INSTRUCTION MANUAL

Serial Number ____________

TYPE 601 STORAGE MONITOR

Tektronix, Inc.
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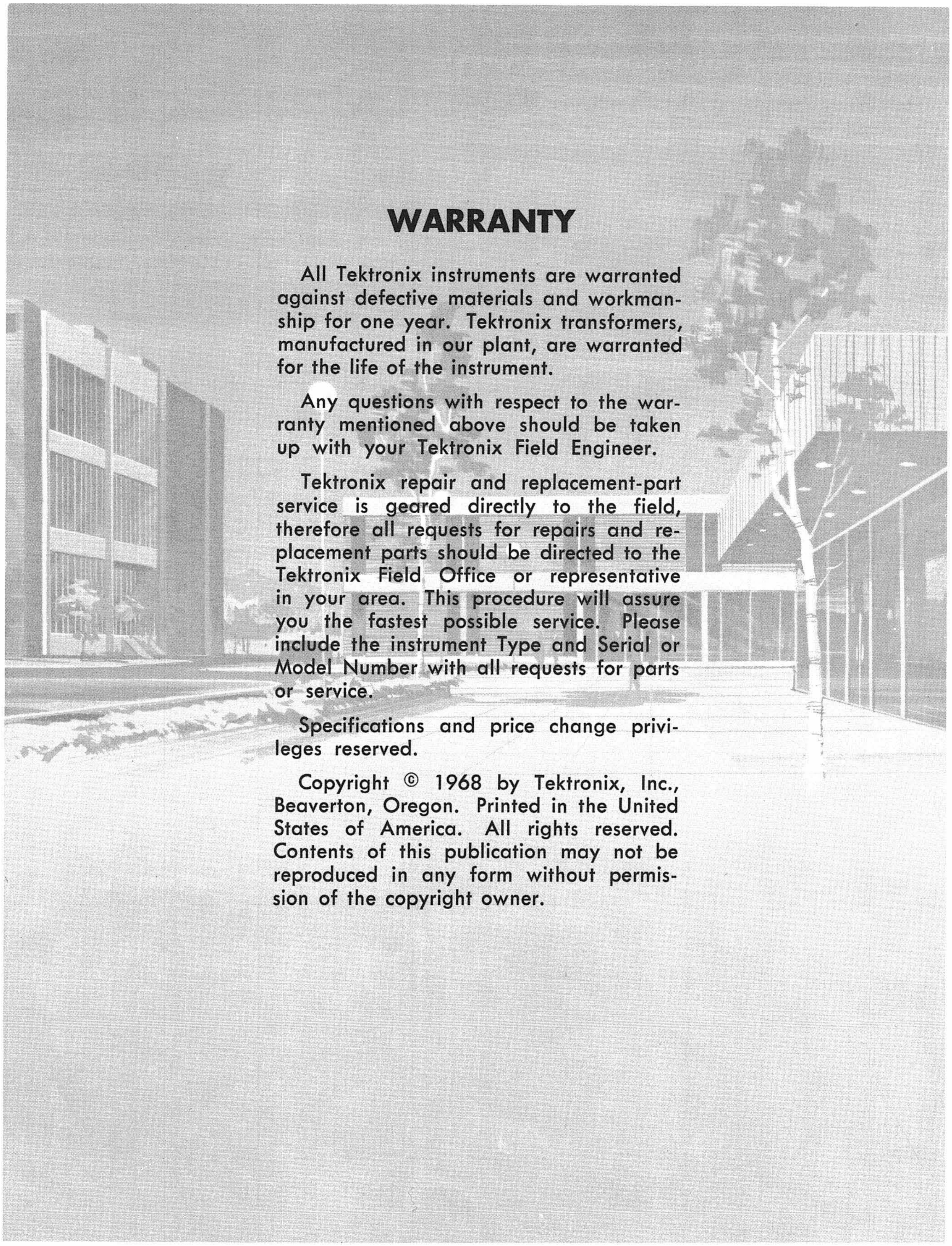

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

CONTENTS

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Stand Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

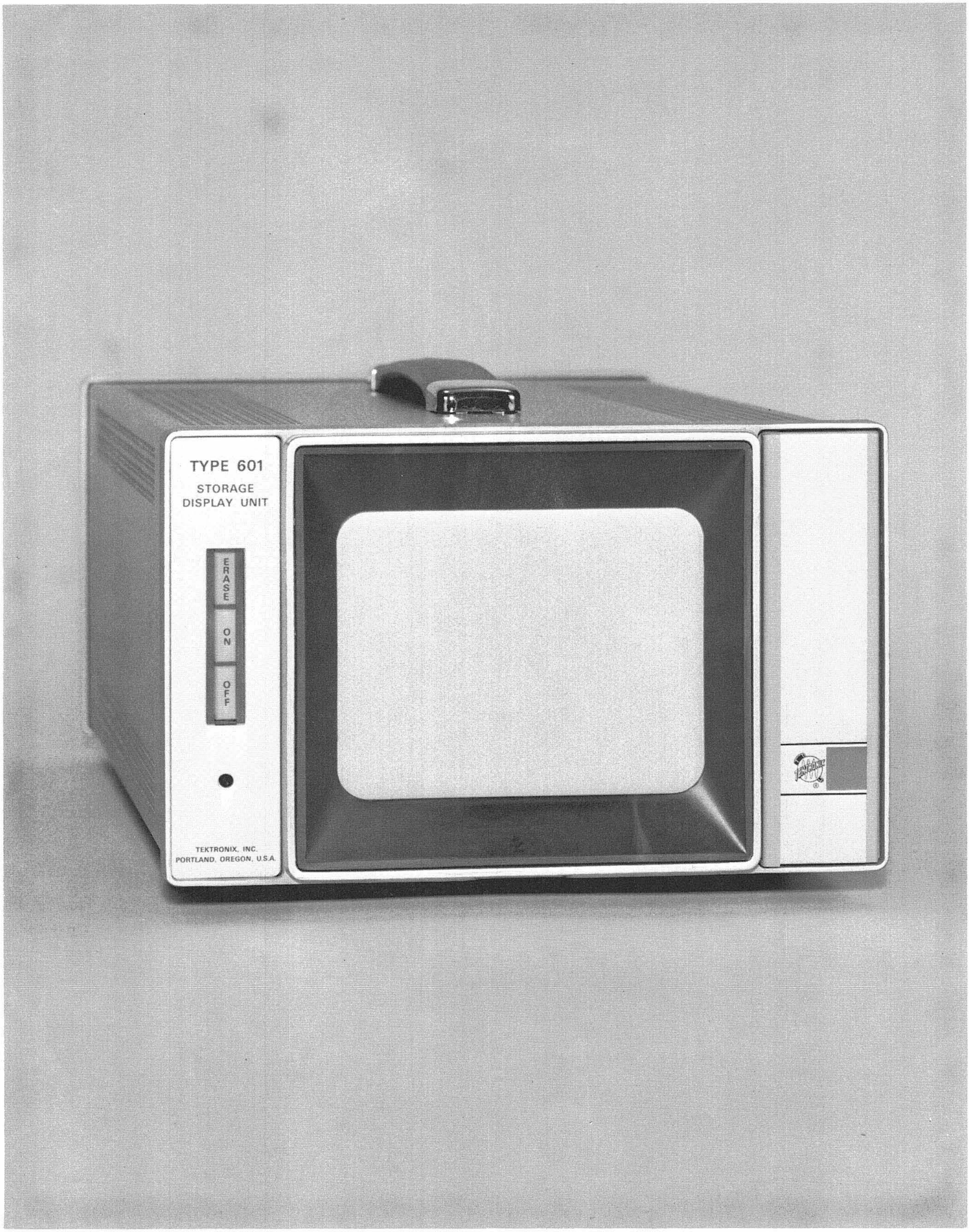

Fig. 1-1. Type 601 Storage Monitor

SECTION 1
CHARACTERISTICS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The Type 601 Storage Display Unit is a special purpose X-Y monitor designed to display and store data from digital computers and other data transmission systems. Differential Inputs are provided on the X and Y Inputs to reject extraneous signals common to interconnecting cables.

The cathode ray tube (T6010) used in the Type 601 is a direct-view, bistable storage tube having an 8 × 10 cm display area. This tube features a raised collector for achieving high resolution.

This instrument will perform to the specifications listed in this section in a laboratory environment with ambient temperature range between 0°C to +50°C, except as indicated. Warm up time for rated accuracies at +25° C, ±5° C, is one minute. The Performance Check procedure given in Section 5 of this manual provides a convenient method of checking the performance of this instrument.

The Type 601 may be used with the Tektronix, Inc. Type C30 camera.

VERTICAL AND HORIZONTAL CHANNELS

Characteristics	Performance Requirements	Supplemental Information
Input Requirements		
Deflection		
Vertical (8 cm full screen)	Variable from 0.75 to 1.1 V for 8 cm with internal gain adjustment.	Set to 1.0 V full screen when shipped.
Horizontal (10 cm full screen)	Variable from 0.9 to 1.1 V for 10 cm with internal gain adjustment.	Set to 1.0 V full screen when shipped.
Signal Rate of Rise	Input signal voltage must reach new writing position within 1 μs for maximum information display rates.	
Input Line Impedance Level	1 kΩ or less recommended.	
Y-T display capability	No significant distortion from DC to 100 kHz.	
Phase Difference	Within 1° between X and Y from DC to 100 kHz.	
Position Stability	Less than 1 mm/hour drift after 20 minute warmup.	
Maximum Input Voltage	±50 V (DC + peak AC)	
Variable Position Range (Internal Adjustment)	Allows setting zero signal position anywhere on screen.	

"Z" AXIS

Input Requirements		
Turn-on Level	+1 V or greater.	
Shut-off Level	+0.5 V or less.	
Maximum Input Voltage	±50 V (DC plus peak AC).	
Signal Rate of Rise	Signal should reach "ON" level within 1 microsecond.	
Recommended Source Impedance	1 kΩ or less.	

DISPLAY

Characteristics	Performance Requirements	Supplemental Information
Quality Area	8 cm by 10 cm.	
Geometry Vertical Horizontal	 1 mm or less. 1 mm or less.	
Display Linearity Vertical Horizontal	 No more than 2% difference between any 2 cm. No more than 5% difference between any 2 cm.	
Recommended Viewing Time	15 minutes or less.	
Erase Time	200 ms or less.	
Dot Writing Time (stored)	9 μs or less.	
Line Writing Speed (stored)	At least 5 cm/ms (at specified resolution).	
Stored Luminance	At least 3 foot-lamberts.	
Contrast Ratio (Average)	At least 3 to 1.	
Stored Resolution Vertical Horizontal	 At least 100 line pairs. At least 125 line pairs.	

POWER SUPPLY

Characteristics	Performance Requirements	Supplemental Information
Line Voltage Range 115 V 230 V	 Low 90 V to 110 V Medium 104 V to 126 V High 112 V to 136 V Low 180 V to 220 V Medium 208 V to 252 V High 224 V to 272 V	
Maximum Power Consumption	57 Watts, 71 VA.	@ 60 Hz
Line Frequency	48 Hz to 440 Hz.	

REMOTE PROGRAM

Characteristics	Performance Requirements	Supplemental Information
Non-store	Switch closure to ground or switching +10 V to 0 V. Current 5 mA or less.	Contact No. 6
Remote Erase	Switch closure to ground or switching +10 V to 0 V. Current 5 mA or less.	Contact No. 18
Program Ground		Contact No. 19
Maximum Input Voltage	±50 V (DC + peak AC)	
Erase Interval	Voltage at this output (contact No. 7) drops from +10 V to 0 V during erase cycle.	Contact No. 7 $Z_o \cong 2\,K\Omega$
Duration of Erase	150 to 200 ms.	
X, Y and Z Inputs	Provide parallel connection to amplifier inputs which may be used instead of BNC connectors. (See Fig. 2-3 in Section 2).	

ENVIRONMENTAL

Characteristics	Performance Requirements	Supplemental Information
Temperature		
Non-operating	—40° C to +65° C	
Operating	0° C to +50° C	
Altitude		
Non-operating	To 50,000 feet	
Operating	To 15,000 feet	

PHYSICAL

Dimension	Without handle and mounting feet (for rack mounting).	With carrying handle and mounting feet.
Height	≈5¼ inches	≈6 inches
Width	≈8½ inches	≈8½ inches
Length	≈17⅜ inches	17⅜ inches
Finish		
Cabinet	Blue vinyl painted aluminum	
Front Casting	Aluminum	
CRT Mask	Delrin[1] plastic	
Weight	≈15 lbs.	≈17½ lbs.

[1]Delrin is a registered trademark of E. I. du pont de Nemours Co.

NOTES

SECTION 2
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

To effectively use the Type 601, the operation and capabilities of the instrument must be understood. This section describes the operation of the front- and rear-panel controls and connectors, and gives first time and general operating information.

Operating Voltage

The Type 601 can be operated from either a 115-volt or a 230-volt nominal line-voltage source. The line-voltage selector converts the instrument from one operating range to the other. In addition, one of three regulating ranges can be selected by the line-voltage range switch. These switches, located on the rear panel (Fig. 2-1), change the primary connections of the power transformer. Use the following procedure to convert this instrument between nominal line voltages or regulating ranges.

1. Disconnect the instrument from the power source.

2. To convert from 115-volts nominal to 230-volts nominal line voltage, slide the line-voltage selector to the 230-volt position. Change the line-cord power plug to match the power-source receptacle or use a 115- to 230-volt adapter.

3. To change regulating ranges, rotate the line-voltage range switch to the desired range. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 2-1).

4. Apply power to the instrument.

CAUTION

Damage to the instrument may result from incorrect switch settings.

TABLE 2-1

Regulating Ranges

Range Selector Switch Position	Regulating Range	
	115-Volts Nominal	230-Volts Nominal
LO (counterclockwise position)	90 to 110 volts	180 to 220 volts
M (middle position)	104 to 126 volts	208 to 252 volts
HI (clockwise position)	112 to 136 volts	224 to 272 volts

Operating Temperature

The Type 601 can be operated where the ambient air temperature is between 0° C and +50° C. The instrument can be stored in ambient temperatures between —40° C and +65° C. After storage at a temperature beyond the operating limits, allow the chassis temperature to come within the operating limits before power is applied. The instrument requires one minute warm up at an ambient room temperature of +25° C, ±5° C, for rated accuracies.

A thermal cutout in this instrument provides thermal protection and disconnects the power to the instrument if the internal temperature exceeds a safe operating level. This device will automatically reapply power when the temperature returns to a safe level.

FUNCTION OF CONTROLS AND CONNECTORS

A brief description of the function or operation of the front- and rear-panel controls and connectors follows: See Fig. 2-1 for locations.

Front-panel

ON pushbutton	Applies power to the instrument.
OFF pushbutton	Removes power from the instrument.
ERASE pushbutton	Erases any information stored on the screen.
POWER INDICATOR lamp	Indicates when power is on.

Front-panel (behind access door)

NOTE

Read First Time Operation before adjusting any of these controls.

INTENSITY adjustment	Utilizes "backlash" pot for combination fine-coarse control of beam current.
FOCUS adjustment	Used in conjunction with ASTIGMATISM adjustment to obtain a well-defined dot display.
ASTIGMATISM adjustment	Used to improve dot focus over entire display.

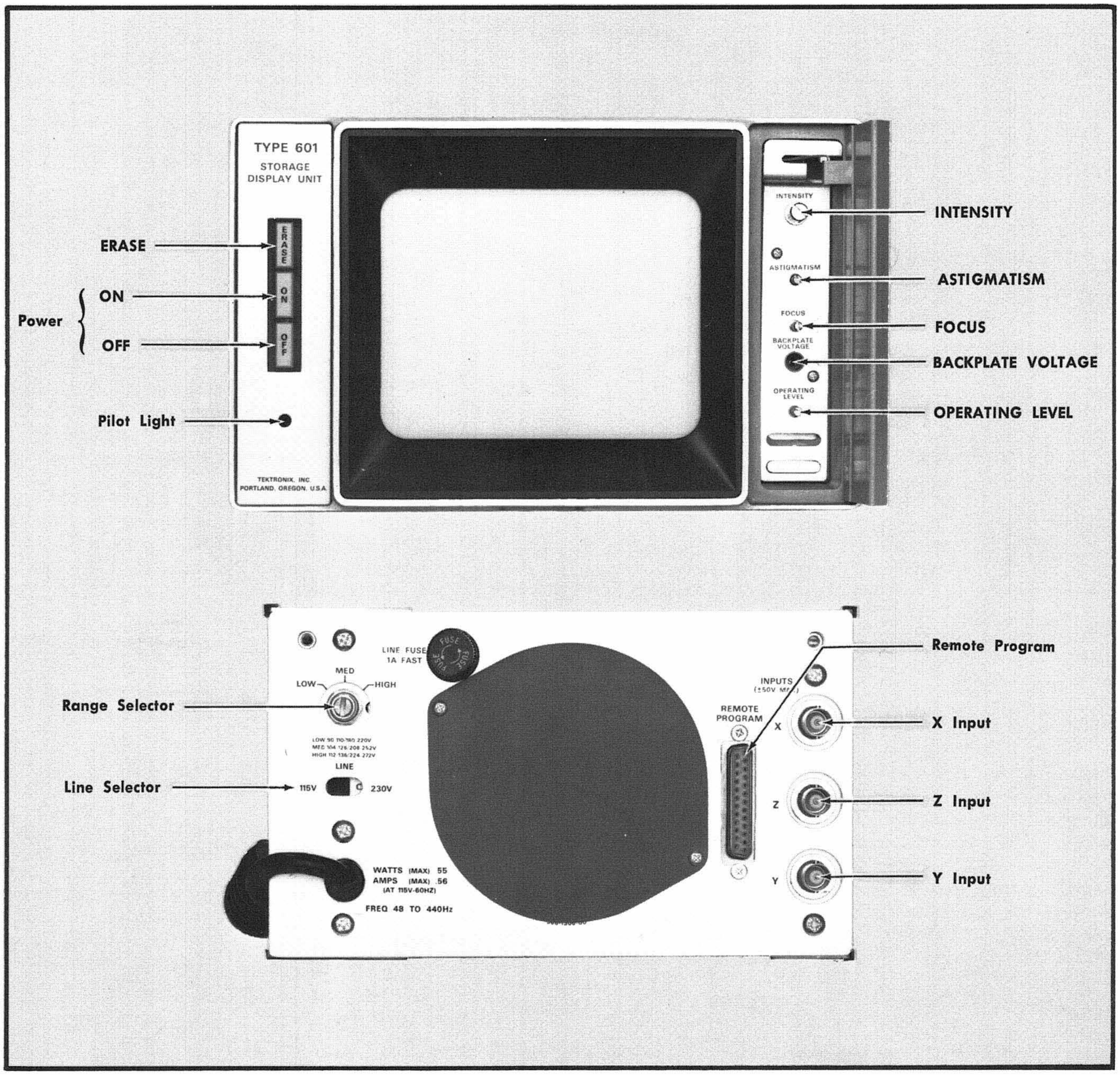

Fig. 2-1. Location of the front- and rear-panel controls and connectors.

OPERATING LEVEL — Permits adjustment of CRT backplate voltage for optimum storage performance.

BACKPLATE VOLTAGE — Convenient voltmeter test point for CRT backplate voltage.

Rear-panel

X INPUT
Y INPUT — Connectors for applying input signals to the Deflection Amplifiers. Differential input provided by isolated shell BNC connectors.

Z INPUT — Connectors for applying input signal to the Z Axis. BNC shell is isolated from ground to 47 Ω.

REMOTE PROGRAM connector — Provides connections to the inputs of the X, Y and Z amplifiers from a remote location. Input signals may be fed to these connectors instead of to the BNC connectors. Other functions and outputs are described below.

Remote Erase. Display will be erased when remote contact is closed.

Remote Non-Store. Closing remote contact puts CRT in "non-store" mode.

Erase Interval. During erase interval a negative-going pulse is present at this

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	contact. This can be used to notify associated equipment such as a computer that the Type 601 is being erased.
115 V-230 V selector	Allows selection of either 115-volts nominal or 230-volts nominal line voltage. (See Operating Voltage, this section.)
Range Selector	Allows selection of any one of three regulating ranges. (See Operating Voltage, this section.)

FIRST TIME OPERATION

The Type 601 Storage Display Unit is ready to be operated when received. The following steps will demonstrate the use of the controls and connectors.

1. Connect the instrument to a suitable power source.

2. Apply the horizontal signal to the X INPUT and vertical signal to the Y INPUT. Apply the beam turn-on signal to the Z INPUT. Refer to GENERAL OPERATING INFORMATION for input signal requirements.

3. Check that the INTENSITY control is turned fully countterclockwise, then push the power switch to ON. Allow one minute warm up.

4. Push the ERASE button to clear the screen of electrons accumulated during warm up.

5. With the beam turn-on signal activated (Z INPUT), slowly increase the INTENSITY until the spot is visible.

CAUTION

If the INTENSITY control is set too high, damage to the CRT phosphor may result.

The spot has been set by the factory to appear as a zero-signal reference point in the lower left-hand corner of the screen. If it is desired that the reference level be changed to accommodate negative-going information, the spot can be moved by adjusting the X and Y Position pots (R10 and R60 on the Deflection Amplifier board), or by applying a DC level to the X and Y INPUTS (see GENERAL OPERATING INFORMATION).

6. Activate the horizontal, vertical and beam turn-on input signals and check for proper storage. If the INTENSITY control is set too low, the information will not store, or will only partially store. Optimum setting of the INTENSITY control is reached when the information stores uniformly. Adjust FOCUS and ASTIGMATISM, if necessary, for a well defined display (for complete adjustment instructions, refer to section 6, Calibration).

7. Erase the stored display by pressing the ERASE button.

8. Repeat steps 6 and 7 a few times to ensure proper operation and optimum storage. Maximum recommended viewing time of a stored display is 15 minutes.

GENERAL OPERATING INFORMATION

General

The Type 601 is designed primarily to display and store data from digital computers and other data transmission systems. The instrument can be operated as an Y-T monitor, however, with limited capabilities. The deflection amplifiers are optimized for a fast settling time, and the Y-T capability is limited to about 100 kHz.

The storage tube in this instrument can be more easily damaged than conventional CRTs. The discussion of storage tubes (page 2-1, this section) should be read thoroughly. For complete instructions for adjusting the FOCUS and ASTIGMATISM controls, and for aligning the display (Tilt and Lean), refer to the calibration procedure in Section 6.

Intensity Control

The INTENSITY control used in this instrument is a special purpose "backlash" potentiometer having both a fine and coarse adjustment range, with a 60° independent rotation on the fine range. The potentiometer consists of two sections sharing a single shaft. When adjusting from the full counterclockwise position with a screwdriver, only the "fine" section is affected for the first 60°. Then as the shaft is turned clockwise, the "coarse" section is engaged and both sections are adjusted simultaneously. This same action occurs when the control is rotated counterclockwise. When the general intensity level is reached, the "fine" section can be adjusted independently of the "coarse" section to arrive at the optimum beam current turn-on level for achieving best resolution over the display area.

Always increase the intensity slowly. A bright, sharply focused spot on the CRT will result in damage to the CRT phosphor. The intensity can be increased to override the Z Axis Amplifier in lieu of beam turn-on signals, but this is not a recommended practice because accidental application of a beam turn-on signal in this condition may result in burn damage to the CRT.

Input Requirements

The input requirements are 0.1 volts for each centimeter of horizontal deflection, and 0.125 volts for each centimeter of vertical deflection. Thus for full scale deflection on both axes, a signal amplitude of 1.0 volt is required. For signals of larger amplitudes (up to 150 volts), provisions have been made for permitting the signal to be attenuated to the desired level. The maximum input voltage without attenuation is 50 volts. The Deflection Amplifiers are optimized to respond to step-function input signals.

It is recommended that the Z Axis Circuit be activated by a positive pulse of one to ten volts amplitude with a zero-volt base; however, do not exceed 50 volts.

Input Attenuation

If it is desired to attenuate the input signals to the Deflection Amplifiers, attenuating resistors must be selected and installed on the amplifier board. First determine the amount of attenuation needed (available signal source vs. input sensitivity). In selecting values of series and shunt attenuating resistors, it must be realized that the 100 kilohm input load resistance will be affected. Find the values of the attenuating resistors as listed in Table 2-2.

When using input signals having high frequency characteristics (rise and fall times 5 μs or faster) it will be necessary to frequency compensate the series attenuating resistors. For each attenuation ratio, the series resistor must be paralleled by a compensating capacitor.

Table 2-2 shows the values of attenuating resistors and compensating capacitors for each attenuation ratio.

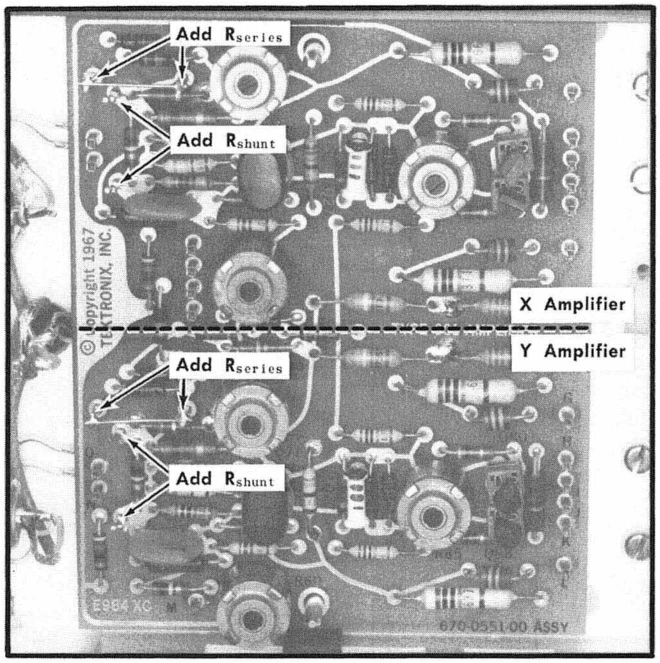

Fig. 2-2. Installing attenuating resistors.

To install the attenuating resistors, remove the wire straps from the stand-off lugs on the Deflection Amplifier board (Fig. 2-2) and replace with the series resistors. Solder the shunt resistors on the other stand-off lugs provided.

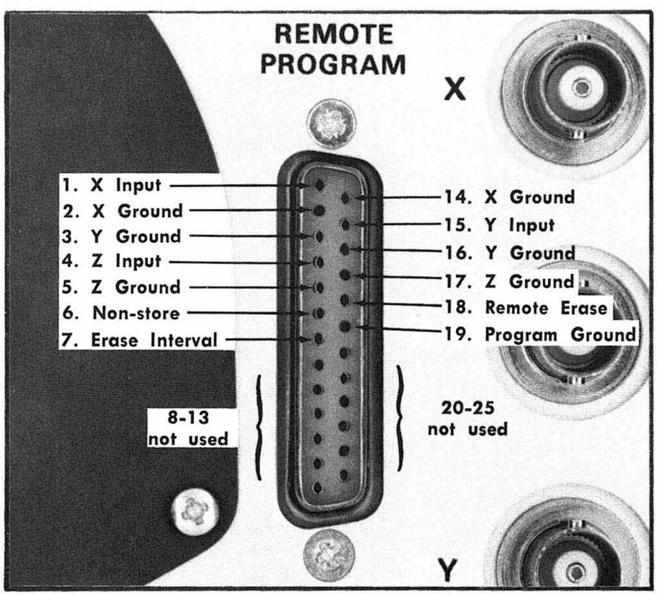

Fig. 2-3. Remote Program Connector.

Check the operation of the instrument after the resistors are installed. Reposition the spot to the zero-signal reference point if necessary, making sure that the X and Y INPUTs are terminated in 1 kΩ or less.

TABLE 2-2

Ratio	Approx R (Series)	Compensating Cap in pF	Approx R (Shunt)
2:1	50 kΩ	12	100 kΩ
5:1	80 kΩ	4.7	25 kΩ
10:1	90 kΩ	3.3	11 kΩ
15:1	93 kΩ	3.3	7 kΩ

Remote Program Connector

The Remote Program Connector, located on the rear panel, is wired as shown in Fig. 2-3. Refer to the schematic diagrams on the pull-out pages at the rear of this manual for further wiring information.

Storage Tubes

Terms and storage nomenclature used in this manual are defined at the start of the circuit description section. A brief discussion on storage tube principles is also presented. The storage tube in the Type 601 is a relatively new development, and can be more easily damaged than conventional CRT's. However with reasonable care, this new type CRT will provide very satisfactory service. The following precautions will prevent damage, increase tube life and maintain optimum performance.

Use only the intensity level required to write a well-defined display. Excessive beam current can cause either a bright burn condition, or if intense enough, a more serious dark burn condition. Avoid continued use of one target area. This causes differential aging of the storage target and may result in differential light emitting qualities over the target area.

Avoid leaving a stored display on the screen longer than required. More than fifteen minutes of viewing time is not recommended. Operation in the ready-to-write (fully erased) state will give longer target life.

When store operation is not required, utilization of the non-store mode will prolong tube life (allowing the tube to be operated in the conventional mode). Conventional operation does not deteriorate the storage screen; however, prolonged periods of a repetitive display should be avoided. This may cause a residual image of the display to appear in the store mode.

Readjustment of the focus and astigmatism is usually required after the beam intensity level is changed to maintain optimum writing speed.

Storage tube characteristics change with use more noticeably than characteristics of conventional tubes. Circuit calibration should be checked frequently to ensure optimum operation. Operating levels for a new tube should be checked after the first 100 hours of operation. Progressively longer periods between checks (up to 250 hours) may then be set.

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SECTION 3
CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains a description of the circuitry used in the Type 601. The description begins with a discussion of the storage techniques employed in this instrument, followed by a block diagram description provided to aid in understanding the overall concept of the circuitry. Then each circuit is described in detail. The electron flow convention is followed in this circuit description.

The schematic diagrams at the rear of the manual should be referred to in addition to the illustrations when studying this circuit description. The block diagram shows the relationship of the major circuits.

Glossary of Terms and Storage Tube Nomenclature

Storage techniques and analysis involves the use of special terminology. The following glossary of terms should assist the reader in understanding their application when describing storage tubes and circuitry.

Background Light Level	The average brightness of the light emitted by the storage target when completely erased, with the backplate set at a given voltage.
Brightness Uniformity Ratio	The ratio of the brightest to the dimmest area when the target is fully stored.
Collimation Lens	An electrostatic low-voltage lens used to adjust the trajectories of the flood gun electrons.
Collimation Electrodes	Elements used in the collimation lens.
Erase	The operation of changing electrode potentials in such a manner that previously stored information is removed.
Fade Positive	The flood gun cathode to backplate potential at which an unwritten area fades up as bright as an adjacent written area anywhere within the quality area, without writing a trace.
Flood Gun	A low-energy electron gun directing a large area flow of electrons toward the entire screen.
Operating Level or Storage Level	The voltage between the flood gun cathode and backplate within the operating range.
Ready-to-write State	The state of the storage target immediately after erase and before writing again.
Rest Potential	Average equilibrium potential assumed by the unwritten areas of the target when it is operated in the storage mode.
Storage Mode	A mode of operation such that written information is stored until intentionally erased.
Storage Target	A surface having the ability to store information when bombarded by an electron beam.
Stored Brightness	The brightness of stored information with the backplate set at a given voltage.
Writing	The process of recording the information on the storage target.
Writing Gun	A high-energy electron gun giving a narrow focused beam. This beam can be deflected and is used to write the information to be stored.
Writing Threshold	The lowest flood gun cathode to backplate voltage at which a signal of fixed writing speed can be stored.
Upper Writing Limit	The highest operating voltage at which a signal can be written and still maintain a given stored resolution under given conditions of operation.

BASIC OPERATING PRINCIPLES OF THE STORAGE TUBE

The Tektronix T6010 CRT is a direct-view storage cathode ray tube. The storage target stores electrical charges on an insulated surface by using the secondary emission properties of the surface. The stored charge is then used to control the flow of electrons to a phosphor screen to give visual output that corresponds to the location of the stored charge.

The storage cathode ray tube contains special storage elements in addition to the conventional writing gun elements. The operating mode of the tube depends primarily on the voltages applied to these storage electrodes. With one condition of applied potentials, the storage screen or target operates in the ready-to-write state; then, when it is bombarded with high energy writing beam current, it shifts to the stored mode to store a written display.

The storage screen contains a special coated surface which continues to emit light when bombarded by the flood gun electrons, provided the surface has been written by the writing gun beam and shifted to the stored state.

Fig. 3-1 illustrates the basic construction of the T6010 storage tube. The flood guns emit two cones of electrons which completely cover the storage target. The collimation electrodes shape the flood beam. The operating level of the tube is the potential difference between the target backplate and the flood gun cathodes.

In the erased, or ready-to-write mode the insulator surface of the target tends to charge down to a potential lower than the backplate potential, and towards the potential of the flood gun cathode. This is due to the ratio of primary current (flood gun beam) to target secondary emission current. The potential to which the target charges is called the rest potential. This potential is such that the flood gun electron landing energy is not enough to illuminate the phosphor in the target. The target is now ready to write. See Fig. 3-2.

In the writing process, the target is scanned by the writing gun electrons. These high energy electrons increase the target secondary emission over the area they scan, so that the ratio of primary current to secondary current becomes greater than one. When this ratio exceeds one, that part of the bombardment surface shifts to a new stable state. Writing has been accomplished and this segment of the target is now stored.

In the written state, the potential difference between the flood gun cathode and target becomes greater and the flood gun electrons now have a landing energy that is sufficient to provide a visual display due to the cathode luminescence of the phosphor-impregnated target. This visual display will continue as long as the flood gun beam covers the target.

At high sweep rates, the writing beam current is not adequate to bring the portion of the target scanned above the crossover point; therefore, the flood gun electrons when landing on the bombarded area will remove the charge developed by the writing gun electrons, and the target will discharge to its initial ready-to-write state without being written. Thus, complete writing is a function of writing beam current density.

When the stored display is no longer desired, the information is erased by a waveform cycle as illustrated in Fig. 3-3. A negative-going pulse is first applied to the flood gun cathodes to increase the flood gun cathode-to-backplate difference of potential and write the entire target area with flood gun electrons. Next, as the flood guns are returned to their operating level, the backplate voltage is pulled well below the rest potential. Then as the backplate voltage is gradually returned, the target is charged to the rest potential and the target is now in the ready-to-write state.

If a more complete study of storage tube operating principles is desired, a Tektronix Circuit Concepts paperback book entitled "Storage Cathode-Ray Tubes and Circuits" is available through your local Tektronix, Inc., Field Office or representative. Tektronix Stock No. 062-0861-00.

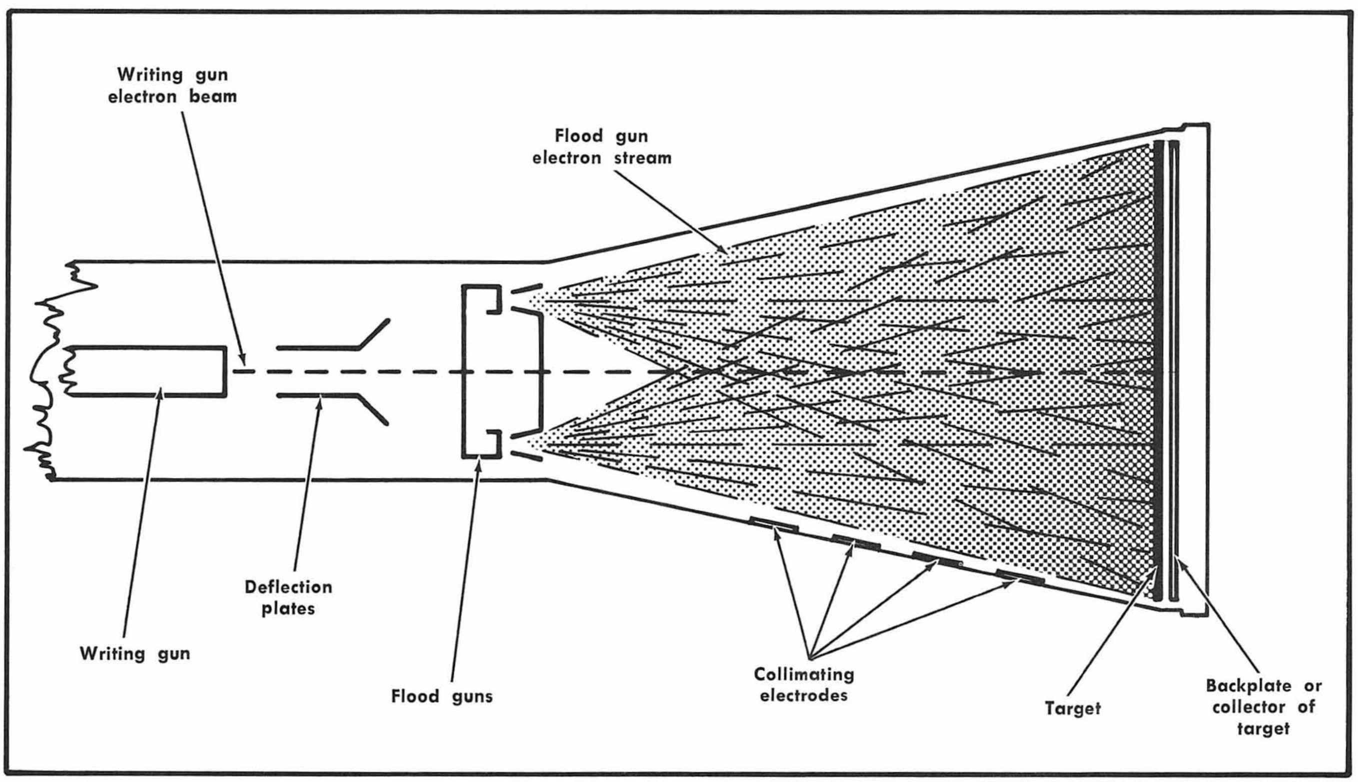

Fig. 3-1. Pictorial diagram of storage tube Type T6010.

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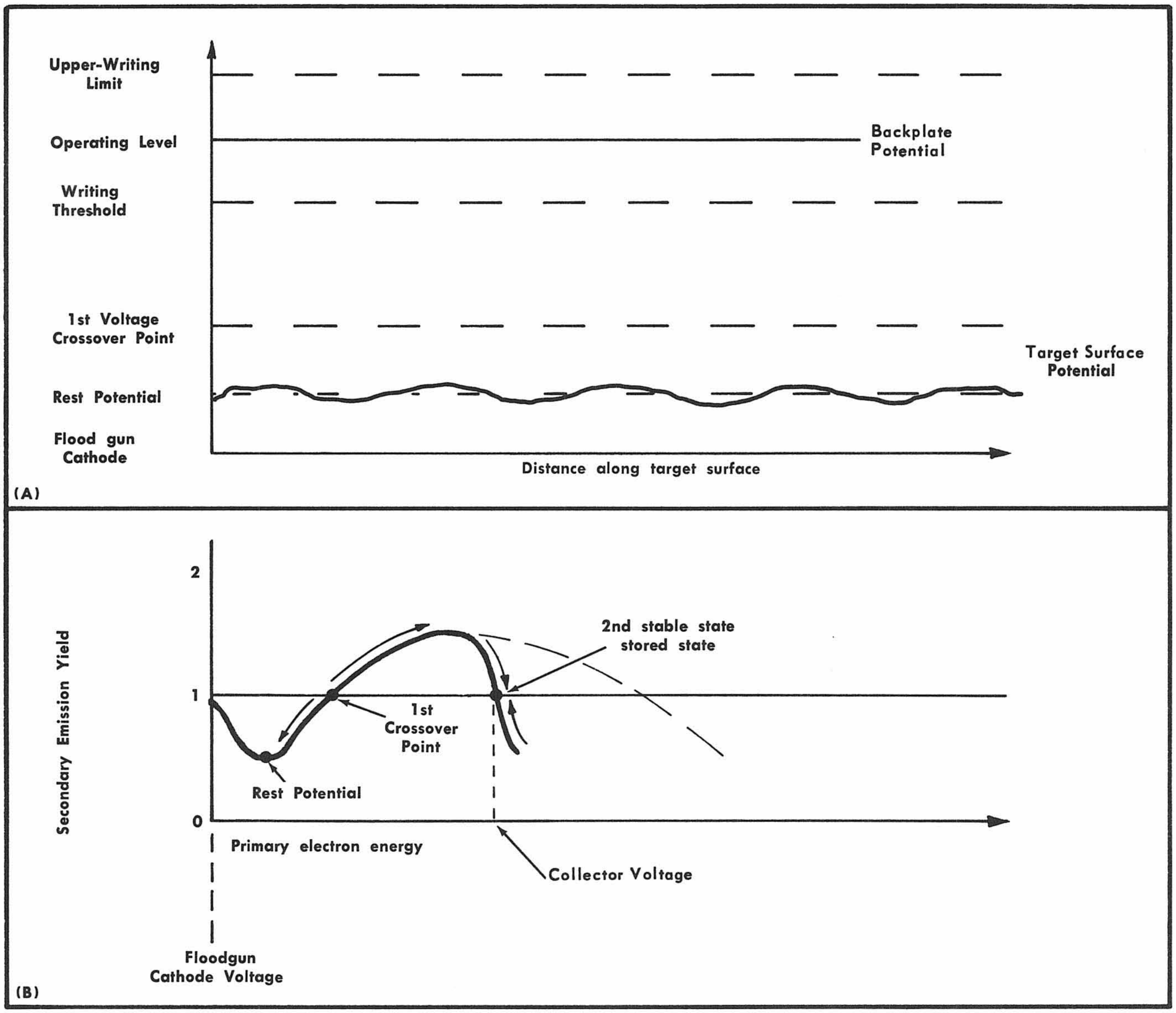


Fig. 3-2. (A) Storage electrode (target to flood gun cathode) operating potentials. (B) Secondary emission curve for insulator showing charging direction.

BLOCK DIAGRAM DESCRIPTION

The X and Y Deflection Amplifiers convert a single-ended input signal to a push-pull output suitable to drive the deflection plates. The gains of these amplifiers are controlled by negative feedback circuits, which also ensure a highly stabilized output.

Beam turn-on signals are applied to the Z Axis Circuit, which controls the writing gun grid. The Z Axis Circuit produces two DC levels, one to blank the CRT and the other to unblank the CRT. Rapid switching between these DC levels is accomplished by a Schmitt Multivibrator. This bistable action corresponds to the "pen up" and "pen down" instruction used in graphic display equipment, such as chart recorders.

The CRT Circuit provides the voltage levels required to operate the CRT. The cathode-to-anode accelerating voltage is about 4 kV; +100 volts is applied to the anode and about —3900 volts is applied to the cathode. The CRT is biased on by unblanking signals from the Z Axis Circuit. Controls are provided to adjust the CRT for optimum display. An oscillator and transformer produce the high-voltage, which is rectified and applied to the CRT cathode and grid. A regulator circuit maintains the high voltage at a constant level.

