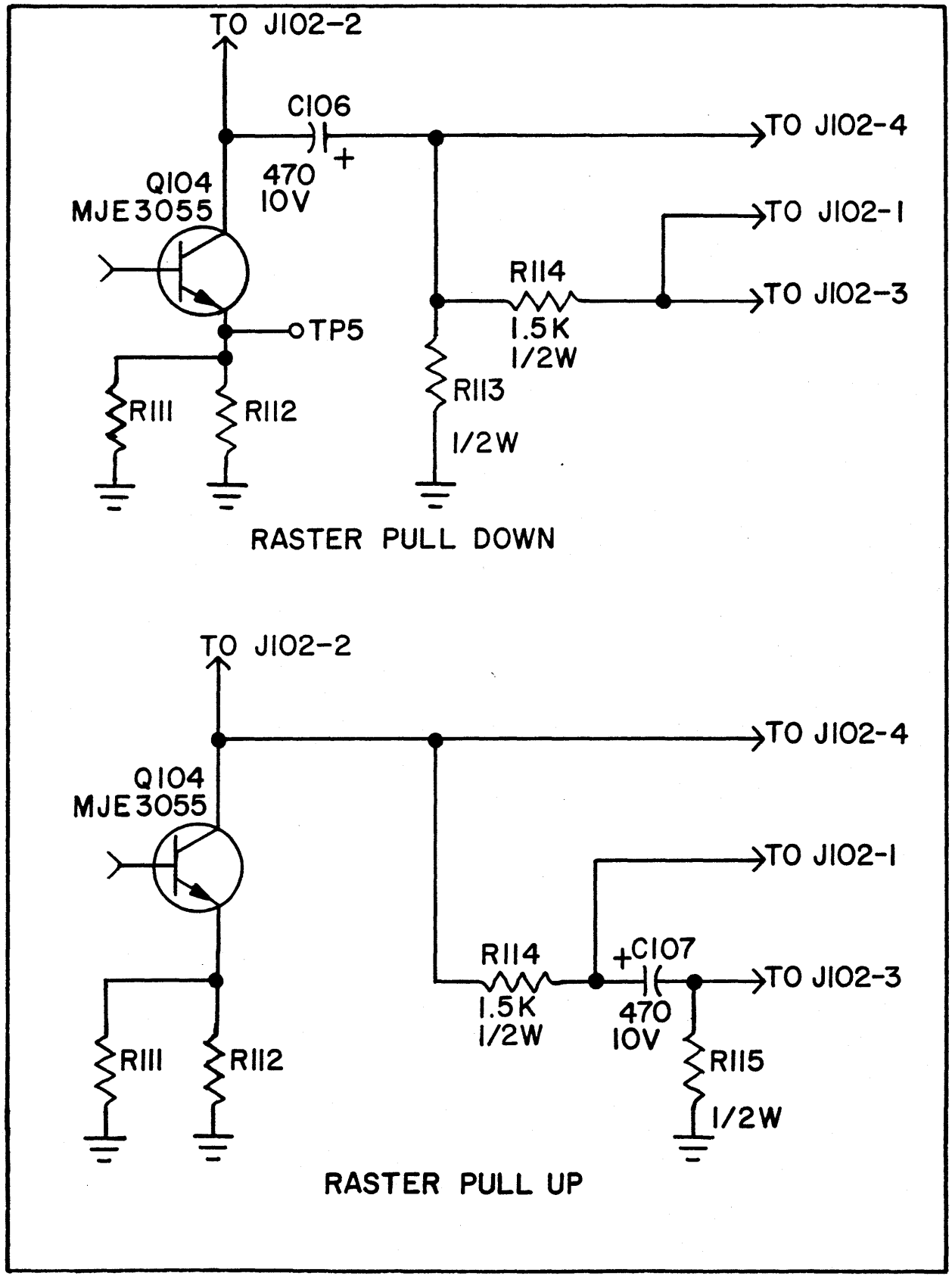


Figure 5-1 Schematic for Raster Shifting

Section 6

SERVICE DATA

6.1 GENERAL

This section contains the replaceable electrical parts list, schematic, PWB component layout and waveforms for servicing of the TV 50, 90, 120 data monitor.

If a part you have ordered has been replaced with a new part or an improved part, our customer service representative will contact you concerning any change in the part.

Change information concerning the TV 50, 90, 120 units is located at the rear of the manual in the supplement section.

6.2 ORDERING PARTS

Most parts contained in the monitor are available commercially from electronic parts outlets. When it is necessary to order spare or replacement parts from BBRC, Electronic Display Division (E.D. DIV.), include the part description, part number, model and serial number data of the monitor as listed on the serial number plate and, if applicable, the schematic reference number listed in the parts list. Orders for these parts should be sent to:

Ball Electronic Display Division
P.O. Box 43376
St. Paul, Minnesota 55164

For rapid service:

Telephone area (612) 786-8900
or
TWX area (910) 563-3552

6.3 RETURNING PARTS

When the monitor requires service or repair in accordance with the enclosed warranty, return the unit or part to:

Ball Electronic Display Division
4501 Ball Road N.E.
Circle Pines, Minnesota 55014

ATTN: Customer Service

Telephone area (612) 786-8900
TWX area (910) 563-3552

Unnecessary delays may be avoided when parts are returned to 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 E.D. DIV's 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 1.5 V peak to peak crosshatch signal applied to the 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. The TV 50 is the only exception, the peak to peak amplitude is specified for TP9, TP12, TP13 and TP14.

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 near J101.

