INSTRUCTION MANUAL

TYPE 647 OSCILLOSCOPE

TEKTRONIX

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

INSTRUCTION MANUAL

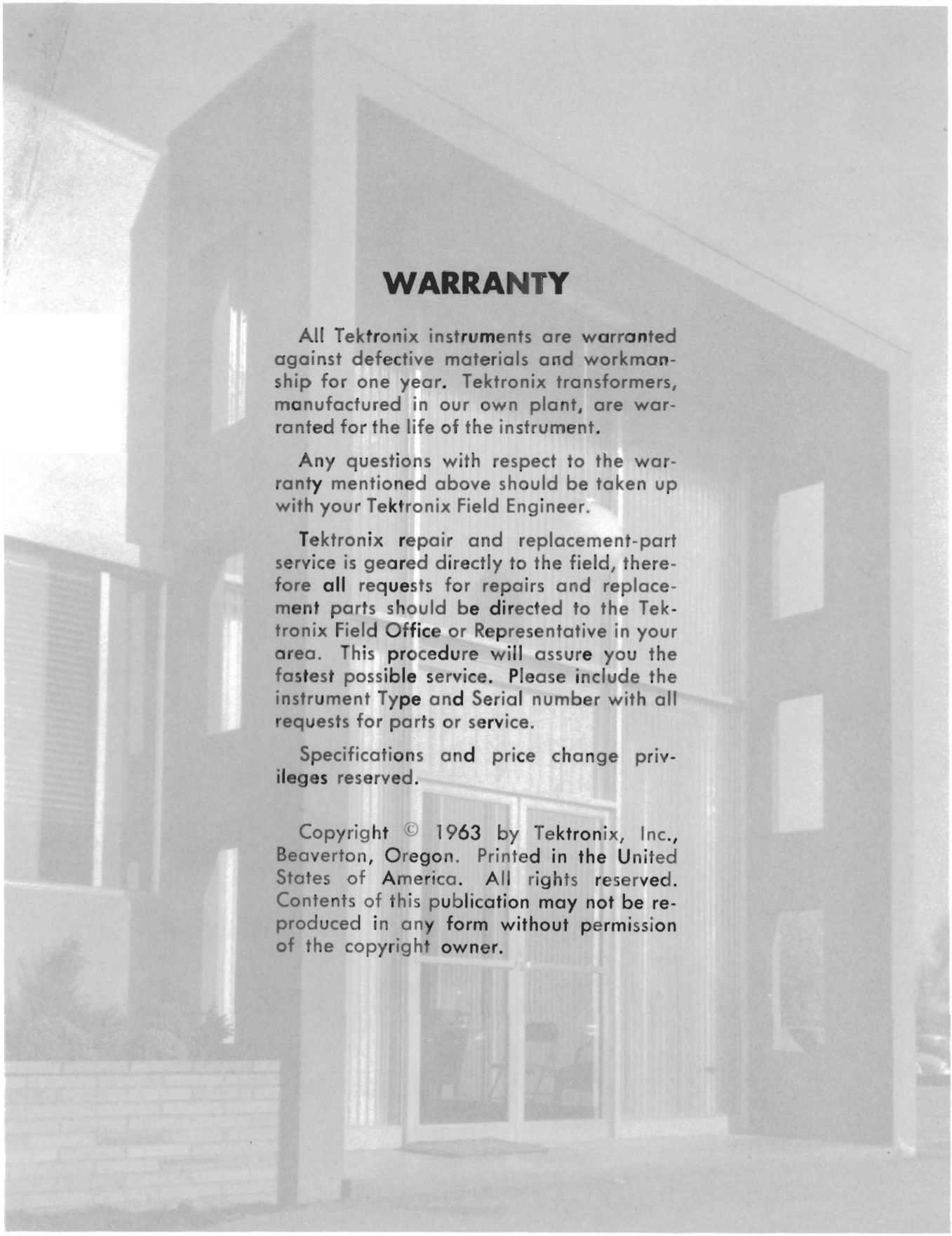
Serial Number 607

TYPE 647 OSCILLOSCOPE

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon ● Phone MI 4-0161 ● Cables: Tektronix

070-370

1163



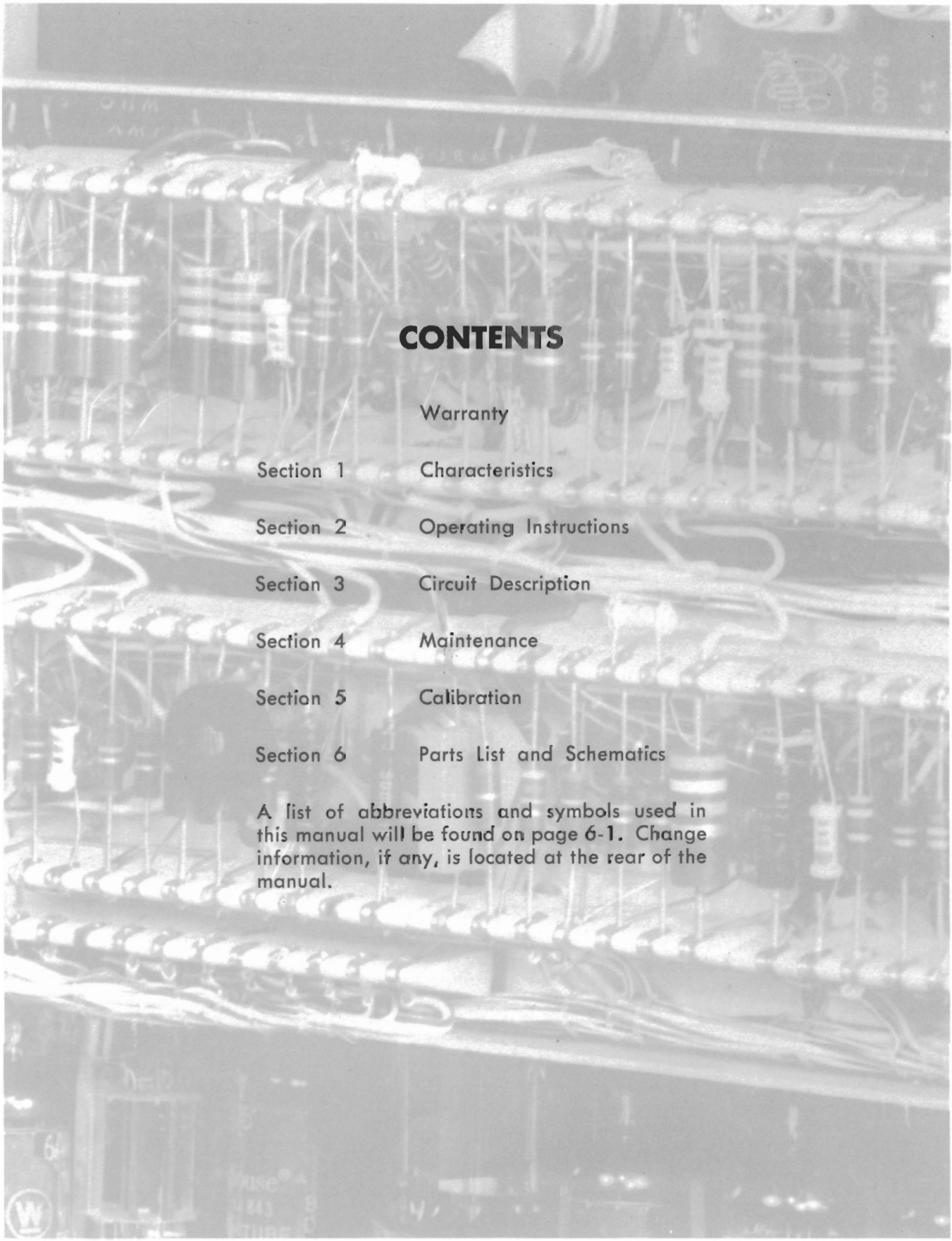
WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own 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.

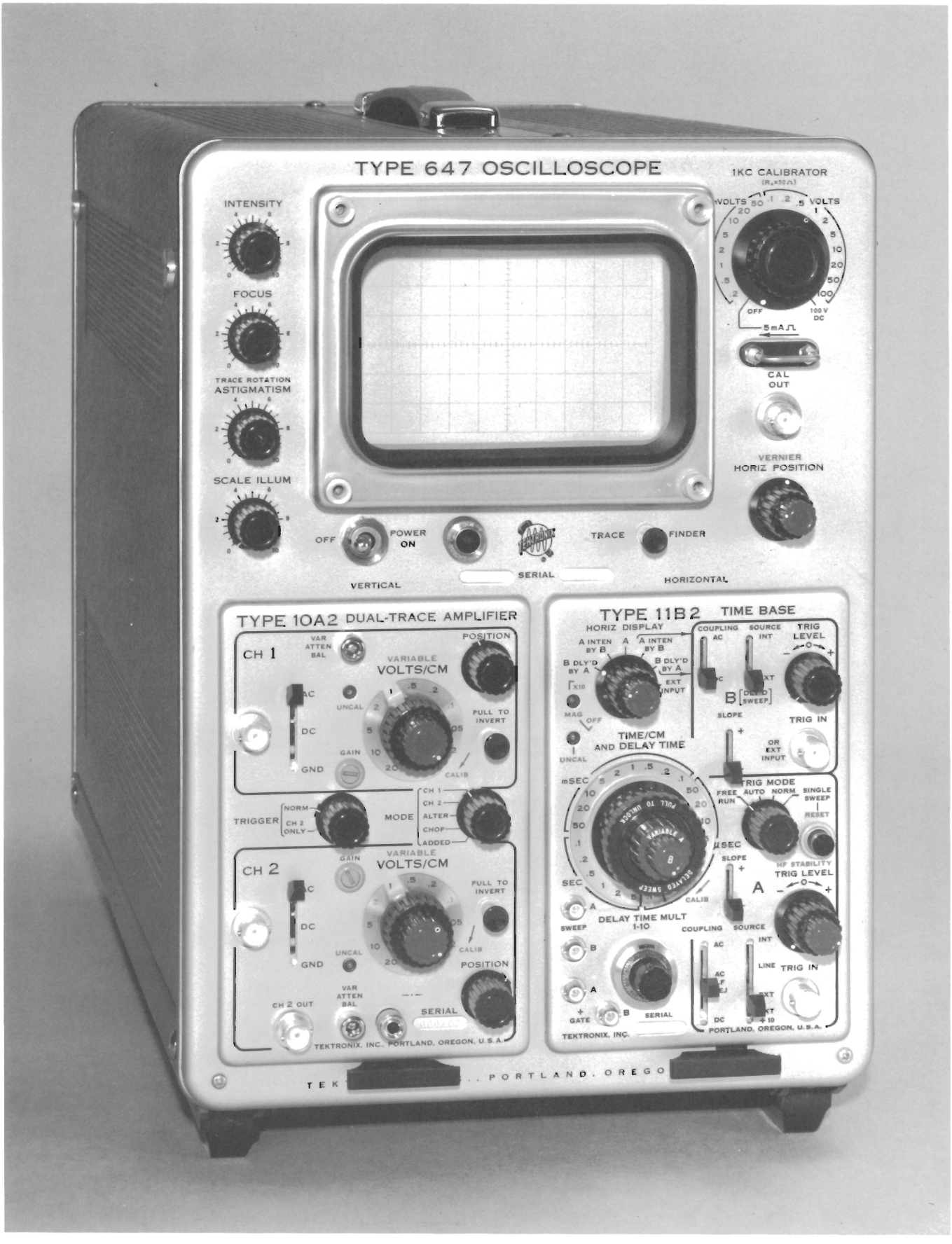
Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument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

Specifications and price change privileges reserved.



CONTENTS

A list of abbreviations and symbols used in this manual will be found on page 6-1. Change information, if any, is located at the rear of the manual.



The Type 647 Oscilloscope

SECTION 1

CHARACTERISTICS

General Information

The Tektronix Type 647 is a general purpose, high-performance oscilloscope designed to operate under severe environmental conditions. The oscilloscope requires a Tektronix 10-Series vertical plug-in unit in the left-hand compartment and a Tektronix 11-Series horizontal plug-in unit in the right-hand compartment.

The electrical characteristics listed below are those of the Type 647, independent of the plug-in units. The environmental characteristics apply to the Type 647 and its plug-in units as a system.

NOTE

Range I and Range II, referred to in certain parts of this section, are the ambient air temperature ranges that apply for a particular characteristic. These ranges are—Range I: 0°C to +40°C, Range II: −30°C to +65°C.

Vertical Amplifier (Range I)

Sensitivity

300 mv/cm, ±1%, through 186 Ω push-pull.

Risetime

Less than 5.8 nsec; 5.5 nsec typical

Bandwidth

Dc to greater than 60 mc (30% down); 64 mc typical.

Display Linearity

A 2 cm centered signal will not change amplitude more than ±1 mm when offset to top or bottom of graticule.

Trace Finder

Compresses display within graticule area. Used to determine nature of improper deflection signal. Pushbutton also actuates trace-finder switch in Horizontal Amplifier. See Section 2.

Horizontal Amplifier

Sensitivity

347 μa/cm per side, ±1%, push-pull.

Maximum Calibrated Deflection Rate

10 nsec/cm.

Bandwidth

Refer to appropriate horizontal plug-in manual for combined response.

Trace Finder

See "Trace Finder" in Vertical Amplifier characteristics.

Single-Sweep Reset

Connection between J101 on the rear panel and the 11-Series plug-in unit interconnecting socket provides for external reset of the single-sweep circuit in certain plug-in units. See J101 under "Rear Panel Connectors" in Section 2.

Cathode-Ray Tube

Type

T6470-31-1.

Phosphor

Type P31 normally supplied.

Accelerating Potential

14 kv.

Graticule Area

6 x 10 cm.

Graticule Markings

Internally marked in 6 vertical and 10 horizontal 1-cm spaces. 2-mm divisions marked on the vertical and horizontal centerlines. No parallax.

Graticule Illumination

Variable edge-lighting produces white (no filters) or red (with filters) graticule markings.

Unblanking

Bias-type, dc-coupled from 11-Series plug-in unit.

Crt Grid Z-Axis Modulation

Dc-coupled from rear-panel CRT GRID binding post. Input resistance about 22 kΩ. Bandwidth for small signals is dc to 10 mc (30% down point), or greater.
peak will produce a visible change in display brightness.

Crt Cathode Z-Axis Modulation

Ac-coupled from rear-panel CRT CATHODE binding post. Input time constant is about 330 μsec (0.015 μfd and 22 kΩ). Typically, a ±3-volt, fast-rise pulse will produce a visible change in display brightness.

Multi-Trace Chop Blanking

Crt circuitry permits multi-trace plug-in units, operating in chopped mode, to momentarily blank the display while switching between input channels.

Trace Rotation Control

Permits alignment of the trace with the graticule lines.

1-Kc Calibrator

Output Voltage Range

Square waves, 0.2 mv to 100 v peak-to-peak and 100 vdc.

Output Voltage Accuracy

(Load resistance 10 megΩ or higher)

0.1 and 100 VOLTS		All Other Voltages	
Range I	Range II	Range I	Range II
±1%	±1.5%	±2%	±3%

Output Resistance

0.2 mVOLTS to 0.1 VOLTS:	50 Ω, ±0.25%
0.2 VOLTS:	50 Ω, ±1%
0.5 to 100 VOLTS:	Varies with switch setting; about 4 kΩ maximum.

Current Through Loop

Square wave at 5 ma peak-to-peak, ±1.5%.

Frequency

1000 cps, ±0.1% (Range II).

Duty Factor

0.5, ±0.1% (Range II).

POWER REQUIREMENTS

Voltage Ranges

95 to 122 vac	190 to 244 vac
100 to 130 vac	200 to 260 vac
106 to 137 vac	212 to 296 vac

When shipped, instrument is wired for voltage range indicated on rear panel. Voltage range can be changed; see diagram attached to power transformer and fuse data provided in Section 4.

Line Voltage Distortion

For proper power supply operation at the lower line voltage limit, the line-voltage sine wave distortion must not exceed 1%.

Line Frequency

50 to 400 cps, ±10%.

Power Consumption

About 185 watts (with Type 10A2 and Type 11B2 plug-in units and 117-volt line).

Power Output Connector J101

Provides power from the regulated supplies of the Type 647 for operating external devices. Also provides an input connection for an external signal to reset the single-sweep circuit in certain 11-Series plug-in units. See Section 2.

ENVIRONMENTAL CHARACTERISTICS

Operating

Temperature

−30°C to +65°C continuous when the instrument is not tipped more than 20° in any direction from level position. Other positions require a decrease in maximum temperature. If operating at −30°C, allow 30 minutes for stabilization.

If simultaneously operated at maximum altitude and maximum line voltage in a particular operating voltage range, maximum operating temperature must be limited to +55°C. A self-resetting thermal cutout interrupts instrument power if internal temperature becomes excessive.

Altitude

15,000 feet, maximum.

Vibration

0.025 inch peak-to-peak, 10-55-10 cps (4 G's) for 15 minutes on each axis in one-minute sweeps.

Non-Operating

Temperature

−55°C to +75°C.

Altitude

50,000 feet, maximum.

Humidity

Meets Mil-Std-202B, method 106A through five cycles (120 hours), freezing and vibration excluded.

Shock

20 G's, one-half sine, for 11 milliseconds. Two shocks each direction along each of the three major axes (total of 12 shocks).

Vibration

Same as under "Operating".

Transit

Meets National Safe Transit type of test when factory packaged: Vibration for one hour at slightly greater than 1 G. 30-inch drops on corners, edges, and flat surfaces.

MECHANICAL CHARACTERISTICS

Construction

Front panel is photo-etched, anodized aluminum. Chassis is aluminum-alloy.

Dimensions

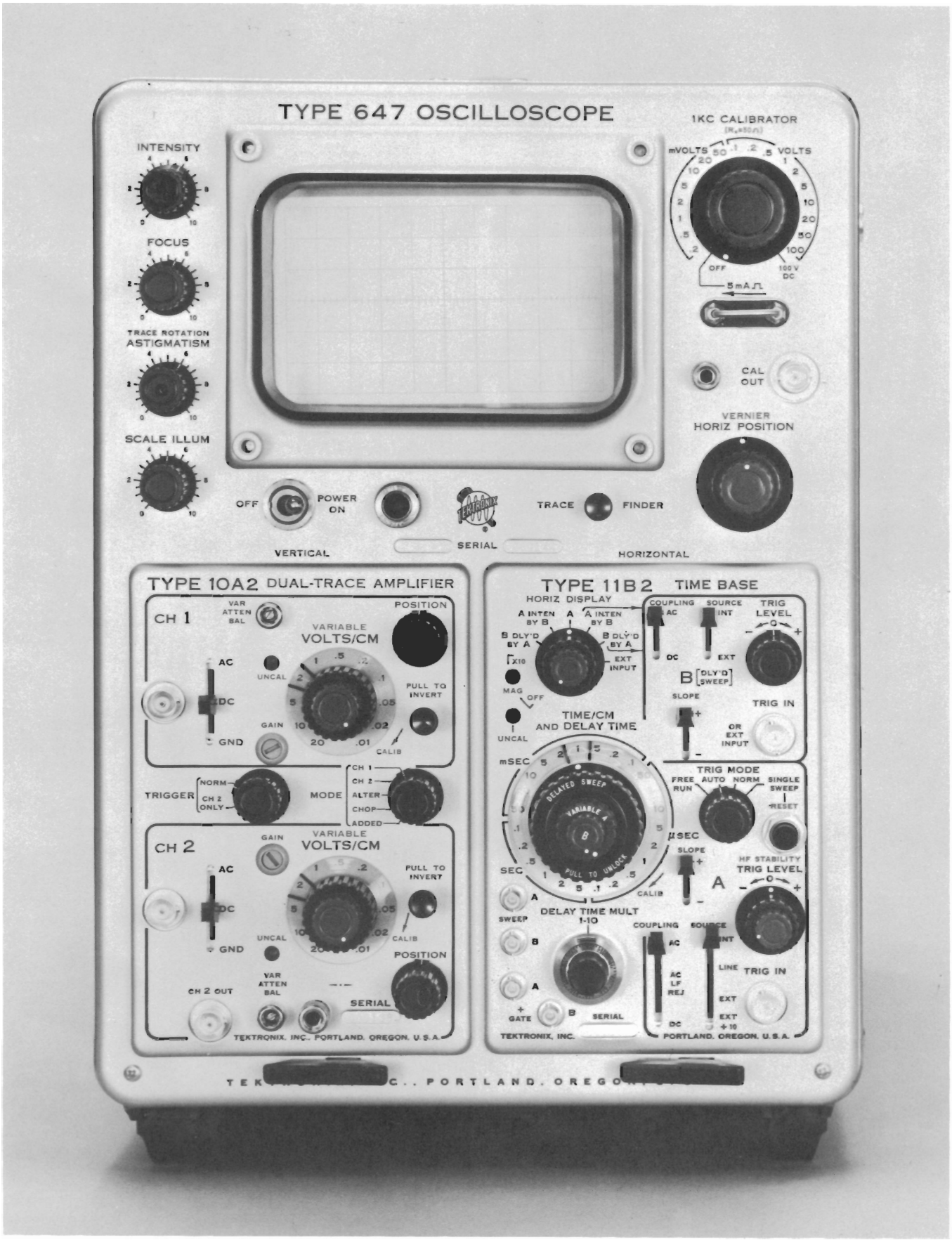
14.5 inches high.
10 inches wide.
23 inches deep.

Weight

40.5 pounds, net.

ACCESSORIES INCLUDED

	Tektronix Part No.
2—Instruction Manuals	070-370
1—Polarized Filter	378-540
1—3-Conductor Power Cord	161-013
1—3-Wire to 2-Wire Adapter	103-013
1—BNC to Binding Post Adapter	103-033
1—20-Inch 50 Ω Coaxial Cable with BNC Connectors	012-076



The Type 647 front panel controls.

SECTION 2

OPERATING INSTRUCTIONS

Introduction

The Type 647, when combined with a 10-Series and an 11-Series plug-in unit, is a complete oscilloscope system. The 10-Series plug-in unit can be operated only in the left compartment and the 11-Series in the right.

This section of the manual describes the function of each control and connector on the Type 647, as well as general operating information.

Operating Temperature

The Type 647 Oscilloscope can be stored where the ambient air temperature is between −55°C and +75°C, and operated where the ambient air temperature is between −30°C and +65°C. After storage at temperatures beyond the operating limits, be certain to allow the chassis temperature to come within the operating limits before power is applied.

Proper cooling of the Type 647 depends on convection. It is important to choose a location for operation where the required air flow, particularly to the bottom and rear of the instrument, is not restricted. Moreover, if operated when the ambient temperature is near +65°C, the instrument must not be tilted more than 20° in any direction from the level position.

When the instrument is operated both at maximum altitude and maximum line voltage in a particular operating voltage range, limit the maximum operating temperature to +55°C.

FIRST-TIME OPERATION

The following describes one way to properly set the FOCUS, ASTIGMATISM, and TRACE ROTATION controls.

1. Install the plug-in units.
2. Set the Type 647 INTENSITY control fully counterclockwise and apply power to the instrument. Allow several minutes for warmup.
3. Set the controls on the plug-in units and the Type 647 INTENSITY control for a free-running, vertically-centered trace of moderate intensity.
4. Set the controls on the 11-Series plug-in unit for a 100 μsec/cm sweep rate.
5. Set the controls on the 10-Series plug-in unit for a vertical sensitivity of 0.05 volt/cm.
6. Set the 1KC CALIBRATOR switch to .2 VOLTS and attach a cable from the CAL OUT connector to the vertical input.
7. Set the controls on the 11-Series plug-in unit for a triggered display.
8. With the FOCUS and ASTIGMATISM controls set at midrange, set the INTENSITY control so that part of the vertical portion of the trace can be seen.
9. Set the ASTIGMATISM control so that the horizontal and vertical portions of the display are equally focused, but not necessarily well focused.
10. Set the FOCUS control so that the vertical portion of the trace is as thin as possible.
11. Repeat steps 9 and 10 for best results. Make the final settings with the INTENSITY control set for the desired display brightness.

NOTE

To check for proper setting of the ASTIGMATISM control, slowly turn the FOCUS control back and forth through its optimum setting. If the ASTIGMATISM control is properly set, the horizontal and vertical portions of the trace will individually come into sharpest focus at the same position of the FOCUS control. This setting of the ASTIGMATISM control should be correct for any type of display. However, it may be necessary to reset the FOCUS control slightly if a large change is made in the INTENSITY control setting.

12. Disconnect the input signal and obtain a free-running, vertically-centered trace.
13. If necessary, set the TRACE ROTATION control (a screwdriver adjustment concentric with the ASTIGMATISM control) so that the trace is parallel with the graticule lines.

FUNCTION OF CONTROLS

INTENSITY	Permits control of display brightness. Lowest useable brightness is generally best for precise measurements since trace thickness decreases as intensity decreases.
FOCUS	Adjusted in conjunction with the ASTIGMATISM control to obtain sharp display definition. See "First-Time Operation" (at left) for a recommended adjustment method.
ASTIGMATISM	Adjusted so that the vertical and horizontal portions of a display are individually brought into sharpest focus at the same position of the FOCUS control.
TRACE ROTATION	A screwdriver adjustment concentric with the ASTIGMATISM control. Permits the operator to offset any trace tilt introduced by the earth magnetic field.

SCALE ILLUM	Permits brightness of the graticule markings to be varied.
1 KC CALIBRATOR	Permits selection of the accurate peak-to-peak square-wave voltage available at the CAL OUT connector. 100-volts dc and 5-ma square wave (through the current loop) also provided. Square-wave frequency is an accurate 1 kc. (See the discussion under "1 KC CALIBRATOR" in this section.)
HORIZ POSITION and VERNIER	Used to move the display horizontally. These controls are electrically part of whichever 11-Series plug-in unit is installed in the Type 647.
TRACE FINDER	When excessive deflection or improper centering result in loss of display, push the TRACE FINDER button so that the display is compressed within the graticule area. Center the display with the positioning controls and establish a vertical deflection amplitude of about 4 cm or less. Release the TRACE FINDER button. The display should then be restored.
OFF—POWER ON	Line switch for oscilloscope. Pilot lamp brightness can be varied by turning the bezel on the lamp housing.

1-KC CALIBRATOR

The following characteristics of the 1-Kc Calibrator provide a convenient means of verifying the accuracy of an oscilloscope system:

1. Accurate peak-to-peak and dc voltage output.
2. Accurate 5 ma peak-to-peak closed-loop current signal.
3. Accurate frequency.
4. Square-wave output signal.

Voltage

The 1-Kc Calibrator provides peak-to-peak voltages from 200 μvolts to 100 volts into high-resistance loads. With switch settings of .2 VOLTS and below, the output source resistance is 50 Ω as indicated by the voltages printed in red on the panel of the Type 647. The voltage across a 50 Ω termination will then be accurate at one-half the value indicated by the switch setting, provided the termination resistance is an accurate 50 Ω.

The +100-volt dc output of the calibrator has many uses, limited only by its current capability. The load resistance should be as high as possible (the output voltage will drop to 99 volts at about 35 kΩ).

Current

The current loop, located above the CAL OUT connector, provides a 5-ma peak-to-peak square wave which can be used for calibrating and checking current-probe systems such as the P6016/131. This current signal is obtained by clipping the probe through the loop and by setting the 1 KC CALIBRATOR switch to the first position clockwise from OFF.

The arrow on the front panel above the current loop indicates conventional current: + to —.

Frequency

The 1 Kc Calibrator is crystal controlled so that the frequency is accurate at 1 kc and the duty factor is stable at 0.5. Thus, the calibrator signal can be used as a time reference for checking or calibrating the basic sweep rate adjustments of 11-Series plug-in units such as the Type 11B2.

Wave Shape

The calibrator square-wave output signal can be used as a reference wave shape when checking or adjusting the compensation elements in passive, high-resistance, voltage probes. Since the flat-top characteristic of the square wave is known, the probe compensation is adjusted so that the signal delivered by the probe produces a flat-topped square-wave display.

REAR-PANEL CONNECTORS

J101

Ten-contact connector J101 on the rear panel of the Type 647 provides power from the regulated low-voltage supplies for operating external devices and the signal input connection for external single sweep reset of certain 11-Series plug-in units such as the Type 11B2. Mating connectors for J101 are available from Tektronix by part number 131-300.

J101 Contact	Voltage	Maximum Current*
A	—75 v	50 ma
B	—15 v	20 ma
C	ground	
D	+15 v	200 ma
E	+100 v	20 ma
F	Single sweep reset input.	
G	nc	
H	nc	
J	nc	
K	nc	

*When the Type 10A2 and 11B2 plug-in units are used.

Fig. 2-1 illustrates two ways to provide an external single-sweep reset pulse suitable for the Type 11B2 plug-in unit.

CRT CATHODE

The ac-coupled CRT CATHODE input connector permits intensity (Z-axis) modulation of the crt display. The input time-constant is about 330 μsec (0.015 μfd and 22 kΩ) which corresponds to a low-frequency response at the crt cathode of —3 db at about 500 cps.

Display intensity increases during negative-going changes in the modulating signal and decreases during positive-going changes. Generally, at least 5-volts peak signal amplitude is required for visible display modulation, depending on the intensity level of the unmodulated display.

CRT GRID

The CRT GRID connector permits gating or modulating the intensity of the crt display through the wide-band, dc-coupled Z-Axis Amplifier in the Type 647. Since the amplifier inverts the signal, negative voltages increase display intensity and positive voltages decrease intensity. The voltage magnitude required for visible modulation depends on the intensity level of the unmodulated display; typically, a 2-volt signal will produce a visible change in the brightness.

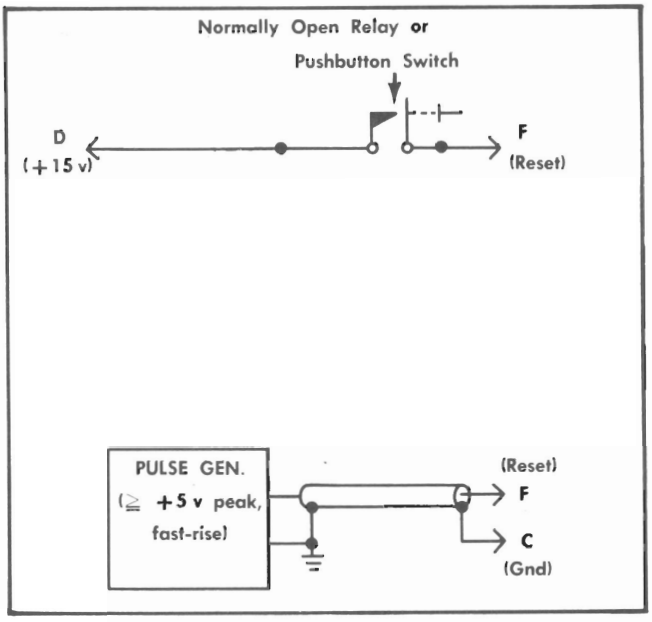


Fig. 2-1. Two means of providing an external single sweep reset pulse.

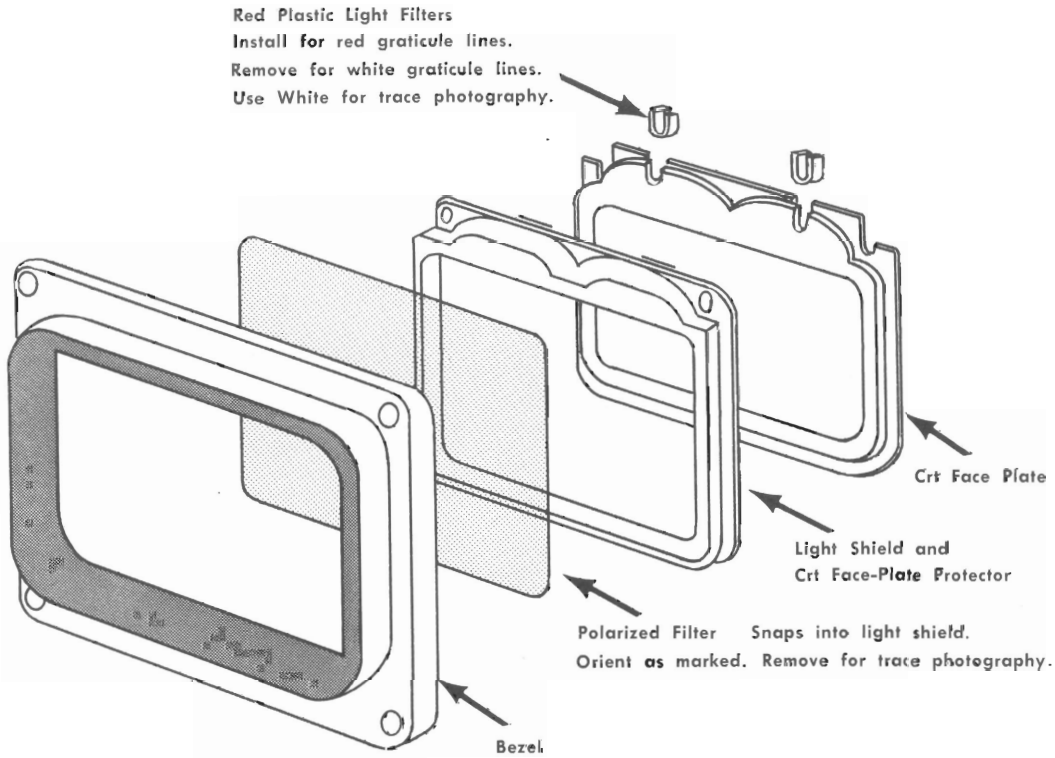


Fig. 2-2. Crt face-plate assembly.