The Storage Circuit controls the operation of the flood guns and target backplate. The collimation electrodes shape the flood gun electron spray for uniform coverage of the target. Erase circuitry, consisting of the Erase Multivibrator and Target Control Amplifier, is incorporated for erasing the stored display and restoring the target to its ready-to-write state. A negative pulse is made available to the REMOTE PROGRAM connector during the erase cycle, to notify associated equipment that the Type 601 is being erased.

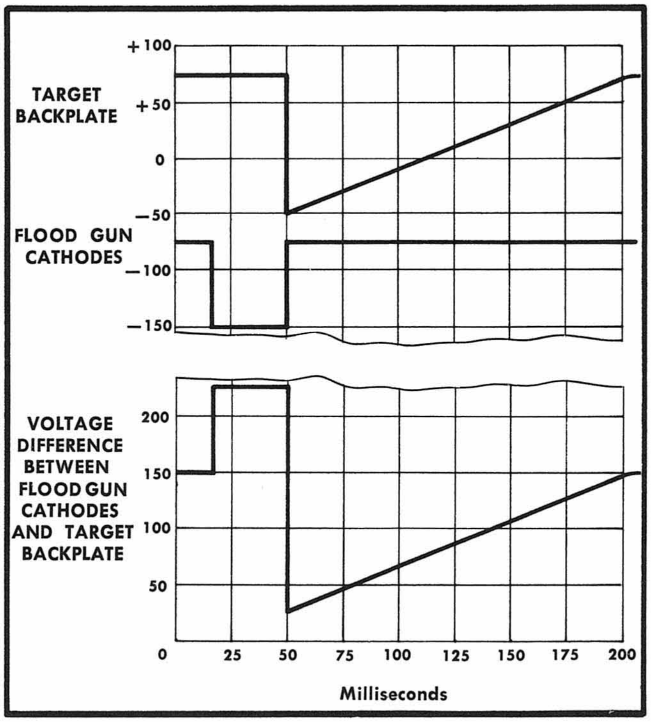


Fig. 3-3. Erase cycle waveform.

The Low-Voltage Power Supply produces the operating power for the instrument from regulated +100-volt, +12.5-volt and —75-volt supplies and unregulated +250-volt, +16-volt and —150-volt supplies. In addition, 6.4 VAC is provided for the CRT heater.

DEFLECTION AMPLIFIERS

General

The deflection amplifiers convert a single-ended input signal to a push-pull output suitable to drive the deflection plates. Negative feedback is employed to ensure a highly stabilized output. Differential inputs are provided to X and Y Amplifiers to reject extraneous signals common to interconnecting cables. Refer to diagram.

NOTE

The following description applies to both the horizontal and vertical deflection amplifiers, however the circuit numbers used are those of the horizontal, or X circuit.

Paraphase Amplifier Input Stage

Q21, Q27, and their associated circuit components form a common-emitter phase inverter (paraphase amplifier). The voltage divider network consisting of R8, R10, R13, R15 and R17 establishes the DC voltage level on the base of Q27, while the network consisting of R2, R6 and R8 offsets the Q21 base current. R10, X Pos, permits adjustment of the level applied to Q27 base.

Diodes D3 and D4 limit the input signal swing to +2.0 volts and —3.5 volts. Provisions have been made for adding attenuating resistors if large signals (up to 150 volts) are to be applied. The signal is developed across the resistance between the emitters of Q21 and Q27, producing signal current through R21 and R28. This results in an output signal of equal amplitudes but opposite polarities (push-pull) at Q21-Q27 collectors.

Output Amplifier

The output signal from the Paraphase Amplifier stage is coupled through emitter followers Q30 and Q38, which furnish the current drive to the Output Amplifier stage. Amplifiers Q41 and Q45 amplify the push-pull signal and apply it to the CRT deflection plates.

The gain of the Deflection Amplifier is controlled by a negative feedback circuit, which provides a highly stabilized output. A portion of the output signal at the collectors of Q41 and Q45 is fed back through R20 and R29 to the emitters of Q21 and Q27. The amount of Q21-Q27 emitter degeneration can be changed by adjustment of R24, Gain, to ensure the correct horizontal deflection for different CRT's. In a like manner R74, Y Gain, can be adjusted to ensure the correct vertical deflection.

Capacitors C20 and C29 decrease the amplifier gain proportionately as the frequency is increased to reduce the overshoot on the leading edge of fast-rising signals and thus speed up the "settling time." With a typical dot writing time of about five microseconds, a settling time of one microsecond or less ensures that the dot will be in position and waiting to be stored.

A sample of each Deflection Amplifier output is fed to networks that compensate for CRT geometry characteristics. R35, Lean, permits compensation for the vertical deflection plates, and R85, Tilt, permits compensation for the horizontal deflection plates. The bases of Q30 and Q38 are kept within about one-half volt of each other by diodes D32 and D33 to prevent overdriving the amplifier by large amplitude transients.

Z AXIS CIRCUIT

General

The CRT writing gun grid is controlled by the Z Axis Circuit which produces two DC levels; one to blank the CRT and the other to unblank the CRT. Rapid switching between these DC levels is accomplished by a Schmitt Multivibrator. This bistable action corresponds to the "pen up" and "pen down" instruction used in graphic equipment, such as chart recorders, etc. Thus a series of input signals can be applied to allow the entire display, or only a portion of the display, to be seen. Fig. 3-4 shows a detailed block diagram of the Z Axis Circuit. The BNC input connector shell is isolated from ground by 47 Ω.

Input Emitter Follower Stage

R105 provides the base current-leakage path for Q109 and establishes the zero DC reference level. Current through R111 is split, with about 0.5 mA through Q109 and R109 to the +12.5-volt supply and the other 0.5 mA through D113 and R118 to the decoupled +100-volt supply. This action keeps the bases of Q109 and Q121 at the same level.

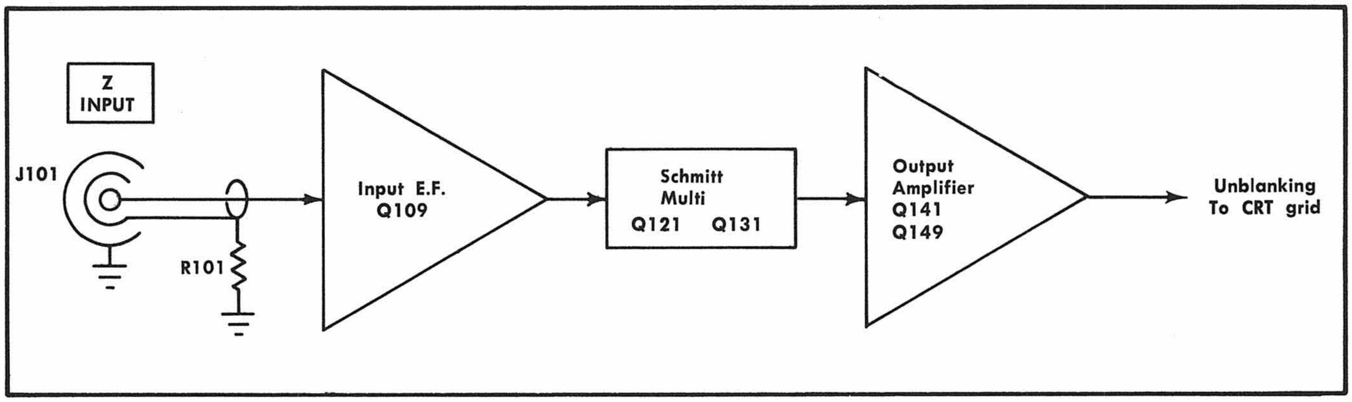


Fig. 3-4. Z Axis Circuit detailed block diagram.

Beam turn-on signals are applied through C103-R103 and R107 to the base of emitter follower Q109. Negative-voltage portions of input signals are grounded through D105. When the emitter of Q109 is pulled positive by the beam turn-on signal, D113 is switched off, diverting current into Q121 base and thus switching the Schmitt Multivibrator.

Schmitt Multivibrator

Q121, Q131 and their associated circuit components are connected to form a Schmitt Multivibrator. Because the output of the Z Axis Circuit is dependent upon the bistable operation of this circuit, two conditions will be discussed; when Q131 is conducting (CRT blanked), and when Q131 is off (CRT unblanked).

The first bistable condition to be discussed is the quiescent, or "pen up" condition (no signals applied), in which the CRT is blanked. Current through D113 and R118 from the Q109 emitter circuit establishes a DC reference level of about zero volts on the base of Q121. The base level of Q131, set to about +0.8 volts by voltage divider R121-R123-R130, holds the Q121-Q131 common emitters at about zero volts. A current of about 6 mA is established by the voltage developed across the parallel combination of R127-R128 and conducted through Q131 and Q141. As will be seen, this results in a DC level at the emitter of Q149 that corresponds to the writing gun beam cutoff potential.

The second bistable condition to be discussed is the "pen down" condition, in which the CRT is unblanked. Assume that a voltage is applied to raise the base of Q121 more positive than the base of Q131. The 6 mA through R127-R128 is conducted through Q121 and R121, lowering the Q121 collector voltage. This action lowers the base level of Q131 to about +0.5 volt, turning Q131 off. With no current through Q131, Q141 is turned off, resulting in a voltage level at the emitter of Q149 which turns the CRT on.

The voltage levels required to switch the multivibrator from one bistable state to the other are the turn-on and shut-off levels. A minimum positive-going signal of about 1 volt is required to raise the Q121 base level more positive than the Q131 base, switching the multivibrator to the second bistable condition described in the preceding paragraph, and turning the CRT on. If the turn-on level exceeds about +5.5 volts, D114 turns on and clamps the base of Q121 at about +4.8 volts. As the signal level moves negative from the positive turned on level and reaches about +0.5 volt, the multivibrator reverts as Q121 base becomes more negative than Q131 base. When shut-off is reached, the multivibrator is switched to the first bistable condition described earlier, cutting the CRT off. D119 improves the switching response of the multivibrator on fast negative-going signals.

Output Amplifier

The Output Amplifier consists of a cascode amplifier stage and an emitter follower stage. The output section of the Schmitt Multivibrator, Q131, is connected with Q141 to form a cascode amplifier. In the bistable condition in which Q131 and Q141 are conducting, D143 turns on to clamp the collector of Q141 at about +11.9 volts, as it would otherwise tend to go negative because of the voltage drop across R141. This produces a DC level of about +11.3 volts at the output of emitter follower Q149, which is applied to the HV secondary controlling the CRT writing gun grid, holding the CRT at cutoff. The CRT biasing conditions are discussed in full detail in the CRT Circuit description.

In the "pen-down" bistable condition in which Q131 is off, Q141 has no current source and also turns off. The collector of Q141 goes positive, turning D143 off. The DC level now at the base of Q149 is about +64 volts, determined by the voltage divider consisting of R141, R143 and R144 between +100 volts and ground. This level, applied through Q149 to the writing gun control grid, causes the CRT to conduct. D146 connected from base to emitter of Q149 improves the response of Q149 to negative-going signals. When the base of Q149 is driven negative, D146 is forward biased and conducts the negative-going portion of the signal, providing a fast-falling edge to quickly turn the CRT off.

CRT CIRCUIT

General

The CRT Circuit provides the voltage levels necessary for operation of the cathode-ray tube (CRT). Intensity, Focus, Geometry, and Astigmatism controls are provided to adjust the CRT for proper display. The cathode-to-anode accelerating potential is about 4 kV; +100 volts is applied to the anode and —3900 volts is applied to the cathode. The biasing conditions of the CRT are dependent on the output

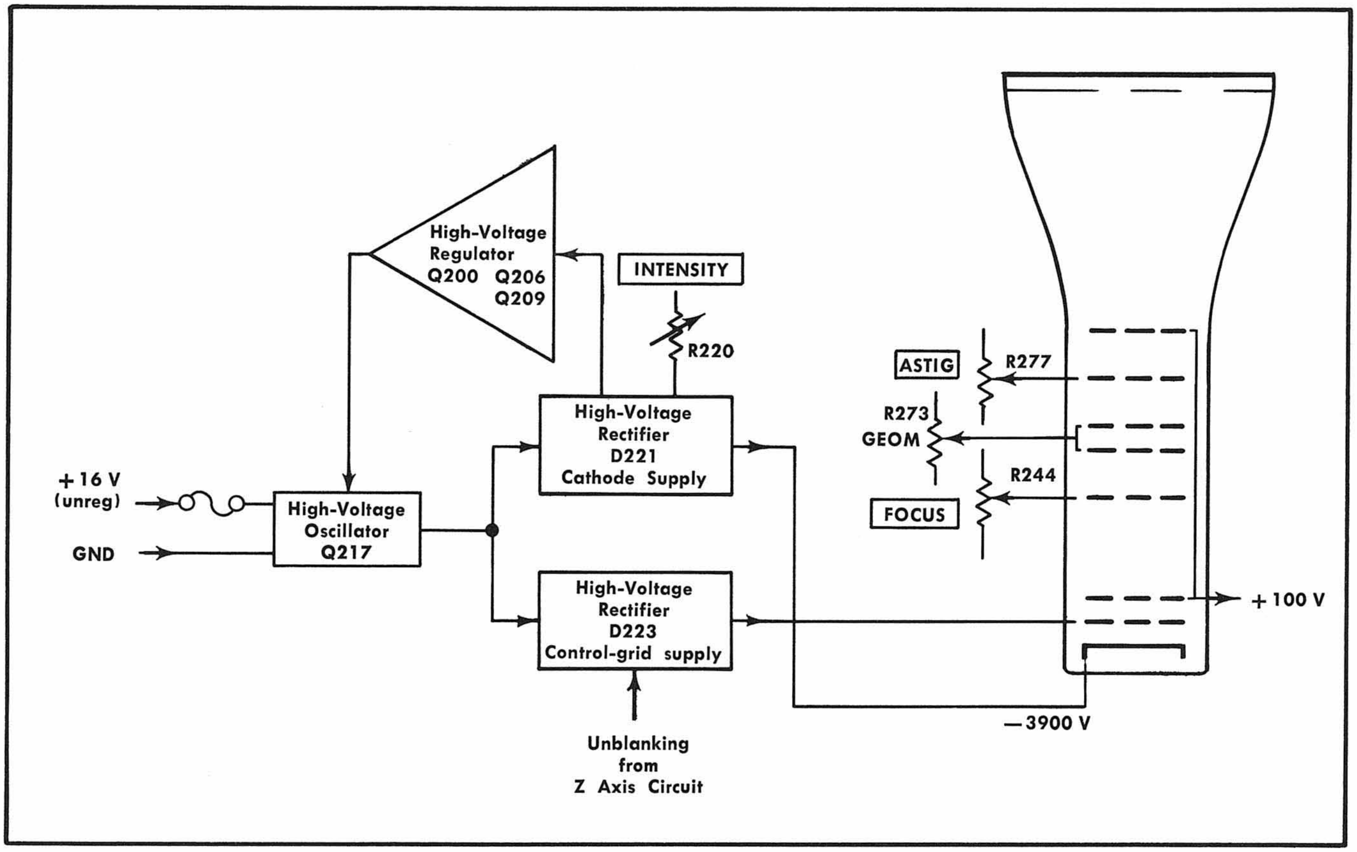


Fig. 3-5. CRT Circuit detailed block diagram.

of the Z Axis Circuit. The control grid has about —3990 volts applied during the blanking period to keep the CRT cut off, and about —3940 volts applied during the unblanking period to turn the CRT beam on. Fig. 3-5 shows a detailed block diagram of the CRT Circuit.

High-Voltage Oscillator

Q217 and its associated circuitry comprise a class C oscillator to produce the drive for the high-voltage transformer, T220. When the instrument is turned on, current through Q200 causes its collector to go positive, forward biasing Q217. C214 begins to charge to the Q217 base voltage. The collector current of Q217 increases and a voltage is developed across the collector winding of T220. This produces a corresponding voltage increase in the feedback winding of T220 which is connected to the base of Q217, causing it to conduct harder. Eventually the rate of collector current increase in Q217 becomes less than that required to maintain the voltage across the collector winding and the output voltage drops. This turns off Q217 by way of the feedback voltage to the base. While the transformer field is collapsing, the charge on C214 is removed. Q217 remains off until the transformer field has collapsed, then C214 begins to charge again to raise the voltage at the base of Q217 positive enough to bias Q217 into conduction again. The cycle repeats at a frequency of 40 to 50 kilohertz. The amplitude of sustained oscillation depends upon the average current delivered to the base of Q217. Fuse F217 protects the +16-Volt Supply if the High-Voltage Oscillator stage is shorted.

High-Voltage Regulator

Feedback from the secondary of T220 is connected to the gate of Field-Effect Transistor Q209 through the voltage divider network R230-R246. This sample of the output voltage is compared to the zero-volt level (ground) at the source of Q209. It is then inverted and amplified by Q209 and applied to emitter follower Q206. Q206 provides the current drive for Q200. Amplitude of the oscillations at the collector of Q217 is determined by the average collector current of Q200.

Regulation is accomplished as follows: If the output voltage at the —3900 V test point starts to go positive (less negative), a sample of this positive-going voltage is applied to the gate of Q209. Conduction of Q209 is increased, causing an increase in Q209 drain current. Conduction of Q206 is increased as its base current is increased. The emitter of Q206 exhibits a gain in current, which is applied to the base of Q200. An increase in conduction of Q200 increases the average collector current, which is applied through the feedback winding of T220 to the base of Q217. Q217 conducts harder, increasing the collector current to produce a larger induced voltage in the secondary of T220. This increased voltage appears as more negative voltage at the —3900 V test point to correct the original positive-going change. By sampling the output from the cathode supply in this manner, the total output of the high-voltage supply is held constant.

Output voltage level of the high-voltage supply is controlled by the High Voltage adjustment, R212, in the gate circuit of Q209. This adjustment sets the conduction level of Q209 which controls the quiescent condition of Q206, Q200 and Q217 similar to the manner just described for a change in output voltage. Diodes D206 and D207 in the base circuit of Q206 protect the High-Voltage Oscillator in the event of component failure in the regulator circuit by limiting the Q206 base voltage to —0.6 volt and +13.1 volts.

High Voltage Rectifiers and Output

The high-voltage transformer, T220, has two output windings. These windings provide the negative CRT cathode potential and the CRT control grid bias. These outputs are regulated by the High-Voltage Regulator stage in the primary of T220 to hold the output voltage constant.

The negative accelerating potential for the CRT cathode is supplied by the half-wave rectifier D221. The output level is adjustable to about —3900 volts on the cathode by the High Voltage adjustment mentioned previously.

The half-wave rectifier D223 provides a negative voltage for the control grid of the CRT. The voltage applied to the control grid is determined by the setting of the INTENSITY control (to be discussed in the next paragraph) and the output level af the Z Axis Circuit. In quiescent operation, this voltage is about —3990 volts, keeping the CRT cut off. The CRT is biased into conduction when the Z Axis Circuit switches to its unblanking state, applying about —3940 volts to the grid.

Beam current intensity is controlled by R220, INTENSITY. R220 is a special purpose "backlash" potentiometer having both a fine an a coarse adjustment range, with 60° independent rotation on the fine range. This type of control is very useful in arriving at the optimum beam current turn-on level for achieving best resoluition over the display area. As the control is rotated clockwise, the wiper arms move toward ground. This lowers the DC reference voltage applied to the secondary winding controlling the cathode, causing the voltage at the —3900 V test point to increase (more negative). The regulator circuit then compensates for this error by conducting less and reducing the voltage in the secondary windings of T220. This action not only raises the voltage at the —3900 V test point to its correct level, but raises the voltage applied to the control grid as well. Thus the control grid becomes more positive with respect to the cathode, increasing the beam current. Beam current is reduced in a like manner by rotating R220 counterclockwise, introducing a positive-going error voltage into the cathode circuit.

The neon bulbs B251, B252 and B253 provide protection if the voltage difference between the control grid and cathode exceeds about 135 volts, and additional protection is provided by D252 if the control grid goes more positive than —3930 volts from the cathode. Zener diode D248 protects the CRT during warm-up by providing a minimum bias of 20 volts. Protection for the Z Axis Circuit is provided by neon bulbs B265 and B266 if the voltage at the emitter of Q149 exceeds about 110 volts.

CRT Control Circuits

In addition to the INTENSITY control discussed previously, three other screwdriver-adjust controls have been provided for arriving at the optimum CRT display. Focus is controlled by R244, FOCUS. R244 is part of the divider network R230-R246 between the CRT cathode supply and +100 volts. The voltage applied to the focus electrode is more positive than the voltage on either the control grid or the CRT cathode. The ASTIG adjustment, R277, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the positive level on the astigmatism grid. The Geometry adjustment, R273, varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display. The +150-volt source for the ASTIG and Geometry controls is provided by zener diode D271.

STORAGE CIRCUIT

General

The Storage Circuit provides the voltage levels necessary to operate the flood guns, collimation electrodes and target backplate. The basic operation of the storage CRT was described earlier in this section of the manual. The erase generator, consisting of the Erase Multivibrator and the Target Control Amplifier, is manually controlled and produces an erase pulse to erase written information. During the erase cycle, a negative-going pulse is produced by the Erase Interval Circuit. This pulse can be used to notify associated equipment, such as a comparator, that the Type 601 is being erased. Fig. 3-6 shows a detailed block diagram of the Storage Circuit.

Flood Guns and Collimation E lectrodes

The flood guns are low-energy electron guns which direct a large area flow, or cones, of electrons toward the entire screen. The collimation electrodes shape the flood spray for uniform coverage of the storage target. The operating level of the tube is the potential difference between the target backplate and the flood gun cathodes. The collimation electrodes have no effect on the bombarding energy of the flood gun electrons.

The flood gun cathodes are connected via D320 to the —75-volt supply. This voltage can be measured at TP321. The Flood Gun Grids control, R323, provides a means of varying the amount of bias for full screen coverage. Uniform luminance is achieved by adjusting R363, Collimation, which controls the DC levels applied to two of the collimation electrodes, CE 3 and CE 4. A change in level at the electrode terminals is provided by a change in current. When the target is in the ready-to-write state, high current causes a low potential at CE 3 and CE 4. As the target becomes written, the reduction in current causes the electrode potential to become more positive. Thus correct collimation is provided under all conditions of operation.

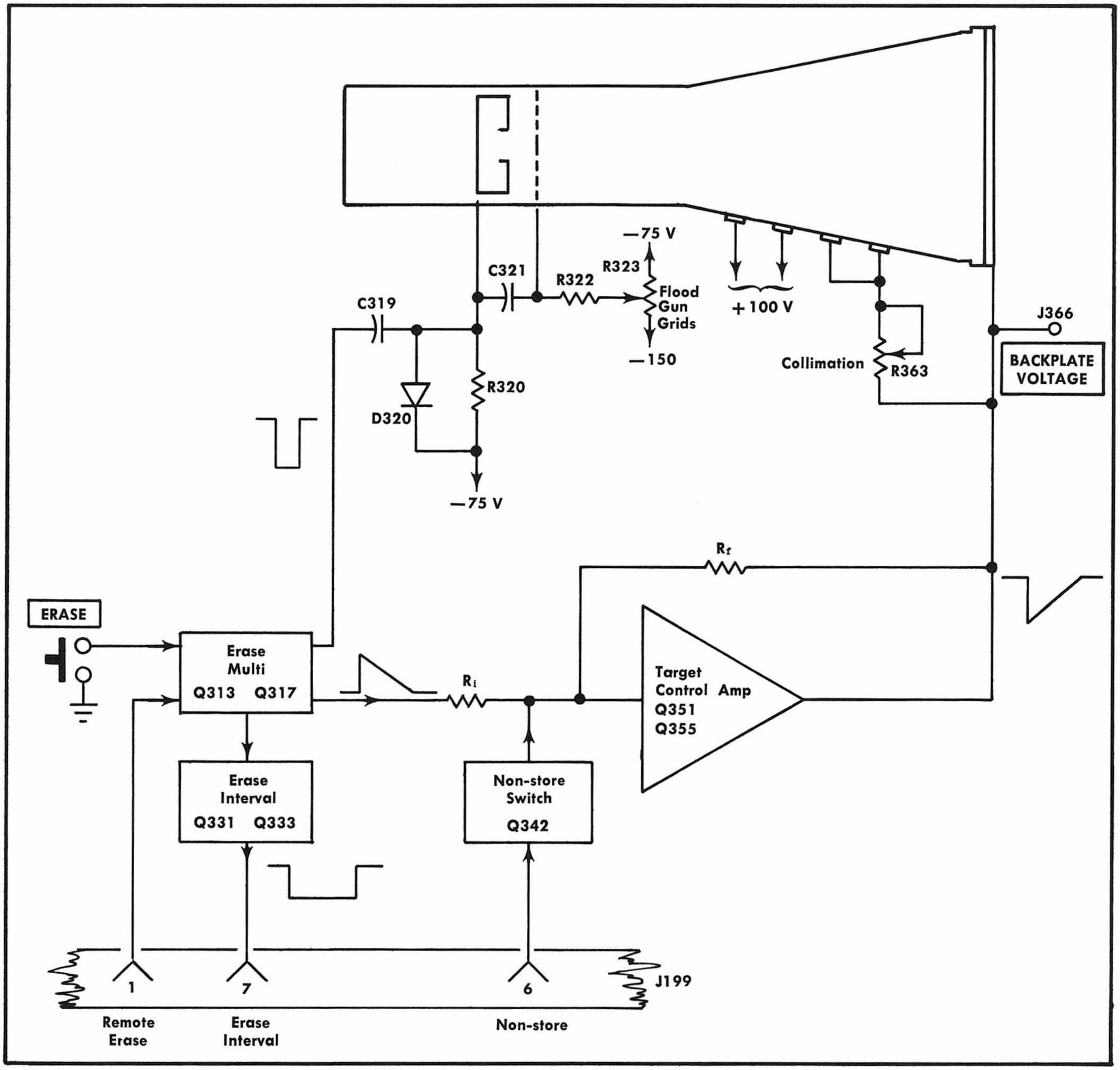


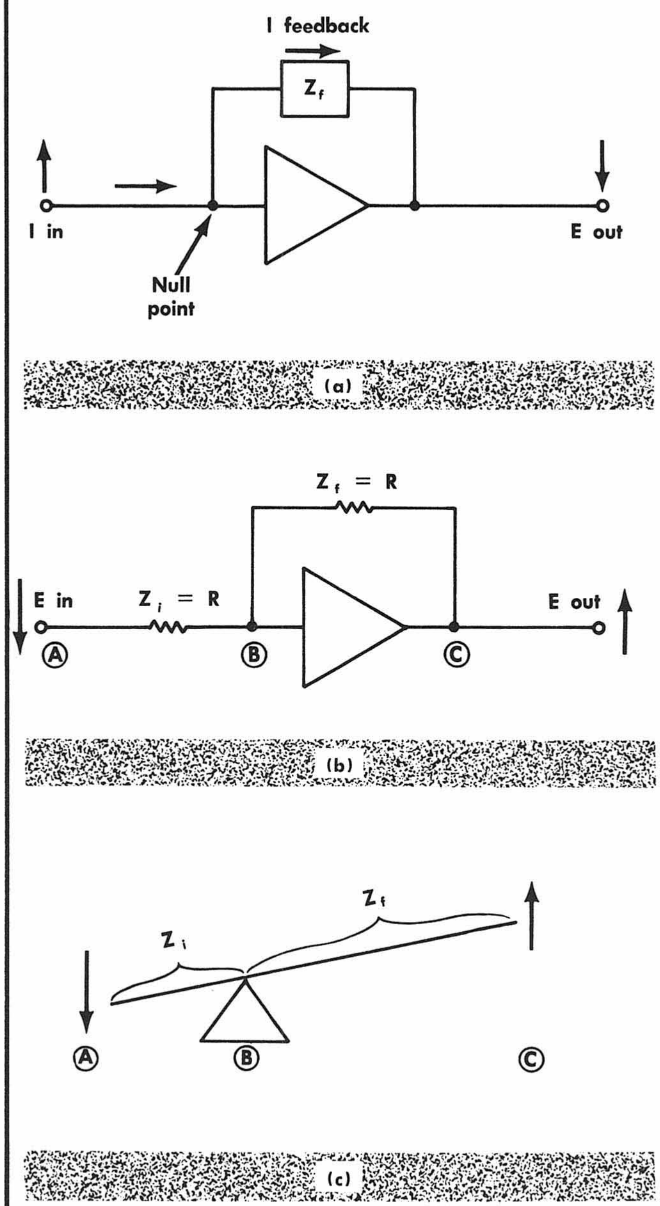
Fig. 3-6. Storage Circuit detailed block diagram.

Target Control Amplifier

Q351, Q355 and their associated circuitry form an operational amplifier, incorporated to maintain a high degree of control of the target backplate voltages. The amount of output accuracy is limited primarily only by the tolerances in the values of the passive elements used in the input and feedback networks. Fig. 3-7 presents a discussion of the basic operational amplifier used in this circuit.

With D338 conducting, the R337-R338 junction is at the same potential as the base of Q351. Current is injected from R327 into the wiper arm of R339, OPERATING LEVEL, and is split. R339 can be adjusted to shift any amount of the injected current to either the Q351 base or the R337-R338 junction. The base of Q351 is the sensing point of the operational amplifier. R358 is the feedback resistor (Z_f). Q355 provides current drive for R358 and prevents loading of Q351 collector.

The output voltage at Q355 emitter is applied to the target backplate. The desired quiescent level at this point can be attained by adjustment of R339, OPERATING LEVEL, which changes the value of current to the sensing point as described in the previous paragraph. D352 provides protection of Q351 under extreme reverse-bias conditions. D355 operates when the backplate is pulled negative, as will be discussed in the Erase Cycle description.



Basically, an operational amplifier is a high-gain amplifier designed to remain stable with large amounts of negative feedback from output to input. Figure (a) shows the conventional operational amplifier symbol. Negative feedback, through a resistor designated "Z_f" is applied from the output to the input. Because the output is inverted (180° out of phase) with respect to the input, the input to which negative feedback is applied is generally termed "— input".

An operational amplifier, using negative feedback, functions in the manner of a self-balancing bridge, providing through the feedback element whatever current is necessary to hold the — input at null (ground potential). The output signal is a function of this current and the impedance of the feedback element.

The — input, held to ground potential by the feedback current, appears as a very low impedance to any signal source. Using resistive feedback, for instance, the input appears to be the resistance of the feedback element, divided by the open-circuit gain of the operational amplifier.

If current is applied to the — input, it tends to develop voltage across the impedance of the feedback element, and move the — input away from ground potential. The output, however, swings in the opposite direction, providing current to balance the input current and hold the — input at ground. If the impedance of the feedback element is high, the output voltage must become quite high to provide enough current to balance even a small input current.

Since the Target Control Amplifier circuit deals with voltage rather than current signals, an additional element, designated "Z_i" (input impedance), is used. Refer to figure (b). This impedance is placed in series with the — input, converting into current that parameter of the input signal which is desired to appear as the voltage at the output.

The operational amplifier becomes a simple voltage amplifier, the gain of which is $-Z_f/Z_i$. The mechanism by which this works is described as follows:

Referring again to figure (b), a voltage is applied to point A, causing current to flow through Z_i. Were it not for the operational amplifier, this current would also flow through Z_f and to ground through the low impedance at point C making Z_i and Z_f a voltage divider, and raising the voltage at point B. However, the operational amplifier operates to hold the voltage at point B (the — input) at ground potential. To do this, it must supply at point C a voltage which will cause a current to flow through Z_f which will just balance the current in the opposite direction flowing through Z_i. When point B is thus held at ground potential, the voltage across Z_i is equal to the applied voltage at A.

The current through Z_i is equal to the applied voltage at A divided by the impedance of Z_i, or E_{in}/Z_i. This same value of current must flow in the opposite direction through Z_f in order to keep point B at ground. The voltage at point C, then, must be E_{in}/Z_i (which is the value of the current in Z_f) multiplied by Z_f. The output is inverted (of opposite polarity) from the input, so it can be said that

$$E_{out} = (-E_{in}) \frac{Z_i}{Z_f},$$

and the voltage gain of this amplifier configuration is seen to be

$$\frac{-Z_f}{Z_i}.$$

As indicated in figure (c), the operational amplifier with resistive input and feedback elements acts in see-saw fashion, the amplifier moving the output end of the see-saw in response to any motion of the input end, causing the system to pivot about an imaginary fulcrum, which is the "sensing point (— input). The distance from the near end to the sensing point or fulcrum corresponds to the Z_i or input resistor, and the distance from the fulcrum to the far end corresponds to Z_f. The motion of the far end depends on the motion of the near end and the ratio of the two distances.

Fig. 3-7. Basic operational amplifier.

Erase Multivibrator

Q313, Q317 and their associated circuitry form a monostable multivibrator, with Q313 normally conducting and Q317 turned off. Switching of this circuit generates the erase pulse.

Conduction of D311 provides a base current path for Q313 through R309 to the +100-volt supply, causing Q313 to conduct heavily. With Q313 saturated, its collector potential is about —75 volts, keeping Q317 turned off. The potential on the collector of Q317 is about +6 volts, set by voltage divider network R319-D317-R317-R324-D324. C316 is charged to the voltage difference between Q313 base and Q317 collector.

When a negative-going step function is applied via C302 or C305 to R308, D311 becomes reverse biased and interrupts Q313 base current. Q313 turns off, and as its collector potential starts to rise, Q317 becomes forward biased. Q317 turns on, conducting heavily. Its collector snaps from about +6 volts to about —75 volts, producing a negative-going step. The state of charge on C316 cannot be changed immediately, thus the negative-going step drives the anode of D311 even further negative. C316 begins to discharge through R309. After an RC-controlled time of about 30 milliseconds, current through R309 has diminished sufficiently to allow the voltage on the anode of D311 to raise to the D311-D303 turn-on level. Q313 turns on, and its collector goes negative by about one-half volt, turning Q317 off. When Q317 turns off, its collector rises rapidly from about —75 volts to about +6 volts.

Erase Cycle

In order to erase the stored display, the erase waveforms shown earlier in this section of the manual (Fig. 3-3) are applied to the flood guns and target backplate. A negative-going pulse is first applied to the flood guns, increasing the potential difference between the cathodes and target backplate. This action, sometimes termed "fade positive", raises the operating level above the upper writing limit and writes the entire target area with flood gun electrons. Next, as the flood guns are returned to their normal operating level, the backplate voltage is pulled negative, well below the rest potential. Then as the backplate voltage is gradually returned, the target is charged to the rest potential and returned to the ready-to-write state. The following paragraphs describe how the erase waveforms are generated.

When the ERASE button is pushed, the contacts of SW301A close, grounding R302. This produces a negative-going step across C302, turning off D311 and switching the Erase Multivibrator. The negative-going step produced at the collector of Q317 is coupled through C319 and C321 to the flood gun cathodes and control grids, and C324 is discharged through D326. The target backplate remains at the operating level potential because D326 isolates the Target Control Amplifier from the negative pulse. With the flood guns pulled negative, the entire target is written.

After an RC-controlled time of about 30 milliseconds, the Erase Multivibrator switches back to its quiescent state. The resulting positive-going step at the collector of Q317 is coupled simultaneously through C319, C321 and C324 to the flood guns and Target Control Amplifier. D326 turns off as the positive-going step is applied to the divider network comprising the Z_i element, causing the operational amplifier system to pivot about its imaginary fulcrum and pull the target backplate negative. D355 connected from base to emitter of Q355 helps discharge the capacitance on the backplate. When the base of Q355 is driven negative to cutoff by the increased conduction of Q351, D355 is forward biased and conducts the negative-going portion of the signal, providing a fast falling edge to quickly pull the backplate negative.

As C324 charges, the voltage at the C324-R326 junction decays from zero volts to —75 volts at an RC-controlled rate until D326 turns on and clamps it. This sawtooth current is applied through R326 to the summing point of the operational amplifier. The voltage changes in the same manner, but opposite in polarity on the target backplate, raising the backplate to the ready-to-write state.

Remote Non-store

In the non-store mode, the target backplate is held below the rest potential, allowing the CRT to operate in a non-storing mode in the manner of a conventional CRT. This feature has been incorporated to prolong the life of the storage tube.

In the store mode, Q342 is turned off because the divider network consisting of R340, R341 and R342 holds its base positive with respect to the emitter. D343 protects Q342 under extreme reverse bias conditions.

When pin 6 of J199 is grounded, R342 is removed from the divider network and Q342 conducts heavily. The Z_i element of the Target Control Amplifier is modified by the addition of R344 and its applied current. Once again the operational amplifier system pivots on its imaginary fulcrum, pulling the target backplate negative.

Erase Interval Circuit

In the quiescent condition when the erase pulse it not being generated, Zener diode D330 provides a +10-volt reference on the base of Q333. Q333 conducts, and about +9.4 volts is present on its emitter. Q331 is turned off because D326 is conducting, holding Q331 base negative.

When the Erase Multivibrator is switched and the collector of Q317 snaps down to about —75 volts, the increase of current through D329 and R329 pulls the base of Q333 negative, turning Q333 and D330 off. D333 connected from base to emitter of Q333 becomes forward biased and conducts. The voltage at the emitter of Q333 falls from about +9.4 volts to about —0.25 volts. Then, when the Erase Multivibrator switches back to its quiescent state, the positive-going step produced at the collector of Q317 is coupled through C324, turning off D326 as discussed previously. This action turns Q331 on, conducting heavily. Q331 now supplies the current through R331 to keep D333 forward biased and the voltage at the emitter of Q333 at about —0.25 volts.

Q331 remains saturated until the voltage at the C324-R326 junction decays from zero volts to about —74.4 volts with the charging of C324. Q331 begins to turn off, its collector current diminishing. D333 turns off, and Zener diode D330 turns on. Q333 turns on as its base is raised to the +10-volt level established by D330. When Q331 is shut off, its base is clamped at about —75.6 volts by the conduction of D326. Q333 emitter is returned to its +9.4-volt level.

The resulting negative pulse at the emitter of Q333 is made available to associated equipment via pin 7 of J199.

LOW-VOLTAGE POWER SUPPLY

General

The Low-Voltage Power Supply circuit provides the operating power for this instrument from three regulated supplies and three unregulated supplies. Electronic regulation is used to provide stable, low-ripple output voltages. Fig. 3-8 shows a detailed block diagram of the Low-Voltage Power Supply.

Power Input

Power is applied to the primary of transformer T401 through P401, fuse F401, thermal cutout TK401 and the ON-OFF switch, SW301B. SW401 connects the split primaries of T401 in parallel for 115 VAC operation, or in series for 230 VAC operation. SW403 allows three ranges of regulation by changing the number of primary windings to fit different line requirements.

Fuse F401 provides overload protection, and thermal cutout TK401 provides thermal protection by opening to interrupt power if the instrument overheats. When the temperature returns to a safe level, TK401 automatically closes to reapply the power.

+100-Volt Supply

The +100-Volt Supply provides the reference voltage for the +12.5-Volt and —75-Volt Supplies. The output from the secondary of T401 is rectified by bridge rectifier D410A-D. This voltage is filtered by R412-C413 and then applied through F413 to the +100-Volt Series Regulator stage to provide a stable output voltage. The Series Regulator can be compared to a variable resistance which is changed to stabilize the output voltage. The current through the Series Regulator stage is controlled by the Error Amplifier to provide the correct regulated output voltage.

The Error Amplifier consists of Q423 and Q425 and is connected as a comparator. That is, the output voltage at the collector of Q423 indicates voltage varations at the base of Q423 relative to the fixed voltage at the base of Q425. Zener diode D425 maintains a fixed 9-volt drop, providing the reference for Q423. The base level of Q425 is determined by voltage divider R433-R434-R435 between the output of this supply and ground. R434 is adjustable to set the output voltage to +100 volts. R429 is the emitter resistor for both comparator transistors and the current through it divides between Q423 and Q425. The output current of the Error Amplifier stage controls the conduction of the Series Regulator stage. This is accomplished as follows: Assume that the output voltage increases because of a change in load or an increase in line voltage. This voltage increase is applied to the base of Q423, increasing the conduction of Q423. The collector of Q423 goes negative, reducing the bias on Q417. This results in reduced current through the Series Regulator, Q413. Reduced current through Q413 also means that the current through the load is reduced, lowering the output voltage to its correct level. In a similar manner the Series Regulator and Error Amplifier stages compensate for output changes due to ripple.

+16-Volt Unregulated Supply

Rectifier D440 A-D provides the unregulated output for the +16-Volt Supply. The input to D440 A-D provides the power for the pilot light. The output is filtered by R442-C443.

+12.5-Volt Supply

Rectified voltage for operation of the +12.5-Volt Supply is provided by the +16-Volt Unregulated Supply and is applied through F443 to the +12.5-Volt Supply Series Regulator stage. Reference voltage for this supply is provided by voltage divider R461-R463 between the regulated +100-Volt Supply and ground. If the +12.5-volt output changes, a sample of this change appears at the base of Q453 as an error signal. Regulation of the ouput voltage is controlled by Error Amplifier Q453-Q455 and Series Regulator Q443 in a manner similar to that described for the +100-Volt Supply.

—75-Volt Supply

Rectified voltage for operation of the —75-Volt Supply is provided by D470 A-D, filtered by R472-C473, and applied through F473 to the —75-Volt Supply Series Regulator stage. Reference voltage for this supply is provided by voltage divider R491-R493 between the regulated +100-Volt Supply and the output of this supply. If the —75-Volt Supply output changes, a sample of this change is applied to the emitter and base of Q485, appearing as an error signal at the base of Q483. Regulation of output voltage is controlled by Error Amplifier Q483-Q485 and Series Regulator Q473 in a manner similar to that described for the +100-Volt Supply.

—150-Volt Unregulated Supply

Output for the —150-Volt Supply is provided by half-wave rectifiers D497 and filtered by C498. This voltage is applied to a voltage divider consisting of R499 and D499. Zener diode D499 maintains a constant voltage drop to keep the output 75 volts more negative than the —75-Volt Supply, thus the output is about —150 volts.

+250-Volt Unregulated Supply

Rectifier D406 A-D provides the unregulated output for the +250-Volt Supply. The output of the +100-Volt Supply is connected to the negative side of the +250-Volt Supply to elevate the output level to +250 volts. The output is filtered by R408-C409.

