INSTRUCTION MANUAL

Serial Number 700.016

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TYPE 581A OSCILLOSCOPE

Tektronix, Inc.
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070-390

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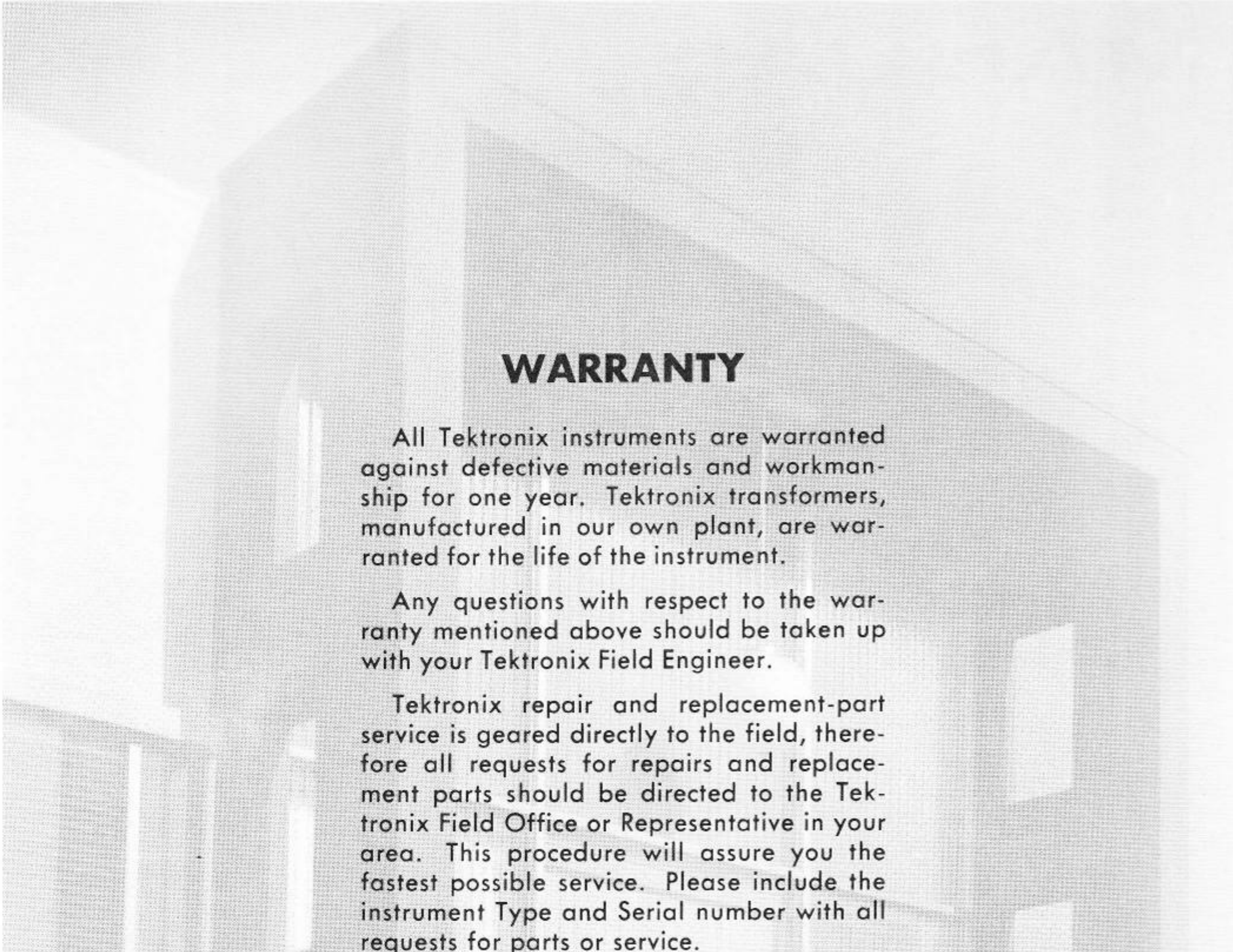


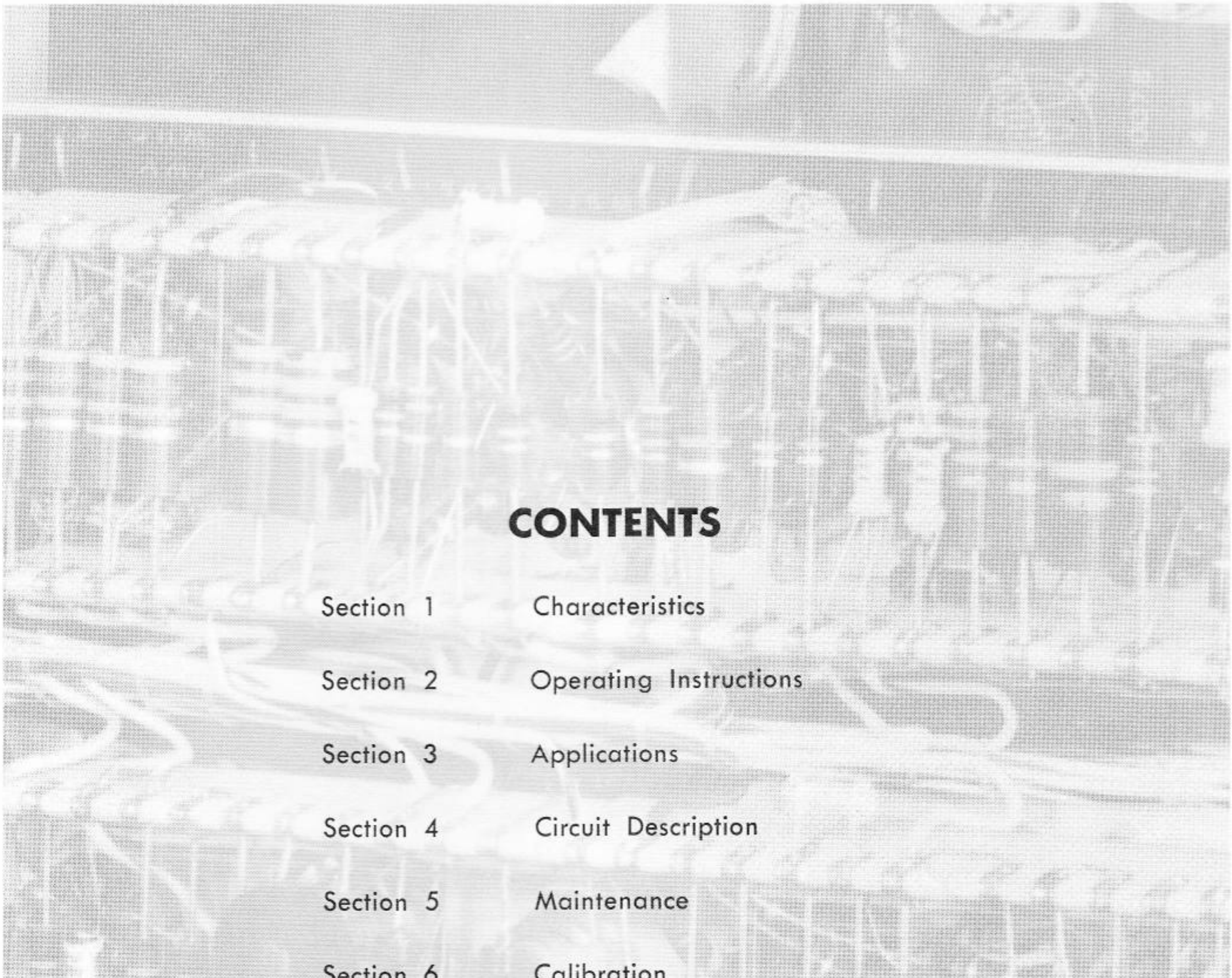
WARRANTY

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.



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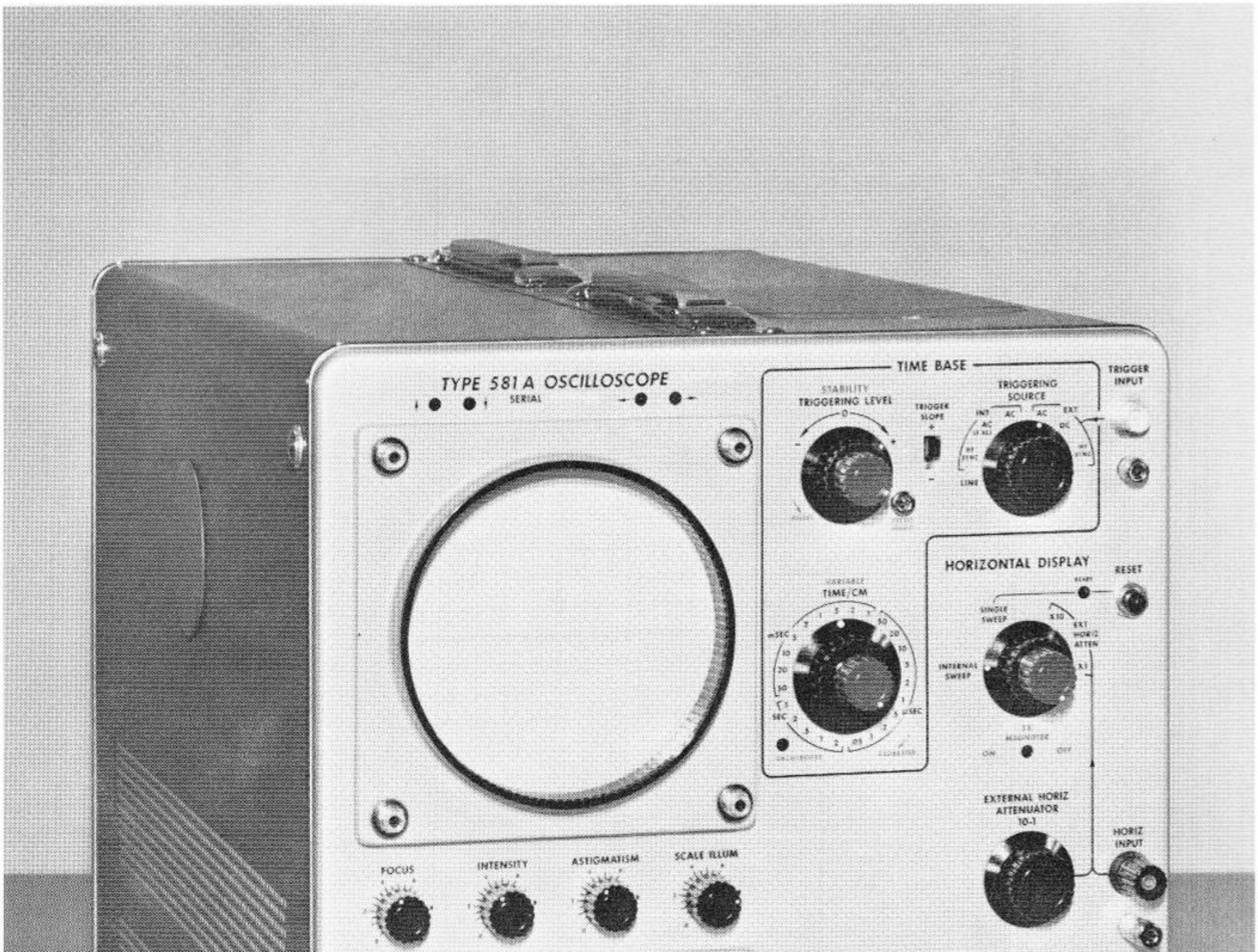
TYPE 581A OSCILLOSCOPE
SERIAL
TIME BASE
TRIGGERING LEVEL
TRIGGER SLOPE
TRIGGERING SOURCE
TRIGGER INPUT
TIME/CM
HORIZONTAL DISPLAY
RESET
EXTERNAL HORIZ ATTENUATOR 10-1
HORIZ INPUT
FOCUS
INTENSITY
ASTIGMATISM
SCALE ILLUM
TYPE 82 DUAL-TRACE PLUG-IN UNIT
INPUT
VARIABLE VOLTS/CM
VERTICAL POSITION
A
V/CM
MODE
B
TEKTRONIX
AMPLITUDE CALIBRATOR
HORIZONTAL POSITION
+GATE OUT
SAWTOOTH OUT
CAL OUT
POWER ON
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.

Type 581A

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SECTION 1
CHARACTERISTICS

General

The Tektronix Type 581A Oscilloscope is a wide range, general purpose, laboratory instrument which provides accurate measurements in the dc to approximately 95 megacycle range. Plug-in preamplifiers are used in the vertical deflection system, permitting the instrument to be used in many applications. Any of the Tektronix 80 Series Plug-In Units can be used with the oscilloscope to satisfy many types of wideband use. Use of the Type 81 Plug-In Adapter permits you to use any of the Tektronix Letter Series Plug-In Units. High calibrated sweep rates allow you to take full advantage of the rise-time capabilities of the instrument.

VERTICAL DEFLECTION SYSTEM

Characteristics for the vertical deflection system of the Type 581A Oscilloscope depend upon the plug-in unit and probe used with the instrument.

Bandpass[1]	DC to approximately 95 megacycles.
Risetime[2]	Better than 3.9 nsec—nominally 3.7 nsec.
Vertical Deflection Factor	0.1 volts per centimeter.
Input Characteristics	A function of the individual plug-in or probe used.

1 Bandpass measured using a Type 80/P80 probe.
2 Risetime measured using a Type 84.

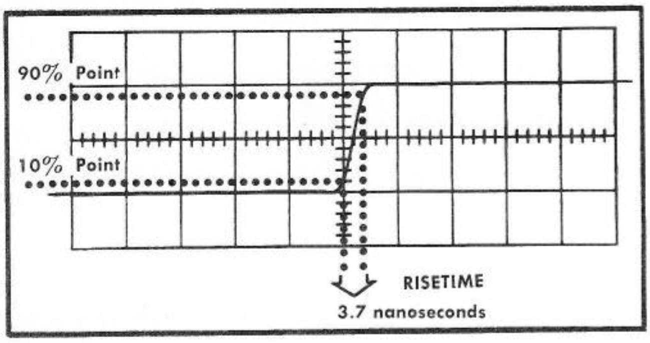

Fig. 1-1. Vertical risetime of the Type 581A Oscilloscope and Type 80 plug in combination.

HORIZONTAL DEFLECTION SYSTEM

Sweep Rates

0.05 microsecond (50 nsec) to 2 seconds per centimeter in 24 accurately calibrated steps. An uncalibrated control in conjunction with the sweep rate selector switch permits sweep rates to be varied continuously between 50 nsec and approximately 5 seconds per centimeter. Calibrated sweep rates are typically within 2% and in all cases within 3%, of the indicated rate.

Magnifier

Provides a 5 times horizontal expansion of the center 2-centimeter portion of the oscilloscope display. It extends the fastest sweep rate to 10 nsec per centimeter with a typically 1% linearity after the first four centimeters of sweep.

Triggering Modes

LINE; INTERNAL AC, AC LOW FREQUENCY REJECT, and HF SYNC; EXTERNAL AC, DC, and HF SYNC. TRIGGERING SLOPE and TRIGGERING LEVEL are adjustable.

Minimum Triggering Signal Requirements:

	Internal			External	
	AC	AC LF REJ	HF SYNC	AC/DC	HF SYNC
15 cps—15 kc	4 mm	------	------	0.3 v	
15 kc—10 mc	4 mm	4 mm	4 mm	0.3 v	0.1 v
10 mc—50 mc	1 cm	1 cm	4 mm	0.5 v	0.1 v
50 mc—100 mc	2 cm	2 cm	4 mm	5.0 v	0.1 v
100 mc—150 mc	3 cm	3 cm	4 mm	2.0 v	0.1 v

External-Horizontal Signal Input

Deflection Factor—approximately 0.2 to 15 volts per centimeter, continuously variable.

Frequency Response—depends on the amount of deflection; The product of frequency response and deflection in centimeters is approximately 4.8 megacycle centimeters.

Input Characteristics—1 megohm paralleled by approximately 47 pf.

OTHER CHARACTERISTICS

Cathode-Ray Tube

Type—T5810-31-1; P1, P2, P7 and P11 phosphors optional. Other phosphors available on special order.

Unblanking—DC coupled.

Accelerating potential—10,000 volts.

Deflection system—electrostatic. Beam deflected vertically by 6 pairs of distributed deflection plates. Beam deflected horizontally by 1 pair of deflection plates.

Useable viewing area—4 centimeters by 10 centimeters.

Graticule

Illumination—variable edge lighting.

Markings—internally marked in 4 vertical and 10 horizontal 1-centimeter divisions with 2-millimeter markings on the centerlines.

Amplitude Calibrator

Waveform—square-waves of approximately 1 kc.

Output voltage—0.2 millivolts peak-to-peak to 100 volts peak-to-peak in 18 steps.

Accuracy—peak-to-peak amplitude of square-waves within 3% of indicated voltage.

Output Impedance—approximately 640 ohms at 100 volts output.

Output Loading—33 k load will reduce 100 volts output 2%. 50 k load will reduce 50 volt output 2%. 100 k load will not effect voltages 1 volt or below.

Power Supplies

Electronically regulated for stable operation with widely varying line voltages and loads.

Line voltage requirements—105 to 125 volts, or 210 to 250 volts.

Power—approximately 560 watts maximum.

Line frequency—50 to 60 cycles.

Output Waveforms Available

Positive Gate—approximately 30 volts peak-to-peak with same duration as sweep.

Sawtooth—sweep sawtooth waveform, approximately 150 volts peak-to-peak.

MECHANICAL CHARACTERISTICS

Ventilation

Forced filtered air. Thermal relay interrupts instrument power in the event of overheating.

Construction

Aluminum-alloy chassis and three-piece cabinet.

Photo-etched anodized panel, blue vinyl covered textured aluminum.

Dimensions—13" wide, $16^3/_4$" high, 24" deep.

Weight—74 pounds

Accessories Included

2 Binding-post adapters (013-004)
1 Test lead (012-031)
1 Power cord (161-010)
1 Adapter, 3 wire or 2 wire (103-013)
1 Light filter
2 Instruction Manuals (070-390)

SECTION 2

OPERATING INSTRUCTIONS

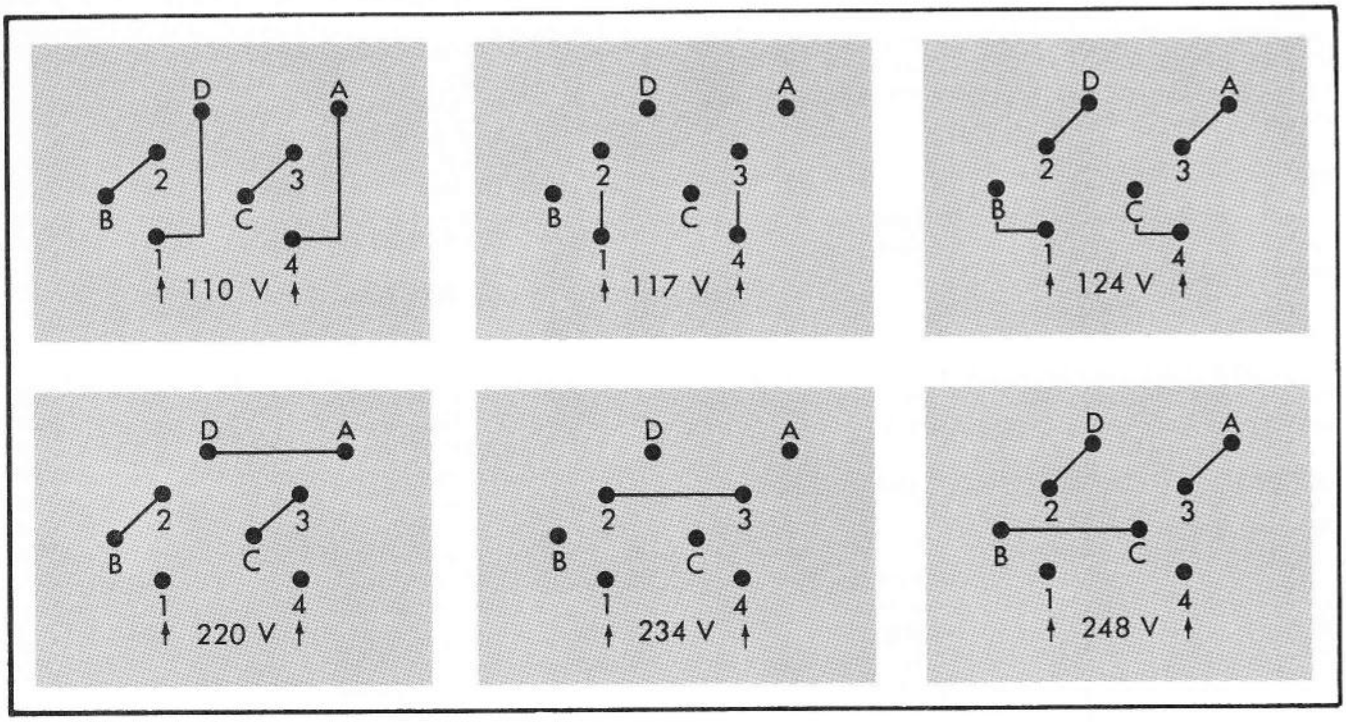

Fig. 2-1. The power transformer has two extra windings permitting nominal primary voltages of 110, 117, 124, 220, 234, 248 volts, 50 or 60 cycle operation.

General

The Type 581A Oscilloscope is an extremely versatile instrument which is adaptable to a great number of applications. However, to make use of the full potentialities of the instrument, it is necessary that you understand completely the operation of each control. This portion of the instruction manual is intended to provide you with the basic information that you require.

PRELIMINARY INSTRUCTIONS

Cooling

A fan maintains safe operating temperature in the Type 581A by circulating filtered air over the rectifiers and other components. When in operation, the instrument must be placed so that the air intake at the back is clear of any obstruction that might impede the flow of air. Side panels should also be in place for proper air circulation. The air filter should be kept clean in accordance with cleaning instructions found in the Maintenance Section of this manual.

Under no circumstances should your Type 581A oscilloscope be operated without the fan running. Without the fan, inside temperature of the oscilloscope will rise to a dangerous level in five to ten minutes. In this event, the thermal cutout switch will disconnect the power and keep it disconnected until the temperature drops to a safe level.

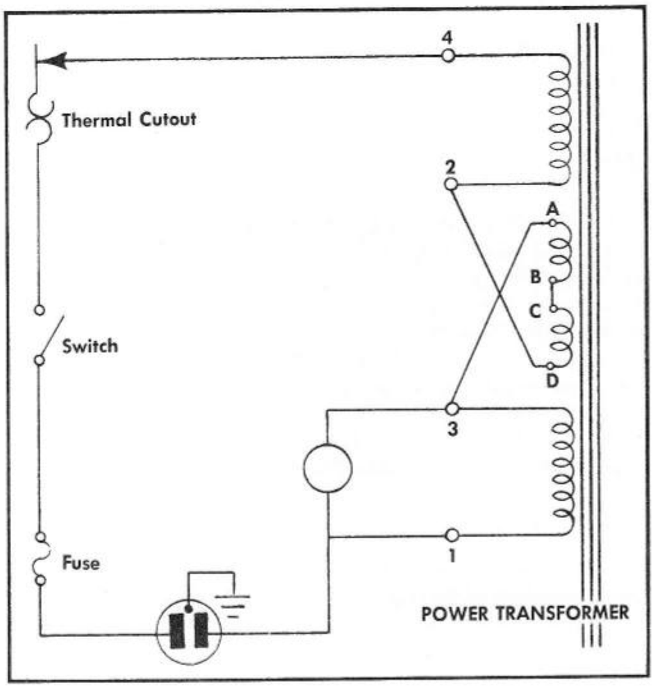

Fig. 2-2. A typical high-voltage fan connection, using as an example the wiring for a 248-volt supply.

Power Requirements

Unless tagged otherwise, this instrument is connected at the factory for operation at 117 volts, 50 to 60 cycles AC.

The power transformer has eight primary terminals making possible operation from six different input voltages. The Type 581A can be operated from primary voltages of 110, 117, 124, 220, 234 and 248 volts, 50 or 60 cycles. Figure 2-1 illustrates proper connections to permit operation on any one of the listed voltages.

Fan Connections

The manner in which the fan is wired depends on the line voltage. For 110-124 or 220-248 volt operation, the fan is connected as shown in Fig. 2-2.

Fuse Data

Fuse data is silk-screened on the rear panel of the instrument adjacent to the fuse holder. Use only the recommended fuses for maximum over-current protection.

OSCILLOSCOPE OPERATING INFORMATION

Plug-In Units

The Type 581A Oscilloscope is designed to operate with the Tektronix 80 Series Plug-In Units. In addition, the Type 81 Plug-In Adapter permits you to use any of the Tektronix Letter-Series Plug-In Units. The particular plug-in unit used must be selected by you to satisfy the requirements of your application.

Preparation for Use

When the plug-in unit to be used has been selected, insert the unit into the plug-in compartment of the Type 581A Oscilloscope and press firmly to insure that the connectors make proper contact. Tighten the plug-in unit locking control to hold the unit securely in place and turn the oscilloscope INTENSITY control fully counterclockwise. Connect the power cord to the rear of the instrument and to the power line and place the POWER switch in the ON position.

When using the Type 81 Plug-In Adapter, insert it into the Type 581A plug-in cage with a letter series plug-in unit in it. This permits the thumb tightening screw of the letter series plug-in to secure the Type 81 in place. It is possible to operate the Type 581A Oscilloscope without damaging it when the Type 81 Plug-In Adapter is in place even when it is not occupied by a letter series plug-in. The frequency response of all letter series plug-in units will be identical to their ratings when used with a Tektronix 540 Series Oscilloscope. See the Type 81 Plug-In Adapter instruction manual for additional information.

Time Delay

A time delay relay used in the Type 581A Oscilloscope delays operation of the instrument for approximately 45 seconds after the POWER switch is turned on to allow a brief tube warmup period. The delay allows the tubes sufficient time to heat before the dc operating voltages are applied.

If the ac power is off for only an instant, the normal 45 second delay will occur before the instrument returns to full operation. This delay will occur regardless of whether the ac power is off because of momentary power failure or is turned off with POWER switch.

INTENSITY Control

The INTENSITY Control is used to adjust the brightness of the oscilloscope display. This permits you to compensate for changes in brightness resulting from changes in the sweep or triggering rate. The INTENSITY Control rotated clockwise to increase brightness and counterclockwise to decrease brightness. Care must be taken when you are using the INTENSITY Control that the brightness is not turned up to the point where the face of the cathode-ray tube is permanently damaged. If the intensity of the beam is turned up too far, the phosphor on the face of the crt may be burned.

FOCUS and ASTIGMATISM Controls

The FOCUS and ASTIGMATISM Controls operate together to allow you to obtain a sharp, clearly defined, spot or trace. FOCUS adjustments need to be made after each change of the INTENSITY Control. For slow sweep rates, proper adjustment of the ASTIGMATISM Control will produce a circular spot, then adjust the FOCUS Control for as small a spot as possible. For fast sweep rates with low repetition rates that produce a dim trace, best focus can be obtained by looking at the waveform and simultaneously adjusting the ASTIGMATISM and the FOCUS Controls. You will find a maximum setting of the INTENSITY Control above which good focus is not possible. Best definition for all signals will be obtained by using the horizontal center six centimeters of the graticule.

Graticule and Scale Illumination Control

The edge-lighted internal graticule is accurately marked with 10 horizontal and 4 vertical 1-centimeter divisions and 2-millimeter subdivisions marked on the vertical centerline and the two horizontal centerlines. The deflection factors of the crt beams are calibrated to these graticule marks. Thus the marks provide a calibrated scale for making time and voltage measurements.

To protect the bonded plastic faceplate of the internal graticule CRT (instrument S/N's 500-up), always use a scratch shield or plastic light filter in front of the CRT. The shield and filter are provided with the instrument. For normal viewing and for photographing the display, use the clear plastic scratch shield. For viewing under bright ambient light conditions, use the light filter to provide better trace-to-screen contrast. When using the light filter, however, be careful not to set the beam intensity so high that it will burn the CRT phosphor.

For instruments with external graticules (S/N's 3975-4999), the color of the graticule illumination may be changed from white to red, or vice versa, by rotating the graticule 180°.

Positioning Controls

Three controls are used to allow you to position the trace to any point on the oscilloscope screen. Two of these controls are used to set the horizontal postion of the trace. The third control is used to set the vertical position of the trace and is located on the front panel of the plug-in unit used with the oscilloscope.

The two HORIZONTAL POSITION Controls move the trace to the right when they are rotated in the clockwise direction and to the left when they are rotated counterclockwise. The combination of the two controls has a total positioning range of approximately 12 centimeters with the sweep magnifier off or approximately 60 centimeters with the sweep magnifier on. The HORIZONTAL POSITION Control has approximately three times the range of the HORIZONTAL POSITION VERNIER Control. The fine range of adjustment of the HORIZONTAL POSITION VERNIER Control makes this control particularly useful whenever fine horizontal positioning is required, as for example, when the sweep magnifier is used.