NOTES

SECTION 3

CIRCUIT DESCRIPTION

Introduction

This section of the manual contains descriptions of each circuit in the Type 647 Oscilloscope. Block diagrams are included in each description to show the major stages of the circuit and the signal flow.

A complete block diagram, showing the relationship between major circuits in the Type 647, is located in Section 6. Complete schematics for each circuit are also located in Section 6.

VERTICAL AMPLIFIER

The Type 647 Vertical Amplifier block diagram is shown in Fig. 3-1. It is a dc-coupled push-pull voltage amplifier having a maximum gain of about 42. A delay line is provided so that the rising portion of a fast-rise event which internally triggers a sweep will be displayed on the crt. RC networks in the emitter circuits provide the high-frequency peaking required to obtain broadband operation.

If the display is driven out of the graticule area by an excessive deflection signal, the TRACE FINDER button may be pressed to actuate switches in the vertical and horizontal amplifiers. The vertical deflection signal is compressed within the limits of the graticule so that the direction of the display loss can easily be determined.

The 186 Ω delay line delays the vertical signal for about 140 nanoseconds. The Phase and Amplitude Equalizers compensate for distortion introduced by the delay line.

The VERT GAIN control R414 delivers the required portion of the vertical deflection signal to Q423 and Q433. These emitter followers drive Q444 and Q454 which form a paraphase amplifier with R445, R447, R457, and R448 as the basic common-emitter elements. The series-parallel RC components in the common-emitter circuit maintain the stage gain at high frequencies. DAMPING control R456D is set to obtain critical damping of the compensation network. VERT CENT control R441 is set to balance the amplifier.

When the TRACE FINDER button is pressed, the dynamic range of the Q444-Q454 stage is decreased. This limits the vertical deflection to less than ±3 centimeters.

The Q444-Q454 collectors drive parallel, push-pull amplifiers Q464A-Q474A and Q464B-Q474B. The common-emitter circuits of these amplifiers are compensated for high frequencies in much the same manner as the previous stage.

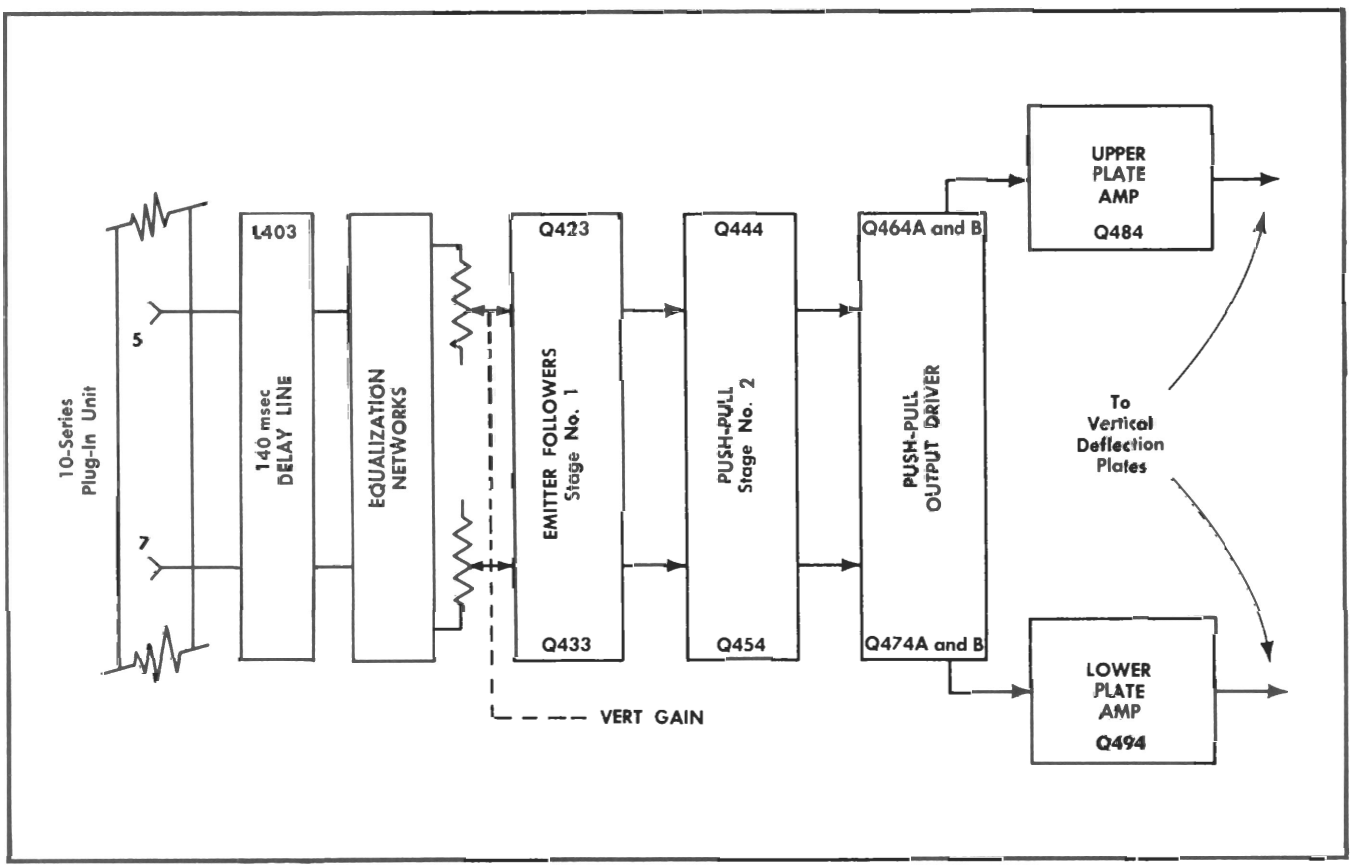


Fig. 3-1. Vertical Amplifier block diagram.

The collectors of the parallel, push-pull amplifiers provide current drive to the emitters of output amplifiers Q484 and Q494. Feedback to the bases of Q484 and Q494 permits the output voltage swing to be shared by the driver stage.

HORIZONTAL AMPLIFIER

The Type 647 Horizontal Amplifier block diagram is shown in Fig. 3-2. The dc-coupled amplifier consists of two independent current-driven operational amplifiers. A 1-ma change in input current will produce about 22-volts change in the output voltage with the HORIZ GAIN control set to midrange. The feedback circuit in each operational amplifier is compensated for best high-frequency response.

If the display is driven off the graticule by an excessive deflection signal, the TRACE FINDER button may be pressed to actuate switches in the horizontal and vertical amplifiers. When the switch in the horizontal amplifier is actuated, one of the operational amplifiers disconnected so that the overall sensitivity decreases by two-to-one. The clipping levels of the remaining operational amplifier will compress the horizontal deflection within the limits of the graticule.

Current-driven operational amplifiers, such as those used in the Type 647, have a low input impedance due to the negative feedback. Any change in the input current results in a nearly equal change in the feedback current. Since the open-loop sensitivity of the operational amplifier is very high, a minute difference between the input and feedback currents is sufficient to control a large voltage swing at the output.

The feedback impedance value determines the magnitude of the output voltage swing according to Ohm's law as follows:

$$(Z \text{ feedback})(\Delta I \text{ feedback} \approx \Delta I \text{ input}) = \Delta V \text{ output}$$

D361, D371, D362, and D363 limit the dynamic input current range to about 5.5 ma per side; a range adequate to provide horizontal deflection to about 2.5 cm beyond the edges of the graticule. D360 shunts excess signal current when D361 and D362 are off due to excess deflection to the left of the graticule.

The voltage at the junction of Zener diode D397 and R396 is about +120 volts. Clamp diode D395, connected to this voltage, prevents the output of the Q373-Q374 amplifier from going higher than +120 volts. Diode D396 serves the same purpose for the Q393-Q394 amplifier.

When the TRACE FINDER button is pushed, a known current is supplied to the Q393-Q394 amplifier which sets the output voltage at +55 to +75 volts. This is approximately the same voltage as would be produced by a "zero deflection" input signal. With one of the two dynamic deflection signals eliminated, the observed deflection is reduced two-to-one and the dynamic range of the Q373-Q374 amplifier, working alone, is insufficient to deflect the beam beyond the graticule limits.

HORIZ CENT is set so that the spot will be centered in the graticule when a "zero deflection" current signal is applied to the Horizontal Amplifier.

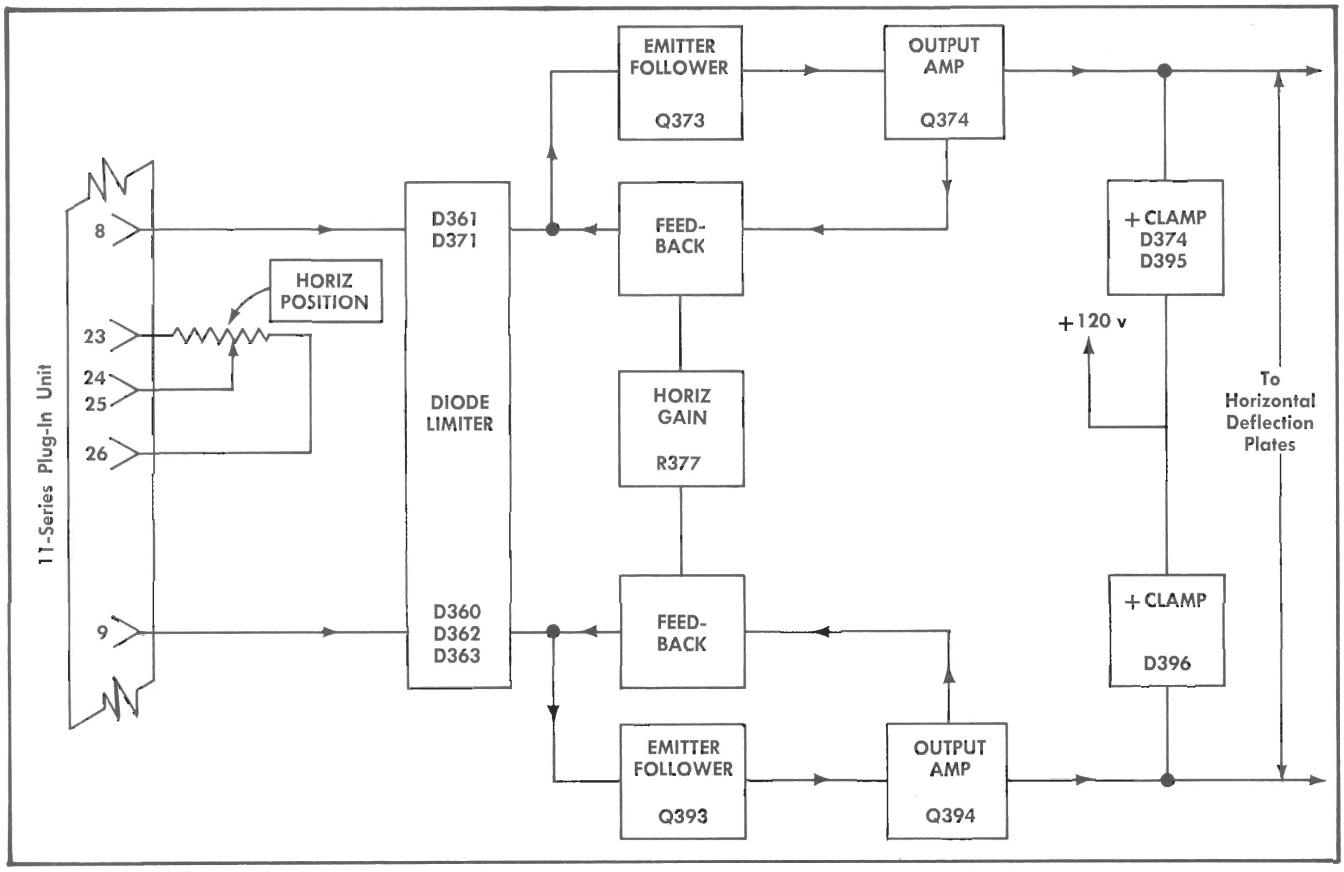


Fig. 3-2. Horizontal Amplifier block diagram.

Variable capacitors C377 and C378 and C397 are set to provide the best amplifier linearity and correct response at high sweep rates.

LOW-VOLTAGE POWER SUPPLY

The Type 647 Low-Voltage Power Supply consists of two positive and two negative interdependent accurately-regulated supplies and one positive unregulated supply. See Fig. 3-3. The most negative supply, —75 volts, is regulated by reference to a Zener diode, while the remaining regulated supplies are referenced to the —75-volt supply. The supplies are also dependent on one another since the error amplifier in each supply is powered by at least one of the other supplies.

The basic operating principle of the supplies is illustrated in Fig. 3-4. A variable resistance, in series with the load across an unregulated dc source, is varied as required so the supplied current will produce the proper voltage across the load. Control of the series resistance element, a transistor, is provided by the error amplifier which constantly compares the voltage across the load to a reference voltage. The error amplifier must detect a constant relationship between the output and reference voltages and will adjust the series resistance value as required to maintain that relationship.

With a line voltage near the center of the instrument operating range, the voltage across C612 in the —75-volt supply is about 105 volts dc. Of this voltage, 75 volts is across the load and the remainder is across the series combination of R613, R637, and Q637.

Since the Q637 emitter current is also the load current, its magnitude determines the output voltage across the load. The output voltage is sampled by divider R630-R631-R632-R634 and sets the Q614B base voltage. If the voltage across the load begins to change, the Q614B base voltage will change. The Q614A collector current will then change due to common-emitter coupling between Q614A and Q614B. The variation in Q614A collector current is amplified by Q623-Q633 and changes the Q637 current, restoring the voltage across the load to the proper value.

This negative feedback causes voltage comparator Q614A-Q614B to seek a condition of equal base voltages. The Q614A base voltage is fixed at about —9 volts by Zener diode D609. Thus, the voltage comparator forces the supply to provide an output voltage which, when divided by R630-R631-R632-R634, will also be —9 volts at the Q614B base.

It is important to note that the voltage comparator will have equal base voltages with any setting of —75 VOLTS adjustment R631 even though the output voltage may not be exactly —75 volts. To obtain a —75-volt output, R631 is set so that the resistive division ratio equals the ratio of 9 volts to the desired output voltage.

The high gain of the error amplifier at dc gives the supply a high degree of dc stability.

One difference between the —75-volt supply and the three remaining regulated supplies is in the way the voltage comparators are connected. For example, in the +100-volt supply, divider R730-R731-R732 is connected between the —75-volt reference and the +100-volt output. Since the

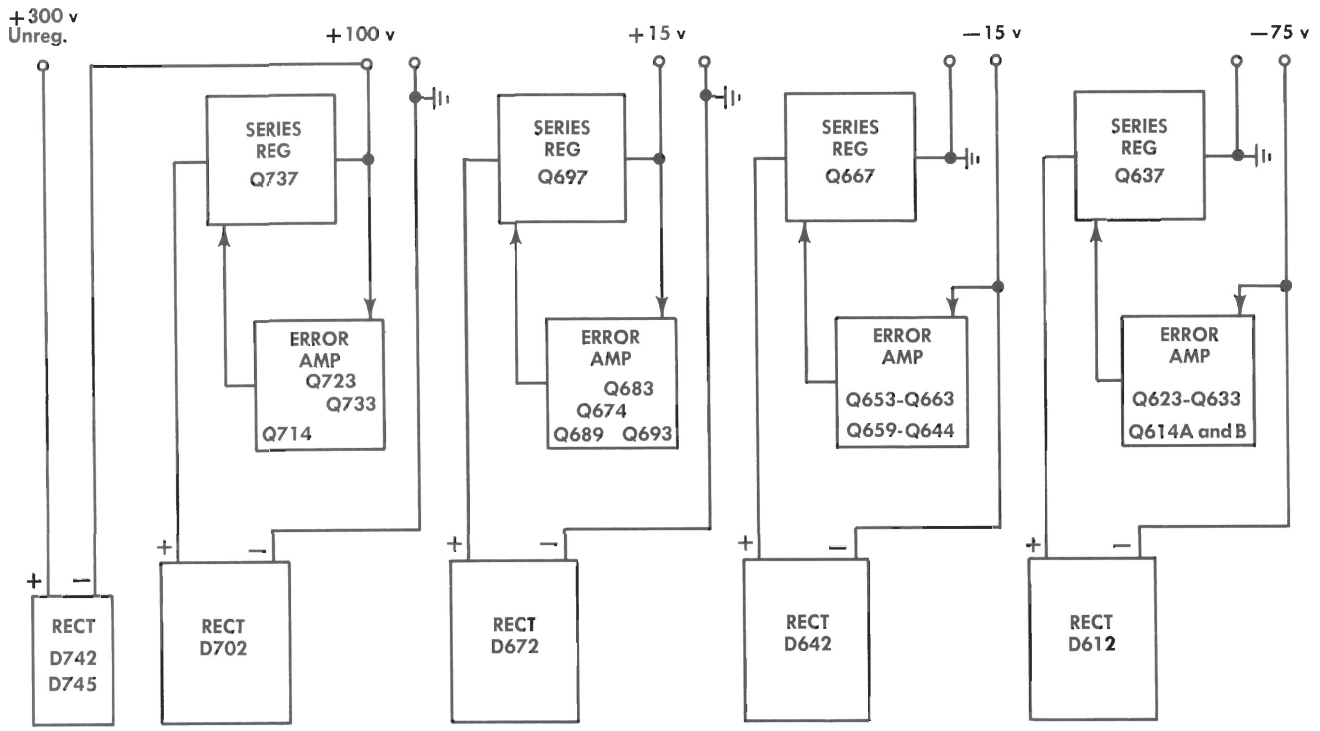


Fig. 3-3. Low-Voltage Power Supply block diagram.

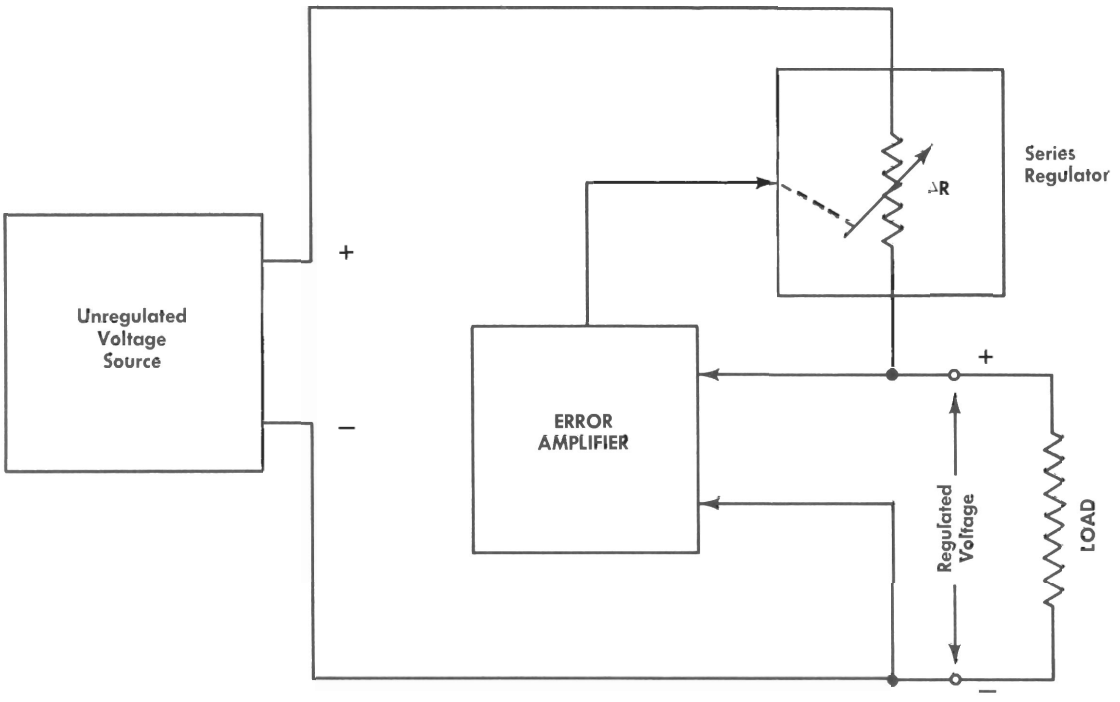


Fig. 3-4. Series regulated supply principle.

emitter of Q714 is connected to ground, any change in the +100-volt output will change the Q714 base current. This same form of voltage comparator is used in the +15-volt supply.

In the −15-volt supply, two connections are interchanged from those in the two positive voltage supplies. The emitter of Q667 is connected to ground and the emitter of Q644 is connected to the supply output. However, the operation is the same as in the +15- and +100-volt supplies; any change in the −15-volt output will produce a change in the Q644 emitter current.

CRT CIRCUIT

The Crt Circuit consists of a cathode-ray tube, its regulated high-voltage power supply, and a Z-axis (intensity) modulation amplifier. See Fig. 3-5. The crt requires operating voltages of +11.8 kv (post accelerator), −2.2 kv (cathode), −2.25 kv variable (control grid), and several lesser variable and fixed voltages for control of focus, astigmatism, geometry, etc.

The high-voltage power supply contains a controlled-amplitude oscillator which drives a step-up transformer. Rectifiers in the transformer secondaries provide the three high voltages for the crt. Negative feedback from the −2.2-kv supply through a voltage comparator regulates the oscillator output amplitude so that the −2.2 kv remains constant with variations in load. To protect the oscillator transistor from excessive dissipation, a protection circuit turns off the oscillator for about 4 seconds if the −2.2-kv supply is overloaded.

The correct ratio between the crt cathode supply voltage and the control-grid and post-accelerator supply is established by the turns ratio of the high-voltage transformer and by the CRT GRID BIAS calibration control which has the effect of a variable volts per turn ratio.

The Z-axis (intensity modulation) amplifier permits changing the crt control grid bias so that the display brightness can be controlled. The amplifier output is connected to the positive end of the floating high-voltage crt control-grid supply, and can vary the grid over a range of about 90 volts. The current input signal for the dc-coupled amplifier is obtained from the INTENSITY control, either or both plug-in units, and/or an external source through the CRT GRID connector on the rear of the instrument. Sensitivity of the wide-band, negative feedback amplifier is about 30 v/ma.

High-Voltage Power Supply

Q820 and the T820 primaries form an Armstrong oscillator. Q804 is a shunt regulator of the Q820 base drive. If Q804 conducts heavily, the base current and therefore the collector current of Q820 decrease. This decreases the ampere-turns ratio in the T820 primary, which results in a decrease in the dc high voltages developed in its secondaries. Conversely, if the Q804 conduction decreases, the magnitude of the dc high voltages will increase.

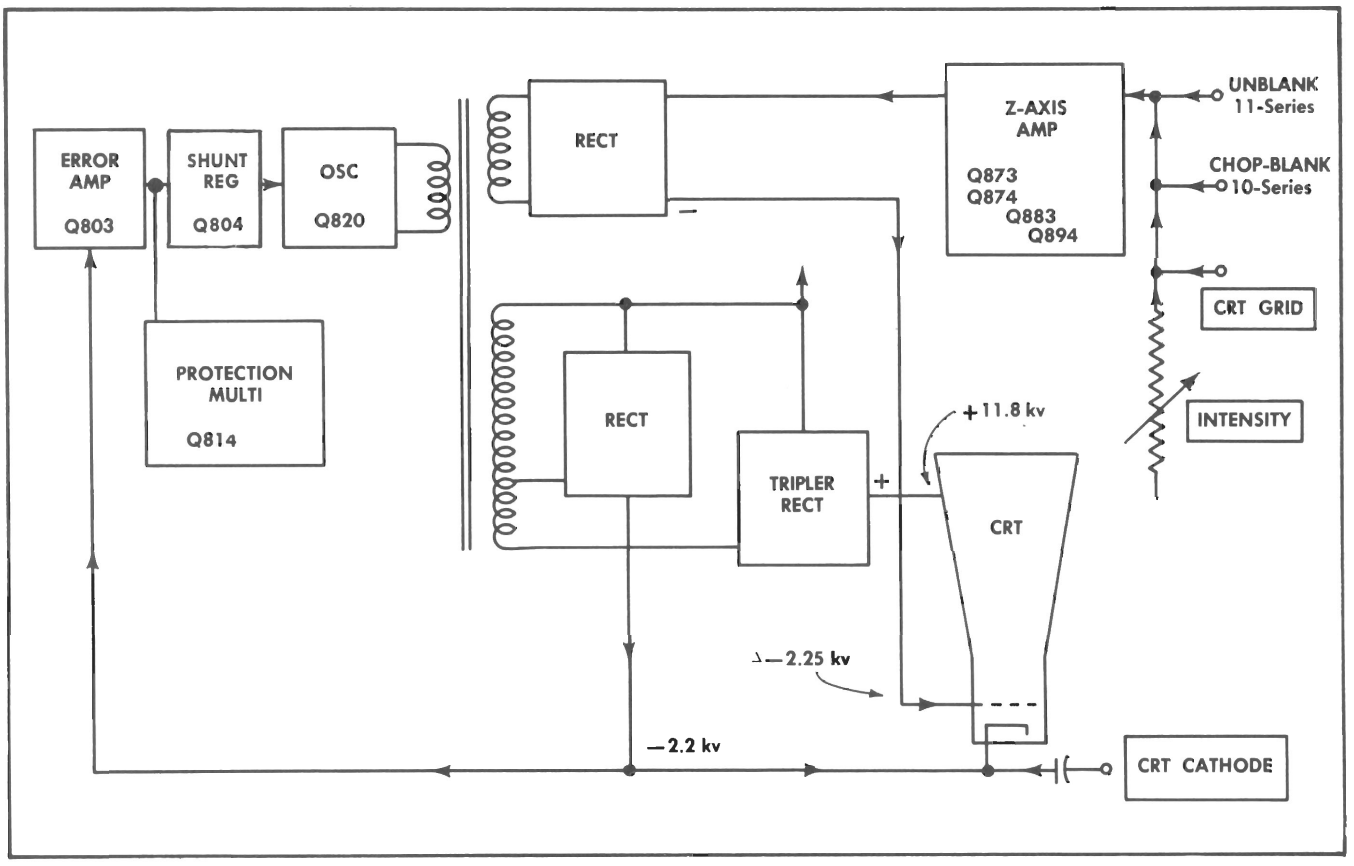


Fig. 3-5. Crt Circuit block diagram.

The conduction level of Q804 is controlled by error amplifier Q803A-Q803B which monitors the output of the —2.2-kv crt cathode supply and compares it with the +100-volt supply. When HIGH VOLTAGE control R801 is set so that the output high voltage is —2.2 kv, there is a 110 μampere current through resistors R802A-R802F. Any change in the crt cathode voltage will change the R802A-R802F current. An amplified current change at oscillator Q820 will cause a change in the oscillator output amplitude, restoring the high voltage to the proper value.

The Q814A-Q814B multivibrator protects oscillator Q820 from damage by attempting to correct for certain abnormal loads, such as accidental shorting of the high voltage during maintenance. In attempting to correct for overloads, the dissipation rating of transistor Q820 could be exceeded.

Under normal conditions, Q814A is saturated and Q814B is off. The low Q814A collector voltage holds off diode D811 and transistor Q814B. With Q814B off, capacitor C818 is charged to about 29 volts.

If the —2.2-kv supply goes out of regulation with a decrease in output voltage, the voltage at the junction of R810 and D815 will become more negative. This turns on diodes D815 and D816, diverting R817 current from the base of Q814A. The Q814A collector voltage then rises, turning on Q814B.

When Q814B turns on, its collector drops and the charge on C818 turns off D817 and Q814A. This positive feedback drives Q814B into saturation. When Q814A turns off, diode D811 turns on, clamping the Q804 base at a level which turns off oscillator Q820. Diodes D815 and D816 prevent the D811 turn-on from turning on Q814A.

When Q814B turns on, C818 begins to discharge through R817. The charge will have decreased sufficiently in about 4 seconds to turn on Q814A. Positive feedback (via the Q814B collector and C818) will drive Q814A into saturation and turn off Q814B and D811.

When D811 turns off, Q804 turns on oscillator Q820. Since no high voltage was produced while the oscillator was off, the error amplifier causes Q820 to immediately produce a very high-amplitude output. If the cause of the original overload has been removed, the crt cathode voltage will rapidly increase to —2.2 kv. The error amplifier will then decrease the Q820 output amplitude to the normal level before the temperature of transistor Q820 has risen enough to cause damage.

The protection circuit will not respond to this momentarily large error signal at the Q804 base. When Q814B turns off, C818 must be recharged. A major portion of the required charge current is supplied by Q814A base current. Thus, Q814A will be unaffected by the Q803B collector current level for about 250 milliseconds while the C818 charge is being restored. Then, if the high-voltage overload still exists, the Q803B error signal will again actuate the protection circuit.

Since only the —2.2-kv supply is regulated directly, the correct crt control-grid and post-accelerator supply voltages

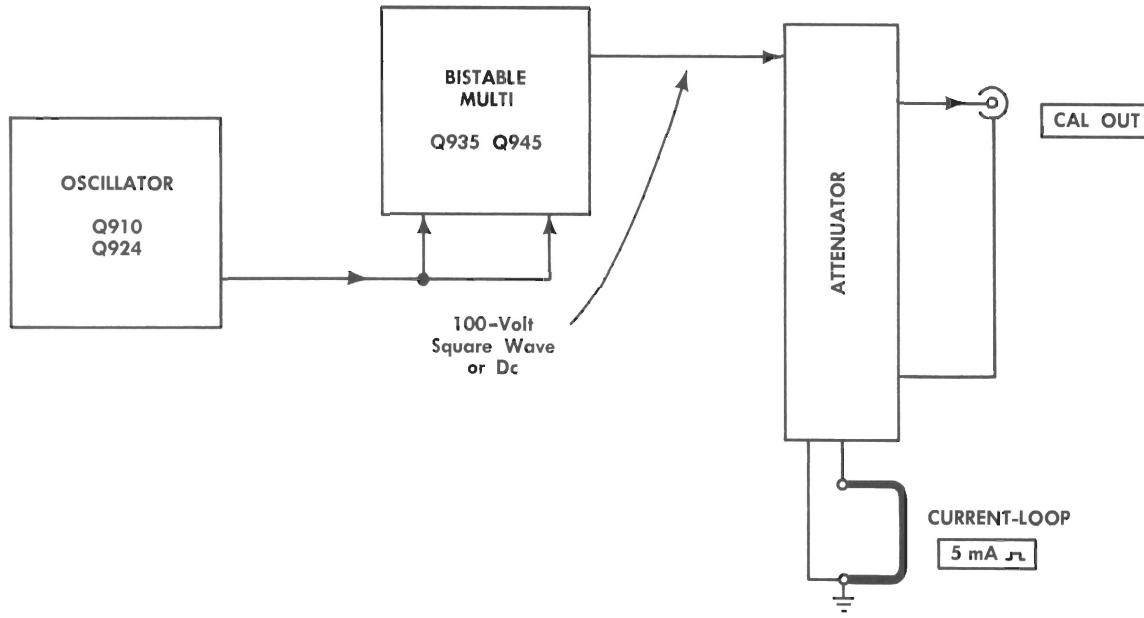


Fig. 3-6. 1-Kc Calibrator block diagram.

are established by the turns ratio of transformer T820 and by the setting of CRT GRID BIAS R832. The high-voltage oscillator will produce whatever amplitude is required to maintain the correct voltage at the negative end of C832, regardless of the voltage value at the positive end of C832. For example, if the R832 setting is changed from zero to +100 volts, the high-voltage oscillator amplitude must increase to produce an additional 100 volts across C832. The increased oscillator amplitude will also increase the voltage across C822 in the crt control-grid supply. But since the voltage at the positive-end of C822 does not vary with the setting of CRT GRID BIAS R832, the full variation appears at the crt control grid. The setting of R832 has only a slight effect on the post-accelerator supply (voltage-tripler) voltage.

Z-Axis Amplifier

The voltage at the positive end of C827 in the crt control-grid supply can be varied with no effect on the voltage across the capacitor. By varying the voltage at the positive end of C827, the crt bias and therefore the display brightness can be varied. The multiple-input Z-axis modulation amplifier provides the means for varying this bias.

