SERVICE MANUAL

Video Monitor
TD Series

5-017-1015

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Rev. C

Ball Electronic Display Division

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Section 1
GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The TD monitor is a solid state unit for use in industrial, commercial and data display fields, where reliability and high quality video reproduction are desired. Applications such as remote monitor for computer terminals and airline flight arrival/departure displays are ideally suited to this unit.

The TD monitor has a single plug-in circuit board with silicon transistors. The unit is equipped with differential input for composite video signal to minimize hum and other extraneous pickup on long video feed cables. The 23 inch cabinet is available with or without studs for versatile mounting configuration.

1.2 ELECTRICAL SPECIFICATIONS

VIDEO AMPLIFIER

Input impedance	10 KΩ Hi-Z; 75Ω Low Z, Rear panel switch for Hi-Z or 75Ω termination.
Input connector:	UHF-looping
Input level:	.30 to 2.0 V p-p composite
Low Frequency tilt:	5% or less with window input signal
DC restorer:	Keyed backporch clamp
Gray scale:	Linear response to stairstep signal
Bandwidth:	17.5 MHZ @ -3db
Rise and Fall time:	Less than 20 nanoseconds

SYNCHRONIZATION

Internal:	Composite video only
Vertical retrace Blanking:	yes
Line rate/Field rate:	525/60 Hz or 625/50 Hz (with 50 Hz AC)

RETRACE TIME

Horizontal:	8 μseconds
Vertical:	600 μseconds

DISPLAY

Picture tube:	23 or 12 inch rectangular
Center resolution:	800 TV lines minimum (P4 at 30 FT-L no panel)
Geometric Distortion:	Less than 2% of active raster height.

POWER SUPPLY

Input voltage:	100 to 240 AC, 50/60 Hz
Input Power:	46W Nominal
Output voltage	+57 VDC short circuit protected +18 KV nominal

ENVIRONMENTAL

Temperature:	Operating range: 5°C to 55°C ambient Storage range: -40°C to 65°C ambient
Humidity:	5 to 80% (non-condensing)
Altitude:	Operating: up to 10,000 ft. Storage: up to 14,00C ft.

1.3 MECHANICAL SPECIFICATION

Front panel controls:	Off/On, brightness and contrast controls
Remaining controls:	Internal

DIMENSIONS (NOMINAL)

MODEL	HEIGHT	WIDTH	DEPTH	WEIGHT (lbs)
TD23M	18"	23-1/16"	18-1/2"	65
TD12C	9-1/16"	11-7/16"	12-1/2"	15
TD12M	10-5/16"	12"	12-13/16"	25

1.4 HUMAN FACTORS SPECIFICATION

1.4.1 X Radiation

This monitor complies with the Federal Regulation for Radiation as required by the Radiation for Health and Safety Act of 1968 and as implemented by title 21, subchapter J of The Code of Federal Regulations.

These regulations place certain requirements on manufacturers, dealers, and distributors of products which can emit X-rays under some conditions of operation or failure. Critical components (shaded on the schematic) must be replaced with EDD approved components.

Title 21 of the code of Federal Requlations, part 1002 specifies that dealers and distributors must keep sales records for all electronic products which are subject to the Federal Radiation Safety Performance Standards to permit tracing of specific television recievers to specific purchasers. (Ref. HEW publication (FDA) 78-8044, Federal Record Keeping Requirements).

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 easisly 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.

1.4.2 Power Requirements

The TD monitor is designed to operate and meet radiation requirements when operated within the respective AC input power specifications. Radiation testing is performed at the maximum specified input voltage for AC powered monitors.

1.4.3 UL Requirements

The TD monitor is designed to meet:

UL standard 796, Printed Wiring Board
UL standard 478, Standard for Electronic Data Processing Units.
UL standard 114, Standard for Office Appliances.

Section 2
INSTALLATION INSTRUCTIONS

2.1 GENERAL

This section describes the installation procedures of the TD series monitor. It also contains information on the space, power and cable termination requirements of the monitor.

2.2 SPACE

The TD-23 monitor occupies an area of 18 inches high, 23-1/16 inches wide and 18-1/2 inches deep.

2.3 POWER

The external power requirements of the unit is 105-130 VAC, 50-60Hz, 46 watts nominal. The power cable supplied with the unit is the standard 3-wire grounding type.

2.4 LOCATION

The monitor shall not be located in an area that restricts air flow around the unit. Nor shall it be placed near any heat generating sources; such as heating vents and heat radiating equipment since this may cause the monitor to overheat.

2.5 CABLE TERMINATION

The two video input connectors J1 and J2 on the rear panel are wired in parallel. The video cable is connected to the video input connector and is terminated by positioning the video termination switch S1 to the 75Ω position. If the video signal is looped through the monitor to other monitors, the video termination switch is set to the Hi-Z position, except on the last monitor, where it is set to the 75Ω posiiion, see figure 2-1.

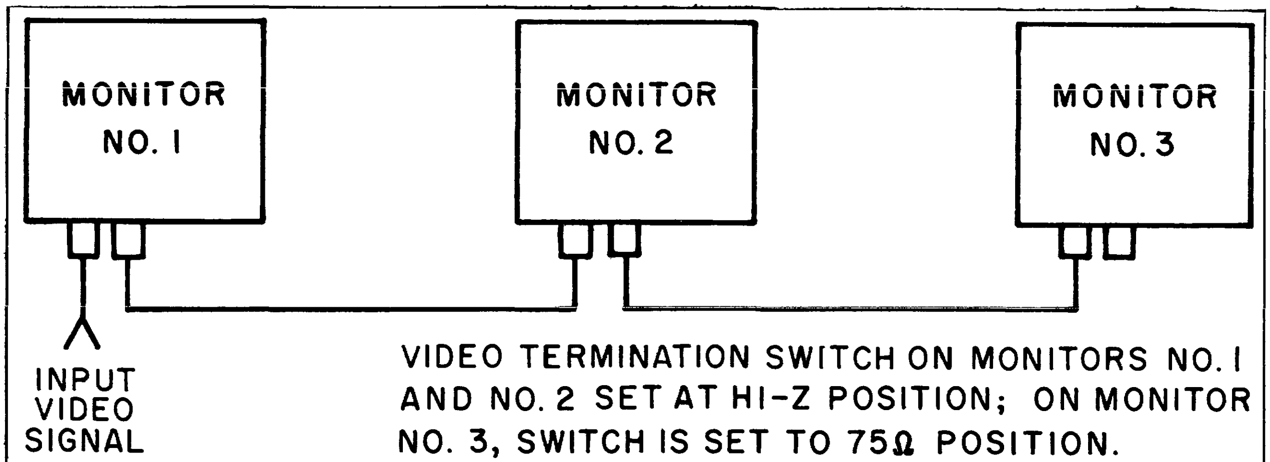


Figure 2-1 Loop through video connection between monitors.

If a ground loop hum is apparent in the picture, placing the differential input switch S2 in the ON position will remove any hum induced in the cable between the monitor and the equipment which is causing it. If a ground loop hum is not apparent in the picture, leave the differential input switch in the OFF position.

2.6 INITIAL TURN-ON PROCEDURE

The TD monitor was tested and aligned before shipment, and should not require further adjustment after installation. The following procedure is recommended for turning on the monitor for the first time:

(1) Connect the monitor to a 120 VAC, 60Hz power source.

(2) Connect a video cable to video input connector at rear of chassis.

(3) Set the video termination and differential input switches to the desired position.

(4) Place power switch in ON position. Adjust Brightness and Contrast controls for desired effect.