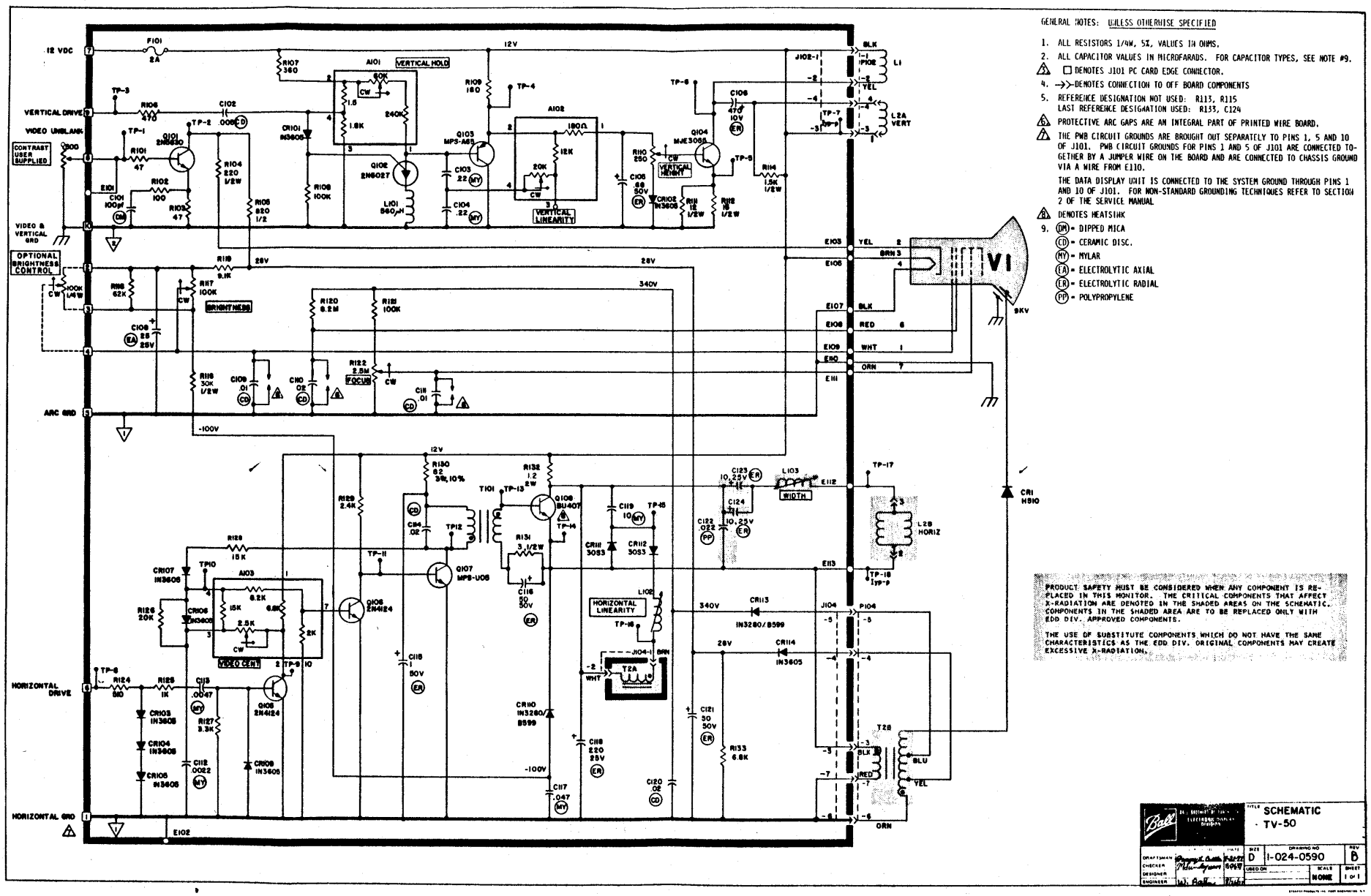


Figure 6-1 TV50 Schematic

PARTS LIST TV50

REF SYM	DESCRIPTION	BBRC PART NUMBER	USED ON 6-002- 0689	0732
A101	RES TRIM, 60K, VERT HOLD	1-011-8006	X	X
A102	RES TRIM, 20K, VERT LIN	1-011-8005	X	X
A103	RES TRIM, 2.5K, VIDEO CENTER	1-011-8001	X	X
	CAPACITOR, FIXED, uF UNLESS NOTED			
C101	100pF±5%, 500V, DM	1-012-0300	X	X
C102	.005±20%, 100V, CD	10-12-7508	X	X
C103	.22±10%, 100V, MY	1-012-2277	X	X
C104	.22±10%, 100V, MY	1-012-2277	X	X
C105	.68; 50V, E	1-012-2264	X	X
C106	470; 10V, E	1-012-2158	X	X
C107	NOT USED			
C108	25; 25V, E	1-012-1380	X	X
C109	.01±20%; 1000V, CD	1-012-2214	X	X
C110	.02±20%; 1000V, CD	1-012-2217	X	X
C111	.01±20%; 1000V, CD	1-012-2214	X	X
C112	.0022±10%; 630V, MY	1-012-2254	X	X
C113	.0047±10%; 630V, MY	1-012-2279	X	X
C114	.02±20%; 100V, CD	10-12-7209	X	X
C115	1; 50V, E	1-012-2189	X	X
C116	50; 50V, E	1-012-2157	X	X
C117	.047±10%; 250V, MY	1-012-2240	X	X
C118	220; 25V, E	1-012-2159	X	X
C119	10±10%; 100V, MY	1-012-2255	X	X
C120	.02±20%; 500V, CD	1-012-0780	X	X
C121	50; 50V, E	1-012-2157	X	X
C122	.022±10%; 250V, PP	1-012-2297	X	X
C123	10-25V, E	1-012-2273	X	X
C124	10; 25V, E	1-012-2273	X	X
	DIODE			
CR1	H510	1-021-0424	X	X
CR101	1N3605	1-021-0410	X	X
CR102	1N3605	1-021-0410	X	X
CR103	1N3605	1-021-0410	X	X
CR104	1N3605	1-021-0410	X	X
CR105	1N3605	1-021-0410	X	X
CR106	1N3605	1-021-0410	X	X
CR107	1N3605	1-021-0410	X	X
CR108	NOT USED			
CR109	1N3605	1-021-0410	X	X
CR110	1N3280/B599	1-021-0403	X	X
CR111	3D53	1-021-0458	X	X
CR112	3D53	1-021-0458	X	X
CR113	1N3280/B599	1-021-0403	X	X
CR114	1N3605	1-021-0410	X	X
	FUSE			
F101	2A-125V, PICO	1-028-0247	X	X
	CONNECTORS			
J102	CONNECTOR, 4 PIN MALE	1-039-0146	X	X
J103	NOT USED			
J104	CONNECTOR, 7 PIN MALE	1-039-0145	X	X

REF SYM	DESCRIPTION	BBRC PART NUMBER	USED ON 6-002- 0698	0732
L1	VERTICAL CHOKE	6-003-0529	X	X
L2	DEFLECTION, TV50	1-023-0231	X	X
L101	560uH	1-016-0302	X	X
L102	LINEARITY	1-016-0328	X	X
L103	WIDTH	1-016-0303	X	X
	TRANSISTOR			
Q101	2N5830	1-015-1172	X	X
Q102	2N6027	1-015-1157	X	X
Q103	MPS-A65	1-015-1186	X	X
Q104	MJE3055	1-015-1156	X	X
Q105	2N4124	1-015-1139	X	X
Q106	2N4124	1-015-1139	X	X
Q107	MPS-U05	1-015-1159	X	X
Q108	BU407	1-015-1210	X	X
	RESISTOR, FIXED, CARBON, ±5%; 1/4W UNLESS NOTED			
R101	47	70-16-0470	X	X
R102	100	70-16-0101	X	X
R103	47	70-16-0470	X	X
R104	220; 1/2W	1-011-2254	X	X
R105	820; 1/2W	1-011-2268	X	X
R106	470	70-16-0471	X	X
R107	360	70-16-0361	X	X
R108	100K	70-16-0104	X	X
R109	180	1-011-2252	X	X
R110	VAR; 250±20%; CO VERT HGT	70-89-0251	X	X
R111	12; 1/2W	1-011-2224	X	X
R112	15; 1/2W	1-011-2226	X	X
R113	NOT USED			
R114	1.5K; 1/2W	1-011-2274	X	X
R115	NOT USED			
R116	62K	70-16-0623	X	X
R117	VAR; 100K±20%; CO BRT ADJ	1-011-5435	X	
R118	30K; 1/2W	1-011-2305	X	X
R119	9.1K	70-16-0912	X	X
R120	8.2M	70-16-0825	X	X
R121	100K	70-16-0104	X	X
R122	VAR; 2.5M±20%, CO FOC ADJ	1-011-5566	X	X
R123	NOT USED			
R124	510	70-16-0511	X	X
R125	1K	70-16-0102	X	X
R126	20K	70-16-0203	X	X
R127	3.3K	70-16-0332	X	X
R128	15K	70-16-0153	X	X
R129	2.4K	70-16-0242	X	X
R130	82±10%; 3W, WW	1-011-2375	X	X
R131	3; 1/2W	1-011-2478	X	X
R132	1.2±10%; 2W, WW	1-011-1395	X	X
R133	6.8K	70-16-0682	X	X
R134	NOT USED			
R135	NOT USED			
	TRANSFORMER			
T1	NOT USED			
T2	HIGH VOLTAGE	6-003-0587	X	X
T101	HORIZ DRIVER	1-017-5402	X	X
	MISCELLANEOUS			
	CRT SOCKET	1-022-0427	X	X