The vertical positioning control has sufficient range to allow the trace to be positioned completely off the top or bottom of the screen or to any intermediate point. The trace moves up when the control is rotated clockwise and down when the control is rotated counterclockwise.

Four small indicator lights located just above the oscilloscope screen indicate the position of the spot or trace. When one of these lamps is lit, it indicates that the trace is off-centered in the direction of the arrow. These four lights allow you to position the spot to the center of the screen even though the intensity is so low that the trace is not visible.

VERTICAL DEFLECTION SYSTEM

Input signals are carried to the oscilloscope main-unit vertical amplifier by the plug-in unit in use. The vertical amplifier gain and transient response are standardized for exchange of Type 80 Series plug-in units, permitting selection of system application in the approximately 95 megacycle range.

An alternate system using the Type 81 Plug-In Adapter makes possible the use of all Tektronix Letter Series plug-in units. When using a Type 81 Plug-In Adapter with a Type K or Type L Plug-In Unit, the system bandpass is dc to 30 megacycles.

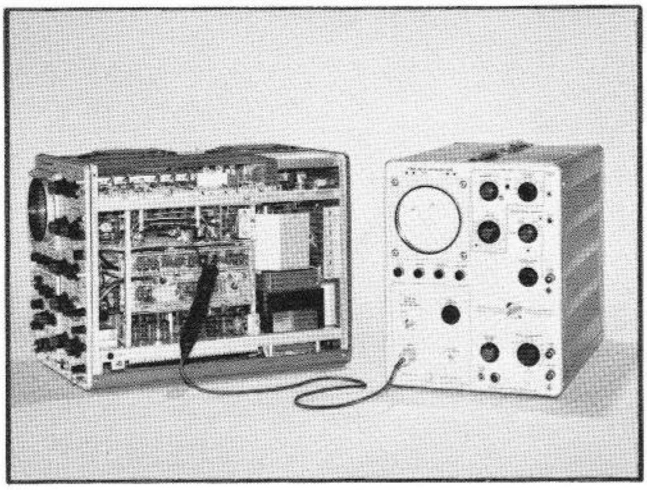

Fig. 2-3. Proper connection of the probe to the input signal source.

Certain precautions must be taken when you are connecting the oscilloscope to the input signal source to insure that accurate information is obtained from the oscilloscope display. This is particularly true when you are observing low-level signals or waveforms containing high- or extremely low-frequency components. For applications where you are observing low-level signals, unshielded input leads are entirely unsatisfactory due to their tendency to pick up stray signals which produce erroneous oscilloscope displays. Shielded cables should be used whenever possible, with the shield connected to the chassis of both the oscilloscope and the signal source. Regardless of the type of input lead used, leads should be kept as short as possible.

Distortion of the input waveform may result if very low-frequency input signals are ac coupled into the oscilloscope, if high-frequency waveforms are not properly terminated, or if the input waveform contains high-frequency components which exceed the pass band of the oscilloscope and plug-in unit combination. You must be aware of the limitations of the instrument.

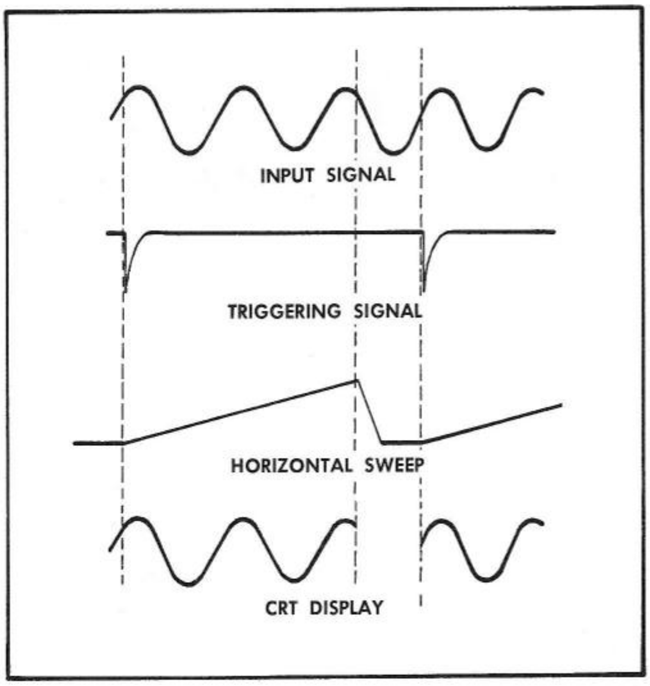

Fig. 2-4. Oscilloscope in triggered sweep operation. Waveform ladder diagram showing sequence of operations from input signal, triggering signal, the sweep, and the crt display.

In analyzing the displayed waveform, you must consider the loading effect that the oscilloscope has on the input-signal source. In most cases this loading effect is negligible; however, in some applications, loading caused by the oscilloscope may materially alter the results obtained. In such cases you may wish to reduce the amount of loading to a negligible amount through the use of a probe.

For further operating instructions refer to the instruction manual for the plug-in that is being used.

HORIZONTAL DEFLECTION SYSTEM

Sweep Rates

The Type 581A Oscilloscope has 24 accurately calibrated sweep rates ranging from .05 microsecond to 2 seconds per centimeter. Calibrated sweep rates are obtained only when the VARIABLE TIME/CM Control is in the fully clockwise position. The VARIABLE TIME/CM Control permits you to vary the sweep rate continuously between .05 microsecond

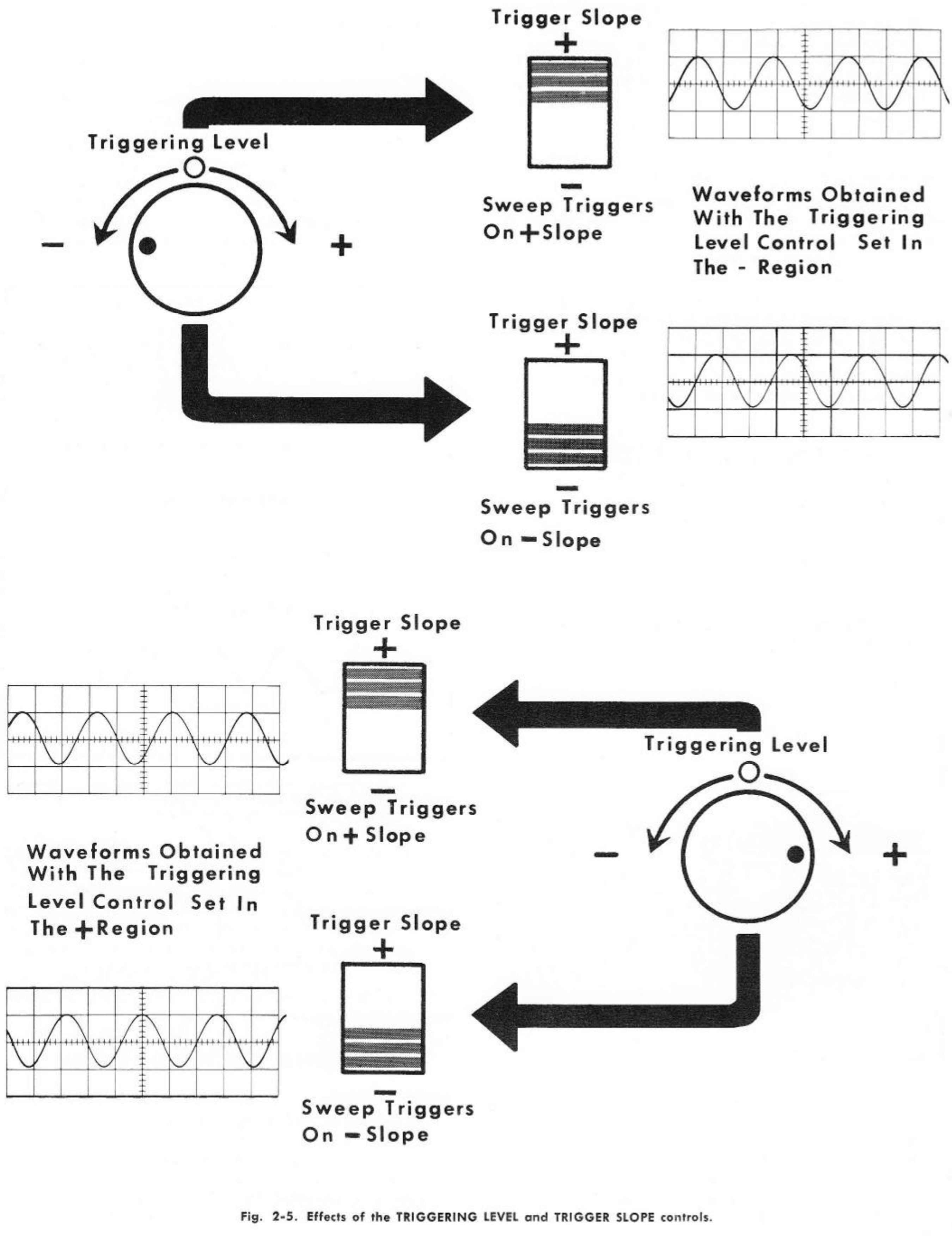

Fig. 2-5. Effects of the TRIGGERING LEVEL and TRIGGER SLOPE controls.

and approximately 5 seconds per centimeter. All sweep rates obtained with the VARIABLE TIME/CM Control in any position but fully clockwise are uncalibrated. Uncalibrated sweep rates are indicated when the UNCALIBRATED lamp is lit.

Triggered Operation

For most uses of the oscilloscope a stable display of some waveform is required. To accomplish this the oscilloscope can be operated so that the horizontal sweep starts at a given point on the displayed waveform. This is known as "triggered" operation. For the present, we will refer to the starting of the sweep, at the left side of the graticule, as "triggering" the sweep.

Triggered operation is useful for observing a waveform which may occur only once, or which may occur at random intervals. For any of these uses, the oscilloscope can be used in such a way that each horizontal sweep is triggered by some waveform other than the one being observed, but which bears a time relationship to the observed waveform.

The waveform used to start the horizontal sweep is called the "triggering signal", whether it is the waveform being observed, or some other waveform. The instructions that follow tell you how to select this signal. They also contain information on triggering according to various modes, depending on the nature of the triggering signal.

Selecting the Triggering Signal

1. To trigger the sweep from the waveform being observed, set the TRIGGERING SOURCE knob to INT—

   AC For normal triggering requirements to 150 mc.

   AC LF REJECT to suppress low frequency components that may cause jitter or otherwise mistrigger the desired waveform.

   HF SYNC for waveforms above 5 mc of insufficient amplitude for normal jitter-free triggering.

2. To trigger the sweep from the power line frequency (as in the case when observing a waveform which has a time relationship to the power-line frequency), set the TRIGGERING SOURCE knob to LINE.

3. To trigger the sweep from some external waveform (one having a time relationship to the waveform being observed), connect the source of the triggering signal to the TRIGGER INPUT connector and set the TRIGGERING SOURCE knob to EXT—

   AC For normal triggering requirements to 150 mc.

   DC if the triggering waveform frequency is below 15 cycles.

   HF SYNC for waveforms above 5 mc of insufficient amplitude for normal jitter-free triggering.

Selection of the Triggering Slope

The horizontal sweep can be triggered on either the rising (+ slope) or falling (— slope) portion of the triggering waveform. This is determined by the position of the TRIGGER SLOPE switch. When the switch is in the + position, the sweep is triggered on the rising portion of the triggering waveform; when the TRIGGER SLOPE switch is in the — position, the sweep is triggered on the falling portion of the waveform (see Figure 2-5).

In many applications the triggering slope is not important since triggering on either slope will provide a display which is suitable to the application. However, in other cases, such as pulse risetime or falltime measurements, the triggering slope is very important and must be selected properly if you are to obtain a useful display. To accurately measure the risetime of a pulse it is necessary for you to trigger the sweep on the rising portion of the waveform. Also, to observe the fall of a pulse it is necessary for you to trigger the sweep on the falling portion of the waveform. In either case, selection of the wrong triggering slope will make it difficult or impossible for you to observe the portion of the waveform you wish to check.

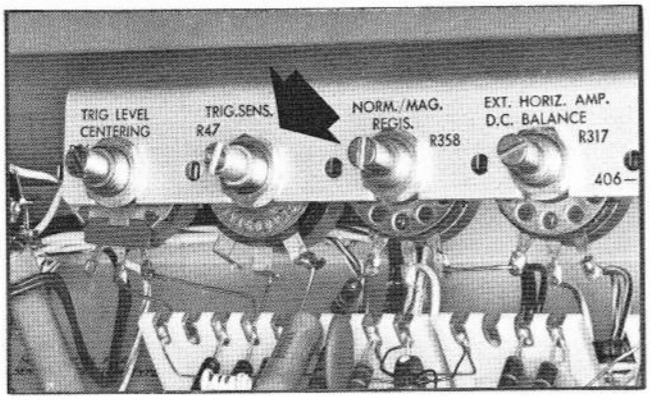

Fig. 2-6. TRIG. SENS. control location.

NOTE

When displaying waveforms above 50 megacycles, the trigger circuit may produce a stable display on only one slope. Be sure to try both + and — positions of the TRIGGER SLOPE switch for best triggering.

Using the STABILITY and TRIGGERING LEVEL Controls

In virtually every triggering application, satisfactory operation can be obtained with the STABILITY Control in the fully counterclockwise, PRESET, position. This setting has the advantage that no further adjustment of the STABILITY control is required when you are switching from one triggering signal to another. However, if it becomes difficult for you to obtain stable triggering with the STABILITY Control at PRESET, it will be necessary for you to adjust the control for proper triggering.

To adjust the STABILITY control, place the TRIGGERING LEVEL control in the fully counterclockwise position. Then rotate the STABILITY control slowly clockwise until a trace appears on the screen. The correct setting is obtained by rotating the control counterclockwise three to five degrees past the point where the trace disappears.

The TRIGGERING LEVEL control determines the point on the triggering waveform where triggering occurs. Rotating the control clockwise causes the sweep to trigger at more positive points on the waveform while rotating the control counterclockwise causes the sweep to trigger at more negative points. Setting the TRIGGERING LEVEL at 0 will cause the sweep to start at approximately the average-voltage point of the waveform.

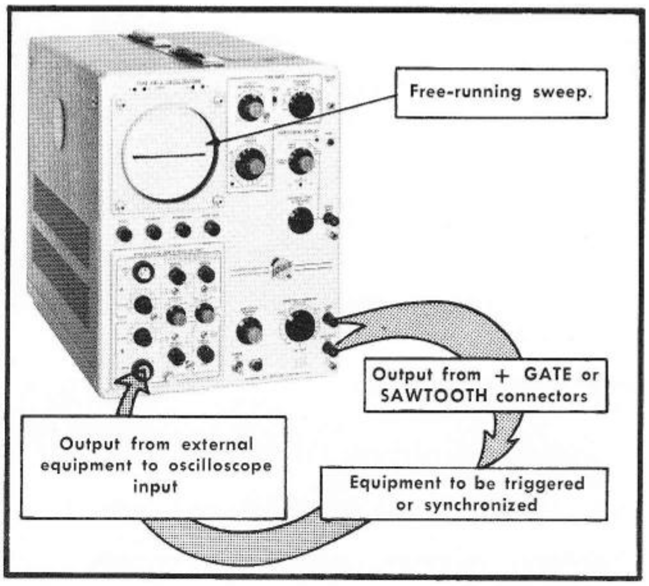

Fig. 2-7. Using the Gate or Sawtooth output waveforms to synchronize or trigger external equipment.

Free-Running Sweep Operation

In the usual oscilloscope application, the sweep is triggered or synchronized by the input waveform. However in some applications it may be more desirable to reverse the process and initiate the input waveform through use of a periodically recurrent waveform from the oscilloscope. In this type of application the sweep is caused to free-run and an output from either the + GATE OUT or SAWTOOTH OUT connectors is used to trigger or synchronize the input waveform.

The sweep can be made to free run by rotating the STABILITY Control fully clockwise. Under these conditions the sweep runs at a rate determined by the setting of the TIME/CM Controls.

In this application it is advisable to place the TRIGGERING SOURCE switch in its EXT-AC position to prevent the vertical signal from producing any possible interference or jitter.

In addition to providing the means for triggering or synchronizing an external piece of equipment, a free-running sweep also provides a convenient reference trace on the oscilloscope screen without requiring an input signal. This trace can be used to position the sweep or to establish a voltage reference line.

Single Sweep Operation

The usual oscilloscope display formed by a repetitive sweep is best for most applications. However, in applications where the displayed waveform is not repetitive or varies in amplitude, slope, or time interval, a repetitive sweep produces a jumbled display. When observing a waveform of this type, it is usually advantageous to use a single sweep presentation.

The Type 581A Oscilloscope permits you to obtain a single sweep presentation and to eliminate all subsequent sweeps so that information is clearly recorded without the confusion resulting from multiple traces. The single sweep feature is selected by placing the HORIZONTAL DISPLAY switch in the SINGLE SWEEP POSITION. The RESET button controls the operation of the single sweep.

When the STABILITY Control is set fully clockwise, a single sweep runs immediately each time the RESET button is depressed. When the STABILITY Control is set for triggered operation, the single sweep does not occur when the RESET button is depressed but waits until a triggering signal is applied. The READY lamp lights to indicate that the sweep

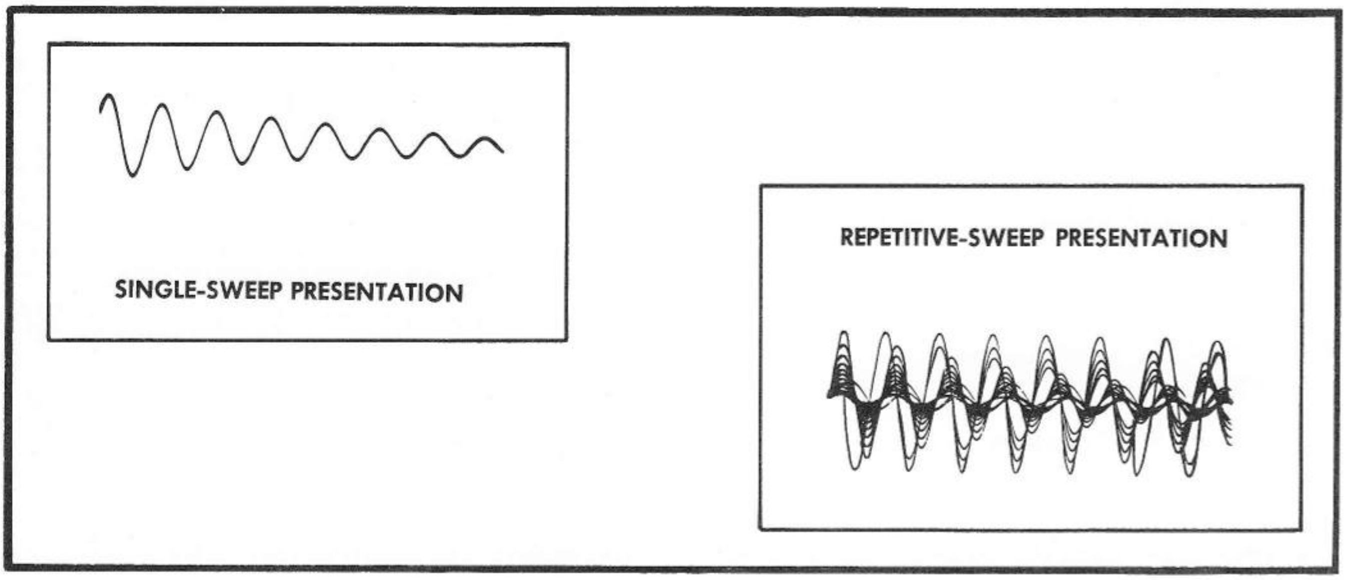

Fig. 2-8. Comparison of single sweep and repetitive sweep presentations of a damped sine wave. Note the jumbled display produced by the repetitive sweep presentation.

is ready to be triggered. When a triggering signal occurs, the single sweep runs and the READY light goes out. Each time the RESET button is depressed the procedure is repeated.

When operating the Type 581A in the single sweep mode the apparent brilliance of the crt trace will be less than during repetitive sweep operation. This is due to both the crt phosphor and your eye persistence making a repetitive sweep look brighter than each individual sweep.

External Horizontal Input

For special applications you can deflect the spot horizontally with some externally derived waveform. This allows you to use the oscilloscope to plot one function versus another.

To use an external horizontal input, connect the externally derived waveform to the HORIZ. INPUT connector and place the HORIZONTAL DISPLAY switch in either X1 or X10 EXT HORIZ. ATTEN. position. The horizontal deflection factor is continuously variable from approximately .2 to approximately 15 volts per centimeter with EXTERNAL HORIZ. ATTENUATOR 10-1 Control and the HORIZONTAL DISPLAY switch.

Sweep Magnifier

The sweep 5X MAGNIFIER allows you to expand any two-centimeter portion of the displayed waveform to the full ten-centimeter width of the graticule. This is done by first using the HORIZONTAL POSITION Control to move the portion of the display you wish to expand to the center of the graticule, then placing the 5X MAGNIFIER switch in the ON position. Any portion of the original unmagnified display can now be observed by rotating the HORIZONTAL POSITION Controls.

In magnified sweep operation, the sweep rate indicated by the position of the TIME/CM control is divided by 5 to obtain the actual time required for the spot to move one centimeter. For example, if the TIME/CM control is set at 5 mSEC, the actual time per centimeter is 5 milliseconds divided by 5, or 1 millisecond per centimeter.

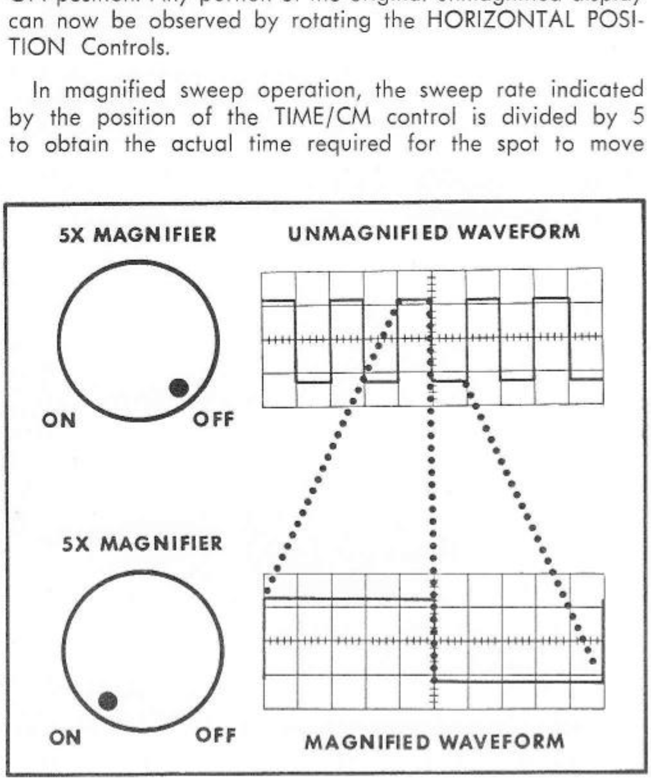

Fig. 2-9. Operation of the sweep magnifier.

Output Waveforms

For certain external applications, the sawtooth sweep waveform is available at the SAWTOOTH OUT connector on the front panel. This positive waveform starts at about —2 volts and rises linearly to a peak amplitude of about 140 volts.

The start and duration of the rising part of the sawtooth coincides with the start and duration of the horizontal sweep on the crt. The rate at which the sawtooth rises is determined by the setting of the TIME/CM Control.

A positive rectangular waveform is available at the + GATE OUT connector. This waveform starts at ground and rises to about 30 volts. The starting time and duration of each pulse coincides with the starting time and duration of the horizontal sweep on the crt, and the positive-going part of the sawtooth available at the SAWTOOTH OUT connector.

AUXILIARY FUNCTIONS

Amplitude Calibrator

The AMPLITUDE CALIBRATOR provides a convenient source of square waves of known amplitude at a frequency of approximately 1 kc. The square waves are used primarily to compensate attenuators or probes and to verify the amplitude calibration of the vertical deflection system of the oscilloscope and plug-in unit.

Calibrator square waves are adjustable from .2 millivolts peak-to-peak to 100 volts peak-to-peak in 18 steps. The amplitude is controlled by the setting of the AMPLITUDE CALIBRATOR switch and is accurate within 3% of the AMPLITUDE CALIBRATOR switch setting, when the output is connected to a high impedance load.

Intensity Modulation

The crt display of the Type 581A Oscilloscope can be intensity modulated by an external signal to display additional information. This is done by disconnecting the grounding bar from the EXTERNAL CRT CATHODE connector at the rear of the instrument and connecting the external signal to this terminal.

When you wish to make very accurate time measurements from the crt display, you can intensity modulate the beam with time markers and make your measurements directly from the time markers presented on the screen. A positive signal of approximately 25 volts is required to cut off the beam from normal intensity. Restore the grounding bar to the EXTERNAL CRT CATHODE connector during normal operation to avoid uneven trace intensity at high sweep rates.

Dual Trace Displays

The Type 82 Dual-Trace Plug-In Unit allows the presentation of two traces to appear as the crt display. The Type 82 permits the display of two functions simultaneously. Detailed instructions for operating the Type 82 Dual-Trace Plug-In Unit are contained in its instruction manual.

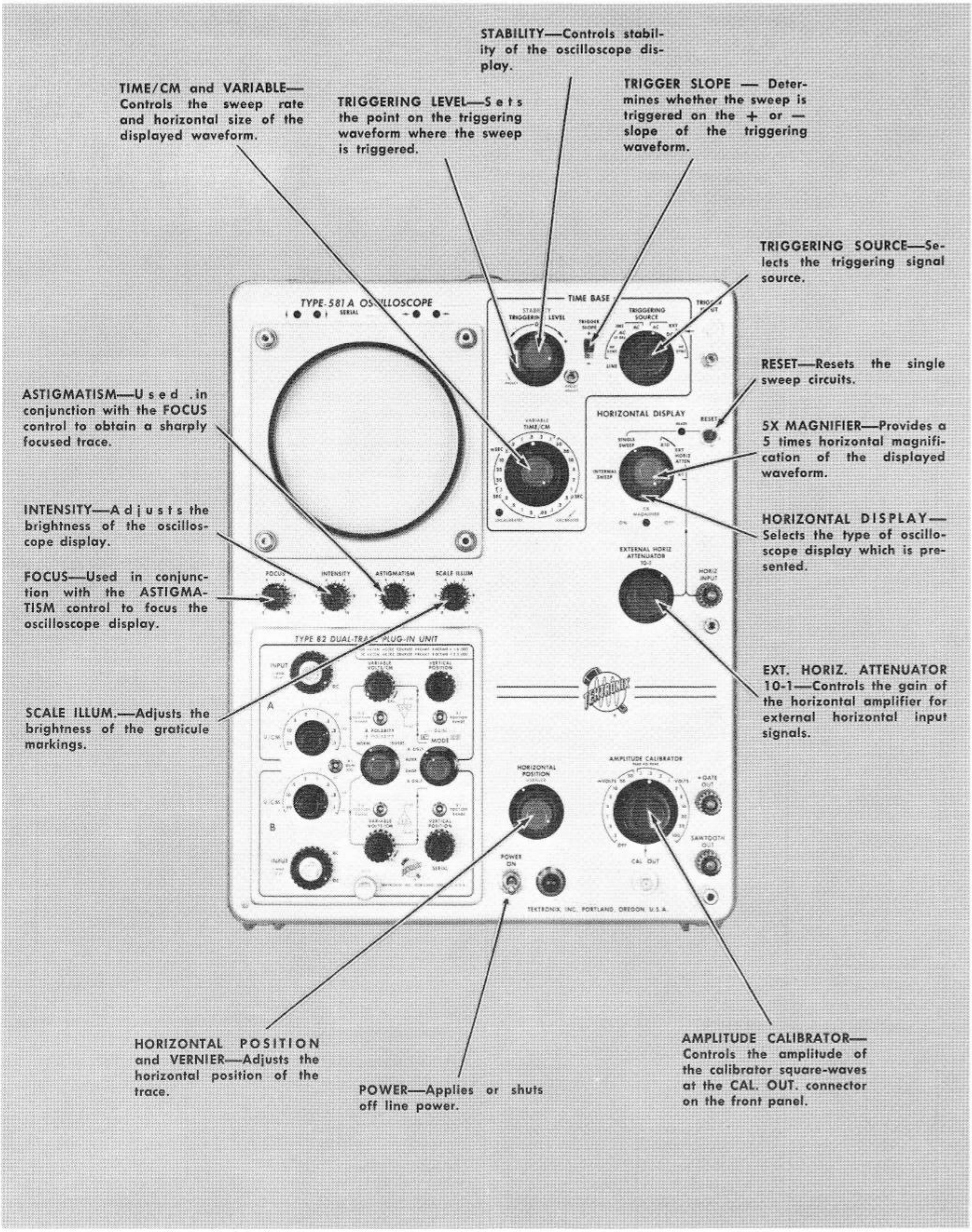

Fig. 2-10. Functions of the front-panel controls.