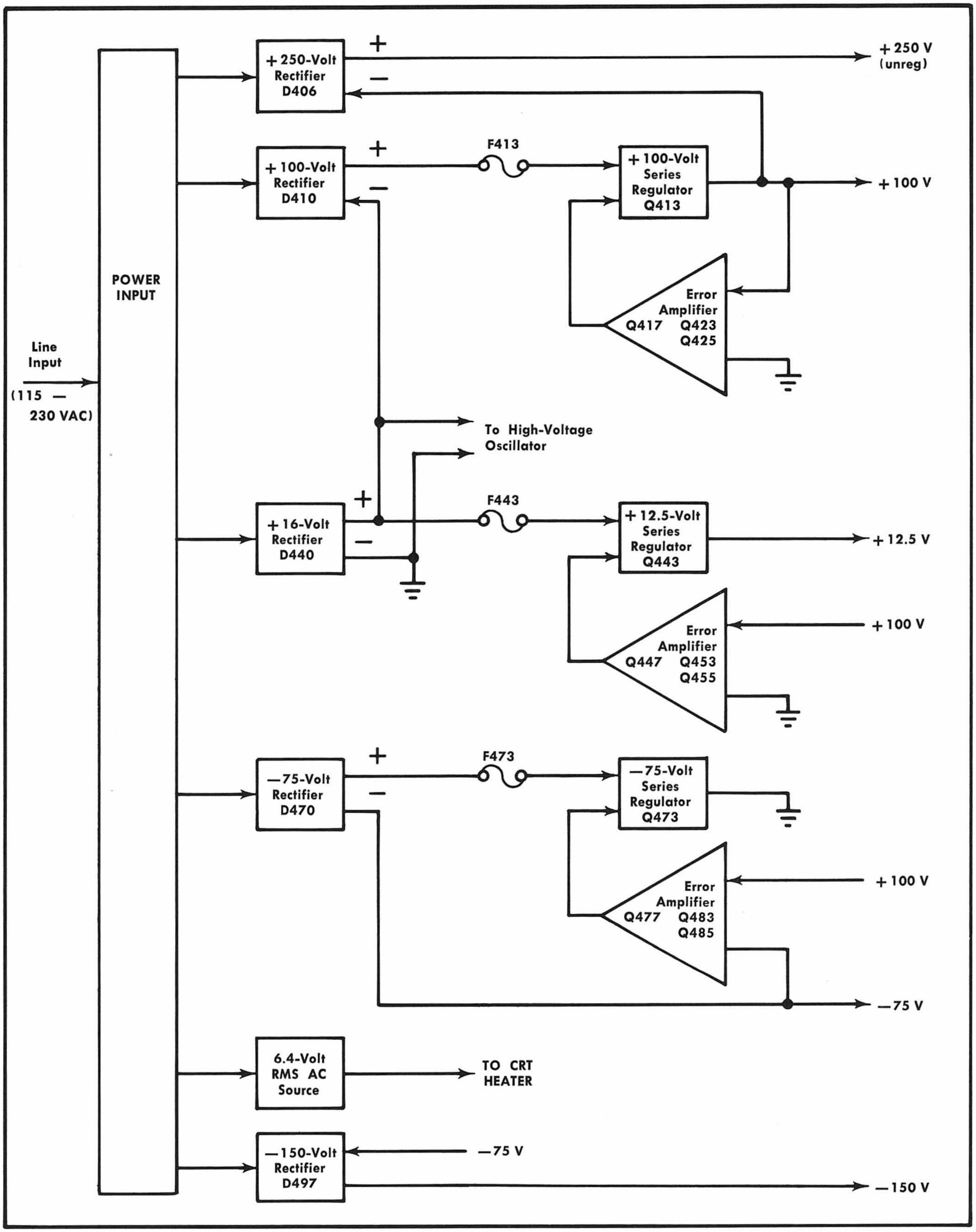


Fig. 3-8. Power Supply detailed block diagram.

SECTION 4
MAINTENANCE

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains information for use in preventive maintenance, corrective maintenance and troubleshooting of the Type 601.

PREVENTIVE MAINTENANCE

General

Preventive maintenance consists of periodic inspection and cleaning at regular intervals. The Type 601 should be checked approximately every 200 hours of operation, or every 2 years, whichever occurs first. If the instrument is subjected to adverse environmental conditions, such as excessive dust, high temperatures or high humidity, the frequency of the checks should be increased.

Cleaning

The Type 601 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path.

The cover provides protection against dust in the interior of the instrument. Operation without the cover in place necessitates more frequent cleaning.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

Exterior. Loose dust accumulated on the outside of the Type 601 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

Clean the graticule and CRT face with a soft, lint-free cloth dampened with a mild detergent and water solution.

Interior. Dust in the interior of the instrument should be removed occasionally due to its electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or circuit boards.

The high-voltage circuits, particularly parts located in the high-voltage compartment and the area surrounding the CRT base socket should receive special attention. Excessive dirt in these areas may cause high-voltage arcing and result in improper instrument operation.

Visual Inspection

The Type 601 should be inspected occasionally for such defects as broken connections, improperly seated transistors, damaged circuit boards and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent a recurrence of the damage.

Transistor Checks

Periodic checks of the transistors in the Type 601 are not recommended. The best check of transistor performance is its actual operation in the instrument. More details on checking transistor operation are given under troubleshooting.

Recalibration

To assure accurate measurements, check the calibration of this instrument after each 500 hours of operation or every 6 months if used infrequently. In addition, replacement of components may necessitate recalibration of the affected circuit. Complete calibration instructions are given in the Calibration section.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by recalibration.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the Type 601 if trouble developes. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective components. An understanding of the circuit operation is very helpful in locating troubles. See the Circuit Description section for complete information.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 9. The component number and electrical value of each component in this instrument are shown on the diagrams. Each main circuit is assigned a series of component numbers. Table 4-1 lists the main circuits in the Type 601 and the series of component numbers assigned to each. Important voltages and waveforms are also shown on the diagrams at the rear of this manual. The portion of the circuit mounted on the circuit board is enclosed with a blue line.

TABLE 4-1

Component Numbers

Component Numbers on diagrams	Diagram Number	Circuit
1-49	1	Horizontal Deflection Amp
50-99	1	Vertical Deflection Amp
100-199	2	Z Axis
200-299	3	CRT
300-399	4	Storage
400-499	5	Power Supply

Switch Wafer Identification. Switch wafers shown on the diagrams are coded to indicate the position of the wafer in the complete switch assembly. The numbered portion of the code refers to the wafer number counting from front, or mounting end of the switch, toward the rear. The letter F and R indicate whether the front or rear of the wafer performs the particular switching function. For example, a wafer designated 2R indicates that the rear of the second wafer is used for this particular switching function.

Circuit Board. Figs 4-15 through 4-23 show the circuit boards used in the Type 601. Each electrical component on each board is identified by its circuit number. The circuit board is also outlined on its schematic diagram with a blue line. These pictures used with the diagrams will aid in locating the components mounted on the circuit boards.

Wiring Color Code. All insulated wire and cable used in the Type 601 is color-coded to facilitate circuit tracing. Signal carrying leads are identified with one or two colored stripes. Regulated voltage supply leads are identified with three stripes to indicate the approximate voltage, using the EIA resistor color code. A white background color indicates a positive voltage and a tan background indicates a negative voltage. The widest color stripe identifies the first color of the code. Table 4-2 gives the wiring color-code for the power supply voltages used in the Type 601.

TABLE 4-2

Power Supply Wiring Color Code

Supply	Background Color	First Stripe	Second Stripe	Third Stripe
−75[1]	tan	violet	green	black
+12.5[1]	white	brown	red	black
+100[1]	white	brown	black	brown
−150[2]	tan	brown	green	brown
+16[2]	white	red		
+250[2]	white	orange	black	brown

[1]**Regulated**
[2]**Unregulated**

Resistor Color Code. In addition to the brown composition resistors, some metal-film resistors and some wire-wound resistors are used in Type 601. The resistance values of wirewound reistors are printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color-coded on the components (some metal-film resistors may have the value printed on the body) with the EIA color code. The color code is read starting with the the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier and a tolerance value (see Fig. 4-1). Metal -film resistors have five stripes consisting of three significant figures, a multiplier and a tolerance value.

Capacitor Marking. The capacitance values of common disc capacitors and small electrolytics are marked in microfarads on the side of the component body. The white ceramic capacitors used in the Type 601 are color coded in picofarads using a modified EIA color code (See Fig. 4-1).

Diode Color Code. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes or a dot. For most silicon or germanium diodes with a series of stripes, the color-code also indicates the type and identifies the Tektronix Part Number using the resistor color-code system (e.g., a diode color-coded blue-brown-gray-green (6, 1, 8, 5) indicates Tektronix Part Number 152-0185-00). The cathode and anode ends of metal diodes can be identified by the diode symbol marked on the body.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the Type 601:

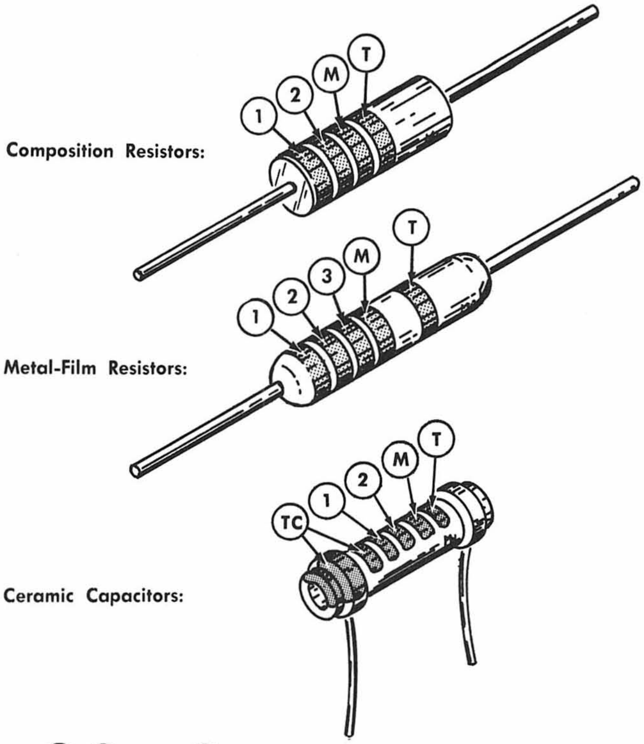
1. Transistor Tester

Description: Tektronix Type 575 Transistor Curve Tracer or equivalent.

Purpose: To test the semiconductors used in this instrument.

2. Multimeter

Description: Electronic Voltmeter, 10 megohms, or greater, input resistance; 0 to 500 volts; 0 to 50 megohms.



(1) (2) and (3) —1st, 2nd and 3rd significant figures;
(M) —multiplier; (T) —tolerance;
(TC) —temperature coefficient.

Resistor and Capacitor Color Code

Color	Significant Figures	Multiplier		Tolerance	
		Resistors	Capacitors	Resistors	Capacitors
Silver	---	10^{-2}	---	±10%	---
Gold	---	10^{-1}	---	±5%	---
Black	0	1	1	---	±20% or 2 pF*
Brown	1	10	10	±1%	±1% or 0.1 pF*
Red	2	10^2	10^2	±2%	±2%
Orange	3	10^3	10^3	±3%	±3%
Yellow	4	10^4	10^4	±4%	+100% −0%
Green	5	10^5	10^5	±0.5%	±5% or 0.5 pF*
Blue	6	10^6	10^6	---	---
Violet	7	---	---	---	---
Gray	8	---	10^{-2}	---	+80% −20% or 0.25 pF*
White	9	---	10^{-1}	---	±10% or 1 pF*
(none)	---	---	---	±20%	±10% or 1 pF*

***For capacitance of 10 pF or less.**

NOTE: (T) and/or (TC) color code for capacitors depends upon manufacturer and capacitor type. May not be present in some cases.

Fig. 4-1. Resistor and ceramic capacitor color code.

Accuracy, within 3% (1% accuracy is necessary to check power supply voltages). Test prods must be insulated to prevent accidental shorting.

Purpose: To check operating voltages and for general troubleshooting in this instrument.

NOTE

A 20,000 ohm/volt VOM can be used to check the voltages in this instrument if allowances are made for the circuit loading of the VOM at high impedance points.

3. Test Oscilloscope (with 10× probe).

Description: DC to 10 MHz frequency response, 1 millivolt to 50 volts/division deflection factor.

Purpose: To check waveforms in the instrument.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given under Corrective Maintenance.

1. Visual Check. Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visual indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

2. Check Signal Source. Be sure that signal source is of the proper DC level and polarity and the Z Axis signal is unblanking the CRT.

3. Check Associated Equipment. Before proceeding with troubleshooting of the Type 601 check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source.

4. Check Instrument Calibration. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be a result of misadjustment or may be corrected by calibration. Complete calibration instructions are given in the Calibration section of this manual.

5. Isolate trouble to a Circuit. To isolate trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located. For example, poor focus indicates that the CRT Circuit (includes high voltage) is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supplies. However, a defective component elsewhere in the instrument can appear as a power supply trouble and may also affect the operation of other circuits.

NOTE

Turn the instrument off before removing or replacing any circuit board.

The Z Axis and Deflection Amplifier circuit boards may be removed to check supply voltages.

Removing the Storage circuit board shuts off the High Voltage.

The Type 601 may be turned on with any circuit board removed with no damage to the instrument.

Table 4-3 lists the tolerances of the power supplies in this instrument. If a power supply voltage is within the listed tolerance the supply can be assumed to be working correctly. If outside the tolerance, the supply may be misadjusted or operating incorrectly. Use the procedure given in the Calibration section to adjust the power supplies.

TABLE 4-3

Power Supply Tolerances

Regulated Supply	Tolerance
—3900	±100 V
—75	±2%
+12.5	±2%
+100	±2%
Unregulated Supply	Range
—150	—144 to —159 V
+16	+14.7 to 22.5 V
+250	+230 to +280 V

Table 4-4 gives some checks which may aid in isolating trouble to a circuit. The test equipment used for these checks should be the same as that called out for the Calibration Procedure.

TABLE 4-4

Check	Procedure
Line Voltage Range Switch	Connect the Type 601 to the AC power line through a variable autotransformer. Set the Line-Range switch (rear panel on the Type 601) to M. Set the 115-230 switch to 115. Set the autotransformer output voltage to approximately 115 volts.

TABLE 4-4 *(cont)*

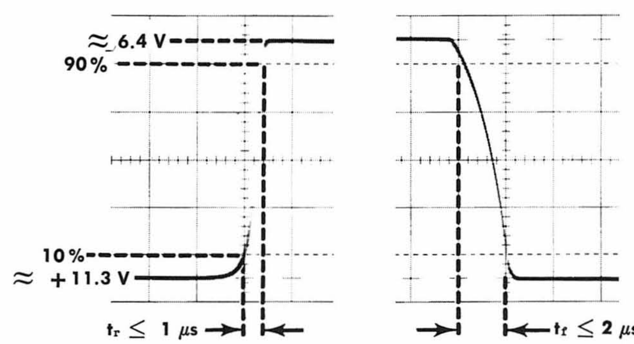
Check	Procedure
	Connect an AC voltmeter to terminals 10 and 11 of the Type 601 power transformer. Adjust the autotransformer for an AC voltage of 75 V across terminals 10 and 11. Switch the Line-Range switch to LO. Voltmeter should read 86 volts at terminals 10 and 11. Switch the Line-Range switch to HI. Voltmeter should read 70 volts at terminals 10 and 11.
Z Axis Circuit board	Terminate X and Y INPUT connectors with 50 Ω BNC Terminations. Connect the Standard Amplitude Calibrator through a 50 Ω coaxial cable to the Type 601 Z INPUT. Set the Standard Amplitude Calibrator to and set the output voltage to 1.0. Connect a Test Oscilloscope to test point TP149 on the Z AXIS circuit board. The DC voltage levels of the square wave seen on the Test Oscilloscope should be ≈ +11.3 volts to ≈ +64 volts (see figure below). Risetime (t_r) should be 1 µs or less from the 10% to 90% amplitude points (see figure below). Falltime (t_f) should be 2 µs or less from the 10% to 90% amplitude points (see figure below). 
X Position Range	Connect 50 Ω terminations to X and Y INPUTS. Set up the Test Oscilloscope as follows: Horizontal Display, B Time Base A Triggering Mode — Auto Slope — + Coupling — AC Source — Normal Level — Clockwise Connect the Test Oscilloscope +Gate A to the Type 601 Z INPUT.

TABLE 4-4 *(cont)*

Check	Procedure
X Pos Range (Cont)	

Set the Y Pos control, R60, to midrange.

Set the X Pos control, R10, to approximately midrange.

If a spot is not visible on the CRT, rotate the INTENSITY control clockwise until a spot appears.

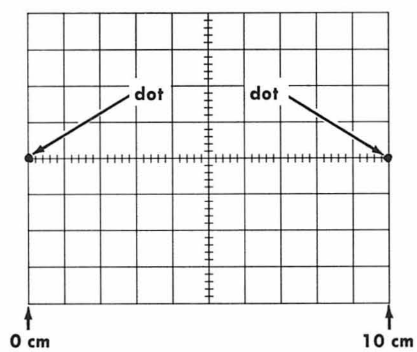
Place a test graticule over the CRT face, centered in the CRT quality area.

Short circuit the Right and Left deflection plate leads at the CRT neckpins with a small screwdriver. (DO NOT ground the leads).

Note the position of the spot on the CRT screen with the Right and Left pins shorted. The spot should lie within ± 0.5 cm of the graticule center (horizontally).

Remove the termination from X INPUT and connect the Standard Amplitude Calibrator set for 1 volt ⊓⊔ .

Adjust the X Pos control to place the display (two dots) as shown below. If dots do not fall on the zero and 10 cm marks, as shown, adjust X GAIN.



Connect a 10X probe to each of the Test Oscilloscope Inputs, Chan 1 and Chan 2. (Check probe compensation).

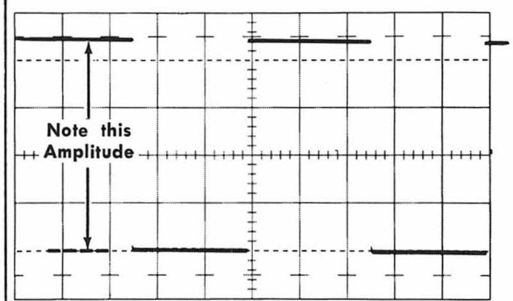
Set the Test Oscilloscope as follows:

Vertical Input	
Volts/cm	5
Chan 1	Normal
Chan 2	Inverted
Mode	Add
Input Selector	DC
Time Base B	
Time/cm	.2 ms
Horizontal Display	B
Triggering	
Mode	Auto
Slope	+
Coupling	AC
Source	Plug-in
Level	Stable display (with probes connected as below)

TABLE 4-4 *(cont)*

Check	Procedure

Connect the probe tips to pins A and F on the Deflection Amplifier board. Observe a waveform similar to that shown below.



Note the amplitude of the displayed waveform.

The gain of the amplifier with the gain control set for 0.1 v/cm CRT sensitivity (1.0 volt signal divided by 10 cm of display) may be calculated by dividing the signal amplitude at the deflection plates (above figure) by the input signal. For example. signal amplitude = 225 volts, divided by input signal, 1 volt = gain (225/1 = 225).

To determine the level of voltage difference necessary to position the spot 6 cm in either direction from center, multiply the gain as determined above, by 0.6 (0.1 V/cm times 6 cm). As in the example above, 225 times 0.6 = 135 volts.

To check for adequate voltage difference of X Pos extremes, proceed as follows:

Remove the 1 volt ⊓⊔ Standard Amplitude Calibrator signal and terminate the X INPUT in 50 Ω.

Reposition the spot to the CRT electrical center (position of the spot with Right and Left neckpins shorted) with the X Pos control.

Position the Test Oscilloscope trace (vertically) to the bottom graticule line with the Test Oscilloscope Vertical Position control(s).

Rotate the X Pos control fully counterclockwise.

Note the deflection of the trace on the Test Oscilloscope. The DC level should change at least 135 volts (2.7 cm) in the example.

Switch Input Chan 2 to Normal and Chan 1 to Inverted.

Reposition the spot to the electrical center of the CRT with the X Pos control.

Position the Test Oscilloscope trace to the bottom graticule line with the Test Oscilloscope Vertical Position control(s).

TABLE 4-4 *(cont)*

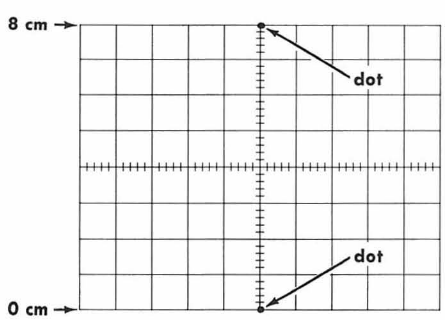
Check	Procedure
X Pos Range (Cont)	Rotate the X Pos control fully clockwise and note the change in Test Oscilloscope deflection. The deflection should be at least 135 volts (2.7 cm) in the example.
Y Pos Range	Connect 50 Ω terminations to X and Y INPUTS. Set up the Test Oscilloscope as follows: Horizontal Display — B Time Base A Triggering Mode — Auto Slope — + Coupling — AC Source — Normal Level — Clockwise Connect the Test Oscilloscope +Gate A to the Type 601 Z INPUT. Set the X Pos control, R10, to midrange. If a spot is not visible on the CRT face, rotate the INTENSITY control clockwise until a spot appears. Place a test graticule over the CRT face, centered in the CRT quality area. Short circuit the Upper and Lower deflection plate leads at the CRT neckpin connectors with a small screwdriver. (DO NOT ground the leads). Note the position of the spot on the CRT with the Upper and Lower CRT pins shorted. The spot should lie within ±0.5 cm of the graticule center (vertically). Remove the termination from the Y INPUT and connect the Standard Amplitude Calibrator set for 1 volt ⊓⊔. Terminate X INPUT in 50 Ω. Adjust the Y Pos control to place the display (two dots) as shown below. If dots do not fall on the zero and 8 cm marks, as shown, adjust Y Gain.  Connect a 10X probe to each of the Test Oscilloscope Inputs, Chan 1 and Chan 2. (Check probe compensation).

TABLE 4-4 *(cont)*

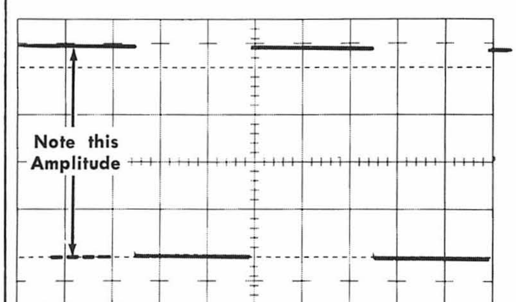
Check	Procedure
	Set the Test Oscilloscope as follows: Vertical Input Volts/cm — 5 Chan 1 — Normal Chan 2 — Inverted Mode — Add Time Base B Time/cm — .2 ms Horiz Display — B Triggering Mode — Auto Slope — + Coupling — AC Source — Plug-in Level — Stable display (with probes connected as below) Connect the probe tips to pins G and L on the Deflection Amplifier board. Observe a waveform similar to that shown below.  Note the amplitude of the displayed waveform. The gain of the amplifier with the Gain control set for 0.125 V/cm CRT sensitivity (1.0 volt signal divided by 8 cm of display may be calculated by dividing the signal amplitude at the deflection plates (above figure) by the Input signal. For example; Signal amplitude = 200, divided by Input Signal (1 volt) = gain (200/1 = 200). To determine the level of voltage difference necessary to position the spot 6 cm in either direction from center, multiply the gain as determined above by 0.75 (0.125 V/cm times 6 cm). As in the example above, 200 times 0.75 = 150 volts. To check for adequate voltage difference of Y Pos extremes proceed as follows:

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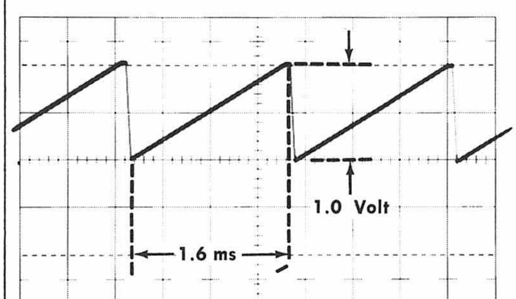
TABLE 4-4 *(cont)*

Check	Procedure
Y Pos Range (Cont)	Remove the 1 volt Standard Amplitude Calibrator signal from the Y INPUT and terminate the Y INPUT in 50 Ω. Position the spot to the electrical center (position with Upper and Lower deflection plates shorted) with Y Pos control. Position the Test Oscilloscope trace (vertically) to the bottom graticule line with the Test Oscilloscope Vertical Position control(s). Rotate the Y Pos control fully counterclockwise. Note the deflection of the trace on the Test Oscilloscope. The DC level should change at least 150 volts (3 cm) in the example. Switch Input Chan 2 to Normal and Chan 1 to Inverted. Position the spot to the electrical center (position with Upper and Lower deflection plates shorted) with Y Pos control. Position the Test Oscilloscope trace to the bottom graticule line with the Test Oscilloscope Vertical Position control(s). Rotate the Y Pos control fully clockwise and note the change in Test Oscilloscope deflection. The deflection should be at least 150 volts (3 cm) in the example.
CRT Stored Resolution	Connect a 50 Ω coaxial cable between the Standard Amplitude Calibrator output and the Type 601 X INPUT. Set the Standard Amplitude Calibrator output to 1 volt Set the Test Oscilloscope Time Base A Triggering Mode to Auto, Triggering Level clockwise, Time/cm at .1 ms and Horizontal Display to B. Feed the Test Oscilloscope +A Gate to the Type 601 Z INPUT. Terminate the Y INPUT in 50 Ω. Observe a display on the Type 601 CRT. Adjust INTENSITY, FOCUS and ASTIGMATISM as necessary for two well defined dots with normal viewing brightness. Adjust X Gain control, R24, on the Deflection Amplifier board for 8 cm of display (two dots) horizontally. Position the display to fall within the graticule area, as necessary, with the X Position control, R10. Move the Standard Amplitude Calibrator signal from X INPUT to Y INPUT.

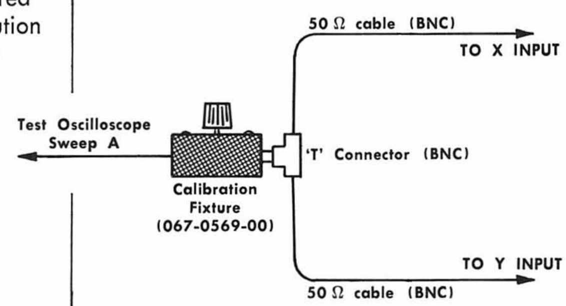
TABLE 4-4 *(cont)*

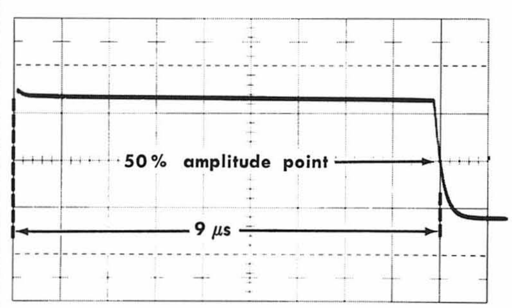
Check	Procedure
	Move the 50 Ω Termination to X INPUT. Adjust Y Gain, R74, on the Type 601 Deflection Amplifier board for 8 cm of display (two dots) vertically. Position the display to fall within the graticule area, as necessary, with the Y Position control, R60. Set the Standard Amplitude Calibrator output to 5 mV, +DC. Connect the Calibration Fixture (067-0569-00) to the Test Oscilloscope Sweep A output. Connect the Calibration Fixture output to the Test Oscilloscope Vertical Input (Plug-in). Set the Test Oscilloscope Vertical Input Volts/div to 0.5. Set the Test Oscilloscope B Time/cm to .5 ms, Triggering Mode to Auto, Slope to +, Coupling to AC, Source to Normal and Triggering Level for a stable display on the Test Oscilloscope CRT. Adjust the Calibration Fixture level control for 2 cm (1.0 volt) of display on the Test Oscilloscope CRT. See figure below.



Check	Procedure
	Adjust the Test Oscilloscope Sweep A Time/cm Variable for 1.6 ms sweep length (3.2 cm at .5 ms/cm) displayed on the Test Oscilloscope CRT. Rotate the Type 601 INTENSITY control fully counterclockwise. Move the 50 Ω coaxial cable from the Test Oscilloscope Input to the Type 601 Y INPUT. Connect the Standard Amplitude Calibrator output to the Type 601 X INPUT. Slowly rotate the Type 601 INTENSITY control clockwise until a trace is seen on the CRT. Adjust FOCUS and ASTIGMATISM as follows: Connect the Test Oscilloscope to the Type 601 as shown in the diagram.

TABLE 4-4 *(cont)*

Check	Procedure
CRT Stored Resolution (Cont)	 Observe a diagonal line on the Type 601 CRT. Adjust the Type 601 FOCUS and ASTIGMATISM controls for a well defined trace. Set the Test Oscilloscope Normal-Single Sweep to Single Sweep. Depress the ERASE button on the Type 601. Check the focus by depressing the Normal-Single Sweep button to Reset. A diagonal line should write and store. (Adjust INTENSITY if necessary). Erase the display. Move the 50 Ω cable (X INPUT) from the "T" connector to the Standard Amplitude calibrator output. Check resolution as follows: Set the Test Oscilloscope Normal-Single Sweep switch to Single Sweep. Depress the Type 601 ERASE button. Depress the Test Oscilloscope Single-Sweep switch to Reset. Slowly rotate the Type 601 INTENSITY control clockwise while repeatedly depressing the Test Oscilloscope Reset switch until the Type 601 screen stores a well defined trace for the full 8 cm length. Between adjustments of the INTENSITY control, depress the ERASE button to erase the screen. Depress the Single Sweep switch to Reset. Switch the Standard Amplitude Calibrator output to —DC. Depress the Single Sweep switch to Reset. Note two stored lines with no bridging of the traces. Clean separation of the stored lines indicates a resolution of 100 line pairs vertically. The entire screen may be checked for resolution by repeating the resolution test while adjusting the X and Y Pos controls (erase, store a line, switch the Standard Amplitude Calibrator to +DC, store a line and check resolution. Erase, store a line, switch Standard Amplitude Calibrator to —DC, store a line and check resolution). Depress the Type 601 ERASE button. Move the Standard Amplitude Calibrator output to the Y INPUT and the Test Oscilloscope Sweep A to the X INPUT. Depress the Test Oscilloscope Single Sweep switch to Reset. Switch the Standard Amplitude Calibrator output to +DC. Depress the Test Oscilloscope Single Sweep switch to Reset. Note two stored lines with no bridging of the traces. Clean separation of the stored lines over 10 cm horizontally (display may be moved by adjusting the Position controls) indicates a stored resolution of 125 line pairs horizontally.
Line Writing Speed, Stored	Check Stored Resolution as detailed above. Rotate the Y Pos control, R60, throughout its range, while repeatedly depressing the Test Oscilloscope Single Sweep Reset switch. This checks writing rate over the entire quality area of the CRT.

Dot Writing Time, Stored	Connect the Test Oscilloscope +Gate A to the Test Oscilloscope Vertical Input.
	Set the Oscilloscope controls as follows:
	Time Base A
	  Time/cm: 1 μs
	Triggering
	  Mode: Auto
	  Slope: +
	  Coupling: AC
	  Source: Normal
	  Level: Clockwise
	Horizontal Display B
	Time Base B
	  Mode: Auto
	  Slope: +
	  Coupling: AC
	  Source: Plug in
	  Level: Stable display
	Adjust A Time/cm Variable to set the square wave width to 9 μs at the 50% amplitude points (See Figure below).
	

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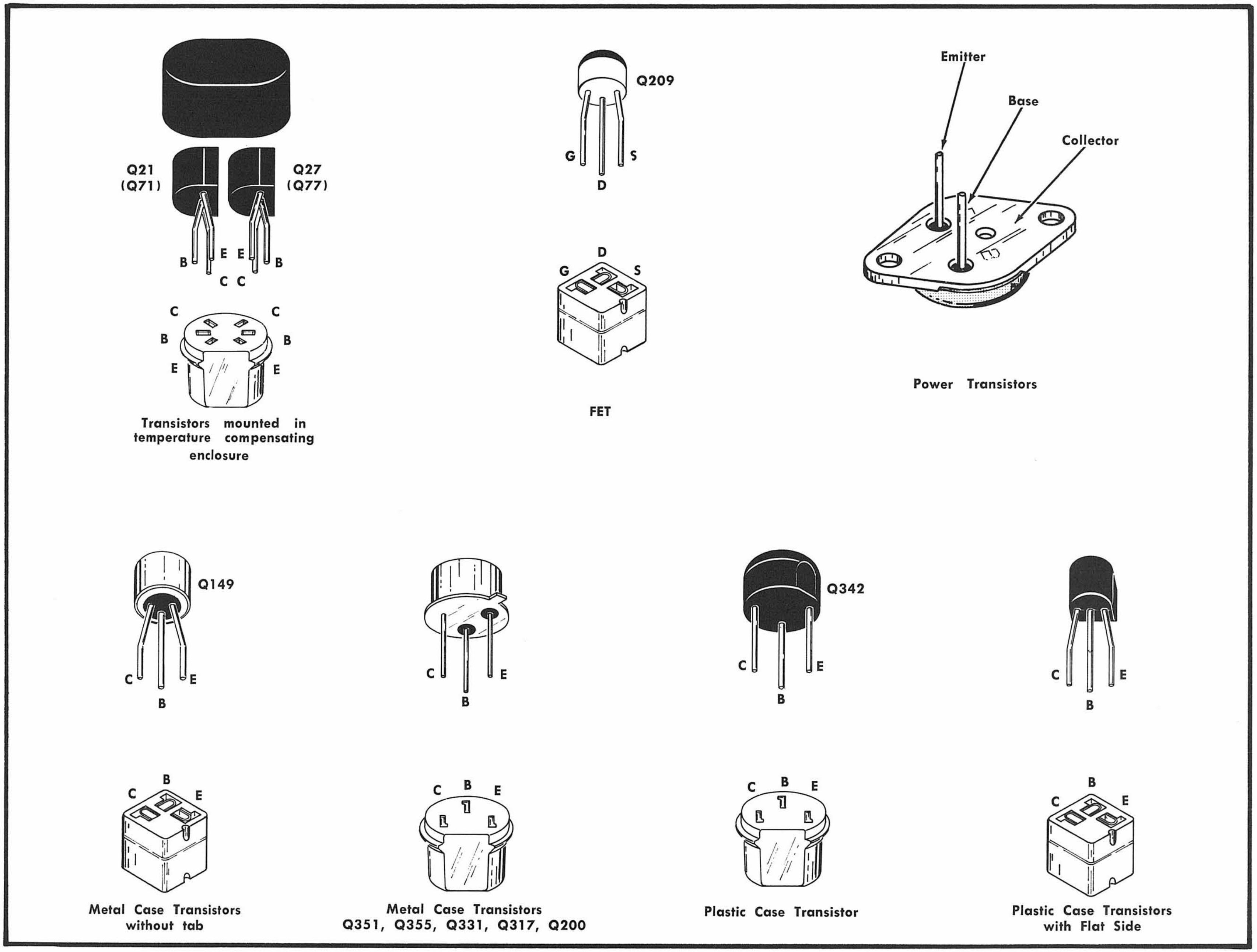


Transistors mounted in temperature compensating enclosure

FET

Power Transistors

Metal Case Transistors without tab

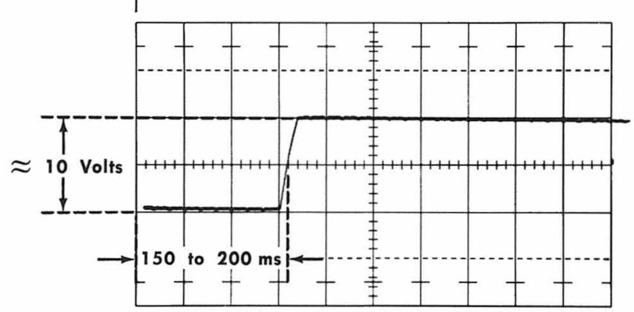
Metal Case Transistors Q351, Q355, Q331, Q317, Q200

Plastic Case Transistor

Plastic Case Transistors with Flat Side

Fig. 4-2. Transistor base pin and socket arrangements.

TABLE 4-4 *(cont)*

Check	Procedure
Dot Writing Time, Stored (Cont)	Connect 50 Ω BNC Terminations to X and Y INPUTS. Move the +GATE A signal from the Test Oscilloscope Input to the Type 601 Z INPUT. Adjust the Type 601 INTENSITY control for normal brightness. Switch Test Oscilloscope Normal-Single Sweep to Reset. Adjust the Type 601 FOCUS and ASTIGMATISM controls for a well defined round dot. (Erase as necessary while adjusting FOCUS and ASTIGMATISM). Increase the intensity if necessary for the dot to store. Set the Test Oscilloscope Single Sweep switch to Reset repeatedly as the X and Y Pos controls are rotated throughout their range. Each time the Reset switch is operated a dot should write and store. The screen should write and store over the quality area.
Erase Interval	Connect a 10X probe to the Test Oscilloscope Vertical Input set to .5 volts/cm. Connect the probe tip to pin B on the Storage Circuit board. Switch the Test Oscilloscope Horizontal Display to B. Set Time Base B Triggering Mode to Trig, Slope to +, Coupling to AC, Source to Norm, Time/cm to 50 ms and Triggering Level for a stable display similar to that in the figure below each time the Type 601 ERASE button is depressed.  If the signal is correct at pin B on the Storage Circuit board, make the same check at pin 7 of the remote program connector.

After the defective circuit has been located, proceed with steps 6 and 7 to locate the defective component(s).

6. Check Voltages and Waveforms. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages are given on the diagrams.

NOTE

Voltages given on the diagrams are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the first page of the circuit diagrams.

7. Check Individual Components. The following procedures describe methods of checking individual components in the Type 601. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

A. TRANSISTORS. The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective it can best be checked by substituting a new component or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 575). Static type testers are not recommended, since they do not check operation under simulated operating conditions. Fig. 4-2 shows transistor base pin and socket arrangements.

B. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be high in one direction and low when the leads are reversed.

C. RESISTORS. Some resistors can be checked with an ohmmeter. Check the Electrical Parts List for the tolerance of the resistors used in this instrument. Resistors normally need not be replaced unless the measured value varies widely from the specified value.

D. CAPACITORS. A leaky or shorted capacitor can be determined by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking whether the capacitor passes AC signals.

8. Repair and Readjust the Circuit. If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

CORRECTIVE MAINTENANCE

General

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Obtaining Replacement Parts

Standard Parts. All electrical and mechanical part replacements for the Type 601 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts lists for value, tolerance, rating and description.

NOTE

When selecting replacement parts it is important to remember that the physical size and shape of a component may affect its performance in the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect instrument performance.

Special Parts. In addition to the standard electronic components, some special parts are used in the Type 601. These parts are manufactured for Tektronix, Inc. in accordance with our specifications. These special parts are indicated in the parts lists by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, Inc., include the following information:

1. Instrument type.
2. Instrument Serial number.
3. A description of the part (if electrical, include circuit number).
4. Tektronix Part Number.

Soldering Techniques

WARNING

Disconnect the instrument from the power source before soldering.

Circuit Boards. Use ordinary 60/40 solder and a 35 to 40 watt pencil type soldering iron on the circuit boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material.

The following technique should be used to replace a component on a circuit board. Most components can be replaced without removing the boards from the instrument.

1. Grip the component lead with long-nose pliers. Touch the soldering iron tip to the lead at the solder connection. Do not lay the iron directly on the board as it may damage the board. See Fig. 4-3.

2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick into the hole to clean it out.

3. Bend the leads of the new component to fit the holes in the board. Insert the leads into the holes in the board so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.

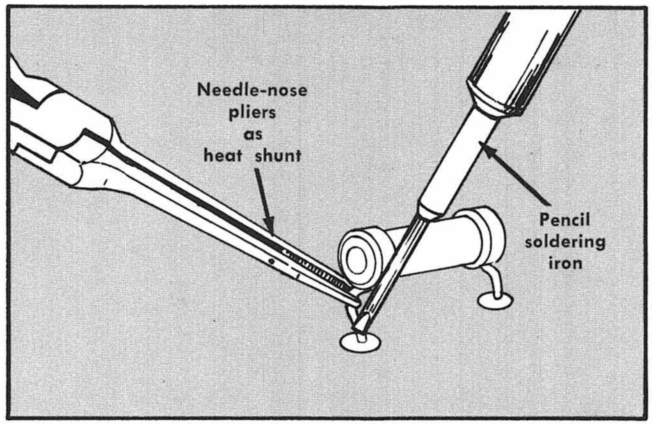


Fig. 4-3. Removing or replacing component on circuit board.

4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint. To protect heat-sensitive components hold the lead between the component body and solder joint with a pair of long-nose pliers or other heat sink.

5. Clip the excess lead that protrudes through the board (if not clipped in step 3).

6. Clean the area around the solder connection with a flux-remover solvent. Be careful not to remove information printed on the board.

Metal Terminals. When soldering metal terminals (e.g., switch terminals, potentiometers, etc.) ordinary 60/40 solder can be used. Use a soldering iron with a 40 to 75 watt rating and a ⅛-inch wide wedge-shaped tip.

Observe the following precautions when soldering metal terminals:

1. Apply heat only long enough to make the solder flow freely.
2. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.
3. If a wire extends beyond the solder joint, clip off the excess.
4. Clean the flux from the solder joint with a flux-remover solvent.

Component Replacement

WARNING

Disconnect the instrument from the power source before replacing components.

Circuit Board Removal. If the circuit board is damaged beyond repair, either the entire assembly including all soldered-on components, or the board only, can be replaced. Part numbers are given in the Mechanical Parts List for either the completely wired or the unwired board.

Push the plastic mounting clips (Fig. 4-4) away from the edge of the circuit board. The springs under the circuit board will push the board upward as the board edge is freed from the plastic mounting clips.

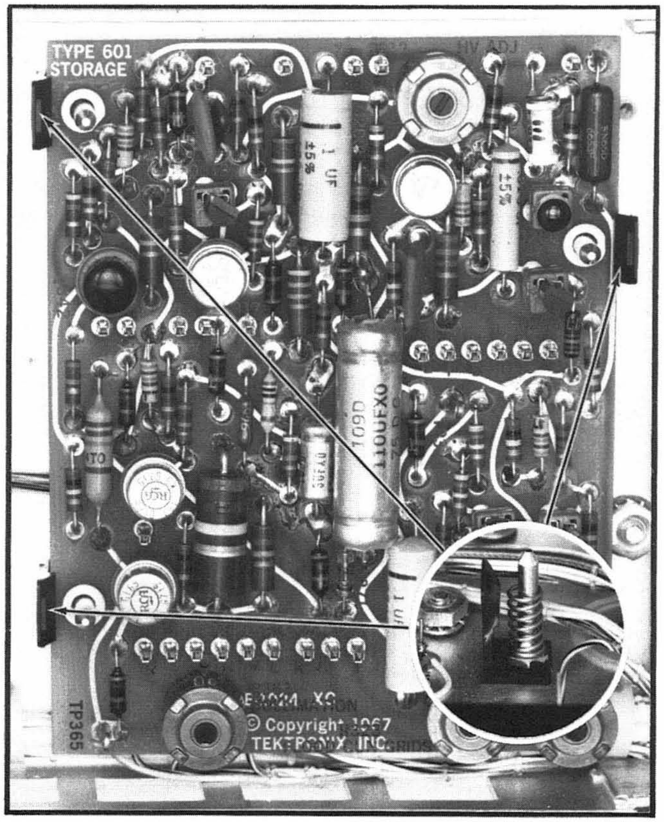


Fig. 4-4. Circuit board mounting clips.