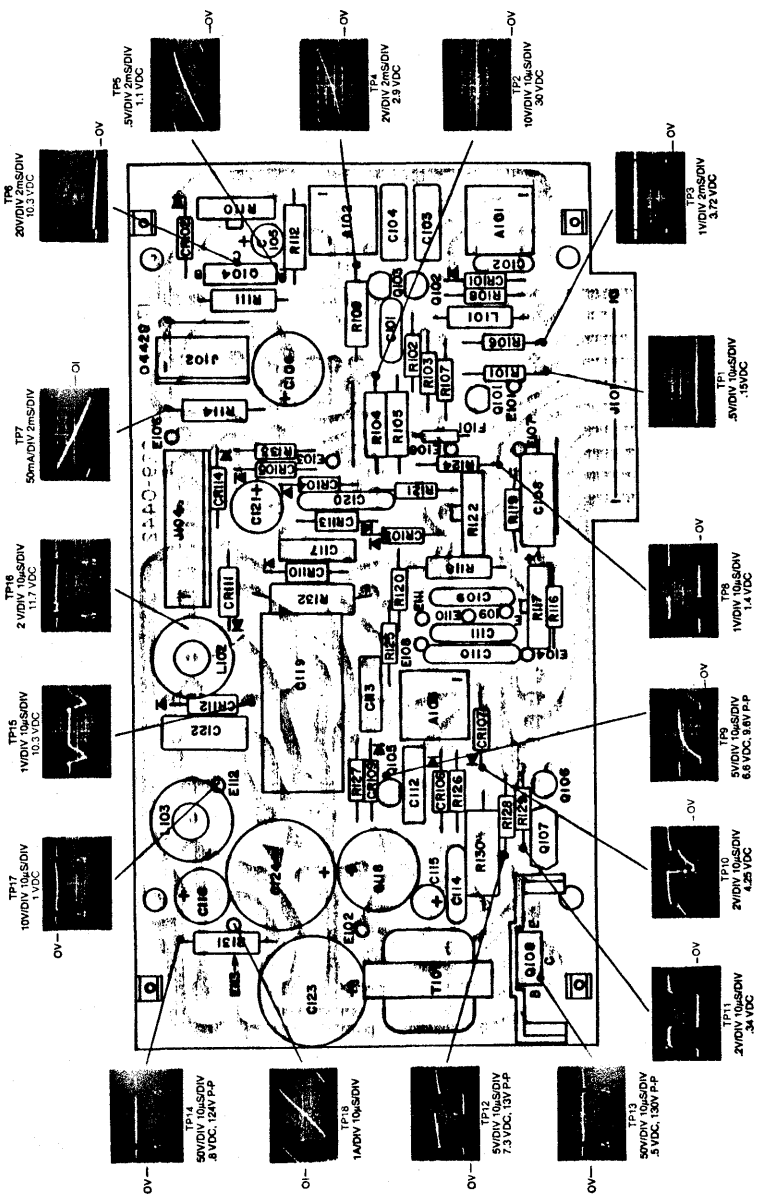


Figure 6-2 TV50 Parts List, Waveform, and Component Layout

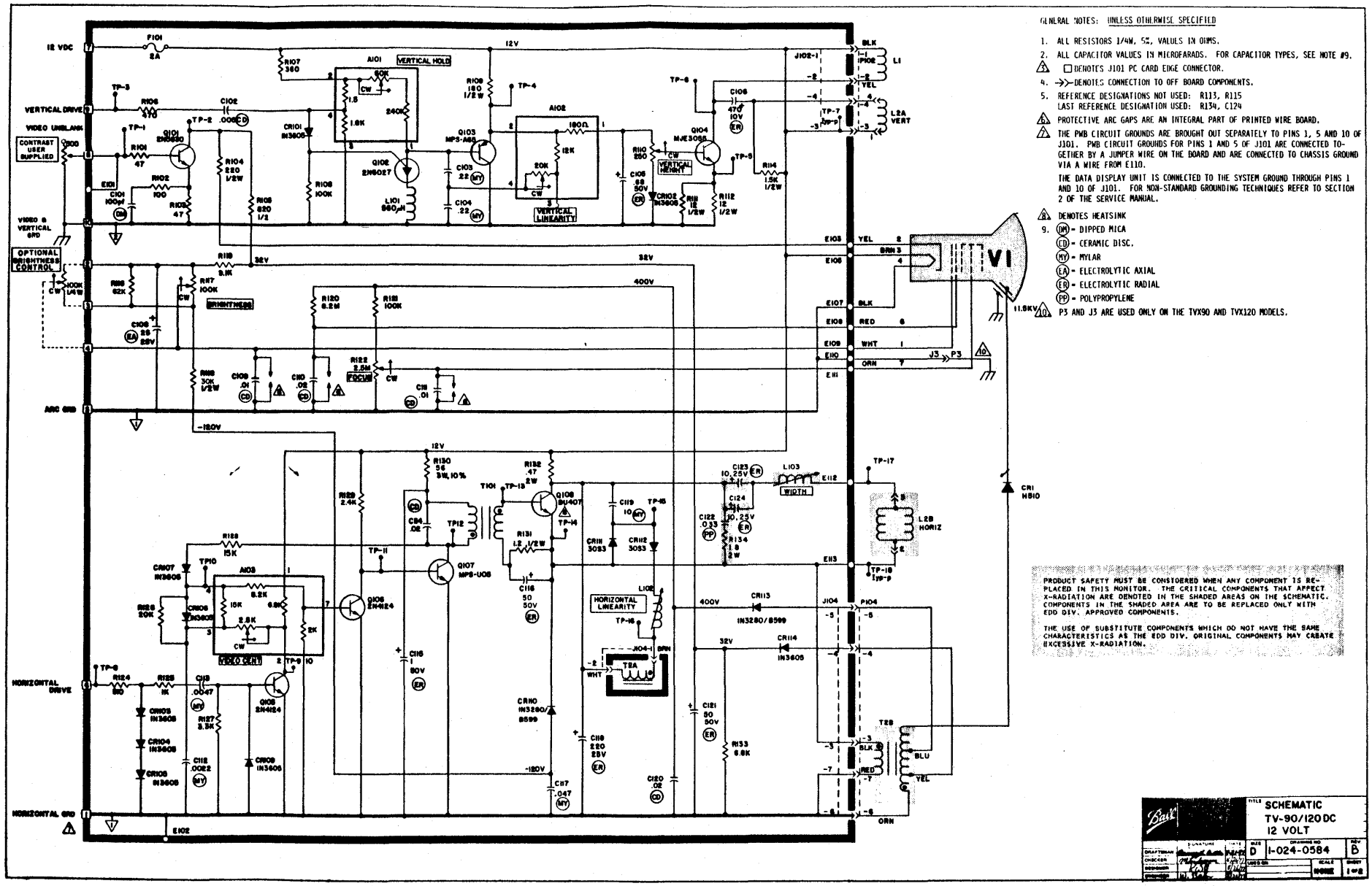


Figure 6-3 TV 90/120, 12V, Schematic

PARTS LIST TV 90/120, 12V

IM1035

REF SYM	DESCRIPTION	BBRC PART NUMBER	USED ON 6-002 0698	0686	0697	0710	0733	0731	0735
A101	RES TRIM, 60K, VERT HOLD	1-011-8006	X	X	X	X	X	X	X
A102	RES TRIM, 20K, VERT LIN	1-011-8005	X	X	X	X	X	X	X
A103	RES TRIM, 2.5K, VIDEO CENTER	1-011-8001	X	X	X	X	X	X	X
	CAPACITOR, FIXED, uF UNLESS NOTED								
C101	100pF±5%, 500v, DM	1-012-0300	X	X	X	X	X	X	X
C102	.005±20%, 100v, CD	10-12-7508	X	X	X	X	X	X	X
C103	.22±10%, 100v, MY	1-012-2277	X	X	X	X	X	X	X
C104	.22±10%, 100v, MY	1-012-2277	X	X	X	X	X	X	X
C105	.68, 50v, E	1-012-2264	X	X	X	X	X	X	X
C106	470, 10v, E	1-012-2158	X	X	X	X	X	X	X
C107	NOT USED								
C108	25, 25v, E	1-012-1380	X	X	X	X	X	X	X
C109	.01±20%, 1000v, CD	1-012-2214	X	X	X	X	X	X	X
C110	.02±20%, 1000v, CD	1-012-2217	X	X	X	X	X	X	X
C111	.01±20%, 1000v, CD	1-012-2214	X	X	X	X	X	X	X
C112	.0022±10%, 630v, MY	1-012-2254	X	X	X	X	X	X	X
C113	.0047±10%, 630v, MY	1-012-2279	X	X	X	X	X	X	X
C114	.02±20%, 100v, CD	10-12-7209	X	X	X	X	X	X	X
C115	1, 50v, E	1-012-2189	X	X	X	X	X	X	X
C116	50, 50v, E	1-012-2157	X	X	X	X	X	X	X
C117	.047±10%, 250v, MY	1-012-2240	X	X	X	X	X	X	X
C118	220, 25v, E	1-012-2159	X	X	X	X	X	X	X
C119	10±10%, 100v, MY	1-012-2255	X	X	X	X	X	X	X
C120	.02±20%, 500v, CD	1-012-0780	X	X	X	X	X	X	X
C121	50, 50v, E	1-012-2157	X	X	X	X	X	X	X
C122	.033±10%, 250V, MY	1-012-2298	X	X	X	X	X	X	X
C123	10, 25v, E	1-012-2273	X	X	X	X	X	X	X
C124	10, 25v, E	1-012-2273	X	X	X	X	X	X	X
	DIODE								
CR1	H510	1-021-0424	X	X	X	X	X	X	X
CR101	1N3605	1-021-0410	X	X	X	X	X	X	X
CR102	1N3605	1-021-0410	X	X	X	X	X	X	X
CR103	1N3605	1-021-0410	X	X	X	X	X	X	X
CR104	1N3605	1-021-0410	X	X	X	X	X	X	X
CR105	1N3605	1-021-0410	X	X	X	X	X	X	X
CR106	1N3605	1-021-0410	X	X	X	X	X	X	X
CR107	1N3605	1-021-0410	X	X	X	X	X	X	X
CR108									
CR109	1N3605	1-021-0410	X	X	X	X	X	X	X
CR110	1N3280/B599	1-021-0403	X	X	X	X	X	X	X
CR111	30S3	1-021-0458	X	X	X	X	X	X	X
CR112	30S3	1-021-0458	X	X	X	X	X	X	X
CR113	1N3280/B599	1-021-0403	X	X	X	X	X	X	X
CR114	1N3605	1-021-0410	X	X	X	X	X	X	X
	FUSE								
F101	2A-125v, PICO	1-028-0247	X	X	X	X	X	X	X
	CONNECTORS								
J102	CONNECTOR, 4 PIN MALE	1-039-0146	X	X	X	X	X	X	X
J103	NOT USED								
J104	CONNECTOR, 7 PIN MALE	1-089-0145	X	X	X	X	X	X	X
P3	CONNECTOR, 1 PIN FEMALE	1-034-0323				X			X