SECTION 3
APPLICATIONS

General

Your Tektronix Type 581A Oscilloscope offers a basic 100 millivolt deflection factor, with a 3 db response of approximately 95 megacycles, permitting accurate measurements of high frequency, low level signals.

Voltage Measurements

The Type 581A Oscilloscope can be used to measure the voltage of the input waveform by using the calibrated vertical-deflection factors of the instrument and associated plug-in unit. The method used for all voltage measurements is basically the same although the actual techniques vary somewhat depending on the type of voltage measurements required. Essentially there are two types of voltage measurements: ac component voltage measurements and instantaneous voltage measurements with respect to some reference potential. Many waveforms contain both ac and dc voltage components. It is often necessary to measure one or both of these components. (See Figure 3-1).

When making voltage measurements, you should display the vertical waveform over only the center two centimeters of the graticule for maximum accuracy. Also, it is important that you do not include the width of the trace in your measurements. You should consistently make all measurements from one side of the trace. If the bottom of the trace is used for one reading, it should be used for all succeeding readings.

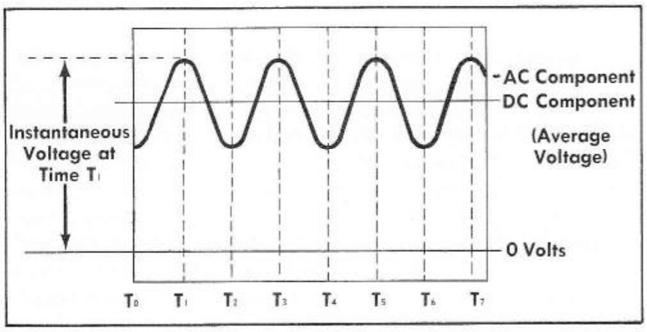

Fig. 3-1. Typical waveform applied to the oscilloscope. Shown are the ac component, dc component, and instantaneous voltage of the waveform.

AC Component Voltage Measurements

In oscilloscope measurements, the ac component of a waveform is usually measured in terms of its peak-to-peak or peak-to-trough value. This type of measurement is most conveniently made by using the graticule to measure the vertical distance between peaks and multiplying this distance by the deflection factor of the oscilloscope. The figure obtained is the actual peak-to-peak voltage. In most cases, the ac component of a waveform can be measured with the Input Selector switch in either the AC or DC position. It may be necessary to use the AC position however, in certain applications to prevent the dc component of the waveform from deflecting the trace off the screen. To prevent inaccuracies, the DC position should be used when low frequency measurements are made.

To make a peak-to-peak voltage measurement on the ac component of a waveform, the following method can be used.

1. With the aid of the graticule, measure the vertical distance in centimeters from the positive peak to the negative peak.

2. Multiply the vertical distance between peaks by 0.1 volt per centimeter when using the Type 80 Plug-In and P80 Probe, or by the plug-in unit VOLTS/CM Control when using the Type 81 Plug-In Adapter with a letter series plug-in to obtain the indicated voltage.

3. Multiply the indicated voltage by the attenuation factor of any probe or attenuator head used to obtain the actual peak-to-peak voltage.

As an example, asume that when using the P80 Probe with a 5-1 attenuator you measure a vertical distance between peaks of 2.1 centimeters. In this case then, 2.1 centimeters multiplied by 0.1 volt per centimeter gives 0.21 volt. This figure multiplied by the attenuation factor of 5 gives the actual peak-to-peak voltage, 1.05 volts.

When sinusoidal waveforms are measured, the peak-to-peak voltage obtained can be converted to peak, rms, or average values through the use of standard conversion factors.

Instantaneous Voltage Measurements

The method used to measure instantaneous voltages is virtually identical to the method described previously for the measurement of the ac component of a waveform. The primary difference is that instantaneous voltage measurements must be made with respect to some reference potential (usually ground). In this type of measurement, the reference potential must be used to first establish a reference line on the oscilloscope screen. Voltage measurements are then made with respect to this reference line. In this type of measurement, the Input Selector switch must be placed in the DC position. The method used to measure instantaneous voltages can also be extended to measurement of the dc component of a waveform since the average voltage of a waveform can be treated as an instantaneous voltage. The dc component of any waveform can therefore be measured if the average voltage can be determined.

In the following procedure, steps are given for establishing the voltage reference line as ground. The same general method may be used to measure voltage with respect to any other potential, however, so long as that potential is used to establish the reference line.

To measure an instantaneous voltage with respect to ground or other reference voltage perform the following steps:

1. To establish the voltage reference line, touch the probe tip to an oscilloscope ground terminal or the voltage

reference required. Adjust the oscilloscope controls for a free-running sweep. Vertically position the trace to a convenient point on the oscilloscope screen. This will depend on the polarity and amplitude of the input signal, but should always be chosen so that the trace lies along one of the major divisions of the graticule. If the trace is widened by stray interference, ground the probe near the tip to reduce the interference. The graticule division corresponding to the position of the trace is the voltage reference line and all voltage measurements must be made with respect to this line. (Do not adjust the vertical positioning control after the reference line has been established.)

2. Remove the probe tip from ground or reference voltage and connect it to the signal source. Adjust the triggering controls for a stable display. The probe ground lead should be very short.

3. Using the graticule, measure the vertical distance in centimeters from the point to be measured to the voltage reference line.

4. Multiply the distance measured first by the VOLTS/CM setting, then by the attenuation factor of the probe used.

As an example assume that when using the P80 Probe with a 10-1 attenuator head you measure a vertical distance of 2.5 centimeters between the reference line and the point to be measured. In this case, 2.5 centimeters multiplied by the basic plug-in sensitivity (0.1 VOLTS/CM) gives 0.25 volt. This figure multiplied by the attenuation head factor of 10 gives the instantaneous voltage, 2.5 volts. If the point that is measured is above the reference line, the polarity is positive; if the point is below the reference line, the polarity is negative.

Time Measurements

The calibrated sweep rates of the Type 581A Oscilloscope cause any horizontal distance on the screen to represent a definite known interval of time. Using this feature you can measure accurately the time between two displayed events directly from the oscilloscope screen. One method which products sufficient accuracy for most applications follows:

1. Using the graticule, measure the horizontal distance between the two displayed events whose time interval you wish to find.

2. Multiply the distance measured by the setting of the appropriate TIME/CM Control to obtain the apparent time interval. (The VARIABLE TIME/CM Control must be in the CALIBRATED position).

3. Divide the apparent time interval by 5 if the magnifier is on to obtain the actual time interval.

For example, assume that the TIME/CM switch setting is 1mSEC, the magnifier is on, and that you measure a horizontal distance of 5 centimeters between events. In this example then, 5 centimeters multiplied by 1 millisecond per centimeter gives you an apparent time interval of 5 milliseconds. The apparent time divided by 5 then gives you the actual time interval of 1 millisecond.

Frequency Measurements

Using the method described in the previous section, you can measure the period (time required for one cycle) of a recurrent waveform. The frequency of the waveform can then easily be calculated since frequency is the reciprocal of the period. For example, if the period of a recurrent waveform is accurately measured and found to be 0.2 microsecond, the frequency is the reciprocal of 0.2 microsecond, or 5 mc.

Phase Measurements

You will recall that a complete cycle of a sinusoidal waveform is 360 degrees. Using this fact it is possible to calibrate the oscilloscope display directly in degrees per centimeter by means of the TIME/CM Controls. For example, if the TIME/CM Controls are adjusted so that one cycle of the input waveform covers 9 centimeters (see Figure 3-2), each centimeter then corresponds to 40 degrees. Under this condition the display is calibrated to 40 degrees per centimeter.

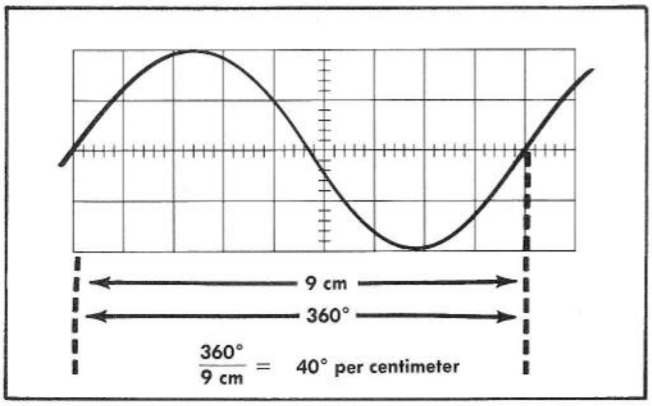

Fig. 3-2. One method for calibrating the oscilloscope display in degrees per centimeter.

It is therefore possible to measure phase angles by: (1) calibrating the display in degrees per centimeter; (2) measuring the displacement between corresponding points on the two phases; and (3) multiplying the displacement by the number of degrees per centimeter. This is the method illustrated in Figure 3-2. Note that the relative amplitude of the two signals does not affect the phase measurement so long as the signals are both centered about the horizontal centerline. It is important to note that the two waveforms shown in the illustration do not appear simultaneously on the oscilloscope screen. The first waveform is displayed and positioned to a convenient reference point. The second waveform is then displayed and compared to this reference point.

When using the Type 581A Oscilloscope for phase measurements, it is necessary to supply an external triggering signal to the oscilloscope. This triggering signal serves, in a sense, as a reference signal. The two input signals are compared indirectly to this reference and directly to each other. Consequently the triggering stability must be maintained to permit accurate phase angle measurements. The external triggering signal must have sufficient amplitude to insure stable triggering. The triggering signal must also be related in frequency to the waveforms on which phase measurements are to be made; however, the actual phase of the triggering signal is not critical. If you so desire, you may use one of the signals to be measured as the external triggering signal. It is essential that once

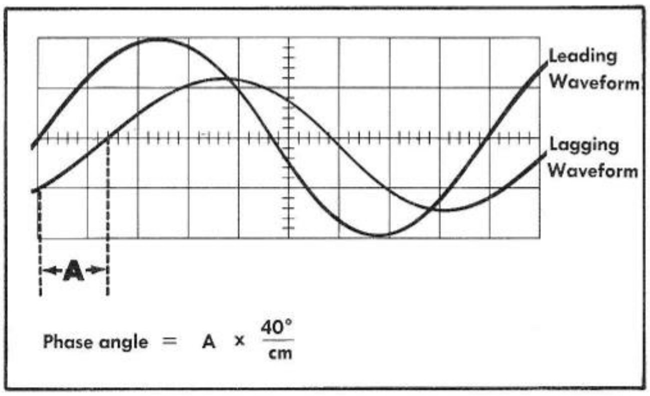

Fig. 3-3. Measurement of the phase angle between two electrical waveforms. It is important to note that the two displayed waveforms do not appear simultaneously on the oscilloscope screen.

the triggering conditions have been established, they are not changed during any phase measurement.

The height of the display should be made as large as possible to improve accuracy. Accuracy of the measurements also depends to a large extent on how well the waveforms are centered about the horizontal centerline of the graticule. Care should be taken to insure that the waveforms are properly centered. A method for obtaining phase measurements is described as follows:

1. Connect the external triggering signal to the TRIGGER INPUT connector. Place the HORIZONTAL DISPLAY switch in the INTERNAL SWEEP position and adjust the triggering controls for a stable display.

2. Connect the first (leading) waveform to the oscilloscope input. Adjust the TIME/CM Control so that one cycle of the input waveform covers exactly 9 centimeters. This corresponds to 40 degrees per centimeter, as in Figure 3-2.

3. Carefully center the displayed waveform about the horizontal centerline using the VERTICAL POSITION Control. Switch on the magnifier and adjust the horizontal position of the trace so that the displayed curve crosses the horizontal cenerline at the extreme left marking of the graticule (see Figure 3-5). Make this adjustment with the HORIZONTAL POSITION Control. The VERNIER HORIZONTAL POSITION Control should be placed in the fully clockwise position.

4. If using the Type 80 Plug-In with P80 Probe, disconnect the first waveform and connect the second (lagging) waveform to the oscilloscope. Switch off the magnifier and using only the VERNIER HORIZONTAL POSITION Control, position the curve onto the screen as far as possible. Carefully center the waveform about the horizontal centerline. Switch the magnifier back on and rotate the VERNIER HORIZONTAL POSITION Control fully clockwise. Without adjusting either the triggering or the HORIZONTAL POSITION Control, measure the distance from the extreme left graticule marking to the point where the curve crosses the horizontal centerline (see Figure 3-6). This distance multiplied by the number of degrees per centimeter is the phase angle.

5. If a multi-channel plug-in is used, display both waveforms simultaneously. The leading waveform can be connected to the A input and the lagging waveform to the B input. The MODE switch of the plug-in should be in the ALTERNATE position. Follow the procedure of step number 4 to compute the phase angle, but keep the reference waveform where it crosses the center horizontal line at the left edge of the graticule markings. (See Fig. 3-5).

(For phase angles up to 80° the measurement should be made with the magnifier on for maximum accuracy. With the magnifier on, the scale calibration is 8 degrees per centimeter. For phase angles greater than 80°, measurements must be made with the magnifier off. With the magnifier off, the scale calibration is 40 degrees per centimeter. When phase angles are measured with the magnifier off, step 3 must be repeated with the magnifier off.)

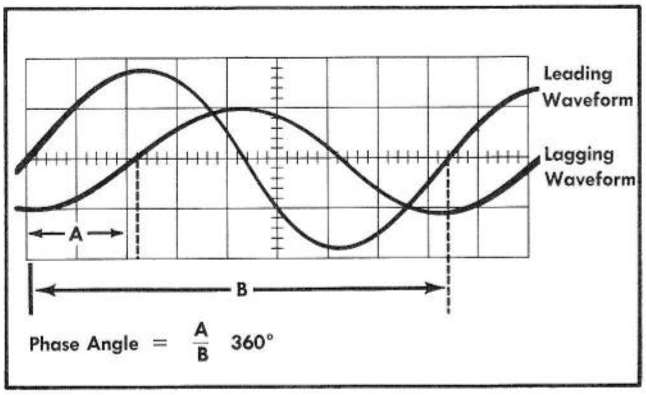

Fig. 3-4. An alternate method for measuring the phase angle between two electrical signals.

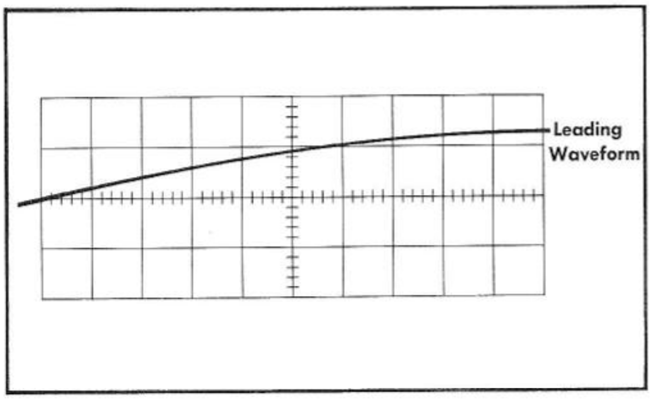

Fig. 3-5. Establishing the reference point with the leading waveform.

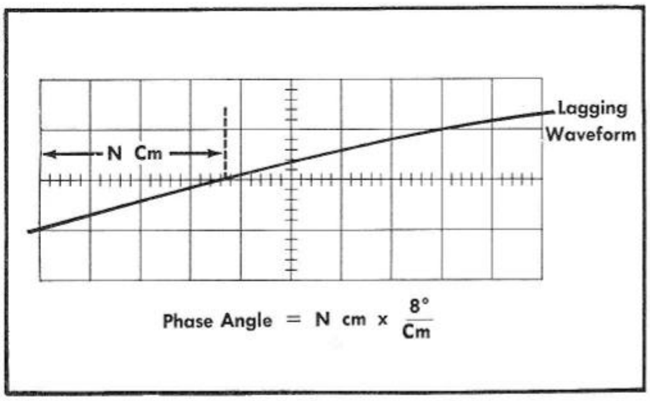

Fig. 3-6. Computing the phase angle. The distance from the reference point established in Fig. 3-5 to the point where the curve crosses the centerline, multiplied by 8° per centimeter is the phase angle.

SECTION 4
CIRCUIT DESCRIPTION

General

This portion of the Instruction Manual presents a detailed discussion of the Type 581A Oscilloscope's circuit operation. This discussion is keyed to various diagrams contained at the back of this manual.

Instrument Operation

The simplified block diagram of Figure 4-1 illustrates the interrelation of the various circuits composing the Type 581A Oscilloscope. The input signal to the oscilloscope is connected to the input connector of the plug-in unit. The output signal from the plug-in unit is then applied to the vertical amplifier of the oscilloscope. The output of the vertical amplifier system is used to drive the vertical deflection plates of the crt.

A Trigger Pickoff circuit in the Vertical Amplifier applies a sample of the input waveform to the Time-Base Trigger circuit. This waveform sample can then be used to trigger a sweep by the Time-Base Generator. In addition, an external waveform or a line frequency waveform can also be used to trigger a sweep.

Signals of widely varying shapes and amplitudes are applied to the Time-Base Trigger circuit. The Trigger Regenerator in turn produces constant amplitude output pulses which are used to start the Time-Base Generator at the proper instant of time. This insures a stable display of the input waveform.

The output pulses from the Trigger Amplifier are applied to the Time-Base Generator to initiate the sweep sawtooth waveform. The selected sawtooth waveform is then amplified by the Horizontal Amplifier and applied to the horizontal deflection plates of the crt.

When an external sweep waveform is used, the waveform is connected through the HORIZ INPUT connector to the External Horizontal Amplifier. The output signal of the External Horizontal Amplifier is then amplified by the Horizontal Amplifier and applied to the crt horizontal deflection plates to produce the desired horizontal deflection.

The Amplitude Calibrator produces a square wave output waveform which can be used to check the deflection factor of the vertical deflection system. The Amplitude Calibrator voltage is also used in compensating probes.

There are six regulated low voltage power supplies used in the Type 581A Oscilloscope. These power supplies provide the operating voltages for all circuits except the cathode-ray tube. Operating voltages for the crt are provided by a separate high voltage power supply contained in the crt circuit. In addition to the high voltage power supply, the crt circuit contains the controls and circuitry which affect the crt display.

VERTICAL DEFLECTION SYSTEM

General

The Type 581A vertical deflection system can be driven by any of the 80 Series plug-in units, or by the Type 81 Plug-In Adapter with any Tektronix letter series plug-in unit.

Input signals to the oscilloscope are applied to the plug-in unit. The output of the plug-in unit is then applied through the interconnecting plug to the Vertical Amplifier Delay-Line Driver stage of the oscilloscope. The signal traverses the Vertical Amplifier Delay-Line Driver stage and is returned to the plug-in for termination. The plug-in unit provides positioning voltages to permit the trace to be positioned vertically on the crt.

The input resistance and capacitance of each plug-in unit (or probe) input connector is discussed in the manual for the unit in use. In all cases, consider the oscilloscope input as a potential load on the signal source, the degree depending upon the signal source impedance, the plug-in input characteristics, and the frequency being measured.

Vertical Amplifier Delay Line Driver

The Vertical Amplifier Delay-Line Driver stage is a balanced distributed amplifier consisting of seven push-pull triode sections. Use of the distributed amplifier principle permits amplification of frequencies up to approximately 95 mc; dc coupling allows amplification of frequencies down to dc. All triode sections are neutralized to prevent spurious oscillations. Gain of the overall vertical amplifier is set by means of the Vert Gain Adj control, R1015.

Stabilization of the Delay-Line Driver Stage—Overall distributed amplifier stabilization involves many details normally disregarded in lower bandpass systems. The Type 581A vertical distributed amplifier has been stabilized by several special methods.

As the push-pull signals enter the grid lines of the Vertical Amplifier Delay-Line Driver stage they pass through a toroidal pulse transformer, T1014. T1014 serves to open the common-mode grid oscillation path to aid in the stabilization of the amplifier. (The "common-mode oscillatory path" applies to the characteristic of distributed amplifiers that they sometimes oscillate with all grids in phase, and all plates of the opposite phase.) Another toroid, T1046, which is located in the plate lines near V1044, also aids in stabilizing the amplifier to prevent common-mode oscillation.

Additional stabilization is provided by capacitive neutralization of each section, with the fourth section adjustable to allow for minor differences in tube and stray capacitances.

The signal velocity of propagation is identical in the grid and plate lines of the Vertical Amplifier Delay-Line Driver stage. Since the amplifier is paraphase, the cathodes must exhibit a similar velocity of propagation. This is provided for by placing small ferrite beads around one of the leads of each cathode coupling capacitor.

Finally, the shield between triode halves of each 6DJ8 has a 150-ohm resistor to ground to reduce the shield Q and increase the isolation between plates at high frequencies.

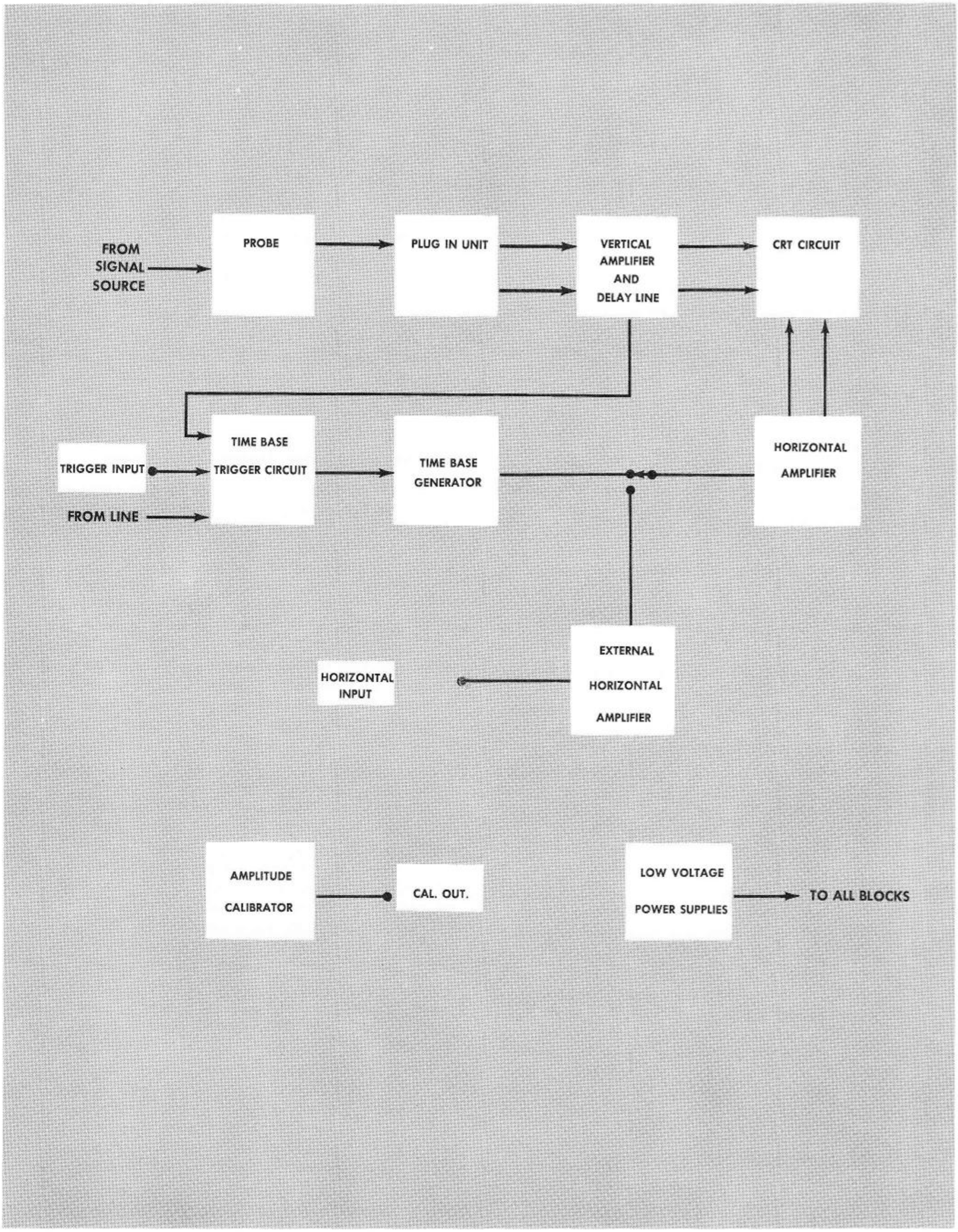

Fig. 4-1. Type 581A Oscilloscope functional block diagram.

Plate Line Termination—The Vertical Amplifier Delay-Line Driver stage plate line is a 186-ohm balanced line terminated at each end.

The fact that the reverse termination is adjustable and quite closely matches the line impedance, makes it unnecessary to make the termination at the other end of the plate line adjustable.

The Vertical Amplifier Delay Line Driver plate line sends its output signal through the fixed delay line, through the Vertical Amplifier Output Stage grid lines, and is terminated at the far end of the Vertical Amplifier Output Stage grid line. Current and Voltage supplied to the Vertical Amplifier Delay Line Driver stage is supplied at the far end of the Vertical Amplifier Output Stage grid line and is carried to the tubes V1014 through V1074 via the fixed delay line.

DC Shift Compensation—A common fault of most high current dc coupled amplifiers is temporary instability following a sudden current change called DC Shift. The DC Shift compensation network is located next to the plate load resistors at the input end of the Vertical Amplifier Delay-Line Driver stage. R1004, C1004 and R1005 make up the compensating time constant to effectively cancel the DC Shift effect.

Trigger Pickoff—At the output of the Vertical Amplifier Delay-Line Driver stage a push-pull tetrode amplifier receives signals for the triggering circuit. Tubes V1084 and V1094 amplify and invert the vertical signal and drive two cathode followers that drive the Time-Base Trigger circuit and the vertical Beam Position Indicator Amplifiers. The Trigger Pickoff circuit is a wide bandpass amplifier capable of sending frequencies to the Time-Base Trigger circuit that are above the vertical amplifier 3 db point.

Delay Line—The push-pull output of the Vertical Amplifier Delay-Line Driver stage is applied through a 186-ohm balanced delay line to the Vertical Amplifier Output Stage. The delay line delays application of the vertical signal to the deflection plates until the crt has been unblanked and the sweep started. This delay allows the leading edge of fast rising pulses to be displayed as much as 60 nanoseconds after the sweep is started.

Vertical Amplifier Output Stage

The Vertical Amplifier Output Stage is a distributed amplifier consisting of five dual-triode sections driven by the signal from the delay line. This stage is similar to the Vertical Amplifier Delay-Line Driver stage with all triodes neutralized to prevent oscillations. The major difference is that each stage has an adjustable compensating capacitor between opposing plates permitting the transient response to be adjusted. Toroidal pulse transformers (1) at the input to the grid line and (2) in the output leads to the grids of the output pentode amplifiers, open the common mode oscillatory circuits aiding stabilization. The output of the distributed amplifier is applied to a push-pull power output stage which supplies the necessary power to drive the vertical deflection plates of the cathode-ray tube.

Cathode-Ray Tube

Six pairs of distributed vertical deflection plates are used in the cathode-ray tube. This arrangement of distributed plates permits the necessary crt sensitivity while at the same time reducing objectionable effects of capacitance between the plates. The deflection plate lines are constructed so that the velocity of the deflection waveform through the line is essentially the same as the velocity of the electrons passing through the plates.

TIME-BASE TRIGGER CIRCUIT

General

Triggering signals from the LINE, TRIGGER INPUT connector, and Trigger Pickoff circuit of the vertical amplifier can be individually connected to the input of the Time-Base Trigger circuit. The triggering signal selected by the TRIGGERING SOURCE switch is then connected to the control grids of the Trigger Difference Amplifier stage V24 and V34.

The Trigger Difference Amplifier is supplied push-pull signals from the internal Trigger Pickoff circuit, but single ended signals from the LINE or TRIGGER INPUT connector sources.