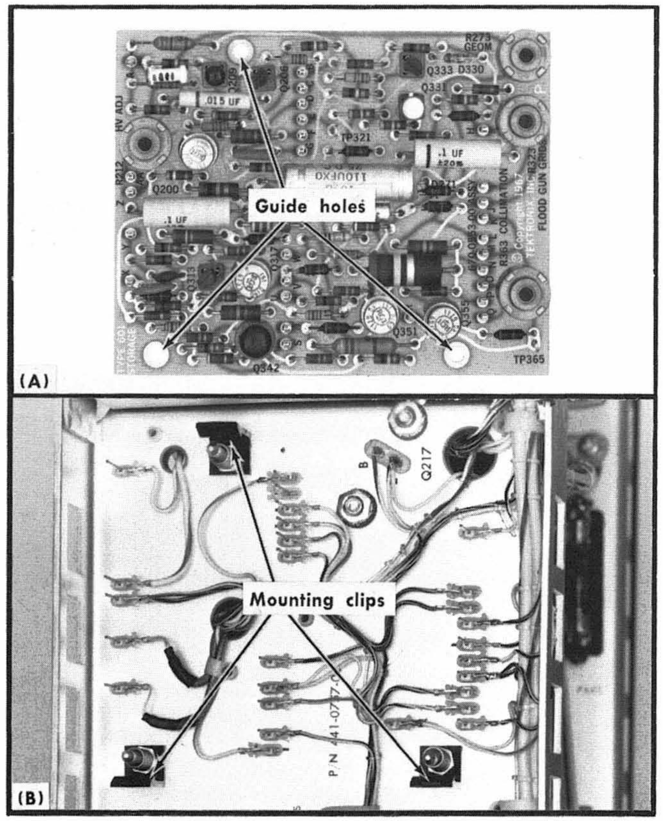


Fig.4-5. (A) Circuit board guide holes and (B) chassis guide pins.

Circuit Board Replacement. Position the circuit board guide holes over the guide pins (Fig. 4-5). Be sure that the connecting pins on the chassis are straight and aligned properly with the connectors on the circuit board. Press straight down on the circuit board, as close as possible to the guide holes. Push downward until the board edge snaps into place in the plastic clips.

Cathode-Ray Tube Removal. Remove the 5 CRT deflection plate pin connectors from the deflection plate pins. See Fig. 4-6 for location and wire colors. Do not bend the CRT deflection plate pins.

Remove the plastic mask from the front of the instrument as shown in Fig. 4-7.

Remove the four phillips head screws which secure the face plate protector. (Fig. 4-8).

Remove the CRT face protector.

Remove the cover plate (Fig. 4-9) from the rear of the instrument.

Remove the CRT base socket from the CRT.

Turn the CRT clamp screw (Fig. 4-10) counterclockwise just far enough to allow the CRT base to slide in the clamp.

Pushing on the CRT base, slide the CRT forward. Pull the CRT out of the instrument from the front. Be sure that the CRT neckpins clear the shield edge as the CRT is pushed out.

CAUTION

Handle with care. Due to the high vacuum that exists inside the CRT, scratching any of the external surfaces or rough handling increases the implosion hazard.

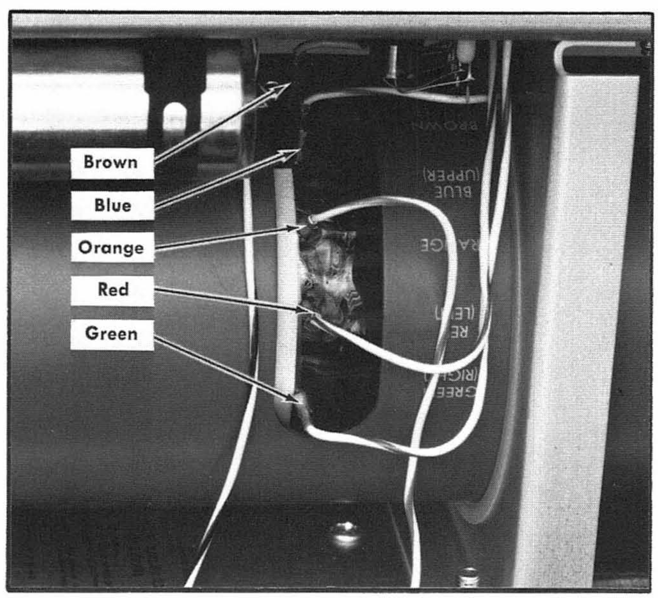


Fig. 4-6. CRT neck pins and connecting wire color codes.

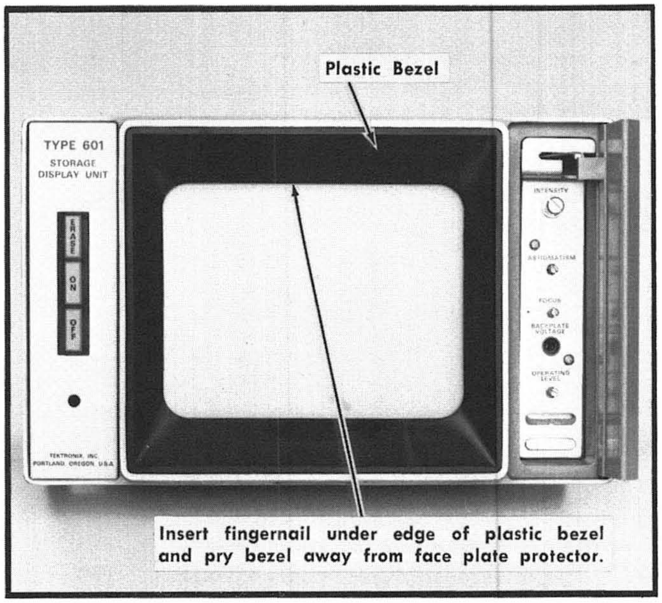


Fig. 4-7. Removing plastic bezel.

Replacing the Cathode-Ray Tube. Slide the CRT into the shield with the wall band connectors (Fig. 4-11) to the right.

Guide the CRT base into the base clamp and slide the CRT toward the rear of the instrument far enough to allow room for the plastic shield.

Place the plastic face plate protector and secure with four Phillips head screws.

Pushing on the CRT base, slide the CRT forward until the CRT face touches the face plate protector.

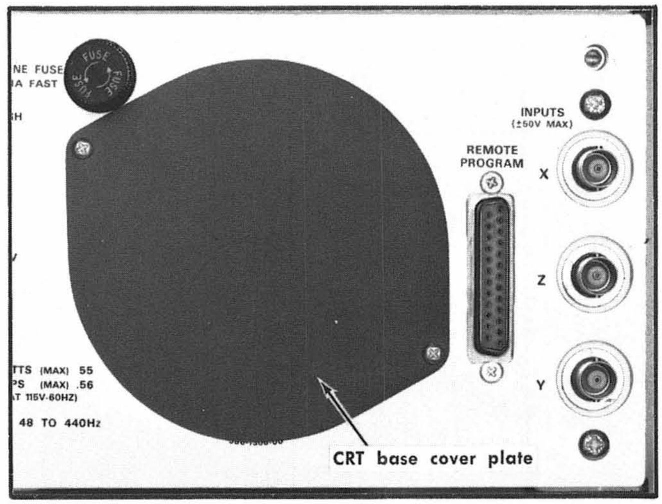


Fig. 4-9. Rear of instrument showing CRT base cover plate.

Tighten the CRT base clamp screw with 4 to 7 inch-ounces of torque (Fig. 4-10).

Loosen the two side screws on the clamp assembly (Fig. 4-10).

Align the CRT face plate square with the front of the instrument. Tighten the two side screws.

Place the CRT base socket onto the CRT base pins.

Replace the deflection plate pin connectors. Fig. 4-6 shows location and lead colors. Do not Bend deflection plate pins.

NOTE

After electrical connections have been made and a signal applied, it may be necessary to re-align

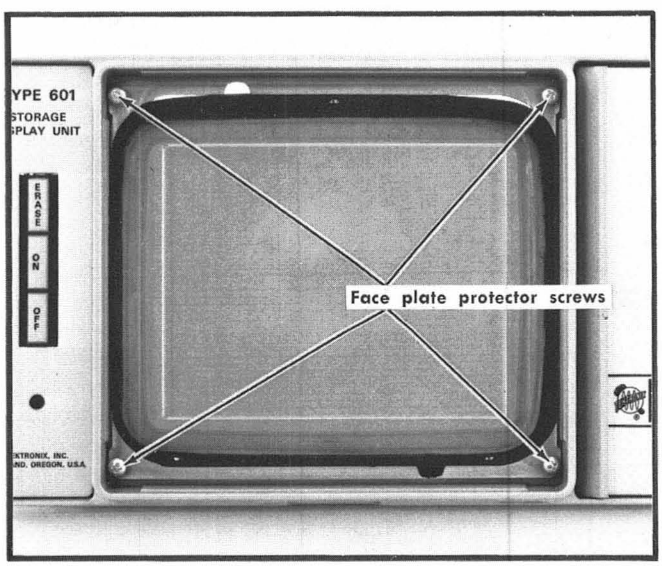


Fig. 4-8. Removing face plate protector screws.

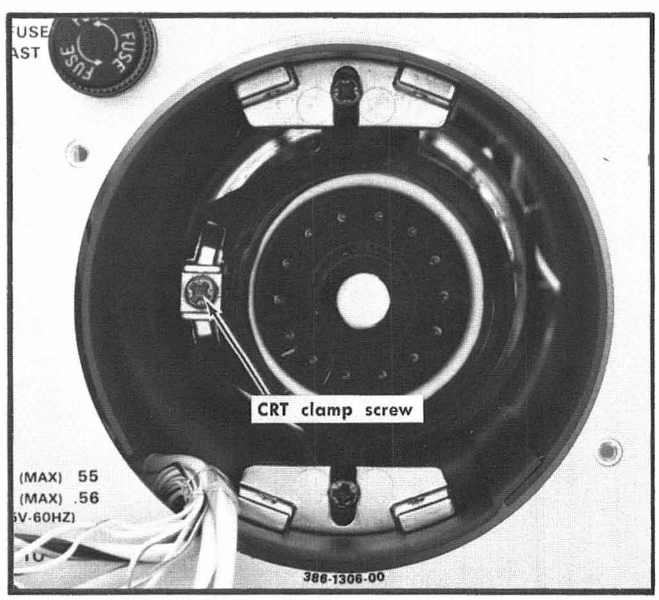


Fig. 4-10. Location of CRT clamp and positioning screws.

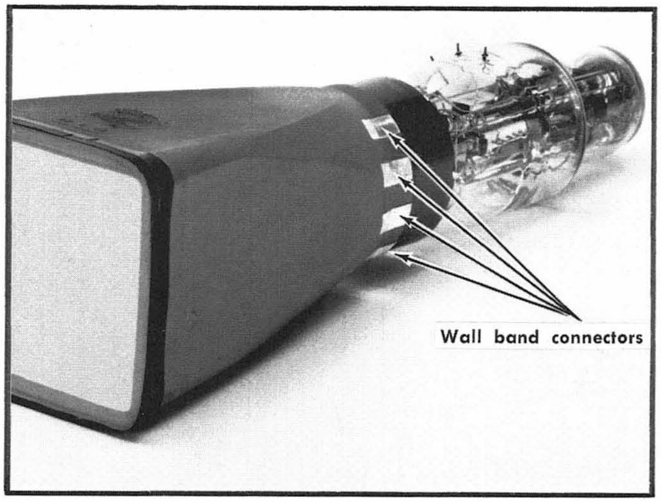


Fig. 4-11. Location of CRT wall band connectors.

the CRT with the graticule. Loosen the two side screws on the base clamp (Fig. 4-10). Rotate the CRT the necessary amount and retighten the screws.

Replace the rear shield (cover).

Replacing the CRT will require instrument recalibration. Refer to Calibration, Section 6.

Transistor Replacement. Transistors should not be replaced unless actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Unnecessary replacement of transistors may affect the calibration of this instrument. When transistors are replaced, check the operation of that part of the instrument which may be affected.

Replacement transistors should be of the original type or a direct replacement. Re-mount the transistors in the same manner as the original. Transistors which have heat radiators or which are mounted on the chassis use silicone grease to increase heat transfer. Replace the silicon grease when replacing these transistors.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

Fig. 4-2 shows the lead configurations of the transistors used in this instrument. This view is as seen from the bottom of the transistor. All transistor sockets in this instrument are wired for the basing used for metal-case transistors.

Fuse Replacement. The power-line fuse is located on the rear panel. Low voltage power supply fuses are mounted on the chassis near the power supply circuit board. See Fig. 4-12. A fuse in the high voltage supply is mounted on the chassis beneath the high voltage section. See Fig. 4-13. Table 4-5 gives the value, location and circuit number.

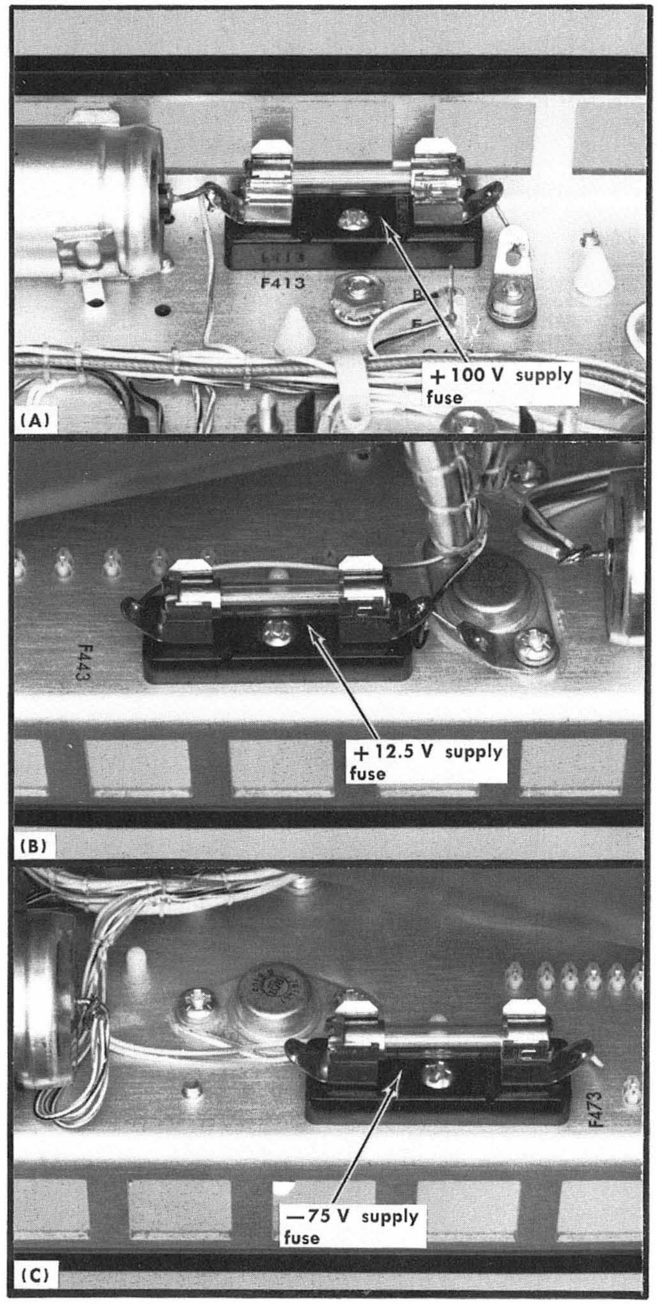


Fig. 4-12. Location of supply fuses (A) +100 volts (B) +12.5 volts and (C) —75 volts.

Rotary Switches. Individual wafers or mechanical parts of rotary switches are normally not replaceable. If a switch is defective, replace the entire assembly. Replacement switches can be ordered either wired or unwired; refer to the Parts List for the applicable part numbers.

When replacing a switch, tag the switch terminals and leads with corresponding identification tags as a guide for installing the new switch. An alternate method is to draw a sketch of the switch layout and record the wire color at each terminal. When soldering to the new switch, be careful that the solder does not flow beyond the rivets on the switch terminals. Spring tension of the switch contact can be destroyed by excessive solder.

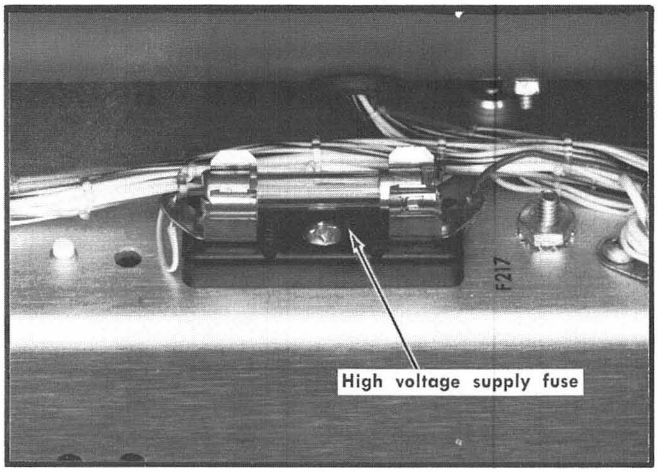


Fig. 4-13. Location of high voltage supply fuse.

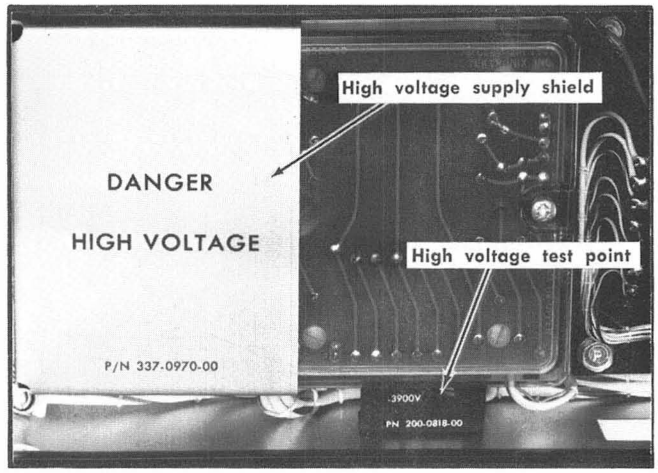


Fig. 4-14. Location of high voltage supply shield and test point.

TABLE 4-5

Fuse	Value	Location
F217	1 A	Mounted in clips on chassis opposite high voltage compartment.
F401	1 A	Mounted in fuseholder near top of rear panel.
F413	1/4 A	Mounted in clips at top of left chassis between Power Supply and Z Axis Circuit Boards.
F443	1 A	Mounted in holder at top of left chassis. (CRT side of chassis opposite Power Supply Circuit Board).
F473	1/4 A	Mounted in holder at top of left chassis. (CRT side of chassis opposite Power Supply Circuit Board.)

Power Transformer Replacement. The power transformer in this instrument is warranted for the life of the instrument. If the power transformer becomes defective, contact your local Tektronix Field Office or representative for a warranty replacement (see the Warranty note in the front of this manual). Be sure to replace only with a direct replacement Tektronix transformer.

When removing the transformer, tag the leads with the corresponding terminal numbers to aid in connecting the new transformer. After the transformer is replaced, check, the performance of the complete instrument using the Performance Check procedure.

High-Voltage Compartment. The components located in the high-voltage compartment can be reached for maintenance or replacement by using the following procedure.

Remove the two hexagonal nuts under the chassis that hold the high voltage transformer shield (Fig. 4-14) in place.

Lift the shield away from the high voltage compartment.

Remove the 3 cover screws.

Lift off the plastic cover.

The entire high voltage assembly can now be lifted out of the plastic compartment for access to the components.

Recalibration After Repair

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuit. Since the low voltage supply affects all circuits, calibration of the entire instrument should be checked if work has been done in the low voltage supply or if the power transformer has been replaced. The Performance Check procedure in Section 5 provides a quick and convenient means of checking instrument operation.

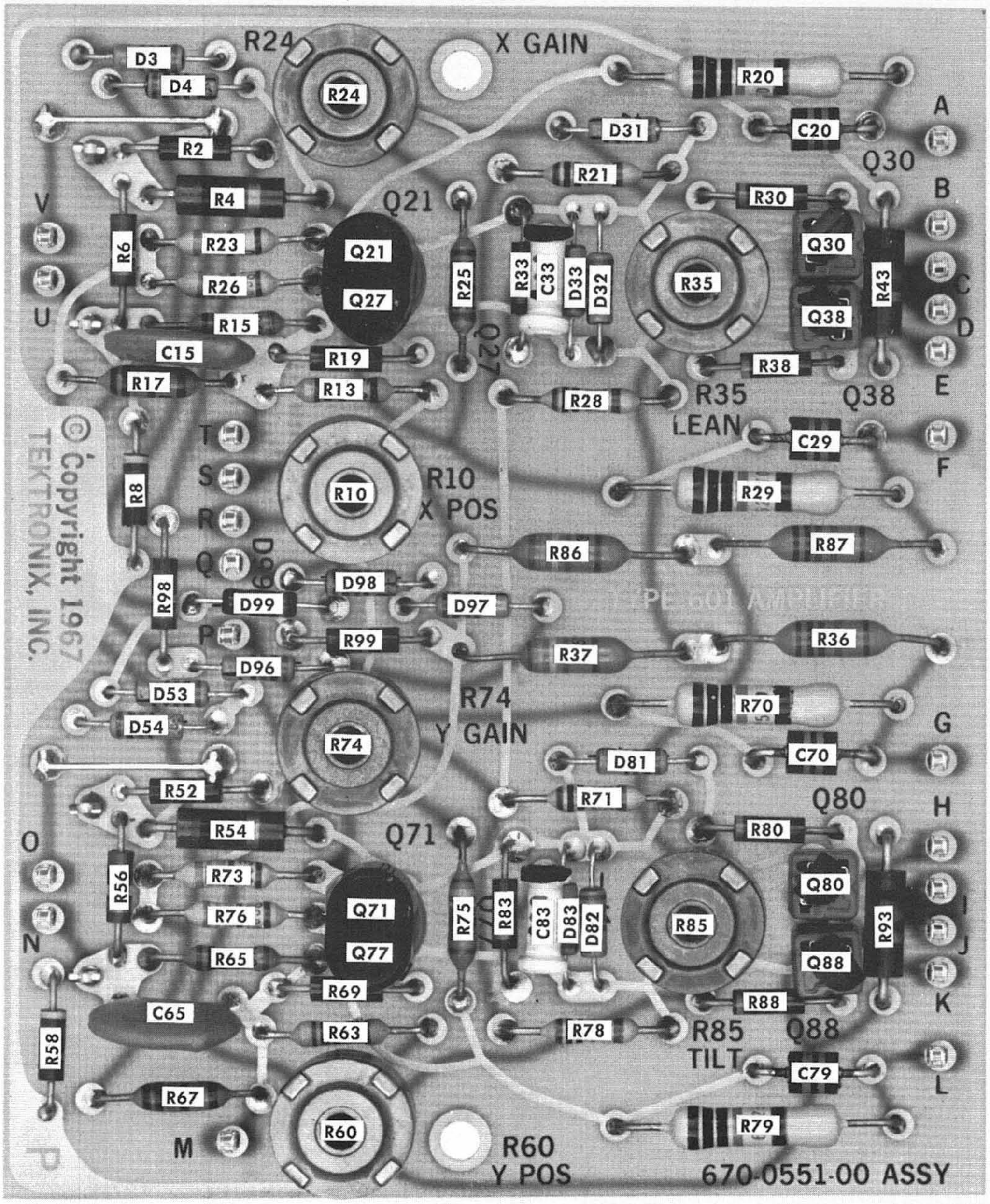


Fig. 4-15. Deflection Amplifier Circuit Board.

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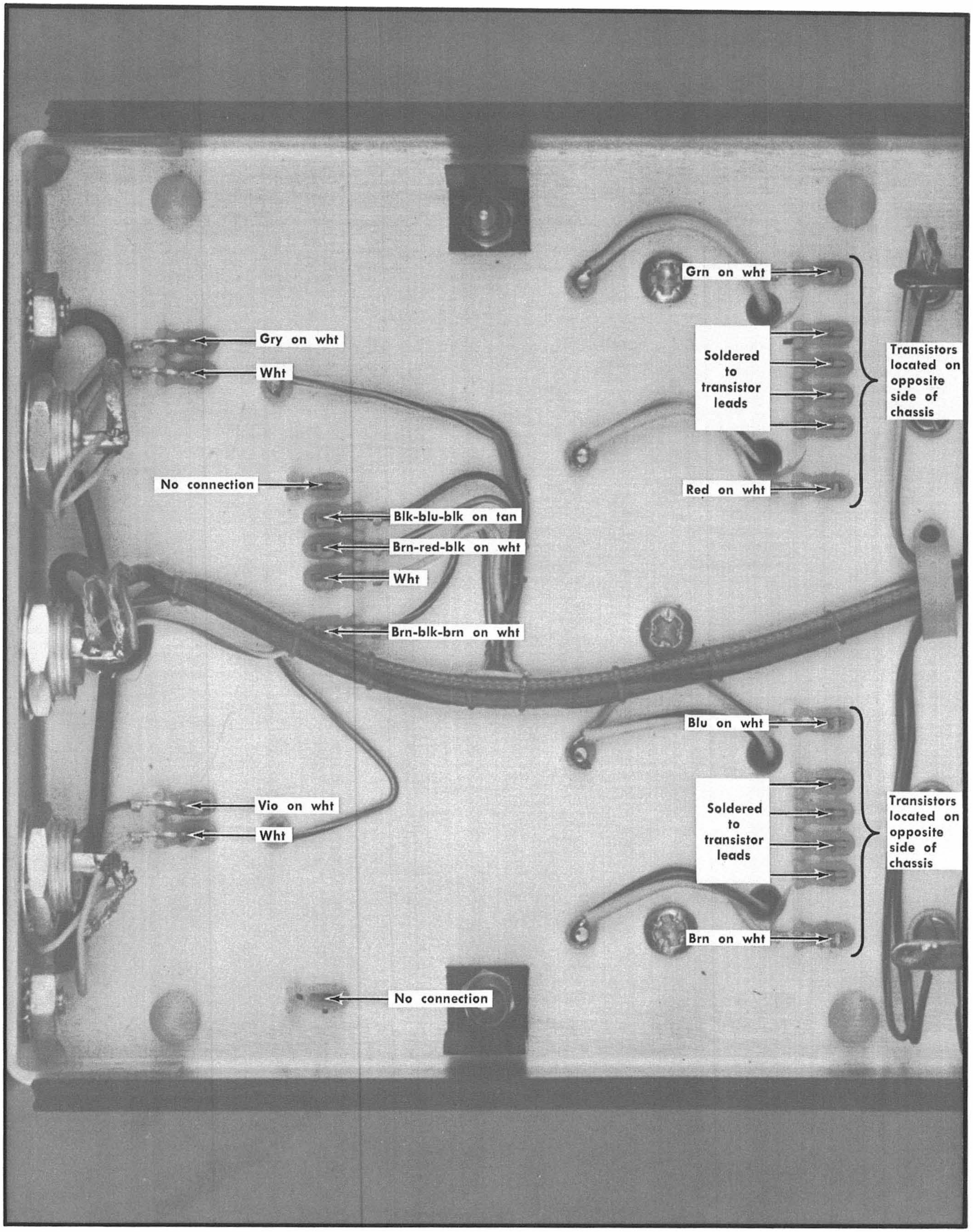

Fig. 4-16. Connecting pins and wire colors, Deflection Amplifiers.

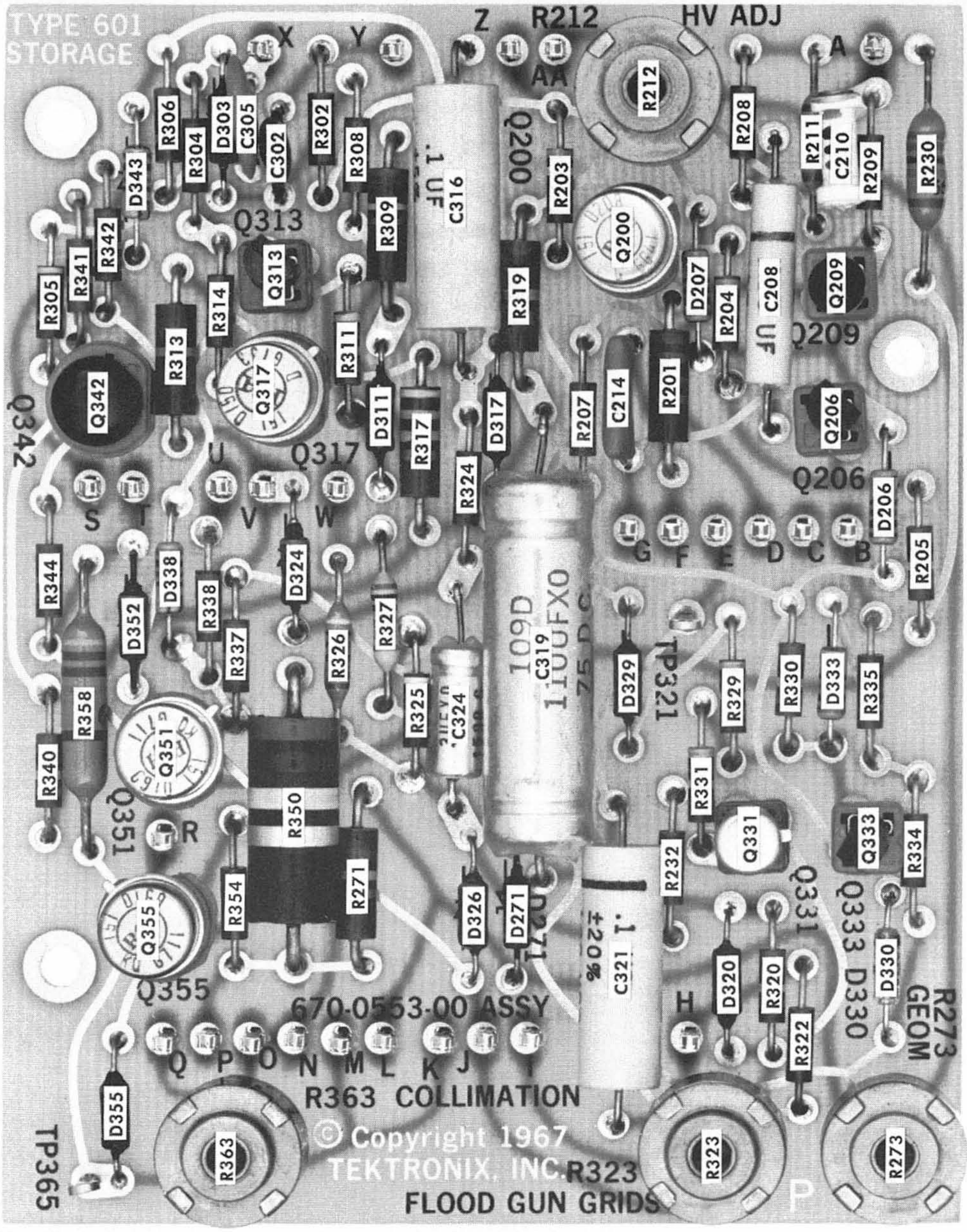

Fig. 4-17. Storage Circuit Board.

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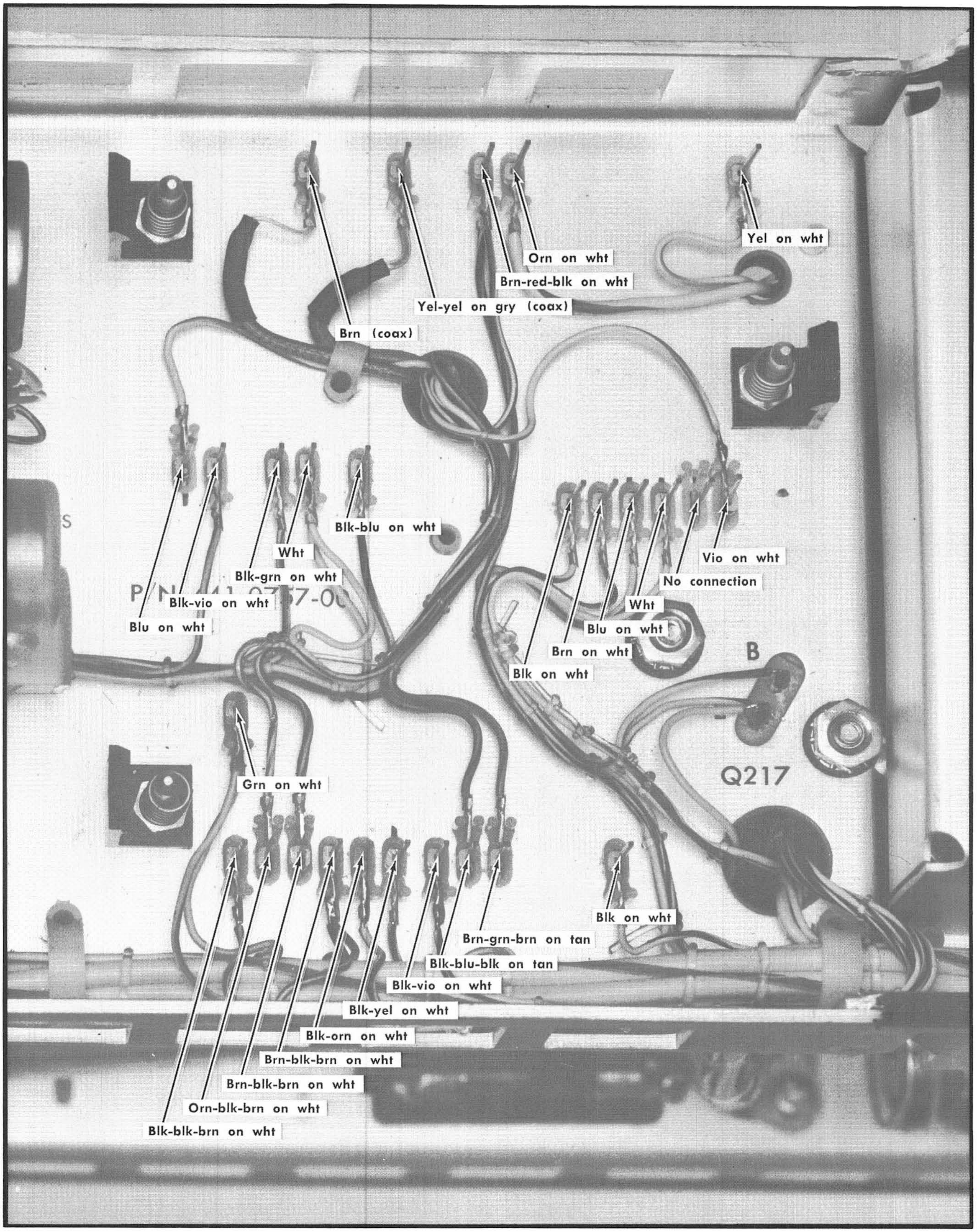

Fig. 4-18. Connecting pins and wire colors, Storage.

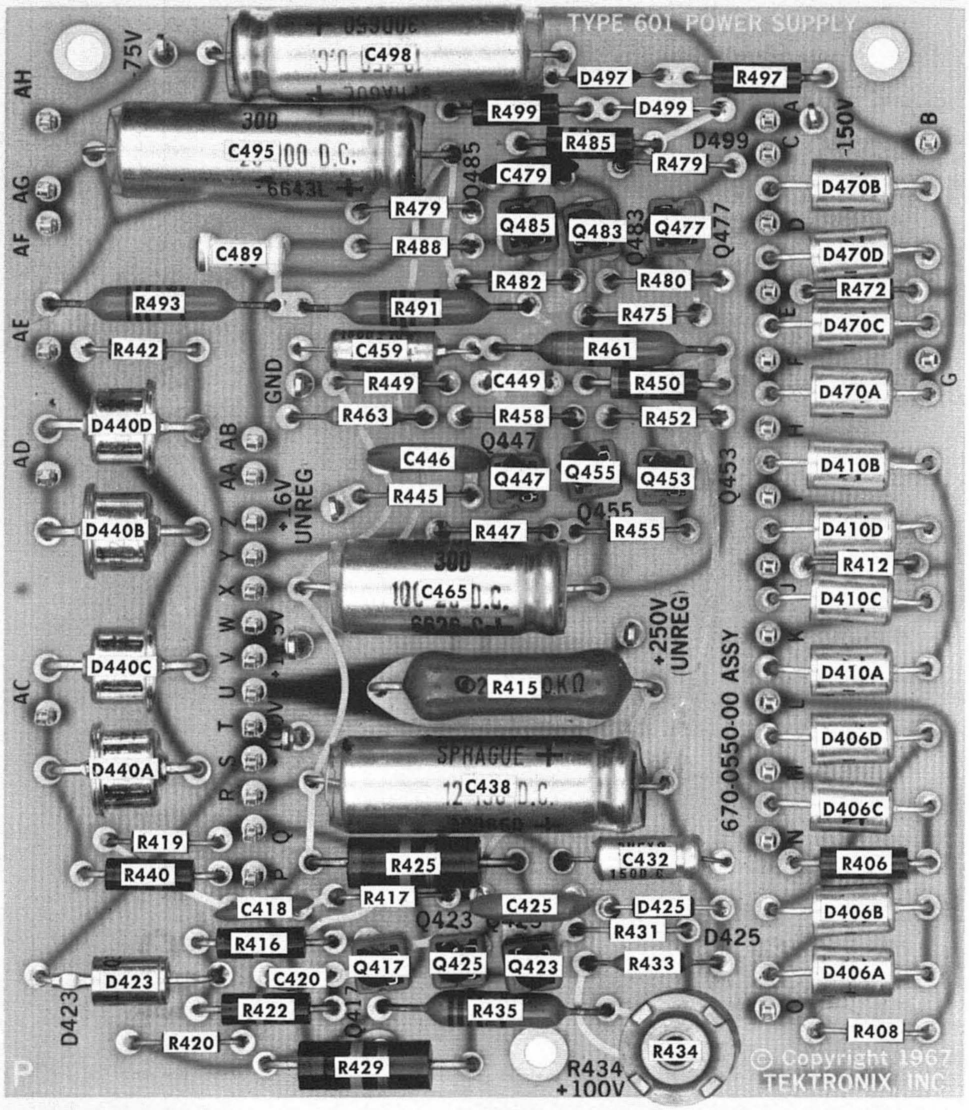

Fig. 4-19. Power Supply Circuit Board.

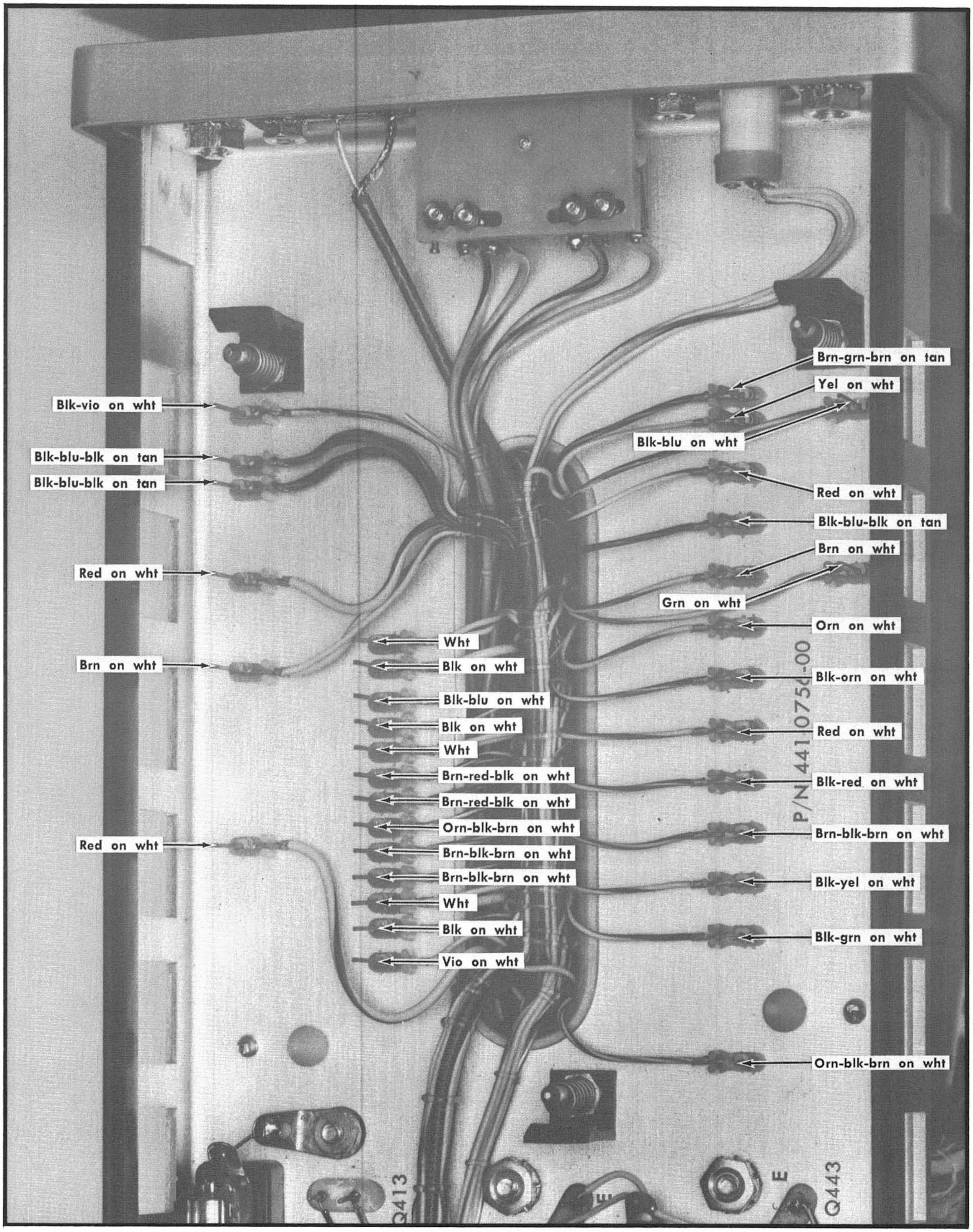

Fig. 4-20. Connecting pins and wire colors, Power Supply.