Q894 provides current drive to an operational amplifier consisting of Q883 and Q874. The operational amplifier drives emitter follower Q873 which sets the voltage at the positive-end of the control grid high-voltage bias supply.

Four sources can vary the Q894 emitter current:

1. The INTENSITY control.
2. The unblanking signal from the 11-Series plug-in unit.
3. The chopped-mode blanking pulse from the 10-Series plug-in unit.
4. An external source connected to the rear-panel CRT GRID binding post.

Since the operational amplifier negative feedback via R878 makes the Q883 base a low-impedance point, the Q894 collector and Q883 base voltages are essentially constant. When any of the four current sources increases the Q894 current, the D886 current will increase causing a decrease in the Q883 and Q874 currents. The Q874 collector voltage will then rise to a level where, according to Ohm's Law:

$$\Delta V_{Q874\ \text{collector}} = R_{R878} \times \Delta I_{D886}$$

Thus ΔI_{R878} essentially equals ΔI_{D886}. (ΔI_{R878} is less than ΔI_{D886} by an amount equal to ΔI_{D886} divided by the operational amplifier open-loop gain. Since this gain is quite high, the difference is slight.) The Q874 collector voltage

is applied to emitter follower Q873 which sets the crt control-grid voltage.

Capacitors C878, C877, and C879 provide control over the high-frequency response of the amplifier. During a rapid positive-going change at the emitter of Q873, C874 turns off diode D874 and boot-straps R874 to a more positive voltage, enabling the Q873 base current to rise rapidly. During a rapid negative-going change at the collector of Q874, Q873 may momentarily turn off and diode D873 will turn on to pull down the Q873 emitter voltage.

Diode D884 will clamp the Q894 collector at about +2 volts if an excessive input signal drives Q894 near turnoff. Diodes D870 and D871 protect the amplifier from the high voltage across C827 in the event that the crt control grid is shorted to chassis.

Trace rotation coil L861 provides the means for rotating the display to align the trace with the internal graticule.

1-KC CALIBRATOR

As shown in Fig. 3-6, the calibrator consists of a crystal-controlled 4-kc oscillator driving a bistable multivibrator which has clamped output levels of zero and +100 volts. These clamp levels provide a precise 100-volt peak-to-peak square wave which may be selected for output or divided to one of 17 lower amplitudes by a precision attenuator. 100-volts dc and a 5-ma square-wave output through a current loop are also available.

The clipped output of crystal-stabilized oscillator Q910-Q924 is applied to the bistable mulitivibrator through capacitors C924 and C925. Assume that Q935 has just switched off and Q945 has just switched on. When Q935 turned off, the positive-going change at its collector turned on diode D933. C924 then charges through R933 and places a substantial reverse bias on D932.

When Q945 turned on, the negative-going change at its collector turned off D943. C925 then began to discharge through R942. The discharge period is such that the negative-going portion of the first oscillator cycle following Q945 turn-on does not turn on D942. But after skipping one cycle, the C925 charge is depleted and D942 turns on during the fast, negative-going change in the second oscillator cycle. This diverts current from the Q945 base, causing the multivibrator to switch states.

Since only every other cycle of the oscillator signal causes the multivibrator to switch states, the frequency division factor is 4, instead of the usual 2.

When Q945 is on, its collector voltage is about −14 volts which turns off D948, since the attenuator series resistors are returned to chassis. When Q945 is off, D944 is off and R947 turns on both D947 and D948. The voltage across the series combination of D947 and R946 will essentially equal the voltage across D948. Thus, the voltage at the junction of D948 and R948B will switch between an accurate +100 volts, established by the 100-volt supply, and zero volts.

The attenuator accurately divides the basic 100-volt square wave to lower amplitudes and provides an accurate 50 Ω output resistance with a switch setting of .2 VOLTS and below. If the 50 Ω output is terminated in 50 Ω, the peak voltage across the termination will be one-half that indicated by the switch setting.

100-volts dc is available for use as a reference when the −15-volt supply is disconnected from the Q935 and Q945 emitters by the switch.

When the attenuator switch is set to the 5-ma square-wave position, an accurate 5 ma through the current loop is switched on and off. The accuracy of this current is established by the accurate 20-kΩ series resistance of attenuator resistors R948B through R948K.

SECTION 4

MAINTENANCE

PREVENTIVE MAINTENANCE

Cleaning the Interior

Internal cleaning should precede calibration since the cleaning process could alter the setting of certain calibration controls.

One way to clean the interior is by vacuum and/or low-pressure compressed air (high-velocity air could damage certain components). Hardened dirt may be removed with a soft paint brush, cotton-tipped swab, or cloth dampened with a water and mild detergent solution. Pay special attention to high-voltage circuits where conductive dust can cause arcing.

The contacts on the plug-in interconnecting jacks and plugs should be lightly lubricated with an oil of the type used on rotary-switch contacts. To extend the life of the contacts, clean and relubricate if the oil becomes contaminated with abrasive dust.

The plug-in unit frame-rod contact springs (located just inside the upper corners of the plug-in unit compartments) should be lubricated with a grease of the type used on rotary-switch detents (e.g. Beacon No. 325).

Visual Inspection

The instrument should be inspected occasionally for such defects as poor connections, broken or damaged ceramic terminal strips, improperly seated tubes or transistors, and heat-damaged parts. The remedy for most visible defects is obvious. But overheating is usually a symptom of other unseen defects and unless the cause is determined before parts are replaced, the damage may be repeated.

Tube and Transistor Checks

Periodic preventive maintenance checks on the tubes and transistors used in the instrument are not recommended. The circuits within the instrument generally provide the most satisfactory means of checking tube or transistor performance. Performance of the circuits is thoroughly checked during recalibration so that substandard tubes and transistors will usually be detected at that time.

Recalibration

To insure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions are contained in Section 5 of this manual.

The calibration procedure can be helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

Cleaning the Exterior

Loose dust may be removed with a cloth and a dry paint brush. Water and mild detergents such as Kelite or Spray White may be used. Abrasive cleansers should not be used.

The graticule and crt face-plate may be cleaned with a soft, lint-free cloth dampened with denatured alcohol.

COMPONENT REPLACEMENT

General Information

Certain parts in the instrument are best replaced if definite procedures are followed as outlined in the following paragraphs.

Many electrical components are mounted in a particular way to reduce or control stray capacitance and inductance. When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance at high frequencies. After repair, portions of the instrument may require recalibration; see Section 5.

Standard Parts

Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the parts list to determine the value, tolerance, and rating required.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered directly from your Tektronix Field Engineer or Field Office. See "Parts Ordering Information" and "Special Notes and Symbols" on the first page of Section 6.

Soldering

Special silver-bearing solder is used to establish a bond to the ceramic terminal strips in Tektronix instruments. This bond may be broken by repeated use (especially if ordinary tin-lead solder is used) or by excessive heating. We recommend solder containing about 3% silver. A small supply of this solder is provided on a spool mounted inside the instrument. Additional silver-bearing solder is usually available locally or may be purchased in one-pound rolls through your Tektronix Field Engineer or Field Office. Order by part number 251-514.

Soldering To Ceramic Strips:

1. Use a wedge-shaped soldering-iron tip about 1/8-inch wide. This will allow you to apply heat directly to the solder in the terminal without touching the ceramic, thereby reducing the amount of heat required.
2. Maintain a clean, properly tinned tip.
3. Use a hot iron for a short time. A 50- to 75-watt iron with good heat storage and transfer properties is adequate.
4. Avoid putting pressure on the strip with the soldering iron or other tools. Excessive pressure may cause the strip to crack or chip.

Ceramic Terminal Strips

Fig. 4-1 shows an assembled ceramic terminal strip. Replacement strips with studs attached are supplied under a single part number and spacers under another number. The original spacers may be reused if undamaged.

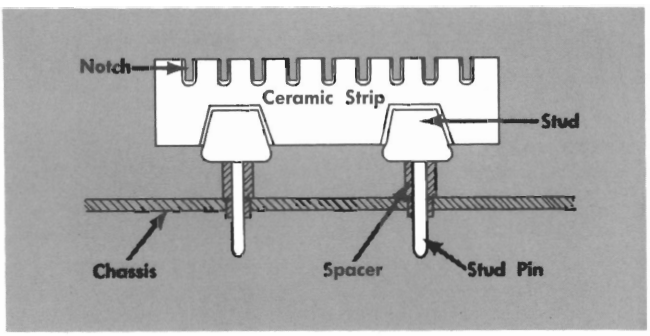


Fig. 4-1. Ceramic strip assembly.

Usually, a strip can be pried out of the chassis or pulled out with a pair of pliers. In some cases, you may choose to use a hammer and punch to drive out the studs from the opposite side of the chassis.

When the damaged strip has been removed, place new or used (but undamaged) spacers in the chassis holes. Then carefully force the studs of the new strip into the spacers until they are completely seated. If necessary, use a soft-faced mallet, tapping lightly directly over the stud area of the strip.

Switch Replacement

Individual wafers normally are not replaced in switch assemblies. Replacement switches may be ordered from Tektronix either unwired or with the associated wires and components attached. See parts list, Section 6.

When soldering leads to a switch, do not let solder flow around and beyond the terminal rivet as this may destroy the contact spring tension.

Tubes and Transistors

Tubes and transistors should not be replaced unless actually defective. When a defect is suspected, it is suggested that circuit conditions be checked first to be certain that a replacement tube or transistor will not be immediately destroyed. In some cases, these checks will also show whether or not the tube or transistor is at fault.

When circuit conditions are known to be safe, install a tube or transistor of the same type that is known to be good and check for proper operation. If the original tube or transistor proves acceptable, return it to its original socket to avoid unnecessary recalibration.

Cathode-Ray Tube and Shield

The following procedure outlines the removal and replacement of the crt. Supplementary steps for removal and replacement of the crt shield are included. Replacement of certain components on the adjacent chassis is easier with the shield removed.

WARNING

Use care when handling a crt. Avoid striking it on any object that might cause it to crack and implode. Flying glass from an imploding crt can cause serious injury. Safety glasses or a plastic face mask are recommended.

To Remove the Crt:

1. Remove the four bezel nuts and the bezel.
2. Slip off the face-plate shield.
3. Remove the high-voltage anode connector.
4. Remove the four deflection-plate leads. Be careful not to bend the crt connector pins.
5. Open the rear radiator door and remove the crt base socket.
6. Loosen the base clamp screw.
7. Start the crt forward by pressing on the crt base center pin.
8. Remove the crt.

To Replace the Crt:

1. Insert the crt.
2. All four edges of the flange around the crt face-plate should touch the front panel of the instrument, but must not be forced. Instead, the crt base clamp should be repositioned so that all four edges of the flange contact the front panel at the same time when the crt is inserted. The crt base clamp is held in place by two allen-head machine screws which are accessible from the rear of the instrument through holes in the power-supply chassis. Loosen the screws and reposition the clamp as required. When the physical alignment of the crt is correct, tighten the machine screws and proceed with the next step. Do not tighten the clamp to the crt base at this time.

3. Replace the base socket, deflection plate leads, and anode lead.
4. Clean the crt face-plate and face-plate shield, and then mount the face-plate shield and the bezel. Tighten the four bezel nuts.
5. Push lightly on the crt base socket to be certain that the crt is as far forward as it will go and then tighten the base clamp.

To Remove and Replace the Crt Shield:

1. With the crt removed, take out the four screws holding the front end of the shield and the two screws holding the rear.
2. Remove the grommet from the anode connector opening.
3. Slide the shield out so that the Trace Rotation Coil leads are accessible. Unsolder the leads, noting the polarity for reinstallation. The shield can now be separated from the instrument.
4. To reinstall the shield, reverse the above procedure.

CORRECTIVE MAINTENANCE

Troubleshooting Aids

This manual and the instrument contain many features intended to speed and simplify maintenance.

The schematics in Section 6 provide a circuit reference number for each electrical component as well as important operating voltages, signals, and conditions for their measurement. The range of circuit reference numbers associated with a particular schematic appear on that schematic. The block diagram provides an overall picture of instrument operation.

Most of the wire in the instrument is color striped to aid in circuit tracing. All regulated low-voltage power supply leads are coded as follows:

1. The basic wire color indicates voltage polarity: tan for negative, white for positive.
2. The stripe colors indicate supply voltage according to the standard EIA color code. Stripes are read in order of decreasing width.

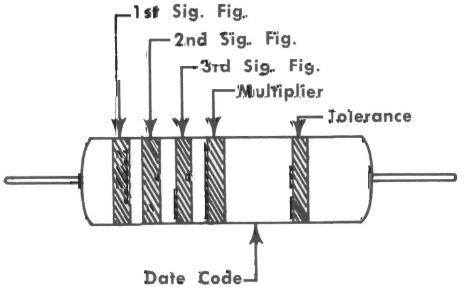


Fig. 4-2. Standard EIA color code for metal film resistors.

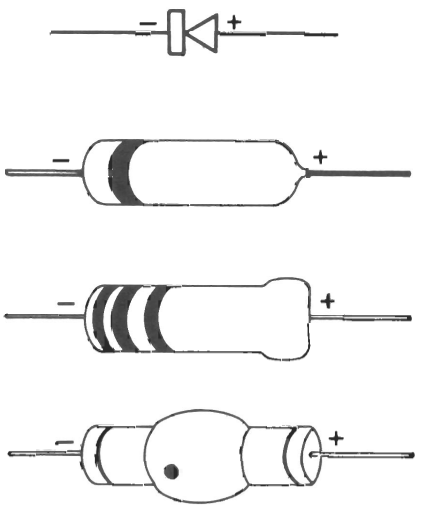


Fig. 4-3. Diode polarities.

For example, the —75-volt supply leads are tan wire (negative) bearing stripes of violet (seven), green (five), black (no zero).

The instrument contains a number of stable metal-film resistors identified by their gray background color and color coding. If a resistor has three significant figures and a multiplier, it will be EIA color coded. If it has four significant figures and a multiplier, the value will be printed on the resistor. For example, a 333 k resistor will be color coded, but a 333.5 k resistor will have its value printed on the resistor body. The color coding sequence is shown in Table 4-1 and Fig. 4-2.

TABLE 4-1
Color Code Sequence

Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	(±) % Tolerance
Black	0	0	0	1	—
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	—
Yellow	4	4	4	10,000	—
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Gray	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	—
Gold				0.1	5
Silver				0.01	—
No Color					10

Switch wafers shown on the schematics are coded to indicate the physical positions of the wafers on a rotary switch. The number portion of the code refers to the wafer position as counted from the front- or driven-end of the switch shaft. Letters F and R indicate whether the front or rear of the wafer is used to perform the particular switching function.

Important test points are marked (e.g. TP374) on the schematics and on the instrument chassis. Pictures on a fold-out page following the schematics show the general locations of these test points.

Fig. 4-3 identifies the polarity of the various diode types used in the instrument.

The following chart lists the proper current ratings for fuses in the Type 647.

Fuse	60 cps 115-Volt Range	50 cps 115-Volt Range	60 cps 230-Volt Range	50 cps 230-Volt Range
F601	3 amp slow-blow	4 amp slow-blow	1.5 amp slow-blow	2 amp slow-blow
F602	4 amp slow-blow			
F613	0.5 amp fast-blow			
F703	0.75 amp fast-blow			
F743	0.75 amp fast-blow			
F820	2 amp fast-blow			

SECTION 5

CALIBRATION

Introduction

This section of the manual contains a complete calibration procedure for the Type 647 Oscilloscope with references for calibrating the Type 10A2 and Type 11B2 plug-in units. The instrument will not require frequent recalibration, but occasional adjustments will be necessary as components age or are replaced.

Calibration is a valuable part of preventive maintenance since many types of minor troubles may be discovered and corrected before they become serious enough to disable the instrument. Major troubles are often more easily isolated to a particular section of the instrument by attempting calibration.

NOTE

This procedure describes calibration of a Type 647, a Type 10A2, and a Type 11B2 as a system. The same three units must then be used together exclusively in all measurements. If any of the units are interchanged with units from another Type 647 system, both systems must be at least partially recalibrated. This calibration procedure will be modified as additional plug-in unit types become available. Copies of the modified procedure will be available at that time through your local Tektronix Field Engineer and Field Office.

Equipment Required

1. Tektronix Type 10A2 Dual-Trace Amplifier plug-in unit.
2. Tektronix Type 11B2 Time Base plug-in unit.

NOTE

These plug-in units need not be calibrated during the first portion of the Type 647 calibration. However, they must be calibrated as described later in the procedure to permit certain adjustments to be made in the Type 647.

3. Ac voltmeter, calibrated in rms, for monitoring the autotransformer output. Required characteristics: 2% accuracy over the full line-voltage range of the Type 647.
4. Autotransformer such as Variac or Powerstat. Required characteristics: Output voltage range covering the full line voltage range of the Type 647. Volt-ampere rating of at least 500.
5. Dc voltmeter such as the Fluke Model 803 or the Electro Instruments Model Eitronic 880. Required characteristics: Input resistance at least 1 megohm. Accuracy at least ±0.05% of reading between 100 millivolts and 100 volts.
6. Oscilloscope and probes such as the Tektronix Type 502A with two P6006 Probes. Required characteristics: Oscilloscope provisions for both single-ended and differential inputs. Maximum calibrated sensitivity of at least 100 μvolts/div. Bandpass from dc to at least 50 kc.
7. Dc voltmeter. Required characteristics: Range to at least 2.5 kv full scale. Input resistance of at least 20 kΩ/v. Accurate within 2% at 2.2 kv.
8. Time-mark generator such as the Tektronix Type 180A. Required characteristics: Marker intervals of 1 millisecond and 20 nanoseconds (50-mc sine wave). Accuracy of at least ±0.01%.
9. Pulse generator such as the Tektronix Type 109. Required characteristics: Pulse risetime no longer than 2 nanoseconds. Pulse amplitude about 50 millivolts across a 50 Ω termination. Pulse repetition rate at least 275 pulses per second.
10. Tektronix Type 113 delay cable to be used as the charge-line for the pulse generator.
11. RG-58A/U coaxial cable equipped with GR Type 874 connectors and having an electrical length of 2 nanoseconds or less. Tektronix part number 017-505.
12. RG-8A/U coaxial cable equipped with GR Type 874 connectors and having an electrical length of 10 nanoseconds or less.
13. Tektronix 50 Ω X10 attenuator: part number 017-044.
14. Tektronix 50 Ω BNC termination unit: part number 011-049.
15. GR Type 874 to BNC jack coaxial adapter. GR part number 874-QBPA.
16. Horizontal test plug; see Fig. 5-1 for details.

PRELIMINARY PROCEDURE

1. Remove the side covers from the Type 647. The bottom cover need not be removed.
2. Disengage the two captive screws which hold the rear heat-sink door closed.
3. Install a Type 10A2 and a Type 11B2 plug-in unit in the Type 647.
4. Connect the Type 647 and the ac voltmeter to the power-line autotransformer output.
5. Connect the autotransformer to the appropriate line-voltage source and set for an output near the center of the line-voltage range for which the Type 647 is wired.
6. Set the controls on the Type 647 and plug-in units as listed in Table 5-1.

TABLE 5-1

Type 647

INTENSITY	Counterclockwise
FOCUS	Midrange
ASTIGMATISM	Midrange
1KC CALIBRATOR	OFF
HORIZ POSITION	Midrange

Type 10A2

MODE	CH 1
TRIGGER	NORM
VOLTS/CM	.5
VARIABLE	CALIB
PULL TO INVERT	Pushed in
POSITION	Counterclockwise
AC-DC-GND	GND

Type 11B2

HORIZ DISPLAY	EXT INPUT
MAG	OFF
A and B TIME/CM	1 mSEC
VARIABLE A and B	CALIB
TRIG MODE	NORM
A SLOPE	+
A COUPLING	AC
A SOURCE	INT
A TRIG LEVEL	Clockwise

7. Turn on the instrument power and allow several minutes for warmup.

NOTE

Pictures on a fold-out page following the schematics show the location of each calibration control and each of the numbered test points listed in the schematics.

CHECK AND ADJUSTMENT PROCEDURE

Low-Voltage Power Supplies

Adjust Voltage; Check Ripple, and Regulation

NOTE

The following ripple checks can produce erroneous indications unless ground-loop hum is minimized. To minimize hum, the Type 647 and the ripple-monitoring test oscilloscope should be powered from the same convenience outlet.

Proper power supply operation at the lower line-voltage limit requires that the line-voltage sine wave contain less than 1% distortion.

a. Connect the precision dc voltmeter and test oscilloscope probe to TP632 in the —75-volt supply. Connect the ground leads of both test instruments to the power supply chassis as near as possible to the test point.

b. With the power-line autotransformer set for a line-voltage near the center of the Type 647 operating range (indicated on a metal tag on the rear panel), check that the supply voltage and ripple are within the limits given in Table 5-2. If the voltage is not within tolerance, see step (c).

c. Adjust the supply voltage control (listed in Table 5-2) so that the voltage is within tolerance.

d. Set the power-line autotransformer for the lower line-voltage limit of the Type 647 and check that the ripple is within the limit given in Table 5-2.

TABLE 5-2

Supply Voltage	Test Point	Tolerance at Midrange Line Voltage	Maximum Ripple (mv p-p)	Voltage Control
—75 v	TP632	±0.23 v	2	—75 VOLTS R631
+100 v	TP737	±0.5 v	2	+100 VOLTS R731
+15 v	TP697	±75 mv	1.5	+15 VOLTS R691
—15 v	TP644	±75 mv	1.5	—15 VOLTS R661
+300 v	TP742	±30 v	10 v	Unregulated

e. Repeat steps (a), (b), (c), and (d) for each remaining supply in the order listed in Table 5-2. Be sure to adjust the supplies in the order listed and then recheck all supply voltages. It may be necessary to adjust the supplies a second time.

f. Remove the Type 10A2 and Type 11B2 plug-in units.

g. Set the power-line autotransformer for the upper line-voltage limit of the Type 647 and check that the ripple is within the limits given in Table 5-2 in each of the four regulated supplies.

h. Reset the power-line autotransformer for a line voltage near the center of the Type 647 operating range. Disconnect the voltmeter and test oscilloscope. Reinstall the plug-in units.

Crt Circuit

1. Adjust HIGH VOLTAGE R801

a. Connect the high-voltage dc voltmeter between the chassis and the HV TEST POINT (—2.2 kv).

b. Adjust HIGH VOLTAGE R801 for an exact 2.2 kv meter indication.

2. Check High-Voltage Regulation

a. Set the power-line autotransformer for the lower-limit operating voltage of the Type 647.

b. With the crt beam positioned off-screen, slowly turn the INTENSITY control from stop-to-stop several times and check that the high voltage remains constant.

NOTE

Few high-voltage meters will resolve the slight voltage change (less than 10 volts) that normally occurs. Hence, unless a high-resolution meter is used, no change in the high voltage should be detected.

c. Reset the power-line autotransformer for a voltage near the center of the Type 647 operating range.

d. Reset the INTENSITY control counterclockwise and disconnect the voltmeter.

3. Adjust CRT GRID BIAS R832

a. Set:

CRT GRID BIAS R832	Counterclockwise
TRIG MODE (Type 11B2)	SINGLE SWEEP
HORIZ DISPLAY (Type 11B2)	A
POSITION (Type 10A2)	Midrange

b. Set the INTENSITY control so the knob-pointer indicates 8.5.

c. Turn CRT GRID BIAS clockwise to obtain a dim spot.

d. Reset the INTENSITY control to 0.

4. Adjust TRACE ROTATION (front panel)

a. Set the INTENSITY control for a trace of moderate brightness.

b. Center the trace vertically and horizontally.

c. Set the FOCUS control for minimum trace thickness.

d. Adjust TRACE ROTATION (front panel) so that the trace is parallel with the graticule lines.

5. Adjust GEOMETRY R863

a. Set:

1KC CALIBRATOR	2 VOLTS
AC-DC-GND (Type 10A2)	AC
TRIG MODE (Type 11B2)	AUTO

b. Connect a coaxial cable between the CAL OUT connector and the vertical input.

c. Set the A TRIG LEVEL control (Type 11B2) for a triggered display.

d. Set the FOCUS and ASTIGMATISM controls for a well defined display.

e. Set the VOLTS/CM switch (Type 10A2) to .2 and turn the VARIABLE control counterclockwise to obtain a 6-cm display amplitude.

f. Adjust GEOMETRY R863 so that the row of pulse tops and the row of pulse bottoms form straight lines.

g. Set the INTENSITY control counterclockwise and remove the signal connection.

6. Adjust Z-Axis Amplifier High-Frequency Response C879

a. Set:

TRIG MODE (Type 11B2)	FREE RUN
A and B TIME/CM (Type 11B2)	.5 μSEC

b. Set the INTENSITY control for a dim trace.

c. Horizontally position the trace so the left end is near the center of the graticule.

d. Slowly turn C879 and note the action of the adjustment. A small segment (about 1-millimeter long) at the left end of the trace should vary in brightness.

e. Adjust C879 so the brightness of the trace segment most nearly matches that of the remainder of the trace.

f. Set the INTENSITY control for normal trace brightness.

1-Kc Calibrator

1. Check Voltage Accuracy

a. Turn off the instrument power and remove transistor Q945.

b. Restore instrument power.

c. Connect the precision dc voltmeter to the CAL OUT connector with a coaxial cable.

d. Set the 1KC CALIBRATOR switch to 100 VOLTS or 100 VDC and check that the output dc voltage is between 99 and 101 volts.

NOTE

The accuracy of the 1-Kc Calibrator 100-volt output is directly determined by the accuracy of the +100-volt power supply.

e. Check the output voltage at each switch setting listed in Table 5-3.

TABLE 5-3

1KC CALIBRATOR	Tolerance
50 VOLTS	49—51 v
20 VOLTS	19.6—20.4 v
10 VOLTS	9.8—10.2 v
5 VOLTS	4.9—5.1 v
2 VOLTS	1.96—2.04 v
1 VOLTS	0.98—1.02 v
.5 VOLTS	0.49—0.51 v
.2 VOLTS	0.196—0.204 v
.1 VOLTS	0.099—0.101 v

NOTE

Due to the type of attenuator used in the 1-Kc Calibrator, the remaining voltages need not be checked.

f. Turn off the instrument power and install transistor Q945.

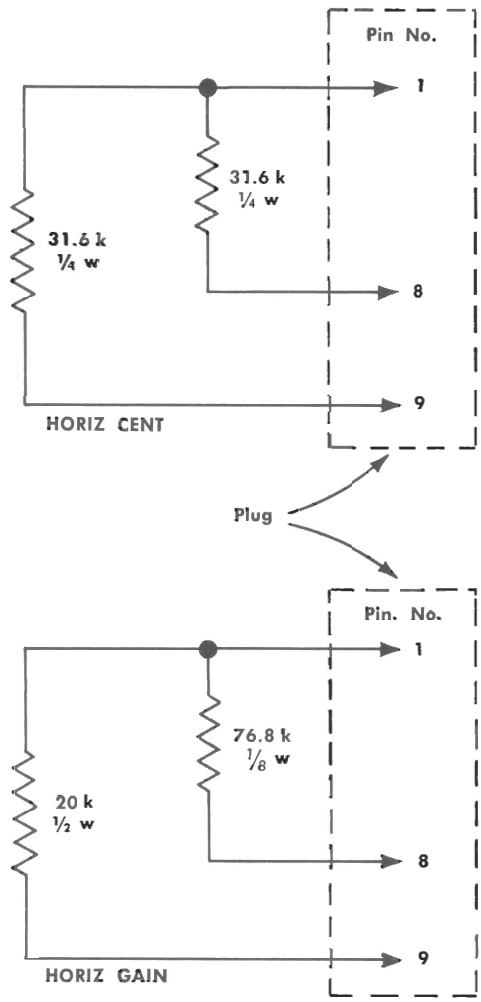
g. Restore instrument power.

2. Check Frequency Accuracy

a. Set:

1KC CALIBRATOR	10 VOLTS
A and B TIME/CM (Type 11B2)	.2 mSEC
TRIG MODE (Type 11B2)	NORM
A TRIG LEVEL (Type 11B2)	0
A COUPLING (Type 11B2)	AC LF REJ
A SOURCE (Type 11B2)	EXT
VOLTS/CM (Type 10A2)	2

b. There should not be a trace on the crt. Connect a coaxial cable between the CAL OUT and the A TRIG IN (Type 11B2) connectors. There should now be a trace on the crt.



Plug is Amphenol number 26-159-32

Tektronix part number 131-096

All resistors 1% tolerance

Fig. 5-1. Horizontal Amplifier test plugs.

c. Apply 1-millisecond markers from the time-mark generator to the vertical input. The display should now consist of two or more pulses which will probably drift across the crt.

d. Check the frequency accuracy by either of the following methods:

Slow Drift: Check that the interval between the arrival of pulses at a particular point on the crt is greater than 1 second.

Fast Drift: Count the number of pulses that pass a given point on the crt within 10 seconds (or 100 seconds). The number of pulses counted should be no greater than the number of seconds in the counting period.

e. Remove the signal connections.

Horizontal Amplifier

1. Adjust HORIZ CENT R364

a. Remove the Type 11B2 from the Type 647.

b. Install the HORIZ CENT Test Plug (see Fig. 5-1).

c. Turn the INTENSITY control clockwise to obtain a dim spot on the crt.

d. Adjust HORIZ CENT R364 to position the spot at the center of the graticule.

e. Remove the HORIZ CENT Test Plug.

2. Adjust HORIZ GAIN R377

a. Install the HORIZ GAIN Test Plug (see Fig. 5-1).

b. Adjust HORIZ GAIN R377 to position the spot at the line that is 1 centimeter from the right edge of the graticule.

c. Repeat steps 1 and 2 to be certain of proper results.

d. Remove the Test Plug and install the Type 11B2 plug-in unit.

NOTE

Calibration and verification of the Type 11B2 plug-in unit should be performed at this point.

Stey 18 in the Type 11B2 procedure contains a NOTE stating that the accuracy of the fastest sweep rate depends on the high-frequency response of the Type 647 Horizontal Amplifier. If sweep-rate inaccuracy is detected, perform step 3 below (adjust C378, C377 and C397) before continuing Type 11B2 calibration.

3. Adjust C378, C377, and C397

a. Use the same set-up and display established in step 18 of the Type 11B2 calibration and verification procedure.

b. Adjust C378 for best timing accuracy in the right half of the graticule (1 cycle/2 cm).

c. Adjust C377 and C397 for best timing accuracy in the left half of the graticule. Adjust these capacitors equally so that the adjustment screws are equal depths in the capacitor bodies.

d. Repeat steps b and c for best results.

e. Set A and B TIME/CM to .2 μSEC and check for 1 cycle/cm. If necessary, readjust the 10-nanosecond/cm sweep rate as described in steps b and c that 10- and 20-nanosecond/cm sweep rates most nearly have the same accuracy, but with one slightly fast and the other slightly slow.

NOTE

When accurate 10- and 20-nanosecond/cm sweep rates are obtained, complete the Type 11B2 calibration. Then continue with the Type 647 calibration beginning with the following Vertical Amplifier procedure.

Vertical Amplifier

1. Adjust VERT CENT R441

a. Reset all controls as listed in Table 5-1, except as follows:

FOCUS	As is
ASTIGMATISM	As is
1KC CALIBRATOR	5 VOLTS
POSITION (Type 10A2)	Midrange
AC-DC-GND (Type 10A2)	AC
VOLTS/CM (Type 10A2)	1
HORIZ DISPLAY (Type 11B2)	A
TRIG MODE (Type 11B2)	AUTO

b. Remove the Type 10A2 from the Type 647.

c. Set the INTENSITY control to obtain a trace on the crt.

d. Adjust VERT CENT R441 to position the trace to the center of the graticule.

e. Install the Type 10A2 in the Type 647.

2. Adjust VERT GAIN R414

a. Connect a coaxial cable between the CAL OUT connector and the vertical input.

b. Connect one signal probe of the differential-input test oscilloscope to pin 5 of the Type 10A2 interconnecting plug and the other probe to pin 7. The test oscilloscope should display the push-pull square-wave output signal of the Type 10A2 plug-in unit.

c. Set the Type 10A2 VARIABLE VOLTS/CM control for a 600-mv peak-to-peak differential output as measured on the test oscilloscope. Do not disturb this setting of VARIABLE control until step (e) is completed.

d. Set the Type 11B2 A TRIG LEVEL control for a triggered display.

e. Adjust VERT GAIN R414 for exactly a 4-cm peak-to-peak vertical deflection on the Type 647.

f. Remove the probes and the signal connections.

NOTE

At this point, calibrate the Type 10A2 through "Attenuator Compensation and Input Time Constant Adjustments" as described in the Type 10A2 instruction manual. The high-frequency compensation of the Type 10A2 and the Type 647 Vertical Amplifier should then be calibrated simultaneously as described in the remaining steps of this procedure.