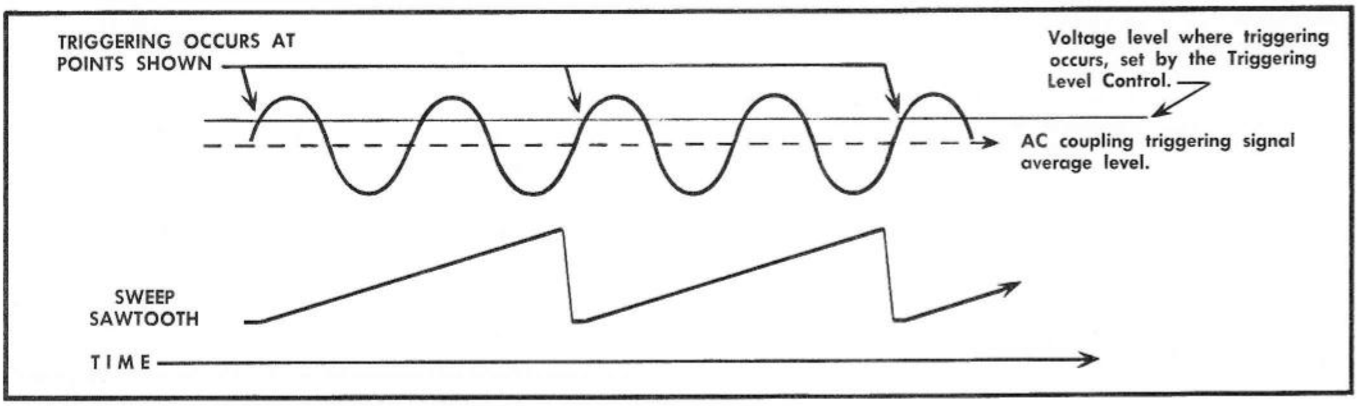

Fig. 4-2. Operation of the trigger circuit. As the triggering signal voltage exceeds the predetermined triggering level, a sweep is triggered.

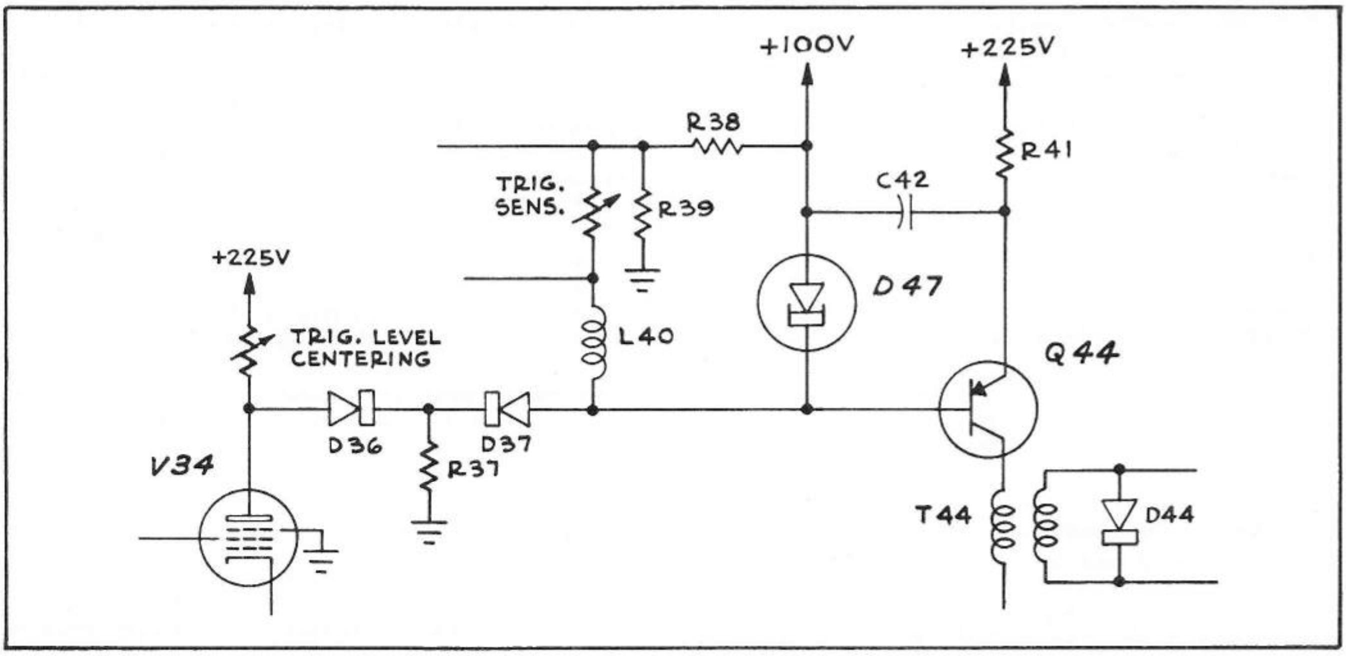

Fig. 4-3. Tunnel diode Trigger Regenerator diagram.

Trigger Difference Amplifier

The Trigger Difference Amplifier stage is used to control the operation of the tunnel diode Trigger Regenerator circuit. The TRIGGERING LEVEL Control establishes the operating point of the Trigger Difference Amplifier by determining the dc voltage applied to one of its grids. By controlling the operating point of the Trigger Difference Amplifier with the TRIGGERING LEVEL Control it is possible to determine at which voltage level of the triggering waveform triggering occurs. (See Figure 4-2).

The Trigger Difference Amplifier is essentially a voltage control for the diode gate, D36 and D37. As the plate of V34 goes negative, D36 is back biased shunting an additional 2 ma through D37 to switch the tunnel diode.

Trigger Regenerator

The Trigger Regenerator output is an almost rectangular waveform of approximately 0.5 volt peak-to-peak. It is dc coupled to the base of the Trigger Amplifier Q44 where it is inverted and amplified. The amplified signal from Q44 is coupled to the Sweep-Gating Multivibrator by the small toroidal pulse transformer T44. T44 inverts and differentiates the tunnel diode waveform such that negative triggering pulses of about 7 volts are applied to the Sweep-Gating Multivibrator. Diode D44 reduces the positive voltage excursion of T44 output voltage from 7 volts to about 4 volts, sufficient to prevent triggering jitter. Capacitor C44 assures a low impedance path to ground for the triggering pulse on the low side of T44 secondary.

Tunnel Diode Operation

The tunnel diode D47 dynamic characteristics are presented in Figure 4-4. You may also wish to refer to the Time-Base Trigger diagram during the following discussion.

The tunnel diode static operating point is represented by point A of Figure 4-4 and is established when the TRIGGERING LEVEL Control is at 0. (The grid voltages of V24 and V34 are both at ground potential).

If the plate current of V34 is increased by either the application of a signal to the Trigger Difference Amplifier, or by rotation of the TRIGGERING LEVEL control, the tunnel diode current can be increased to point B of Figure 4-4

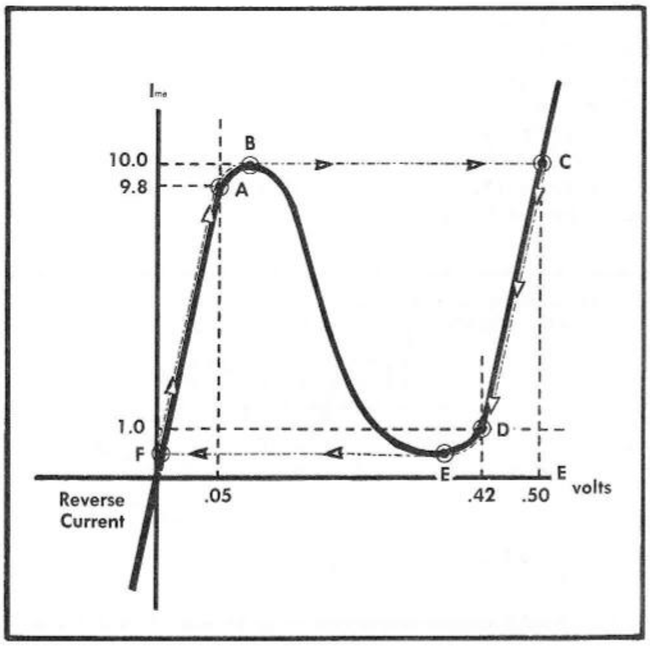

Fig. 4-4. Tunnel Diode, D47, characteristics.

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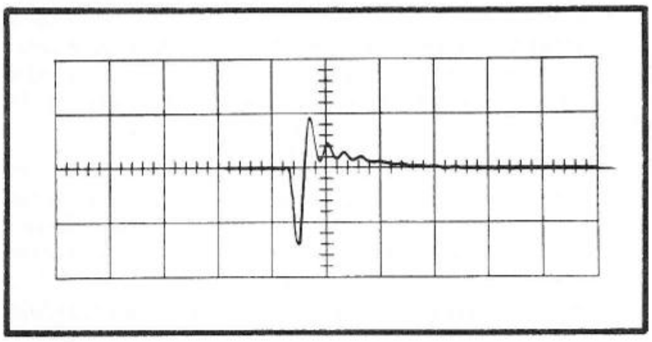

Fig. 4-5. Output pulse of T44. 5 volts per cm, .1 μsec per cm.

where it will switch at a very rapid rate to point C. It is the high impedance to high frequencies of L47 that permits the tunnel diode to switch to point C rather than to some lower current portion of the curve between points C and D. As current through L47 slowly changes, the current of the tunnel diode slowly drops to point D.

If the plate current of V34 is maintained the tunnel diode current will remain at point D. Either by the rotation of the TRIGGERING LEVEL Control or by a signal, the tunnel diode current can be reduced to point E where it will switch rapidly to point F. Again L47 has a voltage impressed across it such that its L/R time constant will soon permit the tunnel diode current to return to point A.

From the above description you can see that the tunnel diode has two possible stable states. It is the slow change in current of the shunt system around the tunnel diode that prevents the tunnel diode Trigger Regenerator system from triggering the Sweep-Gating Multivibrator circuit at too high a rate.

Trigger Amplifier Q44

The base of the transistor Trigger Amplifier Q44 is dc coupled from the cathode of D47 while the emitter is ac coupled from the anode of D47. Since the emitter of Q44 is returned to its positive supply voltage through a large degenerative resistor (long-tailed), the collector current will increase at the time D47 switches, but will return to its original value as soon as C48 charges. The collector current of Q44 will drop to its original value even if D47 remains at its D state indefinitely. As soon as D47 switches from E to A, the collector current of Q44 will decrease until C48 again changes its charge, and Q44 will then stay at its original static current value as long as D47 remains at point A.

TIME-BASE GENERATOR

General

The Time-Base Generator block diagram of Figure 4-6, and the Time-Base Generator diagram at the back of this manual should be used during the following discussion.

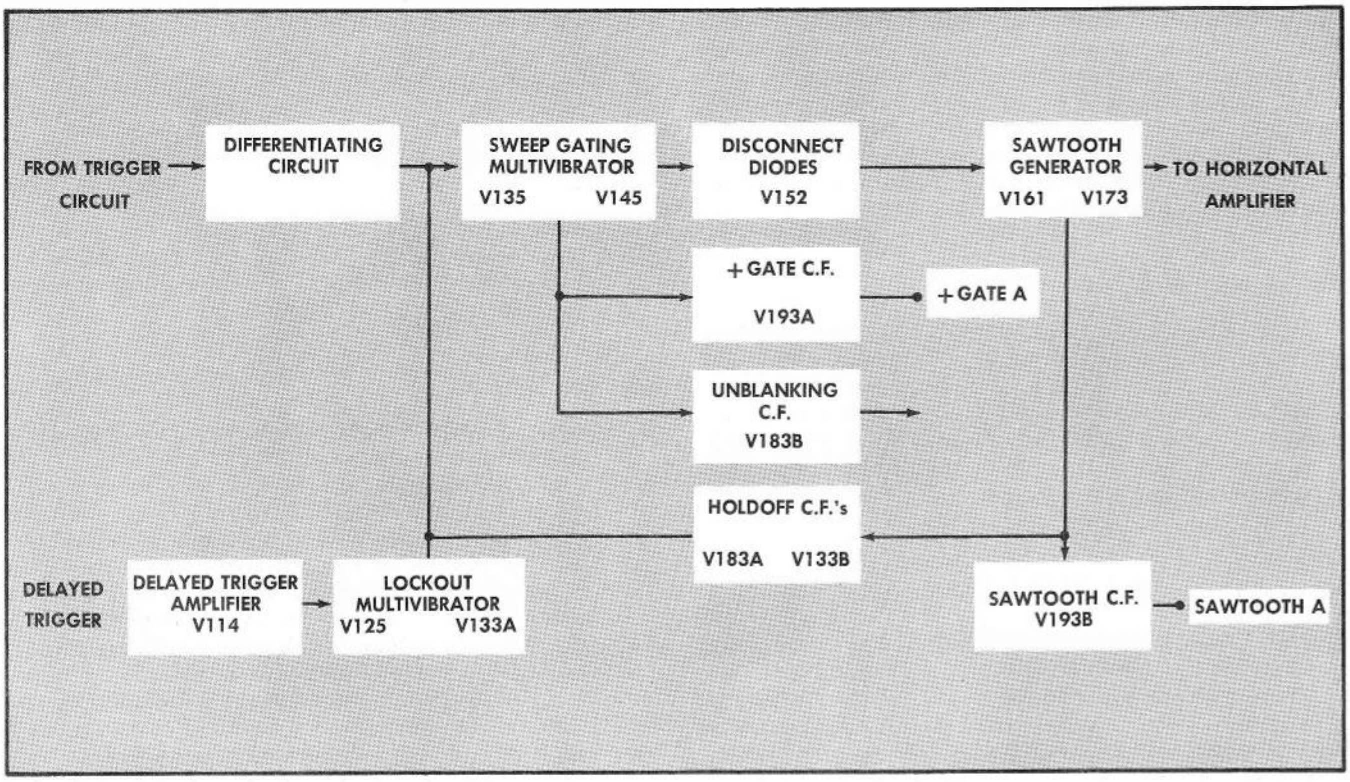

Fig. 4-6. Time-Base Generator block diagram.

The output pulses from the Trigger Regenerator system previously discussed are applied to the grid of V135A, of the Sweep-Gating Multivibrator. The Sweep-Gating Multivibrator is a Schmitt Gating circuit acting as an electronic switch for the Time-Base Generator circuit. When the negative triggering pulse is received, the Sweep-Gating Multivibrator switches, cutting off the Disconnect Diodes V152A and B and allowing the Miller-Runup generator circuit to operate. A positive going square-wave output of the Sweep-Gating Multivibrator is taken from the cathode of V135B and is connected through the Unblanking Cathode Follower V183B to the CRT to unblank the CRT. The unblanking signal is employed only in the INTERNAL SWEEP and SINGLE SWEEP positions of the HORIZONTAL DISPLAY switch. Another positive going square-wave output of the Sweep-Gating Multivibrator is connected through the + Gate Output Cathode Follower V193 to the +GATE OUT connector on the front panel.

The sawtooth voltage used by the Horizontal Amplifier to move the crt spot across the face of the crt screen is also available at the front panel at the SAWTOOTH OUT terminal. Cathode follower V193B isolates the internal sawtooth voltage circuit from external loading.

Sweep Gating Multivibrator

The Sweep-Gating Multivibrator operates as a bistable circuit. In the quiescent state V135A is conducting and its plate is down at about +35 volts. This cuts off V145 through cathode follower V135B and the divider R141-R143, by taking the grid of V145 about 12 volts below its cathode which rests at about —50 volts. With V145 cutoff, its plate is held at about —3 volts with respect to ground by conducttion of Disconnect Diodes V152A and B through R147 and R148. The greater amount of diode current flows through V152A with smaller amounts of current flowing through V152B. Conduction of the lower diode V152B through the Timing Resistor R160 then clamps the control grid of the Miller Runup Tube V161 at about —2.9 volts. Conduction through diode V152A places the Time-Base Generator output voltage at about —10 volts.

Miller Runup Circuit

The quiescent state of the Miller Runup circuit, including V161 and V173, is determined by a dc network between plate and grid of V161. This network consists of the neon glow tube B167, the Runup C.F. V173, the Disconnect Diodes V152A and B, and R151. The purpose of this network is to establish the voltage at the plate of V161 at a value such that it will operate in the linear region of its characteristic curve.

Sweep Generation

If the STABILITY and TRIGGERING LEVEL Controls are adjusted for triggered operation, a negative trigger pulse drives the grid of V135A below cutoff forcing the Sweep-Gating Multivibrator into its other state in which V145 is the conducting tube. Diode D134 and R133 hold the plate of V135A solidly at +100 volts preventing triggering pulses from being amplified. As V145 conducts, its plate drops to about —7.5 volts, cutting off the Disconnect Diodes V152A and B. Any spiking that may occur during this transition is attenuated by the network C150-R150. Since R151 is in series with the transition of the plate of V145 and diode V152A, C151 is used as a speed-up capacitance to assure V152A being cut off at the same time V152B is cut off.

With the Disconnect Diodes cut off, the grid of the Miller Runup tube V161 and the cathodes of the Runup C.F. V173 are free to seek their own voltages. Current through the Timing Resistor R160 then starts V161 control grid toward —150 volts. The plate voltage of V161 begins to rise by an amount equal to the drop in grid voltage times the gain of the stage, carrying with it the grid and cathodes of V173. This raises the voltage at the top of Timing Capacitor C160, which in turn pulls up on the grid of V161 and prevents it from dropping more than about a volt during about a 150 volt rise of the plate.

The Timing Capacitor charging current is then equal to the current through the Timing Resistor. Since the voltage at the grid of the Miller Runup tube remains essentially constant, the voltage drop across the Timing Resistor also remains essentially constant. This provides a constant source of current for charging the Timing Capacitor C160. By this action C160 charges linearly, and the voltage at the cathodes of V173 rises linearly. Any departure from a linear rise in voltage at the grid of the Miller Runup tube is in a direction to correct for the error.

Timing Switch

The linear rise in voltage at the cathode of V173 is used as the sweep time-base. Timing Capacitor C160 and Timing Resistor R160 are selected by the TIME/CM switch SW160. R160 determines the current that charges C160. By means of the TIME/CM switch both the size of the capacitor being charged and the charging current can be selected to cover a wide range of sawtooth slopes (sweep rates). For high sweep rates boot-strap capacitor C165 helps supply current to charge the stray capacitance at the plate of the Miller Runup tube. This permits the plate voltage to rise at the required rate.

If uncalibrated sweep rates are desired, the VARIABLE TIME/CM Control may be turned away from the CALIBRATED position. This control, R160Y, varies the sweep rate over approximately a $2\frac{1}{2}$ to one range.

Sweep Length

The rate at which the spot moves across the face of the CRT is determined by the timing circuit C160 and R160. The length of the sweep, the distance the spot moves across the face of the crt, however, is determined by the setting of the Sweep Length control R176. The sweep sawtooth voltage increases the voltage at the grid and cathode of V183A and at the grid and cathode of V133B. As the voltage at the cathode of V133B rises, the voltage at the grid of V135A will rise. When the voltage at this point is sufficient to bring V135A out of cutoff, the Sweep-Gating Multivibrator circuit will revert to its original state with V135A conducting and V145 cut off. The voltage at the plate of V145 rises, carrying with it the voltage at the diode plates of V152A and B. The diodes then conduct and provide a discharge path for C160 through R151, R147, and R148, and through the resistance of the cathode circuit of V173. The plate voltage of the Miller Runup tube now falls linearly under feedback conditions essentially the same as when it generated the sweep portion of the waveform except for a reversal of direction. The resistance through which C160 discharges is much less than that of the Timing Resistor through which it charged. The capacitor current for this period will therefore be much larger than during the sweep portion, and the plate of the Miller Runup tube will return rapidly to its quiescent voltage. This produces the retrace portion of the sweep sawtooth during which time the crt beam returns rapidly to its starting point.

Holdoff

The Holdoff circuit prevents the Time-Base Generator from being triggered during the retrace interval. That is, the Holdoff circuit allows a finite time for the Time-Base circuits to reach a steady-state condition after the completion of a sweep.

During the trace portion of the sweep sawtooth, the Holdoff Capacitor C180 charges through V183A, as a result of the rise in voltage at the cathode of V183A. At the same time the grid of V135A is being pulled up by V133B, until V135A comes out of cutoff and starts conducting. As mentioned previously, this is the action that initiates the retrace. At the start of the retrace interval C180 starts discharging through the Holdoff Resistor R181. The time constant of this circuit is long enough so that during the retrace interval (and for a period of time after the completion of the retrace) C180 holds the grid of V135A high enough so that it cannot be triggered. However, when C180 discharges to the point where V133B is cutoff, it loses control over the grid of V135A which returns to the level established by the STABILITY Control. The holdoff time required is determined by the size of the Timing Capacitor. For this reason the TIME/CM switch changes the time constant of the Holdoff circuit simultaneously with the change of Timing Capacitors. In the μSEC positions of the TIME/CM switch R181 is shunted by either R180A or R180B, shown on the Timing Switch diagram.

Stability Control

The operational mode of the Time-Base Generator is determined by the setting of the STABILITY Control R110. By means of this control the sweep can be turned off, free run, or adjusted for triggered operation. The STABILITY Control, through cathode follower V125, regulates the grid level of V135A.

For triggered operation, the STABILITY Control is adjusted so that the grid of V135A is just high enough to prevent the Sweep-Gating Multivibrator from free running. Adjusted in this manner a sweep can only be produced when an incoming negative trigger pulse drives the grid of V135A below cutoff.

Moving the arm of the STABILITY Control toward ground, but not so far as to actuate the PRESET switch, will raise the grid level of V135A to a level which will prevent the Sweep Gating Multivibrator from being triggered. This action turns off the sweep. Moving the arm toward —150 volts drops the grid of V135A to the point where the discharge of the Holdoff Capacitor C180 can switch the multivibrator. Adjusted in this manner, the Sweep-Gating Multivibrator will free-run and produce a recurrent sweep.

When the STABILITY Control is turned full counterclockwise to the PRESET position, R110 is switched out of the circuit and R111 is switched in. This control, a front-panel screwdriver adjustment labeled PRESET ADJUST, provides a fixed dc voltage for the grid of V135A. When properly adjusted, PRESET operation can be used for most triggering applications. Where triggering may be difficult the manual STABILITY Control R110 should be used.

Single Sweep Operation

When the HORIZONTAL DISPLAY switch is in the SINGLE SWEEP position, plate voltage is applied to V133A which then operates in conjunction with V125 as a bistable Lockout Multivibrator.

In the first stable state that exists after the completion of a sweep, V125 is cut off and V133A is conducting. In this state, the divider between the plate of V125 and the grid of V133A sets the common bus cathode of the Lockout Multivibrator and consequently the grid voltage of V135A. The Lockout Level Control R125 is adjusted to set the grid of V135A so that the Sweep-Gating Multivibrator cannot be triggered; this "locks out" the sweep.

The front panel push-button labeled RESET permits the Lockout Multivibrator to switch, unlocking the sweep generator for a single sweep. Depressing the RESET button applies a negative voltage pulse to the grid of V133A and places V125 in conduction. The STABILITY Control again has control of the grid of V135A, and should a negative trigger pulse come from the triggering circuitry, a sweep can occur. The RESET switch functions as follows: when open, C102 is charged to about +30 volts. The drop across R121 is essentially zero volts. As the RESET button is depressed, grounding the switch side of C102, the opposite side drops to about —25 volts, cutting off V133A and resetting the Lockout Multivibrator until a single sweep occurs.

Depending on the adjustment of the STABILITY Control, a sweep can now be produced in one of two ways. If the STABILITY Control is turned clockwise, the grid of V135A can be pulled down below about —70 volts causing the Sweep-Gating Multivibrator to switch to its other state and initiate a sweep. If the STABILITY Control is adjusted for triggered operation, the sweep will be initiated by the first negative trigger pulse to arrive at the grid of V135A via T44.

As the sweep begins, the rising sawtooth voltage pulls up the cathode of V133B by the holdoff action previously described. As the cathodes of the Lockout Multivibrator follow the cathode of V133B up, V125 cuts off and V133A conducts; immediately raising the common cathode bus potential from about —70 to about —63 volts. As the sawtooth voltage continues to rise, the cathode of V133B catches the cathode of V133A and carries the common cathode bus voltage up to about —50 volts causing V135A to conduct to revert the Sweep-Gating Multivibrator, and terminate the sweep. (See Figure 4-7).

As the Holdoff Capacitor C180 discharges, the cathodes of the Lockout Multivibrator start to fall. The grid level of V133A is such that this tube comes out of cutoff first,

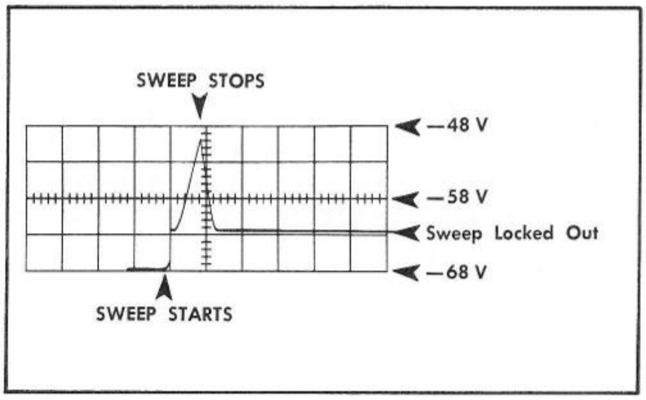

Fig. 4-7. Single sweep waveform showing voltage changes at grid of V135A.

holding the common cathode bus at the locked out voltage level of about —63 volts. As V133A conducts, its plate drops, extinguishing the READY light. A new sweep cannot be initiated until the RESET button is again depressed.

Alternate Trace Sync Pulse

Synchronizing pulses for alternate-trace plug-in preamplifiers are supplied via D142 and the differentiating network C154-R154. Both positive and negative sharply differentiated output pulses are applied from C154-R154 to the plug-in unit. Only the positive pulses are used by the plug-in unit alternate trace switching circuitry.

The quiescent voltage at the junction of D142 and C154 is approximately —3 volts. The quiescent voltage on the other side of D142 is about —3.1 volts. As the Sweep-Gating Multivibrator switches and V145 plate drops to about —7.5 volts, D142 conducts. The plug-in side of C154 then drops about —2 volts (less than the —4.5 volts possible due to additional circuit capacitance loading the output of C154). The charge on C154 rapidly stabilizes at —7.5 volts, and remains there until the Sweep-Gating Multivibrator terminates the sweep. At this time, the plate of V145 rises very rapidly momentarily cutting D142 off. Cutting off D142 disconnects the capacitance of the dual trace switching circuitry at the time that any loading capacitance would slow the action of Disconnect Diodes V152A and B. The positive pulse from C154-R154 switches the alternate-trace plug-in unit from one trace to the next trace. (See the instruction manual for the alternate-trace plug-in unit in use.)

HORIZONTAL AMPLIFIER

General

The input to the Horizontal Amplifier is selected from waveforms applied from the Time-Base Generator and the External Horizontal Amplifier.

The dc-coupled Horizontal Amplifier consists of the Input CF stage followed by the Driver CF stage that drives the paraphase Output Amplifier. The Output Amplifier then drives separate Output CF's that drive the crt horizontal deflection plates. The HF Capacitance Driver tube in the cathode circuit of the left-hand deflection plate Output CF pulls the cathode of the Output CF rapidly down during a sweep. The gain of the Output Amplifier is controlled by negative feedback applied from the left Output CF to a frequency compensated network between the Input CF and the Driver CF. The negative feedback is modified for 5X sweep magnification.

Input Circuit

The positive-going sawtooth voltage produced by the Time-Base Generator circuit is coupled through a frequency-compensated voltage divider to the grid of the Input CF V343A. The input divider has 1.5 to 1 attenuator ratio. The small time-constant network C340-R340 improves the start of the waveform at the fastest sweep rates. The two positioning controls, HORIZONTAL POSITION R333 and HORIZONTAL POSITION VERNIER R338, affect the beam position by altering the dc level at the grid of V343A. The HORIZONTAL POSITION VERNIER Control can move the spot about 2 centimeters while the HORIZONTAL POSITION Control can move the spot from about the center of the crt screen to well off the left edge. These limits apply when the HORIZONTAL DISPLAY switch is in the INTERNAL SWEEP position. Because of their low resistance, an adjustment of the positioning controls does not alter the attenuation of the divider network.

Driver Cathode Follower

Signals from the cathode of V343A pass either through the input portion of the feedback circuit or straight into the grid of the Driver CF V343B. The Driver CF eliminates possible loading of the feedback network by the grid of V364A during high positive sawtooth voltages. The low output impedance of the Driver CF drives the grid of V364A assuring no distortion of the linear sawtooth sweep voltage.

With the 5X MAGNIFIER switch SW 340B in the OFF position, the grid of the Driver CF V343B receives the positive going sawtooth voltage from the center of feedback divider network R348, R349, R355 and R356. The amplitude of the sawtooth voltage as it leaves the cathode of V343A is reduced by a factor of five by the negative going sawtooth voltage applied at the top of R355. With the 5X MAGNIFIER switch SW347B in the ON position, or with the HORIZONTAL DISPLAY switch in either EXT HORIZ. ATTEN position, R348 and R349 are switched out of the circuit, and the total sawtooth voltage from the cathode of V343A is applied to the grid of the Driver CF. Part of the feedback circuit remains connected between the left deflection plate Output CF and the Driver CF, but essentially no feedback action occurs due to the low impedance of the Input CF cathode.