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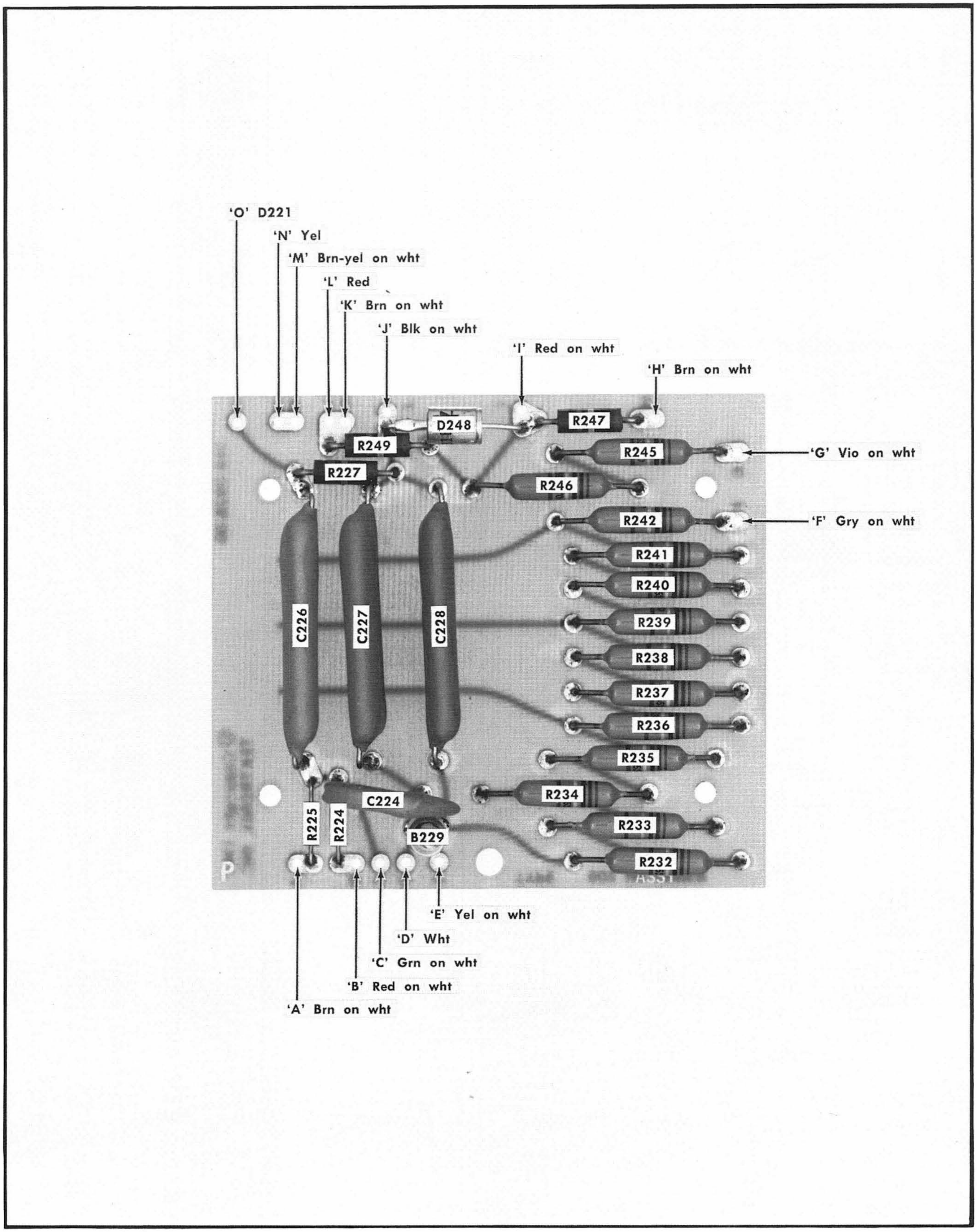

Fig. 4-21. Upper High Voltage Circuit Board.

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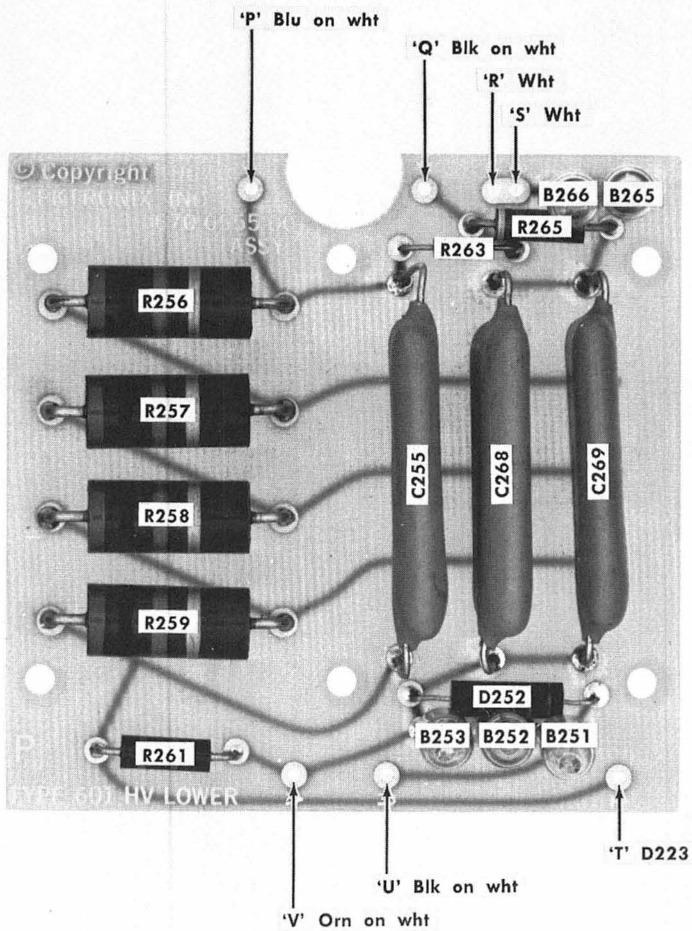

Fig. 4-22. Lower High Voltage Circuit Board.

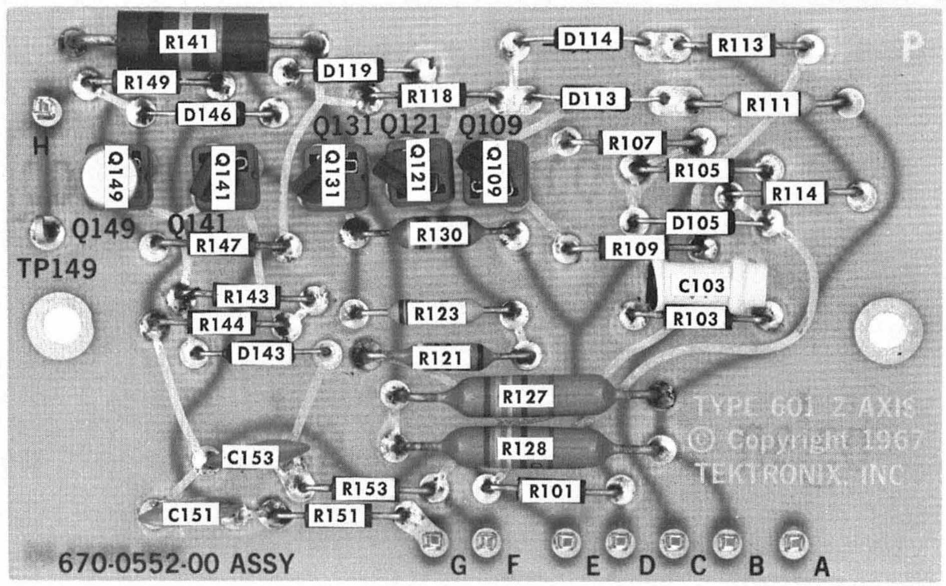

Fig. 4-23. Z Axis Circuit Board.

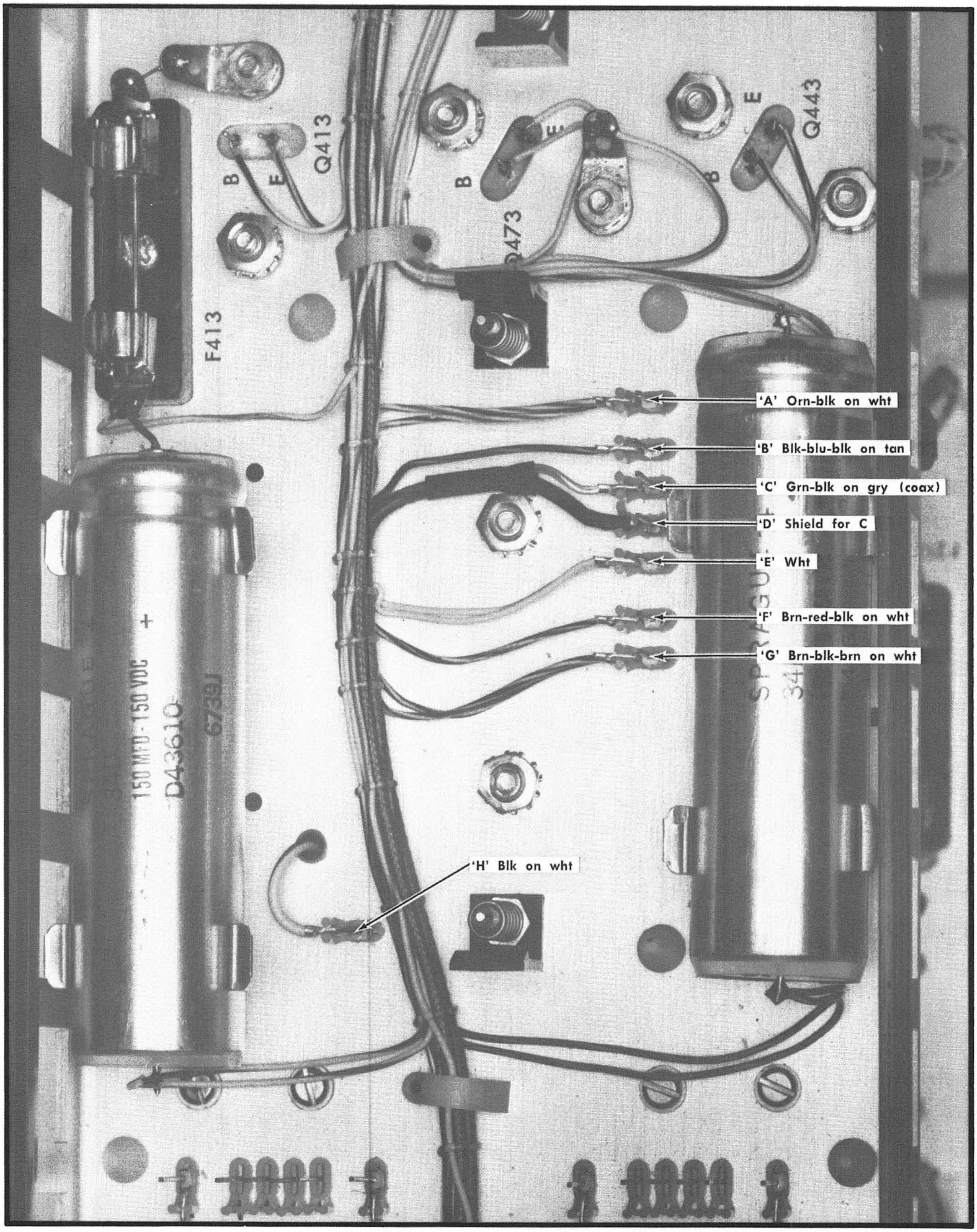

Fig. 4-24. Connecting pins and wire colors, Z Axis.

NOTES

SECTION 5
PERFORMANCE CHECK

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type 601. It is intended to check the calibration of the instrument without the need for performing the complete Calibration Procedure. The Performance Check does not provide for the adjustment of any internal controls (those behind the front-panel access door and on the Deflection Amplifier circuit board excepted). Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer either to the Calibration Procedure in Section 6 of this manual, or to the Maintenance Section.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the original specifications. If equipment is substituted it must meet the specifications of the recommended equipment.

For the most accurate and convenient performance check, special calibration fixtures are used in this procedure. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Test oscilloscope. Dual time-base, DC to at least 10 MHz. Minimum deflection factor, 0.2 volts/division; sweep rates, 1.0 millisecond/division to 0.5 microsecond/division. Must be capable of supplying a 100- to 150-volt sawtooth and a +1- to +50-volt gate output. Tektronix Type 547 with Type 1A1 Dual Trace plug-in recommended.

2. Sawtooth Attenuator. Must be capable of attenuating a 100- to 150-volt sweep sawtooth to one-volt amplitude. Tektronix Calibration Fixture 067-0569-00, or equivalent.

3. Standard amplitude calibrator. Amplitude accuracy, within 0.25%; signal amplitude, five millivolts to 50 volts; output signal, one kilohertz square-wave, positive and negative DC voltage. Tektronix Calibration Fixture 067-0502-00 recommended.

4. Low-Frequency sine-wave generator. Frequency, 100 kilohertz; output amplitude, variable from zero to one volt peak to peak; amplitude accuracy, within 3%. For example, General Radio 1310-A Oscillator (use a General Radio Type 274 QBJ Adapter to provide BNC output).

5. Coaxial cables (three). Impedance, 50-ohm; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-00.

6. Patch cord. Length, 18 inches. Banana terminal on one end, BNC on the other. Tektronix Part No. 012-0091-00.

7. Terminations (two). Impedance, 50-ohm; accuracy, ±3%, connectors, BNC. Tektronix Part No. 011-0049-00.

8. T connector, BNC. Tektronix Part No. 103-0030-00.

9. Test graticule. 8 cm x 10 cm, divided into 1 cm divisions. For example, Tektronix Part No. 331-0097-00.

10. Screwdriver. Three-inch blade. Tektronix Part No. 003-0192-00.

PERFORMANCE CHECK PROCEDURE

General

In the following procedure, test equipment connections or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the equipment listed under Recommended Equipment. If substitute equipment is used, control setting or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Remove the Type 601 from its case.

2. Connect the Type 601 to a power source which meets its voltage and frequency requirements.

3. Check that the INTENSITY control is fully counterclockwise, then push the Type 601 power switch to ON. Allow at least one minute warm up at 25°C, ±5°C, for checking the instrument to the given accuracy.

4. Depress the ERASE button to prepare the storage target.

NOTE

For this Performance Check, it is necessary to adjust the controls on the Deflection Amplifier circuit board. These controls are shown in Fig. 5-1.

DO NOT TOUCH any of the other internal controls. If controls other than those shown in Fig. 5-1 are adjusted, complete recalibration of the Type 601 may become necessary.

1. Check Beam Turn-On and Shut-Off Levels

REQUIREMENT—Turn-On Level is $\geq +1$ volt; Shut-Off Level is $\leq +0.5$ volts.

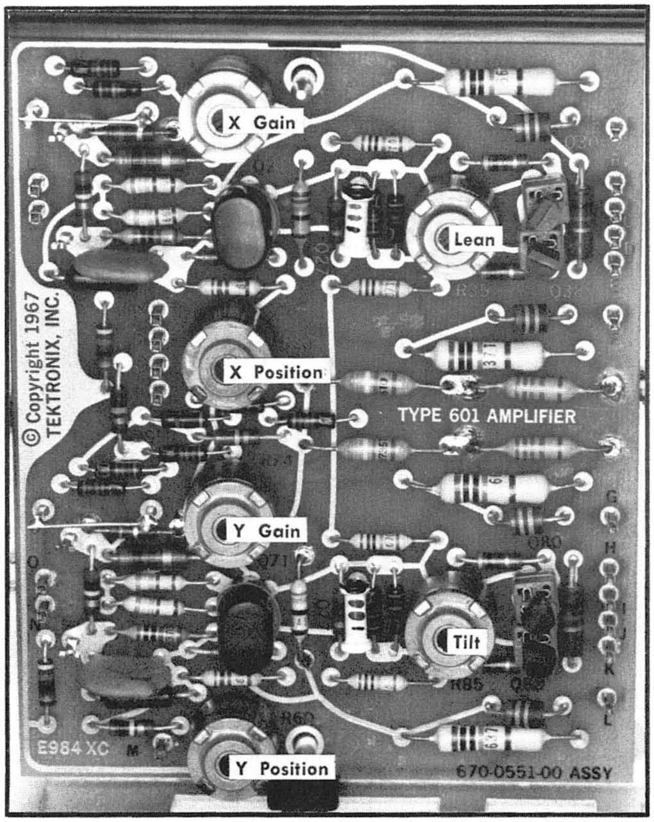

Fig. 5-1. Deflection Amplifier circuit board, showing locations of internal controls that are to be adjusted in this performance check procedure.

a. Connect a 50-ohm termination to each of the X and Y INPUT connectors.

b. Connect the standard amplitude calibrator output to the Z INPUT, using a 50-ohm coaxial cable.

c. Set the standard amplitude calibrator for a 1-volt, +DC output and rotate the Type 601 INTENSITY control clockwise until a spot appears. The spot should be of medium brightness.

CAUTION

If the intensity is set too high, it may result in damage to the CRT phosphors.

d. Set the standard amplitude calibrator amplitude switch to 0.5 volts.

e. CHECK—Spot must disappear. Indicates a beam shut-off level of $\leq$+0.5 volts.

f. Set the standard amplitude calibrator amplitude switch to 1 volt.

g. CHECK—Spot must appear. Indicates a beam turn-on level of at least +1 volt.

h. Set the standard calibrator amplitude switch to 0.5 volts and check that the spot can be made visible by rotating the INTENSITY control clockwise, then turn the INTENSITY control counterclockwise.

i. Remove the standard amplitude calibrator signal.

2. Check Tilt and Lean

REQUIREMENT—Horizontal trace parallel to horizontal graticule lines, vertical trace parallel to vertical graticule lines.

a. Set the test oscilloscope controls as follows:

Horizontal Display	B
Normal-Single Sweep	Normal
A Time Base	
Triggering Mode	Auto
Time/cm	0.5 ms
B Time Base	
Triggering Level	0
Triggering Mode	Trig
Triggering Slope	+
Triggering Coupling	AC
Triggering Source	Int
Time/cm	1.0 ms
Vertical Amplifier	
Mode	Ch 1
Volts/cm	0.2
Input Selector	AC

b. Connect the sweep attenuator test fixture into the test oscilloscope Sweep A binding post and connect the ground lead. Connect a 50-ohm coaxial cable from the test fixture to the test oscilloscope Ch 1 Input. Adjust the B Triggering Level control for a stable display.

c. Adjust the A Time/cm Variable control and test fixture amplitude control for a ramp 10 centimeters long and 5 centimeters high. See Fig. 5-2. This represents a 10 millisecond sawtooth, one volt in amplitude, which will be used to sweep the Type 601.

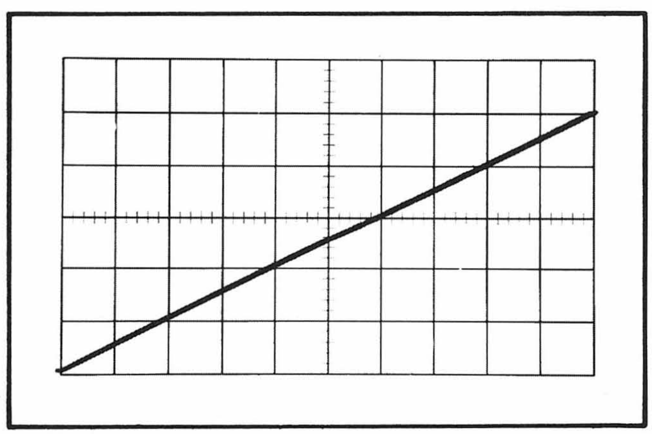

Fig. 5-2. Test oscilloscope display showing 10-millisecond, one-volt sawtooth.

d. Disconnect the cable between the test fixture and Ch 1 Input and attach a T connector to the test fixture. Connect two cables to the T connector; connect one to the X INPUT and the other to the Y INPUT. Connect a patch cord from the test oscilloscope +Gate A binding post to the Z INPUT connector.

e. Adjust INTENSITY, FOCUS and ASTIGMATISM for a well-defined diagonal line of medium brightness.

f. Disconnect the cable between the T connector and Y INPUT and attach a 50-ohm termination to the Y INPUT connector.

g. Remove the plastic mask from the CRT face and place the test graticule in front of the Type 601 screen. Align the graticule edges with the edges scribed on the protection shield, and secure the graticule in place. Position the trace to graticule center with the Y Position control shown in Fig. 5-1.

h. CHECK—The trace should be parallel to the center horizontal line.

i. If necessary, adjust the Tilt control (Fig. 5-1) so that the trace is parallel to the horizontal graticule lines.

j. Reposition the horizontal trace to the bottom graticule line.

k. Move the sawtooth signal from the X INPUT to the Y INPUT and the 50-ohm termination from the Y INPUT to the X INPUT.

l. Position the vertical trace to the graticule center with the X Position control (Fig. 5-1).

m. CHECK—The trace should be parallel to the center vertical line.

n. If necessary, adjust the Lean control (Fig. 5-1) so that the trace is parallel to the vertical graticule lines.

o. Reposition the vertical trace to the left-hand edge of the graticule, set the test oscilloscope Normal-Single Sweep switch to Single Sweep and erase the Type 601 by pushing the ERASE button.

3. Check Geometry

REQUIREMENT—Bowing is ≤1 mm on both X and Y axes.

a. Remove the 50-ohm termination from the X INPUT, then connect a 50-ohm coaxial cable from the standard amplitude calibrator output connector to the X INPUT connector.

b. Set the standard amplitude calibrator for a 0.5-volt square-wave output.

c. Set the test oscilloscope Normal-Single Sweep switch to Normal and adjust the X Gain control (Fig. 5-1) for 5 centimeters of display. Position the left edge of the display to the left-hand edge of the graticule.

d. Set the standard amplitude calibrator for a 10-millivolt square-wave output.

e. CHECK—Bowing of display must not exceed 1 mm. See Fig. 5-3.

f. Position the display to the right-hand edge of the graticule and check geometry as in step e.

g. Reposition the display to the left-hand edge of the graticule, move the sawtooth signal to the X INPUT and the calibrator signal to the Y INPUT.

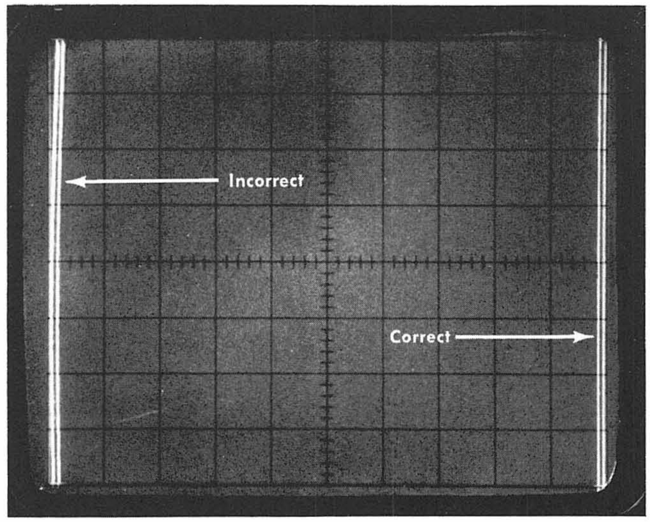

Fig. 5-3. Typical display when checking geometry.

h. Set the standard amplitude calibrator for a 0.5-volt square-wave output and adjust the Y Gain control (Fig. 5-1) for 5 centimeters of display. Position the bottom of the display to the bottom graticule line.

i. Set the standard amplitude calibrator for a 10-millivolt square-wave output and check geometry on the bottom line of the graticule, then on the top line.

j. CHECK—Bowing of display must not exceed 1 mm.

k. Position the horizontal trace to the bottom graticule line, set the test oscilloscope Normal-Single Sweep switch to Single Sweep and erase the Type 601 display.

4. Check Horizontal Stored Resolution

REQUIREMENT—Horizontal resolution is ≥125 line pairs in 10 centimeters.

a. Remove the sawtooth signal from the X INPUT and apply it to the test oscilloscope Ch 1 Input.

b. Change the test oscilloscope controls as follows:

Normal-Single Sweep	Normal
A Time/cm	0.1 ms
B Time/cm	0.5 ms

c. Adjust the A Time/cm Variable control for a ramp 3.2 centimeters long. See Fig. 5-4. This represents a 1.6-millisecond sweep sawtooth.

d. Set the Type 601 X and Y Gain controls for 8 centimeters of deflection on both axes as follows:

1. Connect a 50-ohm termination to the X INPUT. The standard amplitude calibrator signal should still be connected to the Y INPUT.

2. Set the standard-amplitude calibrator for a 1-volt square wave output.

3. Adjust the Y Gain and Y Position controls so that the two displayed dots are 8 centimeters apart; one on the top graticule line and one on the bottom graticule line.

4. Move the calibrator signal to the X INPUT and the 50-ohm termination to the Y INPUT.

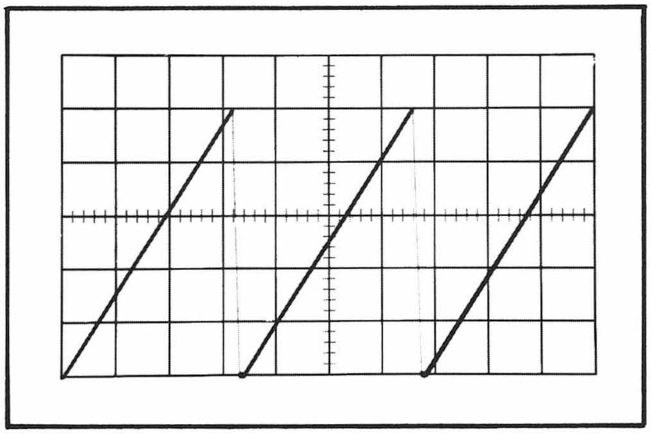

Fig. 5-4 Test oscilloscope display showing 1.6-millisecond, one-volt sawtooth.

5. Adjust the X Gain and X Position controls so that the two displayed dots are 8 centimeters apart; one on the left-hand edge of the graticule and one 2 centimeters from the right-hand edge of the graticule.

6. Remove the 50-ohm termination from the Y INPUT.

e. Apply the 1.6-millisecond, one-volt sawtooth to the Y INPUT.

f. Set the standard amplitude calibrator for a 5-millivolt +DC output.

g. Set the test oscilloscope Normal-Single Sweep switch to Single Sweep and erase the Type 601.

h. Write a single trace by pressing the Normal-Single Sweep switch down to Reset, then set the standard amplitude calibrator for a 5-millivolt —DC output and write another single trace parallel to the first trace. (It may be necessary to slightly increase the INTENSITY setting while performing this step).

i. CHECK—Two stored lines with no bridging of the traces. See Fig. 5-5A. Clean separation of the stored lines indicates a resolution of at least 125 line pairs horizontally (with horizontal deflection adjusted to 1 V/8 cm, or 125 mV/cm, line pairs written 10 mV apart represent 12.5 line pairs per centimeter, or 125 line pairs in 10 centimeters).

5. Check Vertical Line Writing Rate

REQUIREMENT—Line will write at a rate of 5 cm/ms.

a. CHECK—Lines written in step 4 store cleanly. Storage of a 1.6-millisecond sweep in 8 centimeters indicates a line writing speed of 5 cm/ms. This can be checked anywhere within the 8 X 10 cm quality area by positioning with the X position control and writing single traces.)

b. Erase the Type 601 display.

6. Check Vertical Stored Resolution

REQUIREMENT—Vertical resolution is $\geq$100 line pairs in 8 centimeters.

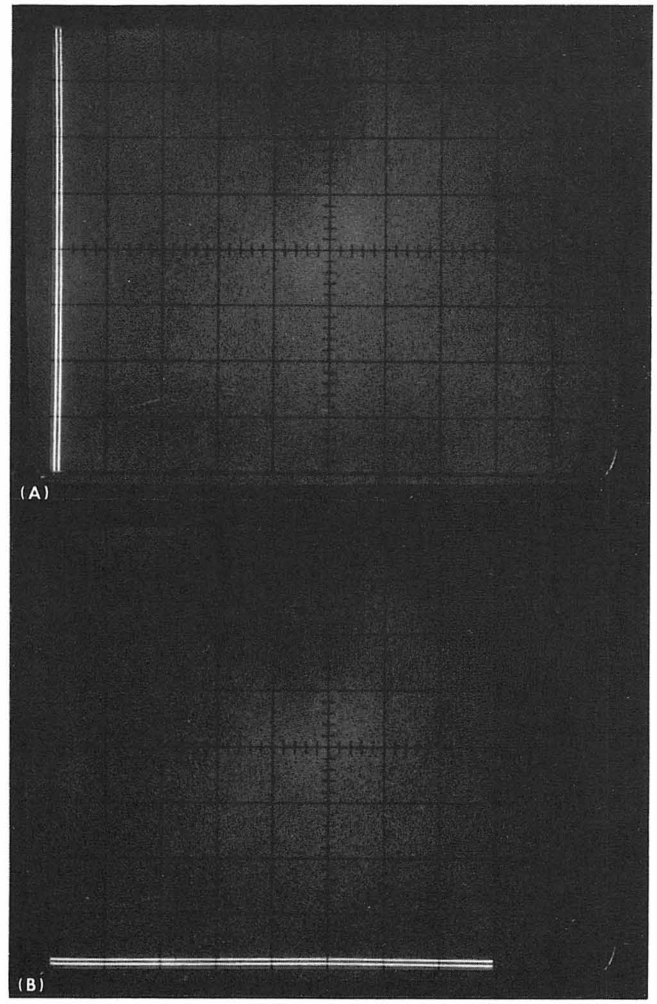

Fig. 5-5. Typical display when checking (A) horizontal resolution and (B) vertical resolution.

a. Move the sawtooth signal to the X INPUT and the calibrator signal to the Y INPUT.

b. Write a single trace by pressing the Normal-Single Sweep switch down to Reset, then set the standard amplitude calibrator for a 5-millivolt +DC output and write another single trace parallel to the first trace.

c. CHECK—Two stored lines with no bridging of the traces. See Fig. 5-5B. Clean separation of the stored lines indicates a resolution of at least 100 line pairs vertically.

7. Check Horizontal Line Writing Rate

REQUIREMENT—Line will write at a speed of 5 cm/ms.

a. CHECK—Lines written in step 6 store cleanly.

b. Erase the Type 601 display and remove the signals from the X and Y INPUTS.

8. Check Dot Writing Time

REQUIREMENT—Dot writing time is $\leq$9 microseconds.

Ⓐ

a. Remove the + Gate A signal from the Z INPUT and apply it to the test oscilloscope Ch 1 Input.

b. Change the test oscilloscope controls as follows:

Normal-Single Sweep	Normal
A Time/cm	0.5 μs
B Time/cm	1.0 μs
Volts/cm	5.0

c. Adjust the A Time/cm Variable control so that the pulse duration is 9 microseconds at the 50% amplitude points. See Fig.5-6.

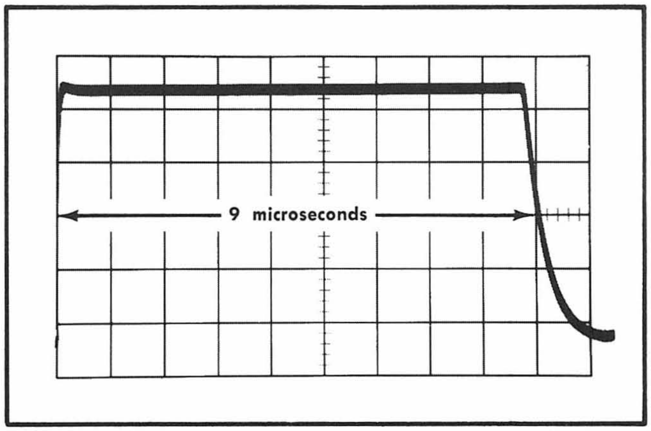

Fig. 5-6. Test oscilloscope display showing 9-microsecond pulse.

d. Connect a 50-ohm termination to each of the X and Y INPUTS.

e. Set the Normal-Single Sweep switch to Single Sweep and move the +Gate A signal from the test oscilloscope Ch 1 Input to the Type 601 Z INPUT.

f. Press the Normal-Single Sweep switch down to Reset repeatedly to write dots within the 8 X 10 cm quality area while adjusting the X and Y Position controls. Slight adjustment of the INTENSITY control may be necessary.

g. CHECK—Each time the Reset switch is operated, a dot should write and store.

h. Set the Normal-Single Sweep switch to Normal and position the dot to the lower left-hand corner of the screen.

i. Remove the 50-ohm terminations from the X and Y INPUTS and erase the Type 601 display.

9. Check Amplifier Gains

REQUIREMENT—1 volt/full scale.

a. Connect a T connector to the standard amplitude calibrator output connector. Connect two 50-ohm coaxial cables to the T connector; connect one each to the X and Y INPUT connectors.

b. Set the standard amplitude calibrator for a 1-volt square-wave output.

c. Adjust the X Gain control (Fig. 5-1) so that one dot touches the left-hand graticule edge and the other dot touches the right-hand graticule edge. Adjust the X Position control as necessary. See Fig. 5-7.

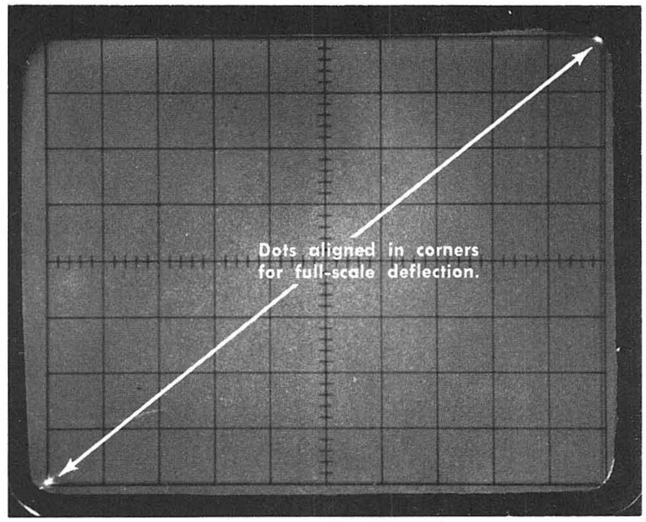

Fig. 5-7. Typical display when checking gain.

d. Adjust the Y Gain control so that one dot touches the top graticule line and the other dot dot touches the bottom graticule line. Adjust the Y Position control as necessary.

e. Remove the calibrator signal and erase the display.

10. Check Y-T Capability

REQUIREMENT—$\leq$100 kHz without significant distortion.

a. Change the test oscilloscope controls as follows:

Time base A

Triggering Mode	Trig
Triggering Source	Ext
Time/cm	20 μs

b. Connect a T connector to the low-frequency oscillator output and connect two 50-ohm coaxial cables to the T connector; connect one cable to the Type 601 Y INPUT and the other cable to the test oscilloscope Time Base A Trigger Input.

c. Apply the one-volt sawtooth from the test oscilloscope Sweep A binding post and sawtooth attenuator to the Type 601 X INPUT.

d. Set the low-frequency oscillator for a 100-kHz output. Adjust the test oscilloscope Time Base A Triggering Level control for a stable display on the Type 601 screen.

e. Adjust the Y Position control to center the display, then adjust the low-frequency oscillator output level for a display amplitude of about 4 centimeters.

f. CHECK—No significant distortion of display (ignore sweep retrace). See Fig. 5-8.

g. Remove the sawtooth signal from the X INPUT.

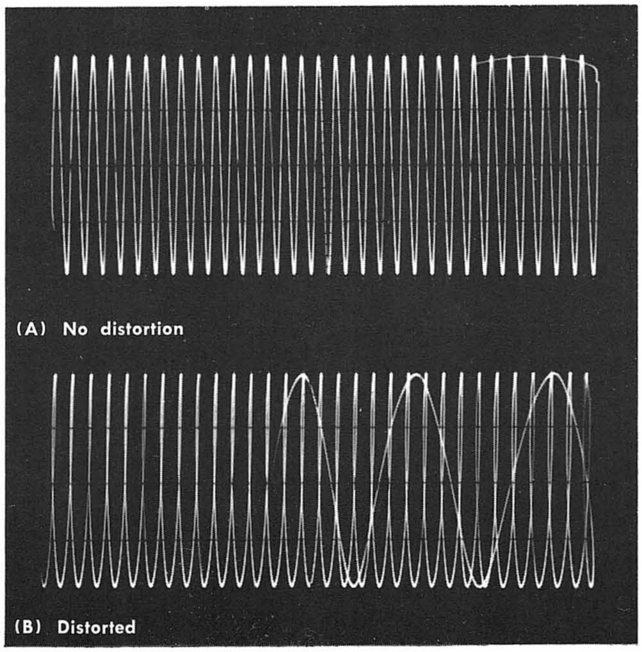

Fig. 5-8. Typical display when checking Y-T capability.

11. Check Phase Difference

REQUIREMENT—Within 1° between X and Y to 100 kHz.

a. Move the oscillator signal from the test oscolloscope to the Type 601 X INPUT. The oscillator should still be connected to the Y INPUT.

b. Change the test oscilloscope Time Base A Triggering Mode to Auto and Source to Int.

c. Adjust the positioning controls and oscillator output level control so that the display is a diagonal line running from the lower left-hand corner of the graticule to the upper right-hand corner.

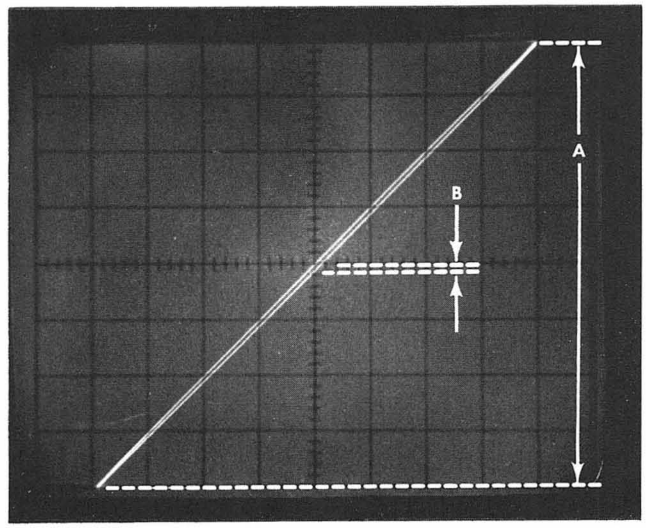

Fig. 5-9. Typical display when checking phase difference.

d. Adjust X Gain so the horizontal display width is 8 centimeters. See Fig. 5-9.

e. CHECK—Measurement B, shown in Fig. 5-9, is $\leq$1.39 mm. This indicates a phase difference of $\leq$1° between the X and Y Amplifiers. No opening in the line indicates 0° phase shift.

f. Adjust X Gain so that the horizontal display width is 10 centimeters.

g. Remove the oscillator signal and connect a 50-ohm termination to the X and Y INPUTS.

h. Using the X and Y Position controls, position the dot to the lower left-hand corner of the graticule.

i. Remove all test equipment and erase the display.

This completes the performance check procedure for the Type 601. If the instrument has met all performance requirements given in this procedure, it is correctly calibrated and within the specified tolerances.

SECTION 6
CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This calibration procedure can be used either for complete calibration of the Type 601, or as an operational check of instrument performance. Completion of every step in this procedure assures that the Type 601 will meet factory performance requirements. If it is desired to merely touch up the calibration, perform only those steps entitled Adjust . . .

NOTE

The Adjust . . . steps provide a check of instrument performance before the adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met.

General

Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in the Maintenance section of this manual.

This procedure is arranged in a sequence which allows the instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be done individually. However, some adjustments affect the calibration of other circuits within the instrument. When a step interacts with others, the steps which need to be checked will be noted.

The location of test points and adjustments is shown in each step. Waveforms which are helpful in determining the correct adjustment or operation are also shown.

EQUIPMENT REQUIRED

General

The following equipment, or its equivalent, is required for complete calibration of the Type 601. Specifications given are the minimum necessary for accurate calibration of this instrument. All test equipment is assumed to be correctly calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

Special Test Equipment

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under Equipment Required can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Equipment Needed

1. Test oscilloscope. Dual time-base, DC to at least 10 MHz. Minimum deflection factor, 0.005 volt/division. Must be capable of supplying a 100 to 150-volt sawtooth and a 1 to 50-volt gate output. Tektronix Type 547 with 1A1 Dual Trace plug-in recommended.

2. Variable autotransformer. Must be capable of supplying at least 100 watts over a voltage range of 90 to 136 volts (180 to 272 volts for 230-volt nominal line). If autotransformer does not have an AC (RMS) voltmeter to indicate output voltage, monitor output with an AC (RMS) voltmeter. For example, General Radio W10MT3W Metered Variac Autotransformer.

3. Electronic Voltmeter. Accuracy, within ±1.0%; range, 0 to 300 volts. For example, General Radio Type 1806-A.

4. DC Voltmeter. Minimum sensitivity, 20,000 ohm/volt. Simpson 262 or Triplett 630.

5. Standard amplitude calibrator. Amplitude accuracy, within 0.25%; signal amplitude, five millivolts to 50 volts; output signal, one-kilohertz square-wave, positive and negative DC voltage. Tektronix Calibration Fixture 067-0502-00 recommended.

6. Sawtooth Attenuator. Must be capable of attenuating a sweep sawtooth to one volt amplitude. Tektronix Calibration Fixture 067-0569-00, or equivalent.

7. 1× Probe. Tektronix P6011 Probe recommended. Tektronix Part No. 010-0192-00.