J3	CONNECTOR, 1 PIN MALE	1-034-0300				X			X
	COIL								
L1	VERTICAL CHOKE	6-003-0572	X	X	X	X	X	X	X
L2	DEFLECTION, TV 120	1-023-0239			X	X	X		X
	OR DEFLECTION, TV 90	1-023-0240	X	X				X	
L101	560uH	1-016-0302	X	X	X	X	X	X	X
L102	LINEARITY	1-016-0328	X	X	X	X	X	X	X
L103	WIDTH	1-016-0323	X	X	X	X	X	X	X

REF SYM	DESCRIPTION	BBRC PART NUMBER	USED ON 6-002- 0698	0686	0697	0710	0733	0731	0735
	TRANSISTOR								
Q101	2N5830	1-015-1172	X	X	X	X	X	X	X
Q102	2N6027	1-015-1157	X	X	X	X	X	X	X
Q103	MPS-A65	1-015-1186	X	X	X	X	X	X	X
Q104	MJE3055	1-015-1156	X	X	X	X	X	X	X
Q105	2N4124	1-015-1139	X	X	X	X	X	X	X
Q106	2N4124	1-015-1139	X	X	X	X	X	X	X
Q107	MPS-U05	1-015-1159	X	X	X	X	X	X	X
Q108	BU407	1-015-1210	X	X	X	X	X	X	X
	RESISTOR, FIXED, CARBON, ±5%, 1/4w UNLESS NOTED								
R101	47	70-16-0470	X	X	X	X	X	X	X
R102	100	70-16-0101	X	X	X	X	X	X	X
R103	47	70-16-0470	X	X	X	X	X	X	X
R104	220, 1/2w	1-011-2254	X	X	X	X	X	X	X
R105	820, 1/2w	1-011-2268	X	X	X	X	X	X	X
R106	470	70-16-0471	X	X	X	X	X	X	X
R107	360	70-16-0361	X	X	X	X	X	X	X
R108	100K	70-16-0104	X	X	X	X	X	X	X
R109	180	1-011-2252	X	X	X	X	X	X	X
R110	VAR, 250±20%, CO VERT HGT	70-89-0251	X	X	X	X	X	X	X
R111	12, 1/2w	1-011-2224	X	X	X	X	X	X	X
R112	12, 1/2w	1-011-2224	X	X	X	X	X	X	X
R113	NOT USED								
R114	1.5K, 1/2w	1-011-2274	X	X	X	X	X	X	X
R115	NOT USED								
R116	62K	70-16-0623	X	X	X	X	X	X	X
R117	VAR, 100K±20%, CO BRT ADJ	1-011-5435	X	X	X	X			
R118	30K, 1/2w	1-011-2305	X	X	X	X	X	X	X
R119	9.1K	70-16-0912	X	X	X	X	X	X	X
R120	8.2M	70-16-0825	X	X	X	X	X	X	X
R121	100K	70-16-0104	X	X	X	X	X	X	X
R122	VAR: 2.5M±20%, CO FOC ADJ	1-011-5566	X	X	X	X	X	X	X
R123	NOT USED								
R124	510	70-16-0511	X	X	X	X	X	X	X
R125	1K	70-16-0102	X	X	X	X	X	X	X
R126	20K	70-16-0203	X	X	X	X	X	X	X
R127	3.3K	70-16-0332	X	X	X	X	X	X	X
R128	15K	70-16-0153	X	X	X	X	X	X	X
R129	2.4K	70-16-0242	X	X	X	X	X	X	X
R130	56±10%, 3W, WW	70-16-2521	X	X	X	X	X	X	X
R131	1.2, 1/2w	1-011-2520	X	X	X	X	X	X	X
R132	.47±10%, 2w, WW	1-011-1394	X	X	X	X	X	X	X
R133	6.8K	70-16-0682	X	X	X	X	X	X	X
R134	1.8±5%, 2W	1-011-2417	X	X	X	X	X	X	X
R135	NOT USED								
	TRANSFORMER								
T1	NOT USED								
T2	HIGH VOLTAGE, TV90	6-003-0605	X					X	
	OR HIGH VOLTAGE, TV90/TRW	6-003-0571		X					
	OR HIGH VOLTAGE, TV120	6-003-0599			X		X		
	OR HIGH VOLTAGE, TVX120	6-003-0586				X			X
T101	HORIZ DRIVER	1-017-5402	X	X	X	X	X		X
	MISCELLANEOUS								
	CRT SOCKET	1-022-0427	X	X	X	X			X