The NORM MAG REGIS Control, R358, is used to eliminate any voltage drop across R348 and R349 when the crt beam is at the center of the screen. It has no appreciable effect with the 5X MAGNIFIER ON. Thus when the two centimeters of display at the center of the screen are to be

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magnified, the display will be expanded symmetrically about the center of the crt when the 5X MAGNIFIER switch is turned ON.

A MAGNIFIER neon lamp is located on the front panel immediately below the HORIZONTAL DISPLAY switch to indicate when the 5X MAGNIFIER is ON.

Output Stage

The Output Amplifier stage V364A-V384A is a paraphase amplifier with output from both plates. Cathode followers V364B-V384B provide high-impedance, low capacitance loads which help to maintain the gain of the stage constant over the sweep range of the instrument. The Output CF's also provide the necessary low-impedance output to drive the capacitance of the horizontal deflection plates. Bootstrap capacitors C364 and C384 improve the response at the fastest sweep rates by supplying additional current from the Output CF stage to charge and discharge the stray capacitance in the plate circuit of the Output Amplifier.

Capacitance Driver

At the fastest sweep rates the current through the left-hand deflection plate Output CF is too small to discharge the stray capacitance in the cathode circuit at the required rate. Additional current to discharge the stray capacitance is provided by V398 connected in the cathode circuit of V364B. This permits the cathode of V364B to run down at the required rate.

Because the plate current of a pentode is fairly constant over a large range of plate voltage, the current through V398 will remain nearly constant even though its plate falls about 150 volts due to the negative sweep sawtooth waveform.

The additional current required for fastest sweep rates is obtained by applying a positive flat-topped pulse to the grid of V398 during the period of the sweep. The pulse is derived by differentiating the positive-going sawtooth from the cathode of V384B with C390 and R390. The pulse amplitude is proportional to the slope of the sawtooth, and thus proportional to the sweep rate.

External Horizontal Amplifier

The External Horizontal Amplifier is a cathode coupled circuit providing the necessary gain to drive the Horizontal Amplifier from external signals. An input attenuator and EXTERNAL HORIZ. ATTENUATOR 10-1 Control provide horizontal deflection factors between approximately 0.2 and 15 volts per centimeter.

A front-panel binding post labeled HORIZ. INPUT couples externally-derived signals to the External Horizontal Amplifier circuit when the HORIZONTAL DISPLAY switch is in either of the EXT HORIZ ATTEN positions. V314B amplifies the external signals before applying them to the input attenuator of the Horizontal Amplifier. The position of the HORIZONTAL DISPLAY switch determines whether the signal is directly coupled to the grid circuit of V314A, or whether a 10:1 frequency-compensated attenuator is connected in the signal path.

The External Horizontal Amplifier V314 is a cathode-coupled amplifier. V314A is a cathode-follower and V314B is a grounded-grid amplifier stage. The EXTERNAL HORIZ ATTENUATOR 10-1 Control provides a means for adjusting the gain over a 10 to 1 range. The Ext Horiz DC Bal Control R317 adjusts the dc level of V314B grid so that its cathode is at the same voltage as the cathode of V314A under no signal conditions. With the cathodes at the same voltage there is no current through the variable attenuator control R314. By this arrangement as adjustment of the EXTERNAL HORIZ ATTENUATOR 10-1 gain control does not change the dc level at the plate of V314B and therefore does not affect the positioning of the beam.

LOW-VOLTAGE POWER SUPPLY

General

The low-voltage power supplies produce all operating voltages for the oscilloscope with the exception of the crt circuit. These power supplies produce regulated voltages of —150, +100, +225, +350, and +500 volts and two unregulated outputs of +180 and +325 volts. In addition a separate transistorized power supply provides regulated +12.6 volts for use by the plug-ins and Vertical Amplifier heaters.

Each of the power supplies operates in a similar manner. A sensing circuit compares a sample of the output voltage against a fixed reference voltage. Any error in the output voltage produces an error signal which is amplified and applied to the series regulator tube(s), causing the series regulators to compensate for the error and return the voltage to normal.

Reference voltage for the —150-volt supply is obtained from a gas filled voltage regulator tube. Reference voltages for the other regulated power supplies, except the +12.6 volt supply, are obtained from the output of the —150-volt supply. Consequently, operation of the regulated power supplies is dependent on operation of the —150-volt supply. The output voltages of all the regulated power supplies are adjusted by adjusting the output of the —150-volt supply.

Power Transformer

Plate and filament power for the tubes in the Type 581A is furnished by a single power transformer, T601. The primary has two equal windings which may be connected in parallel for 117-volt operation, or in series for 234-volt operation. The primary of T601 also has two more windings which may be used as voltage bucking or aiding windings. These windings along with the two main primary windings may be used to allow the instrument to run on line voltages of 110, 117, 124, 220, 234 and 248, depending upon how all the windings are connected.

—150 Volt Supply

Reference voltage for the —150 volt supply is furnished by a gas diode voltage-reference tube V609. This tube, which has a constant voltage drop, establishes a fixed potential of about —87 volts at the grid of V624A, one-half of a difference amplifier. The grid voltage for the other half of the difference amplifier, V624B, is obtained from a divider consisting of R615, R616, and R617. The —150 Adj. control R616 determines the percentage of total output voltage that appears at the grid of V624B and thus determines the total voltage across the divider. This control is adjusted so that the output voltage is —150 volts.

If line-voltage or load fluctuations tend to change the output voltage, an error signal is produced between the two grids of the difference amplifier. The error signal is amplified in V624B and V634 and applied to the grids of the series tubes V627, V637 and V647. The resulting change in voltage at the plates of the series tubes corrects the —150 volt output back to its original value. Capacitors C617 and C628 improve the ac gain of the feedback loop to increase the rate of response of the regulator circuit to sudden changes in output voltage and to reduce ripple.

A small amount of unregulated bus ripple is coupled to the screen of V634 through R637. The phase of the amplified ripple voltage at the plate of V634 is such as to cancel most of the ripple on the —150 volt output.

+100 Volt Supply

Reference for the +100 volt supply is a voltage located at a point near ground potential obtained from the divider R650-R651. V664 essentially compares the reference voltage to ground. Any voltage change at the +100 volt output is amplified and inverted in polarity by V664 and applied to the grid of series regulator V677A correcting the output voltage. Capacitor C650 improves the ac gain of this circuit and helps to eliminate ripple.

A small sample of the unregulated bus ripple appears at the screen of V664 through R667. This produces a ripple component at the grid of series regulator V677A that is opposite in polarity to the ripple at the plate. This tends to cancel the ripple at the cathode and hence on the +100 volt output. This same circuit also improves the regulation in the presence of line- voltage variations.

+225 Volt Supply

The +225-volt supply source is the secondary windings between terminals 5 and 10 and terminals 7 and 14 of T601, part of a two-voltage supply. Diodes D702 A and B serve as full-wave rectifiers for the +225 volt supply, with their center lead connected to the +180 volt unregulated supply. Voltage from the full-wave rectifier system is added to the +180 volt unregulated lead to provide sufficient voltage for the +325 volt unregulated lead and +225 volt regulated supply.

Reference for the +225 volt supply is a voltage located at a point near ground obtained from the divider R680-R681. V684A essentially compares the reference voltage to ground. Any voltage changes at the +225 volt output produces an error voltage between the grids of the difference amplifier V684. The error signal is amplified in both V684 and V694, and coupled to the grids of series regulators V677B and V737A. The voltage change at the cathode of V677B and V737A, due to the regulator action, is opposite in polarity to the original error signal keeping the output voltage constant. The unregulated output of about +325 volts is used by the oscillator of the CRT circuit. It is unnecessary to regulate this voltage as the CRT supply has its own regulator circuit.

+350 Volt Supply

The +350 volt supply source is at the common connection between Diodes D732 A and B. These diodes are part of a fullwave bridge rectifier system.

The negative lead of the +350 volt rectifiers is connected to the +180 volt unregulated bus of the +100-volt power supply. Thus both the +225 volt and +350 volt regulated supplies are elevated on the +180 volt unregulated bus.

Reference for the +350 volt supply is a voltage located at a point near ground obtained from the divider R710-R711. V724 essentially compares the reference voltage to ground. The operation of the regulated circuit is the same as that dscribed for the +100 volt supply.

+500 Volt Supply

Rectified voltage from terminals 20 and 21 of T601 is added to the regulated side of the +350 volt supply to furnish power for the +500 volt regulator. Reference for the 500 volt supply is a voltage located at a point near +350 volts obtained from the divider R740-R741. V754 essentially compares this voltage to the +350 volt supply. The regulator action of this circuit is the same as that described for the +100 volt supply.

+12.6 Volt Supply

A transistorized +12.6 volt dc regulator supplies voltage for use within plug-in units and for Vertical Amplifier heaters of the Type 581A Oscilloscope.

Rectified voltage from terminals 33 and 34 of T601 is used both by the Time-Delay Relay K600 with K601, and by the +12.6 Volt Regulator.

Reference voltage for the +12.6 volt supply is at the center point of five resistors in series-parallel between the +100 volt supply and ground, R781A, and B, R782, R783, and R785 (+12.6v Adj). The reference voltage is applied directly to the base of amplifier Q774 where it is essentially compared to the +12.6 volt bus. Emitter follower Q793 provides current gain to correction signals amplified by Q774, controlling the collector-to-emitter resistance of Q797 to maintain the proper voltage of the +12.6 volt supply.

In order for the +12.6 volt supply to warm up tube heaters before the Time-Delay Relay closes, a special turn-on voltage is applied to the base of Q774 via R780 from the +180 volt unregulated supply.

To protect the power transistors in the event Q774 is removed from its socket, diode D793 will clamp the base of Q793 to the +20 volt unregulated supply. Otherwise the base of Q793 would rise toward the +100 volt unregulated bus and damage both itself and Q797.

Time Delay

A Time-Delay relay K600, in conjunction with relay K601, delays the application of power supply voltages to the oscilloscope tubes for about 15 to 45 seconds. This delay allows the tubes to warm up before operating potentials are applied.

CRT CIRCUIT

Cathode-Ray Tube Controls

The INTENSITY Control R826 varies the voltage at the grid of the crt to control the beam current. The FOCUS Control R856 varies the voltage at the focusing anode to focus the trace. The ASTIGMATISM Control R863 varies the voltage at the astigmatism anode to adjust principally the spot vertical dimension. The Geom Adj R861 varies the field the beam encounters as it passes from the vertical plates to the horizontal plates to control the linearity at the extremes of deflection. The Vert Shield Volts Control R860 permits minor changes of crt deflection sensitivities and linearity.

High-Voltage Supply

A 60-kc modified Hartley oscillator furnishes power for the three power supplies that provide accelerating potentials for the crt. The main components in the oscillator circuits are V800 and the primary of T801 tuned by C808.

A half-wave rectifier V862 provides —1350 volts for the crt cathode. V862 supply is the reference supply, and is the only one of the three that is firmly regulated. A half-wave voltage tripler circuit, V832, V842 and V852, provides +8650 volts for the post deflection accelerator anode. The two supplies provide a total accelerating voltage of 10,000 volts. Both supplies are referenced to the +100 volt regulated supply through the decoupling filter R801-C801.

A floating half-wave rectifier V822 furnishes bias voltage of —1450 volts for the crt grid. This floating grid supply, independent of the cathode supply, allows dc-coupled unblanking to the crt grid. All three supplies employ capacitor-input filters.

Reference for the —1350 volt cathode supply is a voltage near —150 volts obtained from a tap on the divider network R840 through R844. The resistance ratio of the divider is determined by the setting of R840 labeled HV Adj. The reference voltage is essentially compared to —150 volts by V814B. When R840 is properly adjusted, the voltage at the HV Test Point will be —1350 volts.

If variations in load change the voltage on the —1350 volt bus, an error signal will exist between the grid and cathode of V814B. The error signal will be amplified by V814B and V814A; the plate of V814A varies the screen voltage of the oscillator tube V800, thereby controlling its output.

The +8650 volt supply and the negative bias supply are regulated indirectly, as the output voltage of all three supplies is proportional to the output of the oscillator circuit.

Unblanking

As mentioned previously, dc-coupled unblanking is accomplished by employing separate power supplies for the grid and cathode of the crt. Unblanking pulses from the Time-Base Generator control the crt grid through cathode follower 183B and the floating grid supply.

At the fastest sweep rates the stray capacitance of the floating crt grid supply makes it difficult for the crt grid to rise fast enough to unblank the crt in the required time. An isolation network composed of R827, R828, R829, C827, C828 and C829 isolates that capacitive loading. By this arrangement the fast leading edge of the unblanking pulse is coupled through C827, C828, C829 and R829 to the grid of the crt. For short duration unblanking pulses, at the fastest sweep rates, the power supply itself is not appreciably affected.

Longer unblanking pulses at slow sweep rates, charge the stray capacitance in the circuit through R827. This pulls up the floating supply and holds the crt grid at the unblanked potential for the duration of the unblanking pulse.

AMPLITUDE CALIBRATOR

The AMPLITUDE CALIBRATOR is a square-wave generator producing an output at approximately 1 kc which is available at the front panel CAL OUT connector. Multivibrator, V875 and V885A, is connected to switch the cathode follower, V885B, between cutoff and conduction.

During the negative portion of the multivibrator output waveform the grid of V885B is driven well below cutoff and its cathode rests at ground potential. During the positive portion of the waveform V875 is cut off and its plate rests slightly below +100 volts. The voltage at the plate of V875 and grid of V885B, when V875 is cut off, is determined by the setting of the Cal Adj Control R879.

Cathode-follower V885B has a precision, tapped divider for its cathode resistor. When the Cal Adj Control is properly adjusted, the cathode of V885B is at + 100 volts when V875 is cut off. By means of the tapped divider R885 through R893 and a second 1000 to 1 divider R896-R897, output voltage steps are available from 0.2 millivolts to 100 volts. C885, connected between the cathode of V885B and ground, corrects the output waveforms for a slight overshoot.

The purpose of R899 is to cancel any ground current effects on calibrator voltage accuracy that may exist when the Type 581A AMPLITUDE CALIBRATOR is employed as a signal source between the oscilloscope and some other instrument chassis.

SECTION 5
MAINTENANCE

PREVENTIVE MAINTENANCE

Air Filter

Care must be taken to assure free ventilation for the Type 581A in order to prevent instrument overheating. To assure free passage of air, the instrument must be placed so the air intake is not blocked, and the filter must be kept clean. Moreover, the side panels and bottom cover must be in place for proper air circulation; do not remove the covers except during maintenance.

A washable filter is used at the air intake port of the instrument. Under normal operating conditions the filter should be inspected and cleaned if necessary every three to four months. More frequent inspection is required when the operating conditions are more severe.

The following cleaning procedure is suggested:

1. Flush loose dirt out of filter with a stream of hot water.

2. Prepare a hot water and mild soap or detergent solution. Wash the filter as you would wash a sponge so that the adhesive and dirt is loosened and floated off.

3. Rinse the filter and let it dry.

4. Dip or spray filter with fresh Filter Coat or Handi Coater. These products are available from the local representative of the Research Products Corporation and from most air conditioner suppliers.

Fan Motor

The fan motor bearings should be lubricated every three or four months with a few drops of light machine oil. Failure to lubricate the bearings periodically will cause the fan to slow down or stop, thereby causing the instrument to overheat.

Visual Inspection

You should visually inspect the entire oscilloscope every few months for possible circuit defects. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, or broken terminal strips. For most visual troubles the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent, defects in the circuit. It is essential that you determine the cause of overheating before replacing heat-damaged parts in order to prevent further damage.

Soldering and Ceramic Strips

Many of the components in your Tektronix instruments are mounted on ceramic terminal strips. The notches in these strips are lined with a silver alloy. Repeated use of excessive heat, or use of ordinary tin-lead solder will break down the silver-to-ceramic bond. One application of tin-lead solder will not break the bond if excessive heat is not applied.

If you are responsible for the maintenance of a large number of Tektronix instruments, or if you contemplate frequent parts changes, we recommend that you keep on hand a stock of solder containing about 3% silver. This type of solder is used frequently in printed circuitry and should be readily available from radio-supply houses. If you prefer, you can order the solder directly from Tektronix in one pound rolls. Order by Tektronix part number 251-514.

Because of the shape of the terminals on the ceramic strips it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. Fig. 5-1 will show you the correct shape for the tip of the soldering iron. Be sure to file smooth all surfaces of the iron tip to be tinned. This prevents solder from building up on rough spots where it will quickly oxidize.

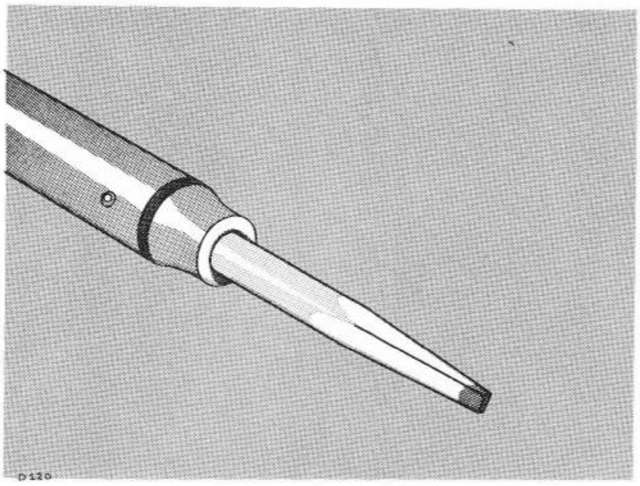


Fig. 5-1. Soldering iron tip properly shaped and tinned.

When removing or replacing components mounted on the ceramic strips you will find that satisfactory results are obtained if you proceed in the manner outlined below.

1. Use a soldering iron of about 75-watt rating.

2. Prepare the tip of the iron as shown in Fig. 5-1.

3. Tin only the first $1/16$ to $1/8$ inch of the tip. For soldering to ceramic terminal strips tin the iron with solder containing about 3% silver.

4. Apply one corner of the tip to the notch where you wish to solder (see Fig. 5-2).

5. Apply only enough heat to make the solder flow freely.

6. Do not attempt to fill the notch on the strip with solder;

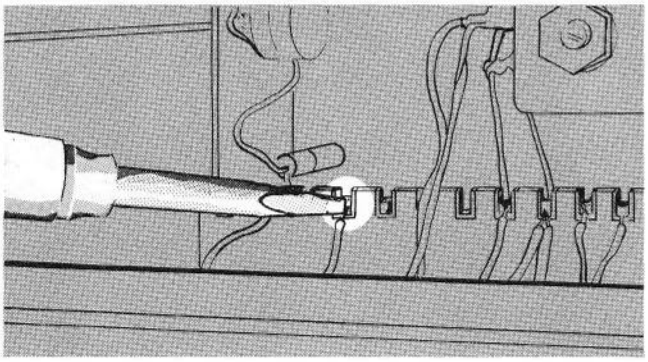


Fig. 5-2. Correct method of applying heat in soldering to a ceramic strip.

instead, apply only enough solder to cover the wires adequately, and to form a slight fillet on the wire as shown in Fig. 5-3.

In soldering to metal terminals (for example, pins on a tube socket) apply the iron to the part to be soldered as shown in Fig. 5-4. Use only enough heat to allow the solder to flow freely along the wire so that a slight fillet will be formed.

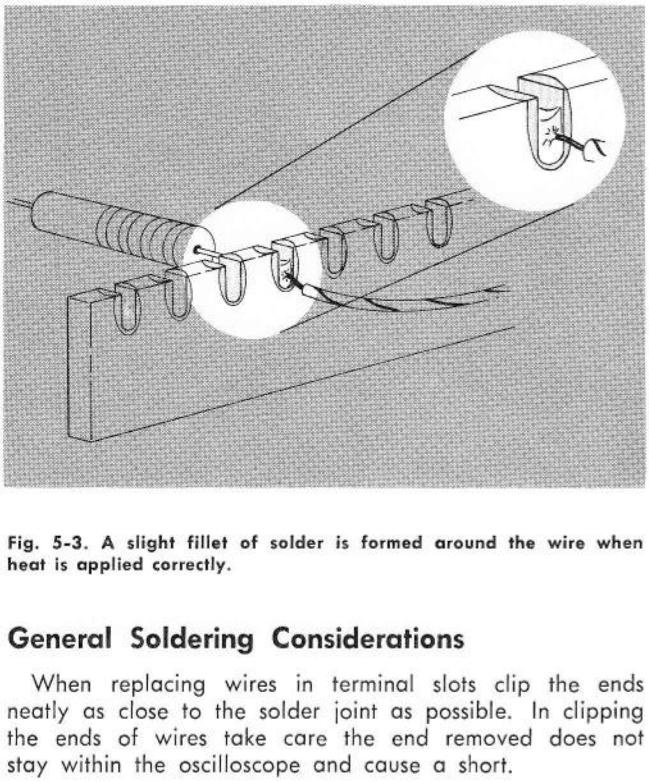


Fig. 5-3. A slight fillet of solder is formed around the wire when heat is applied correctly.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping the ends of wires take care the end removed does not stay within the oscilloscope and cause a short.

Occasionally you will wish to hold a bare wire in place as it is being soldered. A handy device for this purpose is a short length of wooden dowel, with one end shaped as shown in Fig. 5-5. In soldering to terminal pins mounted in plastic rods or coil forms it is necessary to use some form of "heat sink" to avoid melting the plastic. A pair of long-nosed pliers (see Fig. 5-6) make a convenient tool for this purpose.

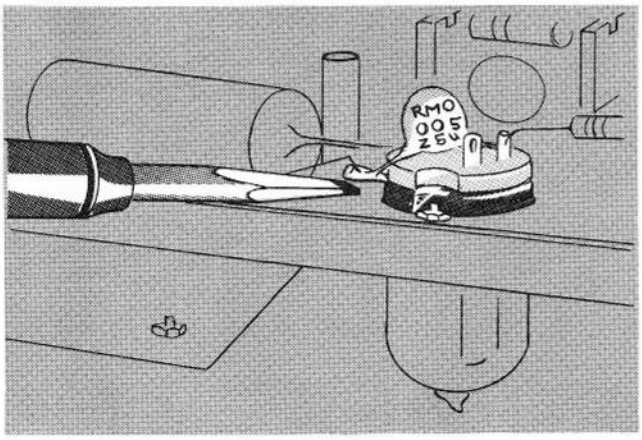


Fig. 5-4. Soldering to a terminal. Note the slight fillet of solder —exaggerated for clarity—formed around the wire.

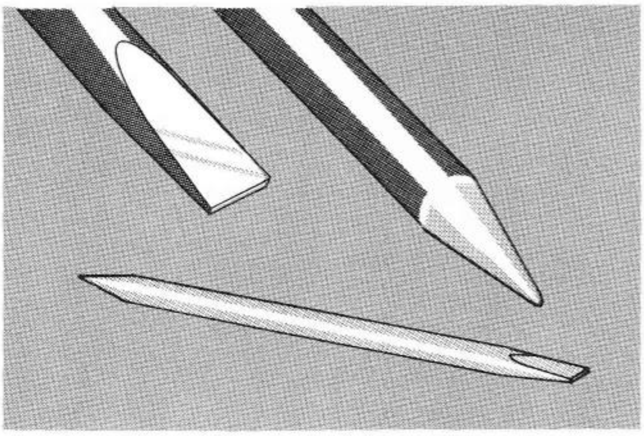


Fig. 5-5. A soldering aid constructed from a 1/4 inch wooden dowel.

Ceramic Strips

Damaged ceramic strips are most easily removed by unsoldering all connections, then using a plastic or hard-rubber mallet to knock the plastic yokes out of the chassis. This can be done by using the mallet to hit the ends of the yokes protruding through the chassis. The strip with the two yokes can then be removed as a unit. The spacers will probably come out with the yokes; if not, they can be removed separately.

Another way of removing the terminal strip is to cut off the side of the yoke with diagonal cutters. This permits the strip to be removed from a difficult area where a mallet cannot be used. The remainder of the yokes and the spacers can be pulled out separately. Since a replacement strip is supplied with yokes already attached, the old yokes need not be salvaged. However, the old spacers can probably be used again.

When the damaged strip and yoke assembly have been removed , place the spacers into the holes in the chassis. Then set the ends of the yoke pins into the spacers. Then press or tap lightly directly above the yokes to drive the yoke pins down through the spacers. Be certain that the yoke pins are driven completely through the spacers. Cut off the portion

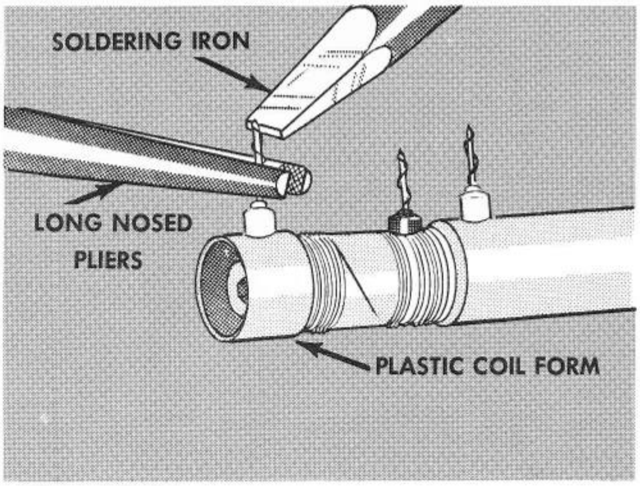


Fig. 5-6. Soldering to a terminal mounted in plastic. Note the use of the long-nosed pliers between the iron and the coil form to absorb the heat.

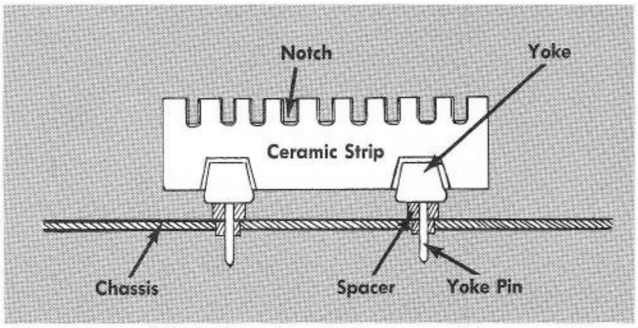


Fig. 5-7. Ceramic strip assembly.

of the yoke pin protruding through the spacers. Fig. 5-7 shows how the ceramic strip parts fit together.

REMOVAL AND REPLACEMENT OF PARTS

General Information

Instructions for the removal of certain parts are contained in the following paragraphs. Because of the nature of the Type 581A replacement of certain parts will require that you recalibrate portions of the oscilloscope in order to insure the proper operation of the instrument. Refer to the Calibration section of this manual when replacing adjustable parts.

Removal of Panels

The panels of the Type 581A Oscilloscope are held in place by small screwhead fasteners. To remove the side panels, use a screwdriver or coin to rotate the fasteners two or three turns counterclockwise; then pull the upper portion of the panels outward from the carrying handles. To remove the bottom panel, lay the instrument on its side, rotate the fasteners two or three turns counterclockwise, and pull off the panel. Panels are replaced by reversing the order of their removal.

Replacement of the Cathode-Ray Tube

CAUTION

When replacing a cathode-ray tube, wear both a plastic face guard and leather gloves. These items will protect the operator in case of an explosion and flying glass.

To remove the cathode-ray tube, first remove the side panels from the instrument. Disconnect the socket from the base of the crt, the lead clips from the deflection plate pins at the neck of the crt and the crt anode connector. Be careful not to bend the neck pins. (Do not disconnect the beam-rotation coil leads at the top of the crt shield.) Remove the graticule cover, the scratch shield (or light filter), the eyebrow and the hold-down spring. Loosen the clamp at the neck of the crt and carefully push the tube forward until it can be removed from the front of the instrument.*

Insert the new crt with the high-voltage anode contact pointing so it will touch the anode contact inside the crt shield. Temporarily replace the scratch shield and graticule cover, then screw down the knurled retaining nuts. Position the crt so the graticule lines are parallel to the sides of the oscilloscope and crt faceplate is touching the scratch shield. Tighten the neck clamp.

After the crt is securely in place, connect the base socket, neck clips and crt anode connector. The color-code information on the crt shield indicates the order in which the neck-pin leads are to be connected. Remove the graticule cover and scratch shield, install the eyebrow and its hold-down spring, then replace the scratch shield and graticule cover.

After replacement of the crt, it will be necessary to calibrate the crt circuit and check the calibration of the rest of the instrument. Adjust the TRACE ROTATION Control before beginning the calibration procedure.