3. Adjust Vertical-System High-Frequency Response

a. Set:

Type 10A2

MODE	CH 1
TRIGGER	NORM
VOLTS/CM	.01
VARIABLE	CALIB
PULL TO INVERT	Pushed in
POSITION	Midrange
AC-DC-GND	DC

Type 11B2

HORIZ DISPLAY	A
MAG	OFF
A and B TIME/CM	.1 μSEC
VARIABLE A	CALIB
TRIG MODE	AUTO
A SLOPE	+
A COUPLING	AC LF REJ
A SOURCE	INT

b. Connect the pulse generator to the Type 10A2 CH 1 input as shown in Fig. 5-2.

c. Set the pulse generator controls for positive-going pulses of about 50-mv amplitude across the termination.

d. Set the HORIZ POSITION control so that the trace begins near the left edge of the graticule.

e. Set the Type 11B2 A TRIG LEVEL control for a stable display.

NOTE

It may be necessary to darken the room and set the INTENSITY control more clockwise to view the display. A viewing hood may also be helpful. Pulse width should be at least 2 cm.

The high-frequency compensation controls affect the shape of the pulse display at the upper corner of the rise and the first centimeter of the top. In adjusting these controls, you should first make the pulse top appear as straight and level as possible; the shape of the corner is of secondary importance. Then, move this straight and level portion toward the corner so that the corner becomes as square as possible.

f. Preset the high-frequency compensation controls as follows:

Type 647

C456D	One-half capacitance
C467	One-half capacitance
C484	Minimum capacitance

Type 10A2

C169 (C269)	Minimum capacitance
C176 (C276)	Minimum capacitance
L465	Maximum inductance (slug centered in coil)

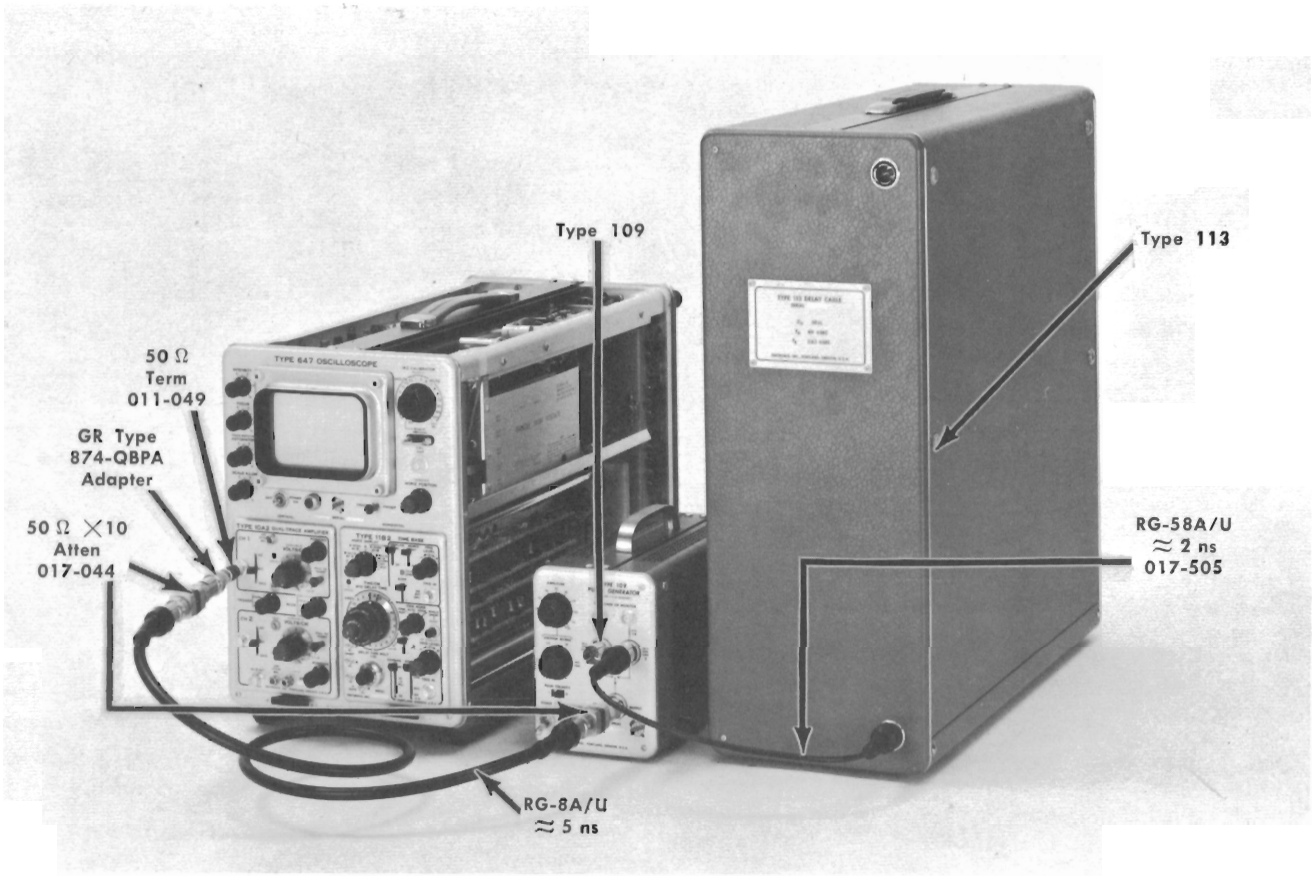


Fig. 5-2. Setup for high-frequency compensation adjustments.

g. Adjust DAMPING R456D to produce ringing on the top of the displayed pulse, then turn it back just far enough to eliminate the ringing. Avoid turning the control back too far from the ringing condition as this will cause undershoot (rolloff).

h. Adjust C467 and C456D so that the pulse top is as straight and level as possible. Any imperfections which remain should average out to a straight line.

i. Adjust C484 and DAMPING R456D to extend the straightline portion of the top as far as possible toward the pulse corner.

j. Adjust C456D to produce a slight rolloff on the pulse corner.

k. Turn the slug in L465 (Type 10A2) clockwise for the squarest pulse corner.

l. Adjust DAMPING R456D so that the portion of the top near the pulse corner is as straight as possible.

m. Adjust C169 and C176 (Type 10A2) for the squarest pulse corner.

n. Repeat steps (i), (k), (l), and (m) for the best square pulse.

o. Set the Type 10A2 Channel 2 front-panel controls to the same positions as those of Channel 1. Set the MODE switch to CH 2 and move the signal input connection to the CH 2 input.

p. Adjust C269 and C276 in the Type 10A2 Channel 2 Input Amplifier for the squarest pulse corner.

4. Check Vertical-System Risetime

a. Use the same setup and display as in the previous step.

b. Set the pulse generator so that the displayed pulse amplitude is 5 cm.

c. Set the Type 11B2 MAG switch to X10.

d. The display sweep rate is now 10 nanoseconds/cm. Check that the risetime between the 10% and 90% amplitude points on the displayed pulse is 7 nanoseconds or less.

SECTION 6
PARTS LIST AND SCHEMATICS

PARTS ORDERING INFORMATION

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

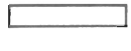
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information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

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

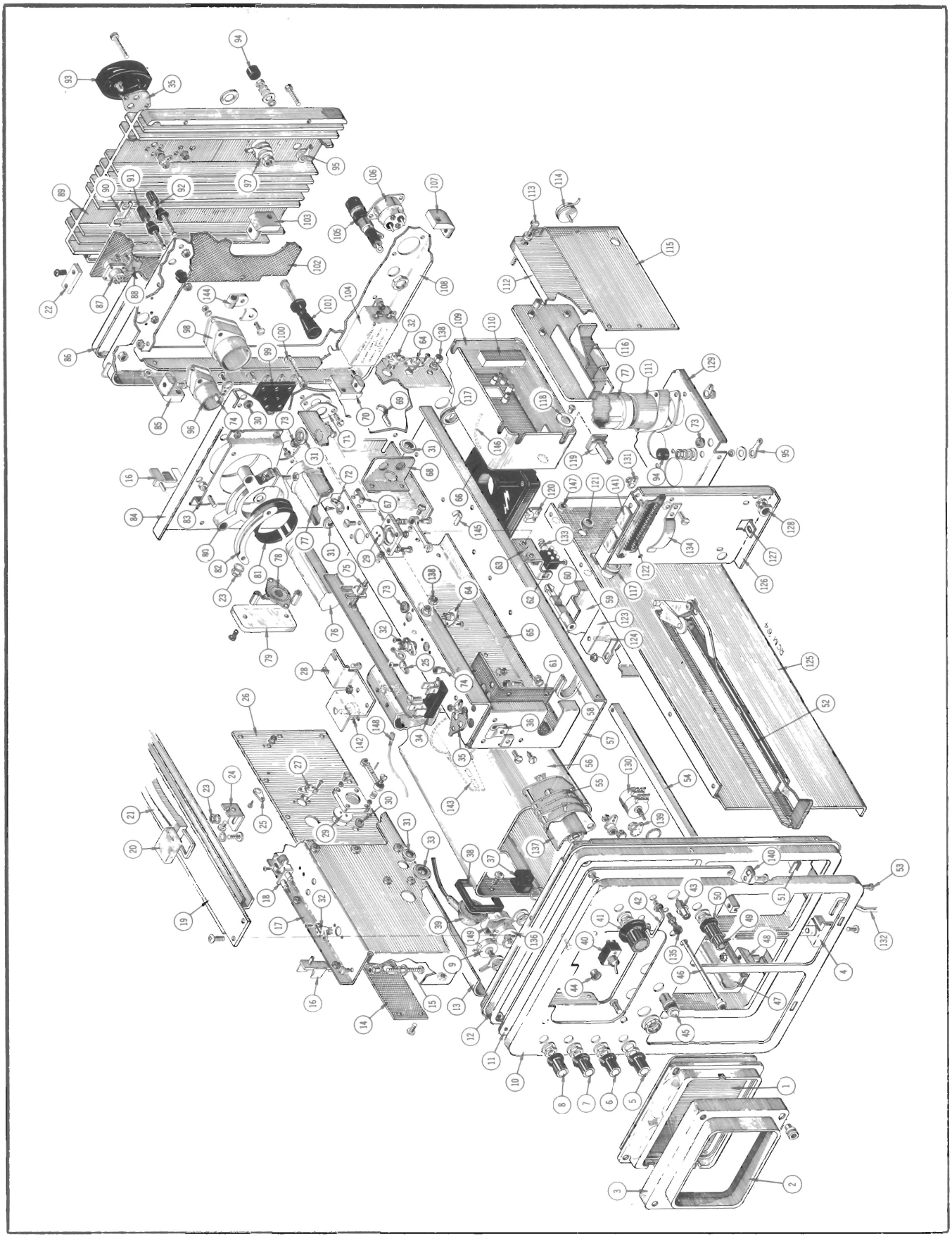
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

EXPLODED VIEW



EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	337-573			1	SHIELD, implosion
2	200-556			1	COVER, graticule and trim assembly
	- - - -			-	mounting hardware: (not included w/cover)
	210-571			1	NUT, graticule cover
3	426-223			1	FRAME, implosion shield
4	391-057	X120		1	BLOCK, flip stand pivot, left
	- - - -			-	mounting hardware: (not included w/block)
	212-023			1	SCREW, 8-32 x 3/8 inch, BHS
	214-408			1	NUT, cam locking
	391-058	X120		1	BLOCK, flip stand pivot, right
	- - - -			-	mounting hardware: (not included w/block)
	212-023			1	SCREW, 8-32 x 3/8 inch, BHS
	214-408			1	NUT, cam locking
5	366-220			1	KNOB, small charcoal—SCALE ILLUM.
	- - - -			-	knob includes:
	213-020			1	SCREW, set, 6-32 x 1/8 inch HSS
6	366-254			1	KNOB, small charcoal—ASTIGMATISM
	- - - -			-	knob includes:
	213-020			1	SCREW, set, 6-32 x 1/8 inch HSS
7	366-220			1	KNOB, small charcoal—FOCUS
	- - - -			-	knob includes:
	213-020			1	SCREW, set, 6-32 x 1/8 inch HSS
8	366-220			1	KNOB, small charcoal—INTENSITY
	- - - -			-	knob includes:
	213-020			1	SCREW, set, 6-32 x 1/8 inch HSS
9	- - - -			2	POT
	- - - -			-	mounting hardware for each: (not included w/pot)
	210-207			1	LUG, solder, 3/8 inch
	210-012			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-978			1	WASHER, 3/8 ID x 1/2 inch OD
	210-590			1	NUT, hex, 3/8-32 x 7/16 inch
10	333-756			1	PANEL, front
	- - - -			-	mounting hardware: (not included w/panel)
	213-088			2	SCREW, thread forming, 4-40 x 1/4 inch, PHS phillips
11	387-775			1	PLATE, front casting
	- - - -			-	mounting hardware: (not included w/plate)
	213-123			10	SCREW, 6-32 x 3/8 inch, FHS phillips
12	426-204			1	FRAME, front
	- - - -			-	frame includes:
	354-057			1	RING, ornamental

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
13	122-113			1	ANGLE, frame, top left
	- - - -			-	mounting hardware: (not included w/angle)
	211-538			4	SCREW, 6-32 x 5/16 inch, FHS phillips
	210-457			4	NUT, keps, 6-32 x 5/16 inch
14	337-576			1	SHIELD, calibrator chassis
	- - - -			-	mounting hardware: (not included w/shield)
	211-007			4	SCREW, 4-40 x 3/16 inch, BHS
15	- - - -			1	RESISTOR, 10 watt
	- - - -			-	mounting hardware: (not included w/resistor)
	211-553			1	SCREW, 6-32 x 1 1/2 inches, RHS phillips
	210-601			1	EYELET
	210-478			1	NUT, hex, resistor mounting
	211-507			1	SCREW, 6-32 x 5/16 inch, BHS
16	352-066			5	HOLDER, ceramic capacitor
	- - - -			-	mounting hardware for each: (not included w/holder)
	361-007			2	SPACER, nylon, .063 inch
17	441-485			1	CHASSIS, calibrator/focus & intensity
	- - - -			-	mounting hardware: (not included w/chassis)
	211-504			6	SCREW, 6-32 x 1/4 inch, BHS
	212-004			3	SCREW, 8-32 x 5/16 inch, BHS
	210-458			3	NUT, keps, 8-32 x 11/32 inch
	210-457			1	NUT, keps, 6-32 x 5/16 inch
18	136-153			1	SOCKET, 2 pin, crystal, w/clamp
	- - - -			-	mounting hardware: (not included w/socket)
	213-055			2	SCREW, thread cutting, 2-32 x 3/16 inch, PHS phillips
19	381-218			1	BAR, top support, w/handle (See Ref. #22)
	- - - -			-	bar includes:
20	344-098			2	CLIP
	212-507			2	SCREW, 10-32 x 3/8 inch, BHS
21	367-037			1	HANDLE
22	- - - -			-	mounting hardware: (not included w/bar)
	381-073			1	BAR, retaining
	212-039			4	SCREW, 8-32 x 3/8 inch, THS phillips
23	- - - -			11	POT
	- - - -			-	mounting hardware for each: (not included w/pot)
	210-940			1	WASHER, 1/4 ID x 3/8 inch OD
	210-583			1	NUT, hex, 1/4-32 x 5/16 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
24	406-929			1	BRACKET, pot
	- - - -			-	mounting hardware: (not included w/bracket)
	211-507			1	SCREW, 6-32 x 5/16 inch, BHS
	210-006			1	LOCKWASHER, internal, #6
	210-407			1	NUT, hex, 6-32 x 1/4 inch
25	210-201			20	LUG, solder, SE #4
	- - - -			-	mounting hardware for each: (not included w/lug)
	213-044			1	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips
26	387-776			1	PLATE, vertical amplifier
	- - - -			-	mounting hardware: (not included w/plate)
	211-504			10	SCREW, 6-32 x 1/4 inch, BHS
27	136-161			8	SOCKET, 3 pin transistor
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-113			2	SCREW, thread forming, 2-32 x 5/16 inch, RHS phillips
28	406-948	100	449	1	BRACKET, crt shield
	407-028	450		1	BRACKET, crt shield
	- - - -			-	mounting hardware: (not included w/bracket)
	211-507			4	SCREW, 6-32 x 5/16 inch, BHS
	210-457			4	NUT, keps, 6-32 x 5/16 inch
29	214-317			5	HEAT SINK, insulator disc
	- - - -			-	mounting hardware for each: (not included w/heat sink)
	352-062			1	HOLDER, transistor heat sink
	343-097			1	CLAMP, transistor heat sink
	211-008			2	SCREW, 4-40 x 1/4 inch, BHS
	211-012			2	SCREW, 4-40 x 3/8 inch, BHS
	210-406			4	NUT, hex, 4-40 x 3/16 inch
	210-599			2	NUT, sleeve
	214-368			1	SPRING, transistor heat sink holder
	210-627			1	RIVET
30	348-002			5	GROMMET, 1/4 inch
31	348-005			3	GROMMET, 1/2 inch
32	136-095			24	SOCKET, 4 pin transistor
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-113			2	SCREW, thread forming, 2-32 x 5/16 inch, RHS phillips
33	348-012			2	GROMMET, 5/8 inch
34	352-031			1	HOLDER, fuse, single
	- - - -			-	mounting hardware: (not included w/holder)
	211-511			1	SCREW, 6-32 x 1/2 inch, BHS
	210-006			1	LOCKWASHER, internal, #6
	210-407			1	NUT, hex, 6-32 x 1/4 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
35	- - - -			3	TRANSISTOR
	- - - -			-	mounting hardware for each: (not included w/transistor)
	387-345			1	PLATE, insulator
	211-511			2	SCREW, 6-32 x 1/2 inch, BHS
	210-935			2	WASHER, fiber, .140 ID x .375 inch OD
	210-202			1	LUG, solder, SE #6
	210-006			1	LOCKWASHER, internal, #6
	210-407			2	NUT, hex, 6-32 x 1/4 inch
36	343-001			1	CLAMP, cable, 1/8 inch
	- - - -			-	mounting hardware: (not included w/clamp)
	211-511			1	SCREW, 6-32 x 1/2 inch, BHS
	210-863			1	WASHER, "D" type
	210-006			1	LOCKWASHER, internal, #6
	210-407			1	NUT, hex, 6-32 x 1/4 inch
37	352-063			2	HOLDER, graticule lamp
	- - - -			-	mounting hardware for each: (not included w/holder)
	213-123			1	SCREW, 6-32 x 3/8 inch, FHS phillips
38	348-049			1	GROMMET, crt shield
39	131-301			1	CONNECTOR, anode
	- - - -			-	connector includes:
	200-544			1	COVER, anode connector
40	260-515			1	SWITCH, toggle—POWER ON
	- - - -			-	mounting hardware: (not included w/switch)
	210-414			1	NUT, hex, 15/32-32 x 9/16 inch
	354-055			1	RING, locking, switch
	210-902			1	WASHER, .470 ID x 21/32 inch OD
	210-473			1	NUT, switch, 15/32-32 x 5/64 inch, 12 sided
41	366-117			1	KNOB, large charcoal—1 KC CALIBRATOR
	- - - -			-	knob includes:
	213-004			1	SCREW, set, 6-32 x 3/16 inch, HSS
42	214-335			1	BOLT, current loop
	- - - -			-	mounting hardware: (not included w/bolt)
	361-059			1	SPACER, current loop
	210-593			2	NUT, hex, current loop, 5-40 x 1/4 inch
	210-849			2	WASHER, fiber, #4
	210-201			2	LUG, solder, SE #4
	210-442			2	NUT, hex, 3-48 x 3/16 inch
43	131-274			1	CONNECTOR, chassis mounted, 1 contact, BNC
	- - - -			-	connector includes:
	- - - -			1	NUT, hex
44	377-105			2	INSERT, graticule light

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
45	136-160			1	SOCKET, indicator light
	- - - -			-	mounting hardware: (not included w/socket)
	210-241			1	LUG, ground
	210-414			1	NUT, hex, $^{15}/_{32}$-32 x $^{9}/_{16}$ inch
46	384-293			1	ROD, extension, switch, w/charcoal knob
47	122-107	100	119	2	ANGLE, frame
	122-118	120		2	ANGLE, rail, bottom
	- - - -			-	mounting hardware for each: (not included w/angle)
	212-039			4	SCREW, 8-32 x $^{3}/_{8}$ inch, THS phillips
	210-458			2	NUT, keps, 8-32 x $^{11}/_{32}$ inch
48	348-042	100	119	4	FOOT, molded gray
	348-052	120		4	FOOT, anti-slide
	- - - -			-	mounting hardware for each: (not included w/foot)
	212-071			2	SCREW, 8-32 x 1 inch, Fil HS
	210-458			2	NUT, keps, 8-32 x $^{11}/_{32}$ inch
49	366-031			1	KNOB, small red—VERNIER
	- - - -			-	knob includes:
	213-004			1	SCREW, set, 6-32 x $^{3}/_{16}$ inch, HSS
50	366-142			1	KNOB, charcoal—HORIZ POSITION
	- - - -			-	knob includes:
	213-004			1	SCREW, set, 6-32 x $^{3}/_{16}$ inch, HSS
51	214-384			2	SPRING, latch bar
52	214-396			2	LATCH, plug-in, assembly (See Ref. #53)
	- - - -			-	each latch includes:
	351-069			1	GUIDE, rail, bottom, plug-in
	351-071			1	GUIDE, latch release bar, delrin
	214-372			1	LATCH, delrin
	214-374			1	SPRING, latch
	210-694			1	RIVET, latch hinge
	358-230			1	BUSHING, latch hinge
	366-258			1	KNOB, nylon, w/release bar
	214-369			1	PIN, latch
53	- - - -			-	mounting hardware for each: (not included w/latch)
	211-522			1	SCREW, 6-32 x $^{5}/_{8}$ inch, FHS phillips
	211-507			1	SCREW, 6-32 x $^{5}/_{16}$ inch, BHS
54	351-060			2	GUIDE, rail, top plug-in
	- - - -			-	mounting hardware for each: (not included w/guide)
	211-507			1	SCREW, 6-32 x $^{5}/_{16}$ inch, BHS
	211-531			1	SCREW, 6-32 x $^{3}/_{8}$ inch, Fil HS
	210-457			1	NUT, keps, 6-32 x $^{5}/_{16}$ inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
55	262-569			1	SWITCH, wired—CALIBRATOR
	- - - -			-	switch includes:
	260-536			1	SWITCH, unwired—CALIBRATOR
	210-207			1	LUG, solder, 3/8 inch
	- - - -			-	mounting hardware: (not included w/switch)
	210-013			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-840			1	WASHER, .390 ID x 9/16 inch OD
	210-413			1	NUT, hex, 3/8-32 x 1/2 inch
56	337-572			1	SHIELD, crt
	- - - -			-	mounting hardware: (not included w/shield)
	211-590			4	SCREW, 6-32 x 1/4 inch, BHB
	211-589			2	SCREW, 6-32 x 5/16 inch, BHB
57	387-771			1	PLATE, plug-in roof
	- - - -			-	mounting hardware: (not included w/plate)
	211-541			2	SCREW, 6-32 x 1/4 inch, FHS phillips
	210-457			2	NUT, keps, 6-32 x 5/16 inch
	212-004			9	SCREW, 8-32 x 5/16 inch, BHS
58	358-166			1	BUSHING, black plastic
59	387-773			1	PLATE, plug-in housing, left
	- - - -			-	mounting hardware: (not included w/plate)
	212-004			3	SCREW, 8-32 x 5/16 inch, BHS
	212-039			1	SCREW, 8-32 x 3/8 inch, THS phillips
	210-458			3	NUT, keps, 8-32 x 11/32 inch
60	384-291			1	ROD, extension, switch
61	387-816			1	PLATE, heat sink
	- - - -			-	mounting hardware: (not included w/plate)
	211-507			3	SCREW, 6-32 x 5/16 inch, BHS
	210-006			3	LOCKWASHER, internal, #6
	210-407			3	NUT, hex, 6-32 x 1/4 inch
62	260-516			2	SWITCH, push—TRACE FINDER
	- - - -			-	mounting hardware: (not included w/switch)
	211-100			2	SCREW, 2-56 x 3/4 inch, RHS
	210-001			2	LOCKWASHER, internal, #2
	210-405			2	NUT, hex, 2-56 x 3/16 inch
63	406-905			1	BRACKET, switch mounting
	- - - -			-	mounting hardware: (not included w/bracket)
	211-504			2	SCREW, 6-32 x 1/4 inch, BHS
64	136-078			2	SOCKET, sub-miniature, 8 pin
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-055			2	SCREW, thread cutting, 2-56 x 3/16 inch, PHS phillips

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
65	441-483			1	CHASSIS, horizontal amplifier
	- - - -			-	mounting hardware: (not included w/chassis)
	211-504			6	SCREW, 6-32 x 1/4 inch, BHS
	212-070			3	SCREW, 8-32 x 5/16 inch, FHS phillips
	212-004			2	SCREW, 8-32 x 5/16 inch, BHS
	210-458			5	NUT, keps, 8-32 x 11/32 inch
66	119-029			1	DELAY LINE ASSEMBLY
	- - - -			-	delay line includes:
	380-049			1	HOUSING, delay line
	200-482			1	COVER, delay line housing
	131-271			1	CONNECTOR, right hand
	131-272			1	CONNECTOR, left hand
	131-157			2	CONNECTOR, terminal stand-off
	131-158			2	CONNECTOR, terminal feed-thru
	211-517			1	SCREW, 6-32 x 1 inch, BHS
	211-513			4	SCREW, 6-32 x 5/8 inch, BHS
	211-011			2	SCREW, 4-40 x 5/16 inch, BHS
	210-004			2	LOCKWASHER, internal, #4
	210-406			2	NUT, hex, 4-40 x 3/16 inch
	210-407			5	NUT, hex, 6-32 x 1/4 inch
67	214-153			1	FASTENER, snap, double pronged
68	406-930			1	BRACKET, transistor
	- - - -			-	mounting hardware: (not included w/bracket)
	211-504			2	SCREW, 6-32 x 1/4 inch, BHS
69	343-089			13	CLAMP, cable, delrin, size "D"
70	214-365			1	HING, bottom
	- - - -			-	mounting hardware: (not included w/hinge)
	212-010			1	SCREW, 8-32 x 3/8 inch, BHS
	212-033			1	SCREW, 8-32 x 3/4 inch, BHS
	210-458			2	NUT, keps, 8-32 x 11/32 inch
71	- - - -			1	TRANSISTOR
	- - - -			-	mounting hardware: (not included w/transistor)
	352-069			1	HOLDER, transistor mounting
	387-867			1	PLATE, mica, transistor
	211-510			2	SCREW, 6-32 x 3/8 inch, BHS
	210-967			2	WASHER, teflon, insulator
	210-803			2	WASHER, 6L x 3/8 inch
	210-006			2	LOCKWASHER, internal, #6
	210-407			2	NUT, hex, 6-32 x 1/4 inch
72	210-204			3	LUG, solder, DE #6
	- - - -			-	mounting hardware for each: (not included w/lug)
	213-044			1	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
73	348-003			4	GROMMET, 5/16 inch
74	348-031			5	GROMMET, snap-in
75	- - - -			1	RESISTOR
	- - - -			-	resistor includes:
	406-301			1	BRACKET, resistor mounting
	- - - -			-	mounting hardware hardware: (not included w/resistor)
	211-513			1	SCREW, 6-32 x 5/8 inch, BHS
	210-006			1	LOCKWASHER, internal, #6
	210-407			1	NUT, hex, 6-32 x 1/4 inch
76	200-255			1	COVER, capacitor, small
77	200-259			4	COVER, capacitor, large
78	260-551			1	SWITCH, thermal cutout
	- - - -			-	mounting hardware: (not included w/switch)
	213-044			2	SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips
79	387-870			1	PLATE, thermal cutout, cover
	- - - -			-	mounting hardware: (not included w/plate)
	385-080			2	ROD, hex
	211-504			2	SCREW, 6-32 x 1/4 inch, BHS
80	354-215			1	RING, crt clamping, assembly (See Ref. #82)
	- - - -			-	ring includes:
	354-211			1	RING, clamping
	211-585			1	SCREW, 6-32 x 1 inch, RHS phillips
	220-419			1	NUT, square, 6-32 x 5/16 inch
81	124-160			1	STRIP, liner, crt clamp
82	- - - -			-	mounting hardware: (not included w/ring)
	214-207			1	NUT, adjusting, securing
	211-576			2	SCREW, 6-32 x 7/8 inch, socket head
	210-949			2	WASHER, 9/64 ID x 1/2 inch OD
83	406-904			1	BRACKET, rear crt support
	- - - -			-	mounting hardware: (not included w/bracket)
	211-504			4	SCREW, 6-32 x 1/4 inch, BHS
84	441-484			1	CHASSIS, power
	- - - -			-	mounting hardware: (not included w/chassis)
	211-504			6	SCREW, 6-32 x 1/4 inch, BHS
	212-004			1	SCREW, 8-32 x 5/16 inch, BHS
	210-458			1	NUT, keps, 8-32 x 11/32 inch
85	214-366			1	HINGE, top
	- - - -			-	mounting hardware: (not included w/hinge)
	212-010			1	SCREW, 8-32 x 5/8 inch, BHS
	212-033			1	SCREW, 8-32 x 3/4 inch, BHS
	210-458			2	NUT, keps, 8-32 x 11/32 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
86	387-768			1	PLATE, rear overlay
87	131-299			1	CONNECTOR, chassis mounted, 10 pin
	- - - -			-	mounting hardware: (not included w/connector)
	211-071			4	SCREW, 4-40 x 3/8 inch, PHS phillips
	210-586			4	NUT, keps, 4-40 x 1/4 inch
88	334-882			1	TAG, voltage rating
	- - - -			-	mounting hardware: (not included w/tag)
	213-088			2	SCREW, thread forming, 4-40 x 1/4 inch, PHS phillips
89	214-362			1	HEAT SINK
	- - - -			-	mounting hardware: (not included w/heat sink)
	213-128			2	SCREW, captive, 6-32 x .875 inch
	354-233			2	RING, retaining
90	346-027			1	STAP, ground
91	129-066			2	POST, binding
	- - - -			-	mounting hardware for each: (not included w/post)
	358-213			1	BUSHING, nylon
	210-457			1	NUT, keps, 6-32 x 5/16 inch
92	129-066			1	POST, binding
	- - - -			-	mounting hardware: (not included w/post)
	210-457			1	NUT, keps, 6-32 x 5/16 inch
93	200-500			4	COVER, transistor
	- - - -			-	mounting hardware for each: (not included w/cover)
	211-093			2	SCREW, 4-40 x 3/4 inch, HSS
	210-004			2	LOCKWASHER, internal, #4
	210-406			2	NUT, hex, 4-40 x 3/16 inch
94	200-548			10	COVER, nut
95	- - - -			10	DIODE
	- - - -			-	mounting hardware for each: (not included w/diode)
	210-224			1	LUG, solder, #10
	210-909			2	WASHER, mica, .625 OD x .196 inch ID
	210-910			1	WASHER, insulator, 5/16 OD x 3/16 inch ID
	210-805			1	WASHER, 10S x 7/16 inch
	210-010			1	LOCKWASHER, internal, #10
	220-411			1	NUT, hex, 10-32 x 3/8 inch
96	432-047			1	BASE, small capacitor
	- - - -			-	mounting hardware: (not included w/base)
	211-514			2	SCREW, 6-32 x 3/4 inch, BHS
	210-006			2	LOCKWASHER, internal, #6
	210-407			2	NUT, hex, 6-32 x 1/4 inch
	386-252			1	PLATE, fiber, small capacitor

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
97	214-344			2	HARDWARE, transistor mounting, package
98	432-048			3	BASE, large capacitor
	- - - -			-	mounting hardware for each: (not included w/base)
	211-514			2	SCREW, 6-32 x 3/4 inch, BHS
	210-006			2	LOCKWASHER, internal, #6
	210-407			2	NUT, hex, 6-32 x 1/4 inch
	386-254			1	PLATE, fiber, large capacitor
99	352-073			1	HOLDER, fuse, triple
	- - - -			-	mounting hardware: (not included w/holder)
	211-559			2	SCREW, 6-32 x 3/8 inch, FHS phillips
	210-006			2	LOCKWASHER, internal, #6
	210-407			2	NUT, hex, 6-32 x 1/4 inch
100	- - - -			1	RESISTOR, 5 watt
	- - - -			-	mounting hardware: (not included w/resistor)
	211-544			1	SCREW, 6-32 x 3/4 inch, THS phillips
	210-478			1	NUT, hex, resistor mounting
	211-507			1	SCREW, 6-32 x 5/16 inch, BHS
101	348-053			4	FOOT, body & cord holder
	348-054			4	FOOT, cap
	- - - -			-	mounting hardware for each: (not included w/foot)
	213-125			1	SCREW, 10-32 x 1 1/2 inches, socket head cap
102	387-806			1	PLATE, back, heat sink
	- - - -			-	mounting hardware: (not included w/plate)
	211-504			4	SCREW, 6-32 x 1/4 inch, BHS
103	105-046			1	STOP, top
	- - - -			-	mounting hardware: (not included w/stop)
	212-010			1	SCREW, 8-32 x 5/8 inch, BHS
	212-033			1	SCREW, 8-32 x 3/4 inch, BHS
	210-458			2	NUT, keps, 8-32 x 11/32 inch
104	119-028			1	FILTER, line
	- - - -			-	mounting hardware: (not included w/filter)
	212-039			2	SCREW, 8-32 x 3/8 inch, THS phillips
	210-458			2	NUT, keps, 8-32 x 11/32 inch
105	352-002			2	HOLDER, fuse, assembly
	- - - -			-	each holder includes:
	352-010			1	HOLDER, fuse
	200-582			1	CAP, fuse
	210-873			1	WASHER, rubber, 1/2 ID x 11/16 inch OD
	- - - -			1	NUT, hex, fuse holder