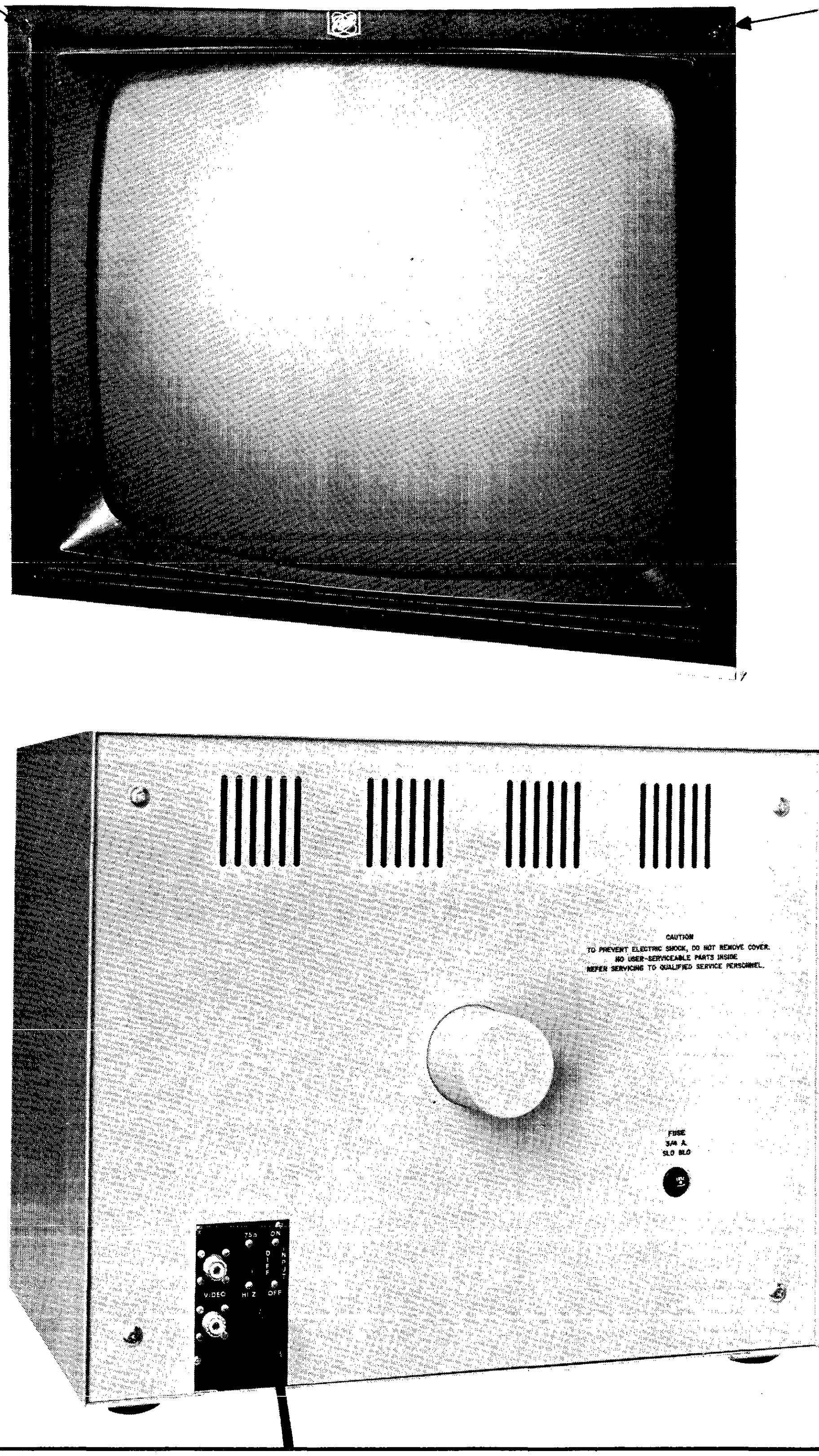


Figure 2-2 Front and Rear view of TD-23 monitor.

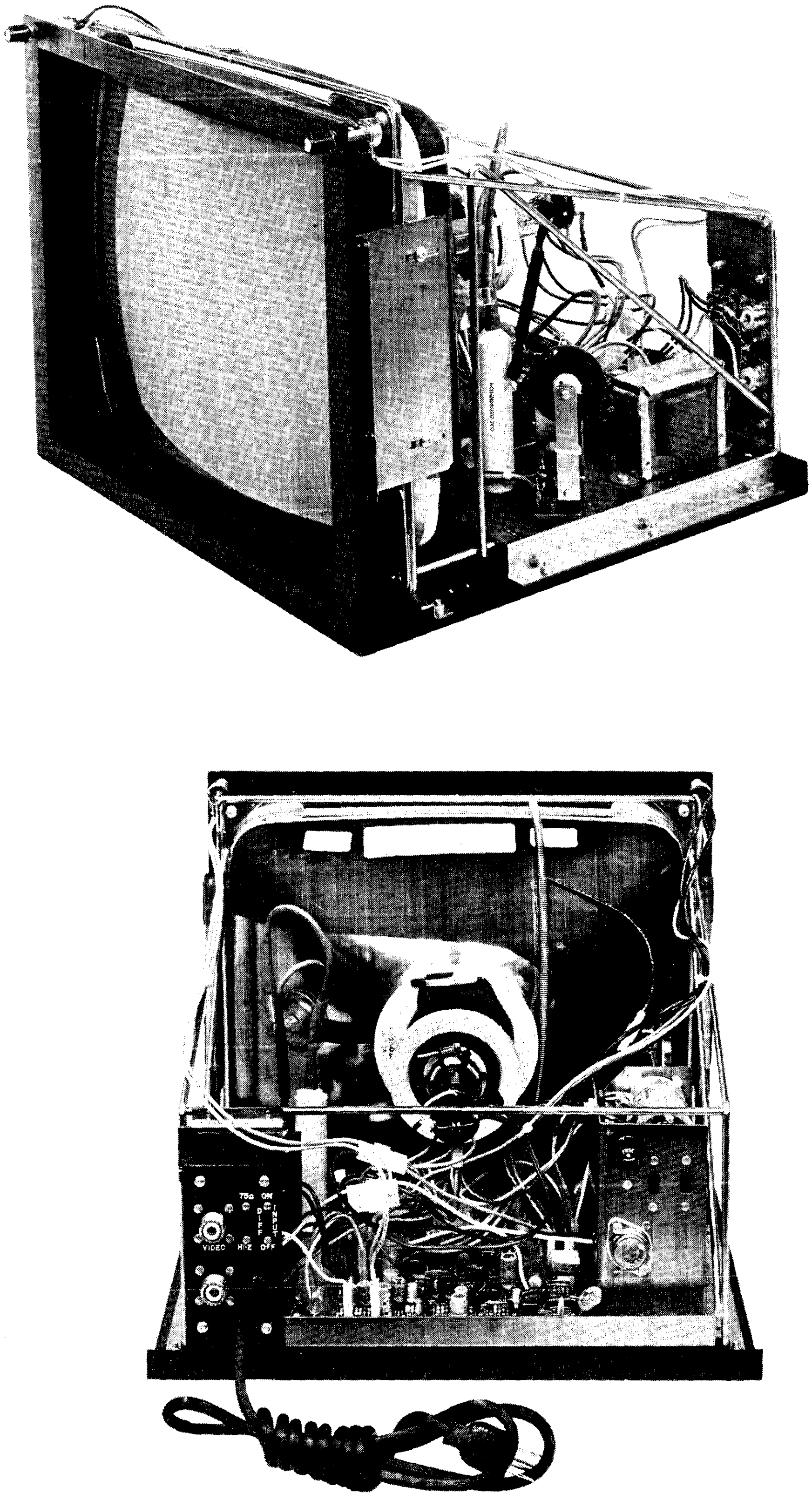


Figure 2-3 Front and rear view of TD12 and TD15

SECTION 3

CIRCUIT THEORY

3.1 GENERAL INFORMATION

This section describes the circuit theory of the TD series monitor. This section is to be used with the waveforms and schematics found in section 5 and 6 of this manual.

3.2 VIDEO AMPLIFIER

The video amplifier consist of transistors Q101 through Q103, integrated circuit U101 and transistor Q105 through Q111.

A composite video signal is applied to the PWA through J102-3 and is ac coupled to the differential amplifier. The differential amplifier consists of Q101 and Q103 with Q102 as the constant current source for the pair. The video gain of this stage is essentially unity. Hum is rejected when S2 is in the ON position because of the inherent common mode rejection of the differential pair. This stage presents an input impedance of 10K to the incoming video signal.

The composite video is ac coupled to the electronic attenuator U101 and direct coupled to sync amplifier Q112. U101 is an integrated circuit and its gain is controlled by the contrast control R3. Its advantage over the conventional method is that the video signal is not routed through the contrast control and the stray capacity associated with these long leads does not cause a roll-off in high frequency response.

The video signal is ac coupled to the base of Q105. Q105 with Q106 forms a compound series feedback stage. This configuration provides a high input impedance and a low output impedance to drive emitter follower Q108. It also has a voltage gain of 9. The output signal from Q106 is coupled to the base of Q108, and its base is biased by the keyed clamp transistor Q107.

The function of the keyed clamp stage is to clamp the blanking level of the composite video signal to a fixed reference voltage which is constant regardless of scene content. It functions as a DC restorer and forces the input voltage during blanking at Q108 to be 1.5 volts. The base of Q107 is driven by composite negative sync and caused Q107 to saturate at the trailing edge; thus clamping occurs during the back porch of the composite video.

Q108 is another emitter follower which isolates the keyed clamp from the output stages Q109, Q110 and Q111. Transistor Q110 and its components comprise the video output driver with a gain of 15 to 18. The bias voltage for Q110 is supplied by DC coupling from Q108 which in turn is biased by the keyed clamp. Q110 operates essentially as a class B amplifier and is referenced to blanking level and allows a greater video swing in the output stage. R135 adds series feedback which stabilizes the voltage gain and operating point against transistor and temperature variation. C115 and C135 increase the gain of the driver at the high frequencies to compensate for the capacitance in Q110 and at the cathode of the CRT.

The signal at the collector of Q110 is direct coupled to the base of the emitter follower Q111, which provides a low source impedance for driving the cathode of the CRT.

Vertical retrace blanking is applied to the base of Q109, which conducts harder during this time to increase the voltage at Q111 emitter and drives the cathode of the CRT to cutoff.

R227 and C159 forms a protection circuit for the output stages in the event of a CRT arc. If a transient voltage of 230 volts or greater appears at the CRT cathode, ionization will take place within the arc gap, providing a low impedance path to ground.

3.3 SYNC PROCESSING

The sync processing circuit consist of Q112, Q114, Q115 and Q118. The function of this circuit is to provide negative vertical sync pulses to drive the vertical oscillator and positive horizontal pulses for the AFC circuitry.

A positive going composite video signal at the collector of Q103 is applied directly to the base of the sync amplifier Q112. This amplifier has a voltage gain of 8 and it applies an amplified composite video signal to the base of Q114, the sync stripper. C118 is used to remove the 3.58mHz color burst signal from the back porch of the horizontal pulse. Q114 is turned on when triggered by the leading edge of the sync pulse and is turned off by the trailing edge of the sync pulse. This on/off action of Q114 results in a negative going composite sync signal of approximately 13.5V p-p at its collector.

The composite sync signal is sent through a vertical integrator (R148 and C122) to the base of Q115, the vertical sync separator. The vertical sync signal at the collector of Q115 is used to trigger the vertical oscillator Q116. The zener diode in the collector circuit of Q115 is used to limit the peak to peak amplitude of the vertical sync pulse to 6.2V.

The vertical portion of the composite sync signal is removed by the differentiator circuit C129 and R167. The horizontal pulse is applied to Q118, inverted and used to drive the AFC stage Q119.