Replacement of Switches

Methods for removal of defective switches are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the Type 581A. If one wafer is defective the entire switch should be replaced. Switches can be ordered from Tektronix either wired or unwired as desired.

Tube Replacements

Care should be taken both in preventive and corrective maintenance that tubes are not replaced unless they are actually causing a trouble. Many times during routine maintenance it will be necessary for you to remove tubes from their sockets. It is important that these tubes be returned to the same socket unless they are actually defective. Unnecessary replacement or switching of tubes will many times necessitate recalibration of the instrument. If tubes do require replacement, it is recommended that they be replaced by previously checked high quality tubes. The best way to check tubes is by placing them in the circuit and checking for proper operation.

*For an instrument with an external graticule crt (instrument S/N's 3975-4999), the procedure is essentially the same as that described, except for the reference to the eyebrow, etc. When installing a new crt of this type, position it so the brush contact inside the crt shield touches the crt anode contact, and the face of the crt is touching the external graticule.

REPLACEMENT PARTS

Standard Parts

Replacements for all parts used in the Type 581A Oscilloscope can be purchased directly from your area Tektronix Field Engineer or Field Office. However, since many of the components are standard electronic parts, they can generally be obtained locally in less time than is required to obtain them from the factory. Before ordering or purchasing parts, be sure to consult the parts list to determine the tolerances and ratings required.

Special Parts

In addition to the standard electronic components mentioned in the previous paragraph, special parts are also used in the assembly of the Type 581A Oscilloscope. These parts and most mechanical parts should be ordered directly from Tektronix. They are normally difficult or impossible to obtain from other saources. All parts may be obtained from other sources. All parts may be obtained through your area Tektronix Field Engineer or Field Office.

TROUBLESHOOTING

Troubleshooting Procedure

This section of the manual contains information for troubleshooting the Type 581A Oscilloscope. Before attempting to troubleshoot the instrument, however, make sure that any apparent trouble is actually due to a malfunction within the instrument and not to improper control settings or to a faulty plug-in unit or probe. Instructions for the operation of the Type 581A and general information concerning plug-in operation, are contained in the Operating Instructions section of this manual. Operating instructions for a specific plug-in unit or probe will be found in the manual for that unit.

When vertical system troubles exist, to determine that the oscilloscope is at fault, the plug-in unit may be replaced with another known to be in good operating condition. If the trouble is still apparent, it is almost a certainty that the oscilloscope is at fault. However, should the trouble appear to have been corrected by replacing the plug-in unit, the trouble most likely lies within the original plug-in unit and not the oscilloscope.

Tube failure is the most prevalent cause of circuit failure. For this reason, the first step in troubleshooting any circuit in the instrument is to check for defective tubes, first by looking for dark heaters, and then replacement by direct substitution. Do not depend on tube testers to indicate the suitability of a tube for certain positions within the instrument. The criterion for useability of a tube is whether or not it works satisfactorily. Be sure to return all good tubes to their original sockets; if this procedure is followed, less recalibration of the instrument will be required upon completion of the servicing.

When replacing any tube in the instrument, check first to see that components through which the tube draws current have not been damaged. Shorted tubes will sometimes overload and damage components. These can generally be located by visual inspection. If no damaged components are apparent, and if tube replacement does not restore operation, it will be necessary to make measurements or other checks within the circuit to locate the trouble.

The component number of each electrical part is shown on the circuit diagrams. The following chart lists the component numbers associated with each circuit.

All numbers less than 100	Time-Base Trigger
All 100 numbers	Time-Base Generator and Timing Switch
All 300 numbers	Horizontal Amplifier and External Horizontal Amplifer
All 600 and 700 numbers	Low-Voltage Power Supply and Regulated Heater Supply
All 800 numbers	CRT Circuit and Calibrator
All 1100 numbers	Power supply decoupling networks for vertical amplifier and plug-ins
All 1200 numbers	Vertical Amplifier Output Stage

Switch wafers shown on the schematic diagrams are coded to indicate the position of the wafer on the actual switches. The number portion of the code refers to the wafer number on the switch assembly. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

CIRCUIT TROUBLESHOOTING

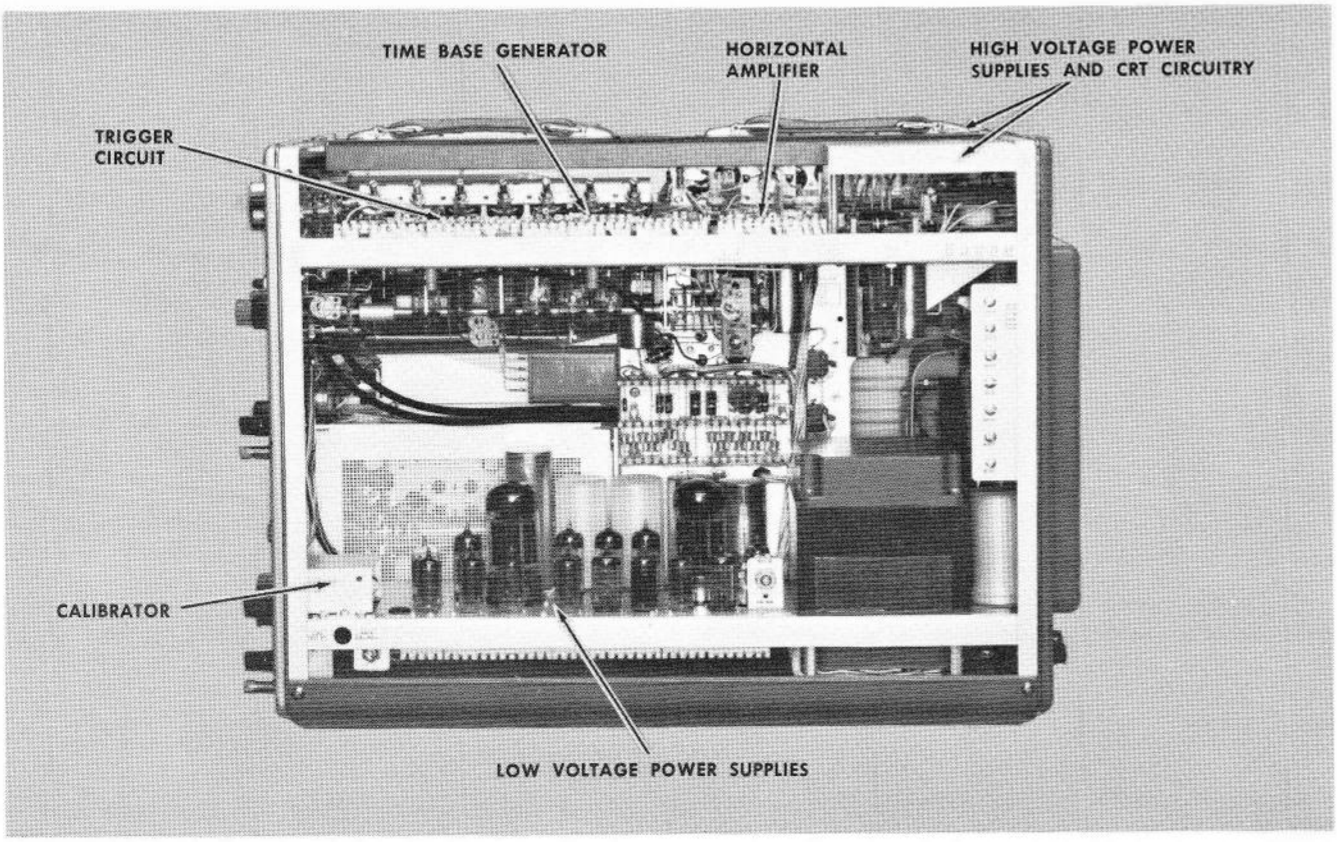
Although the Type 581A is a complex instrument, it can be thought of as consisting of six main circuits, in addition to the Calibrator circuit. These are the—

1. Low-Voltage Power Supply
2. CRT Circuit
3. Vertical Amplifier and Delay Line
4. Time-Base Trigger Circuit
5. Time-Base Generator
6. Horizontal Amplifier

The first circuit to check, for practically any type of trouble, is the Low-Voltage Power Supply. Because of the circuit configuration employed, it is possible for an improper power supply voltage to affect one circuit more than the others. For example, if the gain of the Vertical Amplifier should derease slightly, while the other circuits appear to be functioning normally, this could be due to an improper supply voltage and not to any condition originating in the Vertical Amplifier. In cases of this type, valuable time can be saved by checking the power supply voltages first.

On the other hand, the crt display can often be used to isolate trouble to one particular circuit when trouble exists in that circuit. If there is no vertical deflection, for example, when the intensity and horizontal deflection appear to be normal, the trouble can be: open signal connections, no signal source, the plug-in, the probe, or even loose crt connections.

The material that follows contains information for troubleshooting each circuit for various types of troubles. A



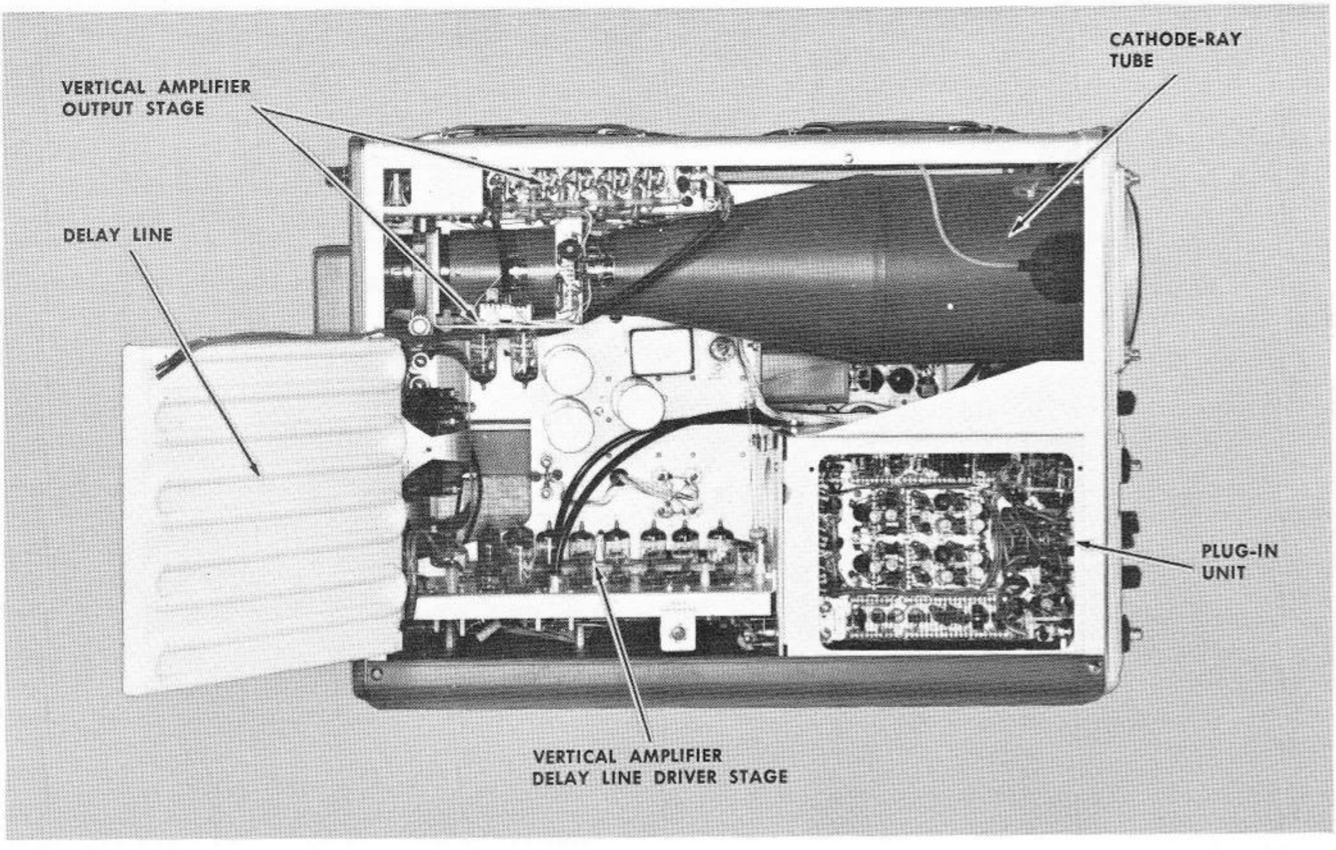


Fig. 5-8. Physical location of circuits which compose the Type 581A Oscilloscope.

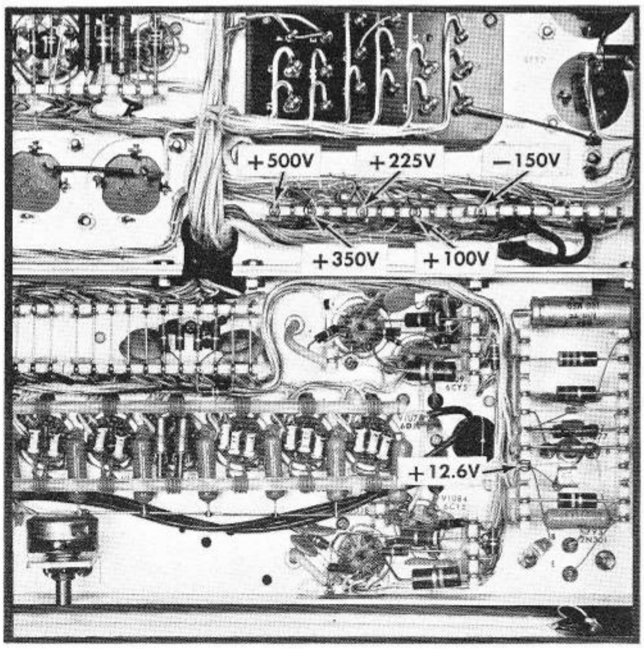


Fig. 5-9. Location of power supply test points underneath the scope.

method is described, in some instances, for locating the stage in which the trouble may be originating: once the stage at fault is known, the component(s) causing the trouble can be located by voltage and resistance measurements or by substitution. In certain other instances the information is more specific and the trouble can be traced to a particular component.

Front-Panel Checks

The following front-panel checks will help you to isolate the trouble in an instrument to a given circuit. However, the interrelation between circuits is such that it is not always possible to isolate the trouble exactly using these checks. If you are unfamiliar with the instrument, these front-panel checks should prove helpful in starting to look for the trouble.

Before attempting any of the following front-panel checks make sure that the plug-in installed in the instrument is operating correctly. If the pilot lamp fails to light when the POWER switch is turned to the ON position, and if the fan fails to operate, turn to the section on troubleshooting the Low-Voltage Power Supply. If the pilot light and fan both operate but the Time-Delay Relay fails to operate with an audible "click" in less than one minute, you should also consult the section on Troubleshooting the Low-Voltage Power Supply.

With a Type 84 Plug-In Test Unit installed, and the pilot light and fan both operating, allow the oscilloscope to run for several minutes.

Set the front-panel controls as follows:

STABILITY	fully clockwise
TRIGGERING LEVEL	0
TRIGGERING SOURCE	INT AC
TRIGGER SLOPE	+
TIME/CM VARIABLE	fully clockwise
TIME/CM	5 mSEC
HORIZONTAL DISPLAY	INTERNAL SWEEP
FOCUS	mid-range
INTENSITY	mid-range
ASTIGMATISM	mid-range
SCALE ILLUM	mid-range
HORIZONTAL POSITION	mid-range
HORIZONTAL POSITION VERNIER	mid-range

Other controls may be left at any setting.

set the Type 84 front-panel controls as follows:

LOAD	NORM
DISPLAY SELECTOR	CAL (2 CM) and ALT SYNC
VERTICAL POSITION	mid-range

Other Type 84 controls may be left at any setting.

With the Type 84 controls as above, there should be two traces, two centimeters apart on the CRT. It may be necessary to readjust the VERTICAL POSITION Control to bring both traces in view.

A second check is then to set the Type 84 DISPLAY SELECTOR switch to EXT. INPUT and patch into the EXT INPUT connector .2 VOLTS of Calibrator signal. It will be necessary now to turn the Type 581A STABILITY Control into the triggerable region and adjust the TRIGGERING LEVEL Control for a stable display.

If either of the tests made so far does not produce a display as described, turn to the section on troubleshooting the Vertical Amplifier. If the first test above does not produce two traces, (but the second test permits a proper display of the Calibrator waveform), check the Time-Base Generator dual-trace sync pulse source. If no Calibrator waveform appears in the second test, turn to Troubleshooting the Amplitude Calibrator.

Additional troubles are discussed below in relation to using a TU-3 or Type 80 Plug-In Unit for this initial trouble test.

If you are using a TU-3 Test-Load Plug-In Unit set the INPUT SELECTOR toggle switch to the SIGNAL position and the oscilloscope AMPLITUDE CALIBRATOR switch to the .2 VOLTS position. If using a Type 80 Plug-In, set the AMPLITUDE CALIBRATOR switch to .2 VOLTS, apply the CAL OUT signal to the P80 Probe.

Using a patch cord which introduces no attenuation, connect the CAL OUT connector to the INPUT connector of the TU-3 Plug-In.

If no spot is evident check the Beam-Position Indicator lamps. If the spot is off the screen vertically turn the VERTICAL POSITION Control from one extreme position to the other, watching the face of the CRT as you do so. If the spot does not appear, and operation of the VERTICAL POSITION Control has no effect on the Beam-Position Indicator lamps, turn to the section on Troubleshooting the Vertical Amplifier.

If the display which appears consists only of a horizontal line, you may check the operation of the Calibrator by disconnecting the end of the patch cord from the CAL OUT connector and grasping the end between your fingers. A series of sloping vertical lines (power line pickup) appearing

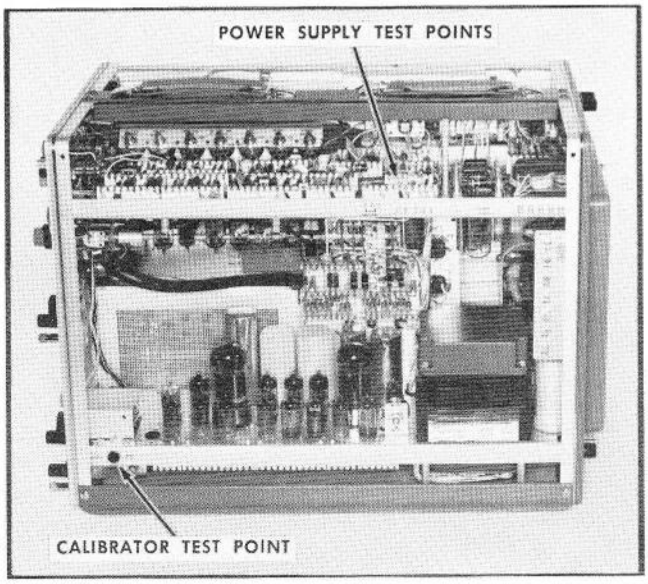


Fig. 5-10. Calibrator and power supply test points.

on the CRT indicate that the Vertical Amplifier is operating and that the AMPLITUDE CALIBRATOR is probably inoperative. See the section on Troubleshooting the AMPLITUDE CALIBRATOR for the remedy.

If the operation of the VERTICAL POSITION Control causes the vertical Beam-Position Indicator lamps to indicate the display can be centered vertically, rotate the HORIZONTAL POSITION Control from one extreme position to the other. If the horizontal Beam-Position Indicator lamps indicate the display remains off screen refer to the section on Troubleshooting the Horizontal Amplifier.

If both sets of Beam-Position lamps indicate that the display is centered, but no display is observed, CAUTIOUSLY advance the INTENSITY Control. Watch for a display to appear on the screen. If no display is seen or if the display is of low intensity or defocused but otherwise normal, refer to the section on Troubleshooting the CRT Circuit.

TROUBLESHOOTING THE VERTICAL AMPLIFIER

No Spot or Trace Visible on CRT

If all power supply voltages are normal, and the CRT is known to be good, failure to obtain a spot or trace on the screen will be due to improper deflection-plate voltages. This condition is caused by a dc unbalance in either or both of the deflection amplifier circuits or by a loose CRT lead.

To determine which circuit is at fault, adjust the Time-Base controls for a free-running sweep at 1 mSEC/CM (STABILITY Control fully clockwise) and set the INTENSITY Control to midrange. Using a screwdriver with an insulated handle, CAREFULLY short the vertical deflection plates together at the neck pins on the CRT. These are the pins marked BLUE (UPPER) and BROWN (LOWER). Be extremely careful not to short either pin to the metal shield around the CRT. If the dc unbalance is being produced in the vertical deflection circuit the trace will appear at or near the center of the CRT when the vertical deflection plates are shorted together. If the trace does not appear, however, the trouble does not lie in the vertical circuit and the dc balance of the horizontal circuit can be checked in a like manner after first stopping the sweep.

If it is determined that the vertical deflection circuit is unbalanced, the next step is to check the system for the fault. This is accomplished in a manner similar to the shorting procedure used to find the CRT electrical center. It is best to guard against common-mode oscillations by performing the shorting operation using a 27 Ω 1-watt resistor. Figure 5-11 illustrates a satisfactory method of holding the shorting resistor for use in the following procedure.

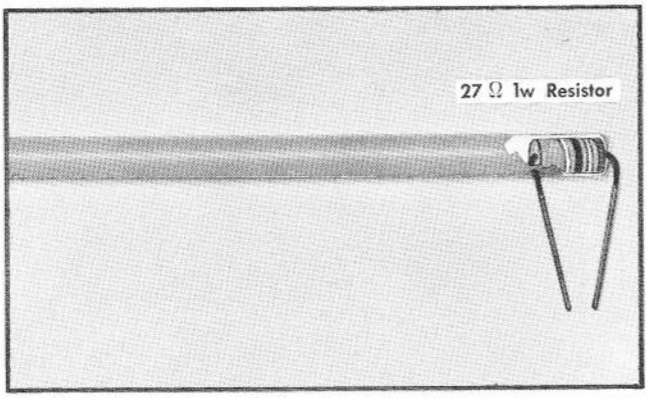


Fig. 5-11. 27-ohm shorting resistor. Part Number 003-002.

1. Use the shorting resistor to short across C1261. If the trace appears, V1274 and V1284 circuit is good.
2. Connect the shorting resistor between the grid lines of the Output Stage near V1214. If the trace appears, all tubes and circuitry from this point to the CRT are good.
3. Connect the shorting resistor between the plate lines of the Vertical Amplifier Delay-Line Driver stage. If the trace appears, the Delay Line is not open.
4. Connect the shorting resistor between the grid lines of the Vertical Amplifier Delay-Line Drive stage. If the trace appears, the vertical amplifier is good and the trouble lies within either the plug-in or the probe. If available, another plug-in unit or probe should be substituted for the suspected unit.

During the shorting procedure, if one of the distributed amplifiers is proven at fault, it is unlikely that just one nonconducting tube could be responsible. Each tube draws only a small portion of the total plate current. If a tube has shorted, excessive current may damage resistors or other parts. A visual inspection will probably reveal the damaged part(s).

Insufficient or No Vertical Deflection

Insufficient deflection indicates a change in the gain characteristics of the Vertical Amplifier. If only a slight

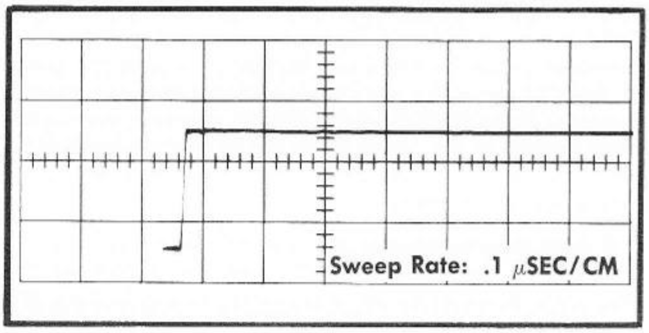


Fig 5-12. Correctly compensated Type 581A and P80 Probe, using Type 107 Square-Wave Generator.

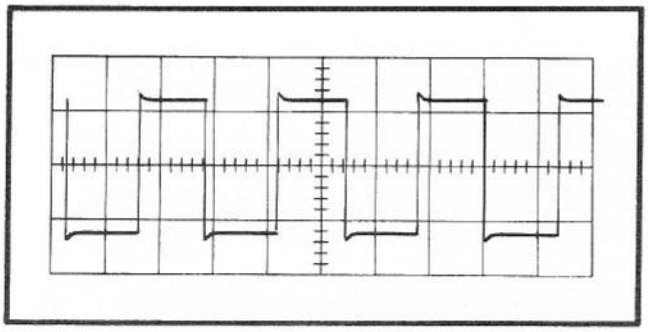


Fig. 5-13. 20 kc waveform from a Type 105, showing effect of overpeaking R8018 within the P80 Probe.

change in deflection is apparent, the circuit can normally be recalibrated for gain.

If the change in deflection is more pronounced, or if there is no deflection at all, the tubes should first be checked by substitution. Then check for components which can affect the gain of the circuit but not the dc balance. Such components are the common cathode resistors; the Gain Adj Control; common screen resistors; and common plate-load resistors.

Waveform Distortion

If compression is severe, refer to step 12 of the Calibration Procedure to make the necessary corrections.

With the Type 84 Plug-In Test Unit in place, turn its DISPLAY SELECTOR to PULSER and operate the Type 581A sweep at .05 μSEC/CM. Use a viewing hood if in a lighted room. Adjust the Type 84 PULSER AMPLITUDE for +2 cm of display, permiting a view of the oscilloscope's transient response. If other than a clean step-function is presented on the CRT, calibration of the vertical amplifier is indicated. Calibration can require tube balancing, replacement, and/or high-frequency adjustments. See the Calibration Procedure including steps 9 through 14, and steps 31 and 32.

TROUBLESHOOTING THE TIME-BASE TRIGGER CIRCUIT

Unstable Triggering

If the display of a repetitive waveform cannot be made stable, the sweep generator may not be receiving proper triggering signals. If the trace can be turned off and on with the STABILITY Control, the sweep generator is capable of being triggered. This indicates the trigger circuitry is not functioning properly.

Trouble can be anywhere from the Trigger Pickoff circuit on the Vertical Amplifier Delay-Line Driver chassis to the grid circuit of the Sweep Gating Multivibrator.

To determine if the trouble is within the Time-Base Trigger circuit, and not the Trigger Pickoff circuit, the LINE triggering signal can be used. Figure 5-14 illustrates three waveforms within the Time-Base Trigger circuit when the triggering signal is 60 cycles.

Should the Time-Base Trigger circuit prove to be functioning properly, the trouble probably lies within the Trigger Pickoff amplifier and cathode follower system. A visual inspection will aid in finding burned components. Tube substitution should be tried when no burned parts are evident. A possible cause of unstable triggering is 60 cycle heater-cathode leakage in a Trigger Pickoff tube. Also voltage measurements can aid in finding the problem. Voltages of important points in the Trigger Pickoff circuit are part of the Vertical Amplifier Delay-Line Driver stage diagram.

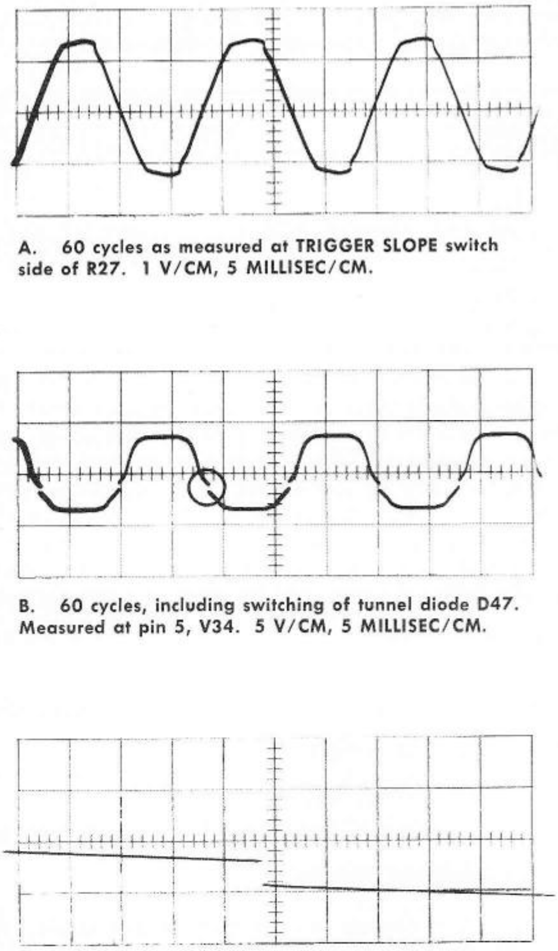
TROUBLESHOOTING THE TIME-BASE GENERATOR

No Horizontal Sweep

If the Time-Base Generator is not producing a sawtooth sweep voltage when the STABILITY Control is adjusted for a free-running sweep, some defect in the generator is holding the Miller Runup circuit. Depending on the on-off states of the Disconnect Diodes V152, Miller Runup circuit may be held at either the high end or the low end of the sawtooth. The manner in which it is held may be determined by measuring the voltage at the SAWTOOTH OUT binding post. If the Miller Runup circuit is held at the high end of the sawtooth the voltage at the front-panel binding post may measure about +300 volts; if held at the low end, the voltage at this point will measure anywhere between ground and —20 volts, depending on the cause. If it rests at —20 volts, the trouble probably is nonconduction of V152A, and it should be replaced. It can also mean that R151 is open.