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
106	131-150			1	CONNECTOR, motor base, male
	- - - -			-	connector includes:
	129-041			1	POST, ground, 4-40 thread one end
	200-185			1	COVER, 3 wire motor base
	205-014			1	SHELL, mounting
	210-003			2	LOCKWASHER, external, #4
	210-551			2	NUT, hex, 4-40 x 1/4 inch
	211-015			1	SCREW, 4-40 x 1/2 inch, RHS
	214-078			2	PIN, connecting
	377-041			1	INSERT, black urea
	- - - -			-	mounting hardware: (not included w/connector)
	213-104			2	SCREW, thread forming, 6-32 x 3/8 inch, THS phillips
107	105-048			1	STOP, bottom
	- - - -			-	mounting hardware: (not included w/stop)
	212-010			1	SCREW, 8-32 x 5/8 inch, BHS
	212-033			1	SCREW, 8-32 x 3/4 inch, BHS
	210-458			2	NUT, keps, 8-32 x 11/32 inch
108	387-769			1	PLATE, rear sub-panel
	- - - -			-	plate includes:
	354-057			1	RING, ornamental
109	380-048			1	HOUSING, high voltage
	- - - -			-	mounting hardware: (not included w/housing)
	211-504			3	SCREW, 6-32 x 1/4 inch, BHS
110	381-225			1	BAR, heat sink, high voltage box
111	432-048			1	BASE, large capacitor
	- - - -			-	mounting hardware: (not included w/base)
	211-588			2	SCREW, 6-32 x 3/4 inch, HHS
	210-006			2	LOCKWASHER, internal, #6
	210-407			2	NUT, hex, 6-32 x 1/4 inch
	386-254			1	PLATE, fiber, large capacitor
112	200-475			1	COVER, high voltage
	- - - -			-	mounting hardware: (not included w/cover)
	211-521			2	SCREW, 6-32 x 1 1/2 inches, RHS
113	- - - -			1	TRANSFORMER
	- - - -			-	mounting hardware: (not included w/transformer)
	211-521			2	SCREW, 6-32 x 1 1/2 inches, RHS
	358-228			2	BUSHING, insulator
	358-231			4	BUSHING, high voltage box

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
114	214-210			1	SPOOL, solder, assembly
	- - - -			-	spool includes:
	214-209			1	SPOOL, solder
	- - - -			-	mounting hardware: (not included w/spool)
	361-007			1	SPACER, nylon, .063 inch
115	337-583			1	SHIELD, high voltage
	- - - -			-	mounting hardware: (not included w/shield)
	211-007			2	SCREW, 4-40 x 3/16 inch BHS
	213-035			3	SCREW, thread cuuting, 4-40 x 1/4 inch, PHS phillips
116	392-151			1	BOARD, high voltage
	- - - -			-	board includes:
	214-163			4	STRIP, ceramic, 2 notches
	124-164			2	STRIP, ceramic, 4 notches
	124-162			1	STRIP, ceramic, 7/16 inch x 4 notches
	- - - -			-	strip includes:
	355-046			1	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip alone)
	361-007			1	SPACER, nylon, .063 inch
117	348-006			4	GROMMET, 3/4 inch
118	- - - -			1	CAPACITOR
	- - - -			-	mounting hardware: (not included w/capacitor)
	210-966			1	WASHER, rubber
	210-261			2	LUG, solder, high voltage
	211-587			1	SCREW, 6-32 x 7/32 inch, HHS
119	166-319			2	SLEEVE, high voltage
	166-320			1	SLEEVE, high voltage anode lead
120	124-119			1	STRIP, ceramic, 7/16 inch x 2 notches
	- - - -			-	strip includes:
	355-046			1	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-007			1	SPACER, nylon, .063 inch
121	348-004			1	GROMMET, 3/8 inch
122	131-097			2	CONNECTOR, chassis mounted, 32 pin
	- - - -			-	mounting hardware for each: (not included w/connector)
	211-014			2	SCREW, 4-40 x 1/2 inch, BHS
	166-029			2	TUBE, spacer
	210-004			2	LOCKWASHER, internal, #4
	210-406			2	NUT, hex, 4-40 x 3/16 inch
123	387-807			1	PLATE, transformer support
	- - - -			-	mounting hardware: (not included w/plate)
	212-004			2	SCREW, 8-32 x 5/16 inch, BHS
	212-045			2	SCREW, 8-32 x 1/2 inch, THS phillips
	385-172			2	ROD, support, spacer
	210-458			4	NUT, keps, 8-32 x 11/32 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
124	- - - -			1	TRANSFORMER (not shown)
	- - - -			-	mounting hardware: (not included w/transformer)
	212-079			2	SCREW, 8-32 x 1/2 inch, HSS
	212-565			4	SCREW, 10-32 x 4 1/2 inches, HHS
	210-812			4	WASHER, fiber #10
	210-010			4	LOCKWASHER, internal, #10
	210-564			4	NUT, hex, 10-32 x 3/8 inch
125	387-770			1	PLATE, frame, center, vertical
	- - - -			-	mounting hardware: (not included w/plate)
	211-583			4	SCREW, 632 x 1 inch Fil HS
	210-592			4	NUT, rod, 6-32 x 5/16 inch
	212-004			2	SCREW, 8-32 x 5/16 inch, BHS
	211-538			1	SCREW, 6-32 x 5/16 inch, FHS phillips
	210-457			1	NUT, keps, 6-32 x 5/16 inch
126	387-774			1	PLATE, plug-in housing, right
	- - - -			-	mounting hardware: (not included w/plate)
	212-004			3	SCREW, 8-32 x 5/16 inch, BHS
	212-039			1	SCREW, 8-32 x 3/8 inch, THS phillips
	210-458			3	NUT, keps, 8-32 x 11/32 inch
127	406-947			2	BRACKET, guide rail
	- - - -			-	mounting hardware for each: (not included w/bracket)
	210-004			2	LOCKWASHER, internal, #4
	210-406			2	NUT, hex, 4-40 x 3/16 inch
128	358-224			4	BUSHING, pin
129	441-482			1	CHASSIS, capacitor
	- - - -			-	mounting hardware: (not included w/chassis)
	212-004			6	SCREW, 8-32 x 5/16 inch, BHS
	210-458			4	NUT, keps, 8-32 x 11/32 inch
130	- - - -			1	POT
	- - - -			-	mounting hardware: (not included w/pot)
	210-013			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-840			1	WASHER, .390 ID x 9/16 inch OD
	210-413			1	NUT, hex, 3/8-32 x 1/2 inch
131	210-202			1	LUG, solder, DE #6
	- - - -			-	mounting hardware: (not included w/lug)
	211-504			1	SCREW, 6-32 x 1/4 inch, BHS
	210-407			1	NUT, hex, 6-32 x 1/4 inch
132	348-057	X120		1	FOOT, flip stand bail
133	214-333			1	SPRING, switch rod

EXPLODED VIEW *(Cont'd)*

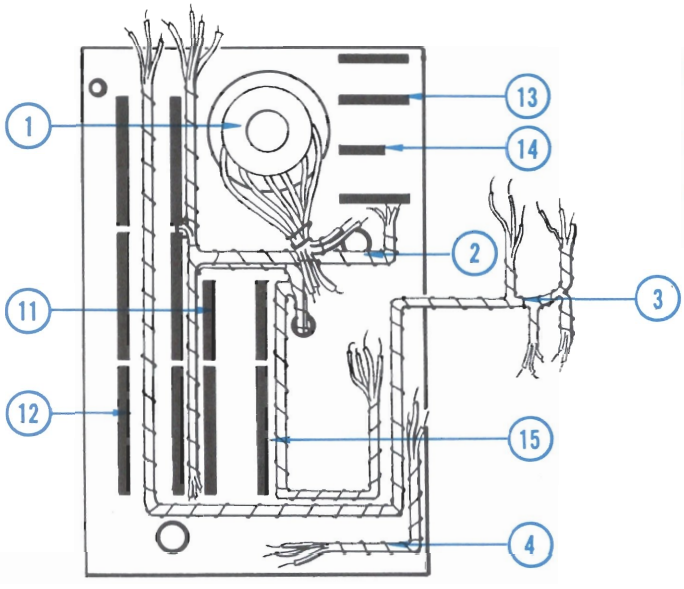
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
134	214-373			2	SPRING, plug-in release
	- - - -			-	mounting hardware for each: (not included w/spring)
	211-504			2	SCREW, 6-32 x 1/4 inch, BHS
135	129-035			1	POST, ground, assembly
	- - - -			-	post includes:
	355-507			1	STEM, adapter
	200-103			1	CAP
	210-046			1	LOCKWASHER, internal, .400 OD x .261 inch ID
	210-455			1	NUT, hex, 1/4-28 x 3/8 inch
136	- - - -			2	POT
	- - - -			-	mounting hardware for each: (not included w/pot)
	210-013			1	LOCKWASHER, internal, 3/8 x 11/16 inch
	210-978			1	WASHER, 3/8 ID x 1/2 inch OD
	210-590			1	NUT, hex, 3/8-32 x 7/16 inch
137	122-112			1	ANGLE, frame, top right
	- - - -			-	mounting hardware: (not included w/angle)
	211-538			4	SCREW, 6-32 x 5/16 inch, FHS phillips
	210-457			2	NUT, keps, 6-32 x 5/16 inch
138	- - - -			5	POT
	- - - -			-	mounting hardware for each: (not included w/pot)
	210-940			1	WASHER, 1/4 ID x 3/8 inch OD
	210-583			1	NUT, hex, 1/4-32 x 5/16 inch
	210-598			1	NUT, hex, 1/4-32 x 5/16 inch x 1/8 inch thick
139	210-241			1	LUG, ground
140	214-355	100	459	4	SPRING, plug-in ground
	214-459	460		4	SPRING, plug-in ground
	- - - -			-	mounting hardware for each: (not included w/spring)
	212-023			1	SCREW, 8-32 x 3/8 inch, BHS
	210-458			1	NUT, keps, 8-32 x 11/32 inch
141	214-376			2	SPRING, plug-in rail
142	- - - -	X450		1	POT
	- - - -			-	mounting hardware: (not included w/pot)
	210-223			1	LUG, solder, 1/4 inch
	210-940			1	WASHER, 1/4 ID x 3/8 inch OD
	210-583			1	NUT, hex, 1/4-32 x 5/16 inch
143	343-110	X450		1	CLAMP, crt coil form
144	343-004			2	CLAMP, cable, 3/8 inch
	- - - -			-	mounting hardware for each: (not included w/clamp)
	211-510			1	SCREW, 6-32 x 3/8 inch, BHS
	210-863			1	WASHER, "D" type

EXPLODED VIEW *(Cont'd)*

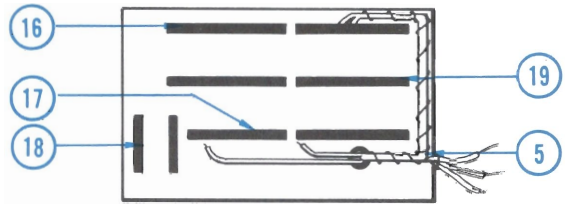
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
145	343-088			1	CLAMP, cable, Size "C"
146	346-032			1	STRAP, mousetail
147	348-055			1	GROMMET, plastic, ¼ inch
148	175-587			1	WIRE, crt lead, .500 foot, striped red, w/connector
	175-591			1	WIRE, crt lead, .417 foot, striped green, w/connector
	175-641			1	WIRE, crt lead, .833 foot, striped brown, w/connector
	175-642			1	WIRE, crt lead, .833 foot, striped blue, w/connector
149	200-269			1	COVER, pot

CABLE HARNESS AND CERAMIC STRIP DETAIL

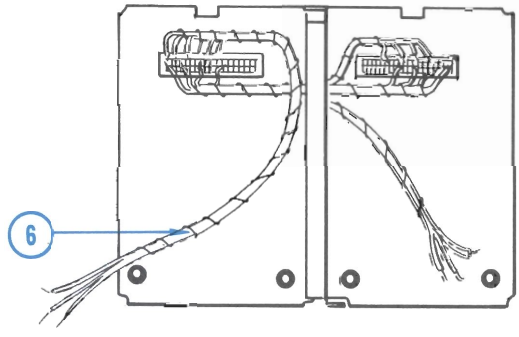
POWER CHASSIS



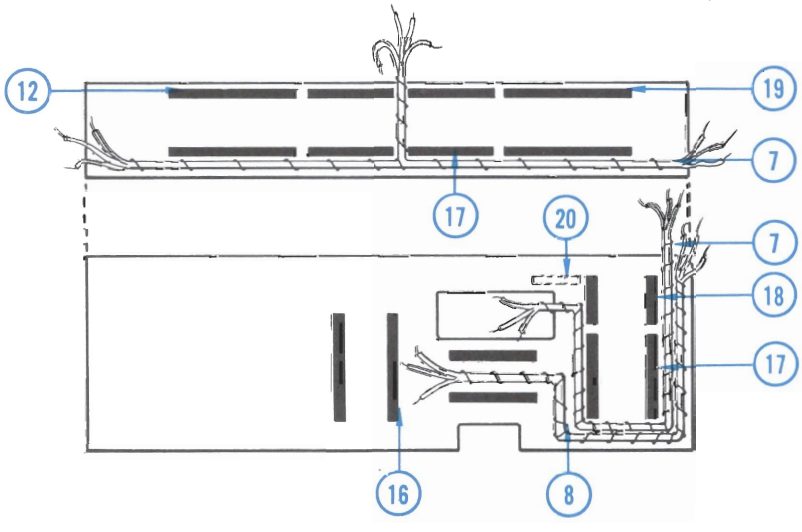
VERTICAL AMPLIFIER CHASSIS



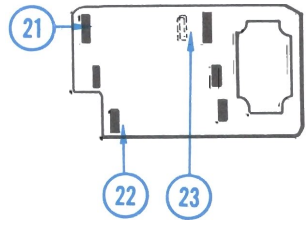
PLUG-IN HOUSING



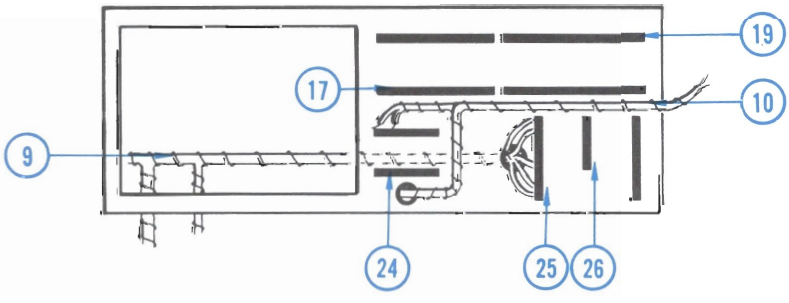
HORIZONTAL AMPLIFIER CHASSIS



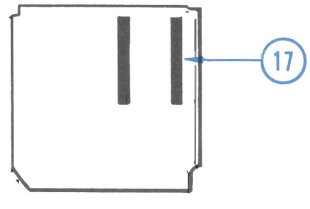
HIGH VOLTAGE CHASSIS



CALIBRATOR/FOCUS AND INTENSITY CHASSIS



CAPACITOR CHASSIS



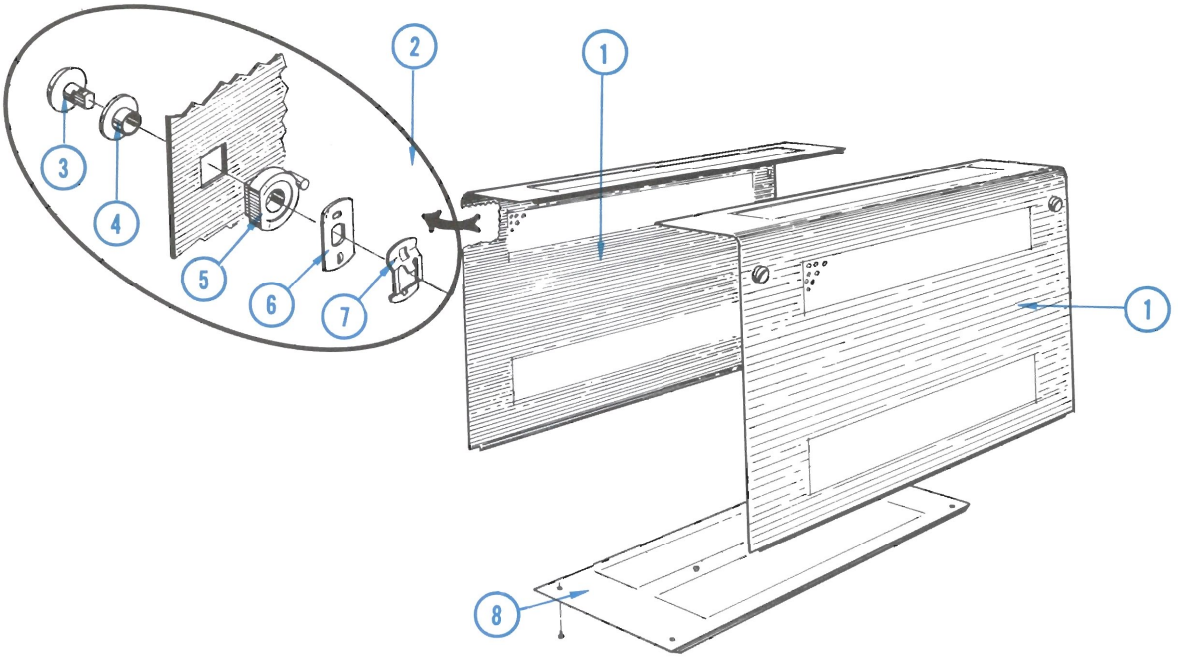
CABLE HARNESS & CERAMIC STRIP DETAIL

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	179-752			1	CABLE HARNESS, crt socket
	- - - -			-	cable harness includes:
	136-162			1	SOCKET, crt assembly
	- - - -			-	socket, includes:
	136-117			1	SOCKET, crt
	131-178			11	CONNECTOR, cable end, crt socket
	387-393			1	PLATE, back, crt socket
	213-086			2	SCREW, thread cutting, 2-32 x 7/16 inch, PHS phillips
2	179-747			1	CABLE HARNESS, power
3	179-798			1	CABLE HARNESS, heat sink
4	179-802			1	CABLE HARNESS, 110 volt
5	179-751			1	CABLE HARNESS, vertical amplifier
6	179-748			1	CABLE HARNESS, connector
7	179-753			1	CABLE HARNESS, high voltage
8	179-754			1	CABLE HARNESS, unblanking
9	179-749			1	CABLE HARNESS, focus & intensity
10	179-750			1	CABLE HARNESS, calibrator
11	124-148			2	STRIP, ceramic, 7/16 inch x 9 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each each: (not included w/strip)
	361-009			2	SPACER, nylon, .313 inch
12	124-145			8	STRIP, ceramic, 7/16 inch x 20 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-008			2	SPACER, nylon, .188 inch
13	124-147			3	STRIP, ceramic, 7/16 inch x 13 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-009			2	SPACER, nylon, .313 inch
14	124-149			1	STRIP, ceramic, 7/16 inch x 7 notches
	- - - -			-	strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-009			2	SPACER, nylon, .313 inch
15	214-145			2	STRIP, ceramic, 7/16 inch x 20 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-009			2	SPACER, nylon, .313 inch
16	124-146			4	STRIP, ceramic, 7/16 inch x 16 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-007			2	SPACER, nylon, .063 inch

CABLE HARNESS & CERAMIC STRIP DETAIL *(Cont'd)*

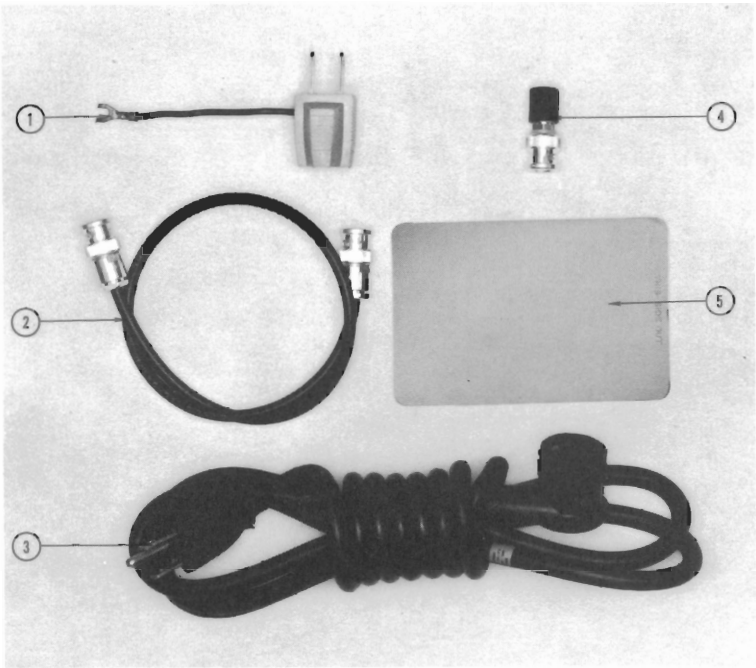
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
17	124-147			13	STRIP, ceramic, 7/16 inch x 13 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-007			2	SPACER, nylon, .063 inch
18	124-148			4	STRIP, ceramic, 7/16 inch x 9 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-007			2	SPACER, nylon, .063 inch
19	124-145			7	STRIP, ceramic, 7/16 inch x 20 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-007			2	SPACER, nylon, .063 inch
20	124-093			1	STRIP, ceramic, 7/16 inch x 5 notches
	- - - -			-	strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-007			2	SPACER, nylon, .063 inch
21	124-164			2	STRIP, ceramic, 4 notches
22	124-163			4	STRIP, ceramic, 2 notches
23	124-162			1	STRIP, ceramic, 7/16 inch x 4 notches
	- - - -			-	strip includes:
	355-046			1	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-007			1	SPACER, nylon, .063 inch
24	124-149			2	STRIP, ceramic, 7/16 inch x 7 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-007			2	SPACER, nylon, .063 inch
25	124-147			2	STRIP, ceramic, 7/16 inch x 13 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-008			2	SPACER, nylon, .188 inch
26	124-149			1	STRIP, ceramic, 7/16 inch x 7 notches
	- - - -			-	strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-008			2	SPACER, nylon, .188 inch

CABINET



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	387-772			2	PLATE, cabinet side
	- - - -			-	each plate includes:
2	214-361			2	LATCH, quarter turn, assembly
	- - - -			-	each latch includes:
3	214-400			1	PIN, securing, index
4	358-218			1	BUSHING, latch bearing
5	387-871			1	PLATE, latch index
6	387-804			1	PLATE, latch locking
7	214-359			1	SPRING, latch
8	387-797			1	PLATE, bottom
	- - - -			-	mounting hardware: (not included w/plate)
	212-075			4	SCREW, 8-32 x 1/4 inch, THS phillips
	211-542			2	SCREW, 6-32 x 5/16 inch, THS phillips

ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	103-013			1	ADAPTER, power cord
2	012-076			1	CABLE, 50 Ω, BNC both ends
3	161-013	100	119	1	CORD, power, right angle
	161-022	120		1	CORD, power, right angle
4	103-033			1	ADAPTER, BNC to binding post
5	378-540			1	FILTER, polarized light

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description			S/N Range
		Bulbs			
B604	150-029	Incandescent G.E. 349			Graticule Light
B605	150-029	Incandescent G.E. 349			Graticule Light
B606	150-029	Incandescent G.E. 349			Pilot Light
B852	150-030	Neon NE-2V			
B853	150-030	Neon NE-2V			
B854	150-030	Neon NE-2V			
		Capacitors			
		Tolerance ±20% unless otherwise indicated.			
		Tolerance of all electrolytic capacitors as follows (with exceptions):			
		3V — 50V = —10%, +250%			
		51V — 350V = —10%, +100%			
		351V — 450V = —10%, +50%			
C365	283-068	.01 μf	Cer	500 v	
C366	283-068	.01 μf	Cer	500 v	
C377	281-095	.2-1.5 pf	Teflon	Var	
C378	281-077	1.3-5.4 pf	Air	Var	
C397	281-095	.2-1.5 pf	Teflon	Var	
C398	285-572	.1 μf	PTM	200 v	
C404A	281-503	8 pf	Cer	500 v	±0.5 pf
C404B	281-503	8 pf	Cer	500 v	±0.5 pf
C404C	283-557	200 pf	Mica	500 v	10%
C406A	281-503	8 pf	Cer	500 v	±0.5 pf
C406B	281-503	8 pf	Cer	500 v	±0.5 pf
C406C	283-557	200 pf	Mica	500 v	10%
C417	283-079	.01 μf	Cer	250 v	
C443	283-081	.1 μf	Cer	25 v	
C445	281-592	4.7 pf	Cer		±0.5 pf
C456B	281-603	39 pf	Cer	500 v	5%
C456D	281-081	1.8-13 pf	Air	Var	
C456E	281-602	68 pf	Cer	500 v	5%
C456F	281-602	68 pf	Cer	500 v	5%
C464	281-603	39 pf	Cer	500 v	5%
C465	281-576	11 pf	Cer	500 v	5%
C466	281-586	25 pf	Cer	500 v	5%
C467	281-079	1.5-9.1 pf	Air	Var	

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
C469	283-081	.1 μf	Cer	25 v		
C474	281-603	39 pf	Cer	500 v	5%	
C475	281-576	11 pf	Cer	500 v	5%	
C476	281-603	39 pf	Cer	500 v	5%	
C483	283-079	.01 μf	Cer	250 v		
C484	281-076	1.2-3.5 pf	Air Var			
C601, C602, C603 } †						
C609	290-171	100 μf	EMT	12 v		
C610	285-644	.033 μf	PTM	600 v		
C611	285-572	.1 μf	PTM	200 v		
C612	Use *290-232	400 μf	EMC	250 v		
C615	285-623	.47 μf	PTM	100 v		
C622	285-569	.01 μf	PTM	200 v		
C631	290-198	17 μf	EMT	150 v		
C642	Use *290-253	3900 μf	EMC	30 v		
C660	283-078	.001 μf	Cer	500 v		
C661	290-162	22 μf	EMT	35 v		
C663	285-598	.01 μf	PTM	100 v	5%	
C672	Use *290-253	3900 μf	EMC	30 v		
C690	283-078	.001 μf	Cer	500 v		
C691	290-162	22 μf	EMT	35 v		
C692	283-078	.001 μf	Cer	500 v		
C694	283-081	.1 μf	Cer	25 v		
C701	285-644	.033 μf	PTM	600 v		
C702	Use *290-232	400 μf	EMC	250 v		
C714	285-622	.1 μf	PTM	100 v		
C731	290-198	17 μf	EMT	150 v		
C739	281-524	150 pf	Cer	500 v		
C741	285-644	.033 μf	PTM	600 v		
C742	Use *290-254	170 μf	EMC	250 v		
C743	290-171	100 μf	EMT	12 v		
C744	285-598	.01 μf	PTM	100 v	5%	
C745	285-587	.1 μf	PTM	600 v		
C802	283-010	.05 μf	Cer	50 v		
C803	283-010	.05 μf	Cer	50 v		
C811	283-081	.1 μf	Cer	25 v		
C815	285-598	.01 μf	PTM	100 v	5%	
C818	290-189	33 μf	EMT	35 v	10%	
C820	290-117	50 μf	EMT	50 v		
C821	285-623	.47 μf	PTM	100 v		
C822	283-042	.015 μf	Cer	3000 v		
C827	283-042	.015 μf	Cer	3000 v		
C831	285-572	.1 μf	PTM	200 v		
C832	283-042	.015 μf	Cer	3000 v		
C833	283-044	.001 μf	Cer	3000 v		

†Furnished as a unit with *119-028 (Line Filter).