3.4 VERTICAL DEFLECTION

The vertical deflection circuit consist of a vertical oscillator, an emitter follower, a vertical output amplifier and the vertical deflection coil of the yoke.

The vertical oscillator Q116 is synchronized by the vertical sync pulse from Q115 and it produces a sawtooth waveform signal. This signal is fed through an emitter follower to the input of the vertical output amplifier Q1. This amplifier provides a sawtooth current waveform for the vertical deflection coil of the yoke.

The vertical oscillator Q116 is a thyristor functioning as a programmable unijunction and operates as a relaxation oscillator. The free running frequency is set by the DC voltage at it's gate and anode. This voltage is determined by the resistive voltage divider network of R153, R154 and R155. This voltage can be varied by the vertical hold control R154. The oscillator is synchronized by a negative vertical sync pulse applied to the gate of Q116 from Q115 through C123.

The sawtooth forming network consists of C126, C127 and R157. These capacitors charge exponentially at the vertical rate during the vertical scan time. The vertical height control adjusts the amplitude of the sawtooth waveform by controlling the charging rate of C126 and C127. To maintain a linear charging rate, the output of Q117 is fed back through R160 and R161 to the junction of C126 and C127. The charging path is from ground through C126 and C127, past the anode of Q116 and through the vertical height control (R158) to B+. The vertical oscillator is at cutoff during the time that these capacitors are charging. When the anode voltage exceeds Q116 gate voltage, it turns on and rapidly discharges C126 and C127 through L102. The tuned circuit consisting of L102, C126 and C127 provide a stable control of the dropout time to maintain interlace.

The sawtooth signal at Q116 anode is direct coupled to the base of Q117. This transistor is a darlington pair emitter follower driver for the vertical output amplifier. It presents a high imput impedance in shunt with R157 to prevent loading of the wave shaping network across which the sawtooth waveform is shaped. It also provides a low output impedance and high current gain to drive the base of the vertical amplifier Q1.

The positive going sawtooth waveform at Q117 emitter is fed back through the resistive voltage divider of R160 and R161. This divider along with C127 integrates the sawtooth waveform and introduces a parabolic component to control linearity. The amount of feed back is controlled by the vertical linearity control R160.

Height control R158 varies the amplitude of the sawtooth voltage developed by controlling the effective B+ applied to R157 and therefore controls the vertical raster size on the CRT.

The vertical output stage Q1 uses a NPN power type transistor operating as a class AB amplifier. The output is transformer coupled to provide a proper impedance match with the yoke. CR108, R164 and C128 form a clamp circuit which limits the collector voltage at Q1 to safe levels during retrace. R139 prevents oscillations by providing damping across the vertical yoke coils.

3.5 HORIZONTAL DEFLECTION

Transistors Q120 and Q121 and their components form an astable multivibrator operating at the horizontal rate. Zener diode VR103 and R177 provide a stable 6.2 volts source to this circuit from the 18 volt supply. The network consisting of R189, R190 and thermistor RT101 is used to stabilize the frequency of the multivibrator with temperature variation. The frequency of the multivibrator normally would increase with temperature due to base-emitter voltage of Q120 and Q121 varying inversely with temperature. As the temperature increases, the thermistor resistance decreases; thereby lowering the effective source voltage applied to the main timing network consisting of R187, R185 and C140. This action slows down the charging current into C140 and holds the off time of Q121 constant. The other timing network for Q120 and Q121 consists of R181 and C138. The time constants chosen are such that the output square wave at Q121 is positive for 38 μseconds and grounded for 25 μseconds. This establishes the proper duty cycle for the output stages. The output at Q121 is DC coupled to pre-driver inverter Q122 which produces sharp rise and fall times for coupling to the driver transistor Q129.

Q129 is driven alternately into saturation and cutoff by the square wave ac coupled from Q122. Its output is transformer coupled to the horizontal output stage Q3. Phasing of T101 is chosen such that Q3 turns off when Q129 turns on. This allows Q3 to turn off quickly, thus minimizing power dissipation.

During conduction of the driver transistor, energy is stored in the coupling transformer. The voltage at the secondary is then negative and keeps Q3 cut off. As soon as the primary current of T101 is interrupted due to the base signal driving Q129 into cut off, the secondary voltage changes polarity. Q3 starts conducting, and base current flows. This gradually decreases at a rate determined by the transformer inductance and circuit resistance.

The horizontal output stage has three main functions: to supply the yoke with the correct horizontal scanning currents; develop 18 kV for the CRT anode and DC voltage for the CRT bias, focus and accelerating grids.

Q3 acts as a switch which is turned on or off by the rectangular waveform on the base. When Q3 is turned on, the supply voltage plus the charge on C158 causes yoke 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 negative voltage in its base which causes the output circuit to oscillate. A high reactive voltage in the form of a half cycle positive voltage pulse is developed by the yoke's inductance and the primary of T3. The peak magnetic energy which was stored in the yoke during scan time is then transferred to C156 and the yoke's distributed capacity. During this cycle, the beam is returned to the center of the screen.

The charged capacitances now discharge into the yoke 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 yoke moves the scanning beam to the left of the screen.

After slightly more than half a cycle, the voltage across C156 biases the damper diode CR121 into conduction and prevents the flyback pulse from further oscillating. The magnetic energy that was stored in the yoke from the discharge of the distributed capacity is released to provide sweep for the left half of scan and to charge C158 through the rectifying action of the damper diode. The beam is then at the center of the screen. The cycle will repeat as soon as the bias voltage of Q3 becomes positive.

C158 serves to block DC currents through the yoke 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 describe the same arc.

L103 is an adjustable width control placed in series with the horizontal deflection coils. The variable inductive reactance allows a greater or lesser amount of the deflection current to flow through the horizontal yoke and varies the width of the horizontal scan.

The positive flyback pulse developed during horizontal retrace time is rectified by CR116 and filtered by C148. This produces approximately 600 VDC which is coupled through the focus control R219 to G4 of the CRT. The resistive divider R221 and R225 provides approximately 400 VDC for the G2 of the CRT. This same pulse is transformer coupled to the secondary windings of T3. It is rectified by CR1 and R5 to provide 18kV for the CRT anode. It is also rectified by CR120 to provide a -80 V source for the brightness control R4.

In the event the -55 V supply voltage rises excessively due to a failure in the regulator circuit, Q128 will conduct and shunt the +18 V supply for Q118 through Q122 to ground. This will shut down the high voltage supply of the monitor and prevent X radiation. R212 is a selected resistor (for replacement of R212, see section 4.2) that enables Q128 to conduct when the +55 volt supply exceeds 59 V ±1V.

3.6 AUTOMATIC FREQUENCY CONTROL

The function of this circuit is to compare the phase (frequency) of the horizontal oscillator with the incoming sync signal and generate a DC control voltage which holds the oscillator in phase lock with the input sync signal.

The automatic frequency control circuit consists of stages Q118, Q119 and Q123. The composite sync coupled from Q114 is differentiated at Q118 and fed to phase splitter Q119. The positive and negative balanced sync outputs of Q119 and applied to the diode phase detector CR111 and CR112. Also applied to the diodes is a sawtooth voltage derived from the horizontal flyback pulse by the way of Q123 and integrator R173 and C134. The phase compared output appears as a DC correction voltage after filtering by R179, C135 and C136. This correction voltage is then applied to the base of Q121 to effect frequency control.

3.7 LOW VOLTAGE POWER SUPPLY

The low voltage supply module is capable of operating from AC line voltage of 100V, 120V, 220V or 140V, 50/60Hz.

The power supply input voltage is determined by the setting of the two slide switches located at the rear of the supply. These switches are stamped to indicate the appropriate line voltage setting.

To set the supply for a particular line voltage, the numbers on the two switches are added together. This allows the supply to be set for four different input line voltages. The position of the switches and the resultant input voltages is shown in the schematic.

NOTE

When changing the AC input voltage from 100/120 to 220/240, the fuse (F1) must also be changed

INPUT VOLTAGE	*FUSE SIZE*
100/120	*3/4A 125V SB*
220/240	*3/8A 250V SB*

The low voltage supply uses a series-pass regulator designed to maintain a constant DC output for changes in input voltage, load impedance and temperature. Also included is a current limiting circuit designed to protect transistors connected to the 55V output of the regulated supply from accidental output short circuits and load malfunctions.

The low voltage regulator consists of Q2, Q124, Q125, Q126, Q127 and their components. R206 and its circuitry control the current limiting feature.

The primary voltage is stepped down at the secondary of T1 where it is rectified by a full wave bridge rectifier A1. Capacitor C2 is used as a filter capacitor to smooth the rectified output of A1. Transistor Q2 is used as a series pass stage to drop the rectified voltage to +57 VDC and to provide a low output impedance. Approximately 7 volts is applied to the base of Q127 through a divider network of R209 and 211. A reference voltage from zener diode VR104 is applied to the emitter of Q127.

If the output voltage changes, an error current is generated through Q127. This error current modulates the base current of Q125. Since Q2 is driven by Q126 (in a darlington configuration), output drive is regulated in this manner to bring the output voltage back to its proper level.

The short circuit protection or current limiting action can be explained as follows. Assume the 55 volt bus becomes shorted to ground. This reduced output voltage is sensed by the base of Q127, turning that transistor off because of the reverse bias across its emitter base junction. Simultaneously, the increased current through R206 increases the forward voltage drop across the base emitter junction of Q126 and turns it on. The increased collector current through Q126 shunts away the base current of Q125. Since Q2 is driven directly from Q125, its output current becomes limited. This closed loop operation continues until a stable point is reached at which the current available during a short circuit condition is maintained at approximately 100 mA. This "foldback" action limits dissipation in the monitor to safe levels during fault conditions and prevents needless device failures due to accidental short circuits.