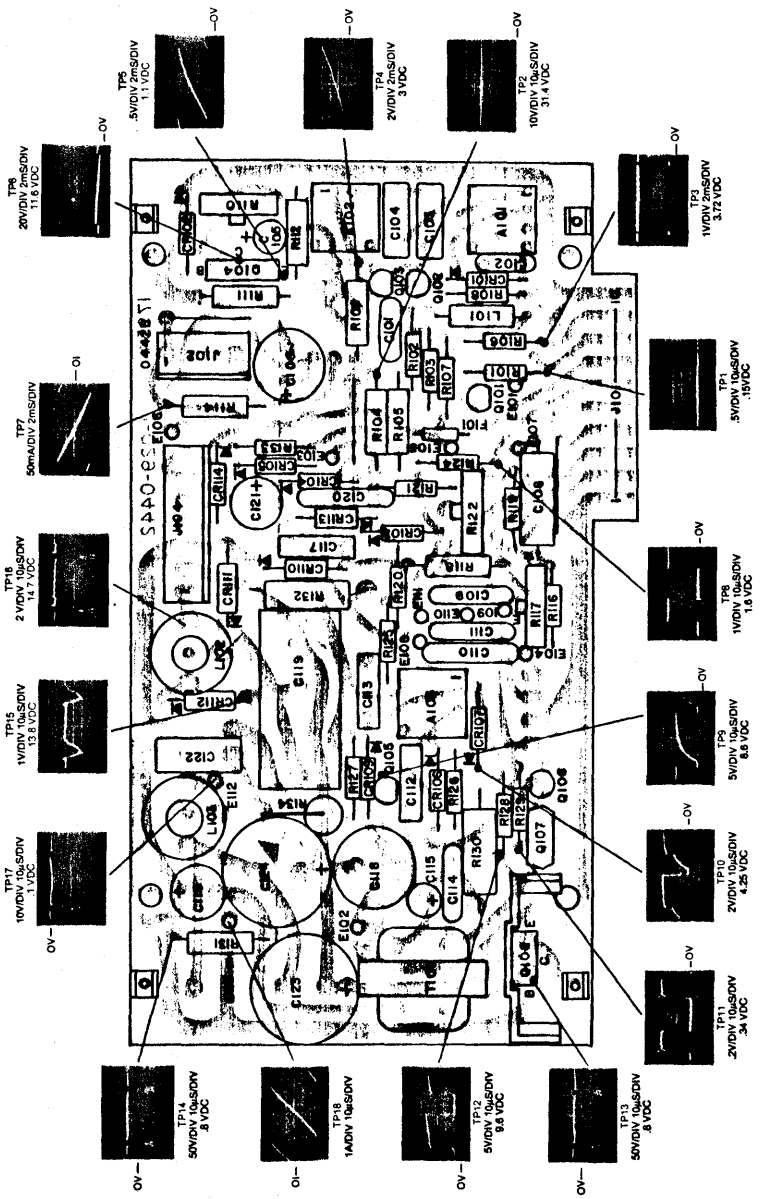


Figure 6-4 TV 90/120, 12V Parts List, Waveform and Component Layout

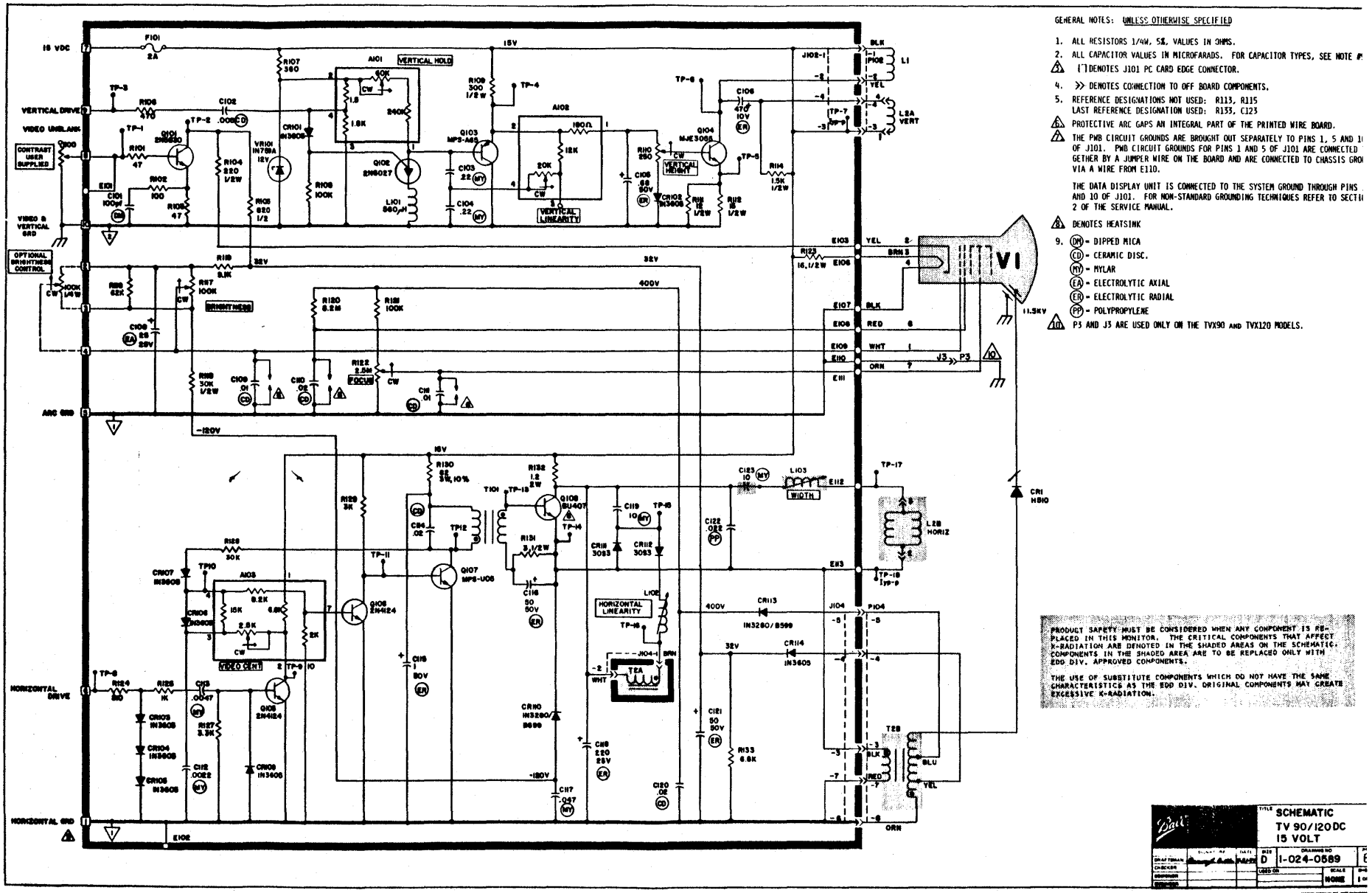


Figure 6-5 TV 90/120, 15V Schematic

REF SYM	DESCRIPTION	BBRC PART NUMBER	USED ON 6-002- 0695	0688	0713	0728	0730	0734
A101	RES TRIM, 60K, VERT HOLD	1-011-8006	X	X	X	X	X	X
A102	RES TRIM, 20K, VERT LIN	1-011-8005	X	X	X	X	X	X
A103	RES TRIM, 2.5K, VIDEO CENTER	1-011-8001	X	X	X	X	X	X
	CAPACITOR, FIXED, uF UNLESS NOTED							
C101	100PF±5%, 500V, DM	1-012-0300	X	X	X	X	X	X
C102	.005±20%, 100V, CD	10-12-7508	X	X	X	X	X	X
C103	.22±10%, 100V, MY	1-012-2277	X	X	X	X	X	X
C104	.22±10%, 100V, MY	1-012-2277	X	X	X	X	X	X
C105	.68, 50V, E	1-012-2264	X	X	X	X	X	X
C106	470, 10V, E	1-012-2158	X	X	X	X	X	X
C107	NOT USED							
C108	25, 25V, E	1-012-1380	X	X	X	X	X	X
C109	.01±20%, 1000V, CD	1-012-2214	X	X	X	X	X	X
C110	.02±20%, 1000V, CD	1-012-2217	X	X	X	X	X	X
C111	.01±20%, 1000V, CD	1-012-2214	X	X	X	X	X	X
C112	.022±10%, 630V, MY	1-012-2254	X	X	X	X	X	X
C113	.0047±10%, 630V, MY	1-012-2279	X	X	X	X	X	X
C114	.02±20%, 100V, CD	10-12-7209	X	X	X	X	X	X
C115	1, 50V, E	1-012-2189	X	X	X	X	X	X
C116	50, 50V, E	1-012-2157	X	X	X	X	X	X
C117	.047±10%, 250V, MY	1-012-2240	X	X	X	X	X	X
C118	220, 25V, E	1-012-2159	X	X	X	X	X	X
C119	10±10%, 100V, MY	1-012-2255	X	X	X	X	X	X
C120	.02±20%, 500V, CD	1-012-0780	X	X	X	X	X	X
C121	50, 50V, E	1-012-2157	X	X	X	X	X	X
C122	.022±10%, 250V, PP	1-012-2297	X	X	X	X	X	X
C123	10±10%, 100V, MY	1-012-2255	X	X	X	X	X	X
C124	NOT USED							
	DIODE							
CR1	H510	1-021-0424	X	X	X	X	X	X
CR101	1N3605	1-021-0410	X	X	X	X	X	X
CR102	1N3605	1-021-0410	X	X	X	X	X	X
CR103	1N3605	1-021-0410	X	X	X	X	X	X
CR104	1N3605	1-021-0410	X	X	X	X	X	X
CR105	1N3605	1-021-0410	X	X	X	X	X	X
CR106	1N3605	1-021-0410	X	X	X	X	X	X
CR107	1N3605	1-012-0410	X	X	X	X	X	X
CR108	NOT USED							
CR109	1N3605	1-021-0410	X	X	X	X	X	X
CR110	1N3280/B599	1-021-0403	X	X	X	X	X	X
CR111	30S3	1-021-0458	X	X	X	X	X	X
CR112	30S3	1-021-0458	X	X	X	X	X	X
CR113	1N3280/B599	1-021-0403	X	X	X	X	X	X
CR114	1N3605	1-021-0410	X	X	X	X	X	X
	FUSE							
F101	2A-125V, PICO	1-028-0247	X	X	X	X	X	X
	CONNECTORS							
J102	CONNECTOR, 4 PIN MALE	1-039-0146	X	X	X	X	X	X
J103	NOT USED							
J104	CONNECTOR, 7 PIN MALE	1-039-0145	X	X	X	X	X	X