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description			S/N Range
C835	281-556	500 pf	Cer	10,000 v	
C836	281-556	500 pf	Cer	10,000 v	
C837	281-556	500 pf	Cer	10,000 v	
C838	283-096	500 pf	Cer	20,000 v	
C844	283-042	.015 μf	Cer	3000 v	
C845	283-042	.015 μf	Cer	3000 v	
C846	283-042	.015 μf	Cer	3000 v	
C851	285-572	.1 μf	PTM	200 v	
C854	283-042	.015 μf	Cer	3000 v	
C863	283-079	.01 μf	Cer	250 v.	
C864	285-572	.1 μf	PTM	200 v	
C870	283-079	.01 μf	Cer	250 v	
C874	281-543	270 pf	Cer	500 v	10%
C877	281-534	3.3 pf	Cer		±.25 pf
C878	281-500	2.2 pf	Cer	500 v	±0.5 pf
C879	281-005	1.5-7 pf	Cer Var		
C882	285-569	.01 μf	PTM	200 v	
C891	283-080	.022 μf	Cer	25 v	
C902	285-627	.0033 μf	PTM	100 v	5%
C903	285-626	.0015 μf	PTM	100 v	
C914	285-622	.1 μf	PTM	100 v	
C916	290-026	5 μf	EMT	25 v	
C923	283-081	.1 μf	Cer	25 v	
C924	285-627	.0033 μf	PTM	100 v	5%
C925	285-627	.0033 μf	PTM	100 v	5%
C926	290-026	5 μf	EMT	25 v	
C935	281-519	47 pf	Cer	500 v	10%
C936	283-081	.1 μf	Cer	25 v	
C937	283-081	.1 μf	Cer	25 v	
C945	281-504	10 pf	Cer	500 v	10%
C946	285-572	.1 μf	PTM	200 v	
C948A	281-534	3.3 pf	Cer		±.25 pf
C948K	281-525	470 pf	Cer	500 v	
C948Z	281-523	100 pf	Cer	350 v	

Diodes

D360	152-141	Silicon 1N3605	
D361	152-141	Silicon 1N3605	
D362	152-141	Silicon 1N3605	
D363	152-141	Silicon 1N3605	
D371	152-141	Silicon 1N3605	
D374	152-126	Zener 1N3024A 15 v	
D395	*152-061	Silicon Tek Spec	
D396	*152-061	Silicon Tek Spec	
D397	152-060	Zener 1N3027A 20 v	
D609	152-124	Zener 1N938A 9 v	
D611	*152-061	Silicon Tek Spec	
D612A,B,C,D,	152-066	Silicon 1N3194	
D636	152-096	Zener 1N2997B 51 v	

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D642A,B,C,D	152-113	Silicon RCA40108	
D669	152-141	Silicon 1N3605	
D672A,B,C,D	152-113	Silicon 1N3605	
D699	152-141	Silicon 1N3194	
D702A,B,C,D	152-066	Silicon RCA40108	
D714	152-135	Zener 1N3042A 82 v	
D716	152-134	Zener 1N3044A 100 v	
D736	152-133	Zener 1N3001B 68 v	
D737	152-066	Silicon 1N3194	
D739	152-141	Silicon 1N3605	
D742	152-066	Silicon 1N3194	
D743	152-066	Silicon 1N3194	
D745	152-066	Silicon 1N3194	X220-up
D804	152-119	Zener 1N969A 22 v	
D811	152-141	Silicon 1N3605	
D815	152-141	Silicon 1N3605	
D816	152-141	Silicon 1N3605	
D817	152-141	Silicon 1N3605	
D820	152-104	Zener 1N3016A 6.8 v	
D870	152-002	Silicon 1N1329	
D871	152-002	Silicon 1N1329	
D872	*152-061	Silicon Tek Spec	
D873	152-141	Silicon 1N3605	
D874	*152-061	Silicon Tek Spec	
D884	152-141	Silicon 1N3605	
D886	152-141	Silicon 1N3605	
D891	152-141	Silicon 1N3605	
D932	152-141	Silicon 1N3605	
D933	152-141	Silicon 1N3605	
D942	152-141	Silicon 1N3605	
D943	152-141	Silicon 1N3605	
D944	*152-061	Silicon Tek Spec	
D947	*152-061	Silicon Tek Spec	
D948	152-141	Silicon 1N3605	

Fuses

F601	159-005	3 Amp 3AG Slo-Blo	
F602	159-027	4 Amp 3AG Slo-Blo	
F613	159-025	.5 Amp 3AG Fast-Blo	
F703	159-042	.75 Amp 3AG Fast-Blo	
F743	159-042	.75 Amp 3AG Fast-Blo	
F820	159-021	2 Amp 3AG Fast-Blo	

Inductors

Ckt. No.	Tektronix Part No.	Description	S/N Range
L394	108-254	600 μh	
LR400	*108-278	.3 μh (wound on a 3.3 Ω, 5% resistor)	
LR401	*108-278	.3 μh (wound on a 3.3 Ω, 5% resistor)	
L403	*119-029	Delay Line Assembly	
L404	*108-220	.15 μh	
L405	*108-277	.07 μh	
L406	*108-220	.15 μh	
L407	*108-088	3.2 μh	
L414	*108-182	.3 μh	
L443	*108-088	3.2 μh	
L469	*108-260	.1 μh	
L479	*108-260	.1 μh	
L487	276-532	Core, Shield Bead	
L497	276-532	Core, Shield Bead	
L861	*108-279	Beam Rotator (X-Axis)	
L865	*108-295	Beam Rotator (Y-Axis)	X450-up

Resistors

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

R350A R350B	311-401	1 k 5 k	2 w 2 w	Var Var		HORIZ POSITION VERNIER
R360	324-317	19.6 k	1 w		Prec	1%
R361	323-302	13.7 k	½ w		Prec	1%
R362	323-347	40.2 k	½ w		Prec	1%
R363	323-338	32.4 k	½ w		Prec	1%
R364	311-400	2 x 500		Var		HORIZ CENT
R365	302-274	270 k	½ w			
R366	302-274	270 k	½ w			
R367	301-153	15 k	½ w			5%
R370	323-352	45.3 k	½ w		Prec	1%
R371	323-237	2.87 k	½ w		Prec	1%
R373	301-222	2.2 k	½ w			5%
R374	308-178	15 k	8 w	WW		5%
R376	324-296	11.8 k	1 w		Prec	1%
R377	311-326	10 k		Var		HORIZ GAIN
R378	321-251	4.02 k	⅛ w		Prec	1%
R379	321-251	4.02 k	⅛ w		Prec	1%
R390	324-289	10 k	1 w		Prec	1%
R391	323-237	2.87 k	½ w		Prec	1%
R393	301-822	8.2 k	½ w			5%
R394	*310-607	8.8 k	10 w	WW		1%
R396	324-296	11.8 k	1 w		Prec	1%
R397	302-104	100 k	½ w			
R398	301-270	27 Ω	½ w			5%
R404	321-047	30.1 Ω	⅛ w		Prec	1%
R406	321-047	30.1 Ω	⅛ w		Prec	1%

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.	Description				S/N Range
R407	315-751	750 Ω	1/4 w			5%
R410	321-121	178 Ω	1/8 w		Prec	1%
R411	321-121	178 Ω	1/8 w		Prec	1%
R414A,B	311-379	2 x 200 Ω		Var	WW	VERT GAIN
R416	322-171	590 Ω	1/4 w		Prec	1%
R417	322-187	866 Ω	1/4 w		Prec	1%
R421	315-151	150 Ω	1/4 w			5%
R423	315-391	390 Ω	1/4 w			5%
R425	315-221	220 Ω	1/4 w			5%
R433	315-391	390 Ω	1/4 w			5%
R441	311-389	2 x 10 k		Var		VERT CENT
R442	315-472	4.7 k	1/4 w			5%
R444	323-105	121 Ω	1/2 w		Prec	1%
R445	322-093	90.9 Ω	1/4 w		Prec	1%
R447	323-607	600 Ω	1/2 w		Prec	1%
R448	303-121	120 Ω	1 w			5%
R452	315-472	4.7 k	1/4 w			5%
R454	323-105	121 Ω	1/2 w		Prec	1%
R456B	315-680	68 Ω	1/4 w			5%
R456D	311-095	500 Ω		Var		DAMPING
R456E	321-195	1.05 k	1/8 w		Prec	1%
R456F	315-822	8.2 k	1/4 w			5%
R457	323-607	600 Ω	1/2 w		Prec	1%
R458	301-472	4.7 k	1/2 w			5%
R465	321-097	100 Ω	1/8 w		Prec	1%
R466	315-151	150 Ω	1/4 w			5%
R467	*310-610	970 Ω	2 w	Mica Plate		1%
R468	*310-610	970 Ω	2 w	Mica Plate		1%
R469	301-100	10 Ω	1/2 w			5%
R475	321-097	100 Ω	1/8 w		Prec	1%
R476	315-151	150 Ω	1/4 w			5%
R477	*310-610	970 Ω	2 w	Mica Plate		1%
R478	*310-610	970 Ω	2 w	Mica Plate		1%
R480	323-245	3.48 k	1/2 w		Prec	1%
R481	*310-609	4 k	2 w	Mica Plate		1%
R482	323-207	1.4 k	1/2 w		Prec	1%
R483	301-100	10 Ω	1/2 w			5%
R484A, R484B	*310-608	1400 Ω	20 w	Mica Plate	Center Tapped	1%
R490	323-245	3.48 k	1/2 w		Prec	1%
R491	*310-609	4 k	2 w	Mica Plate		1%
R492	323-207	1.4 k	1/2 w		Prec	1%
R604	311-377	25 Ω	12.5 w	Var		SCALE ILLUM
R609	324-284	8.87 k	1 w		Prec	1%
R610	316-333	33 k	1/4 w			
R611	316-101	100 Ω	1/4 w			

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R612	323-368	66.5 k	½ w		Prec	1%
R613	307-009	4.7 Ω	1 w			
R614	323-418	221 k	½ w		Prec	1%
R615	302-102	1 k	½ w			
R622	302-331	330 Ω	½ w			
R623	302-333	33 k	½ w			
R630	308-254	1.37 k	½ w		WW	1%
R631	311-421	1 k		Var	WW	—75 VOLTS
R632	308-259	10.7 k	1 w		WW	1%
R633	302-333	33 k	½ w			
R634	322-147	332 Ω	¼ w		Prec	1%
R636	304-470	47 Ω	1 w			
R637	308-123	20 Ω	5 w		WW	5%
R642	302-103	10 k	½ w			
R644	316-224	220 k	¼ w			
R649	*308-087	.5 Ω	1 w		WW	1%
R653	316-683	68 k	¼ w			
R660	308-257	5.11 k	½ w		WW	1%
R661	311-378	250 Ω		Var	WW	—15 VOLTS
R662	308-263	15.4 k	½ w		WW	1%
R663	306-271	270 Ω	2 w			
R664	302-223	22 k	½ w			
R669	323-391	115 k	½ w		Prec	1%
R672	302-103	10 k	½ w			
R674	316-184	180 k	¼ w			
R679	308-244	.3 Ω	2 w		WW	
R683	302-223	22 k	½ w			
R690	308-255	3.65 k	½ w		WW	1%
R691	311-378	250 Ω		Var	WW	+15 VOLTS
R692	308-261	15 k	1 w		WW	1%
R693	302-273	27 k	½ w			
R694	316-101	100 Ω	¼ w			
R699	323-385	100 k	½ w		Prec	1%
R702	304-473	47 k	1 w			
R703	308-179	5 Ω	5 w		WW	5%
R714	302-103	10 k	½ w			
R716	316-224	220 k	¼ w			
R719	302-473	47 k	½ w			
R723	302-333	33 k	½ w			
R730	308-264	21.5 k	1 w		WW	
R731	311-380	500 Ω		Var	WW	+100 VOLTS
R732	308-260	13.3 k	1 w		WW	
R733	302-333	33 k	½ w			
R736	use 308-223	35 Ω	3 w		WW	5%
R737	308-279	20 Ω	5 w		WW	
R739	323-387	105 k	½ w		Prec	1%

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R742	304-104	100 k	1 w			
R744	302-560	56 Ω	½ w			100-219
R744	302-121	120 Ω	½ w			220-up
R745	302-270	27 Ω	½ w			
R800	323-498	1.5 meg	½ w		Prec 1%	
R801	311-408	20 k		Var	WW HIGH VOLTAGE	
R802A	324-531	3.32 meg	1 w		Prec 1%	
R802B	324-531	3.32 meg	1 w		Prec 1%	
R802C	324-531	3.32 meg	1 w		Prec 1%	
R802D	324-531	3.32 meg	1 w		Prec 1%	
R802E	324-531	3.32 meg	1 w		Prec 1%	
R802F	324-531	3.32 meg	1 w		Prec 1%	
R803	323-476	887 k	½ w		Prec 1%	
R804	316-103	10 k	¼ w			
R805	316-123	12 k	¼ w			
R806	316-222	2.2 k	¼ w			
R807	316-335	3.3 meg	¼ w			
R808	304-223	22 k	1 w			
R809	316-101	100 Ω	¼ w			
R810	316-563	56 k	¼ w			
R811	315-132	1.3 k	¼ w		5%	
R812	315-432	4.3 k	¼ w		5%	
R814	316-103	10 k	¼ w			
R815	316-105	1 meg	¼ w			
R817	301-564	560 k	½ w		5%	
R818	301-222	2.2 k	½ w		5%	
R819	316-101	100 Ω	¼ w			
R820	306-151	150 Ω	2 w			
R821	316-563	56 k	¼ w			
R824	316-183	18 k	¼ w			
R825	316-105	1 meg	¼ w			
R826	306-106	10 meg	2 w			
R827	306-106	10 meg	2 w			
R828	306-106	10 meg	2 w			
R829	306-106	10 meg	2 w			
R831	302-102	1 k	½ w			
R832	311-329	50 k		Var	CRT GRID BIAS	
R833	302-103	10 k	½ w			
R834	302-103	10 k	½ w			
R838	302-105	1 meg	½ w			
R840	306-395	3.9 meg	2 w			
R841	306-395	3.9 meg	2 w			
R842	306-395	3.9 meg	2 w			
R843	306-395	3.9 meg	2 w			
R844	311-121	5 meg		Var	FOCUS	
R845	302-275	2.7 meg	½ w			
R850	316-473	47 k	¼ w			
R851	316-563	56 k	¼ w			

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.	Description				S/N Range
R852	302-101	100 Ω	½ w			
R853	301-223	22 k	½ w			5%
R854	302-105	1 meg	½ w			
R855	302-101	100 Ω	½ w			
R856	302-104	100 k	½ w			
R861†	311-412	2 x 1 k		Var	WW	TRACE ROTATION
R863	311-110	100 k		Var		GEOMETRY
R864†	311-412	100 k		Var	WW	ASTIGMATISM
R865	311-458	5 k		Var	WW	Y AXIS ALIGNMENT
R870	316-101	100 Ω	¼ w			
R871	316-102	1 k	¼ w			
R873	306-333	33 k	2 w			
R874	305-622	6.2 k	2 w			5%
R875	308-178	15 k	8 w		WW	5%
R876	316-470	47 Ω	¼ w			
R878	323-335	30.1 k	½ w		Prec	1%
R882	315-202	2 k	¼ w			5%
R884	316-332	3.3 k	¼ w			
R885	321-379	86.6 k	⅛ w		Prec	1%
R886	324-317	19.6 k	1 w		Prec	1%
R891	316-682	6.8 k	¼ w			
R892	316-470	47 Ω	¼ w			
R893	316-470	47 Ω	¼ w			
R894	301-223	22 k	½ w			5%
R895	322-229	2.37 k	¼ w		Prec	1%
R896	321-253	4.22 k	⅛ w		Prec	1%
R897	311-011	5 k		Var		INTENSITY
R902	316-183	18 k	¼ w			
R903	316-183	18 k	¼ w			
R904	316-332	3.3 k	¼ w			
R911	316-103	10 k	¼ w			
R914	316-222	2.2 k	¼ w			
R916	316-472	4.7 k	¼ w			
R921	316-103	10 k	¼ w			
R923	316-470	47 Ω	¼ w			
R924	315-222	2.2 k	¼ w			5%
R926	315-272	2.7 k	¼ w			5%
R931	316-683	68 k	¼ w			
R932	323-483	1.05 meg	½ w		Prec	1%
R933	316-103	10 k	¼ w			
R934	316-152	1.5 k	¼ w			
R935	316-392	3.9 k	¼ w			
R937	302-100	10 Ω	½ w			
R941	316-683	68 k	¼ w			
R942	323-483	1.05 meg	½ w		Prec	1%
R943	316-103	10 k	¼ w			

†R861 and R864 furnished as a unit.

Resistors (Cont'd)

Ckt. No.	Tektronix Part No.		Description			S/N Range
R944	316-152	1.5 k	¼ w			
R945	316-392	3.9 k	¼ w			
R946	302-100	10 Ω	½ w			
R947	308-025	20 k	10 w	WW	5%	
R948B	323-289	10 k	½ w	Prec	1%	
R948C	323-635	6.667 k	½ w	Prec	1%	
R948D	323-634	1.789 k	½ w	Prec	1%	
R948E	323-633	801 Ω	½ w	Prec	1%	
R948F	323-632	452 Ω	½ w	Prec	1%	
R948G	323-631	146.1 Ω	½ w	Prec	1%	
R948H	323-630	72.4 Ω	½ w	Prec	1%	
R948J	323-629	43.1 Ω	½ w	Prec	1%	
R948K	323-628	28.6 Ω	½ w	Prec	1%	
R948L	323-627	21.4 Ω	½ w	Prec	1%	
R948X	323-636	50 k	½ w	Prec	1%	
R948Y	323-638	50 k	½ w	Prec	¼%	
R948Z	323-637	50 Ω	½ w	Prec	1%	
R949	*308-090	¼ Ω	1 w	WW		

Switches

	Unwired	Wired		
SW360	260-516		Push Button	TRACE FINDER
SW458	260-516		Push Button	TRACE FINDER
SW601	260-515		Toggle	POWER ON
SW948	260-536	*262-569	Rotary	1 KC CALIBRATOR

Thermal Cutout

TK601	260-551	Thermal Cutout 187°

Transformers

T600†	*119-028	Line Filter	
T601	*120-331	L.V. Power	100-219
T601	*120-339	L.V. Power	220-up
T820	*120-332	H.V. Power	

Transistors

Q373	*151-133	Selected from 2N3251
Q374	*151-124	Selected from TA1938
Q393	*152-133	Selected from 2N3251
Q394	*151-124	Selected from TA1938

† Furnished as a unit with C601, C602 and C603.

Transistors (Cont'd)

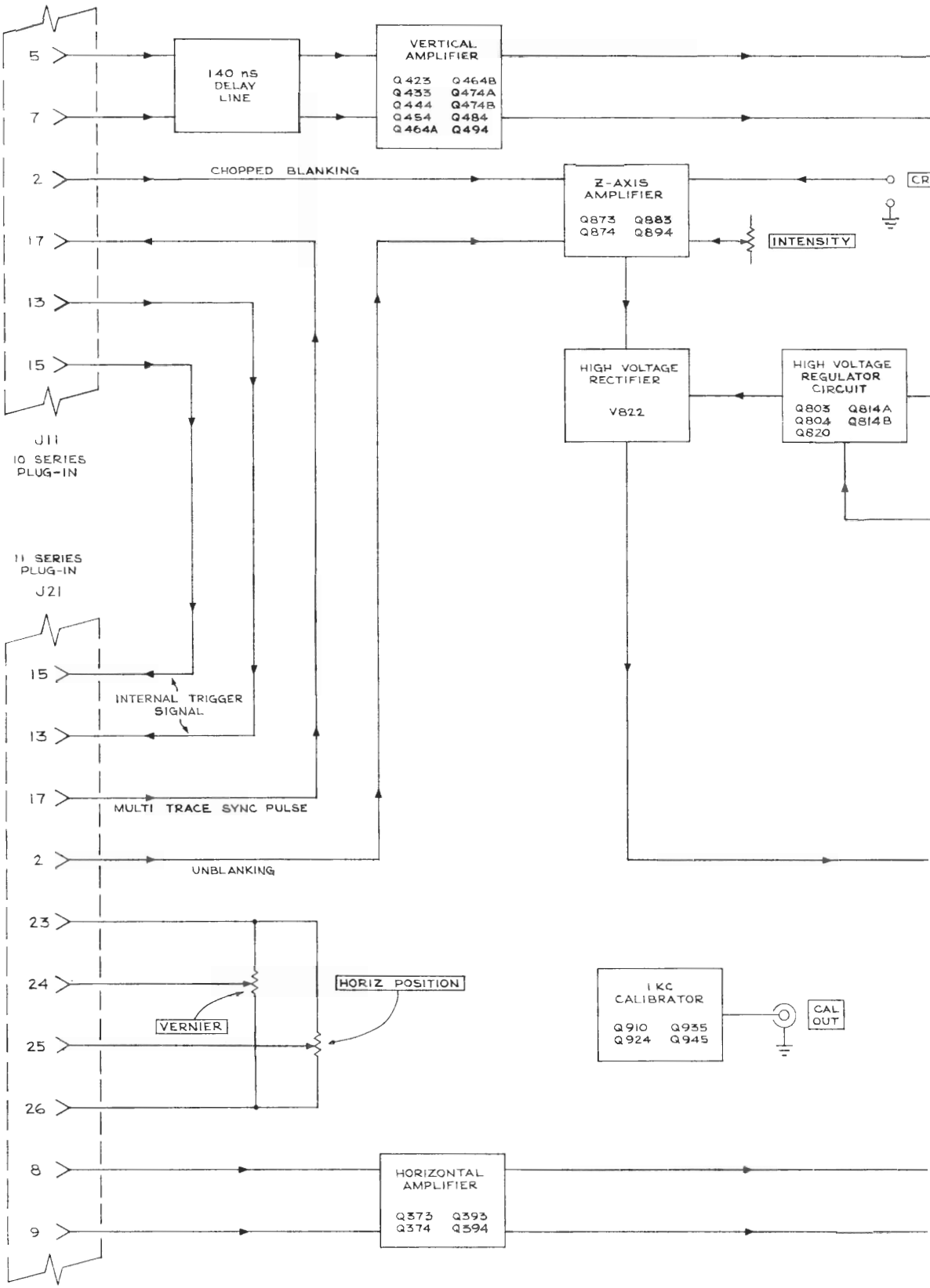
Ckt. No.	Tektronix Part No.	Description	S/N Range
Q423	*151-127	Selected from 2N2369	
Q433	*151-127	Selected from 2N2369	
Q444	*151-127	Selected from 2N2369	
Q454	*151-127	Selected from 2N2369	
Q464A	*151-127	Selected from 2N2369	
Q464B	*151-127	Selected from 2N2369	
Q474A	*151-127	Selected from 2N2369	
Q474B	*151-127	Selected from 2N2369	
Q484 Q494	*153-524	Matched pair	
Q614	*151-104	Replaceable by 2N2913	
Q623	*151-096	Selected from 2N1893	
Q633	*151-096	Selected from 2N1893	
Q637	151-113	2N1488	
Q644	*151-126	Replaceable by 2N2484	
Q653	*151-103	Replaceable by 2N2219	
Q659	*151-103	Replaceable by 2N2219	
Q663	*151-103	Replaceable by 2N2219	
Q667	151-112	2N1489	
Q674	*151-126	Replaceable by 2N2484	
Q683	*151-103	Replaceable by 2N2219	
Q689	*151-103	Replaceable by 2N2219	
Q693	151-125	2N1701	
Q697	151-110	152-04 Westinghouse	
Q714	*151-126	Replaceable by 2N2484	
Q723	*151-103	Replaceable by 2N2219	
Q733	*151-103	Replaceable by 2N2219	
Q737	151-111	151-07 Westinghouse	
Q803	*151-104	Replaceable by 2N2913	
Q804	*151-103	Replaceable by 2N2219	
Q814A	*151-103	Replaceable by 2N2219	
Q814B	*151-103	Replaceable by 2N2219	
Q820	151-112	2N1489	
Q873	*151-124	Selected from TA1938	
Q874	*151-124	Selected from TA1938	
Q883	*151-108	Replaceable by 2N2501	
Q894	*151-108	Replaceable by 2N2501	
Q910	*151-126	Replaceable by 2N2484	
Q924	*151-103	Replaceable by 2N2219	
Q935	*151-103	Replaceable by 2N2219	
Q945	*151-124	Selected from TA1938	

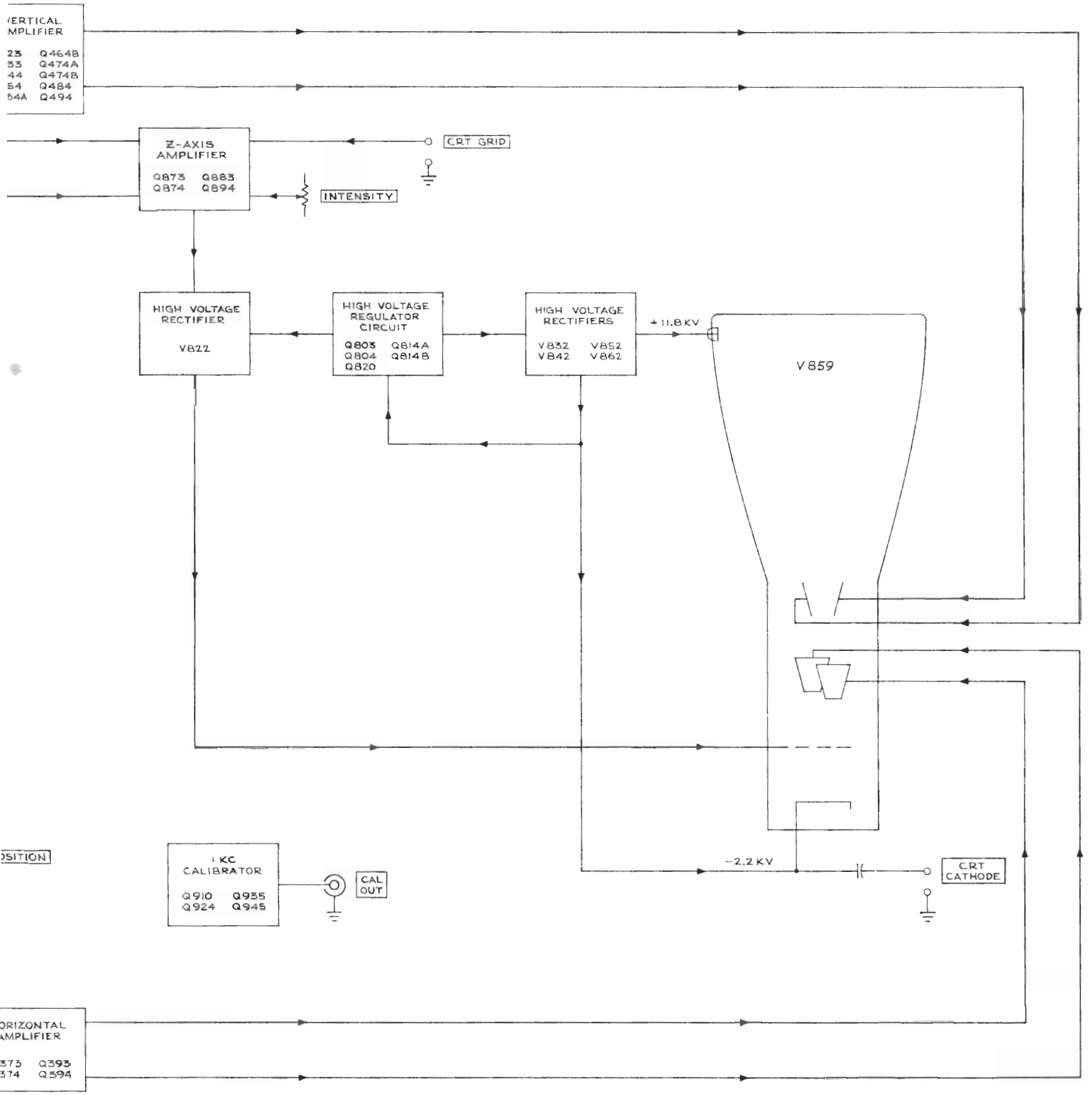
Electron Tubes

Ckt. No.	Tektronix Part No.	Description	S/N Range
V822	154-051	5642	
V832	154-051	5642	
V842	154-051	5642	
V852	154-051	5642	
V859	*154-424	CRT T6470-31-1 Standard Phosphor	100-219
V859	*154-448	CRT T6470-31-1 Standard Phosphor	220-up
V862	154-051	5642	

Crystal

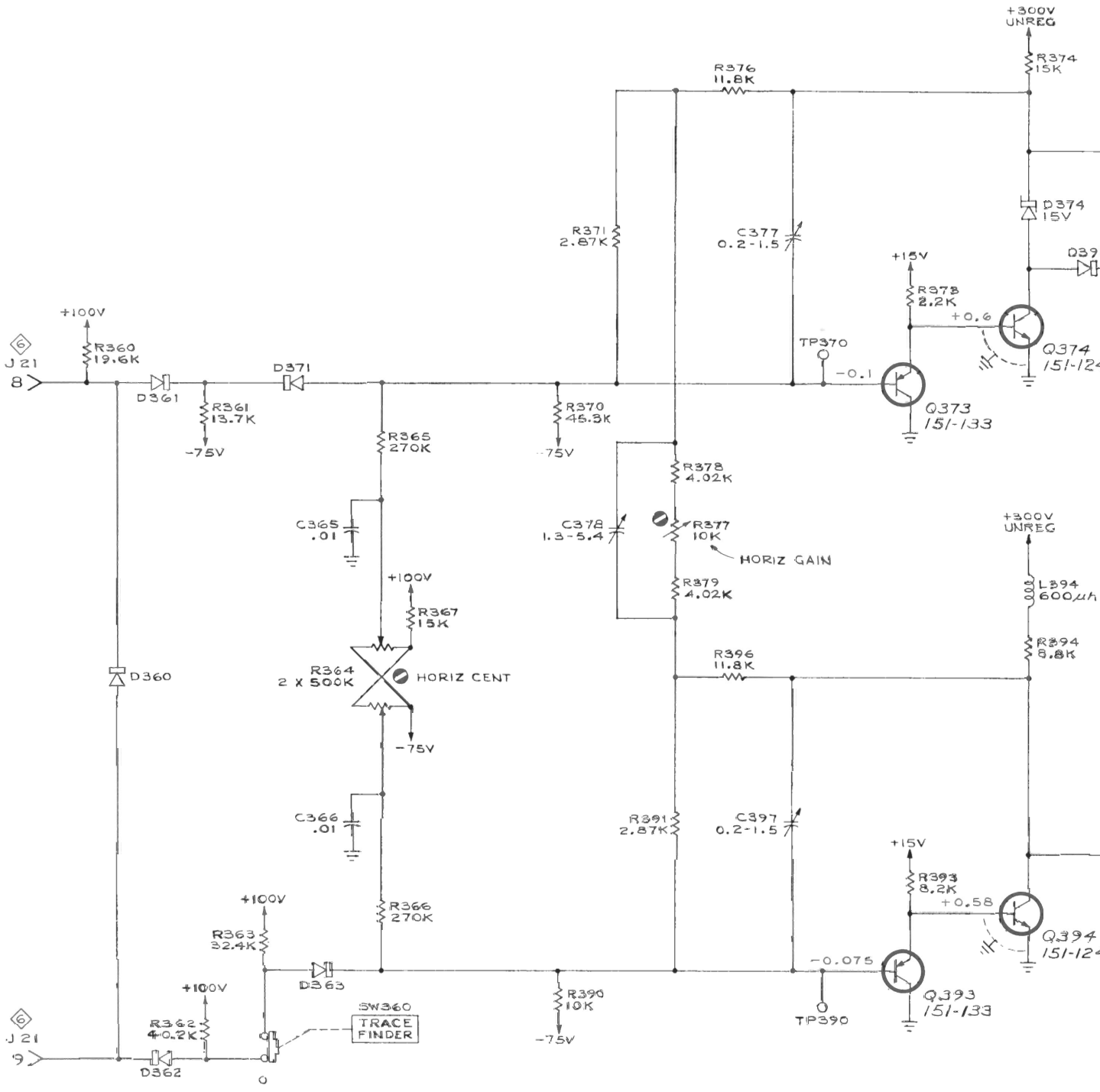
Y900	158-015	4 KC	


5
7
140 nS DELAY LINE
VERTICAL AMPLIFIER
Q423 Q464B
Q433 Q474A
Q444 Q474B
Q454 Q484
Q464A Q494
2
CHOPPED BLANKING
Z-AXIS AMPLIFIER
Q873 Q883
Q874 Q894
INTENSITY
CR
17
13
15
HIGH VOLTAGE RECTIFIER
V822
HIGH VOLTAGE REGULATOR CIRCUIT
Q803 Q814A
Q804 Q814B
Q820
J11
10 SERIES PLUG-IN
11 SERIES PLUG-IN
J21
15
INTERNAL TRIGGER SIGNAL
13
17
MULTI TRACE SYNC PULSE
2
UNBLANKING
23
24
HORIZ POSITION
VERNIER
25
26
1 KC CALIBRATOR
Q910 Q935
Q924 Q945
CAL OUT
8
9
HORIZONTAL AMPLIFIER
Q373 Q393
Q374 Q394



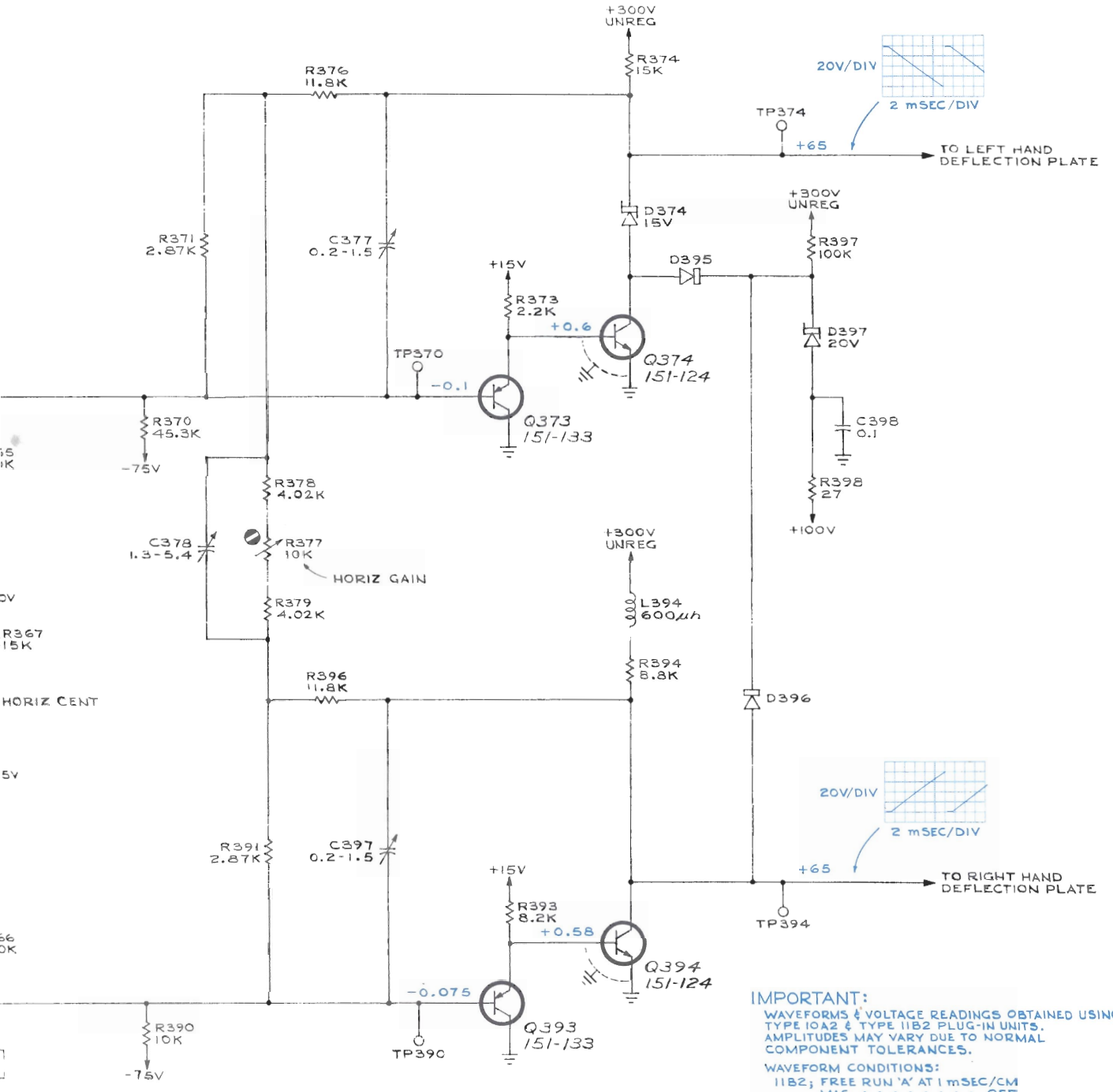
DON
664

BLOCK DIAGRAM



REFERENCE DRAWING:

⑥ INTERCONNECTING SOCKETS



IMPORTANT:

WAVEFORMS & VOLTAGE READINGS OBTAINED USING TYPE 10A2 & TYPE 11B2 PLUG-IN UNITS. AMPLITUDES MAY VARY DUE TO NORMAL COMPONENT TOLERANCES.