SECTION IV

ADJUSTMENT AND MAINTENANCE

4.1 GENERAL

This section is for the adjustment procedures and maintenance procedures for the TD series monitor.

CAUTION

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

4.2 HV SHUTDOWN RESISTOR REPLACEMENT (R212)

Refer to figure 4-1 for component location on PWA and test equipment termination.

1. Connect a DC voltmeter + lead to R216 and the - lead to chassis ground. This meter is for monitoring the B+ voltage.

2. Connect one end of a clip lead to R211 and the other end to chassis ground. This will disable the voltage regulator circuit.

3. Connect a 100K range resistor decade box across the male molex pins for R212 and set the decade box for 300Ω resistance.

4. Plug the monitor AC plug (P1) in to a 0-140 V variac and set the variac voltage control for 0 volts.

5. You are going to determine what value of R212 that causes HV shutdown (loss of raster) when the B+ voltage is 59V ±1V.

   a. Turn on the monitor and place the brightness and contrast controls in the center of their rotation.

   b. Turn on the variac and slowly increase the AC input voltage to the monitor while watching the B+ voltage. Note the B+ voltage reading prior to HV shutdown (loss of raster).

6. If HV shutdown occurs prior to 59V ±1V, increase the value of R212 and repeat step 5b.

7. When the HV shutdown occurs at 59V ±1V, note the decade box resistance value and use this resistance for R212.

8. Install R212 and repeat step 5b to varify that the shutdown voltage will occur at 59V ±1V.

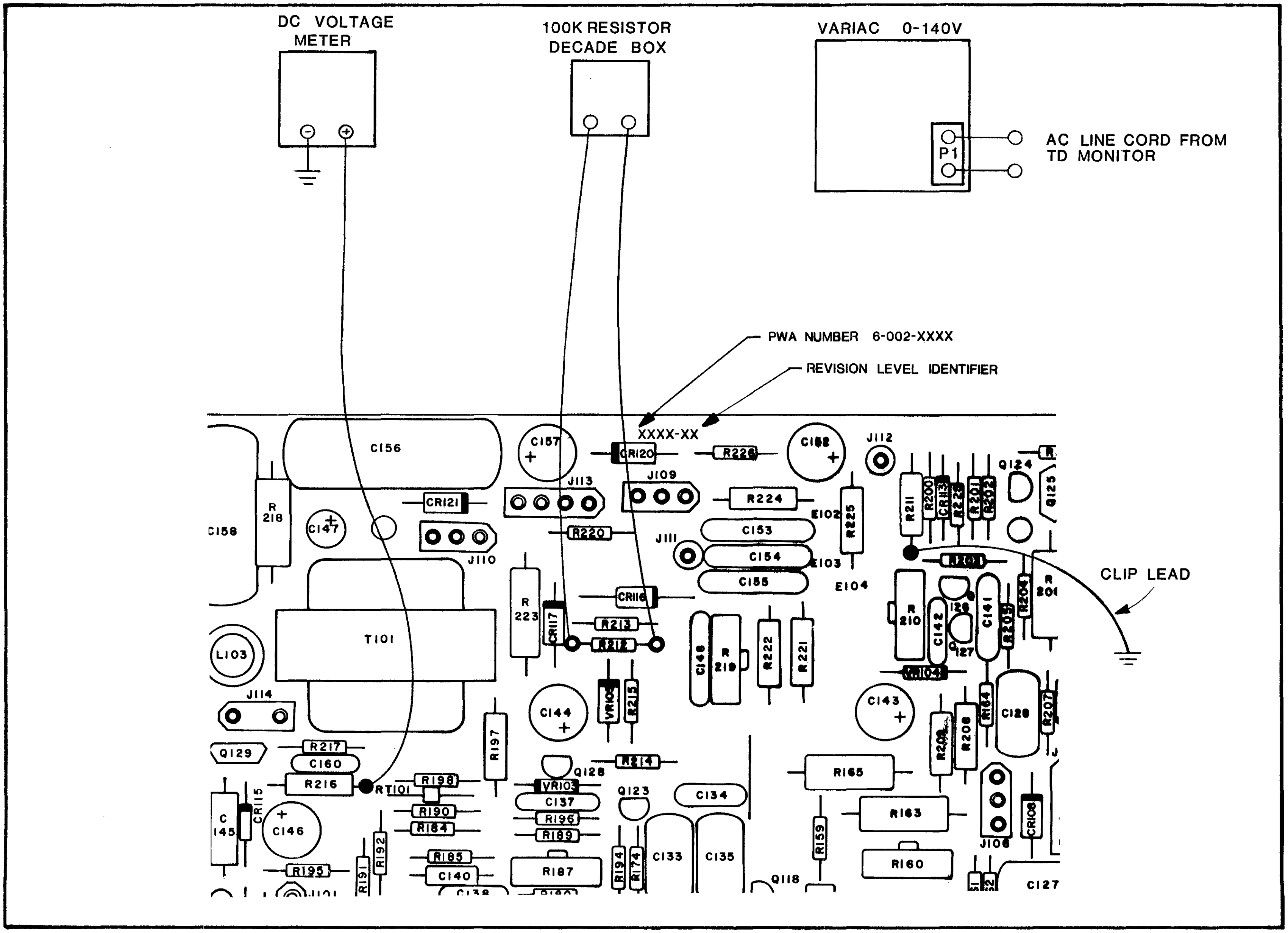


Figure 4-1 Test Equipment Lead Placement for Selecting R212

4.3 VERTICAL CIRCUIT ADJUSTMENT

1. Apply a crosshatch video signal to the unit via J1 or J2.
2. Adjust vertical hold control R154 to the center of its range.
3. Adjust vertical height control R158 for a full raster from top to bottom.
4. Adjust vertical linearity control R160 and vertical height control R158 for equal spacing between the horizontal lines of the crosshatch signal.

4.4 HORIZONTAL CIRCUIT ADJUSTMENT

1. Apply a crosshatch video signal to the monitor through J1 or J2.
2. Adjust the horizontal hold control R187 to lock in the picture horizontally.
3. Adjust width coil L103 for a full raster from left to right.
4. Adjust linearity sleeve on the CRT neck for equal spacing between the vertical lines of the crosshatch signal.

4.5 CHASSIS REMOVAL

4.5.1 TD23 Model

Remove input signal cable from J1 or J2. Remove screws holding cabinet back and remove back from set. Discharge CRT HV anode to chassis ground and disconnect it from CRT. Disconnect CRT socket deflection coil plugs, brightness and contrast control plugs. Remove screws holding chassis to cabinet bottom. Remove chassis from cabinet.

4.5.2 TD12 and TD15 Models

Remove input signal cable from input panel. Remove screws holding cabinet back and remove it from set. Remove screws holding chassis to cabinet bottom and lift out chassis from cabinet.

4.6 CRT REPLACEMENT

WARNING

Extreme care shall be taken when handling the CRT. Safety glasses and gloves must be worn when handling the CRT. Care must be taken to prevent scratching or nicking the Crt or subject it to undue pressure when removing or inserting the CRT into the monitor.

DO NOT LIFT CRT BY THE NECK

4.6.1 TD23 Model

Remove signal input cables from input panel. Remove screws holding cabinet back and remove back from cabinet. Discharge CRT HV anode to ground. Disconnect HV anode, deflection coil plugs, brightness and contrast controls plugs.

To protect CRT, insert a thin piece of cardboard between mask and CRT in the upper right corner. Insert a thin wide blade screwdriver between the mask and cardboard insert and pry the mask outward by twisting the screwdriver against the CRT face.

Remove screws holding the CRT and remove CRT from cabinet. Do Not lift CRT by the neck.

Reverse removal procedure to install CRT.

4.6.2 TD12 and TD15 models

Follow chassis removal procedures in section 4.5.2.

Discharge CRT HV anode directly to ground and remove anode lead from CRT. Disconnect CRT socket and deflection coil plugs.

On TD12 models - remove screws holding mask to frame and tilt mask upward. Remove CRT mounting screws and lift CRT out of frame. Do Not lift CRT by the neck.

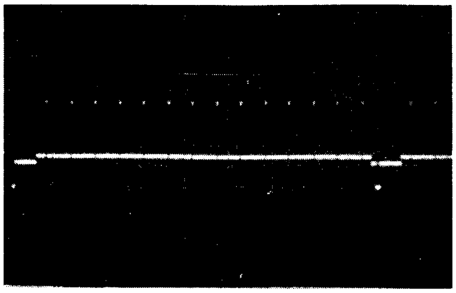
On TD15 models - pull mask outward from frame and tilt upward to provide access to CRT mounting screws. Remove CRT mounting screws and lift out CRT from frame. Do Not lift CRT by the neck.

SECTION V

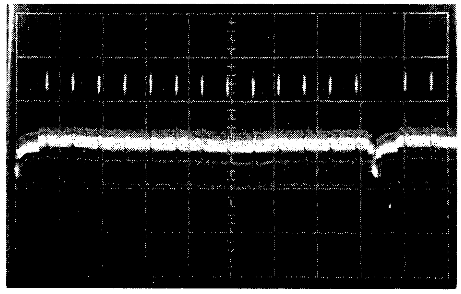
WAVEFORMS

5.1 GENERAL

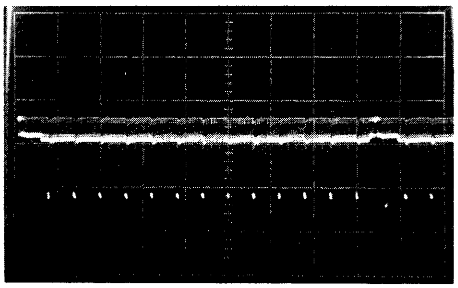
The waveforms shown on the following pages were taken using a crosshatch video input signal applied to J1. The video termination switch S1 is in the 75Ω position and the differential input switch S2 is set to the OFF position.