P3	CONNECTOR, 1 PIN FEMALE	1-034-0323				X		X
J3	CONNECTOR, 1 PIN MALE	1-034-0300				X		X
	COIL							
L1	VERTICAL CHOKE	6-003-0529	X	X	X	X	X	X
L2	DEFLECTION TV90	1-023-0237	X				X	
	OR DEFLECTION TVX 120/TV120	1-023-0231		X	X	X		X
L101	560uH	1-016-0302	X	X	X	X	X	X
L102	LINEARITY	1-016-0328	X	X	X	X	X	X
L103	WIDTH	1-016-0323	X	X	X	X	X	X

REF SYM	DESCRIPTION	BBRC PART NUMBER	USED ON 6-002- 0695	0688	0713	0728	0730	0734
	TRANSISTOR							
Q101	2N5830	1-015-1172	X	X	X	X	X	X
Q102	2N6027	1-015-1157	X	X	X	X	X	X
Q103	MPS-A65	1-015-1186	X	X	X	X	X	X
Q104	MJE3055	1-015-1156	X	X	X	X	X	X
Q105	2N4124	1-015-1139	X	X	X	X	X	X
Q106	2N4124	1-015-1139	X	X	X	X	X	X
Q107	MPS-U05	1-015-1159	X	X	X	X	X	X
Q108	BU407	1-015-1210	X	X	X	X	X	X
	RESISTOR, FIXED, CARBON, ±5%, 1/4W UNLESS NOTED							
R101	47	70-16-0470	X	X	X	X	X	X
R102	100	70-16-0101	X	X	X	X	X	X
R103	47	70-16-0470	X	X	X	X	X	X
R104	220, 1/2W	1-011-2254	X	X	X	X	X	X
R105	820, 1/2W	1-011-2268	X	X	X	X	X	X
R106	470	70-16-0471	X	X	X	X	X	X
R108	100K	70-16-0104	X	X	X	X	X	X
R109	300, 1/2W	1-011-2257	X	X	X	X	X	X
R110	VAR; 250±20%, CO VERT HGT	70-89-0251	X	X	X	X	X	X
R111	12, 1/2W	1-011-2224	X	X	X	X	X	X
R112	15, 1/2W	1-011-2226	X	X	X	X	X	X
R113	NOT USED							
R114	1/5K 1/2W	1-011 2274	X	X	X	X	X	X
R115	NOT USED							
R116	62K	70-16-0623	X	X	X	X	X	X
R117	VAR; 100K±20%, CO BRT ADJ	1-011-5435	X	X		X		
R118	30K, 1/2W	1-011-2305	X	X	X	X	X	X
R119	9.1K	70-16-0912	X	X	X	X	X	X
R120	8.2M	70-16-0825	X	X	X	X	X	X
R121	100K	70-16-0104	X	X	X	X	X	X
R122	VAR; 2.5M±20%, CO FOC ADJ	1-011-5566	X	X	X	X	X	X
R123	16, 1/2W	1-011-2227	X	X	X	X	X	X
R124	510	70-16-0511	X	X	X	X	X	X
R125	1K	70-16-0102	X	X	X	X	X	X
R126	NOT USED							
R127	3.3K	70-16-0332	X	X	X	X	X	X
R128	15K	70-16-0153	X	X	X	X	X	X
R129	3K	70-16-0302	X	X	X	X	X	X
R130	82±10%, 3W, WW	1-011-2375	X	X	X	X	X	X
R131	3, 1/2W, CO	1-011-2478	X	X	X	X	X	X
R132	1.2±10%, 2W, WW	1-011-1395	X	X	X	X	X	X
R133	6.8K	70-16-0682	X	X	X	X	X	X
R134	NOT USED							
	TRANSISTOR							
T1	NOT USED							
T2	HIGH VOLTAGE TV90/15V	6-003-0602	X				X	
	OR HIGH VOLTAGE TV120/15V	6-003-0530		X				
	OR HIGH VOLTAGE TV120	6-003-0587			X			
	OR HIGH VOLTAGE TVX120	6-003-0604				X		X
T101	HORIZ DRIVER	1-017-5402	X	X	X	X	X	X
	MISCELLANEOUS							
	CRT SOCKET	1-022-0427	X	X	X	X	X	X