WAVEFORM CONDITIONS:

11B2; FREE RUN 'A' AT 1 mSEC/CM
MAG . . . . . OFF
10A2; CH 1 MODE AT 1VOLT/CM
.5VOLT 1KC CALIBRATOR APPLIED
ACTUAL PHOTOGRAPHS OF WAVEFORMS ARE SHOWN.

VOLTAGE CONDITIONS

11B2 SET FOR EXT INPUT
NO SIGNAL APPLIED TO EITHER PLUG-IN
SPOT CENTERED
READINGS ARE MEASURED IN VOLTS WITH 20KΩ/VOLT METER.

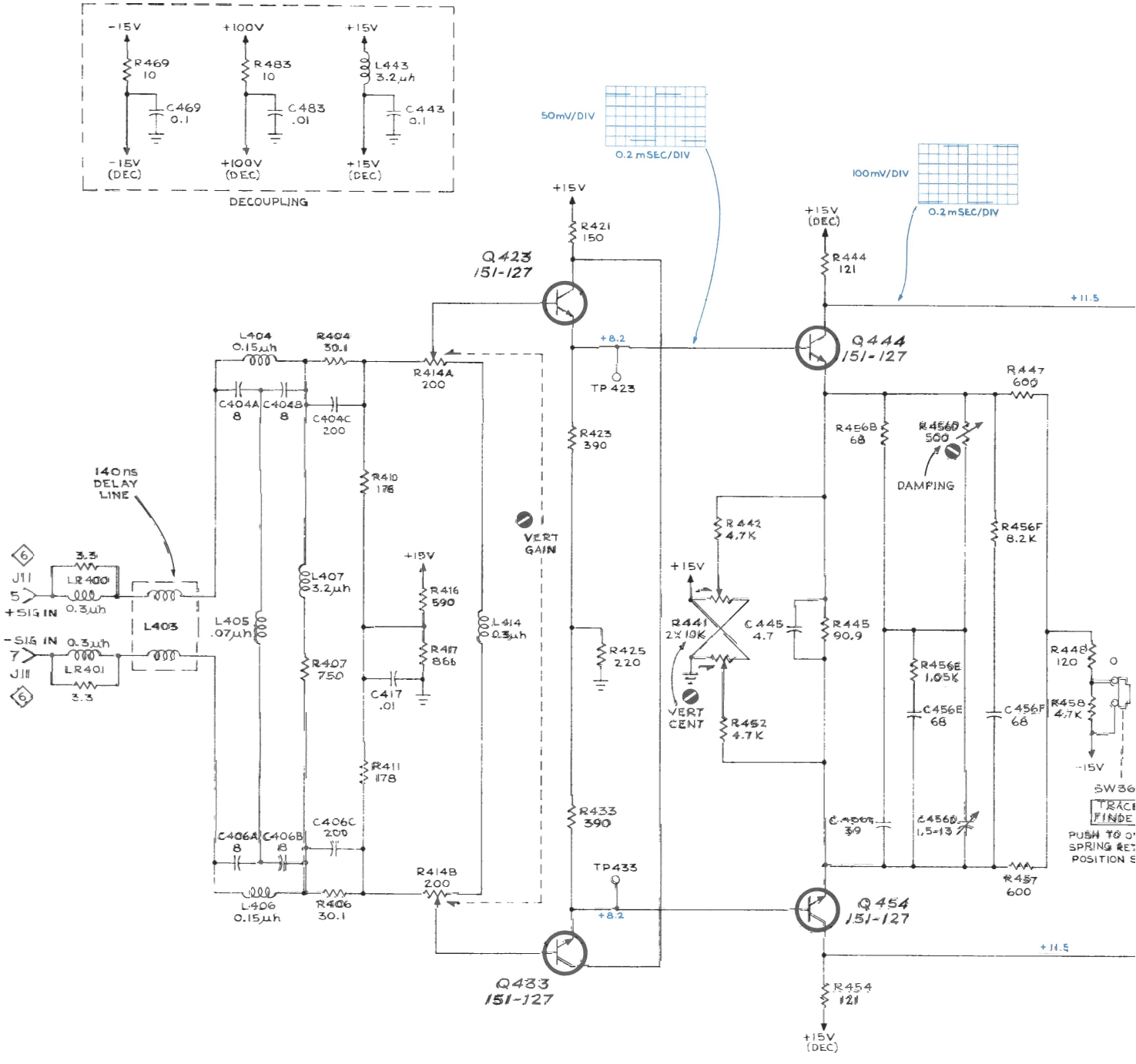
DRAWING:

NNECTING SOCKETS

MRH
864

B2

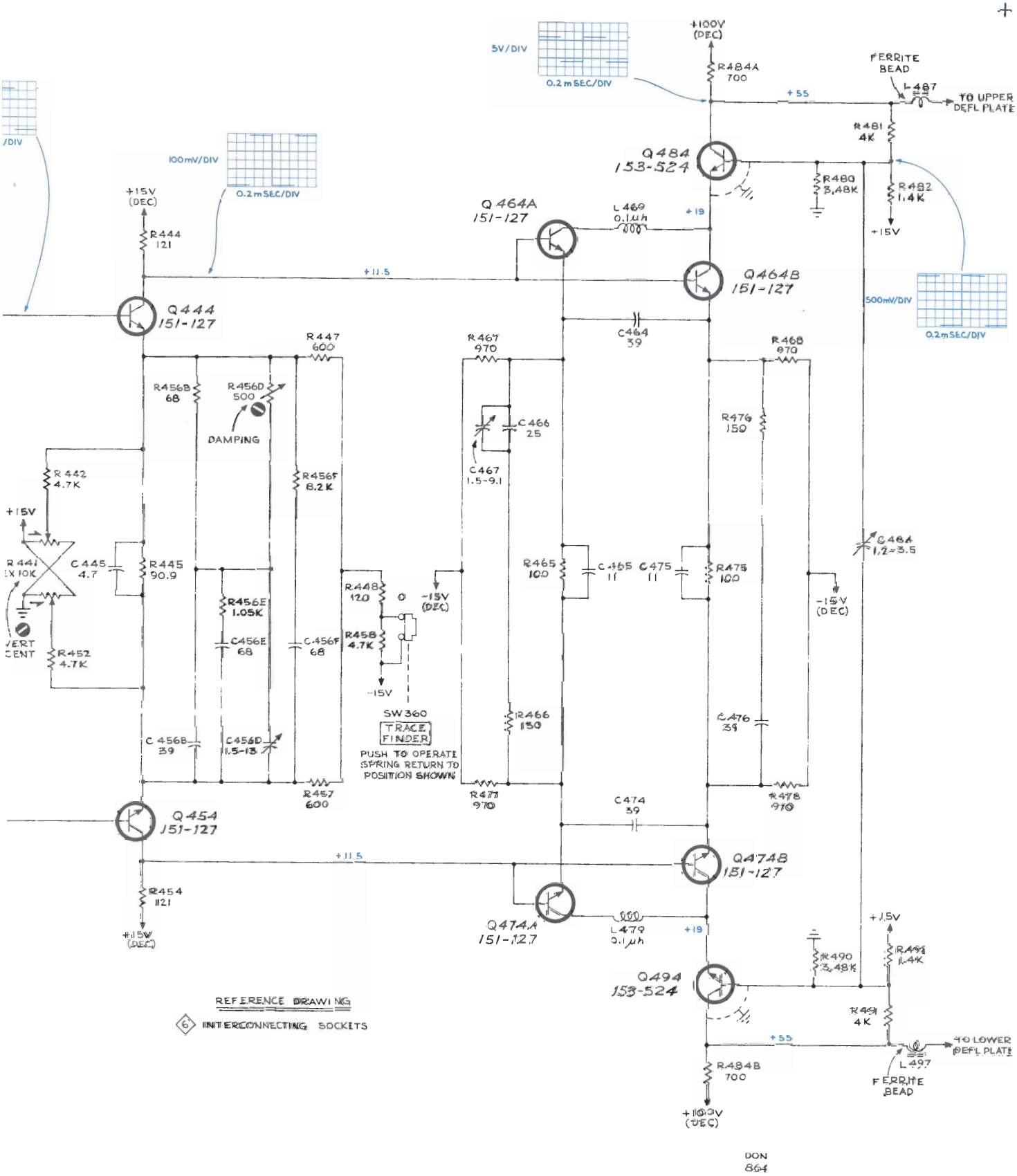
HORIZONTAL AMPLIFIER ◇1



SEE IMPORTANT NOTE ON HORIZ. AMP. DIAG. FOR WAVEFORM & VOLTAGE CONDITIONS.

REFERENCE DRAWING:

6 INTERCONNECTING SOCKETS



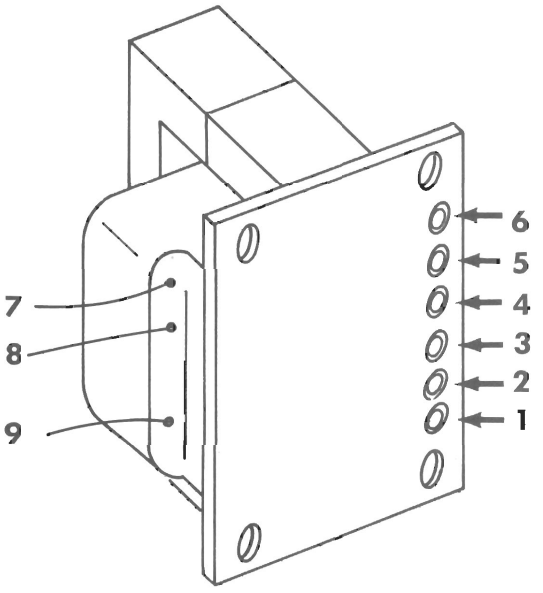
REFERENCE DRAWING

6 INTERCONNECTING SOCKETS

DON 864

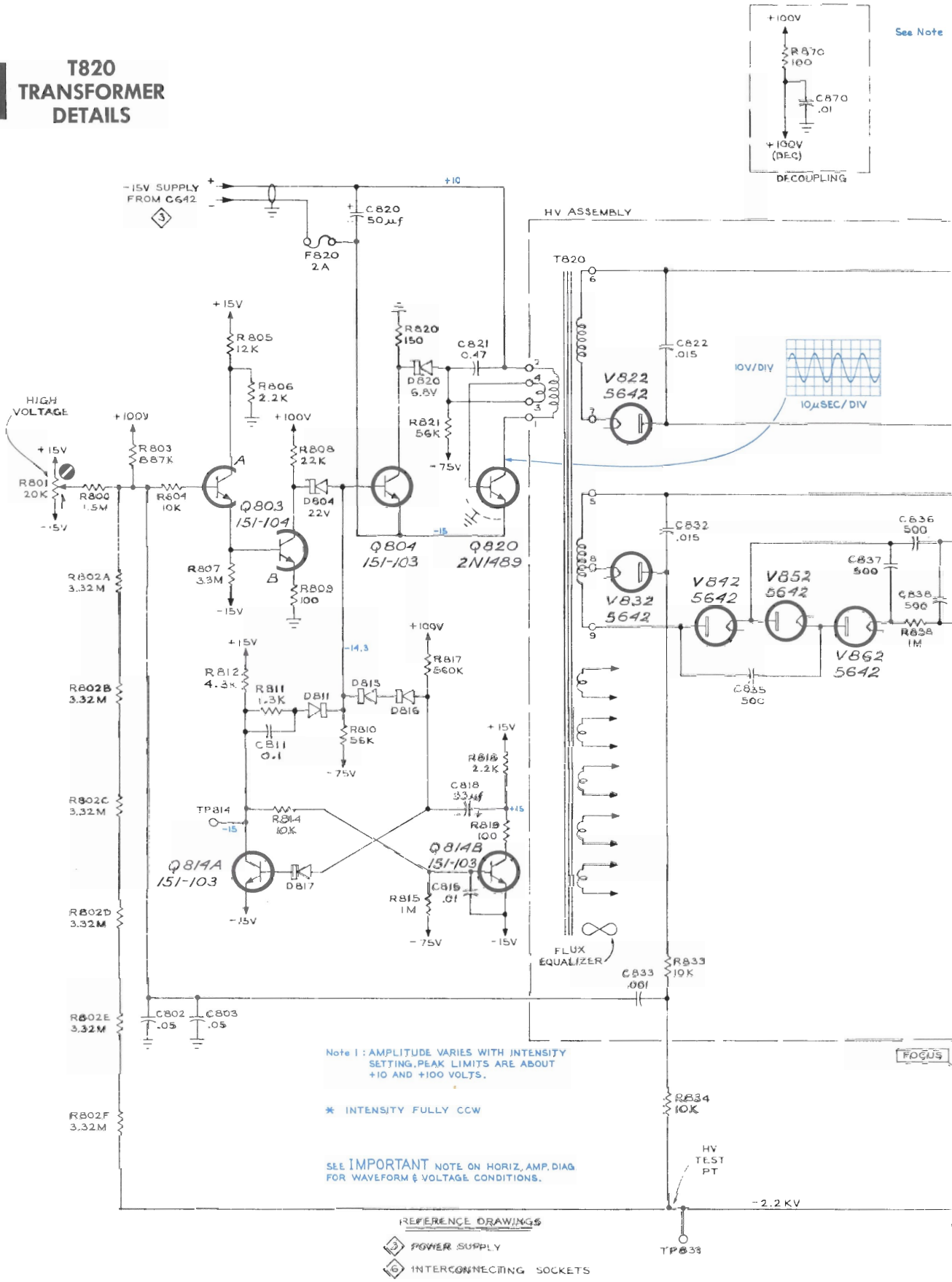
A1

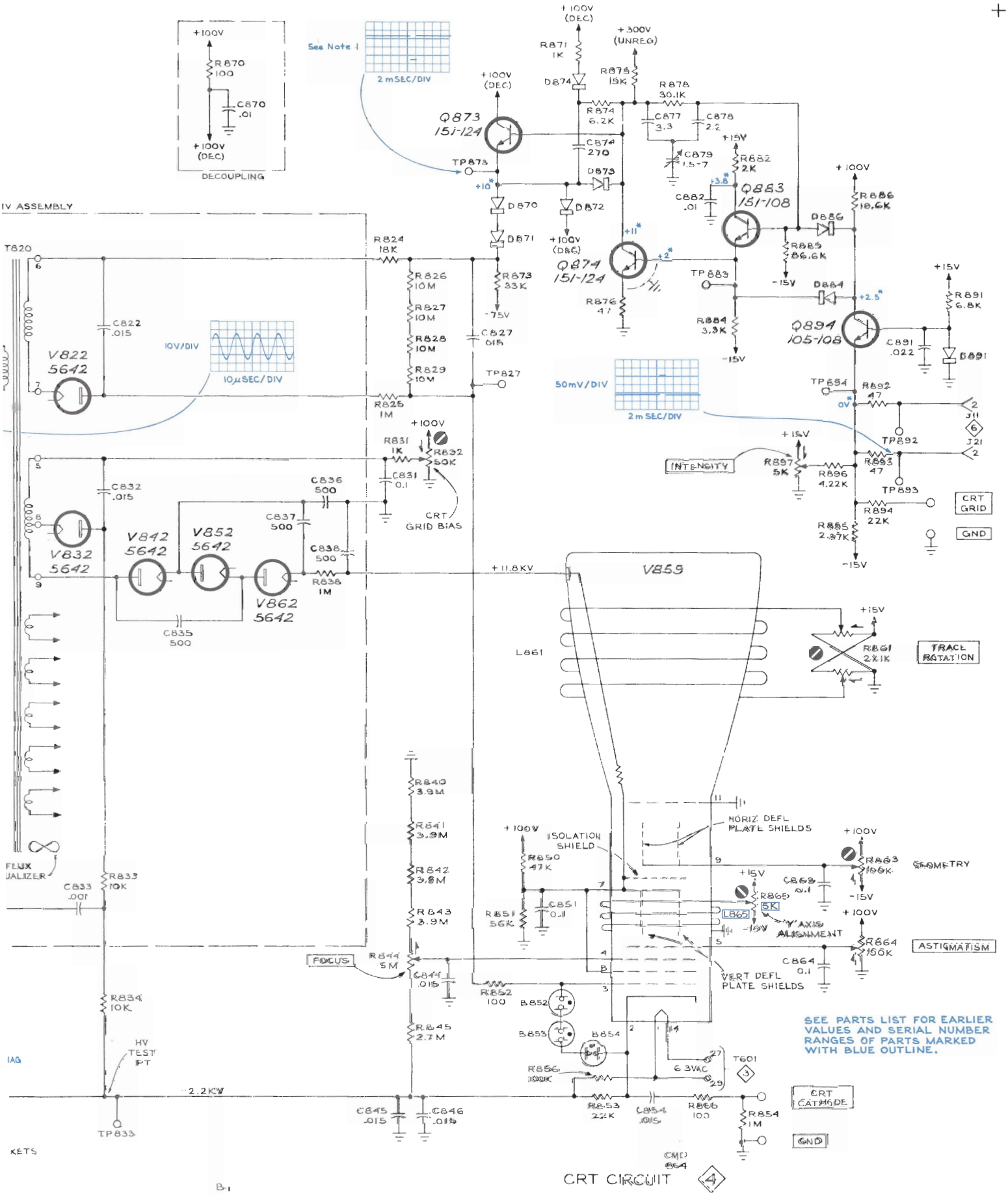
VERTICAL AMPLIFIER 2

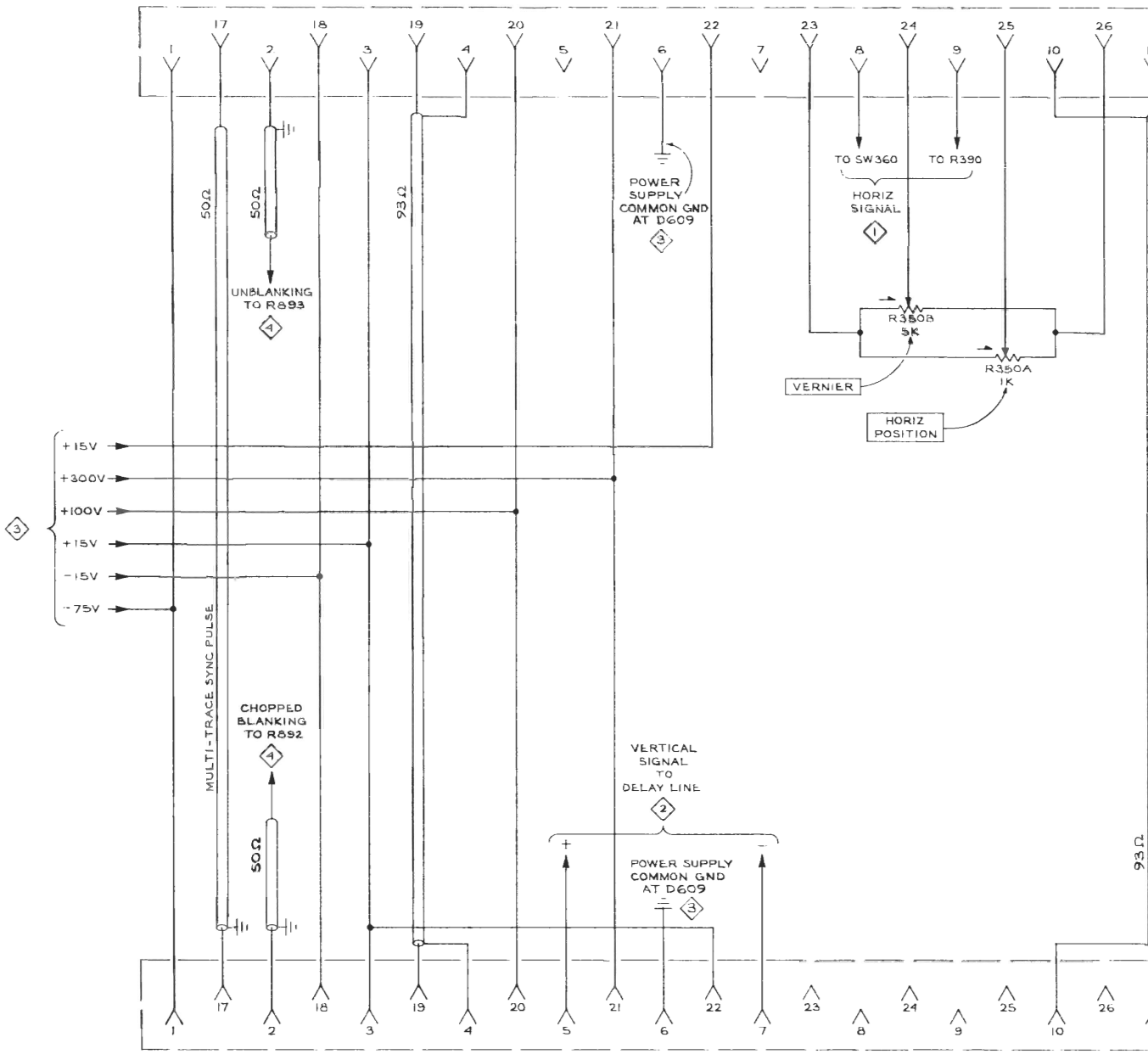


T820 TRANSFORMER DETAILS

T820 TRANSFORMER DETAILS

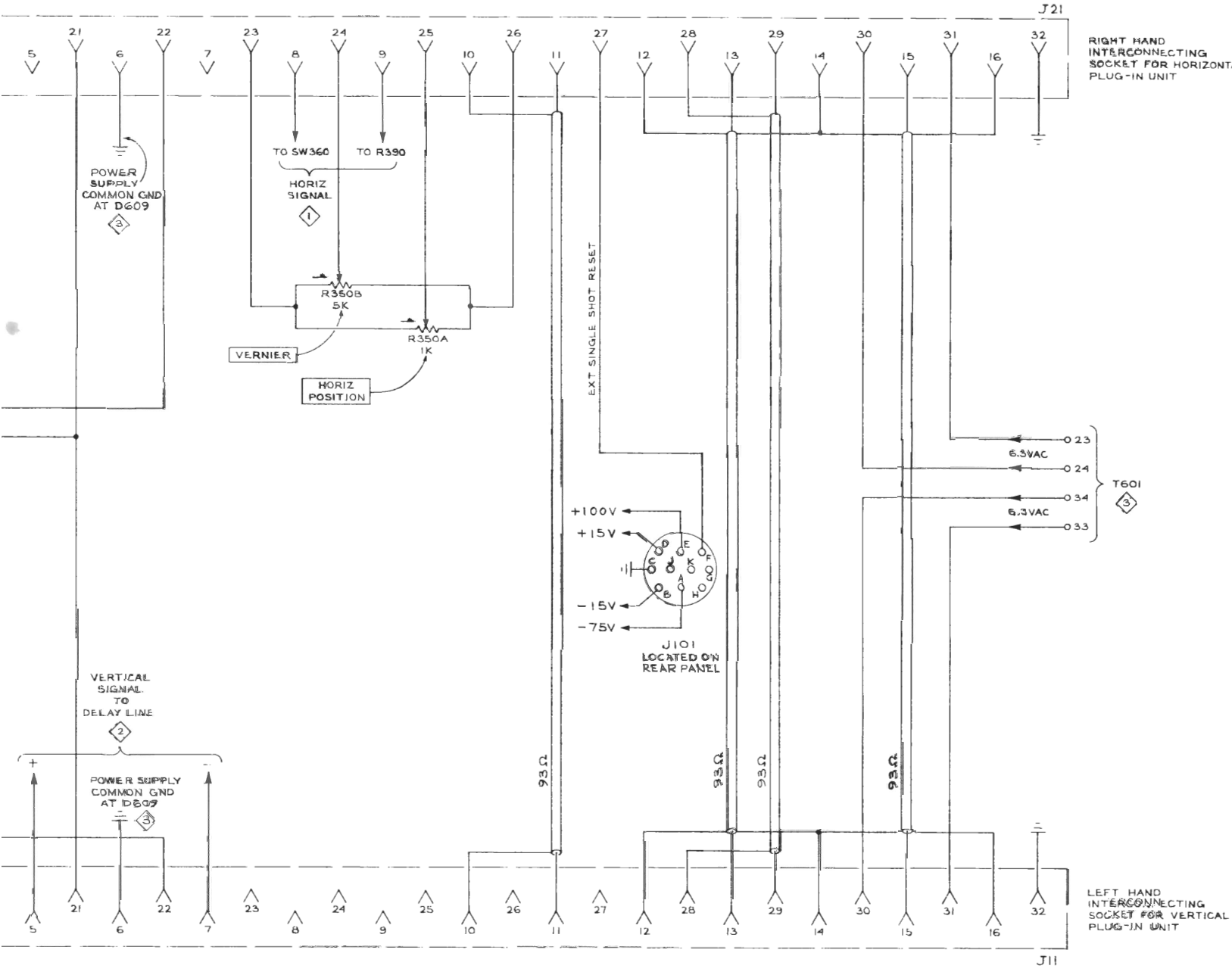


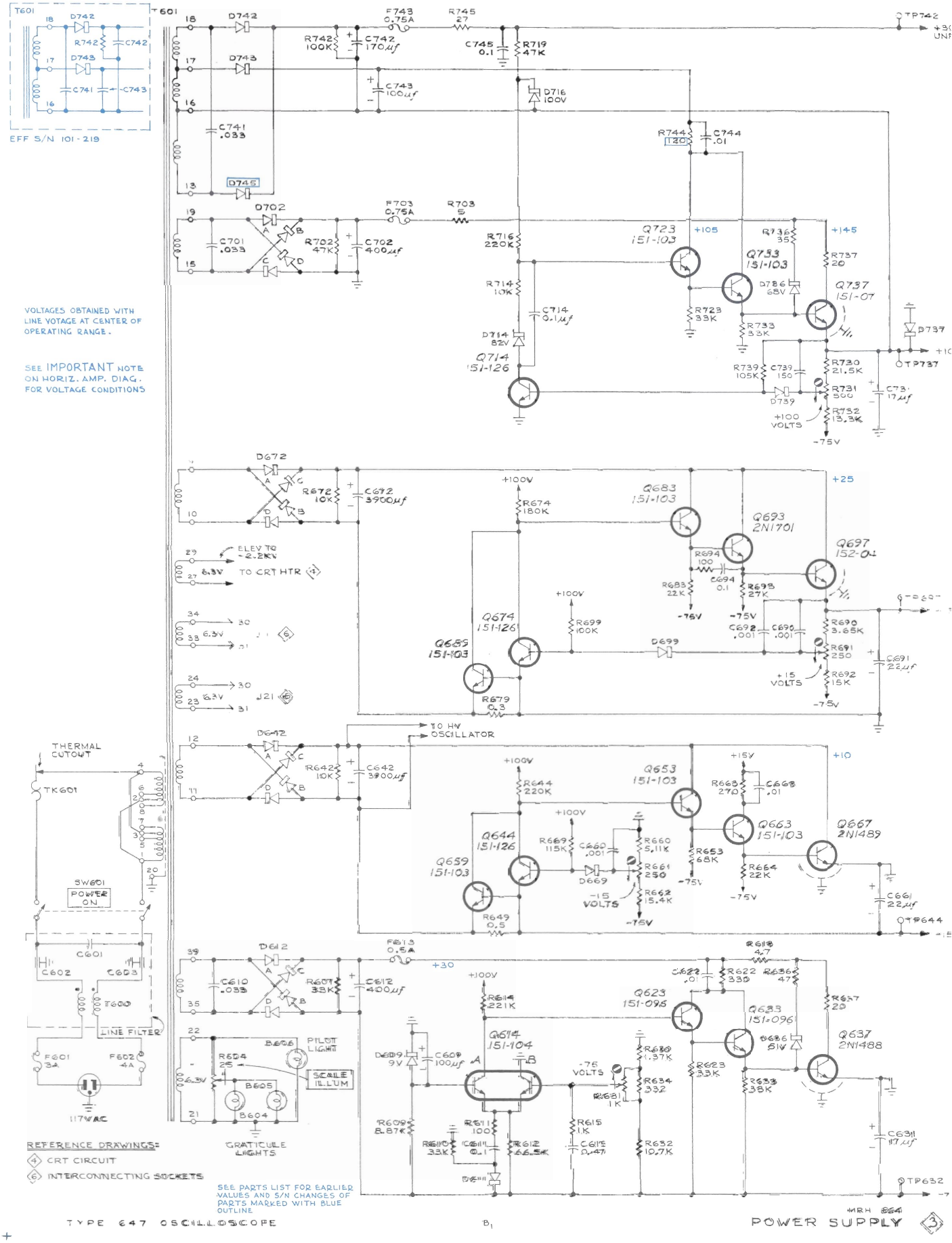

+100V
R870
100
C870
.01
+100V (DEC.)
DECOUPLING
See Note 1
2 mSEC/DIV
+100V (DEC.)
R871
1K
D874
+300V (UNREG.)
R875
15K
R878
30.1K
R874
6.2K
C877
3.3
C878
2.2
Q873
151-124
C874
270
C879
1.5-7
+15V
R882
2K
TP873
D873
+10*
+3.8*
Q883
151-108
C882
.01
+100V
R886
18.6K
D870
D872
D871
+100V (DEC.)
+11*
+2*
Q874
151-124
R876
47
R885
86.6K
-15V
D884
TP883
R884
3.3K
+2.5*
Q894
105-108
+15V
R891
6.8K
C891
.022
D891
IV ASSEMBLY
T820
R824
18K
R826
10M
R827
10M
R828
10M
R829
10M
R873
33K
-75V
C827
.015
TP827
C822
.015
10V/DIV
10μSEC/DIV
V822
5642
R825
1M
50mV/DIV
2 m SEC/DIV
TP894
R892
47
0V*
J11
6
J21
2
TP892
INTENSITY
+15V
R897
5K
R896
4.22K
R893
47
TP893
CRT GRID
R894
22K
R895
2.37K
GND
-15V
+100V
R831
1K
R832
50K
C831
0.1
CRT GRID BIAS
C832
.015
C836
500
C837
500
C838
500
R838
1M
V832
5642
V842
5642
V852
5642
V862
5642
C835
500
+11.8KV
V859
L861
+15V
R861
2.1K
TRACE ROTATION
R840
3.9M
R841
3.9M
R842
3.9M
R843
3.9M
+100V
ISOLATION SHIELD
R850
47K
R851
56K
C851
0.1
HORIZ DEFL PLATE SHIELDS
+100V
R863
100K
GEOMETRY
+15V
C863
0.1
R865
5K
L865
-15V
'Y' AXIS ALIGNMENT
+100V
R864
100K
ASTIGMATISM
C864
0.1
VERT DEFL PLATE SHIELDS
FLUX DALIZER
C833
.001
R833
10K
FOCUS
R844
5M
C844
.015
R852
100
B852
B853
B854
R834
10K
R845
2.7M
HV TEST PT
-2.2KV
TP833
C845
.015
C846
.015
R856
100K
6.3VAC
T601
3
R853
22K
C854
.015
R866
100
R854
1M
CRT CATHODE
GND
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
CRT CIRCUIT
4
CMD 864
B-1