8. Coaxial cables (two). Impedance, 50 ohm; length, 42 inches; connectors, BNC. Tektronix Part No. 012-0057-00.

9. Patch cord. Length, 18 inches. Banana terminal on one end, BNC on the other. Tektronix Part No. 012-0091-00.

10. Terminations (two). Impedance, 50 ohm; accuracy, ±3%; connectors, BNC. Tektronix Part No. 011-0049-00.

11. T connector, BNC. Tektronix Part No. 103-0030-00.

12. Test graticule. 8 cm × 10 cm, divided into 1 cm divisions. For example, Tektronix Part No. 331-0248-00.

13. Screwdriver. Three-inch shaft. Tektronix Part No. 003-0192-00.

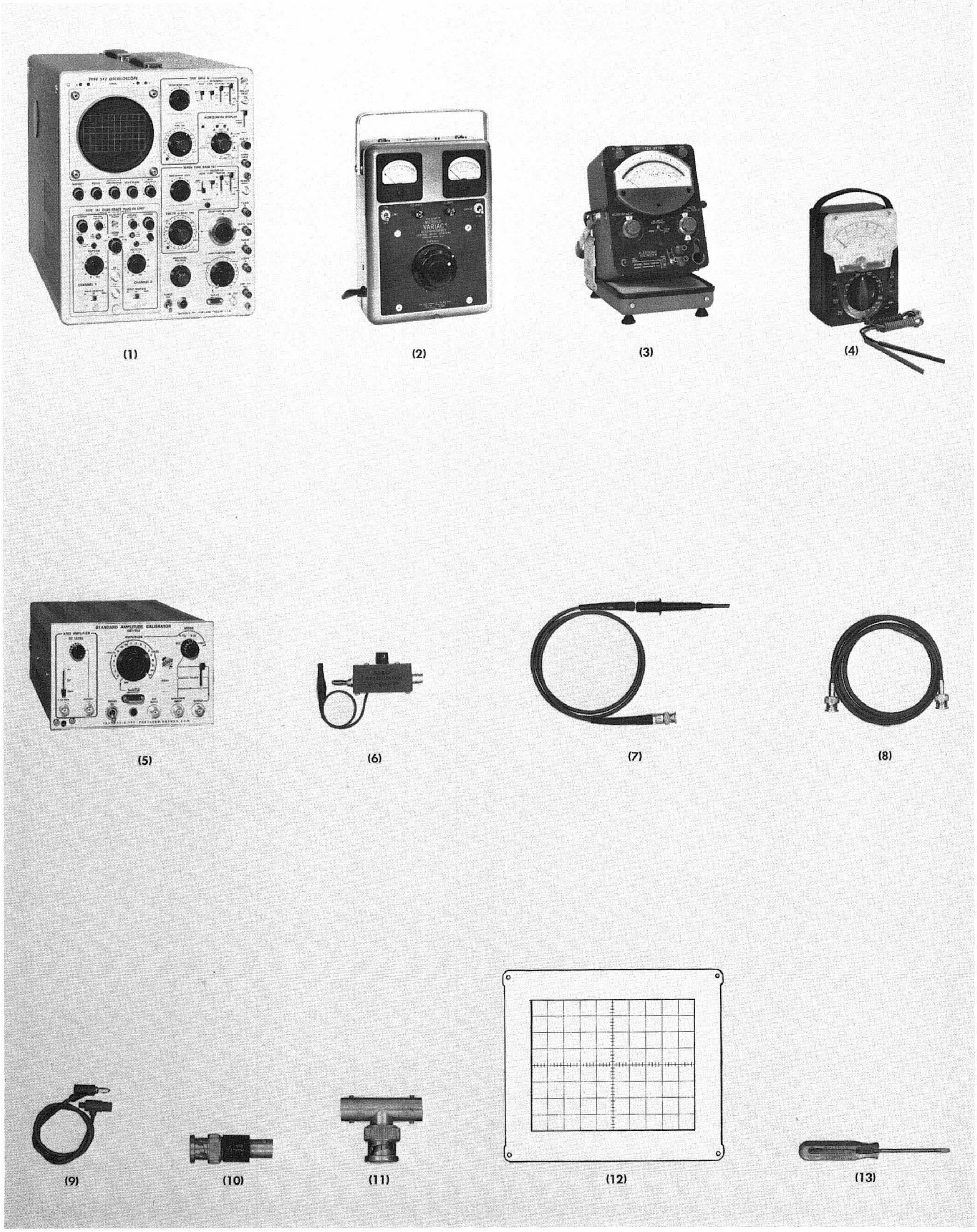

Fig. 6-1. Recommended calibration equipment.

CALIBRATION RECORD AND INDEX

This Abridged Calibration Procedure is provided to aid in checking the operation of the Type 601. It may be used as a calibration guide by the experienced calibrator, or it may be used as a calibration record. Since the step numbers and titles used here correspond to those used in the complete Calibration Procedure, the following procedure serves as an index to locate a step in the complete Calibration Procedure. Characteristics are those listed in the Characteristics section of this manual.

Type 601, Serial No. ______________________

Calibration Date ______________________

CALIBRATION PROCEDURE

General

In the following calibration procedure, a test equipment setup is shown for each major setup change. Complete control settings are listed following the picture. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

NOTE

When performing a complete recalibration, best performance will be provided if each adjustment is made to the exact setting, even if the Check is within the allowable tolerance.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Remove the Type 601 from its case.

2. Set the Line Selector to 115 V and the Range Selector to MEDIUM.

3. Connect the autotransformer to a suitable power source.

4. Connect the Type 601 power cord to the autotransformer output.

5. Set the autotransformer for a 115-volt output.

6. Check that the INTENSITY control is fully counterclockwise, then push the Type 601 power switch to ON. Allow at least one minute warm up at 25°C, ±5°C, for checking the instrument to the given accuracy.

NOTES

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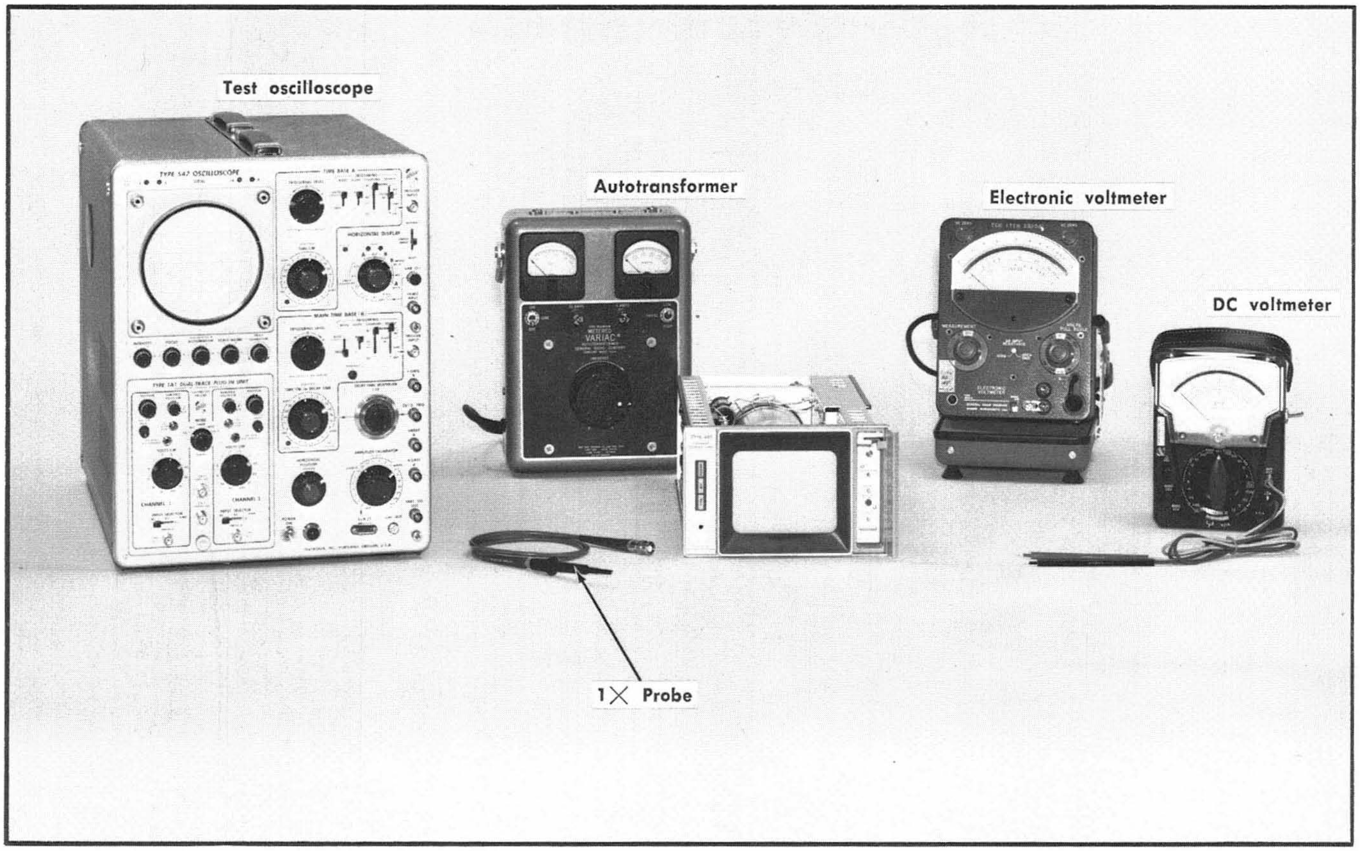

Fig. 6-2. Equipment required for steps 1 through 5.

POWER SUPPLIES

Control Settings

Type 601

INTENSITY	Full counterclockwise
FOCUS	Midrange
ASTIGMATISM	Midrange
OPERATING LEVEL	Leave as is

Test Oscilloscope (Optional—To check ripple)

Intensity	Nominal brightness
Focus	Well-defined trace
Astigmatism	Well-defined trace
Normal-Single Sweep	Normal
Horizontal Display	B
B Time Base	
Triggering Level	0
Triggering Mode	Auto
Triggering Slope	+
Triggering Coupling	AC
Triggering Source	Int
Time/cm	1 ms
Vertical Amplifier	
Mode	Ch 1
Volts/cm	0.01
Input Selector	AC

1. Adjust +100-Volt Power Supply ⓘ

a. Test equipment setup is shown in Fig. 6-2.

b. Connect the electronic voltmeter between the +100-volt test point and ground (see Fig. 6-3).

c. ADJUST—R434, +100 V (Fig. 6-3), for exactly +100 volts.

d. INTERACTION—Operation of all circuits within the Type 601 is affected by the +100-volt supply.

2. Check Low-Voltage Power Supplies

a. Connect the electronic voltmeter between each low-voltage test point and chassis ground. See Fig. 6-3 for test point locations.

b. CHECK—Each supply is within the tolerance listed in Table 6-1.

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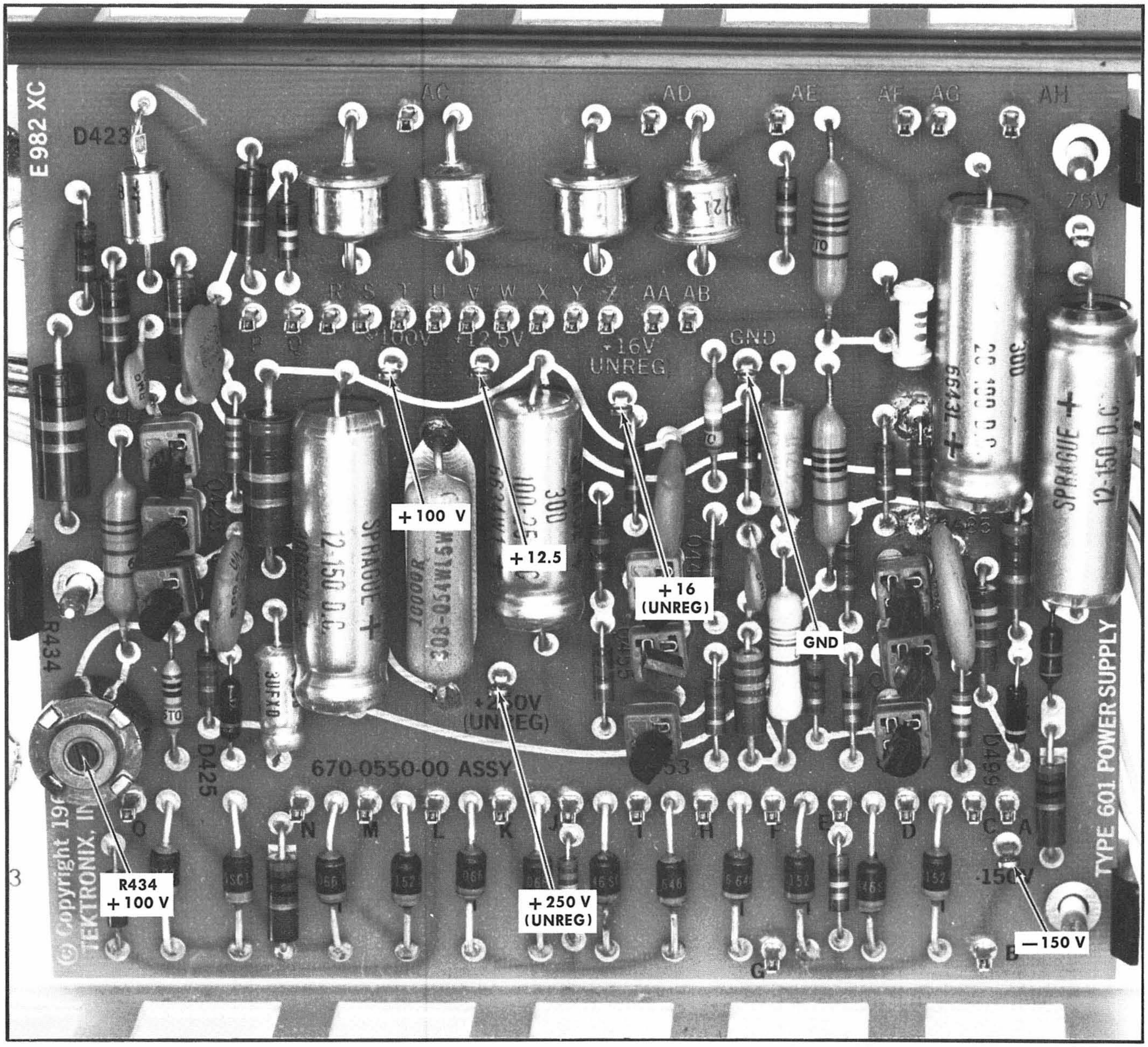


Fig. 6-3. Locations of power supply test points and R34, +100 V adjustment.

TABLE 6-1

Supply	Tolerance	Maximum Ripple
+250 V	+230 V to +280 V	——
+100 V	+98 V to +102 V	5 mV
+16 V	+14.7 V to +22.5 V	——
+12.5 V	+12.25 V to +12.75 V	5 mV
−75 V	−73.5 V to −76.5 V	5 mV
−150 V	−144 V to −159 V	——

3. Check Low-Voltage Power Supply Regulation and Ripple (Optional Check)

a. To check regulation, connect the electronic voltmeter between each low-voltage supply test point and chassis ground. To check ripple, connect the 1X probe from the test oscilloscope Channel 1 Input to each test point.

b. Set the autotransformer output to 104 VAC.

c. CHECK—Each supply output and ripple amplitude must be within the tolerance listed in Table 6-1.

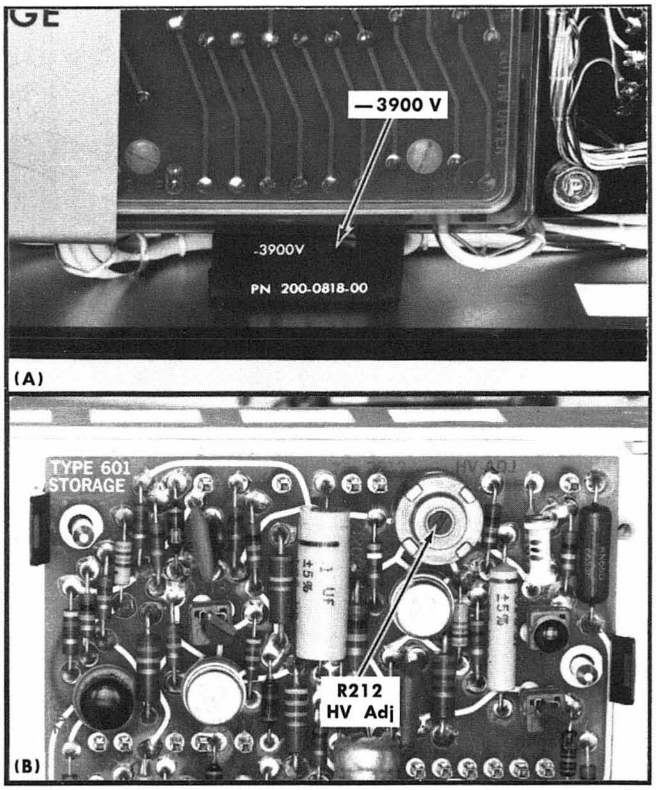


Fig. 6-4. Location of (A) —3900-volt test point, and (B) R212, High Voltage adjustment.

d. Set the autotransformer output to 126 VAC.

e. CHECK—Each supply output and ripple amplitude must be within the tolerance listed in Table 6-1.

f. Return the autotransformer output to 115 VAC and disconnect the electronic voltmeter and test oscilloscope.

4. Adjust High Voltage ⓿

a. Connect the DC voltmeter between ground and the —3900-volt test point (Fig. 6-4A).

b. ADJUST—R212, High Voltage (Fig. 6-4B), for a meter reading of exactly —3900 volts.

5. Check High Voltage Regulation (Optional Check)

a. With the DC voltmeter connected between ground and the —3900-volt test point, adjust the autotransformer for an output of 104 VAC and then to 126 VAC to check the regulation of the High-Voltage supply.

b. CHECK—Meter reading is —3900 volts, ±100 V.

c. Remove the DC voltmeter and return the autotransformer output to 115 VAC.

NOTE

The Type 601 may now be connected directly to the power source for the remainder of the calibration procedure, provided the Line Selector and Range Selector switches are set to the proper positions for the source line voltage.

NOTES

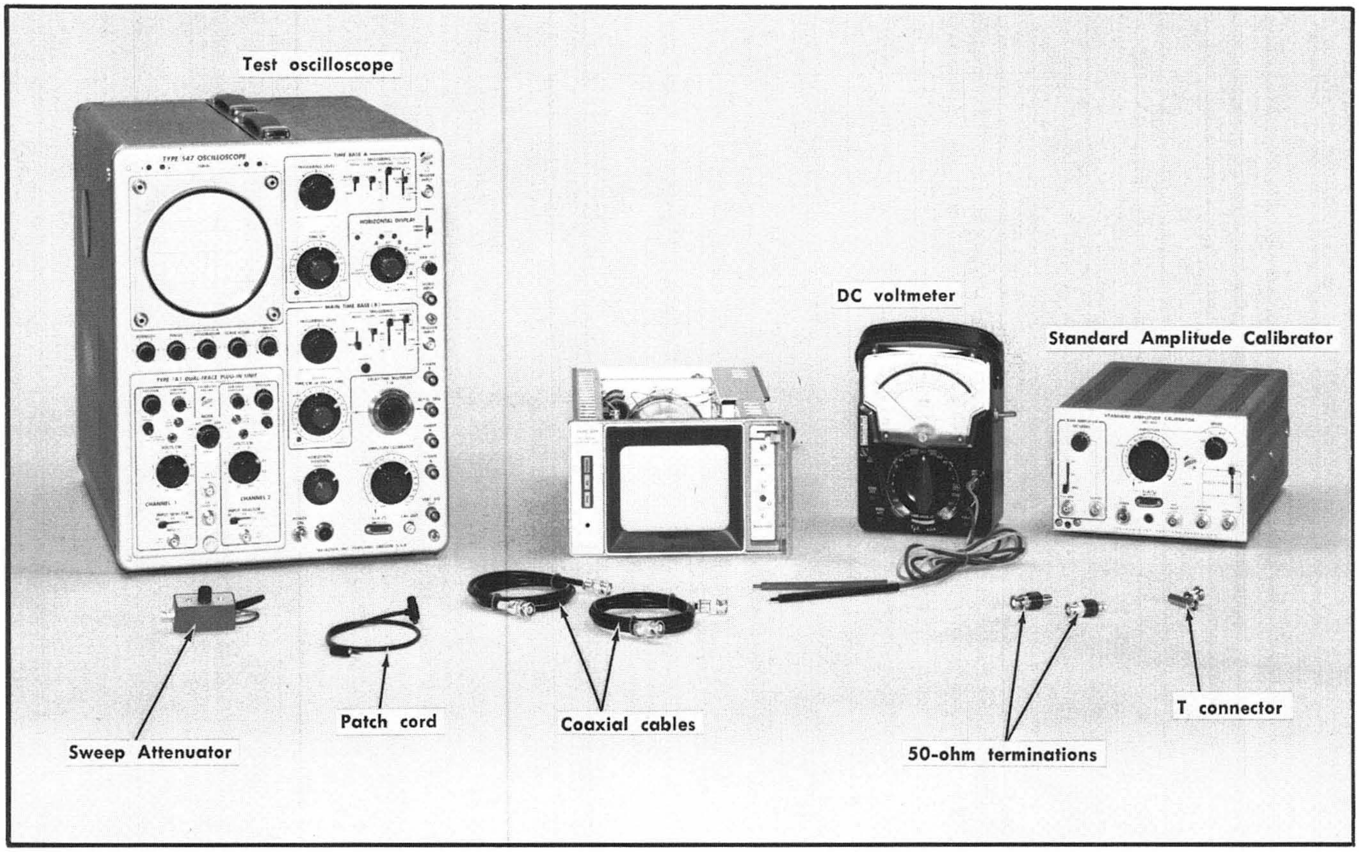


Fig. 6-5. Equipment required for steps 6 through 12.

STORAGE SYSTEM

Control Settings

Type 601

INTENSITY	Full counterclockwise
FOCUS	Midrange
ASTIGMATISM	Midrange
OPERATING LEVEL	Leave as is

Test Oscilloscope

Intensity	Nominal brightness
Focus	Well-defined trace
Astigmatism	Well-defined trace
Normal-Single Sweep	Normal
Horizontal Display	B
A Time Base	
Triggering Mode	Auto
Time/cm	0.5 ms
B Time Base	
Triggering Level	0
Triggering Mode	Trig
Triggering Slope	+
Triggering Coupling	AC
Triggering Source	Int
Time/cm	1.0 ms
Vertical Amplifier	
Mode	Ch 1
Volts/cm	0.2
Input Selector	AC

6. Check Operating Level Range

a. Test equipment setup is shown in Fig. 6-5.

b. Connect a DC voltmeter, set to the 300-volt range, between the BACKPLATE VOLTAGE test point located on the front panel (or TP365 on the Storage Board; see Fig. 6-6) and the flood gun cathodes, TP321 (Fig. 6-6).

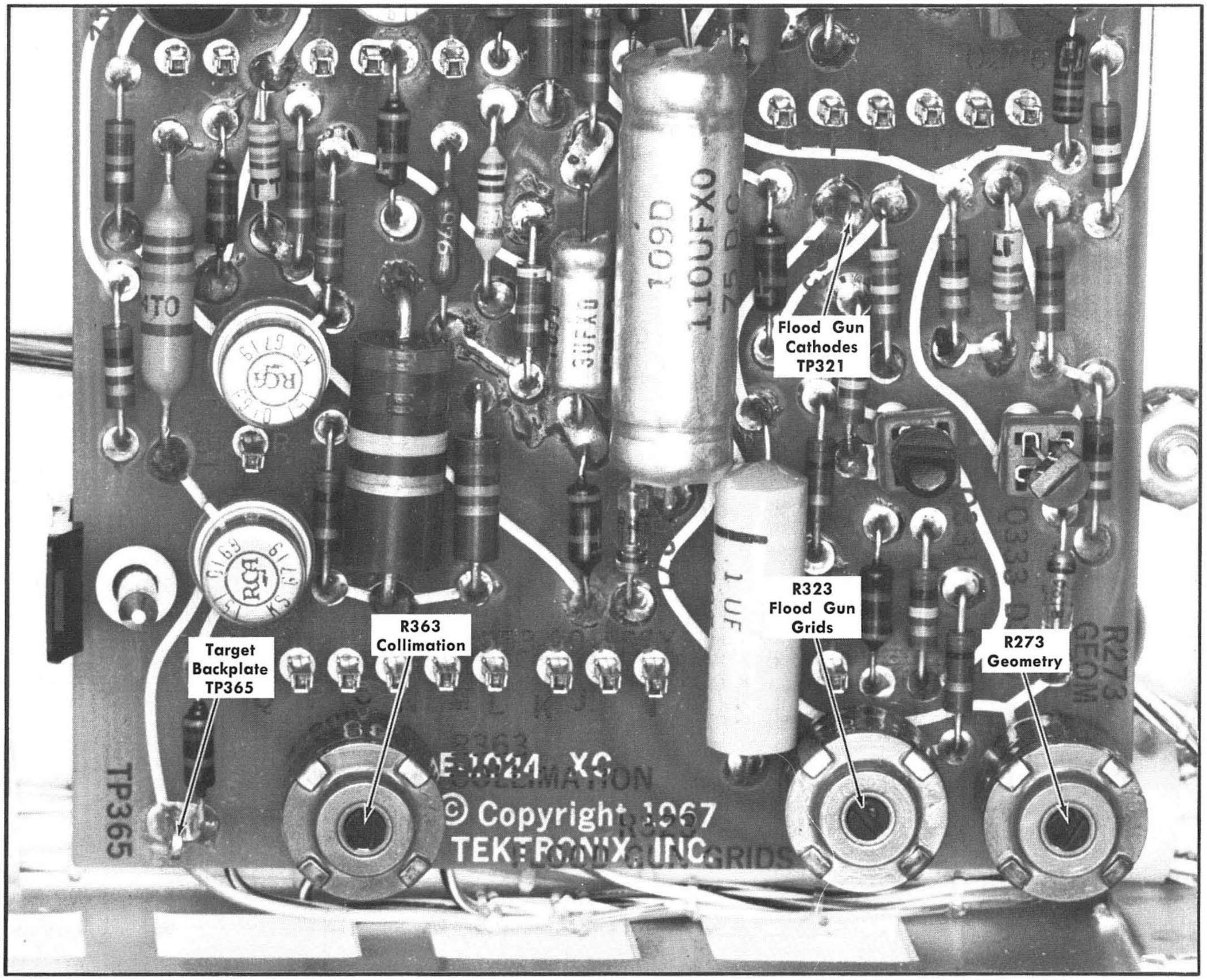


Fig. 6-6. Location of storage controls and test points.

c. Record the voltmeter reading so that the operating level can be reset to this voltage after the range is checked.

d. Rotate the OPERATING LEVEL control fully counterclockwise and note the voltmeter reading.

e. CHECK—Operating level (cathode-to-target backplate voltage) is $\leq$125 volts.

f. Rotate the OPERATING LEVEL control fully clockwise, note the voltmeter reading, and rotate the OPERATING LEVEL control counterclockwise.

g. CHECK—Operating level noted in step f is $\geq$285 volts.

h. Push the ERASE button, then adjust the OPERATING LEVEL control to the voltage recorded in step c.

7. Adjust Collimation and Flood Gun Grids ⓿

a. Connect the sweep sawtooth attenuator test fixture into the test oscilloscope Sweep A binding post and connect the ground lead. Connect a 50-ohm coaxial cable from the test fixture to the test oscilloscope Ch 1 Input. Adjust the B Triggering Level control for a stable display.

b. Adjust the A Time/cm Variable control and test fixture amplitude control for a ramp 10 centimeters long and 5 centimeters high. See Fig. 6-7. This represents a ten-millisecond sawtooth, one volt in amplitude, which will be used to sweep the Type 601.

c. Connect a 50-ohm termination to each of the X and Y INPUT connectors. Connect a banana-to-BNC patch cord from the test oscilloscope +Gate A binding post to the Z INPUT connector.

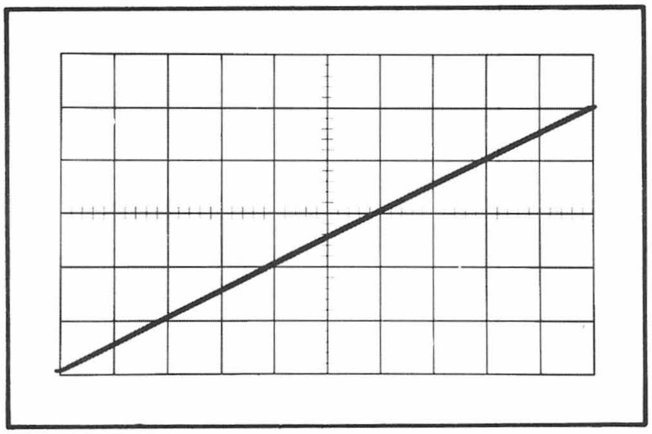


Fig. 6-7. Test oscilloscope display showing a 10-millisecond, one-volt sawtooth.

d. Slowly rotate the INTENSITY control clockwise until a spot is barely perceptible.

e. Using the X and Y positioning controls (see Fig. 6-9), place the spot in the lower left-hand corner of the screen.

f. Remove the 50-ohm termination from the X INPUT connector, then disconnect the coaxial cable from the test oscilloscope vertical input connector and connect it to the X INPUT connector, applying the sawtooth signal to the X-axis amplifier.

g. Adjust the INTENSITY control for a sweep of nominal brightness, then write the entire screen by positioning the trace vertically with the Y Position control. If the screen fails to write, slightly adjust the INTENSITY control clockwise and repeat the process until the screen is fully written.

h. Return the trace to the bottom graticule line and set the test oscilloscope Normal-Single Sweep switch to Single Sweep to turn off the Type 601 CRT beam.

i. With the screen fully written, rotate the Flood Gun Grids control, R323 (Fig. 6-6), fully counterclockwise. Note the shadows around the edges of the screen.

j. Slowly rotate the Flood Gun Grids control clockwise until the shadows just disappear, then rotate the control another 10° clockwise past this point.

k. Rotate the Collimation control, R363 (Fig. 6-6), fully clockwise.

l. While continuously pushing the ERASE button, note that the screen edges are brightened and pulled in. See Fig. 6-8A.

m. Rotate the Collimation control counterclockwise, and while continuously pushing the ERASE button, note the screen edges brighten and exhibit a halo effect. See Fig. 6-8B.

n. While continuously pushing the ERASE button, adjust the Collimation control clockwise until uniform edge lighting is achieved (Fig. 6-8c).

o. INTERACTION—Collimation affects vertical and horizontal gain, linearity and storage capabilities.

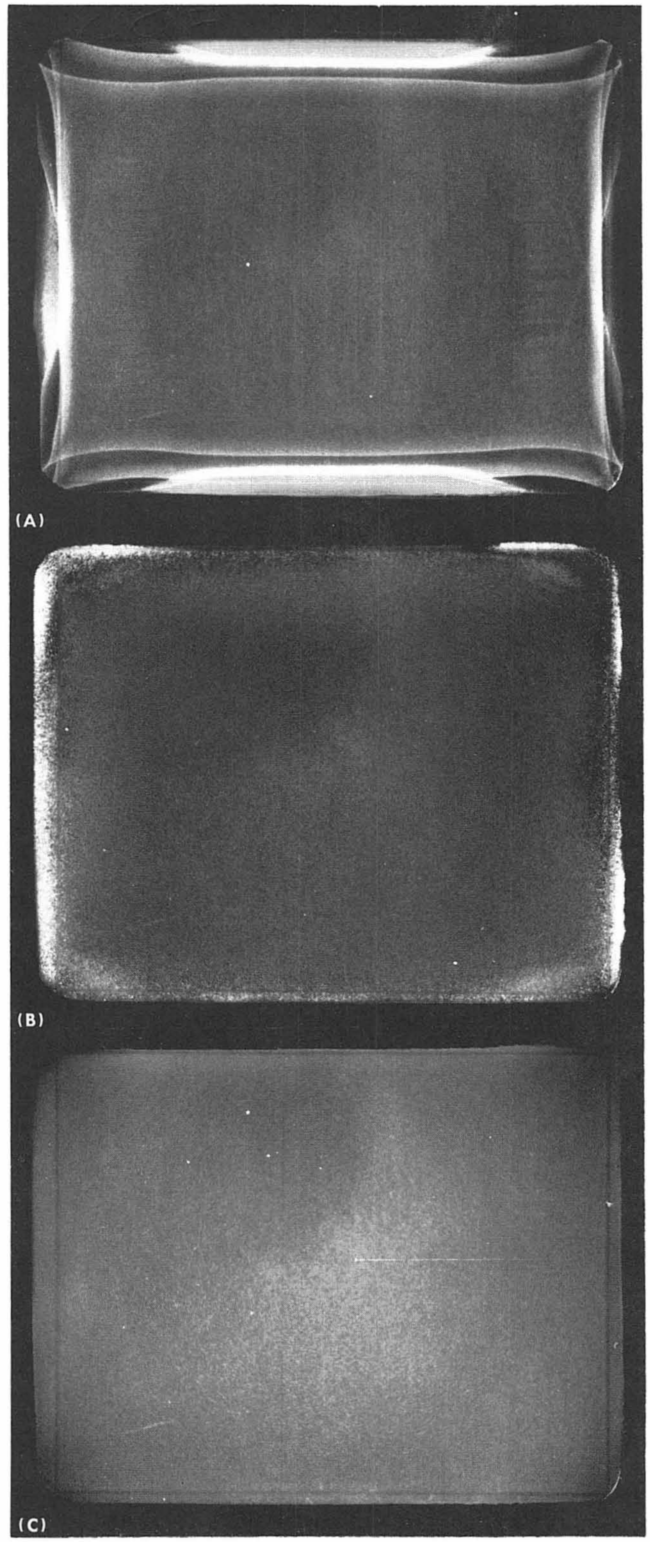


Fig. 6-8. Typical display showing Collimation adjusted (A) too far clockwise, (B) too far counterclockwise, and (C) for uniform brightness.

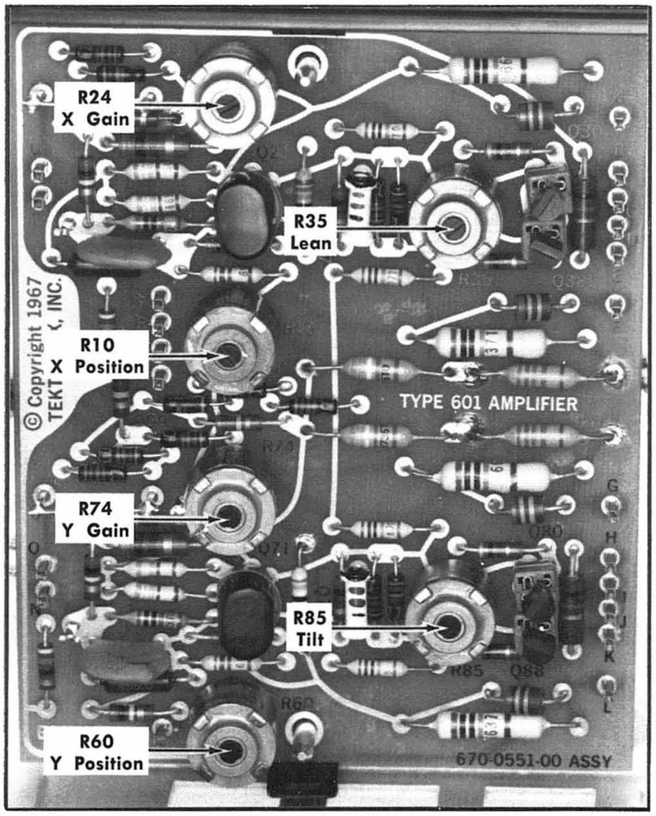


Fig. 6-9. Location of Deflection Amplifier controls.

8. Adjust Focus and Astigmatism

a. Optimum focusing is best achieved on a diagonal line, which is produced by applying the test oscilloscope sawtooth to both the X and Y amplifiers.

b. Remove the 50-ohm termination from the Y INPUT, and connect a 50-ohm coaxial cable to the Y INPUT connector. Disconnect the cable from the test fixture, attach a T connector, then connect both cables to the T connector.

c. Actuate the sawtooth signal by placing the test oscilloscope Normal-Single Sweep switch to Normal.

d. Adjust the FOCUS and ASTIGMATISM controls for a well-defined trace.

e. Set the test oscilloscope Normal-Single Sweep switch to Single Sweep and erase the Type 601 display.

f. Check the focusing by pressing the Normal-Single Sweep switch down to the Reset position and writing a diagonal line on the Type 601 screen. Adjust INTENSITY if necessary. Erase the display when the check is completed.

g. Disconnect the cable from the Y INPUT and install the 50-ohm termination on the Y INPUT connector.

9. Adjust Operating Level

NOTE

IF CRT PERFORMANCE HAS BEEN SATISFACTORY, NO ADJUSTMENT OF THE OPERATING LEVEL CONTROL IS NECESSARY. PROCEED TO STEP 10. Some compromises in the CRT display can be made with slight adjustment of the OPERATING LEVEL. When the operating level is increased, the brightness and writing speed increase; however, the contrast ratio decreases. When the operating level is decreased, the contrast ratio increases, but the brightness and writing speed decrease. If the operating level is changed, collimation and gain are affected.

a. Locate Writing Threshold as follows:

1. Press the ERASE button to prepare the target area for storage.

2. Write approximately 3 lines per centimeter on the target area by depressing the test oscilloscope Normal-Single Sweep switch down to the Reset position. After each line is written, change the vertical position before writing the next trace.

3. Carefully check the written lines for breaks or gaps of 0.025 inches or more. If no breaks or gaps are evident after 10 seconds, note the voltmeter reading, then adjust the OPERATING LEVEL control to reduce the operating level by 5 volts.

4. Erase twice, wait 10 seconds, then write again and check for breaks or gaps.

5. Repeat this procedure of decreasing the operating voltage level in 5-volt steps until breaks of approximately 0.025 inches occur. This is the Writing Threshold. Note this voltage and rotate the OPERATING LEVEL control clockwise until the original level noted in step 3 is reached.

NOTE

Do not change the INTENSITY, FOCUS or ASTIGMATISM control settings.

b. Locate the Upper Writing Limit as follows:
storage.

1. Press the ERASE button to prepare the target area for storage.

2. Write approximately 3 lines per centimeter on the target area by depressing the test oscilloscope Normal-Single Sweep switch down to the Reset position. After each line is written, change the vertical position before writing the next trace.

3. Carefully check the stored lines and background for trace spreading of about 0.025 inches or background fade-up. If no trace spreading or background fade-up is evident after 10 seconds, adjust the OPERATING LEVEL control to increase the operating level by 5 volts.

4. Erase twice, wait 10 seconds, then write again and check for spreading or fade-up.

5. Repeat this procedure until trace spreading of approximately 0.025 inches, or background fade-up, occurs. This is the Upper Writing Limit. Note this voltage.

c. Adjust the OPERATING LEVEL control for an operating point midway between the Writing Threshold and Upper Writing Limit.

d. Disconnect the DC voltmeter.

e. INTERACTION—Collimation and gain.

10. Adjust Tilt and Lean

a. Remove the plastic CRT mask and place the test graticule in front of the Type 601 screen. Align the outer vertical and horizontal lines of the graticule with the scribed lines on the CRT face. Secure the graticule in place.

b. Set the test oscilloscope Normal-Single Sweep switch to Normal and adjust the Y position control to place the horizontal trace on the graticule centerline.

c. ADJUST—R85, Tilt (Fig. 6-9), so that the trace is parallel to the horizontal graticule centerline. See Fig. 6-10.

d. Reposition the horizontal trace to the bottom graticule line.

e. Move the sawtooth signal from the X INPUT to the Y INPUT and the 50-ohm termination from the Y INPUT to the X INPUT.

f. Adjust the X Position control to place the vertical trace on the graticule centerline.

g. ADJUST—R35, Lean (Fig. 6-9), so that the trace is parallel to the vertical graticule centerline.

h. Reposition the vertical trace to the left-hand edge of the graticule, set the test oscilloscope Normal-Single Sweep switch to Single Sweep and erase the Type 601.

11. Adjust Geometry

a. Remove the 50-ohm termination from the X INPUT, then connect a 50-ohm coaxial cable from the standard amplitude calibrator output connector to the X INPUT connector.

b. Set the standard amplitude calibrator for a 0.5-volt square-wave output.

c. Set the test oscilloscope Normal-Single Sweep switch to Normal and adjust the X Gain control, R24 (Fig. 6-9), for 5 centimeters of display. Position the left edge of the display to the left-hand edge of the graticule.

d. Set the standard amplitude calibrator for a 10-millivolt square-wave output.

e. ADJUST—Geom, R273 (Fig. 6-6), for minimum bowing of the display. Bowing must not exceed 1 mm. See Fig. 6-11.

f. Position the display to the right-hand edge of the graticule and check geometry as in step e.

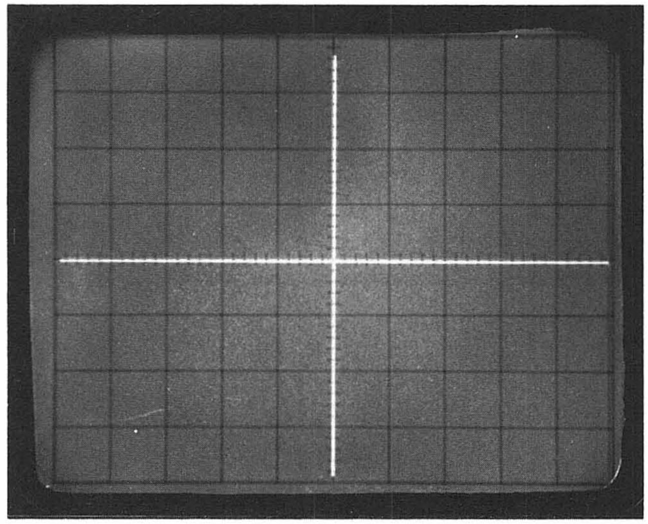


Fig. 6-10. Typical display when checking Tilt and Lean.

g. Reposition the display to the left-hand edge of the graticule, move the sawtooth signal to the X INPUT and the calibrator signal to the Y INPUT.

h. Set the standard amplitude calibrator for a 0.5-volt square-wave output and adjust the Y Gain control, R74 (Fig. 6-9), for 5 centimeters of display. Position the bottom of the display to the bottom graticule line.

i. Set the standard amplitude calibrator for a 10-millivolt square-wave output and check horizontal geometry on the bottom line of the graticule, then on the top line.

j. ADJUST—Geom, R273, for minimum bowing of the display. Bowing must not exceed 1 mm.

k. Repeat the vertical and horizontal geometry checks until optimum adjustment of the geometry control is reached.

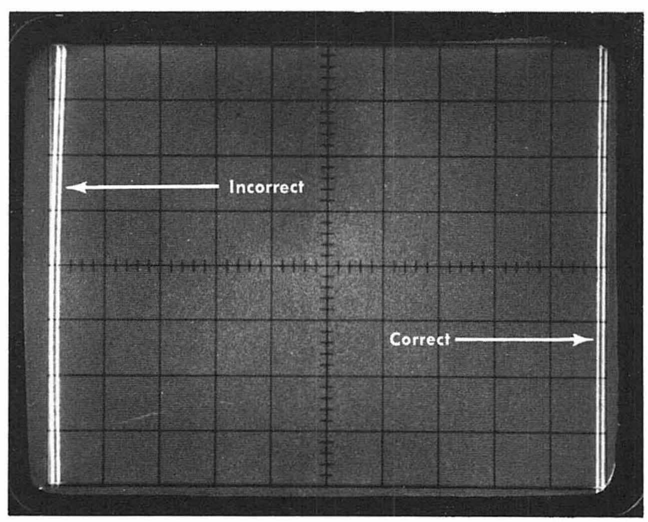


Fig. 6-11. Typical display when checking geometry.