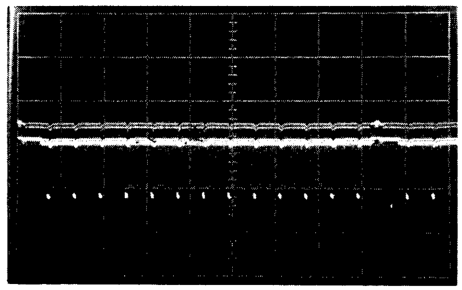
J1 VIDEO INPUT
500mV/cm 2ms/cm
1V P-P



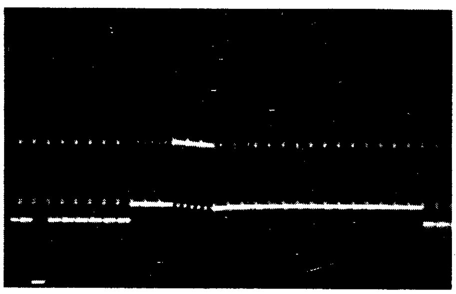
Q105 BASE
1V/cm 2ms/cm
.28V P-P



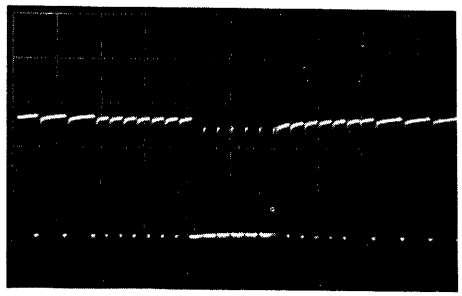
Q106 EMITTER
100mV/cm 2ms/cm
180mV P-P



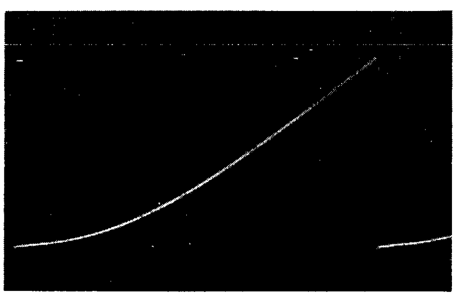
E101 COLLECTOR
.5V/cm 2ms/cm
.8V P-P



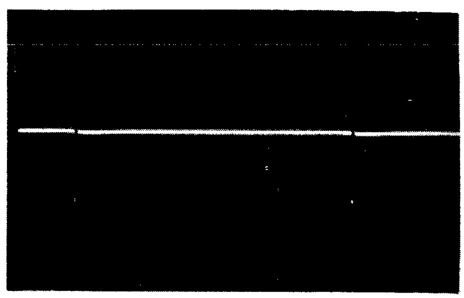
Q113 EMITTER
2V/cm 200μs/cm
6V P-P



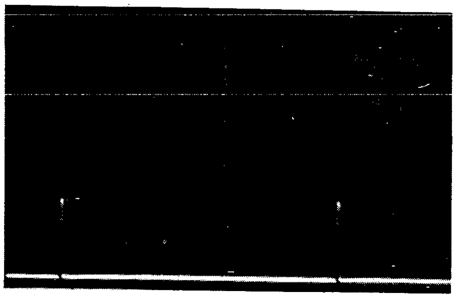
Q114 COLLECTOR
5V/cm 100μs/cm
13.5V P-P



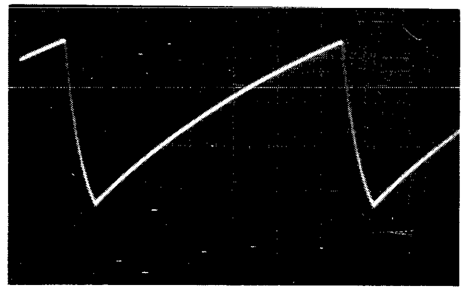
Q116 ANODE
2V/cm 2ms/cm
8V P-P



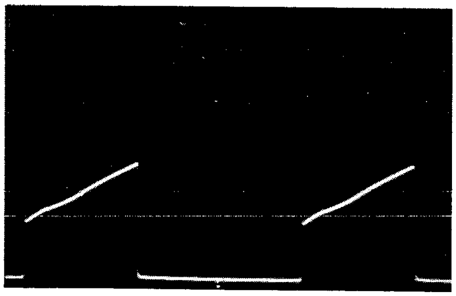
Q119 EMITTER
5V/cm 10μs/cm
8V P-P



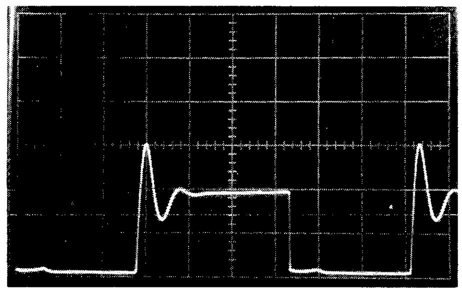
Q119 COLLECTOR
5V/cm 10μs/cm
9V P-P



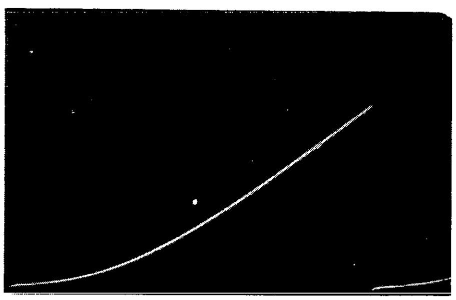
JJUNCTION R173 & C133
2V/cm 10μs/cm
7.6V P-P