If the Miller Runup circuit is held at the high voltage end of the sawtooth, replace V152, as it can mean both heaters are open. Or replace the Miller Runup Tube V161 as its heaters can be open or its cathode can have low emission and give the same effect. Usually if V161 is not conducting, B167 will be glowing brightly.

In the event the front panel SAWTOOTH OUT connector voltage rests at +350, there is probably a grid to plate short within V173; replace it. When this occurs, B167 glows brightly at the electrode attached to pin 6 of V161. If this reverse conduction condition is permitted to continue for longer than about 15 minutes it may be necessary to replace B167 with a new neon glow tube. The reason for this is that B167 may be unstable thereafter.



A. 60 cycles as measured at TRIGGER SLOPE switch side of R27. 1 V/CM, 5 MILLISEC/CM.

B. 60 cycles, including switching of tunnel diode D47. Measured at pin 5, V34. 5 V/CM, 5 MILLISEC/CM.

C. Circled portion of waveform B expanded. .5V/CM 1 μSEC/CM.

Fig. 5-14. Trigger Circuit waveforms when using LINE triggering. TRIGGER SLOPE switch set to +.

If the heater of V173 is open, both neon glow tubes will be glowing brightly and there will be no sweep.

If all tubes have been checked, then check for open plate and cathode resistors in the Sweep Gating Multivibrator circuit, the Hold-Off circuit and the Runup CF circuit. Also check that the STABILITY Control can vary the voltage at the grid of V135A.

Nonlinear Sweep

A nonlinear sweep voltage will be generated if the current charging the Timing Capacitor C160 does not remain constant. If the nonlinearity occurs at all sweep rates a defective Miller Runup Tube is the probable cause. If the nonlinearity occurs only at certain sweep rates a leaky Timing Capacitor is the probable cause but the Miller Runup Tube should not be overlooked. A defective bootstrap capacitor C165 can cause the sweep to be nonlinear at the faster sweep rates. If the sweep appears linear in all but the 1 and 2 SEC/CM rates, set the STABILITY Control fully counterclockwise. If the spot moves to a point near the center of the CRT, there is very likely heater-cathode leakage in V152B and it should be replaced.

Insufficient Horizontal Deflection

If the horizontal trace starts at the left side of the graticule, but retraces before reaching the right side, the Hold-Off circuit is causing V135A to conduct too soon. If the trace cannot be expanded to the full width of the graticule with the SWP LENGTH Control R176, check the resistance values in the cathode circuit of V173.

TROUBLESHOOTING THE HORIZONTAL AMPLIFIER

No Spot or Trace Visible on CRT

To determine whether the Horizontal Amplifier is in a state of dc unbalance, short the horizontal deflection plates together at the neck pins of the CRT in the manner explained for troubleshooting the Vertical Amplifier. The horizontal deflection plates are marked RED (LEFT) and GREEN (RIGHT). The INTENSITY Control should be set to mid-range. If a spot appears when the horizontal deflection plates are shorted together (it may be necessary to adjust the VERTICAL POSITION Control), the trouble lies in the Horizontal Amplifier.

CAUTION

Do not permit the spot to remain on the CRT at this setting of the INTENSITY Control. Either reduce the intensity until the spot is just visible, or remove the short from the horizontal deflection plates.

The procedure for troubleshooting the Horizontal Amplifier is similar to that explained for troubleshooting the Vertical Amplifier for unbalance. The shorting strap can be moved from the deflection plates back toward the Input Amplifier stage, until a point is reached where the trace does not appear. When the stage at fault is determined, check for defective tubes and components associated with that stage.

Insufficient or No Horizontal Deflection

If the gain of the Horizontal Amplifier decreases from normal, the trace will not extend from the left to the right side of the graticule. In addition, the timing will no longer correspond to the calibrated value indicated by the TIME/CM switch. (This is to distinguish insufficient sweep caused by trouble in the Horizontal Amplifier from that caused by a trouble in the Time-Base Generator, e.g., an improper adjustment of the SWP LENGTH Control. In the latter case the trace will be shortened but the timing will not be affected.)

If the change in gain is slight, as indicated by improper timing and a slightly decreased sweep, the amplifier can usually be recalibrated. Since the gain of the Horizontal Amplifier affects the timing of the sweep, care must be taken to insure that the gain adjustments are accurately made. Be sure to refer to the Calibration Procedure if it is necessary to adjust the gain of the Horizontal Ampifier.

If the decrease in gain of the Horizontal Amplifier is more pronounced, or if there is no sweep at all (in which case only a spot will be visible on the horizontal axis), check for defective components which can affect the gain but not the dc balance. In addition to the tubes, such components are the common cathode resistors and controls.

TROUBLESHOOTING THE LOW-VOLTAGE POWER SUPPLY

Proper operation of every circuit in the Type 581A including the plug-in unit, depends on proper operation of the Low-Voltage Power Supply. The regulated dc voltages must remain within their specified tolerances for the instrument and plug-in unit to retain their calibration.

WARNING

Exercise care in checking the power supply. Because of their high current capabilities and low impedance, the Low-Voltage supplies can produce more harmful shocks than the high-voltage supply in the CRT Circuit.

Open Primary Circuit (Dead Circuit)

If the pilot lamp and the fan do not come on when the power is turned on, check the source of power and the power cord connections. Check the fuse at the rear of the instrument. If the fuse is blown replace it with one of the proper value and turn the instrument on again. If the new fuse blows immediately, check the power transformer for shorted primary or secondary windings. Also check for a shorted rectifier. If the new fuse does not blow until the time-delay relay has activated (a "click" can be heard), check for a shorted condition in the regulator circuits and the loading on the supply.

If the fuse is good, check for an open primary winding in the power transformer. If your instrument is wired for 220, 234 or 248 volt operation, check for an open Thermal Cutout Switch. The resistance of this switch is about 0.1 Ω. (If your instrument is wired for 117 volt operation, the fan will come on even though the Thermal Cutout Switch is open.)

If both the fan and pilot lamp come on, the primary circuit of the power transformer is operating normally.

Incorrect Output Voltage

Test points for checking the Low-Voltage Power Supply including the +12.6-volt supply, are located on the right side of the instrument, underneath the Power Supply and Vertical Amplifier Delay-Line Driver chassis (see Fig. 5-9.) The voltage for each test point (except the +12.6-volt supply) is also silk-screened on the lip of the chassis adjacent to the ceramic strip on the top right side in front of the shield covering the high voltage transformer (see Fig. 5-10).

If any of the supplies fail to regulate, the first thing to check is the line voltage. The supplies are designed to regulate at a line voltage between 105 and 125 volts with the design center at 117 volts, or between 210 and 250 volts with the design center at 234 volts, rms, 50-60 cycle single phase ac. The other design center voltages have similar line voltage ranges.

If the line voltage is the correct value, the next step is to remove the plug-in unit and measure the resistance between each regulated bus and ground. The following resistance values are approximate minimum readings.

REGULATED BUS	APPROX. MINIMUM RESIST. TO GROUND
−150 v	3.5 k
+100 v	3 k
+225 v	20 k
+350 v	30 k
+500 v	35 k
+12.6 v	5-10 Ω

If the resistance values between the regulated buses and ground check out, check the series regulator tubes. Then make sure that the line voltage is set near the design center for your instrument and check the rms voltage across the secondary winding for each supply. If the secondary voltages are all correct, check the operation of the bridge rectifiers. This can be done by measuring the rectified voltage at the input to each regulator. Then check for off-value resistors, especially in the dividers, and for open or leaky capacitors.

The material that follows may be used as a quick index for troubleshooting the regulator circuits:

If the output voltage is high with excessive ripple, check:

a. For high line voltage.

b. For open voltage-regulator tube, V609.

c. The amplifier tubes in the regulator circuit, V664, etc.

d. For insufficient loading.

If the output voltage is high with normal ripple, check for proper resistance values in the dividers. Refer to the diagram to determine the location of the resistors involved. Since these are generally precision resistors (±1% tolerance) the use of a good bridge is recommended in checking the value.

If the output is low with excessive ripple, check:

a. For low line voltage.

b. For shorted voltage-regulator tube, V609.

c. The series tubes in the regulator circuit, V677A, etc.

d. For excessive loading.

e. Open or leaky filter capacitors.

f. Defective rectifiers.

If the output is low with normal ripple, check:

a. The resistance values in the dividers.

b. The capacitors across the dividers.

IMPORTANT

If any components in the —150 volt supply are changed, or if the setting of the —150 Adj Control is changed, it will be necessary to check the calibration of the instrument.

TROUBLESHOOTING THE AMPLITUDE CALIBRATOR

If the output square-wave is not symmetrical (the positive portion has a duration different from that of the negative portion), the two tubes in the Multivibrator circuit are not being held cutoff for equal periods. This will normally be caused by a defective tube. If tube replacement does not correct the waveform the circuit components must be checked. The pentodes in the Multivibrator held cutoff for an interval determined by the discharge of C871 and the triode is held cutoff for an interval determined by the discharge of C874. A change in the value of either capacitor, or in the value of the resistors through which they discharge, could produce an asymmetrical waveform.

In addition, the time needed for these capacitors to discharge a given amount is affected by the potential toward which they discharge; this would be the voltage at the plate of the triode in the case of C871, and the voltage at the screen of the pentode in the case of C874. Since these voltages are affected by the value of R870 and R875, these resistors should be checked. The resistors in the plate circuit of the pentode should also be checked, since they will affect the plate-to-screen ratio of the pentode.

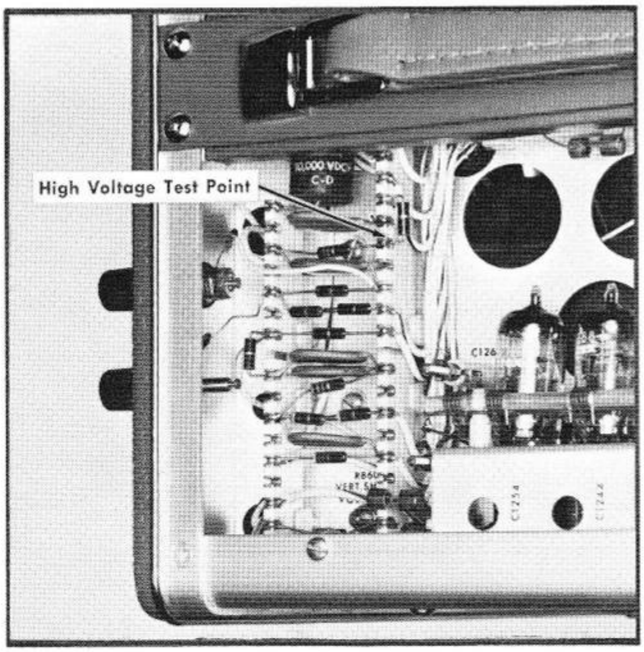


Fig. 5-15. Location of the high voltage test point.

Incorrect Output Voltage

The amplitude of the output square-wave is determined almost entirely by the plate circuit of V875. The accuracy of square-wave voltages less than 100 volts is determined by the resistance values in the divider in the cathode-follower stage. A quick check of the +100 volt maximum output value can be made by turning off the AMPLITUDE CALIBRATOR and measuring the voltage at the Cal Test Pt (see Fig. 5-8 and 5-10). If the test point does not measure exactly +100 volts, the CAL OUT voltages will not be correct.

The Cal Adj Control R879 will vary the voltage at the test point over about a 5-volt range. If this voltage cannot be set to exactly +100 volts, and if the tubes have been replaced, then check to be sure V875 is completely cut-off.

TROUBLESHOOTING THE CRT CIRCUIT

The intensity, focus, geometry and calibration of the CRT display depend on proper operation of the three high-voltage supplies in the CRT circuit.

No Spot or Trace

If the low-voltage power supply is operating normally, but no spot or trace is visible on the CRT, the trouble could be a defective CRT, a defect in the CRT cathode circuit including the —1350 volt supply, or an unbalanced dc condition in either or both of the deflection amplifiers. In the latter case the dc unbalance is producing improper positioning voltages and the beam is deflected off the screen.

To determine which circuit is at fault, turn the ASTIGMATISM Control fully counterclockwise, then turn the INTENSITY Control clockwise. If a flare is observed on the CRT screen, one of the deflection amplifiers is probably at fault. If no flare is observed with the INTENSITY Control turned fully clockwise, the trouble will either be due to a defective CRT or to an inoperative cathode supply circuit. The cathode supply can be checked by measuring the voltage at the HV Test Point (Fig. 5-15). The voltage at this point should be —1350 volts, although it will vary with the setting of the HV Adj Control R840. If a voltage reading near —1350 volts is obtained, turn the instrument off and measure the resistance of R847, the 27-k resistor connected to the test point. If this resistor is not open a defective CRT is indicated.

If the voltage at the HV Test Point is zero or abnormally low, replace the Oscillator tube V800 and the Error-Signal Amplifier tube V814. If this does not restore operation the Oscillator circuit should be checked.

A quick check on the operation of the Oscillator circuit can be made by observing the heater glow in the rectifier tubes, located under the shield at the upper right rear of the instrument. If no heater glow is visible the Oscillator circuit is inoperative. This could be due to an open transformer T801, or to a defective component in the circuit of V800 or V814.

If heater glow is visible in the rectifier tubes, the Oscillator circuit is operating. If the heater glow appears to be dim, however, the output of the Oscillator may be insufficient for proper operation. A more accurate check on the Oscillator may be made by removing the shield covering the high-voltage transformer and measuring the bias at the grid of V800. This can be measured at the junction of C806. The voltage at this point should measure about —65 volts.

WARNING

Do not let your hand or body touch the chassis when making this check.

If the Oscillator circuit is operating properly, but the voltage of the HV Test Point does not measure in the vicinity of —1350 volts, V862 is most likely defective.

Abnormal Intensity

If a trace is visible on the CRT, the intensity of the trace may be used to identify trouble in either the negative bias supply or the positive anode supply.

If the trace is excessively bright, and does not change as the INTENSITY Control is adjusted, check the negative bias supply including the lead to the grid of CRT. Check for a defective rectifier tube V822, an open supply winding or filament winding, an open resistor including the INTENSITY Control, or a shorted or leaky capacitor. If trouble is not found in any of these components, a defective CRT is indicated.

If the intensity of the trace is extremely low, check for an inoperative positive supply. Also check the anode connection to the CRT, including R836 and C836.

If the accelerating potentials appear to be too high, as evidenced by decreased deflection sensitivity, check the Error-Signal Amplifier circuit.

If a badly distorted trace or spot is visible on the CRT, check the Geom Adj Control R861 and its connection to the neck pin on the CRT. Also check the ASTIGMATISM Control R864 and its connection to the CRT base socket. If the FOCUS Control has no effect on the trace, check this control (R856) and its connection to the CRT base socket.

IMPORTANT

If any components in the Oscillator, Error-Signal Amplifier or —1350-volt cathode supply circuit are changed, or if the setting of the HV Adj Control is changed, it will be necessary to check the calibration of the instrument.

SECTION 6
CALIBRATION

General

The Type 581A Oscilloscope is a stable instrument and should not require frequent calibration. However, it will be necessary to recalibrate certain parts of the instrument when tubes or components are changed, and periodic recalibration is desirable from the standpoint of preventive maintenance.

In the instructions that follow, the steps are arranged in the proper sequence for full calibration. Each numbered step contains the information necessary to make one adjustment. In some steps, two or more adjustments are included when these adjustments interact or when they can be made easily without many changes in front-panel control settings. If a complete recalibration is not necessary, you may perform individual steps, PROVIDING that the steps performed do not affect other adjustments. It is most important that you are fully aware of the interaction of adjustments. Generally speaking, the interaction of controls will be apparent in the schematic diagrams. If you are in doubt, check the calibration of the entire section on which you are working.

If you make any adjustments on the power supplies, you will have to check the calibration of the entire instrument.

EQUIPMENT REQUIRED

The following equipment is necessary for a complete recalibration of the Type 581A Oscilloscope:

1. A dc voltmeter having a sensitivity of at least 5000 Ω/v with corrected reading accurate to at least 1% at 12.6, 100, 150, 225, 350, and 500 volts, and at least 3% at 1350 volts. Portable multimeters should be regularly checked against an accurate standard and corrected readings noted where necessary at the above listed voltages. Be sure your meter is accurate.

2. An accurate rms-reading ac voltmeter, having a range of 0-150 volts (0-250 or 0-300 for 234-volt operation).

3. Variable line-voltage autotransformer having a rating of at least 7.5 amperes for 117 volts and 4 amperes for 234 volts.

4. Time-Mark Generator Tektronix Types 180, 180A, or equivalent, having markers at 1, 5, 10, 50, 100, 500 μsec; 1, 5, 10, 50, 100, 500 msec and 1 sec; sine-wave outputs of 10 mc and 50 mc; all having an accuracy of at least 1%. A coaxial output cable is required with the Time-Mark Generator.

5. Tektronix Type 84 Plug-In Unit.

6. Low-Capacitance Recalibration Tools.

Additional Tools: A three-inch screwdriver and a 0.050" allen wrench.

7. A 27 Ω resistor as illustrated in Figure 5-11.

8. Test Oscilloscope, Tektronix Type 540 Series with a Type K Plug-In Unit or equivalent providing triggered sweeps and a bandpass of at least dc to 30 mc.

9. In the event the calibration of the Type 581A must be done in a brightly lighted room, a polarized viewing hood can be used to increase the display contrast.

Preliminary

Preset the front-panel controls of the Type 581A and Type 84 as follows:

FOCUS	midrange
INTENSITY	fully counterclockwise
ASTIGMATISM	midrange
STABILITY	counterclockwise, but not preset
TRIGGERING LEVEL	counterclockwise
TRIGGER SLOPE	+
TRIGGERING SOURCE	AC-INT.
TIME/CM	1 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	INTERNAL SWEEP
5X MAGNIFIER	OFF
HORIZONTAL POSITION	midrange
VERNIER	midrange
POWER	OFF
AMPLITUDE CALIBRATOR	OFF

Before installing the Type 84 and applying power to the instrument the resistances of the power supplies should be checked. The typical resistances of the supplies may be found in the chart below.

NOMINAL RESISTANCES OF POWER SUPPLIES

SUPPLY	APPROX. RESISTANCE TO GROUND
+12.6	5.5 ohms
−150	1 k
+100	1 k
+225	2 k
+350	9 k
+500	25 k

Install the Type 84 and preset its controls as follows:

LOAD	NORM
+12.6 LOAD (behind front-panel)	switch towards panel
VERTICAL POSITION	midrange
DISPLAY SELECTOR	EXT INPUT
PULSER AMPLITUDE	0
PULSER FREQUENCY	midrange

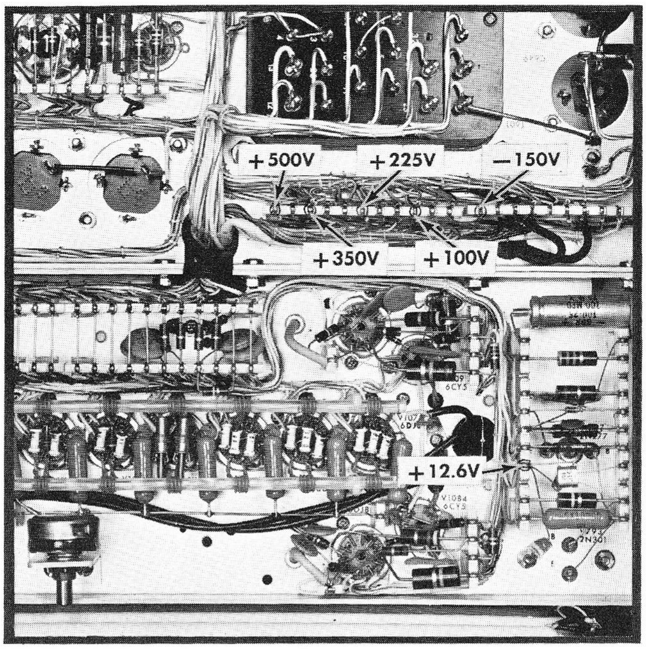


Fig. 6-1. Location of Power Supply Test Points. (Bottom View.)

Connect the power cord and the ac voltmeter to the output of the autotransformer. Turn the POWER switch to the ON position and adjust the autotransformer for an output of 117 volts (or 234 volts). Allow the instrument to warm up for several minutes before proceeding with the calibration adjustments. During calibration, periodically check the input voltage to the instrument and adjust the autotransformer as necessary to maintain the voltage at the design center voltage except when the power supply regulation is being checked.

CAUTION

Do not reset the —150 Control unless the power supply voltages are actually out of tolerance or you are planning to perform a complete calibration of the instrument.

Check the delay time of the time delay relay. The relay armature should pull-in with a "click" sound after 15 to 45 seconds time has elapsed.

PROCEDURE

1. Low-Voltage Power Supplies

Measure the output voltage of the —150v, +100v, +225v, +350v, and +500v regulated supplies at the points indi-

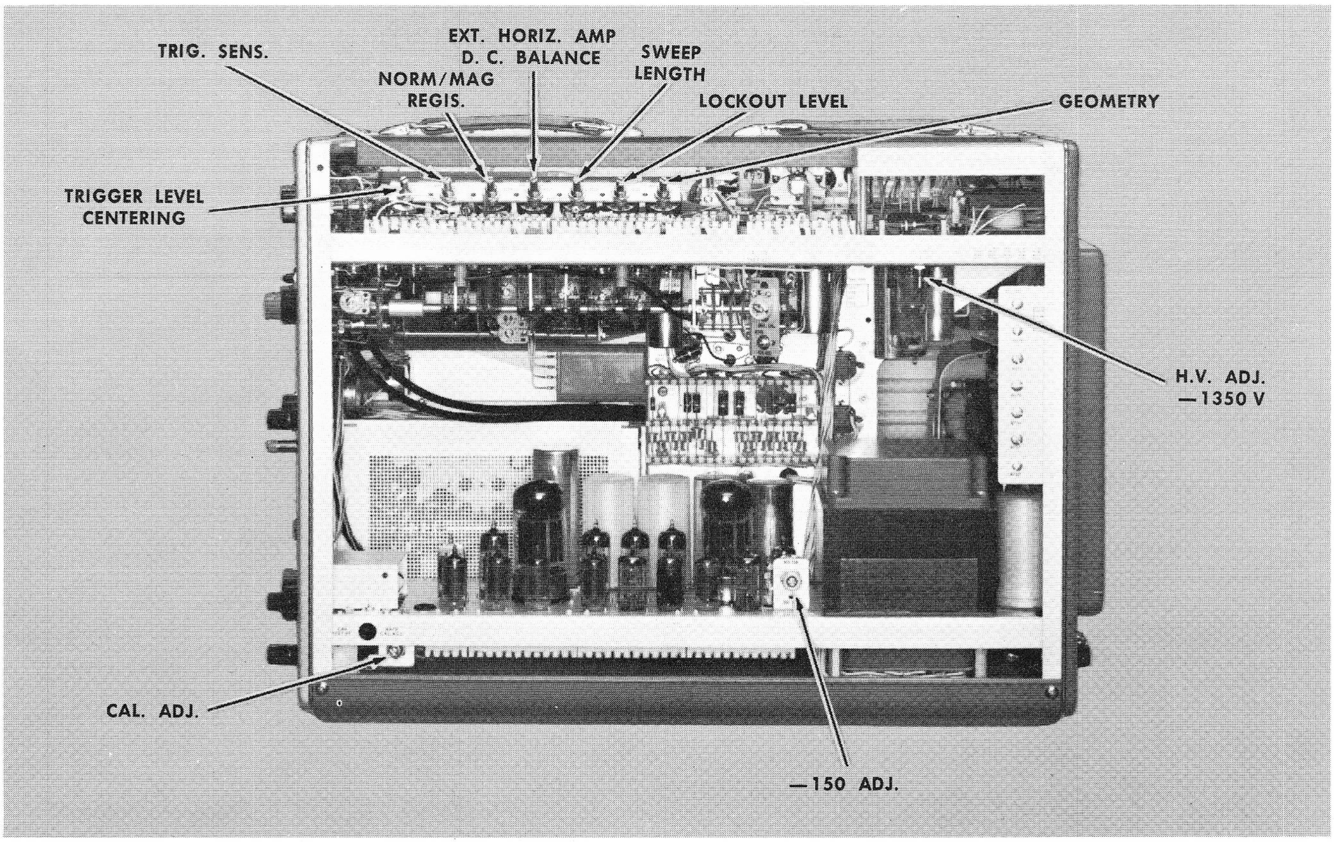


Fig. 6-2. Location of Type 581A Oscilloscope internal adjustment controls.

cated, in fig. 6-1. The output voltage of the —150 v and the other regulated supplies must be within 2% of their rated values. You should set the —150 Control (see fig. 6-1) so that all of these voltages are within the specified tolerance.

Measure the output voltage of the +12.6v regulated supply at the point indicated in fig. 6-1. If the output voltage is not +12.6 volts then readjust R785 until the 12.6 volt reading is obtained.

To check the regulation of the power supplies, set the LOAD switch of the Type 84 to HIGH and adjust the line voltage for 105 volts (or the similar low-line voltage for your design center voltage). Now check the voltage of each supply. It should still be within 2% of its proper value.

The power supply ripple is checked by connecting a one times probe from the test oscilloscope to the supply being checked. The table below gives the approximate ripple amplitudes of each power supply.

After the power supplies have been checked on low-line voltage then the line voltage should be raised to 125 volts (or the similar voltage) and the LOAD switch of the Type 84 set to LOW. Now again repeat the voltage and ripple checks. The same limits still apply.

When the power supply regulation checks are completed return the LOAD switch of the Type 84 to NORM and the line voltage to the design center voltage.

TYPICAL RIPPLE AMPLITUDES

SUPPLY	TYPICAL RIPPLE
+12.6	10 mv at low and high-line
+150	5 mv at low and high-line
+100	15 mv at low and high-line
+225	5 mv at low and high-line
+350	30 mv at low and high-line
+500	30 mv at low and high-line

2. AMPLITUDE CALIBRATOR Adjustments

The Cal Adj (R879) Control should be set to provide exactly +100 volts at the Cal Test Pt when the AMPLITUDE CALIBRATOR switch is in the OFF position. Under these conditions, the CAL OUT voltages should then be within 3% of the front-panel readings.

To make this adjustment connect the voltmeter between the CAL TEST PT jack and ground (see fig. 6-2), and adjust the Cal R879 Control for a reading of exactly +100 volts. To assure suitable symmetry of the calibrator waveform, the reading at this point should not be less than 45 v nor more than 55 v when the calibrator is turned on. Readings outside this range are generally caused by unbalanced multivibrator tubes (V875 or V885A).

3. High-Voltage Power Supply Adjustment

Connect the voltmeter between ground and the high-voltage check point (see fig. 6-3), and set the H V Adj Control (see fig. 6-2) for a meter reading of exactly —1350 volts. Disconnect the voltmeter.

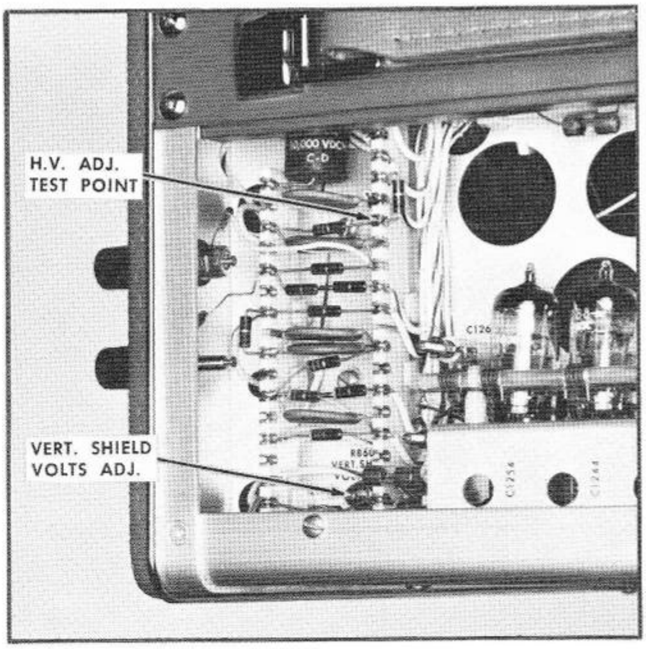


Fig. 6-3. Top view of the Type 581A showing the location of high voltage test point and VERT. SHIELD VOLTS ADJ. control.