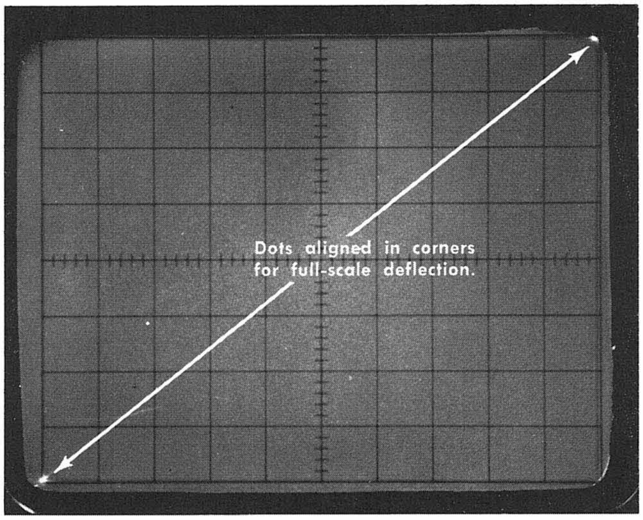


Fig. 6-12. Typical display when checking X and Y Gain.

l. Position the horizontal trace to the bottom graticule line, set the test oscilloscope Normal-Single Sweep switch to Single Sweep and erase the Type 601.

m. Remove the signals from the X and Y INPUT connectors.

12. Adjust X and Y Amplifier Gain ⓘ

NOTE

The X and Y Gains should be adjusted for full-scale deflection, depending upon the input signals used. As an example, the following procedure shows the proper adjustment for one volt full-scale deflection in both axes.

a. Connect a T connector to the standard amplitude calibrator output connector; connect one coaxial cable from the T connector to the X INPUT connector and another from the T connector to the Y INPUT connector.

b. Set the standard amplitude calibrator for a 1-volt square-wave output and set the test oscilloscope Normal-Single sweep switch to Normal.

c. Adjust R24, X Gain, so that one dot touches the left-hand graticule edge and the other dot touches the right-hand graticule edge. Adjust the X Position control as necessary. See Fig. 6-12.

d. Adjust R74, Y Gain, so that one dot touches the top graticule edge and the other dot touches the bottom graticule edge. Adjust Y Position as necessary.

e. This ensures that a 1-volt signal applied to either input will cause full-scale deflection.

f. Erase the Type 601 and disconnect all test equipment.

This completes the calibration procedure for the Type 601.

NOTES

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

SECTION 7
ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
				Bulbs			
B229	150-0002-00			Neon NE-2			
B251	150-0002-00			Neon NE-2			
B252	150-0002-00			Neon NE-2			
B253	150-0002-00			Neon NE-2			
B265	150-0002-00			Neon NE-2			
B266	150-0002-00			Neon NE-2			
B440	150-0046-00			Incandescent #21070			

Capacitors

Tolerance ±20% unless otherwise indicated.

Ckt. No.	Tektronix Part No.	Eff	Disc	Description			
C15	283-0010-00			0.05 μF	Cer	50 V	
C20	281-0537-00			0.68 pF	Cer	500 V	
C29	281-0537-00			0.68 pF	Cer	500 V	
C33	281-0511-00			22 pF	Cer	500 V	10%
C65	283-0010-00			0.05 μF	Cer	50 V	
C70	281-0537-00			0.68 pF	Cer	500 V	
C79	281-0537-00			0.68 pF	Cer	500 V	
C83	281-0511-00			22 pF	Cer	500 V	10%
C103	281-0519-00			47 pF	Cer	500 V	10%
C151	283-0003-00			0.01 μF	Cer	150 V	
C153	283-0003-00			0.01 μF	Cer	150 V	
C208	285-0719-00			0.015 μF	PMT	100 V	5%
C210	281-0536-00			1000 pF	Cer	500 V	10%
C214	283-0134-00			0.47 μF	Cer	50 V	+80%—20%
C224	283-0057-00			0.1 μF	Cer	200 V	+80%—20%
C226	283-0071-00			0.0068 μF	Cer	5000 V	
C227	283-0071-00			0.0068 μF	Cer	5000 V	
C228	283-0071-00			0.0068 μF	Cer	5000 V	
C255	283-0071-00			0.0068 μF	Cer	5000 V	
C268	283-0071-00			0.0068 μF	Cer	5000 V	
C269	283-0071-00			0.0068 μF	Cer	5000 V	
C302	283-0110-00			0.005 μF	Cer	150 V	
C305	283-0004-00			0.02 μF	Cer	150 V	
C316	285-0703-00			0.1 μF	PTM	100 V	5%
C317	283-0178-00	XB060000		0.1 μF	Cer	100 V	+80%—20%
C319	290-0330-00			110 μF	Elect.	75 V	

Capacitors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
C321	285-0622-00			0.1 μF	PTM	100 V	
C324	290-0305-01			3 μF	Elect.	150 V	10%
C358	283-0000-00	XB060000		0.001 μF	Cer	500 V	
C363	283-0002-00	XB060000		0.01 μF	Cer	500 V	
C409	290-0331-00			200 μF	Elect.	250 V	+50%—10%
C413	290-0328-00			150 μF	Elect.	150 V	+50%—10%
C418	283-0004-00			0.02 μF	Cer	150 V	
C420	283-0000-00			0.001 μF	Cer	500 V	
C425	283-0010-00			0.05 μF	Cer	50 V	
C432	290-0305-01			3 μF	Elect.	150 V	10%
C438	290-0200-00			12 μF	Elect.	150 V	
C443	290-0329-00			2400 μF	Elect.	25 V	+75%—10%
C446	283-0010-00			0.05 μF	Cer	50 V	
C449	283-0000-00			0.001 μF	Cer	500 V	
C459	290-0284-00			4.7 μF	Elect.	35 V	10%
C465	290-0215-00			100 μF	Elect.	25 V	
C473	290-0328-00			150 μF	Elect.	150 V	+50%—10%
C479	283-0002-00			0.01 μF	Cer	500 V	
C489	281-0543-00			270 pF	Cer	500 V	10%
C495	290-0226-00			20 μF	Elect.	100 V	
C498	290-0200-00			12 μF	Elect.	150 V	

Semiconductor Device, Diodes

Ckt. No.	Tektronix Part No.	Eff	Disc	Description		
D3	*152-0185-00			Silicon	Replaceable by 1N4152	
D4	*152-0185-00			Silicon	Replaceable by 1N4152	
D31	*152-0185-00			Silicon	Replaceable by 1N4152	
D32	*152-0185-00			Silicon	Replaceable by 1N4152	
D33	*152-0185-00			Silicon	Replaceable by 1N4152	
D53	*152-0185-00			Silicon	Replaceable by 1N4152	
D54	*152-0185-00			Silicon	Replaceable by 1N4152	
D81	*152-0185-00			Silicon	Replaceable by 1N4152	
D82	*152-0185-00			Silicon	Replaceable by 1N4152	
D83	*152-0185-00			Silicon	Replaceable by 1N4152	
D96	*152-0185-00			Silicon	Replaceable by 1N4152	
D97	*152-0185-00			Silicon	Replaceable by 1N4152	
D98	*152-0185-00			Silicon	Replaceable by 1N4152	
D99	152-0278-00			Zener	1N4372A	0.4 W, 3 V, 5%
D105	*152-0233-00			Silicon	Tek Spec	
D113	*152-0233-00			Silicon	Tek Spec	
D114	*152-0185-00			Silicon	Replaceable by 1N4152	
D119	*152-0185-00			Silicon	Replaceable by 1N4152	
D143	*152-0061-00			Silicon	Tek Spec	
D146	*152-0233-00			Silicon	Tek Spec	

Semiconductor Device, Diodes *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc		Description	
D206	*152-0185-00			Silicon	Replaceable by 1N4152	
D207	*152-0185-00			Silicon	Replaceable by 1N4152	
D221	152-0218-00	B010100	B039999	Silicon	20 mA	10,000 V
D221	152-0408-00	B040000		Silicon	5 mA	10,000 V
D223	152-0218-00	B010100	B039999	Silicon	20 mA	10,000 V
D223	152-0408-00	B040000		Silicon	5 mA	10,000 V
D248	152-0304-00			Zener	1N968B	0.4 W, 20 V, 5%
D252	152-0170-00			Silicon	1N441	
D271	152-0255-00			Zener	0.4 W, 51 V, 5%	
D303	*152-0107-00			Silicon	Replaceable by 1N647	
D311	*152-0107-00			Silicon	Replaceable by 1N647	
D317	*152-0107-00			Silicon	Replaceable by 1N647	
D320	*152-0107-00			Silicon	Replaceable by 1N647	
D321	*152-0185-00	XB060000		Silicon	Replaceable by 1N4152	
D322	*152-0185-00	XB060000		Silicon	Replaceable by 1N4152	
D323	*152-0185-00	XB060000		Silicon	Replaceable by 1N4152	
D324	*152-0107-00			Silicon	Replaceable by 1N647	
D326	*152-0107-00			Silicon	Replaceable by 1N647	
D329	*152-0107-00			Silicon	Replaceable by 1N647	
D330	152-0149-00			Zener	1N961B	0.4 W, 10 V, 5%
D333	*152-0185-00			Silicon	Replaceable by 1N4152	
D338	*152-0185-00			Silicon	Replaceable by 1N4152	
D343	*152-0185-00			Silicon	Replaceable by 1N4152	
D352	*152-0107-00			Silicon	Replaceable by 1N647	
D355	*152-0107-00			Silicon	Replaceable by 1N647	
D362	152-0066-00	XB060000		Silicon	1N3194	
D364	152-0066-00	XB060000		Silicon	1N3194	
D406A,B,C,D (4)	152-0066-00			Silicon	1N3194	
D410A,B,C,D (4)	152-0066-00			Silicon	1N3194	
D423	152-0150-00			Zener	1N3037B	1 W, 51 V, 5%
D425	152-0212-00			Zener	1N936	9 V, 0.005%/C TC
D440A,B,C,D (4)	152-0198-00			Silicon	MR1032A (Motorola)	200 V
D470A,B,C,D, (4)	152-0066-00			Silicon	1N3194	
D497	*152-0107-00			Silicon	Replaceable by 1N647	
D499	152-0215-00			Zener	1N3041B	1 W, 75 V, 5%

Fuses

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc		Description
F217	159-0022-00			1 A 3AG	Fast-Blo
F401	159-0022-00			1 A 3AG	Fast-Blo
F413	159-0028-00			¼ A 3AG	Fast-Blo
F443	159-0022-00			1 A 3AG	Fast-Blo
F473	159-0028-00			¼ A 3AG	Fast-Blo

Connectors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
J1	131-0274-00			BNC, Chassis mtd.
J51	131-0274-00			BNC, Chassis mtd.
J101	131-0274-00			BNC, Chassis mtd.
J199	*131-0569-00			25 pin, female
J366	131-0255-00			Terminal Jack, blue

Transistors

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description	
Q21	*151-0195-00			Silicon	Replaceable by MPS 6515
Q27	*151-0195-00			Silicon	Replaceable by MPS 6515
Q30	151-0188-00			Silicon	2N3906
Q38	151-0188-00			Silicon	2N3906
Q41	151-0150-00			Silicon	2N3440
Q45	151-0150-00			Silicon	2N3440
Q71	*151-0195-00			Silicon	Replaceable by MPS 6515
Q77	*151-0195-00			Silicon	Replaceable by MPS 6515
Q80	151-0188-00			Silicon	2N3906
Q88	151-0188-00			Silicon	2N3906
Q91	151-0150-00			Silicon	2N3440
Q95	151-0150-00			Silicon	2N3440
Q109	*151-0195-00			Silicon	Replaceable by MPS 6515
Q121	151-0190-00			Silicon	2N3904
Q131	151-0190-00			Silicon	2N3904
Q141	151-0190-00			Silicon	2N3904
Q149	151-0250-00			Silicon	2N5184
Q200	151-0208-00			Silicon	2N4036
Q206	*151-0216-00			Silicon	Replaceable by MOT MPS 6523
Q209	151-1005-00			Silicon	FET
Q217	*151-0148-00			Silicon	Selected 40250 (RCA)
Q313	151-0190-00			Silicon	2N3904
Q317	151-0150-00			Silicon	2N3440
Q331	151-0250-00			Silicon	2N5184
Q333	*151-0195-00			Silicon	Replaceable by MPS 6515
Q342	*151-0228-00			Silicon	Tek Spec
Q351	151-0169-00			Silicon	2N3439
Q355	151-0169-00			Silicon	2N3439
Q413	151-0149-00			Silicon	2N3441
Q417	151-0190-00			Silicon	2N3904
Q423	*151-0192-00			Silicon	Replaceable by MPS 6521
Q425	*151-0192-00			Silicon	Replaceable by MPS 6521
Q443	*151-0148-00			Silicon	Selected 40250 (RCA)
Q447	151-0190-00			Silicon	2N3904
Q453	*151-0195-00			Silicon	Replaceable by MPS 6515
Q455	*151-0195-00			Silicon	Replaceable by MPS 6515
Q473	151-0149-00			Silicon	2N3441
Q477	151-0190-00			Silicon	2N3904
Q483	*151-0195-00			Silicon	Replaceable by MPS 6515
Q485	*151-0195-00			Silicon	Replaceable by MPS 6515

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R2	316-0275-00			2.7 MΩ	¼ W	
R4	301-0102-00			1 kΩ	½ W	5%
R6	315-0104-00			100 kΩ	¼ W	5%
R8	315-0470-00			47 Ω	¼ W	5%
R10	311-0463-00	B010100	B059999	5 kΩ, Var		
R10	311-1227-00	B060000		5 kΩ, Var		

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R13	321-0253-00			4.22 kΩ	1/8 W	Prec	1%
R15	321-0193-00			1 kΩ	1/8 W	Prec	1%
R17	321-0358-00			52.3 kΩ	1/8 W	Prec	1%
R19	315-0101-00			100 Ω	1/4 W		5%
R20	323-0385-00			100 kΩ	1/2 W	Prec	1%
R21	321-0385-00			100 kΩ	1/8 W	Prec	1%
R23	322-0344-00			37.4 kΩ	1/4 W	Prec	1%
R24	311-0462-00	B010100	B059999	1 kΩ, Var			
R24	311-1225-00	B060000		1 kΩ, Var			
R25	321-0170-00			576 Ω	1/8 W	Prec	1%
R26	322-0344-00			37.4 kΩ	1/4 W	Prec	1%
R28	321-0385-00			100 kΩ	1/8 W	Prec	1%
R29	323-0385-00			100 kΩ	1/2 W	Prec	1%
R30	315-0302-00			3 kΩ	1/4 W		5%
R33	315-0102-00			1 kΩ	1/4 W		5%
R35	311-0541-00	B010100	B059999	20 kΩ, Var			
R35	311-1230-00	B060000		20 kΩ, Var			
R36	322-0471-00			787 kΩ	1/4 W	Prec	1%
R37	322-0463-00			649 kΩ	1/4 W	Prec	1%
R38	315-0302-00			3 kΩ	1/4 W		5%
R41	308-0108-00			15 kΩ	5 W	WW	5%
R43	301-0201-00			200 Ω	1/2 W		5%
R45	308-0108-00			15 kΩ	5 W	WW	5%
R52	316-0275-00			2.7 MΩ	1/4 W		
R54	301-0102-00			1 kΩ	1/2 W		5%
R56	315-0104-00			100 kΩ	1/4 W		5%
R58	315-0470-00			47 Ω	1/4 W		5%
R60	311-0463-00	B010100	B059999	5 kΩ, Var			
R60	311-1227-00	B060000		5 kΩ, Var			
R63	321-0253-00			4.22 kΩ	1/8 W	Prec	1%
R65	321-0193-00			1.1 Ω	1/8 W	Prec	1%
R67	321-0358-00			52.3 kΩ	1/8 W	Prec	1%
R69	315-0101-00			100 Ω	1/4 W		5%
R70	323-0385-00			100 kΩ	1/2 W	Prec	1%
R71	321-0385-00			100 kΩ	1/8 W	Prec	1%
R73	322-0344-00			37.4 kΩ	1/4 W	Prec	1%
R74	311-0462-00	B010100	B059999	1 kΩ, Var			
R74	311-1225-00	B060000		1 kΩ, Var			
R75	321-0168-00			549 Ω	1/8 W	Prec	1%
R76	322-0344-00			37.4 kΩ	1/4 W	Prec	1%
R78	321-0385-00			100 kΩ	1/8 W	Prec	1%
R79	323-0385-00			100 kΩ	1/2 W	Prec	1%
R80	315-0302-00			3 kΩ	1/4 W		5%
R83	315-0102-00			1 kΩ	1/4 W		5%
R85	311-0541-00	B010100	B059999	20 kΩ, Var			
R85	311-1230-00	B060000		20 kΩ, Var			
R86	322-0463-00			649 kΩ	1/4 W	Prec	1%
R87	322-0471-00			787 kΩ	1/4 W	Prec	1%
R88	315-0302-00			3 kΩ	1/4 W		5%
R91	308-0108-00			15 kΩ	5 W	WW	5%

Scan by Zenith

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R93	301-0201-00			200 Ω	½ W		5%
R95	308-0108-00			15 kΩ	5 W	WW	5%
R98	315-0223-00			22 kΩ	¼ W		5%
R99	315-0154-00			150 kΩ	¼ W		5%
R101	315-0470-00			47 Ω	¼ W		5%
R103	315-0103-00			10 kΩ	¼ W		5%
R105	315-0913-00			91 kΩ	¼ W		5%
R107	315-0101-00			100 Ω	¼ W		5%
R109	315-0101-00			100 Ω	¼ W		5%
R111	321-0373-00			75 kΩ	⅛ W	Prec	1%
R113	315-0622-00			6.2 kΩ	¼ W		5%
R114	315-0302-00			3 kΩ	¼ W		5%
R118	315-0204-00			200 kΩ	¼ W		5%
R121	321-0190-00			931 Ω	⅛ W	Prec	1%
R123	321-0299-00			12.7 kΩ	⅛ W	Prec	1%
R127	323-0327-00			24.9 kΩ	½ W	Prec	1%
R128	323-0327-00			24.9 kΩ	½ W	Prec	1%
R130	321-0189-00			909 Ω	⅛ W	Prec	1%
R141	303-0203-00			20 kΩ	1 W		5%
R143	315-0163-00			16 kΩ	¼ W		5%
R144	315-0203-00			20 kΩ	¼ W		5%
R147	315-0101-00			100 Ω	¼ W		5%
R149	315-0184-00	B010100	B049999	180 kΩ	¼ W		5%
R149	315-0104-00	B050000		100 kΩ	¼ W		5%
R151	315-0100-00			10 Ω	¼ W		5%
R153	315-0100-00			10 Ω	¼ W		5%
R201	301-0181-00			180 Ω	½ W		5%
R203	315-0392-00			3.9 kΩ	¼ W		5%
R204	315-0302-00			3 kΩ	¼ W		5%
R205	315-0104-00			100 kΩ	¼ W		5%
R207	315-0104-00			100 kΩ	¼ W		5%
R208	315-0103-00			10 kΩ	¼ W		5%
R209	315-0104-00			100 kΩ	¼ W		5%
R211	321-0418-00			221 kΩ	⅛ W	Prec	1%
R212	311-0508-00	B010100	B059999	50 kΩ, Var			
R212	311-1234-00	B060000		50 kΩ, Var			
R220A } R220B }	311-0684-00			20 kΩ / 50 kΩ Var			
R224	315-0472-00			4.7 kΩ	¼ W		5%
R225	315-0273-00			27 kΩ	¼ W		5%
R227	301-0103-00			10 kΩ	½ W		5%
R230	322-0464-00			665 kΩ	¼ W	Prec	1%
R232	323-0498-00			1.5 MΩ	½ W	Prec	1%
R233	323-0498-00			1.5 MΩ	½ W	Prec	1%
R234	323-0498-00			1.5 MΩ	½ W	Prec	1%
R235	323-0498-00			1.5 MΩ	½ W	Prec	1%
R236	323-0498-00			1.5 MΩ	½ W	Prec	1%
R237	323-0498-00			1.5 MΩ	½ W	Prec	1%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R238	323-0498-00			1.5 MΩ	½ W	Prec	1%
R239	323-0498-00			1.5 MΩ	½ W	Prec	1%
R240	323-0498-00			1.5 MΩ	½ W	Prec	1%
R241	323-0498-00			1.5 MΩ	½ W	Prec	1%
R242	323-0498-00			1.5 MΩ	½ W	Prec	1%
R244	311-0397-00	B010100	B019999	2 MΩ, Var			
R244	311-0397-01	B020000		2 MΩ, Var			
R245	323-0498-00			1.5 MΩ	½ W	Prec	1%
R246	323-0498-00			1.5 MΩ	½ W	Prec	1%
R247	301-0104-00			100 kΩ	½ W		5%
R249	301-0104-00			100 kΩ	½ W		5%
R256	306-0106-00			10 MΩ	2 W		
R257	306-0106-00			10 MΩ	2 W		
R258	306-0106-00			10 MΩ	2 W		
R259	306-0106-00			10 MΩ	2 W		
R261	301-0565-00			5.6 MΩ	½ W		5%
R263	315-0393-00			39 kΩ	¼ W		5%
R265	301-0471-00			470 Ω	½ W		5%
R271	301-0513-00			51 kΩ	½ W		5%
R273	311-0551-00	B010100	B059999	500 kΩ, Var			
R273	311-1252-00	B060000		500 kΩ, Var			
R277	311-0699-00			250 kΩ, Var			
R302	315-0105-00			1 MΩ	¼ W		5%
R304	315-0105-00			1 MΩ	¼ W		5%
R305	316-0475-00			4.7 MΩ	¼ W		
R306	316-0125-00			1.2 MΩ	¼ W		
R308	315-0103-00			10 kΩ	¼ W		5%
R309	301-0754-00			750 kΩ	½ W		5%
R311	315-0473-00			47 kΩ	¼ W		5%
R313	301-0273-00			27 kΩ	½ W		5%
R314	315-0183-00			18 kΩ	¼ W		5%
R315	316-0102-00	XB060000		1 kΩ	¼ W		
R317	301-0433-00			43 kΩ	½ W		5%
R318	315-0243-00	XB060000		24 kΩ	¼ W		5%
R319	301-0103-00			10 kΩ	½ W		5%
R320	315-0104-00			100 kΩ	¼ W		5%
R322	315-0105-00			1 MΩ	¼ W		5%
R323	311-0551-00	B010100	B059999	500 kΩ, Var			
R323	311-1252-00	B060000		500 kΩ, Var			
R324	315-0202-00			2 kΩ	¼ W		5%
R325	315-0913-00			91 kΩ	¼ W		5%
R326	321-0384-00			97.6 kΩ	⅛ W	Prec	5%
R327	321-0385-00			100 kΩ	⅛ W	Prec	5%
R329	315-0474-00			470 kΩ	¼ W		5%
R330	315-0104-00			100 kΩ	¼ W		5%
R331	315-0474-00			470 kΩ	¼ W		5%
R332	315-0205-00			2 MΩ	¼ W		5%
R334	315-0103-00			10 kΩ	¼ W		5%
R335	315-0202-00			2 kΩ	¼ W		5%
R337	315-0823-00			82 kΩ	¼ W		5%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R338	315-0102-00			1 kΩ	¼ W		5%
R339	311-0310-00			5 kΩ, Var			
R340	315-0104-00			100 kΩ	¼ W		5%
R341	315-0103-00			10 kΩ	¼ W		5%
R342	315-0123-00	B010100	B059999	12 kΩ	¼ W		5%
R342	315-0243-00	B060000		24 kΩ	¼ W		5%
R343	311-0613-00	XB060000		100 kΩ, Var			
R344	315-0753-00	B010100	B059999	75 kΩ	¼ W		5%
R344	315-0184-00	B060000		180 kΩ	¼ W		5%
R350	306-0154-00			150 kΩ	2 W		
R354	315-0102-00			1 kΩ	¼ W		5%
R358	323-0445-00			422 kΩ	½ W	Prec	1%
R363	311-0551-00	B010100	B059999	500 kΩ, Var			
R363	311-1252-00	B060000		500 kΩ, Var			
R406	301-0100-00			10 Ω	½ W		5%
R408	315-0184-00			180 kΩ	¼ W		5%
R412	315-0184-00			180 kΩ	¼ W		5%
R415	308-0054-00			10 kΩ	5 W	WW	5%
R416	301-0153-00			15 kΩ	½ W		5%
R417	315-0433-00			43 kΩ	¼ W		5%
R419	315-0104-00			100 kΩ	¼ W		5%
R420	315-0102-00			1 kΩ	¼ W		5%
R422	301-0203-00			20 kΩ	½ W		5%
R425	303-0123-00			12 kΩ	1 W		5%
R429	303-0203-00			20 kΩ	1 W		5%
R431	315-0271-00			270 Ω	¼ W		5%
R433	321-0222-00			2 kΩ	⅛ W	Prec	1%
R434	311-0480-00	B010100	B059999	500 Ω, Var			
R434	311-1224-00	B060000		500 kΩ, Var			
R435	323-0323-00			22.6 kΩ	½ W	Prec	1%
R440	301-0201-00			200 Ω	½ W		5%
R442	315-0103-00			10 kΩ	¼ W		5%
R445	315-0270-00			27 Ω	¼ W		5%
R447	315-0562-00			5.6 kΩ	¼ W		5%
R449	315-0102-00			1 kΩ	¼ W		5%
R450	301-0363-00			36 kΩ	½ W		5%
R452	315-0221-00			220 Ω	¼ W		5%
R455	315-0222-00			2.2 kΩ	¼ W		5%
R458	315-0221-00			220 Ω	¼ W		5%
R461	323-0341-00			34.8 kΩ	½ W	Prec	1%
R463	321-0260-00			4.99 kΩ	⅛ W	Prec	1%
R472	315-0104-00			100 kΩ	¼ W		5%
R475	315-0102-00			1 kΩ	¼ W		5%
R477	315-0393-00			39 kΩ	¼ W		5%
R479	315-0511-00			510 Ω	¼ W		5%
R480	315-0103-00			10 kΩ	¼ W		5%
R482	315-0221-00			220 Ω	¼ W		5%
R485	301-0243-00			24 kΩ	½ W		5%
R488	315-0221-00			220 Ω	¼ W		5%
R491	323-0318-01			20 kΩ	½ W	Prec	½%

Resistors *(cont)*

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description			
R493	323-0306-01			15 kΩ	½ W	Prec	½%
R497	301-0100-00			10 Ω	½ W		5%
R499	301-0822-00			8.2 kΩ	½ W		5%

Switches

Unwired or Wired

SW301A,B	260-0920-00	Push	Assembly, ON-OFF
SW401	260-0675-00	Slide	Line Voltage
SW403	260-0906-00	Rotary	Line Voltage

Thermal Cut-Out

TK401	260-0413-00	175°F ±5°F

Test Points

TP149	*214-0579-00	Pin, Test Point
TP321	*214-0579-00	Pin, Test Point
TP365	*214-0579-00	Pin, Test Point

Transformers

T220	*120-0530-00	H.V. Power
T401	*120-0499-00	L.V. Power

Electron Tube

V279	*154-0521-00	CRT T6010-203

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear either on the back of the diagrams or on pullout pages immediately following the diagrams of the instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
  Detail Part of Assembly and/or Component
  mounting hardware for Detail Part
    Parts of Detail Part
    mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS

(Located behind diagrams)

SECTION 8
MECHANICAL PARTS LIST

FIG. 1 MECHANICAL PARTS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-1	333-1024-00			1	PANEL, front, left
-2	333-1025-00			1	PANEL, front, insert
	- - - - - -			-	mounting hardware: (not included w/panel)
-3	213-0055-00			2	SCREW, thread forming, 2-32 x $^{3}/_{16}$ inch, PHS
-4	200-0786-00			1	DOOR, access panel
	- - - - - -			-	door includes:
-5	334-1182-00			1	TAG, door
	- - - - - -			-	mounting hardware: (not included w/door)
-6	214-1004-00			2	BAR, spring, double shoulder
-7	214-0965-00			1	SPRING, helical torsion
	- - - - - -			-	mounting hardware: (not included w/spring)
-8	211-0025-00	B010100	B030389	1	SCREW, 4-40 x $^{3}/_{8}$ inch, FHS
	211-0101-00	B030390		1	SCREW, 4-40 x $^{1}/_{4}$ inch, FHS
	361-0007-00	B010100	B030389X	1	SPACER, plastic, 0.188 inch long
-9	210-0804-00	B010100	B030389X	2	WASHER, flat, 0.170 ID x $^{3}/_{8}$ inch OD
	210-0586-00	B010100	B030389	1	NUT, keps, 4-40 x $^{1}/_{4}$ inch
	220-0515-01	B030390		1	NUT, sleeve, 6-32 x 0.118 inch
-10	348-0055-00			1	GROMMET, plastic, $^{1}/_{4}$ inch diameter
-11	337-0969-00			1	SHIELD, implosion
	- - - - - -			-	mounting hardware: (not included w/shield)
-12	211-0097-00			4	SCREW, 4-40 x $^{5}/_{16}$ inch, PHS
-13	331-0192-00			1	MASK, graticule
-14	386-1304-01			1	SUB-PANEL, front
-15	352-0084-01			1	HOLDER, neon bulb
-16	200-0609-00			1	CAP, neon bulb holder
-17	378-0541-01			1	FILTER, lens, neon
-18	354-0314-00			1	RING, cathode ray tube shockmount
-19	337-0959-01			1	SHIELD, cathode ray tube
	- - - - - -			-	mounting hardware: (not included w/shield)
-20	211-0590-00			3	SCREW, 6-32 x $^{1}/_{4}$ inch, PHB
-21	131-0606-00			1	ASSEMBLY, CRT connector
	- - - - - -			-	mounting hardware: (not included w/assembly)
-22	211-0110-00			3	SCREW, 4-40 x $^{5}/_{16}$ inch, PHB
-23	210-0586-00			3	NUT, keps, 4-40 x $^{1}/_{4}$ inch
-24	252-0564-00			FT	CHANNEL, plastic, 11 inches
-25	348-0004-00			1	GROMMET, rubber, $^{3}/_{8}$ inch diameter
-26	348-0145-00			1	GROMMET, plastic, "U" shaped
-27	352-0123-01			2	HOLDER, CRT retainer
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-28	211-0590-00			2	SCREW, 6-32 x $^{1}/_{4}$ inch, PHB

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-29	386-1305-00			1	SUPPORT, chassis, CRT
	- - - - - -			-	mounting hardware: (not included w/support)
-30	211-0504-00			3	SCREW, 6-32 x 1/4 inch, PHS
-31	343-0138-00			1	RETAINER, CRT
	- - - - - -			-	mounting hardware: (not included w/retainer)
	211-0599-00			2	SCREW, 6-32 x 3/4 inch, FIL HB
	220-0444-00			2	NUT, square, 6-32 x 1/4 inch
-32	343-0123-01			2	CLAMP, CRT
	- - - - - -			-	mounting hardware for each: (not included w/clamp)
-33	211-0600-00			1	SCREW, 6-32 x 2 inches, FIL HB
-34	220-0444-00			1	NUT, square, 6-32 x 1/4 inch
-35	200-0616-00			1	COVER, CRT socket
-36	441-0757-00			1	CHASSIS, power
	- - - - - -			-	mounting hardware: (not included w/chassis)
-37	212-0023-00			3	SCREW, 8-32 x 3/8 inch, PHS
-38	210-0458-00			5	NUT, keps, 8-32 x 11/32 inch
-39	348-0150-00			1	GROMMET, plastic, U shape
-40	348-0055-00			2	GROMMET, plastic, 1/4 inch diameter
-41	348-0056-00			3	GROMMET, plastic, 3/8 inch diameter
-42	348-0031-00			1	GROMMET, plastic, 3/32 inch diameter
-43	210-0201-00			1	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-44	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-45	129-0072-00			1	POST, tie off, 15/16 inch long
	- - - - - -			-	mounting hardware: (not included w/post)
-46	361-0007-00			1	SPACER, plastic, 0.188 inch long
-47	129-0006-00			1	POST, connecting, insulating
	- - - - - -			-	mounting hardware: (not included w/post)
-48	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-49	255-0249-00			FT	CHANNEL, plastic, 9 1/4 inches long
-50	131-0255-00			1	CONNECTOR, terminal jack
-51	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-52	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
-53	210-0583-00			2	NUT, hex., 1/4-32 x 5/16 inch
-54	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-55	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0046-00			1	LOCKWASHER, internal, 0.261 ID x 0.400 inch OD
	210-0583-00			2	NUT, hex., 1/4-32 x 5/16 inch
	210-0940-00			1	WASHER, flat, 1/4 ID x 3/8 inch OD
-56	200-0608-00			1	COVER, plastic, variable resistor
-57	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-58	210-0590-00			2	NUT, hex., 3/8-32 x 7/16 inch
-59	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	210-0978-00			1	WASHER, flat, 3/8 ID x 1/2 inch OD
-60	- - - - - -			1	TRANSISTOR
	- - - - - -			-	mounting hardware: (not included w/transistor)
-61	211-0510-00			2	SCREW, 6-32 x 3/8 inch, PHS
-62	210-0202-00			1	LUG, solder, SE #6
-63	386-0143-00			1	PLATE, mica, insulating
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-64	343-0088-00			3	CLAMP, cable, plastic, small
-65	343-0089-00			5	CLAMP, cable, plastic, large
-66	344-0147-00			3	CLIP, circuit board
	- - - - - -			-	mounting hardware for each: (not included w/clip)
-67	214-0967-00			1	PIN, guide
	214-0966-00			1	SPRING, compression
-68	210-0586-00			1	NUT, keps, 4-40 x 1/4 inch
-69	- - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
	200-0663-00	XB020390		1	CAP, screw tip
-70	212-0576-00	B010100	B020389	2	SCREW, 10-32 x 1 3/8 inches, HHS
	212-0590-00	B020390		2	SCREW, 10-32 x 1 1/2 inches, HHS
-71	212-0517-00			2	SCREW, 10-32 x 1 3/4 inches, HHS
-72	210-0812-00			4	WASHER, fiber, 1/8 ID x 3/8 inch OD
-73	220-0410-00			4	NUT, keps, 10-32 x 3/8 inch
-74	361-0175-00			1	SPACER, transformer mount
-75	131-0682-02			27	TERMINAL, feed thru
-76	670-0553-00	B010100	B059999	1	ASSEMBLY, circuit board—STORAGE
	670-0553-01	B060000		1	ASSEMBLY, circuit board—STORAGE
	- - - - - -			-	assembly includes:
	388-0924-00	B010100	B059999	1	BOARD, circuit
	388-0924-01	B060000		1	BOARD, circuit
-77	136-0183-00			5	SOCKET, transistor, 3 pin
-78	136-0220-00			5	SOCKET, transistor, 3 pin
-79	136-0263-00	B010100	B040479	27	SOCKET, connector, pin
	136-0263-01	B040480		27	SOCKET, connector, pin
-80	214-0579-00			2	PIN, connector, test point

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-81	337-0971-00			1	SHIELD, high voltage box
	- - - - - -			-	mounting hardware: (not included w/shield)
-82	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
	621-0432-00			1	ASSEMBLY, high voltage
	- - - - - -			-	assembly includes:
-83	380-0115-00			1	HOUSING, high voltage
-84	179-1224-00			1	CABLE HARNESS
-85	136-0276-00			1	ASSEMBLY, CRT socket
	- - - - - -			-	assembly includes:
	136-0202-01			1	SOCKET, CRT, w/pins
-86	166-0319-00			3	SLEEVE, plastic
-87	670-0555-00			1	ASSEMBLY, circuit board, HIGH VOLTAGE (lower)
	- - - - - -			-	assembly includes:
	388-0929-00			1	BOARD, circuit
	- - - - - -			-	mounting hardware: (not included w/assembly)
-88	211-0040-00			4	SCREW, 4-40 x 1/4 inch, BHS, nylon
-89	670-0554-00			1	ASSEMBLY, circuit board, HIGH VOLTAGE (upper)
	- - - - - -			-	assembly includes:
	388-0928-00			1	BOARD, circuit
	- - - - - -			-	mounting hardware: (not included w/assembly)
-90	211-0040-00			4	SCREW, 4-40 x 1/4 inch, BHS, nylon
-91	361-0137-00			4	SPACER, plastic
	214-0931-00	B010100	B039999X	2	RETAINER, compartment (not shown)
-92	200-0714-00			1	COVER, plastic, high voltage
	- - - - - -			-	mounting hardware: (not included w/cover)
-93	211-0529-00			2	SCREW, 6-32 x 1 1/4 inches, PHS
-94	211-0510-00			1	SCREW, 6-32 x 3/8 inch, PHS
	- - - - - -			-	mounting hardware; (not included w/assembly)
-95	211-0507-00			3	SCREW, 6-32 x 5/16 inch, PHS
-96	337-0970-00			1	SHIELD, high voltage
	- - - - - -			-	mounting hardware: (not included w/shield)
-97	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-98	200-0818-00			1	COVER, plastic, terminal
-99	260-0675-00			1	SWITCH, unwired—115 V LINE 230 V
	- - - - - -			-	mounting hardware: (not included w/switch)
-100	210-0586-00	B010100	B010214	2	NUT, keps, 4-40 x 1/4 inch
	210-0406-00	B010215		2	NUT, hex., 4-40 x 1/4 inch
	337-1036-00			1	SHIELD
-101	260-0906-00			1	SWITCH, unwired—LOW MED HIGH
	- - - - - -			-	mounting hardware: (not included w/switch)
-102	210-0978-00			1	WASHER, flat, 3/8 ID x 1/2 inch OD
-103	210-0590-00			1	NUT, hex., 3/8-32 x 1/2 inch

FIG. 1 MECHANICAL PARTS *(cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-104	179-1223-00			1	CABLE HARNESS, switch
-105	386-1306-00			1	PLATE, rear
-106	161-0046-00			1	CORD, power
-107	358-0161-00			1	BUSHING, strain relief
-108	131-0569-00			1	CONNECTOR, 25 pin, female
	- - - - - -			-	mounting hardware: (not included w/connector)
-109	211-0101-00			2	SCREW, 4-40 x 1/4 inch, FHS
-110	210-0201-00			1	LUG, solder, SE #4
-111	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-112	352-0002-00			1	ASSEMBLY, fuse holder
	- - - - - -			-	assembly includes:
-113	352-0010-00			1	HOLDER, fuse
-114	200-0582-00			1	CAP, fuse, black
-115	210-0873-00			1	WASHER, rubber, 1/2 ID x 11/16 inch OD
-116	- - - - - -			1	NUT
-117	337-0968-01			1	SHIELD, electrical
	- - - - - -			-	mounting hardware: (not included w/shield)
-118	211-0008-00			2	SCREW, 4-40 x 1/4 inch, PHS
	210-0004-00			2	LOCKWASHER, internal, #4
-119	441-0756-00			1	CHASSIS, circuit board
	- - - - - -			-	mounting hardware: (not included w/chassis)
	212-0023-00			2	SCREW, 8-32 x 3/8 inch, PHS
	210-0458-00			4	NUT, keps, 8-32 x 11/32 inch
-120	348-0056-00			1	GROMMET, plastic, 3/8 inch diameter
-121	348-0031-00			5	GROMMET, plastic, 5/32 inch diameter
-122	131-0274-00			3	CONNECTOR, coaxial, 1 contact, female w/hardware
-123	131-0359-00			6	CONNECTOR, terminal feed thru
	- - - - - -			-	mounting hardware for each: (not included w/connector)
-124	358-0176-00			1	BUSHING, plastic
-125	214-0757-00			4	HEAT SINK, transistor, w/hardware
-126	344-0016-00			2	CLIP, capacitor mounting, 1 inch
	- - - - - -			-	mounting hardware for each: (not included w/clip)
	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-127	344-0117-00			2	CLIP, capacitor mounting, 1/4 inch
	- - - - - -			-	mounting hardware for each: (not included w/clip)
-128	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-129	255-0249-00			FT	CHANNEL, plastic, 15 5/8 inches