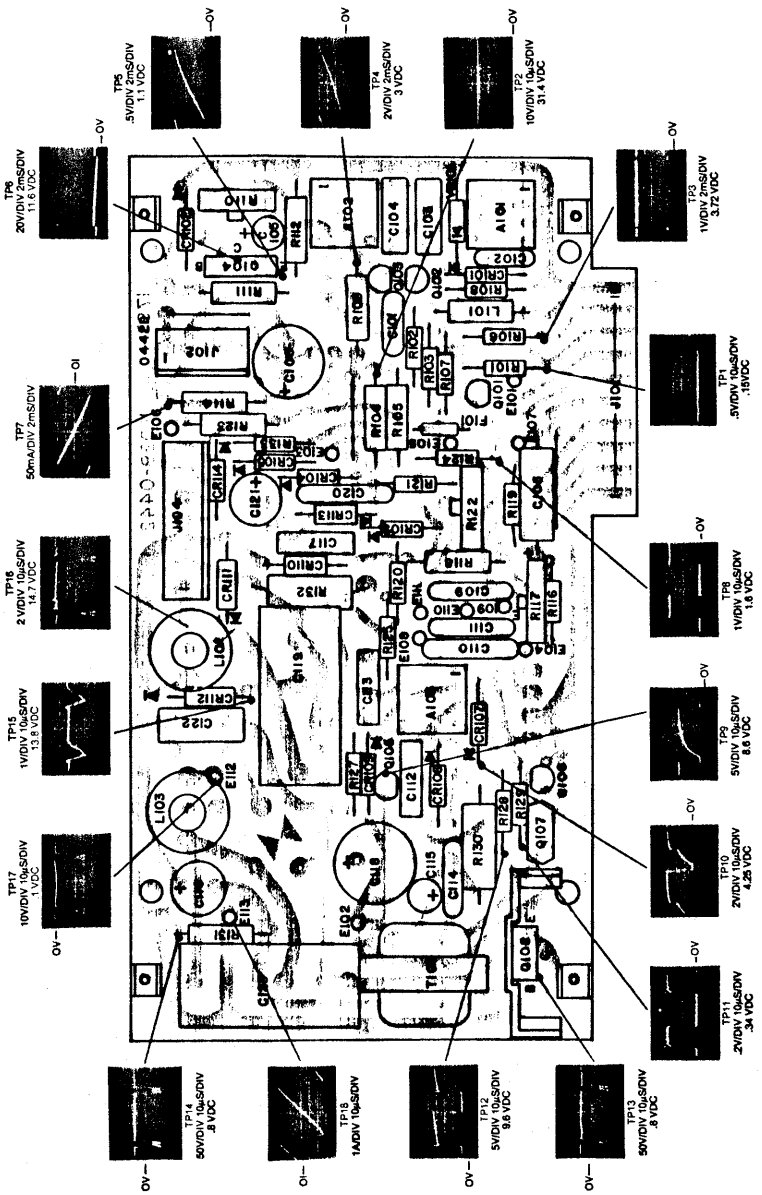


Figure 6-6 TV 90/120, 15V Parts List, Waveform and Component Layout

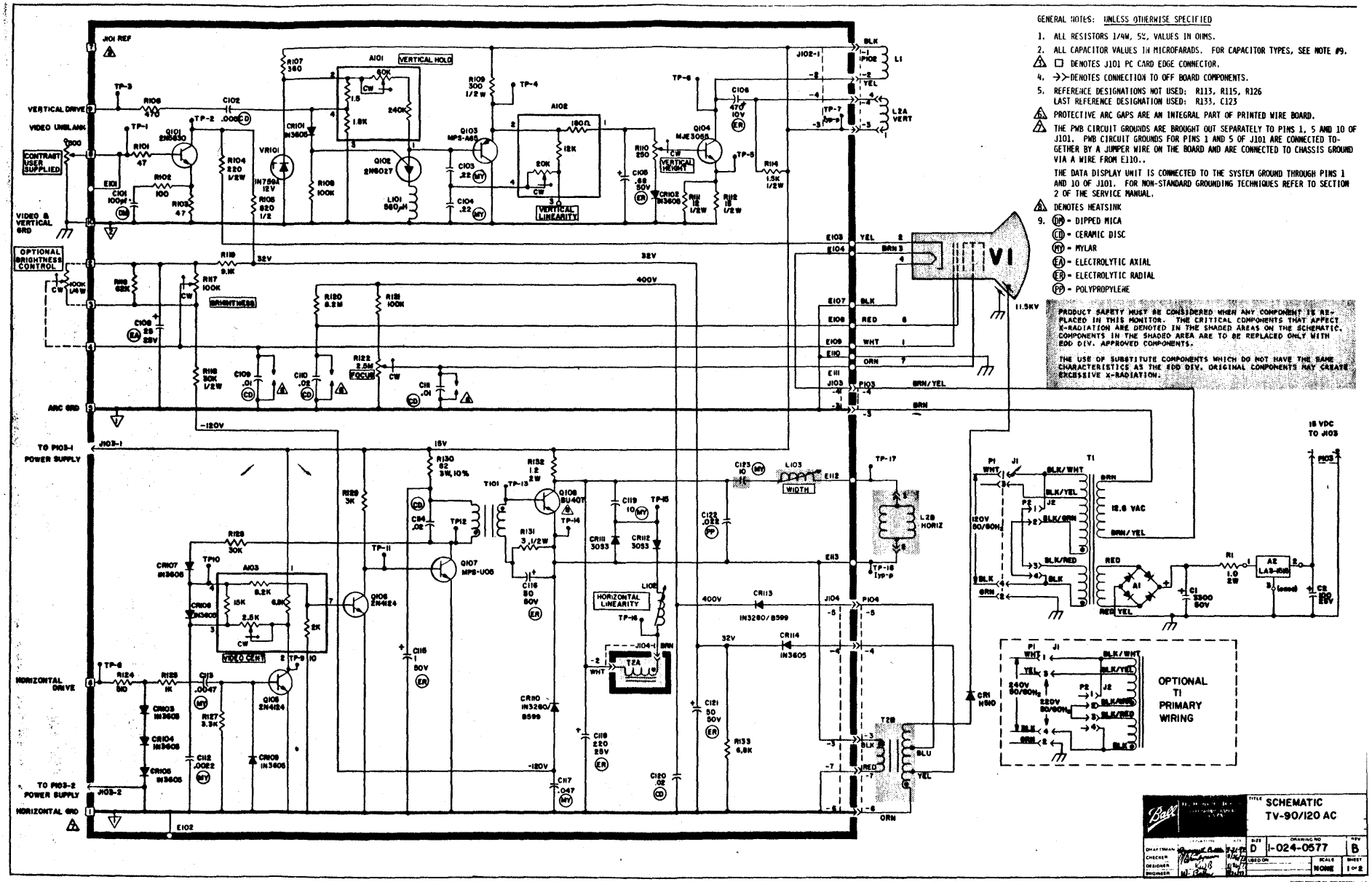


Figure TC 90/120, AC Schematic

PARTS LIST, TV 90/120 AC

REF SYM	DESCRIPTION	BBRC PART NUMBER	USED ON 6-002- 0696	0654	0714	0729
A1	INT CIRCUIT LAS-1515	1-025-0122	X	X	X	X
A2	BRIDGE RECTIFIER	1-021-0413	X	X	X	X
A101	RES TRIM, 60K, VERT HOLD	1-011-8006	X	X	X	X
A102	RES TRIM, 20K, VERT LIN	1-011-8005	X	X	X	X
A103	RES TRIM, 2.5K, VIDEO CENTER	1-011-8001	X	X	X	X
	CAPACITOR, FIXED, uF UNLESS NOTED					
C1	3300, 50V, E	1-012-2286	X	X	X	X
C2	100, 25V, E	1-012-2076	X	X	X	X
C101	100PF±5%, 500V, DM	1-012-0300	X	X	X	X
C102	.005±20%, 100V, CD	10-12-7508	X	X	X	X
C103	.22±10%, 100V, MY	1-012-2277	X	X	X	X
C104	.22±10%, 100V, MY	1-012-2277	X	X	X	X
C105	.68, 50V, E	1-012-2264	X	X	X	X
C106	470, 10V, E	1-012-2158	X	X	X	X
C107	NOT USED					
C108	25, 25V, E	1-012-1380	X	X	X	X
C109	.01±20%, 1000V, CD	1-012-2214	X	X	X	X
C110	.02±20%, 1000V, CD	1-012-2217	X	X	X	X
C111	.01±20%, 1000V, CD	1-012-2214	X	X	X	X
C112	.0022±10%, 630V, MY	1-012-2254	X	X	X	X
C113	.0047±10%, 630V, MY	1-012-2279	X	X	X	X
C114	.02±20%, 100V, CD	10-12-7209	X	X	X	X
C115	1, 50V, E	1-012-2189	X	X	X	X
C116	50, 50V, E	1-012-2157	X	X	X	X
C117	.047±10%, 250V, MY	1-012-2240	X	X	X	X
C118	220, 25V, E	1-012-2159	X	X	X	X
C119	10±10%, 100V, MY	1-012-2255	X	X	X	X
C120	.02±20%, 500V, CD	1-012-0780	X	X	X	X
C121	50, 50V, E	1-012-2157	X	X	X	X
C122	.022±10%, 250V, PP	1-012-2297	X	X	X	X
C123	10±10%, 100V, MY	1-012-2255	X	X	X	X
C124	NOT USED					
	DIODE					
CR	H510	1-021-0424	X	X	X	X
CR101	1N3605	1-021-0410	X	X	X	X
CR102	1N3605	1-021-0410	X	X	X	X
CR103	1N3605	1-021-0410	X	X	X	X
CR104	1N3605	1-021-0410	X	X	X	X
CR105	1N3605	1-021-0410	X	X	X	X
CR106	1N3605	1-021-0410	X	X	X	X
CR107	1N3605	1-021-0410	X	X	X	X
CR108	NOT USED					
CR109	1N3605	1-021-0410	X	X	X	X
CR110	1N3280/B599	1-021-0403	X	X	X	X
CR111	30S3	1-021-0458	X	X	X	X
CR112	30S3	1-021-0458	X	X	X	X
CR113	1N3280/B599	1-021-0403	X	X	X	X
CR114	1N3605	1-021-0410	X	X	X	X
	FUSE					
F101	NOT USED					
	CONNECTORS					
J102	CONNECTOR, 4 PIN MALE	1-039-0146	X	X	X	X
J103	CONNECTOR, 4 PIN MALE	1-039-0146	X	X	X	X
J104	CONNECTOR, 7 PIN MALE	1-039-0145	X	X	X	X