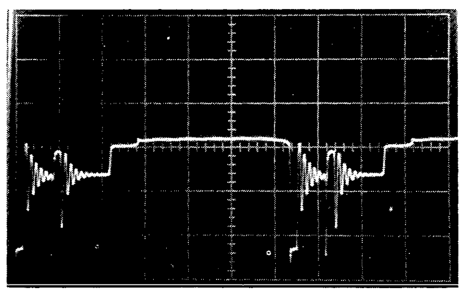
Q122 COLLECTOR
2V/cm 10μs/cm
5.4V P-P



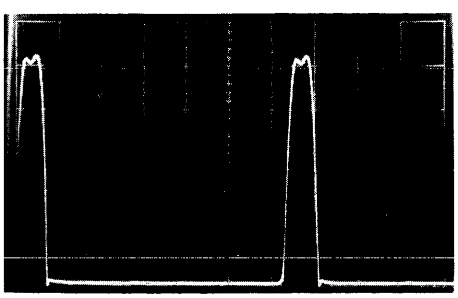
Q129 COLLECTOR
50V/cm 10μs/cm
150V P-P



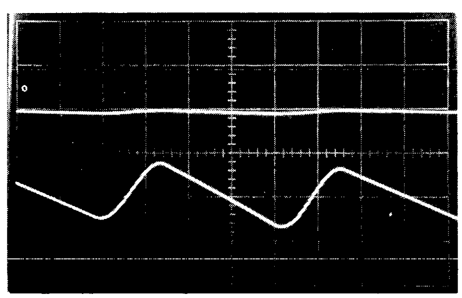
Q1 EMITTER
2V/cm 2ms/cm
8V P-P



Q3 BASE
5V/cm 10μs/cm
14V P-P



Q3 COLLECTOR
100V/cm 10μs/cm
520V P-P



J105-1
TOP WAVEFORM 20V/cm (DC) - 78V DC
BOTTOM WAVEFORM IV/cm (AC) 1.4V ripple

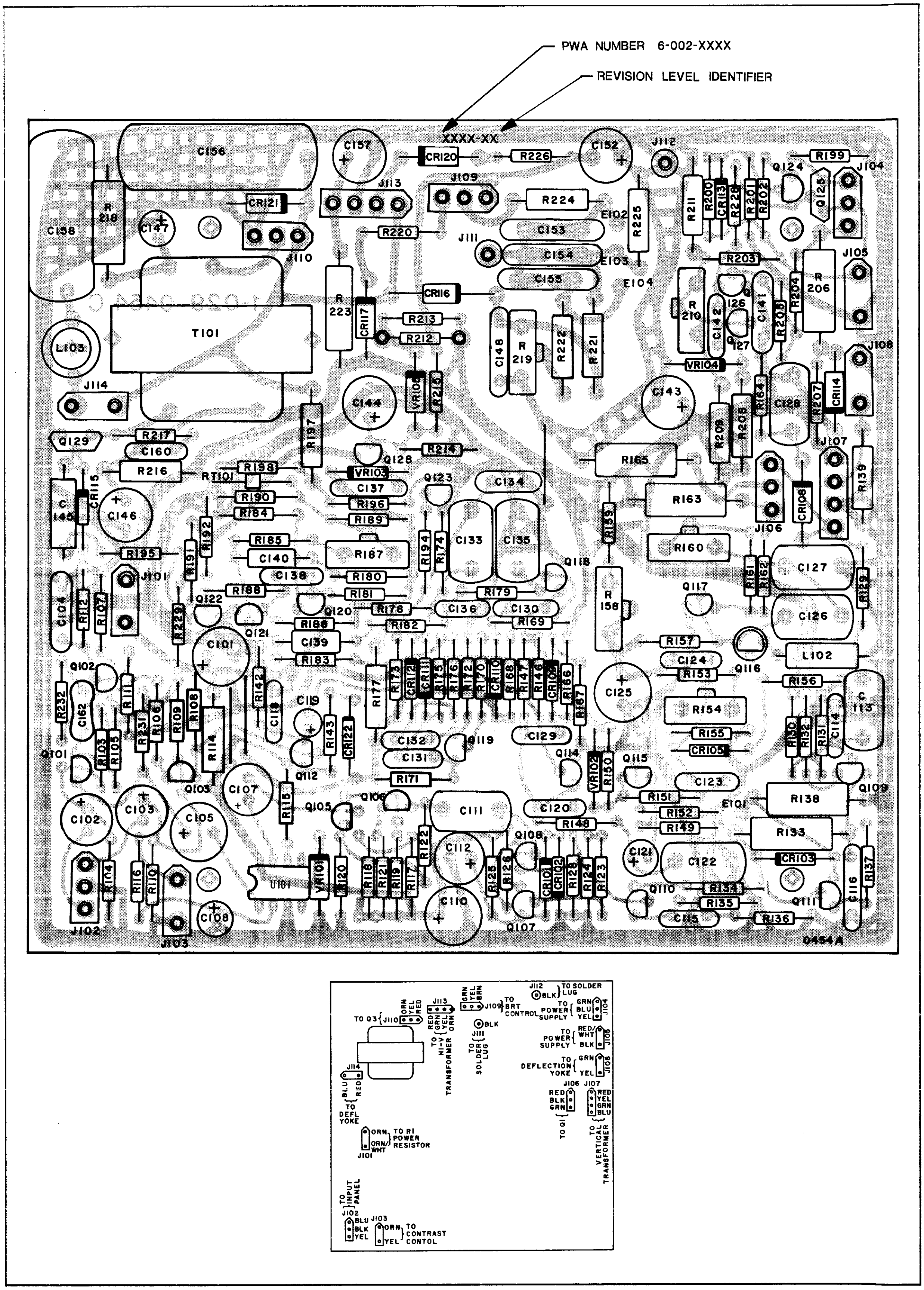


Figure 5-1 Circuit Board Component Location and Intercabling Diagram.

SECTION 6
TD PARTS LIST

6.1 GENERAL

This section contains the replaceable electrical parts list and schematic for the TD monitor.

The parts list and schematic in this manual is for our standard TD series monitor and will not accurately represent a specific customer designed monitor for a specific application.

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 Ball Electronic Display Division (Ball E.D.D.), include the part description, part number, model and serial number data of the Data 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 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, transportaion 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 COMPONENT REPLACEMENT PARTS AFFECTING PRODUCT SAFETY

Product safety must be considered whenever a component is replaced in this unit. The critical components that affect x-radiation are denoted by the shaded areas on the schematic and indicated on the parts list with an asterick preceding the reference symbol designator. These components are to be replaced only with Ball Electronic Display Division approved parts.

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

6.5 PWA IDENTIFICATION

The PWA (Printed Wiring Assembly) part number has a 6-002-XXXX prefix. The last four digits of the assembly number is stamped on the component side of the board and its location is indicated in figure 5-1.

Do not confuse the PWA number with the numbers etched on the conductor side of the Printed Wiring Board. The PWA number is always located on the component side of the PWA.

6.6 MONITOR PARTS LIST

The asterick (*) preceding the reference symbol (REF SYM) indicated that this part is a critical component that affects product safety (Refer to paragraph 6.4 for details).

NOTE

This parts list is for our Standard TD Series Monitor using one of the following PWA numbers: 6-002-0858; 0859; and 0860.

REF SYM	DESCRIPTION	BEDD PART NUMBER
A1	Bridge Rectifier, VS148	1-021-0413
	Capacitor, fixed: µF unless otherwise stated	
C1	.001±10%; 1000V, ceramic disc	1-012-2274

REF SYM	DESCRIPTION	BEDD PART NUMBER
	CAPACITOR Fixed: µF unless otherwise stated	
C2	1500; 100V, electrolytic	1-012-2186
C101	100; 25V, electrolytic	1-012-2200
C102	100; 10V, electrolytic	1-012-2160
C103	100; 10V, electrolytic	1-012-2160
C104	.02 ±20%; 500V, ceramic disc	1-012-0780
C105	47; 25V, electrolytic	1-012-2165
C106	Not used	
C107	22; 25V, electrolytic	1-012-2212
C108	1; 50V, electrolytic	1-012-2189
C109	Not used	
C110	100; 25V, electrolytic	1-012-2200
C111	.1 ± 10%; 200V, mylar	1-012-0870
C112	100; 10V, electrolytic	1-012-2160
C113	.1 ± 10%; 200V, mylar	1-012-0870
C114	.01 ± 20%; 100V, ceramic disc	10-12-7109
C115	68pF ± 5%; 500V, dipped mica	10-57-5680
C116	.1 ± 20%; 100V, ceramic disc	10-12-7104
C117	Not used	
C118	75pF ± 5%; 1000V, ceramic disc	1-012-0280
C119	1; 50V, electrolytic	1-012-2189
C120	270pF ± 5%; 500V, dipped mica	1-012-0396
C121	1; 50V, electrolytic	1-012-2189
C122	.022 ± 10%; 400V, mylar	1-012-2265
C123	.001 ± 20%; 1000V, ceramic disc	1-012-0540
C124	470pF ± 5%; 500V, dipped mica	1-012-0460
C125	47; 50V, electrolytic	1-012-2157
C126	.22 ± 10%; 200V, mylar	1-012-0930
C127	.22 ± 10%; 200V, mylar	1-012-0930
C128	.1 ±10%; 400V, mylar	1-012-2239
C129	200pF ± 5%; 500V, dipped mica	10-57-5201
C130	100pF ± 5%; 500V, dipped mica	1-012-0300
C131	.002 ± 20%; 1000V, ceramic disc	1-012-2219
C132	.002 ± 20%; 1000V, ceramic disc	1-012-2219
C133	.1 ±10%; 200V, mylar	1-012-0870
C134	.01 ±20%; 100V, ceramic disc	10-12-7109
C135	.15 ±10%; 200V, mylar	1-012-0925
C136	.001 ±20%; 1000V, ceramic disc	1-012-0540
C137	.02 ± 20%; 500V, ceramic disc	1-012-0780
C138	680pF ± 5%; 300V, dipped mica	10-57-5681
C139	.0022 ± 10%; 200V, mylar	10-47-7222
C140	.001 ± 10%; 200V, mylar	10-47-7102
C141	.1 ± 20%; 100V, ceramic disc	10-12-7104
C142	27pF ± 5%; 500V, dipped mica	1-012-2161
C143	4.7; 160V, electrolytic	1-012-2195
C144	47; 25V, electrolytic	1-012-2165
C145	.022 ± 10%; 200V, mylar	10-47-7223

REF SYM		DESCRIPTION	BEDD PART NUMBER
		<u>CAPACITOR Fixed; μF unless otherwise stated</u>	
C146		4.7; 160V, electrolytic	1-012-2195
C147		22; 25V, electrolytic	1-012-2212
C148		.01 ±20%; 1000V, ceramic disc	1-012-2214
C149		Not used	
C150		Not used	
C151		Not used	
C152		4.7; 160V, electrolytic	1-012-2195
C153		.01; 1000V, ceramic arc gap	1-012-0112
C154		.01; 1000V, ceramic arc gap	1-012-0112
C155		.01; 1000V, ceramic arc gap	1-012-0112
*C156		.0056 ±10%; 2000V, mylar (PWA 0859 & 0858)	10-35-7562
	or	.0068 ±10%; 1600V, mylar (PWA 0860)	1-012-2210
C157		4.7; 160V, electrolytic	1-012-2195
*C158		1 ±10%; 200V, polycarbonate (PWA 0858 & 0860)	1-012-2220
	or	1.2 ±10%; 100V, polycarbonate (PWA 0859)	1-012-2223
C159		2pF; 230V, arc gap	1-012-0111
C160		.001 ±20%; 1000V, ceramic disc	1-012-0540
C161		Not used	
C162		20pF ±5%; 500V, dipped mica	10-57-5200
		<u>DIODE</u>	
CR1		D0438	1-021-0438
CR101		D0410	1-021-0410
CR102		D0410	1-021-0410
CR103		D0467	1-021-0467
CR104		Not used	
CR105		D0410	1-021-0410
CR106		Not used	
CR107		Not used	
CR108		D0403	1-021-0403
CR109		D0410	1-021-0410
CR110		D0410	1-021-0410
CR111		D0410	1-021-0410
CR112		D0410	1-021-0410
CR113		Not used	
CR114		IN4001	78-62-4001
CR115		D0410	1-021-0410
CR116		D0447	1-021-0447
CR117		D0403	1-021-0403
CR118		Not used	
CR119		Not used	
CR120		D0403	1-021-0403
CR121		D0436	1-021-0436
CR122		D0410	1-021-0410

REF SYM		DESCRIPTION	BEDD PART NUMBER
		FUSE	
F1		3/4A-125V, slo-blo	1-028-0242
		CONNECTOR	
J1		Receptacle, female, 1 contact UHF	1-039-0113
J2		Receptacle, female, 1 contact UHF	1-039-0113
		COIL	
*L1		Deflection coil assembly (TD 23)	6-004-0342
	or	Deflection coil assembly (TD 12)	6-004-0363
	or	Deflection coil assembly (TD 15)	6-004-0329
L2		Fixed; 10μH	15-13-1100
L101		Not used	
L102		Fixed, 330μH	15-13-7331
*L103		Adj; width	1-016-0309
		TRANSISTOR	
Q1		2SD199	1-015-1176
Q2		DTS410	78-85-0410
Q3		DTS402	78-85-0402
Q101		2N4124	1-015-1139
Q102		2N4124	1-015-1139
Q103		2N4124	1-015-1139
Q104		Not used	
Q105		2N4124	1-015-1139
Q106		2N3906	1-015-1145
Q107		2N4124	1-015-1139
Q108		2N4124	1-015-1139
Q109		2N4124	1-015-1139
Q110		MPS-6565	1-015-1185
Q111		MPS-6565	1-015-1185
Q112		2N3906	1-015-1145
Q113		Not used	
Q114		MPS-A16	1-015-1193
Q115		2N4124	1-015-1139
Q116		2N6027	1-015-1157
Q117		MPS-A65	1-015-1186
Q118		2N4124	1-015-1139
Q119		2N3906	1-015-1145
Q120		2N4124	1-015-1139
Q121		2N4124	1-015-1139
Q122		2N4124	1-015-1139
Q123		2N4124	1-015-1139
Q124		MPS-L51	1-015-1175