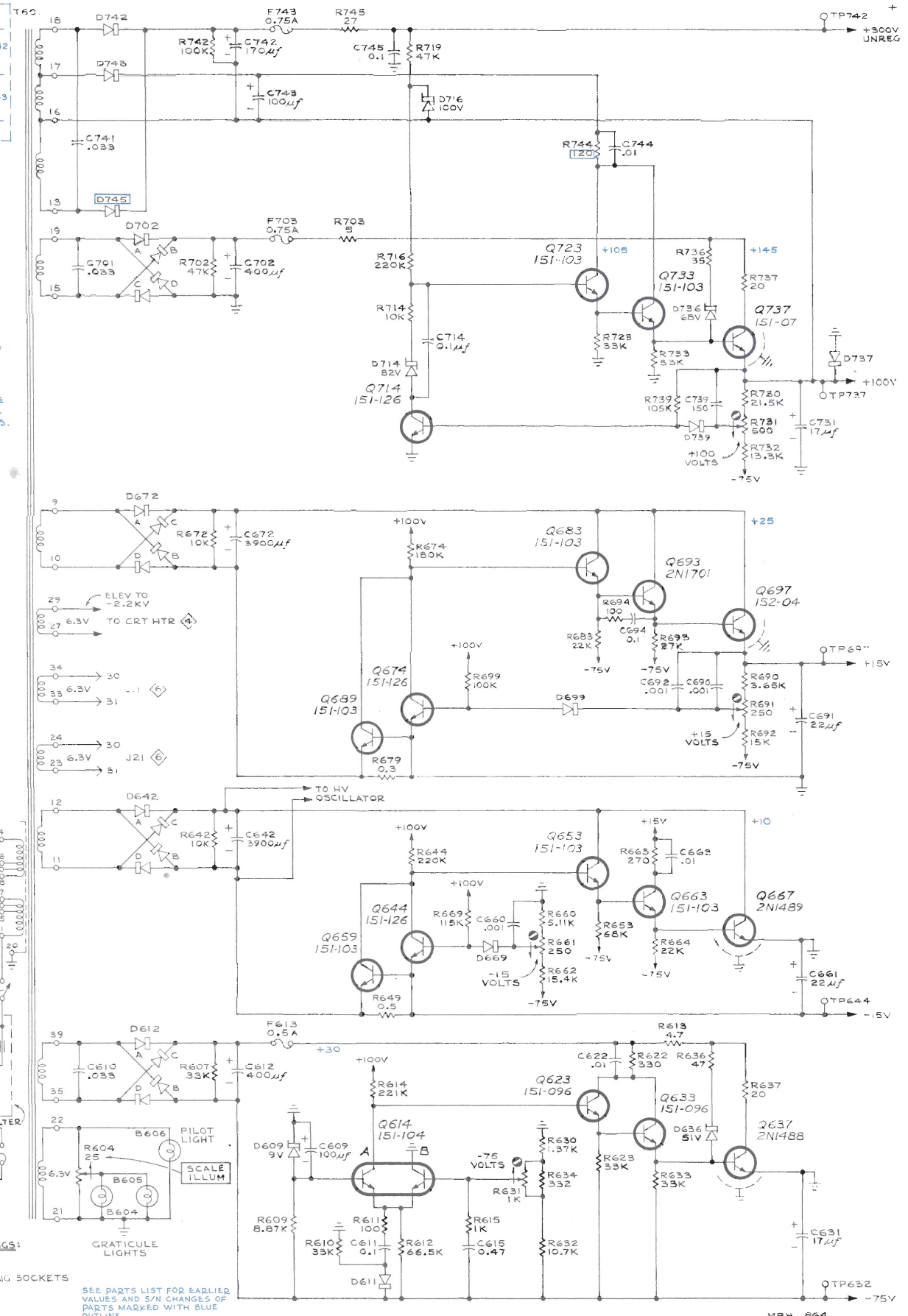


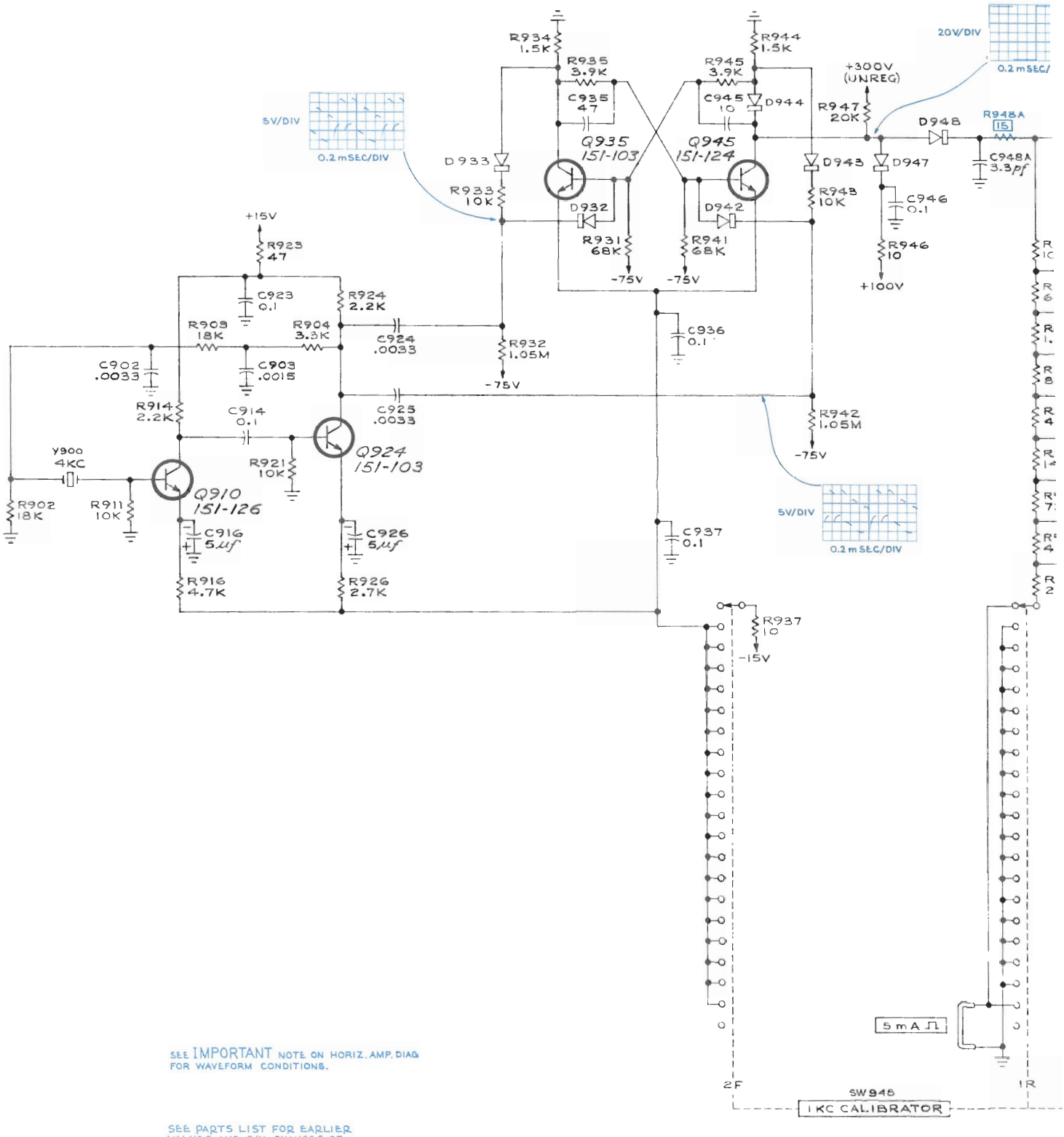
REFERENCE DRAWINGS

1. HORIZONTAL AMPLIFIER
2. VERTICAL AMPLIFIER
3. POWER SUPPLY
4. CRT CIRCUIT


J21
RIGHT HAND INTERCONNECTING SOCKET FOR HORIZONTAL PLUG-IN UNIT
TO SW360
TO R390
HORIZ SIGNAL
1
POWER SUPPLY COMMON GND AT D609
3
R350B 5K
R350A 1K
VERNIER
HORIZ POSITION
EXT SINGLE SHOT RESET
+100V
+15V
-15V
-75V
J101 LOCATED ON REAR PANEL
6.3VAC
6.3VAC
T601
3
VERTICAL SIGNAL TO DELAY LINE
2
POWER SUPPLY COMMON GND AT D609
3
93Ω
93Ω
93Ω
93Ω
LEFT HAND INTERCONNECTING SOCKET FOR VERTICAL PLUG-IN UNIT
J11

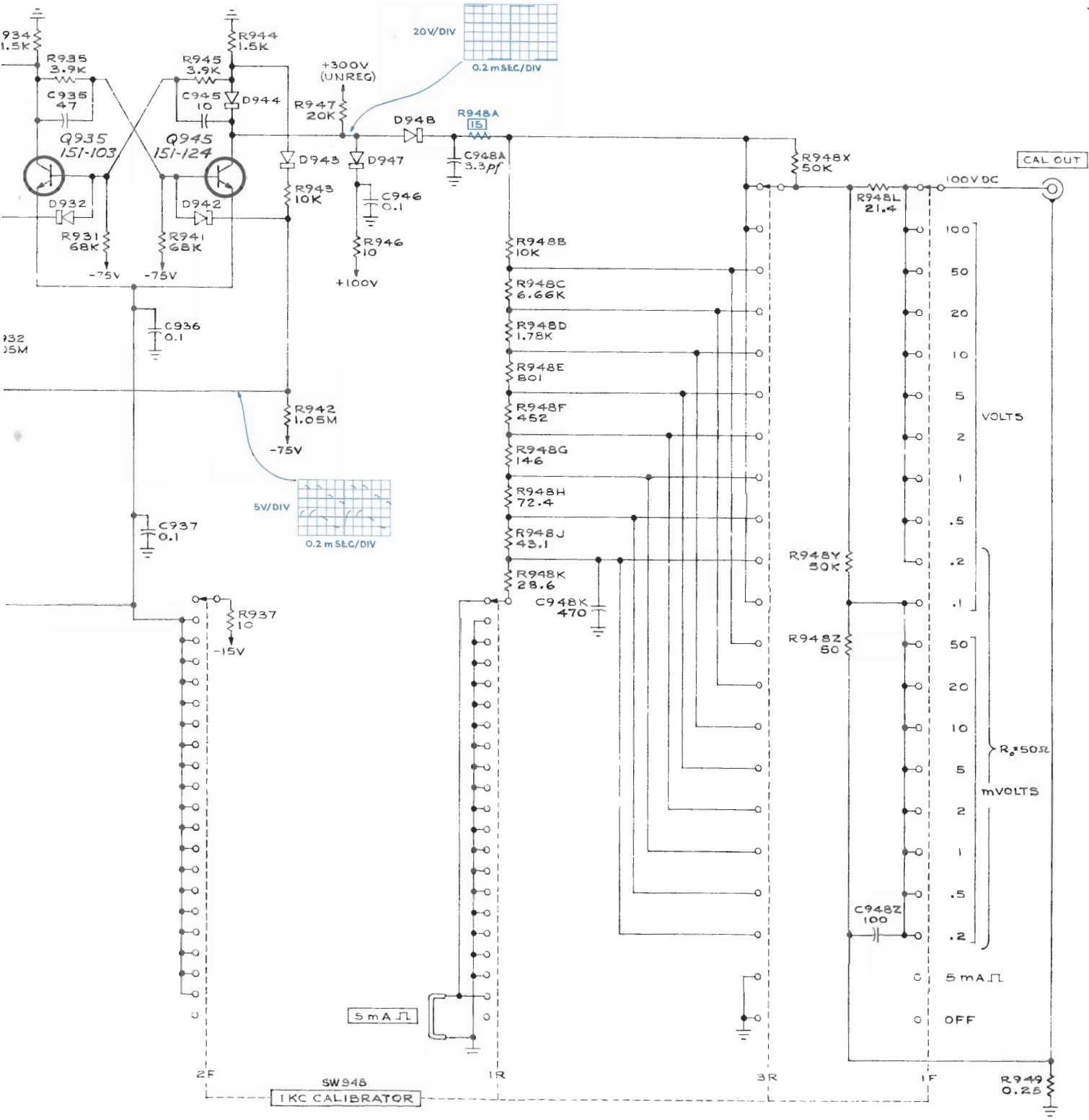

T601
D742
R742
C742
D743
C741
C743
EFF S/N 101-219
F743 0.75A
R745 27
R742 100K
C742 170µf
C745 0.1
R719 47K
C743 100µf
D716 100V
C741 .033
D745
R744 120
C744 .01
F703 0.75A
R703 5
D702
C701 .033
R702 47K
C702 400µf
R716 220K
Q723 151-103
+105
R736 35
+145
Q733 151-103
R737 20
D786 68V
Q737 151-07
R714 10K
C714 0.1µf
R723 33K
R733 3.3K
D714 82V
Q714 151-126
R739 105K
C739 150
R730 21.5K
R731 500
D739
C73· 17µf
+100 VOLTS
R732 13.3K
-75V
TP737
D737
VOLTAGES OBTAINED WITH LINE VOTAGE AT CENTER OF OPERATING RANGE.
SEE IMPORTANT NOTE ON HORIZ. AMP. DIAG. FOR VOLTAGE CONDITIONS
D672
R672 10K
C672 3900µf
ELEV TO -2.2KV
6.3V
TO CRT HTR
6.3V
J21
+100V
R674 180K
Q683 151-103
Q693 2N1701
Q697 152-01
+25
R694 100
C694 0.1
R683 22K
R693 27K
-75V
C692 .001
C690 .001
R690 3.65K
R691 250
R692 15K
+15 VOLTS
C691 22µf
Q674 151-126
Q685 151-103
R699 100K
D699
R679 0.3
TO HV OSCILLATOR
D642
R642 10K
C642 3900µf
R644 220K
Q653 151-103
+15V
R663 270
C663 .01
+10
Q644 151-126
Q659 151-103
R669 115K
C660 .001
D669
R660 5.11K
R661 250
R662 15.4K
-15 VOLTS
R653 68K
Q663 151-103
Q667 2N1489
R664 22K
C661 22µf
TP644
R649 0.5
THERMAL CUTOUT
TK601
SW601 POWER ON
C601
C602
C603
T600
LINE FILTER
F601 3A
F602 4A
117V AC
D612
C610 .033
R607 33K
C612 400µf
F613 0.5A
+30
R618 4.7
C622 .01
R622 330
R636 47
R637 20
Q623 151-096
Q633 151-096
Q637 2N1488
D686 51V
R623 3.3K
R633 38K
R634 332
R680 1.37K
R681 1K
-75 VOLTS
R615 1K
C615 0.47
R632 10.7K
C631 117µf
TP632
R614 221K
Q614 151-104
D609 9V
C609 100µf
R609 8.87K
R611 100
R610 33K
C611 0.1
R612 66.5K
D611
B606 PILOT LIGHT
R624 25
6.3V
SCALE ILLUM
B605
B604
GRATICULE LIGHTS
REFERENCE DRAWINGS:
(4) CRT CIRCUIT
(6) INTERCONNECTING SOCKETS
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE


T60
D742
F743 0.75A
R745 27
TP742
+300V UNREG
R742 100K
C742 170µf
C745 0.1
R719 47K
D748
C743 100µf
D716 100V
C741 .033
R744 120
C744 .01
D745
D702
F703 0.75A
R703 5
C701 .033
R702 47K
C702 400µf
R716 220K
Q723 151-103
+105
R736 35
+145
Q733 151-103
R737 20
R714 10K
D736 68V
Q737 151-07
C714 0.1µf
R728 33K
R733 3.3K
D737
D714 82V
Q714 151-126
R739 105K
C739 150
R730 21.5K
TP737
+100V
R731 500
C731 17µf
D739
+100 VOLTS
R732 13.3K
-75V
D672
C672 3900µf
R672 10K
+100V
R674 180K
Q683 151-103
+25
Q693 2N1701
Q697 152-04
ELEV TO -2.2KV
6.3V
TO CRT HTR
R694 100
C694 0.1
R683 22K
R693 27K
-75V
TP69"
+15V
Q674 151-126
R699 100K
Q689 151-103
D699
C692 .001
C690 .001
R690 3.65K
R691 250
C691 22µf
+15 VOLTS
R692 15K
R679 0.3
J21
TO HV OSCILLATOR
D642
C642 3900µf
R642 10K
R644 220K
Q653 151-103
R665 270
C665 .01
+10
Q644 151-126
R669 115K
C660 .001
R660 5.11K
R653 68K
Q663 151-103
Q667 2N1489
Q659 151-103
D669
R661 250
R664 22K
-15 VOLTS
R662 15.4K
C661 22µf
R649 0.5
TP644
-15V
D612
F613 0.5A
+30
R613 4.7
C610 .033
R607 33K
C612 400µf
C622 .01
R622 330
R636 47
R614 221K
Q623 151-096
R637 20
Q633 151-096
B606 PILOT LIGHT
R604 25
SCALE ILLUM
B605
B604
GRATICULE LIGHTS
D609 9V
C609 100µf
Q614 151-104
A
B
-75 VOLTS
R630 1.37K
D636 51V
Q637 2N1488
R623 33K
R634 332
R631 1K
R633 33K
R609 8.87K
R611 100
R615 1K
C615 0.47
R610 33K
C611 0.1
R612 66.5K
R632 10.7K
C631 17µf
D611
TP632
-75V
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.
MRH 864
POWER SUPPLY 3
7 OSCILLOSCOPE
5.



SEE IMPORTANT NOTE ON HORIZ. AMP. DIAG FOR WAVEFORM CONDITIONS.

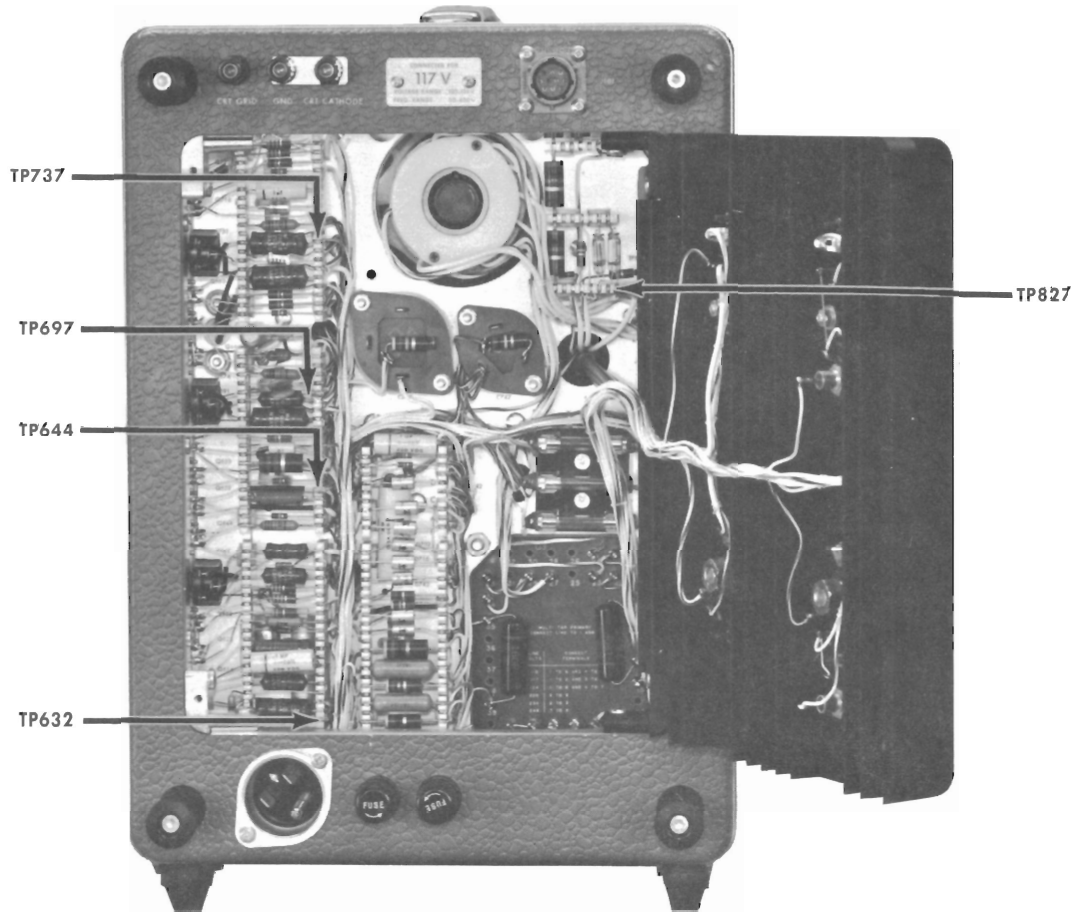
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

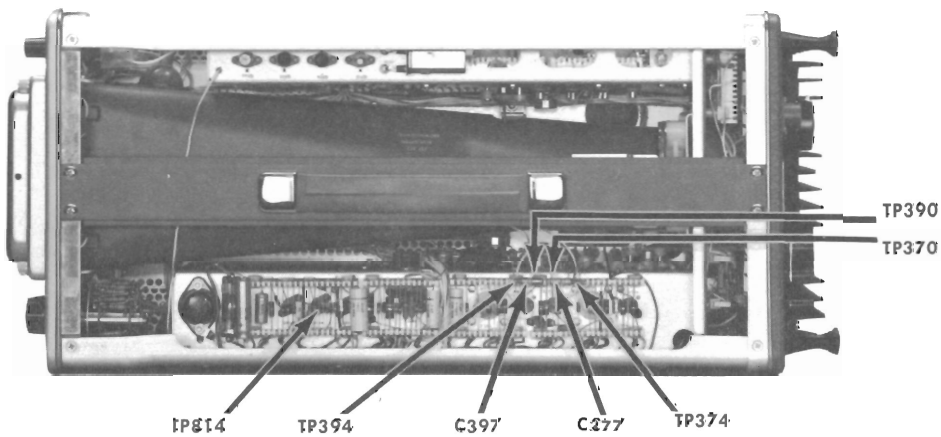


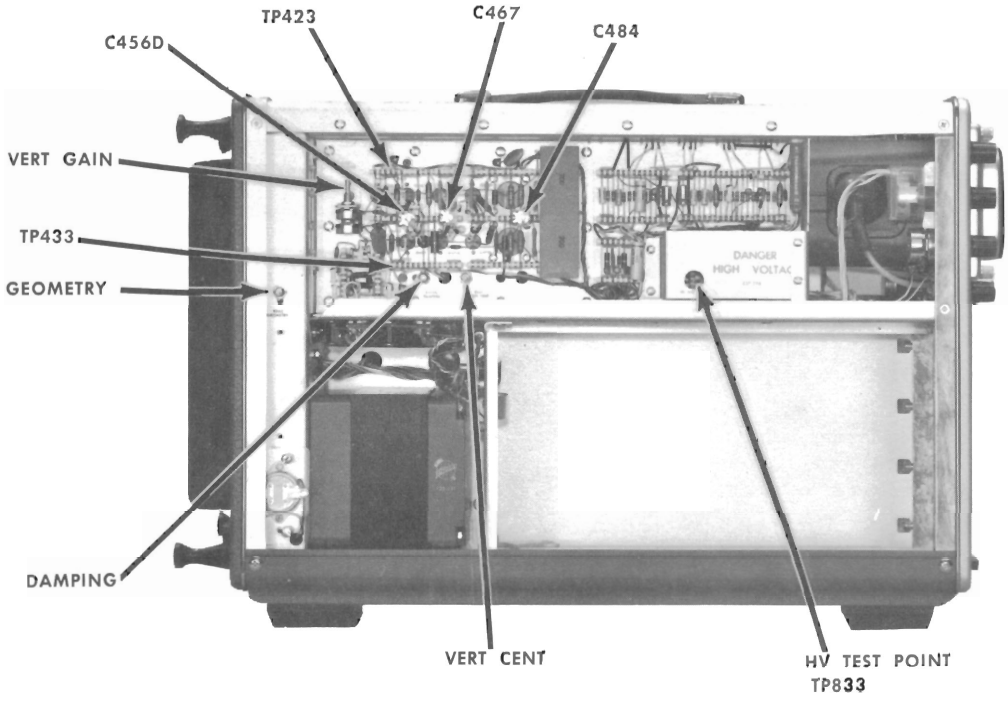
MRH
864

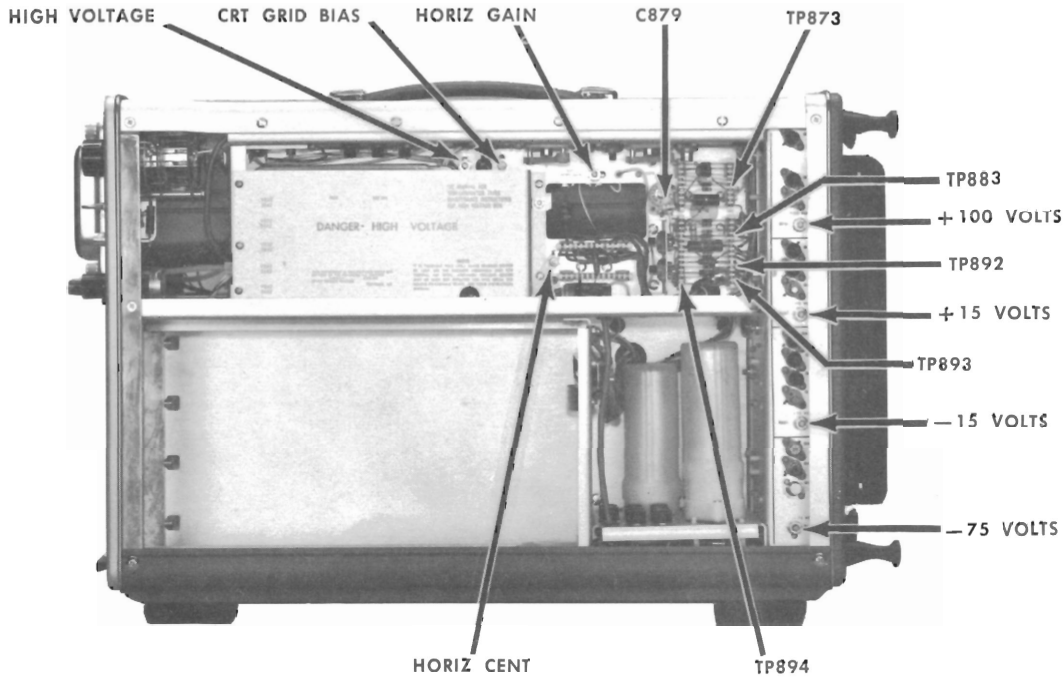
A1

CALIBRATOR 5


TP737
TP697
TP644
TP632
TP827


TP390
TP370
TP814
TP394
C397
C277
TP374


TP423
C467
C484
C456D
VERT GAIN
TP433
GEOMETRY
DAMPING
VERT CENT
HV TEST POINT
TP833


HIGH VOLTAGE
CRT GRID BIAS
HORIZ GAIN
C879
TP873
TP883
+100 VOLTS
TP892
+15 VOLTS
TP893
—15 VOLTS
—75 VOLTS
HORIZ CENT
TP894

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 647 -- TENT. S/N 551

TYPE RM647 -- TENT. S/N 200

PARTS LIST CORRECTION

CHANGE TO:

Q820	*153-531	2N1489	Checked

M9026/1164

TYPE 647 -- TENT. S/N 530
TYPE RM647 -- TENT. S/N 200

PARTS LIST CORRECTIONS

REMOVE:

C803	283-010	.05 µf	Cer	50 v

CHANGE TO:

C802	285-622	.1 µf	PTM	100 v

SCHEMATIC CORRECTION

Disconnect the end of R611 connected to the emitters of Q614 and replace it at the collector of Q614A.

TYPE 647 -- TENT. S/N 553

PARTS LIST CORRECTION

ADD:

*R601	302-105	1 meg	1/2 w	10%

* Add across input terminals of T600.

TYPE 544, RM544
TYPE 546, RM546
TYPE 547, RM547
TYPE 647

NOTE

When installing replacement transistors on heat sinks in the instrument, the bottom of the transistor where it contacts the heat sink should be coated with silicon grease. If a heat sink has been replaced along with the transistor, then that area of the heat sink which contacts the chassis of the instrument should also be coated with silicon grease.

SECTION 1, CHARACTERISTICS

CHANGE TO:

Vertical Amplifier (Range 1)

Risetime

Less than 5.8 nsec; 5.5 nsec typical.

Bandwidth

Dc to greater than 60 mc (30% down); 64 mc typical.

Display Linearity

A 2-cm centered signal will not change amplitude more than ±1 mm when offset to top or bottom of graticule.

Horizontal Amplifier

Bandwidth

Refer to appropriate horizontal plug-in manual for combined response.

Cathode-Ray Tube

Crt Grid Z-Axis Modulation

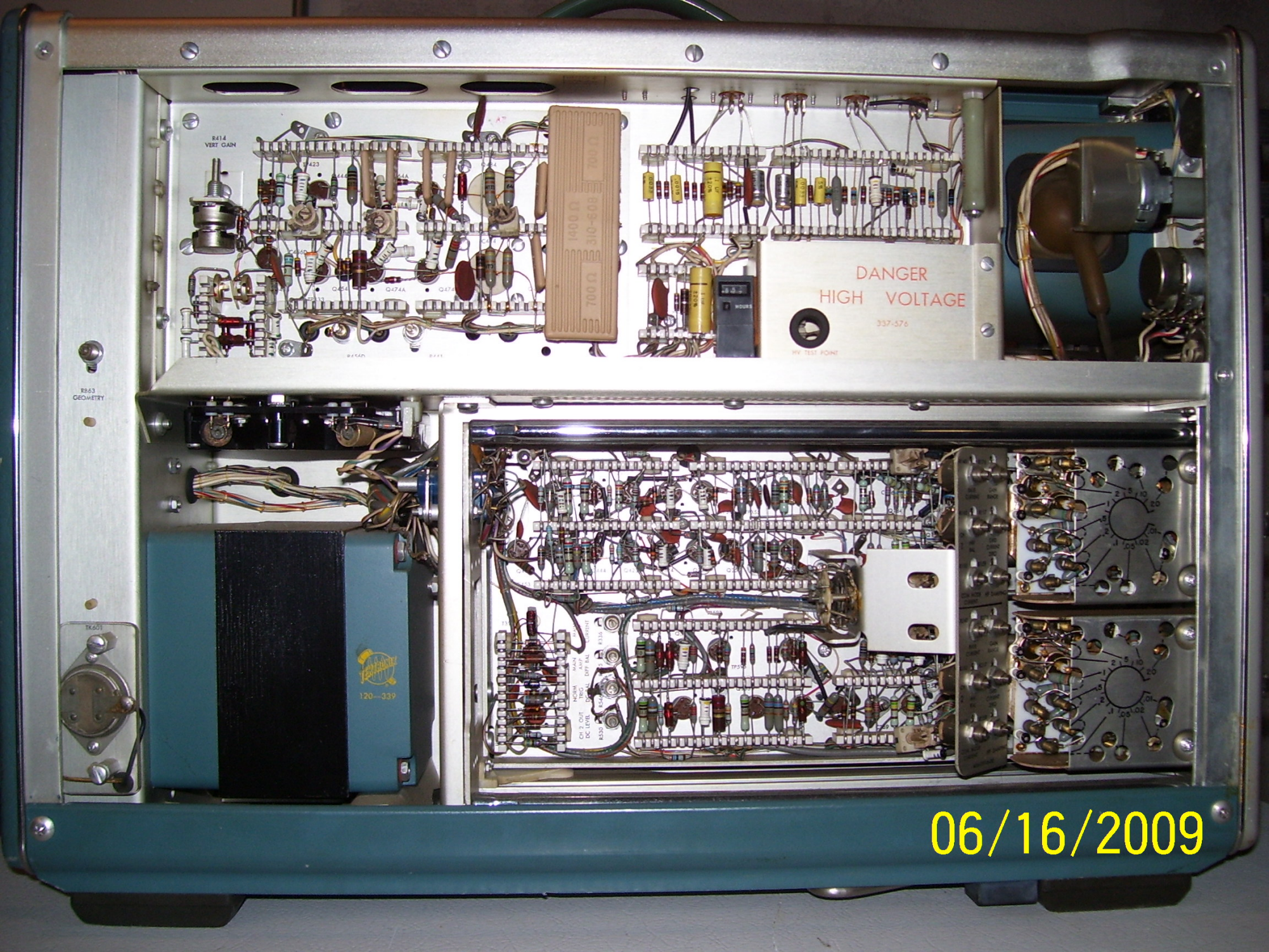
Dc-coupled from rear-panel CRT GRID binding post. Input resistance about 22 kΩ. Bandwidth for small signals is dc to 10 mc (30% down point), or greater. Typically, ±2 volts peak will produce a visible change in display brightness.


TYPE 647 OSCILLOSCOPE
1KC CALIBRATOR
INTENSITY
FOCUS
TRACE ROTATION
ASTIGMATISM
SCALE ILLUM
CAL OUT
VERNIER
HORIZ POSITION
OFF
POWER ON
TRACE
FINDER
VERTICAL
SERIAL
HORIZONTAL
TYPE 10A2 DUAL-TRACE AMPLIFIER
CH 1
VOLTS/CM
POSITION
INPUT
AC
DC
GND
TRIGGER
MODE
CH 2
VOLTS/CM
POSITION
CH2 OUTPUT
TYPE 11B2 TIME BASE
HORIZ DISPLAY
TIME/CM AND DELAY TIME
DELAY TIME MULT
TRIG MODE
TRIG LEVEL
TRIG IN
SLOPE
COUPLING
SOURCE
TEKTRONIX INC
PORTLAND OREGON U.S.A.

06/16/2009


CONNECTED FOR
117 V
VOLTAGE RANGE 100-130 V
FREQ. RANGE 50-400~
CRT GRID GND CRT CATHODE
POSITIVE SIGNAL BLANKS TRACE
J101
Q667
Q637
D636
Q697
Q737
D736
FUSE DATA
ALL SLOW BLOW
06/16/2009


117 V
06/16/2009


R414
VERT GAIN
DANGER
HIGH VOLTAGE
337-576
R863
GEOMETRY
120-339
06/16/2009


SEE MANUAL FOR
SEMI-CONDUCTOR TYPES AND
MAINTENANCE INSTRUCTIONS
FOR HIGH VOLTAGE BOX.
DANGER HIGH VOLTAGE
NOTE
+100 VOLTS
+15 VOLTS
-15 VOLTS
-75 VOLTS
06/16/2009


153-531
06/16/2009