REF SYM	DESCRIPTION	PART NUMBER	USED ON 6-002- 0696	0654	0714	0729
	COIL					
L1	VERTICAL CHOKE	6-003-0529	X	X	X	X
L2	DEFLECTION, TV 120/AC	1-023-0231		X	X	
OR	DEFLECTION, TV 90/AC	1-023-0237	X			X
L101	560uH	1-016-0302	X	X	X	X
L102	LINEARITY	1-016-0328	X	X	X	X
L103	WIDTH	1-016-0303	X	X	X	X
	TRANSISTOR					
Q101	2N5830	1-015-1172	X	X	X	X
Q102	2N6027	1-015-1157	X	X	X	X
Q103	MPS-A65	1-015-1186	X	X	X	X
Q104	MJE3055	1-015-1156	X	X	X	X
Q105	2N4124	1-015-1139	X	X	X	X
Q106	2N4124	1-015-1139	X	X	X	X
Q107	MPS-U05	1-015-1159	X	X	X	X
Q108	BU407	1-015-1210	X	X	X	X
	RESISTOR, FIXED, CARBON, ±5%, 1/4W UNLESS NOTED					
R101	47	70-16-0470	X	X	X	X
R102	100	70-16-0101	X	X	X	X
R103	47	70-16-0470	X	X	X	X
R104	220, 1/2W	1-011-2254	X	X	X	X
R105	820, 1/2W	1-011-2268	X	X	X	X
R106	470	70-16-0471	X	X	X	X
R107	360	70-16-0361	X	X	X	X
R108	100K	70-16-0104	X	X	X	X
R109	300, 1/2W	1-011-2257	X	X	X	X
R110	VAR, 250±20%, CO VERT HGT	70-89-0251	X	X	X	X
R111	12, 1/2W	1-011-2224	X	X	X	X
R112	15, 1/2W	1-011-2226	X	X	X	X
R113	NOT USED					
R114	1.5K, 1/2W	1-011-2274	X	X	X	X
R115	NOT USED					
R116	62K	70-16-0623	X	X	X	X
R117	VAR, 100K±20%, CO BRT ADJ	1-011-5435	X	X		
R118	30K, 1/2W	1-011-2305	X	X	X	X
R119	9.1K	70-16-0912	X	X	X	X
R120	8.2M	70-16-0825	X	X	X	X
R121	100K	70-16-0104	X	X	X	X
R122	VAR, 2.5M±20%, CO FOC ADJ	1-011-5566	X	X	X	X
R123	NOT USED					
R124	510	70-16-0511	X	X	X	X
R125	1K	70-16-0102	X	X	X	X
R126	NOT USED					
R127	3.3K	70-16-0332	X	X	X	X
R128	30K	70-16-0303	X	X	X	X
R129	3K	70-16-0302	X	X	X	X
R130	82±10, 3W, WW	1-011-2375	X	X	X	X
R131	3, 1/2W, CO	1-011-2478	X	X	X	X
R132	1.2±10%, 2W, WW	1-011-1395	X	X	X	X
R133	6.8K	70-16-0682	X	X	X	X
R134	NOT USED					
R135	NOT USED					
	TRANSFORMER					
T1	POWER	6-003-0569	X	X	X	X
T2	HIGH VOLTAGE	6-003-0530		X	X	
OR	HIGH VOLTAGE	6-003-0602	X			X
T101	HORIZ DRIVER	1-017-5402	X	X	X	X
VR101	ZENER, 1N759A,'12V	78-15-0759	X	X	X	X
	MISCELLANEOUS					
	CRT SOCKET	1-022-0427	X	X	X	X
	ASSY POWER SUPPLY	6-003-0570	X	X	X	X
	ASSY JUMPER PLUG	6-004-0749	X	X	X	X
	SOCKET TRANSISTOR	1-022-0433	X	X	X	X

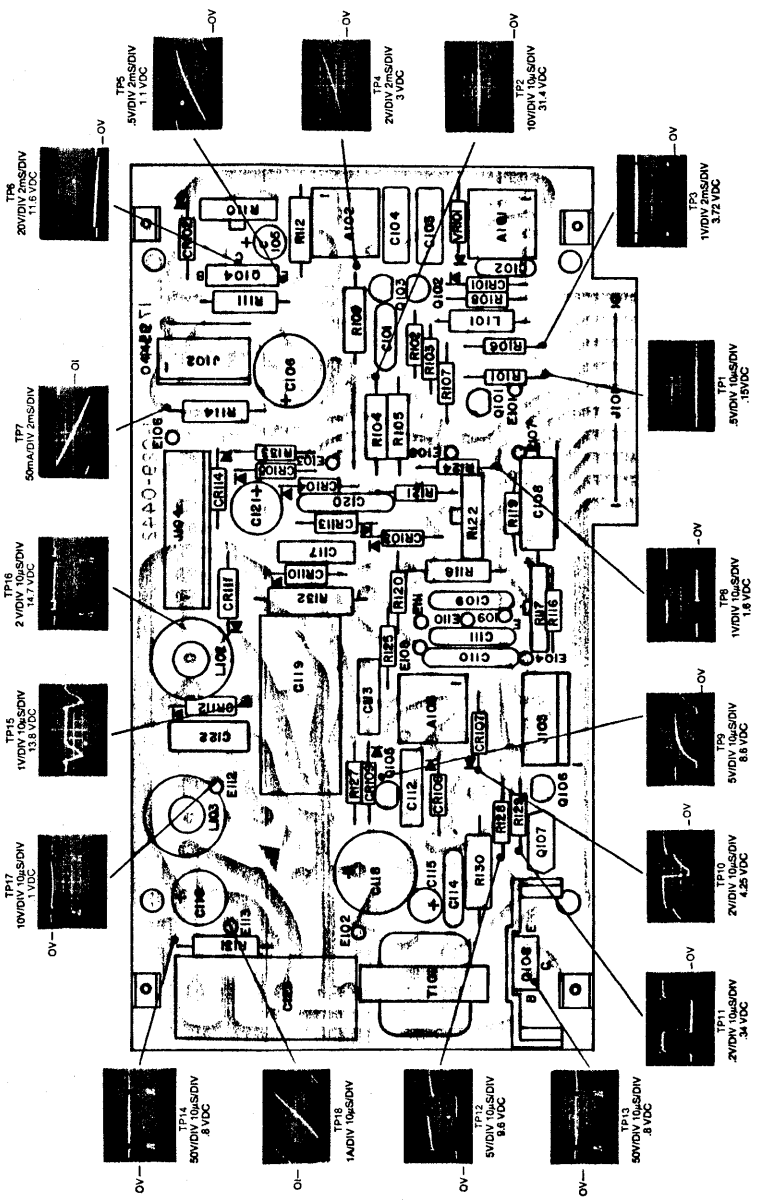


Figure 6-8 TV 90/120 AC Parts List, Waveform and Component Layout

Section 7

SUPPLEMENT

7.1 GENERAL

We are continually striving to provide you with a service manual that represents the units you have ordered. Because of printing and shipping requirements we can't get these changes immediately in to the printed manuals. This section will contain change information concerning the TV 50, 90, 120 data display models.

Each change supplement section will identify the model(s) affected by revision level of the final assembly.

Section 1 through 6 represents the TV 50, TV 90 and TV 120 at the B revision level. The revision level of your unit can be identified by the revision letter following the unit model number on the serial number tag. The high voltage transformer assembly, PWB assembly, power supply module and frame assembly are also identified with a revision level. The revision level is noted after the last four digits of the board assembly part number which is stamped on the board.

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.

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.