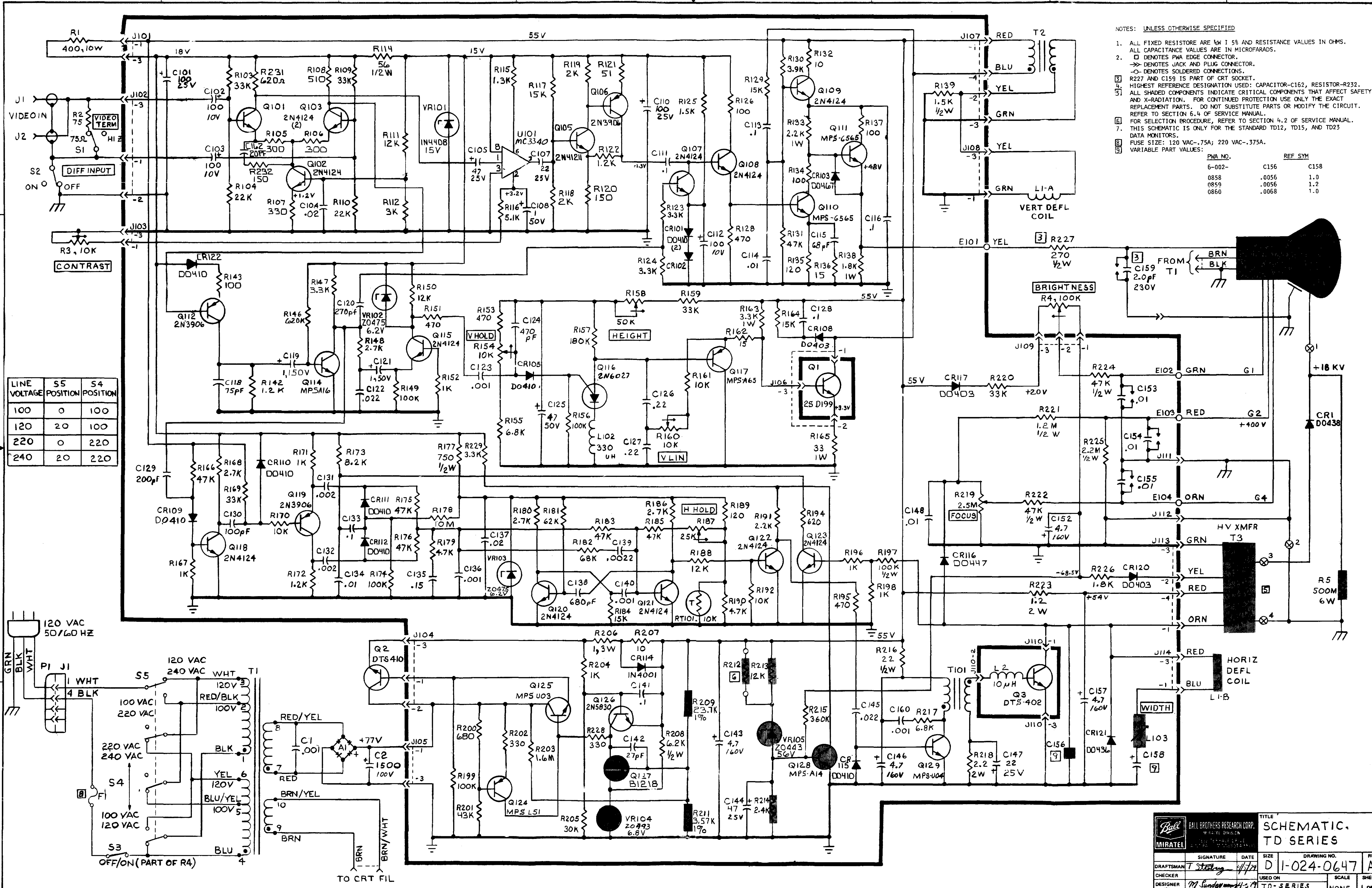
REF SYM	DESCRIPTION	BEDD PART NUMBER
	TRANSISTOR	
Q125	MPS-U03	1-015-1153
Q126	2N5830	1-015-1172
*Q127	B1218	1-015-1218
*Q128	MPS-A14	1-015-1158
Q129	MPS-U04	1-015-1167
	RESISTOR, fixed;±5%; 1/4W, carbon film, unless otherwise stated	
R1	400Ω±10%; 10W, wirewound	1-011-2442
R2	75Ω, 1/2W	1-011-2243
R3	Var; 10K±30%; 1/2W, composition, contrast	6-004-0660
R4	Var; 100K±30%; 1/2W, composition, brightness	6-004-0659
*R5	500M±15%; 6W, deposited carbon	1-011-2456
R101	Not used	
R102	Not used	
R103	33K	70-16-0333
R104	22K	70-16-0223
R105	300Ω	70-16-0301
R106	300Ω	70-16-0301
R107	330Ω	70-16-0331
R108	510Ω	70-16-0511
R109	33K	70-16-0333
R110	22K	70-16-0223
R111	12K	70-16-0123
R112	3K	70-16-0302
R113	Not used	
R114	56Ω; 1/2W	1-011-2240
R115	1.3K	70-16-0132
R116	5.1K	70-16-0512
R117	15K	70-16-0153
R118	2K	70-16-0202
R119	2K	70-16-0202
R120	150Ω	70-16-0151
R121	51Ω	70-16-0510
R122	1.2K	70-16-0122
R123	3.3K	70-16-0332
R124	3.3K	70-16-0332
R125	1.5K	70-16-0152
R126	100Ω	70-16-0101
R127	Not used	
R128	470Ω	70-16-0471
R129	15K	70-16-0153
R130	3.9K	70-16-0392
R131	47K	70-16-0473
R132	10Ω	70-16-0100

REF SYM	DESCRIPTION	BEDD PART NUMBER
	RESISTOR, Fixed:±5%; 1/4W, carbon film, unless otherwise stated	
R133	2.2K; 1W, composition	1-011-2445
R134	100Ω	70-16-0101
R135	120Ω	70-16-0121
R136	15Ω	70-16-0150
R137	100Ω	70-16-0101
R138	1.8K; 1W, composition	1-011-2424
R139	1.5K; 1/2W	1-011-2274
R140	Not used	
R141	Not used	
R142	1.2K	70-16-0122
R143	100Ω	70-16-0101
R144	Not used	
R145	Not used	
R146	620K	70-16-0624
R147	3.3K	70-16-0332
R148	2.7K	70-16-0272
R149	100K	70-16-0104
R150	12K	70-16-0123
R151	470Ω	70-16-0471
R152	1K	70-16-0102
R153	470Ω	70-16-0471
R154	Var; 10K±20%; 1/8W, composition vert hold adj	1-011-5312
R155	6.8K	70-16-0682
R156	100K	70-16-0104
R157	180K	70-16-0184
R158	Var; 50K±20%; 1/8W, composition vert height adj	1-011-5373
R159	33K	70-16-0333
R160	Var; 10K±20%; 1/8W, composition vert linearity	1-011-5312
R161	10K	70-16-0103
R162	15Ω	70-16-0150
R163	3.3K; 1W, composition	1-011-2425
R164	15K	70-16-0153
R165	33Ω; 1W, composition	1-011-0115
R166	47K	70-16-0473
R167	1K	70-16-0102
R168	2.7K	70-16-0272
R169	33K	70-16-0333
R170	10K	70-16-0103
R171	1K	70-16-0102
R172	1.2K	70-16-0122
R173	8.2K	70-16-0822
R174	100K	70-16-0104
R175	47K	70-16-0473
R176	47K	70-16-0473
R177	750Ω; 1/2W	70-17-0751
R178	10M	70-16-0106
R179	4.7K	70-16-0472

REF SYM	DESCRIPTION	BEDD PART NUMBER
	RESISTOR, Fixed:±5%; 1/4W carbon film unless otherwise stated	
R180	2.7K	70-16-0272
R181	62K	70-16-0623
R182	68K	70-16-0683
R183	47K	70-16-0473
R184	15K	70-16-0153
R185	47K	70-16-0473
R186	2.7K	70-16-0272
R187	Var; 25K±20%; 1/8W, composition, horizontal hold	1-011-5325
R188	12K	70-16-0123
R189	120Ω	70-16-0121
R190	4.7K	70-16-0472
R191	2.2K	70-16-0222
R192	10K	70-16-0103
R193	Not used	
R194	620Ω	70-16-0621
R195	470Ω	70-16-0471
R196	1K	70-16-0102
R197	100K; 1/2W	1-011-2318
R198	1K	70-16-0102
R199	100K	70-16-0104
R200	680Ω	70-16-0681
R201	43K	70-16-0433
R202	330Ω	70-16-0331
R203	1.6M	1-011-2550
R204	1K	70-16-0102
R205	30K	70-16-0303
R206	1Ω±10%; 3W, wirewound	1-011-1742
R207	10Ω	70-16-0100
R208	6.2K; 1/2W	1-011-2289
*R209	23.7K±1%; 1/2W, metal film	1-011-2549
R210	Not used	
*R211	3.57K±1%; 1/2W, metal film	1-011-2517
*R212	Selected (minimum resistance 300Ω)	1-011-2517
*R213	12K	70-16-0123
R214	2.4K	70-16-0242
R215	360K	70-16-0364
R216	22Ω; 1/2W	1-011-2230
R217	6.8K	70-16-0682
R218	2.2Ω; 2W, wirewound	1-011-0120
R219	Var; 2.5M±20%; 1/8W, composition focus adj	1-011-5566
R220	33K	70-16-0333
R221	1.2M; 1/2W	1-011-2344
R222	47K; 1/2W	1-011-2310
R223	1.2Ω; 2W, wirewound	1-011-1395
R224	47K; 1/2W	1-011-2310
R225	2.2M; 1/2W	1-011-2350
R226	1.8K	70-16-0182