FIG. 1 MECHANICAL PARTS *(cont)*

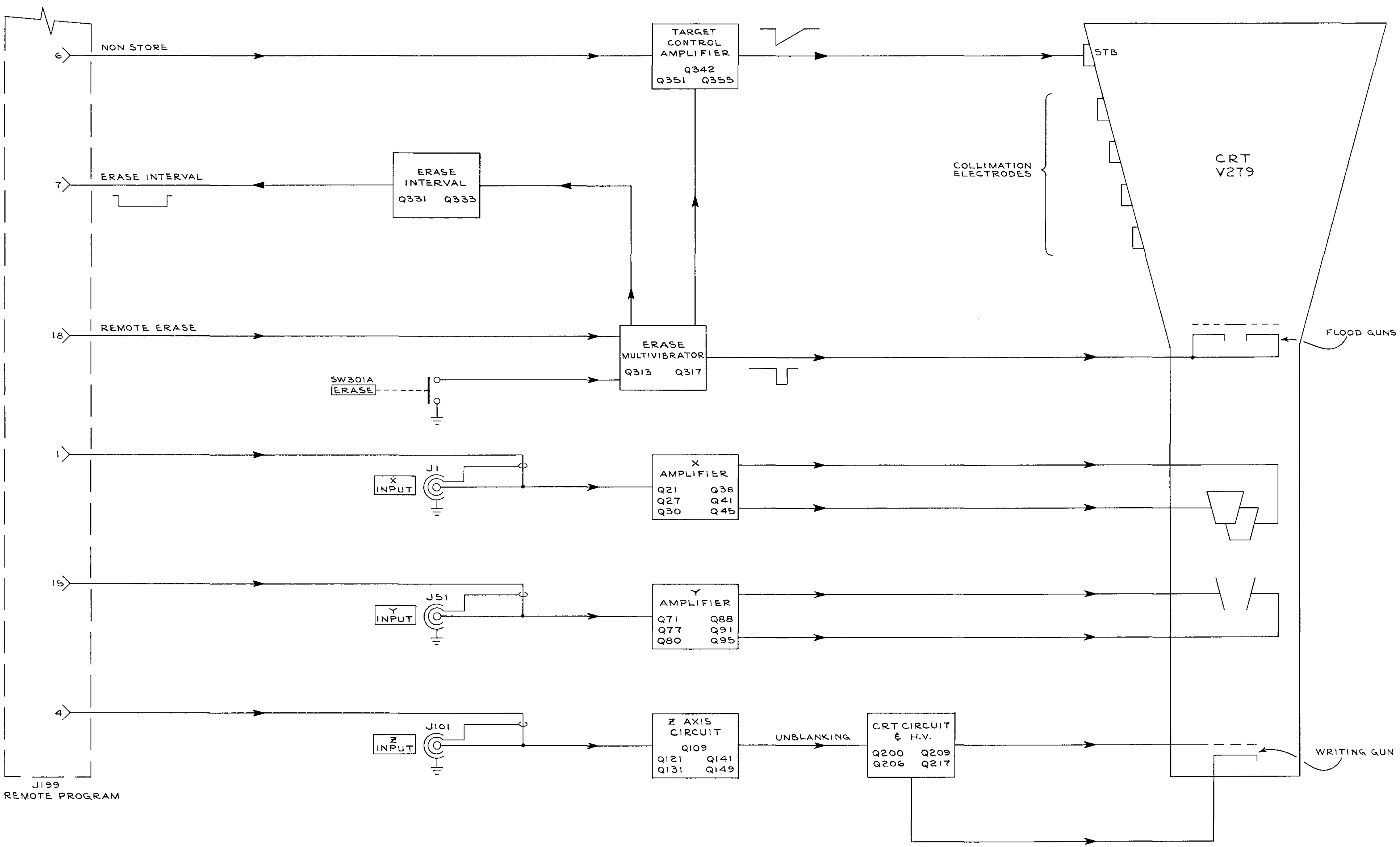
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
1-130	- - - - - -			3	TRANSISTOR
	- - - - - -			-	mounting hardware for each: (not included w/transistor)
-131	211-0510-00			2	SCREW, 6-32 x 3/8 inch, PHS
-132	386-0143-00			1	PLATE, mica, insulating
	210-0811-00			2	WASHER, fiber, #6
	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
-133	210-0202-00			1	LUG, solder, SE #6
-134	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-135	352-0031-00			3	HOLDER, fuse
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-136	213-0054-00			1	SCREW, thread forming, 6-32 x 5/16 inch, PHS
-137	252-0564-00			FT	CHANNEL, plastic, 7 3/4 inches
-138	- - - - - -			1	THERMAL CUTOUT
	- - - - - -			-	mounting harware: (not included w/cutout)
	211-0504-00			2	SCREW, 6-32 x 1/4 inch, PHS
	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-139	343-0089-00			2	CLAMP, cable, plastic, large
-140	179-1226-00			1	CABLE HARNESS, chassis, w/connector
-141	105-0065-00			9	SUPPORT, circuit board
	- - - - - -			-	mounting hardware for each: (not included w/support)
-142	361-0007-00			7	SPACER, plastic, 0.188 inch long
-143	344-0147-00			7	CLIP, circuit board mounting
	- - - - - -			-	mounting hardware for each: (not included w/clip)
-144	214-0967-00			1	PIN, guide
	214-0966-00			1	SPRING, helical compression
-145	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-146	131-0682-00			12	TERMINAL, feed thru
-147	131-0682-02			52	TERMINAL, feed thru
-148	670-0551-00			1	ASSEMBLY, circuit board—DEFLECTION AMPLIFIER
	- - - - - -			-	assembly includes:
	388-0922-00			1	BOARD, circuit
-149	131-0505-00	B010100	B040519	8	CONNECTOR, terminal stud
	214-0519-00	B040520		8	CONNECTOR, terminal stud
-150	136-0220-00			4	SOCKET, transistor, 3 pin
-151	136-0235-00			2	SOCKET, transistor, 6 pin
-152	136-0263-00	B010100	B040479	22	SOCKET, connector, pin
	136-0263-01	B040480		22	SOCKET, connector, pin

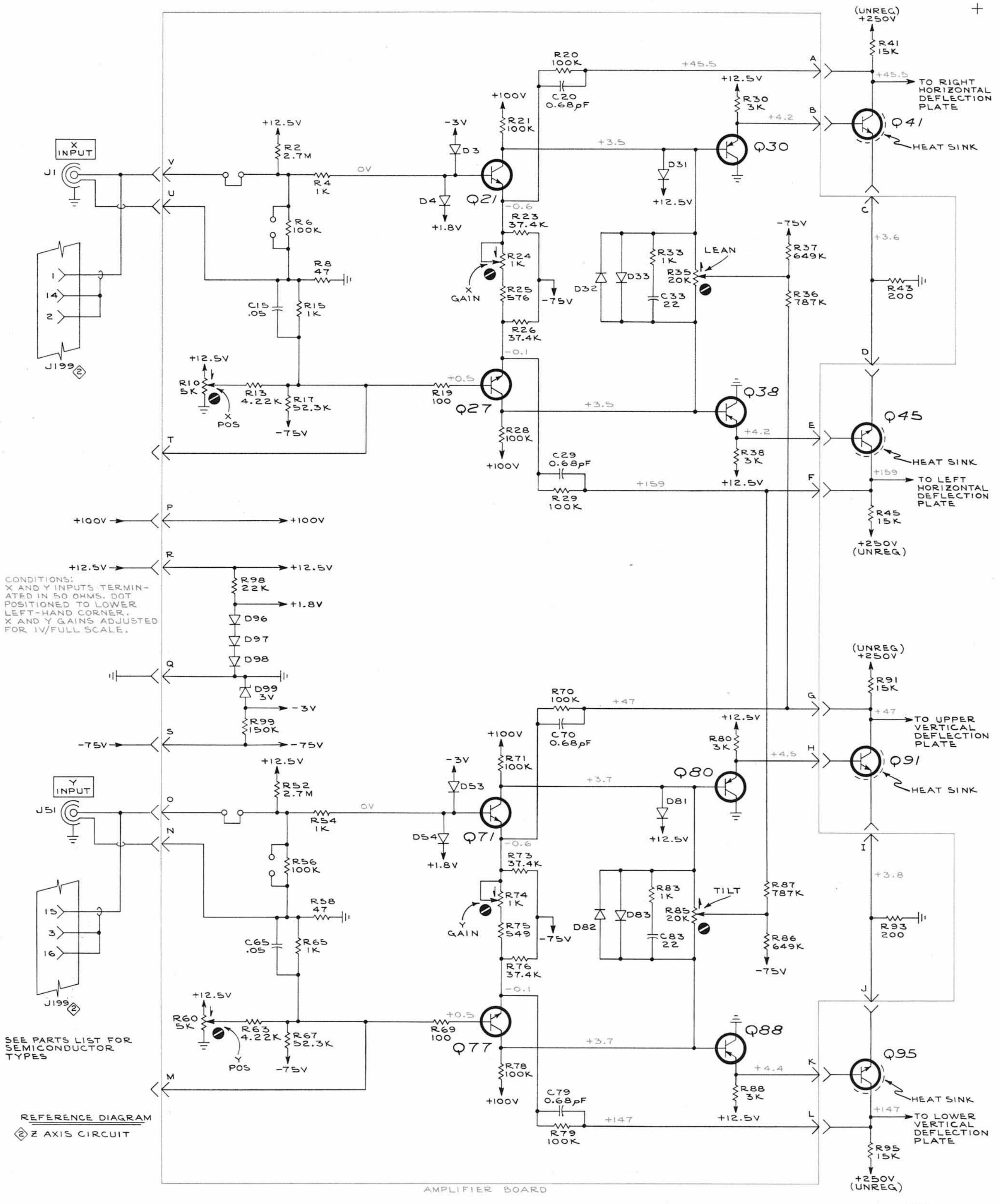
FIG. 1 MECHANICAL PARTS *(cont)*

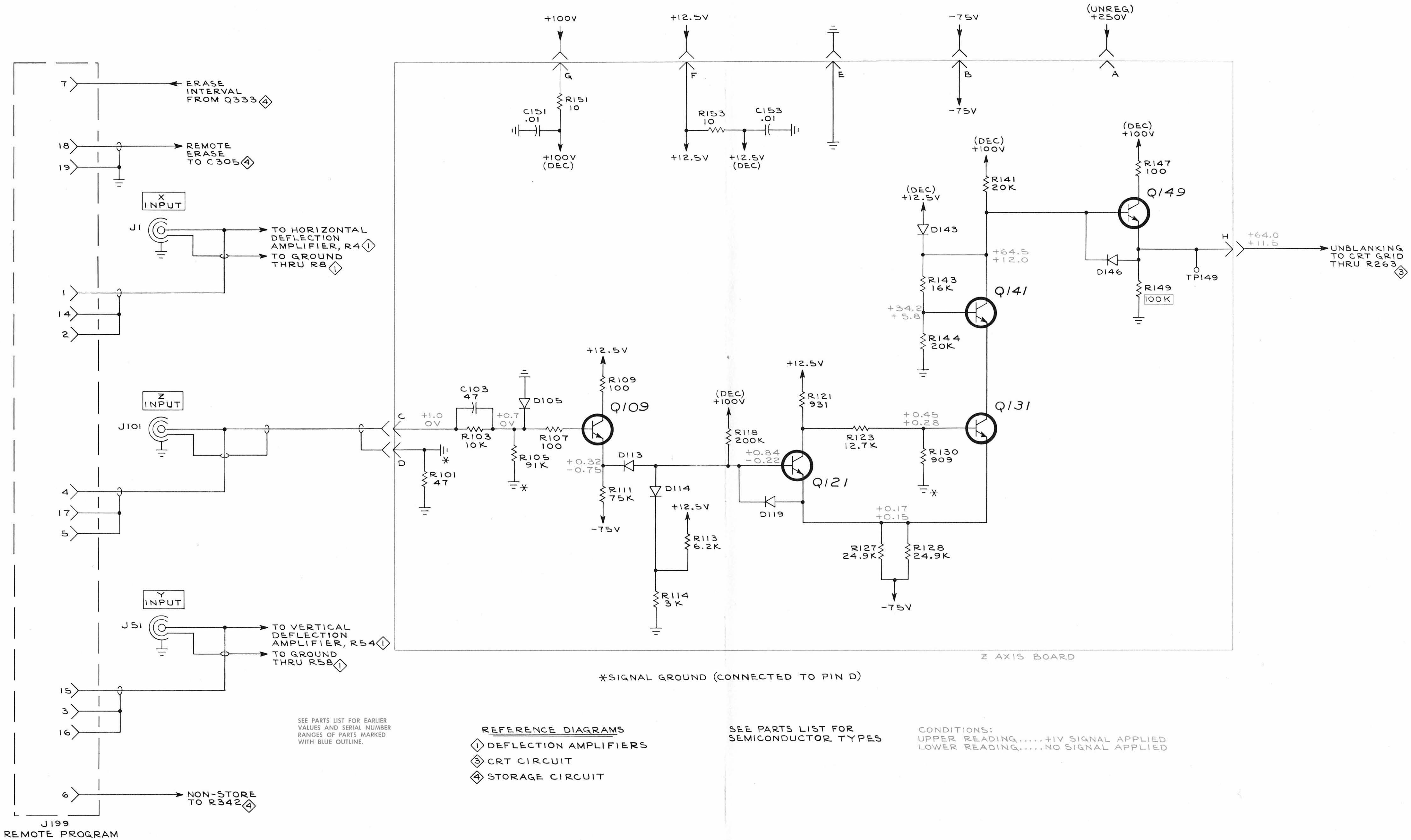
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
-153	670-0552-00			1	ASSEMBLY, circuit board—Z AXIS
	- - - - - -			-	assembly includes:
	388-0923-00			1	BOARD, circuit
-154	136-0220-00			5	SOCKET, transistor, 3 pin
-155	136-0263-00	B010100	B040479	8	SOCKET, connector, pin
	136-0263-01	B040480		8	SOCKET, connector, pin
-156	214-0579-00			1	PIN, test point
-157	670-0550-00			1	ASSEMBLY, circuit board—LOW VOLTAGE POWER
	- - - - - -			-	assembly includes:
	388-0921-00			1	BOARD, circuit
-158	136-0220-00			9	SOCKET, transistor, 3 pin
-159	136-0263-00	B010100	B040479	34	SOCKET, connector, pin
	136-0263-01	B040480		34	SOCKET, connector, pin
-160	214-0579-00			7	PIN, test point
-161	260-0920-00			1	ASSEMBLY, push button—ERASE ON OFF
	- - - - - -			-	assembly includes:
-162	380-0084-00			1	HOUSING, push button
-163	366-0342-06			1	KNOB, push button—ERASE
-164	366-0342-05			1	KNOB, push button—ON
-165	366-0342-04			1	KNOB, push button—OFF
-166	670-0546-00	B010100	B020279	1	ASSEMBLY, circuit board—erase switch
	131-0634-00	B020280		1	ASSEMBLY, contact—erase switch
	- - - - - -			-	mounting hardware: (not included w/assembly)
-167	211-0087-00			2	SCREW, 2-56 x 3/16 inch, FHS
-168	214-0998-01			2	PIN, straight, headed
-169	407-0424-00	B010100	B040879	1	BRACKET, sensitive switch
	407-0424-01	B040880		1	BRACKET, sensitive switch
	213-0178-00			2	SCREW, set, 4-40 x 1/8 inch long
-170	214-1005-00			1	ACTUATOR, bar, switch
	- - - - - -			-	mounting hardware: (not included w/actuator)
-171	213-0177-00			1	SCREW, shouldered
	214-1003-00			1	SPRING, helical, compression
	210-0405-00			1	NUT, hex., 2-56 x 3/16 inch
-172	260-0612-00			2	SWITCH, unwired—sensitive
	- - - - - -			-	mounting hardware for each: (not included w/switch
-173	211-0034-00			2	SCREW, 2-56 x 1/2 inch, RHS
-174	214-1015-00			1	NUT, plate, 2-56
	- - - - - -			-	mounting hardware: (not included w/assembly)
	210-0801-00			2	WASHER, flat, 0.140 ID x 0.281 inch OD
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
-175	348-0146-00			1	PAD, cushioning, 1/2 inch wide x 3 inches long

FIG. 2 CABINET

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
2-1	390-0018-00	B010100	B049999	1	CABINET, wrap-around
	390-0018-01	B050000		1	CABINET, wrap-around
	- - - - - -			-	cabinet includes:
-2	248-0138-00	B010100	B020299	4	FOOT, plastic, black
	348-0187-00	B020300		4	FOOT, plastic
	- - - - - -			-	mounting hardware for each: (not included w/foot)
-3	211-0503-00			1	SCREW, 6-32 x 3/16 inch, PHS
-4	210-0006-00	B010100	B040719X	1	LOCKWASHER, internal, #6
-5	367-0037-00			1	HANDLE, carrying
	- - - - - -			-	mounting hardware: (not included w/handle)
-6	344-0098-00			2	CLIP, chrome
-7	213-0155-00			2	SCREW, 10-32 x 0.40 inch, BHS
-8	105-0074-00			1	LATCH, plastic, cabinet
	- - - - - -			-	mounting hardware: (not included w/latch)
-9	210-0802-00			2	WASHER, flat, 0.150 ID x 5/16 inch OD
-10	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
	- - - - - -			-	mounting hardware: (not included w/latch)
-11	212-0092-00			2	SCREW, 8-32 x 5/8 inch, THS


NON STORE
6
ERASE INTERVAL
7
REMOTE ERASE
18
1
15
4
J199
REMOTE PROGRAM
TARGET CONTROL AMPLIFIER
Q342
Q351 Q355
ERASE INTERVAL
Q331 Q333
ERASE MULTIVIBRATOR
Q313 Q317
SW301A
ERASE
J1
X INPUT
X AMPLIFIER
Q21 Q38
Q27 Q41
Q30 Q45
J51
Y INPUT
Y AMPLIFIER
Q71 Q88
Q77 Q91
Q80 Q95
J101
Z INPUT
Z AXIS CIRCUIT
Q109
Q121 Q141
Q131 Q149
UNBLANKING
CRT CIRCUIT & H.V.
Q200 Q209
Q206 Q217
STB
COLLIMATION ELECTRODES
CRT
V279
FLOOD GUNS
WRITING GUN


X INPUT
J1
J199 2
Y INPUT
J51
(UNREG) +250V
R41 15K
+45.5
TO RIGHT HORIZONTAL DEFLECTION PLATE
Q41
HEAT SINK
R20 100K
C20 0.68pF
+100V
R21 100K
+12.5V
R2 2.7M
R4 1K
0V
-3V
D3
D4
Q21
+1.8V
R30 3K
+4.2
+3.5
Q30
D31
+12.5V
R6 100K
R8 47
R23 37.4K
R24 1K
R25 576
R26 37.4K
GAIN
X
-75V
D32
D33
R33 1K
R35 20K
C33 22
LEAN
R37 649K
R36 787K
R43 200
+3.6
C15 .05
R15 1K
R10 5K
R13 4.22K
R17 52.3K
POS
R19 100
+0.5
-0.1
-0.6
Q27
R28 100K
C29 0.68pF
R29 100K
+159
Q38
Q45
+4.2
R38 3K
TO LEFT HORIZONTAL DEFLECTION PLATE
R45 15K
+250V (UNREG)
+100V
+12.5V
CONDITIONS: X AND Y INPUTS TERMINATED IN 50 OHMS. DOT POSITIONED TO LOWER LEFT-HAND CORNER. X AND Y GAINS ADJUSTED FOR 1V/FULL SCALE.
R98 22K
+1.8V
D96
D97
D98
D99 3V
-3V
R99 150K
-75V
R70 100K
+47
C70 0.68pF
TO UPPER VERTICAL DEFLECTION PLATE
R91 15K
Q91
R80 3K
+4.5
Q80
+3.7
R71 100K
R52 2.7M
R54 1K
D53
D54
Q71
D81
R56 100K
R58 47
R73 37.4K
R74 1K
R75 549
R76 37.4K
Y
D82
D83
R83 1K
R85 20K
C83 22
TILT
R87 787K
R86 649K
R93 200
+3.8
C65 .05
R65 1K
R60 5K
R63 4.22K
R67 52.3K
R69 100
Q77
R78 100K
C79 0.68pF
R79 100K
+147
Q88
+4.4
R88 3K
Q95
TO LOWER VERTICAL DEFLECTION PLATE
R95 15K
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
REFERENCE DIAGRAM
2 Z AXIS CIRCUIT
AMPLIFIER BOARD



*SIGNAL GROUND (CONNECTED TO PIN D)

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

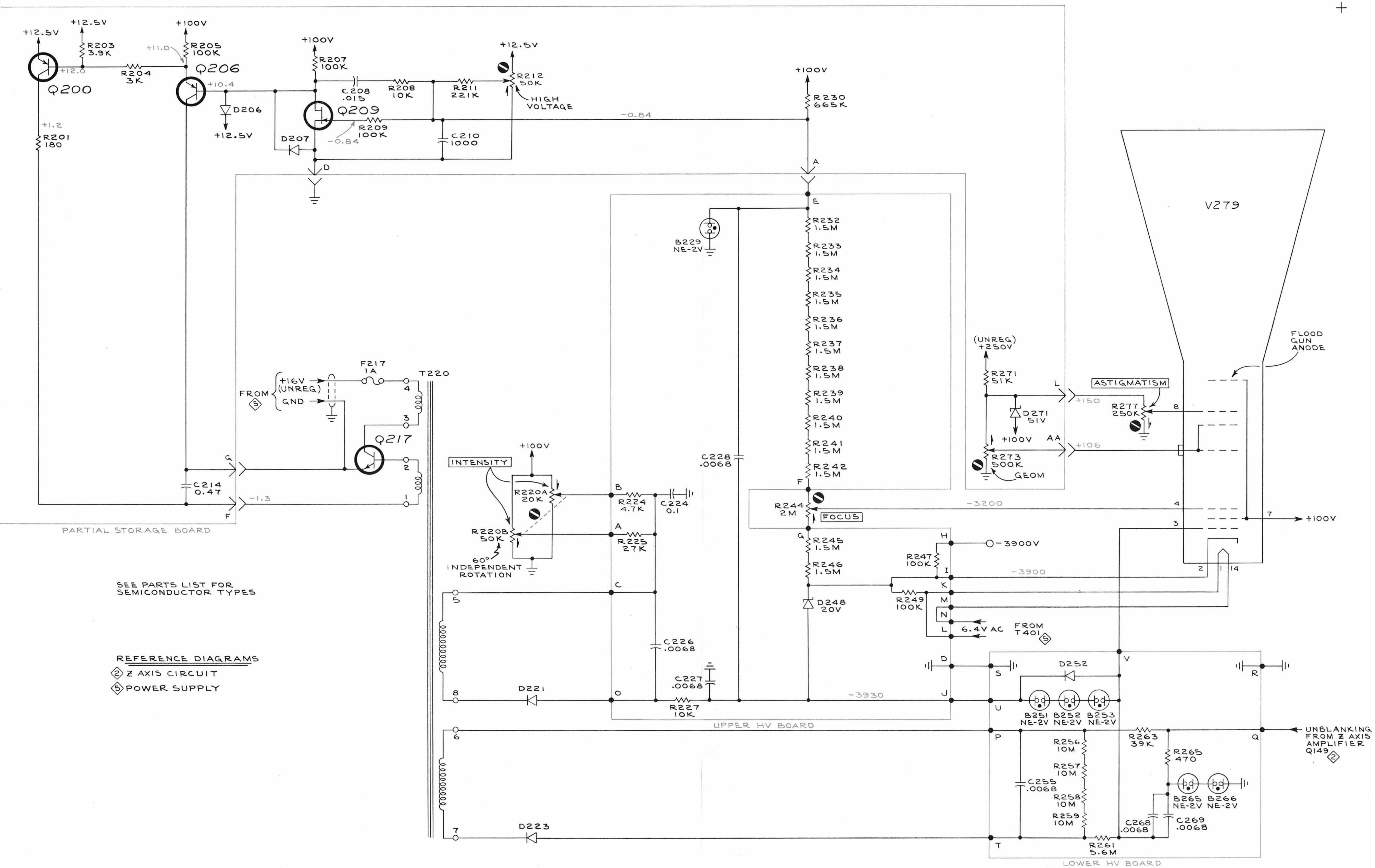
REFERENCE DIAGRAMS
1 DEFLECTION AMPLIFIERS
3 CRT CIRCUIT
4 STORAGE CIRCUIT

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

CONDITIONS:
UPPER READING.....+1V SIGNAL APPLIED
LOWER READING.....NO SIGNAL APPLIED

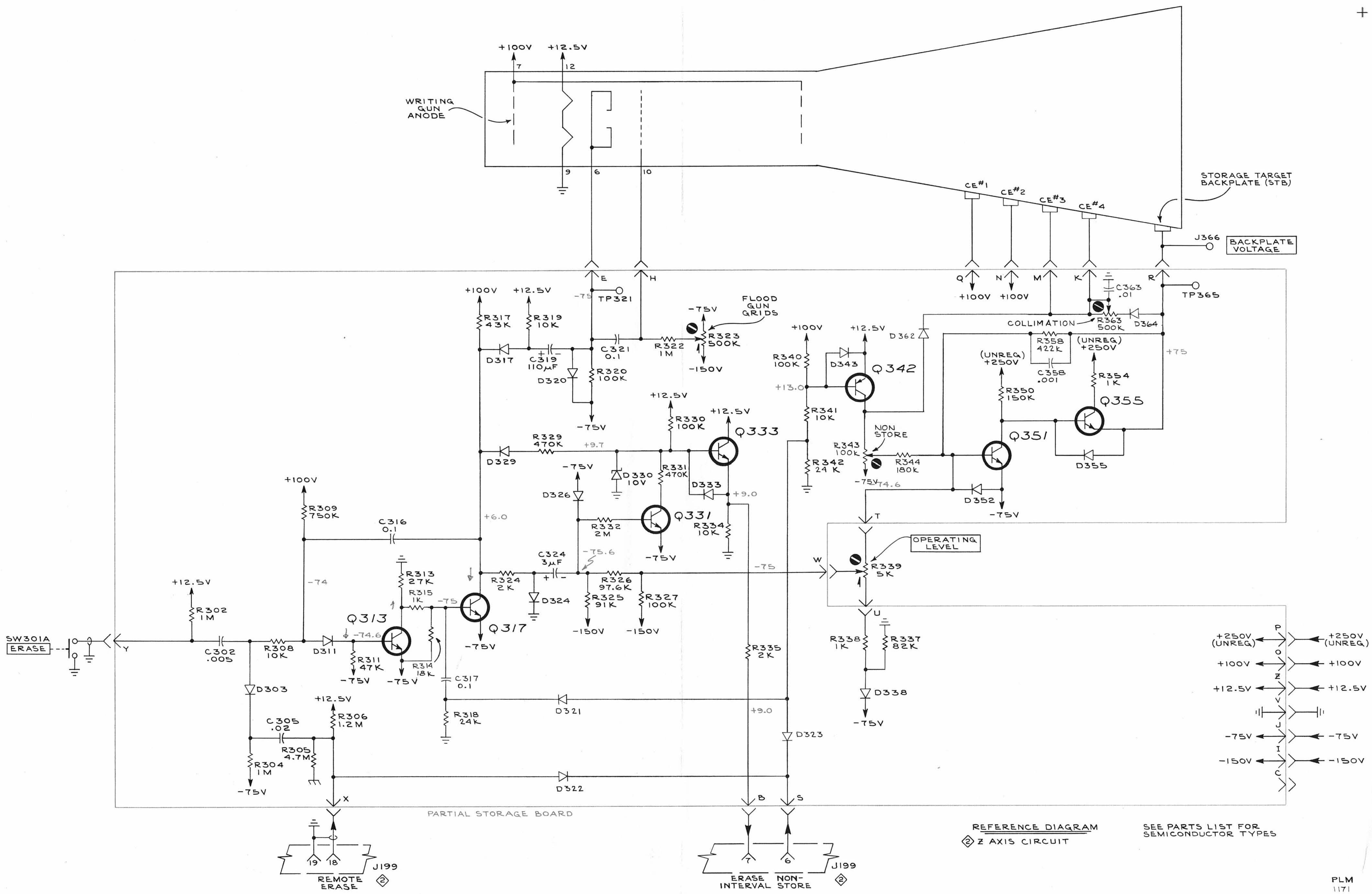
Z AXIS CIRCUIT 2

PLM
0870



SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS
2 Z AXIS CIRCUIT
5 POWER SUPPLY



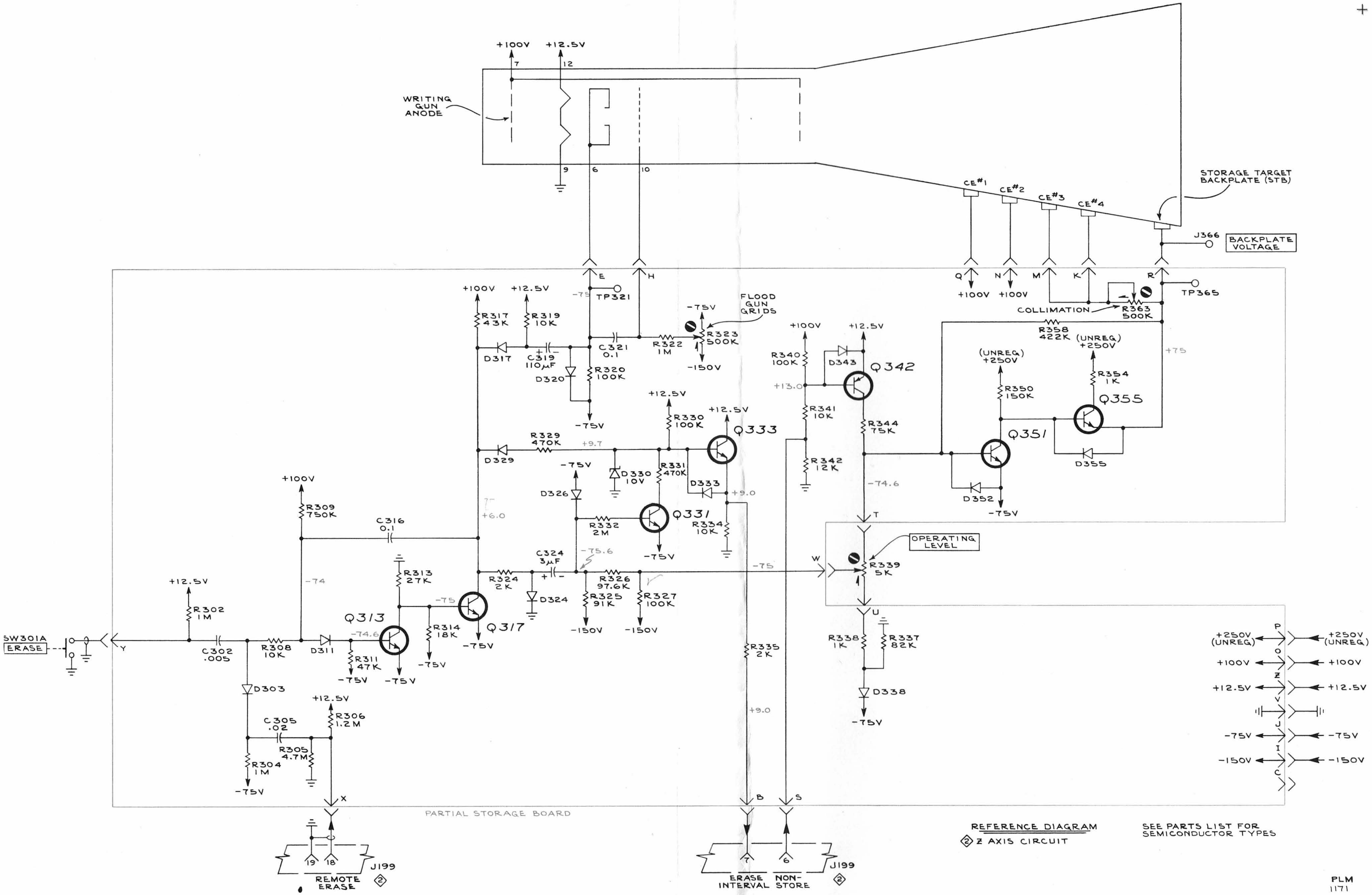
TYPE 601 STORAGE DISPLAY UNIT

REFERENCE DIAGRAM
② Z AXIS CIRCUIT

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

PLM
1171

STORAGE CIRCUIT ④
SN B060000-UP

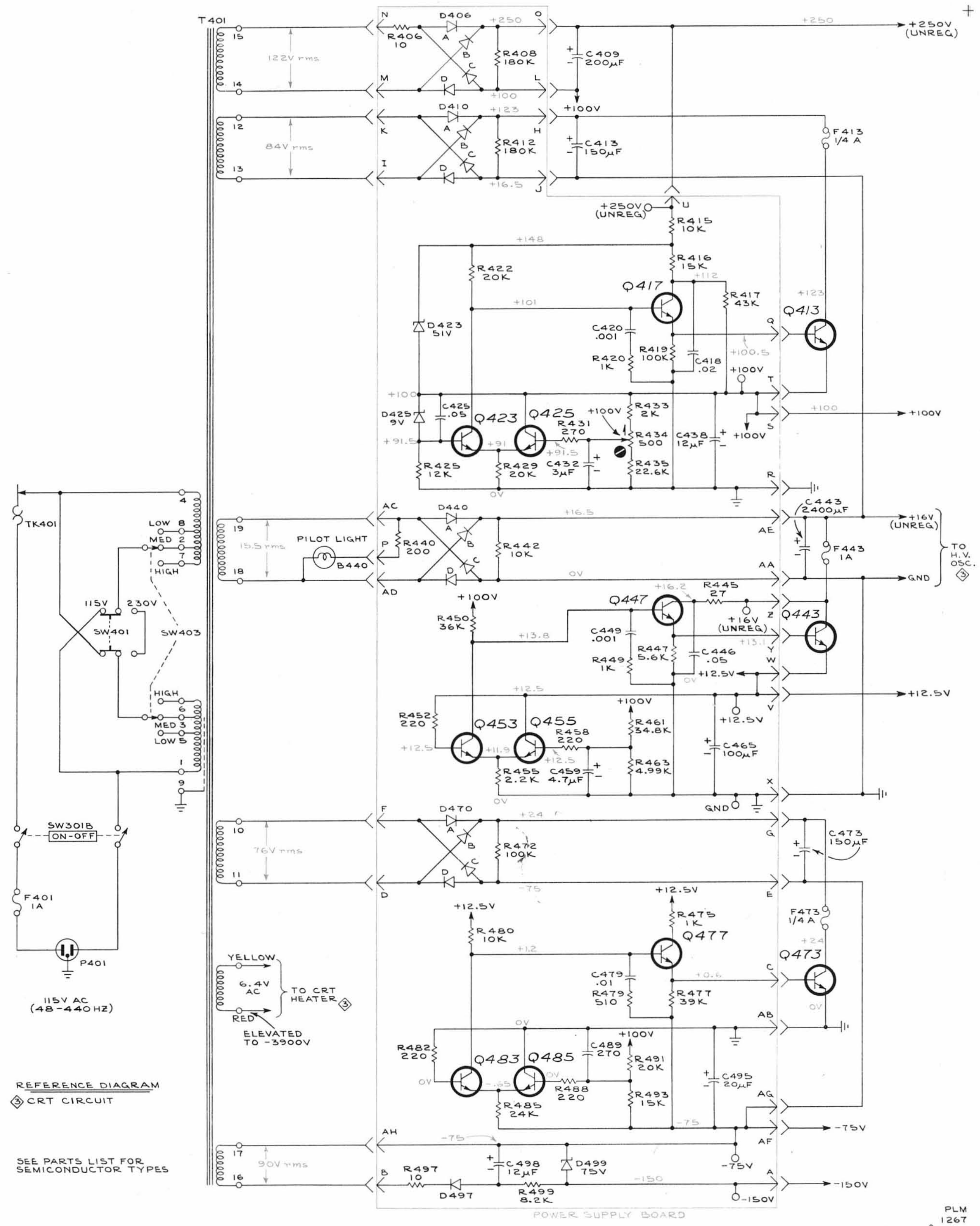


TYPE 601 STORAGE DISPLAY UNIT

STORAGE CIRCUIT 4

SN B010100 - B059999

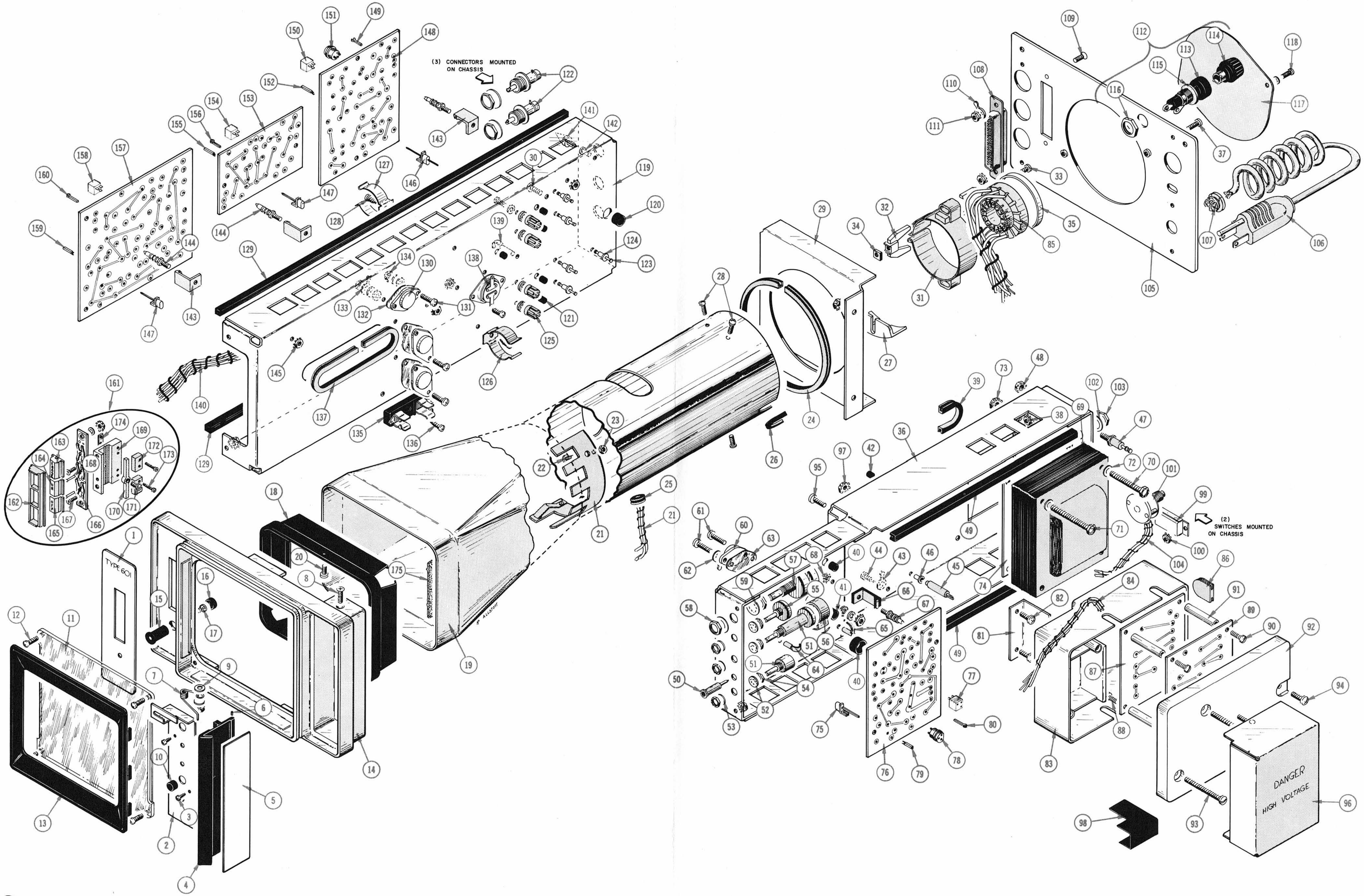
Scan by Zenith



TYPE 601 STORAGE DISPLAY UNIT

POWER SUPPLY ⑤

Fig. 1 MECHANICAL PARTS



TYPE 601 STORAGE DISPLAY UNIT

Fig. 2 CABINET

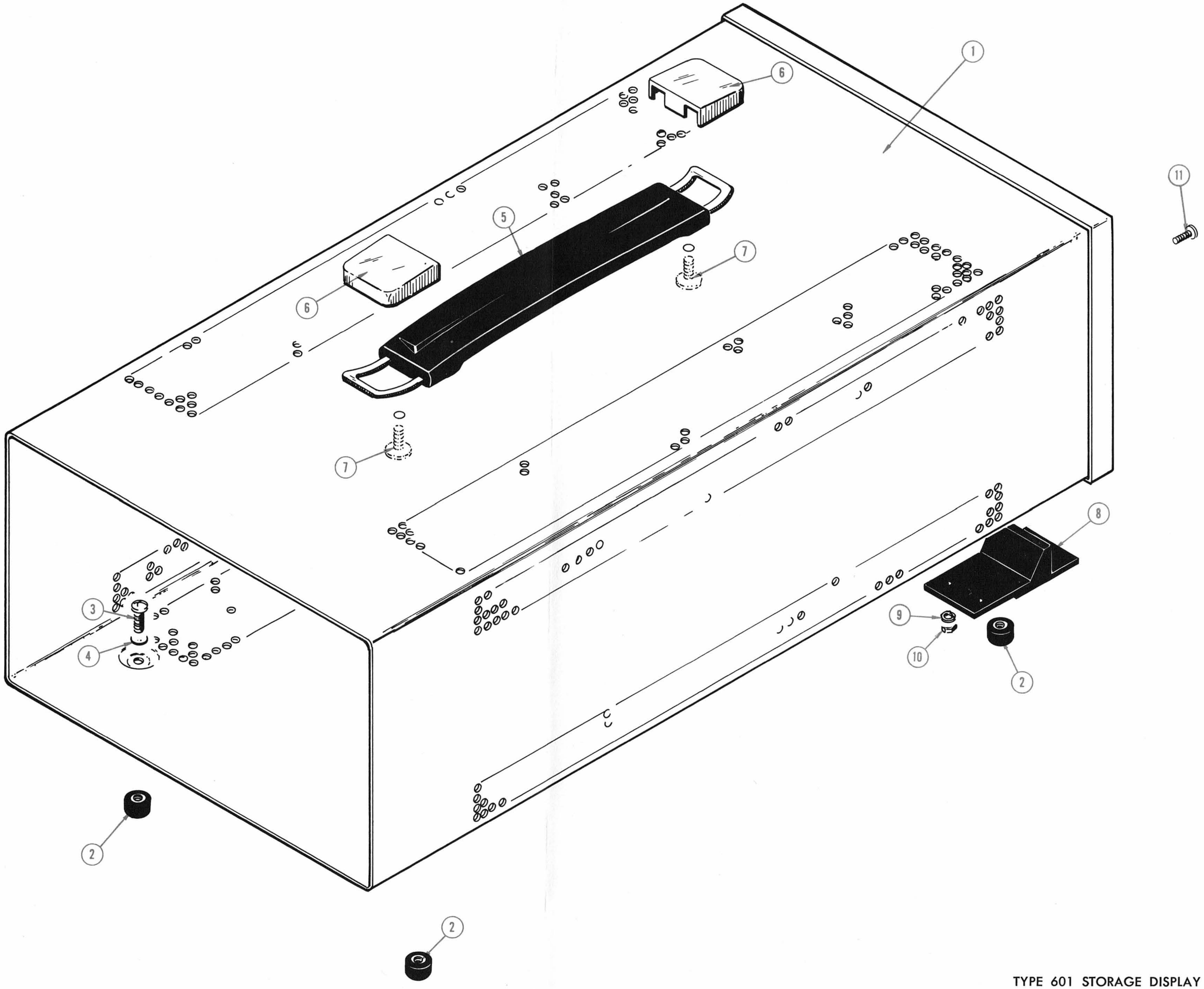


Fig. 2

OPTIONAL ACCESSORIES (Not shown)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
	016-0248-00			1	ADAPTER, camera, C-30
	016-0115-02			1	RACKMOUNTING CABINET for two 601's
	016-0116-00			1	PANEL ASSEMBLY, 1/2 rack width

Ⓐ2

Fig. 3 STANDARD ACCESSORIES

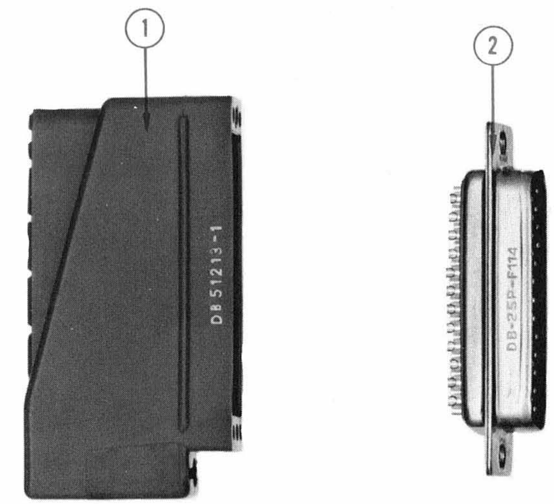


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
3-1	200-0821-00			1	COVER, connector
-2	131-0570-00			1	CONNECTOR, 25 pin, male
	070-0747-00			2	INSTRUCTION MANUAL (not shown)

Ⓑ1

Fig. 3 ACCESSORIES