REF SYM	DESCRIPTION	BEDD PART NUMBER
	RESISTOR, fixed: ±5%; 1/4W, carbon film unless otherwise stated	
R227	270Ω; 1/2W	1-011-2256
R228	330Ω	70-16-0331
R229	3.3K	70-16-0332
R230	Not used	
R231	620Ω	70-16-0621
R232	150Ω	70-16-0151
	THERMISTOR	
RT101	ID101; 10K @ 25°C	1-011-7000
	SWITCH	
S1	Slide, DPDT	85-73-0278
S2	Slide, DPDT	85-73-0278
S3	Rotary, Off-On (part of R4)	6-004-0659
S4	Slide, SPDT	1-018-0255
S5	Slide, 3PD3	1-018-0256
	TRANSFORMER	
T1	Power	6-003-0655
T2	Vertical output	6-003-0341
*T3	High Voltage, TD23 & TD15	6-003-0404
or	High Voltage, TD-12	6-003-0406
T101	Horizontal driver	1-017-5380
	INTEGRATED CIRCUIT	
U101	MC3340	1-025-0123
	ZENER DIODE	
V1	Refer to 1-014-XXXX number on CRT	
VR101	IN4408, 15V	1-021-0405
VR102	Z0475, 6.2V	1-021-0475
VR103	Z0475, 6.2V	1-021-0475
*VR104	Z0493, 6.8V	1-021-0493
*VR105	Z0443, 56V	1-021-0420
	MISCELLANEOUS	
	Assembly, PWA, TD-12	6-002-0860
	Assembly, PWA, TD-23	6-002-0858
	Assembly, PWA, TD-15	6-002-0859
	Assembly, power supply TD-23	6-003-0422

REF SYM	DESCRIPTION	BEDD PART NUMBER
	MISCELLANEOUS	
	Assembly, power supply TD12 & 15	6-003-0433
	Assembly, heatsink TD-23	6-003-0361
	Assembly, heatsink TD12 & 15	6-003-0379
	Assembly, cabinet TD-23M	6-001-0198
	Assembly, cabinet TD-23MV	6-001-0197
	Assembly, cabinet TD-12MV	6-001-0103
	Assembly, cabinet TD-12M	6-001-0104
	Assembly, cabinet TD-15M	6-001-0111
	Assembly, cabinet TD-15MV	6-001-0109



LINE VOLTAGE	S5 POSITION	S4 POSITION
100	0	100
120	20	100
220	0	220
240	20	220

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL FIXED RESISTORE ARE ¼W I 5% AND RESISTANCE VALUES IN OHMS. ALL CAPACITANCE VALUES ARE IN MICROFARADS.
2. ☐ DENOTES PWA EDGE CONNECTOR.
   →» DENOTES JACK AND PLUG CONNECTOR.
   -O- DENOTES SOLDERED CONNECTIONS.
3. R227 AND C159 IS PART OF CRT SOCKET.
4. HIGHEST REFERENCE DESIGNATION USED: CAPACITOR-C162, RESISTOR-R232.
5. ALL SHADED COMPONENTS INDICATE CRITICAL COMPONENTS THAT AFFECT SAFETY AND X-RADIATION. FOR CONTINUED PROTECTION USE ONLY THE EXACT REPLACEMENT PARTS. DO NOT SUBSTITUTE PARTS OR MODIFY THE CIRCUIT. REFER TO SECTION 6.4 OF SERVICE MANUAL.
6. FOR SELECTION PROCEDURE, REFER TO SECTION 4.2 OF SERVICE MANUAL.
7. THIS SCHEMATIC IS ONLY FOR THE STANDARD TD12, TD15, AND TD23 DATA MONITORS.
8. FUSE SIZE: 120 VAC-.75A; 220 VAC-.375A.
9. VARIABLE PART VALUES:

PWA NO. 6-002-	REF SYM C156	C158
0858	.0056	1.0
0859	.0056	1.2
0860	.0068	1.0

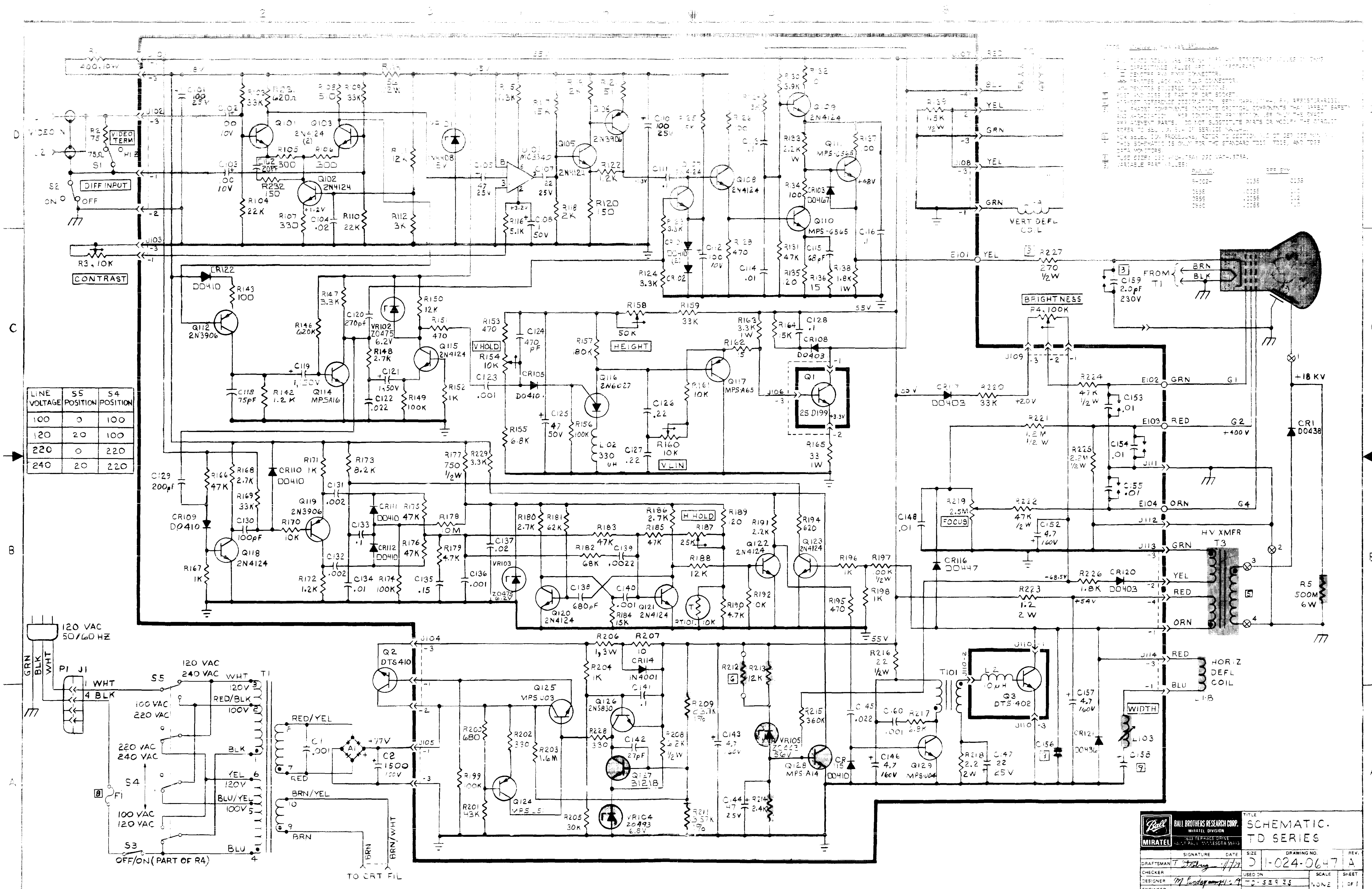
BALL BROTHERS RESEARCH CORP.
MIRATEL DIVISION

TITLE: SCHEMATIC, TD SERIES

	SIGNATURE	DATE
DRAFTSMAN	T Sterling	4/5/79
CHECKER		
DESIGNER	M Sundquist	4-5-79
ENGINEER		

SIZE: D | DRAWING NO.: 1-024-0647 | REV.: A

USED ON: TD-SERIES | SCALE: NONE | SHEET: 1 OF 1


BALL BROTHERS RESEARCH CORP.
MIRATEL DIVISION
SCHEMATIC-
TD SERIES
DRAWING NO. D 11-024-0647
REV. A
SCALE NONE
SHEET 1 OF 1
BRIGHTNESS
CONTRAST
HEIGHT
V HOLD
VLIN
H HOLD
FOCUS
WIDTH
VIDEO IN
VIDEO TERM
DIFF INPUT
VERT DEFL COIL
HORIZ DEFL COIL
HV XMFR T3
+18 KV
120 VAC 50/60 HZ
OFF/ON (PART OF R4)
TO CRT FIL

LINE VOLTAGE	S5 POSITION	S4 POSITION
100	0	100
120	20	100
220	0	220
240	20	220

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.

Ball