4. CRT Alignment

With no vertical input signals applied, center the trace on the CRT with the Vertical Position Control. Turn the INTENSITY Control clockwise to display the trace, and adjust the FOCUS and ASTIGMATISM Controls if necessary. Position the trace to the horizontal centerline.

Check the alignment of the trace relative to the horizontal graticule lines. If the trace is not aligned parallel to the centerline, adjust R865, the TRACE ROTATION Control to bring it into alignment.

S/N 3975-5000. Obtain a trace in the same manner and position to the horizontal centerline. If the trace and graticule line do not coincide over the width of the graticule, notice the amount of misalignment. Turn the red knob near the CRT base to align the trace with the graticule line.

5. Graticule Alignment (S/N 3975-5000)

To check the alignment of the graticule, position a free-running trace upward until the trace dims and disappears. The graticule should be located such that the trace will go as far above as below the scribed graticule area.

To align the graticule, remove the graticule cover and loosen the set screw which holds the nylon cam located in the lower left corner of the graticule. Rotate the cam with a pointed tool and position the graticule until the horizontal centerline coincides with the imaginary line on the face midway between the points at the top and bottom of the screen where the trace disappears. While holding the cam with the tool, tighten the set screws. Replace the graticule cover.

6. Check High-Voltage Power Supply Regulation

To check for proper regulation; defocus the trace with the FOCUS and ASTIGMATISM Controls and turn the IN-

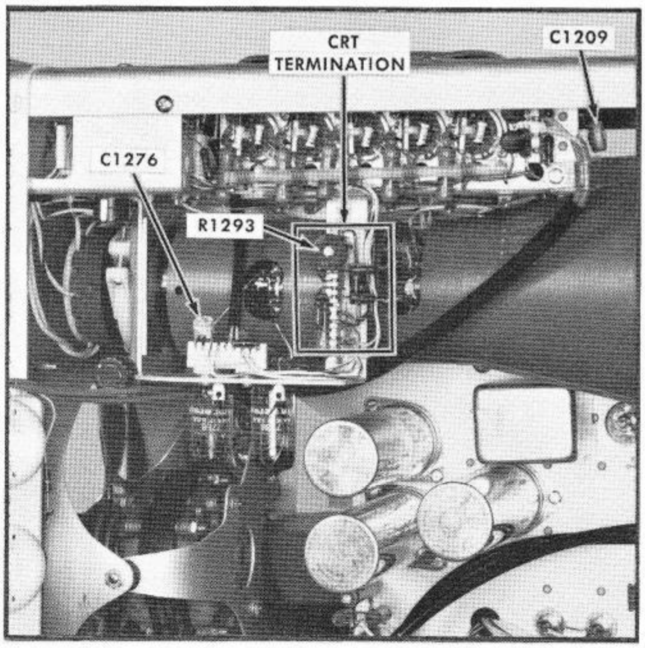


Fig. 6-4. Left Side view showing the location of important items.

TENSITY Control fully clockwise. Vary the autotransformer voltage between 105 v and 125 v (or the similar range for other design center. (If the power supply is regulating, the trace will not show any signs of blooming. (Blooming is when the display changes size as the supply voltage changes.) Set the autotransformer control for the design center voltage, turn down the intensity, and focus the trace.

7. Vert Shield Volts Adjustment

Make this adjustment only when replacing the CRT.

Connect a dc voltmeter from the center terminal of the Vert Shield Volts Control (see fig. 6-3) to the chassis. Set the shield voltage at +300 volts. Complete step 8 now, and then return to complete the adjustment of the Vert Shield Volts Control.

Having adjusted the Geometry Control as in step 8, now reduce the CALIBRATOR signal to produce one centimeter of deflection. Free run the sweep by turning the STABILITY Control fully clockwise. With the VERTICAL POSITION Control, slowly position the trace to the top of the screen and to the bottom of the screen. If the Vert Shield Volts Control is properly set the trace will not change focus at either the top or bottom of the CRT graticule. If it does change focus, as evidenced by a change in line thickness, readjust the Vert Shield Volts Control to correct it. Also, while positioning the trace up and down there should not be more than a total of 0.75 millimeters change in sensitivity. The Vert Shield Volts Control affects both the focus and compression/expansion of the CRT vertical sensitivity. It is best not to adjust the Vert Shield Volts Control more than ±15 volts from the previously set +300 volts.

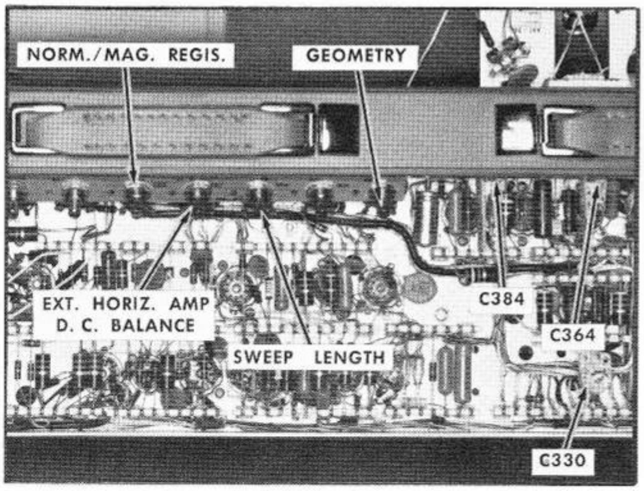


Fig. 6-5. Top View of Trigger Regenerator circuit showing location of internal adjustment controls.

8. CRT Geometry

The geometry of the CRT display is adjusted by means of the Geometry Control. To achieve optimum linearity, vertical lines are displayed on the CRT and the Geometry Control is adjusted for minimum curvature of the lines.

Make this adjustment carefully, recording any vertical tilt at the center of the CRT. The recorded tilt will then add to or subtract from the risetime measurement to be made in step 32.

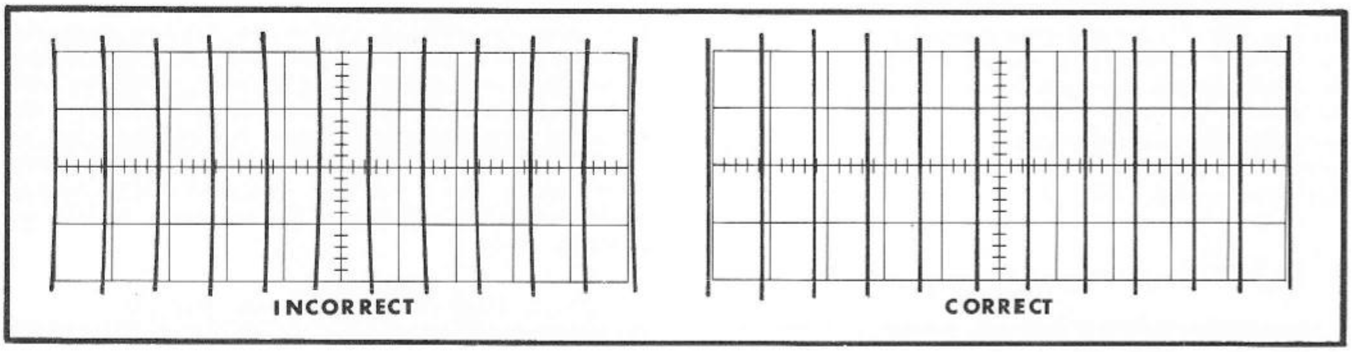


Fig. 6-6. Adjustment of the GEOMETRY control.

Set the front-panel controls as follows:

TRIGGER SLOPE	+ or −
TRIGGERING SOURCE	INT AC
TIME/CM	2 mSEC
VARIABLE	CALIBRATED

Connect a jumper between the CAL OUT connector and the EXT INPUT connector on the Type 84. The AMPLITUDE CALIBRATOR switch should be set so that only the vertical lines of the square-wave signal will be displayed on the CRT. Adjust the triggering controls for a stable display. Now adjust the Geometry Control (see fig. 6-6) for straightest possible vertical lines running parallel to the left and right edges of the graticule. It is normal for the vertical lines to bend in the areas above and below the graticule scribe lines. Disconnect the jumper between the Amplitude Calibrator and the Type 84 after completion of step 7.

NOTE

Time-markers from the Type 180A may be used for this adjustment. If time-markers are used, be sure to position the base line of the timing comb off the CRT screen.

9. Check Vertical Oscillations

When the delay line is either in the latched position or is opened outward, no oscillations should appear on the screen. If oscillations appear when displaying 2 cm of calibrator signal, adjust the neutralizing capacitors, C1041 and C1042 (see fig. 6-7), for no oscillations. Use a plastic low-capacity tool.

10. Check Vertical Amplifier Balance

Short the vertical deflection plates together at the neck pins on the CRT. (Be careful not to short the plates to the CRT shield.) When the vertical-deflection plates are shorted, the trace will appear at the electrical center of the CRT. Remove the short and vertically position the trace to coincide with the electrical center.

Using a 27 ohm shorting resistor such as in figure 5-11, carefully short pin 2 of V1274 to pin 2 of V1284 (C1261), Fig. 6-7. Observe the electrical center shift. Next short pin 2 to pin 7 of V1214. The trace should not shift from the electrical center more than 0.5 cm in either case. Now push the SCOPE AMPL BALANCE CHECK button on the Type 84. This shorts pins 2 and 7 of V1014 together. The trace should not have shifted more than 0.5 cm.

NOTE

When the total vertical system unbalance is over 0.5 cm as you short the grid lines of the Vertical Amplifier Delay Line Driver stage, it will be necessary to find the tube(s) causing the unbalance. Lay the oscilloscope on its right side. Using a clip lead and a small insulated handle screwdriver, electrically turn off each vertical amplifier tube one at a time using the following procedure.

How to turn off each vertical amplifier dual 6DJ8 without removing it from the socket.

A. In the Vertical Amplifier Delay Line Driver stage the cathode of all tubes is at about +52 volts. Thus if the voltage at pins 3 and 8 (the cathodes) can be elevated above the grid voltage, the tubes will be biased to cutoff. This can be done by elevating the cathode to +100 volts. With a clip lead attached to the metal part of an insulated handle screwdriver, touch the screwdriver tip to the cathode end of R1013. Then touch the other end of the clip lead to the +100 volt-supply as pictured in figure 6-9. Repeat with all tubes in the Vertical Amplifier Delay Line Driver stage. If more than half the tubes have been unbalanced in the direction of the major unbalance, replacing one or two of them with tubes unbalanced oppositely will probably correct the problem.

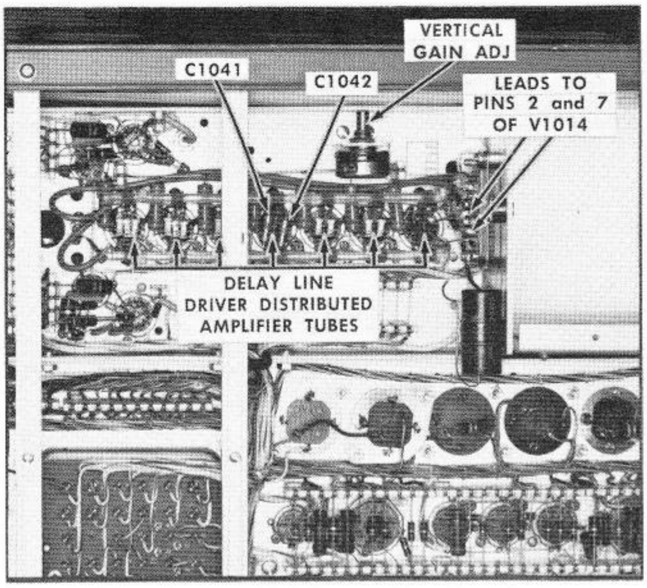


Fig. 6-7. Bottom view of driver distributed amplifier.

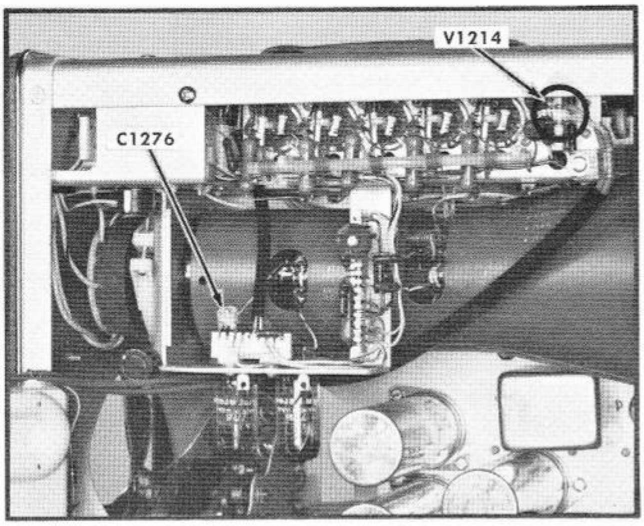


Fig. 6-8. Locations of grid shorting points described in Step 12.

B. In the Vertical Amplifier Output Amplifier Stage the cathode of all tubes is at about +100 volts. These tubes can be placed in cutoff if the cathodes are elevated to +225 volts. Place the tip of the screwdriver at the cathode end of R1213. Then touch the other end of the clip lead to the +225-volt supply. Repeat with all 6DJ8 tubes through V1254. Replace those that contribute heavily to the system unbalance, and re-check.

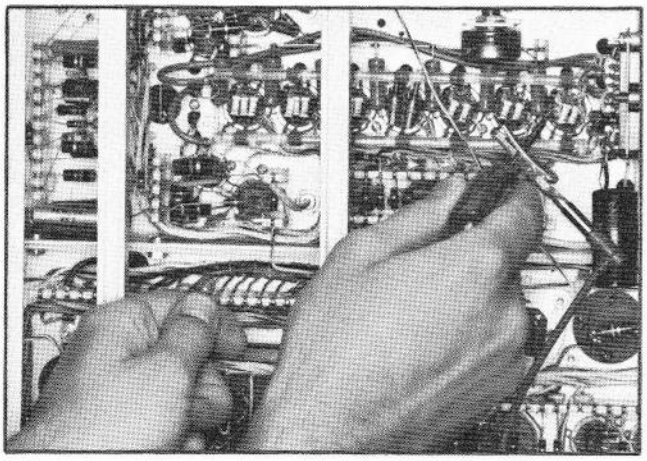


Fig. 6-9. Elevating cathodes of V1014 by applying +100 v to R1013. Be very careful to avoid grounding +100 v supply.

11. Vert Gain Adjustment

Reset the following Type 581A controls:

STABILITY	full clockwise
TIME/CM	.5 mSEC
INTENSITY	reduce to a normal level

Set the DISPLAY SELECTOR of the Type 84 to CAL (2 CM) and ALT SYNC position. Adjust the Vert Gain Control for exactly 2 cm of vertical separation between the lines. Make sure that when measuring the distance, the same side of the trace is used each time.

12. Check Vertical Compression or Expansion

Center the display used in the above step initially about the graticule horizontal centerline. Then moving the display up and down, measure any changes in apparent sensitivity. The signal must not be compressed or expanded more than 0.5 mm at either the top or bottom of the graticule. The total expansion and/or compression must not exceed 0.75 mm.

The CRT vertical shield voltage can be changed a minor amount to slightly alter the CRT vertical linearity. Therefore it may be possible to establish a balance between the CRT vertical shield voltage adjustments and the geometry adjustment that will permit both proper focusing and compression or expansion less than that described above. When changing either the CRT shield voltage or Geometry Control setting, check for proper focus and small spot size.

13. Check DC Shift

Reset the DISPLAY SELECTOR switch to EXT INPUT and vertically position the trace off the CRT. Depress the SCOPE AMPL BALANCE CHECK button to bring the trace back into the CRT. The trace will move suddenly to the electrical center of the system. After the trace stops in the center of the graticule, it should not drift over 1 mm. If it does, either C1004 has changed value and needs replacing or there are bad 6DJ8 tubes within the vertical system.

Release the button and reposition the trace back onto the CRT.

14. Check Vertical Drift

Vary the line voltage autotransformer from low-line voltage to high-line voltage. From the stable trace position at low-line voltage to a possible new stable position at high-line voltage, the trace should not drift more than 2 mm. If it does, check for old vertical tubes.

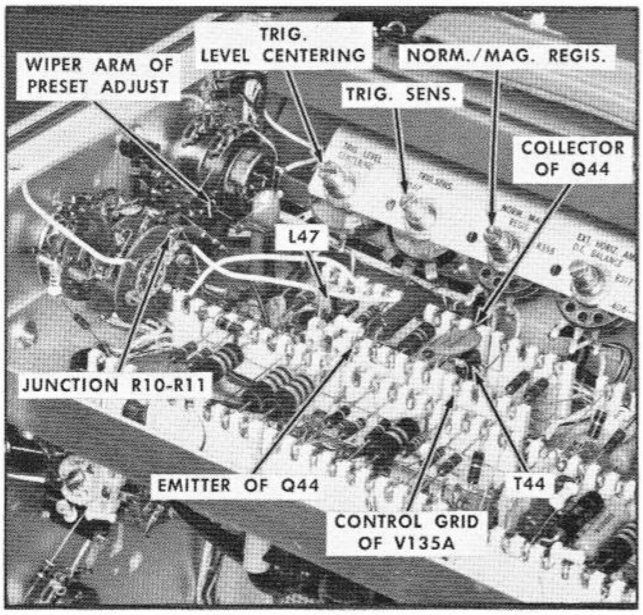


Fig. 6-10. Top view, showing location of triggering adjustments and test points.

15. TRIGGERING LEVEL Control Zero Set

Place the TRIGGERING SOURCE switch at INT AC and the TRIGGER SLOPE switch at +. The STABILITY Control can be at any position except PRESET.

(Use either a sensitive voltmeter or the test oscilloscope for this step.)

Set the test oscilloscope controls as follows: vertical at .05 VOLTS and DC, triggering controls at +LINE and AUTO., and the TIME/CM switch at 2 mSEC. Center the trace on the test oscilloscope for a zero reference.

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Connect a 10X probe from the test oscilloscope to the junction of R10 and R11 (see Fig. 6-10). Adjust the TRIGGERING LEVEL Control to position the trace on the test oscilloscope at the zero reference line. If necessary, loosen the TRIGGERING LEVEL knob and set it at the zero position and tighten the knob. Check for exact zero setting of the knob by observing the test oscilloscope trace for no vertical shift when the probe is disconnected and connected a few times at the junction. Leave the TRIGGERING LEVEL Control set at zero during the following adjustments. Disconnect the 10X probe from the test point.

16. Trig Sens and Trig Level Centering

Having previously adjusted the TRIGGERING LEVEL Control zero set, connect a clip-lead jumper from the junction of R10-R11 to ground to maintain an exact ground reference.

With no triggering signal present, set the Type 581A TIME/CM switch to .5 mSEC, and the STABILITY Control to its triggerable position. (The STABILITY Control triggerable position is about 5 degrees counterclockwise from its free-run position.)

Set the Amplitude Calibrator to 50 mVOLTS. Connect a jumper from the EXT INPUT of the Type 84 to the CAL OUT connector. Adjust the Trig Level Centering Control so a trace is properly triggered on both + and — TRIGGER SLOPE. Reduce the Amplitude Calibrator to 20 mVOLTS. Adjust the Trig Sens Control and if necessary touch up the Trig Level Centering Control, so that a trace is properly triggered on both + and — TRIGGER SLOPE. Reduce the Amplitude Calibrator to 10 mVOLTS. The trace should NOT be able to be triggered at either + or — TRIGGER SLOPE. If a stable display appears, slightly reduce the Trig Sens Control and recheck the operation at 20 mVOLTS. Disconnect the Amplitude Calibrator signal.

17. Preset Stability

With the display and control settings as in step 16, switch the STABILITY Control into its PRESET position, STABILITY Control full counterclockwise.

Connect a voltmeter between the center arm of the PRESET ADJUST Control and ground. Turn the PRESET ADJUST Control full counterclockwise. Now slowly turn the control clockwise until the trace just appears. Observe the voltmeter reading at this point. Continue to rotate the control in a clockwise direction until the trace brightens. Again note the voltmeter reading. Set the PRESET ADJUST Control so that the voltage reading of the center arm is midway between the point where the trace cannot be seen and the point where the trace brightnes. This setting is midrange in the triggerable area of the PRESET Control. Disconnect the voltmeter.

18. Checking Time-Base Trigger

Remove the jumper to ground from the TRIGGERING LEVEL Control. Connect 10 mVOLTS of signal from the Amplitude Calibrator to the EXT INPUT of the Type 84. Set the TRIGGERING SOURCE switch on the Type 581A to INT AC. Using the triggering controls the oscilloscope should trigger on both + and — TRIGGER SLOPE. Reset the TRIGGERING SOURCE switch to INT AC LF REJ. The oscilloscope should again trigger on both slopes of the TRIGGER SLOPE switch.

Move the TRIGGERING SOURCE switch to EXT AC and connect a second jumper from the CAL OUT connector to the TRIGGER INPUT connector. Set the AMPLITUDE CALIBRATOR switch to .2 VOLTS. Using the triggering controls the Type 581A should trigger on both + and — TRIGGER SLOPE. Change the TRIGGERING SOURCE switch to EXT DC. Using the trigger controls the oscilloscope should trigger on both + and — TRIGGER SLOPE. Disconnect the two jumpers from the equipment.

Apply 50 mc from the Type 180A to the EXT INPUT of the Type 84. Set the TRIGGERING SOURCE Control of the Type 581A to INT HF SYNC and the TIME/CM Control to .05 μSEC. With 4 mm of 50 mc sine-wave the oscilloscope should give a stable display by adjusting TRIGGERING LEVEL Control. Now set the TRIGGERING SOURCE switch to EXT HF SYNC and connect a second lead from the Type 180A to the TRIGGER INPUT connector. Apply 1 volt of a *50 mc sine-wave signal from the Type 180A to the Type 581A. The oscilloscope should give a stable display by adjusting TRIGGERING LEVEL Control.

19. Check Line Trigger

Set the TRIGGERING SOURCE switch to LINE. Turn the SCALE ILLUM Control fully counterclockwise. Set the TIME/CM switch at 2 mSEC. Connect a jumper between the EXT INPUT of the Type 84 and the hot lead of one of the graticule lamps. Turn up the SCALE ILLUM Control until the amplitude of the display is about 2 centimeters. The TRIGGERING LEVEL Control should produce a sweep over about one half its total rotation. Disconnect the jumper.

20. Lock-Out Level Adjustment

Test Scope Settings:

TIME/CM	1 mSEC
VOLTS/CM	1 volt
INPUT SELECTOR	DC
SWEEP	free run

Type 581A Settings:

TIME/CM	.5 mSEC
HORIZONTAL DISPLAY	INTERNAL SWEEP
STABILITY CONTROL	Counterclockwise, but not PRESET
TRIGGERING LEVEL Control	at "O"
No vertical input signal	

Connect the test scope 10X probe to the junction of R130, pin 7 of V125; pin 3 of V133A and pin 8 of V133B. (See fig. 6-11.)

Position the trace on the test scope so that it is at the graticule center. Rotate the STABILITY Control on the Type 581A so that its trace free runs. Back the STABILITY Control of the Type 581A counterclockwise so that the trace just extinguishes. Note the position of the trace on the test scope. Turn the HORIZONTAL DISPLAY switch on the Type

***If it is desired to check the triggering ability of the Type 581A up to 100 mc, a Tektronix frequency-doubler adapter is recommended for use with the Type 180A. Tektronix part number of the adapter is: 015-056 (BNC connector fittings) or 015-013 (UHF connector fittings).**

581A to the SINGLE SWEEP position. Note the new position of the trace on the test scope. This position should be 10 to 11 volts more positive than the original setting when the Type 581A HORIZONTAL DISPLAY switch was in the INTERNAL SWEEP position. If the difference is not 10 to 11 volts, rotate the LOCKOUT LEVEL Control until the test scope shows a 10 to 11 volt difference.

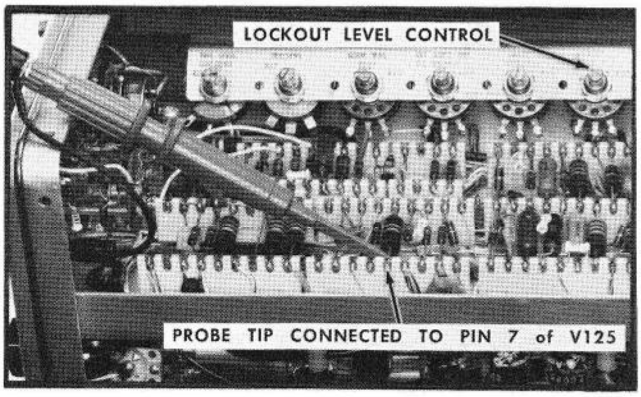

Fig. 6-11. Adjustment of LOCKOUT LEVEL control.

To check the operation of the single sweep circuit, return the HORIZONTAL DISPLAY switch to the INTERNAL SWEEP position. Feed .2 volts of Amplitude Calibrator signal into the EXT INPUT connector of the Type 84. Properly trigger the display while switching the TRIGGER SLOPE switch from + to —. Remove the Amplitude Calibrator signal, turn the HORIZONTAL DISPLAY switch to SINGLE SWEEP and press the RESET button. The READY lamp should light. While observing the Type 581A crt, reconnect the Amplitude Calibrator signal to the Type 84. A single sweep should occur and the READY lamp should go out.

NOTE

In the time-base generator calibration instructions that follow, all of the adjustments, with the exception of steps 22, 24, 28, and 30 interact to some degree. For this reason it is important that you make the adjustments in the proper sequence.

21. Magnifier Gain

Set the Type 581A Oscilloscope controls as follows:

HORIZONTAL DISPLAY	INTERNAL SWEEP
TRIGGER SLOPE	+
TRIGGERING SOURCE	AC-INT
TIME/CM	1 mSEC
5X MAGNIFIER	OFF

Connect a jumper from the EXT INPUT of the Type 84 to the MARKER OUT connector on the Type 180A. Set the Type 180A for 1 mSEC and 100 μSEC markers output. Adjust the triggering controls for a stable display. Turn the 5X MAGNIFIER ON. Adjust the Mag Gain Control to display one large marker every 5 cm and two small markers every cm. Position the entire sweep length. Check to see that the 5X MAGNIFIER indicating lamp is ON.

22. Sweep Magnifier Registration

With the 5X MAGNIFIER switch at the ON position, horizontally position the display so the first marker is directly behind the center vertical graticule line. Set the 5X MAGNIFIER switch to OFF and adjust the Norm Mag Regis Control (see fig. 6-12) so the first marker again falls behind the vertical centerline.

To check the sweep magnifier registration at the center of the display, horizontally position the fifth large time marker behind the vertical centerline and place the 5X MAGNIFIER switch to ON and then to OFF. The time marker should remain stationary at the graticule centerline.

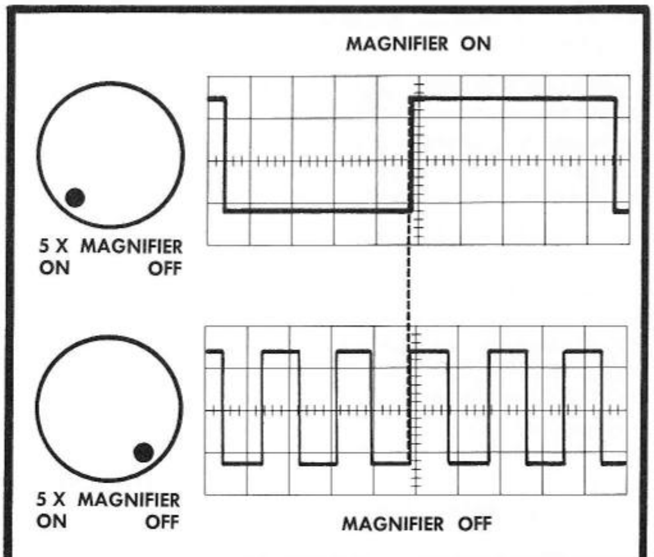

Fig. 6-12. Adjustment of the NORM./MAG. REGIS. control.

NOTE

To calibrate the time-base circuits accurately all timing adjustments are made on the basis of time markers or sine waves appearing between the 1-cm and 9-cm vertical graticule lines.

23. Sweep Calibration

Apply only 1 mSEC markers from the Type 180A and adjust the triggering controls for a stable display. Position the trace to begin at the left edge of the graticule. Adjust the Swp Cal Control (see fig. 6-13) for one time-marker per cm from the 1-cm line to the 9-cm line.

24. Sweep Length

With the controls and display remaining as given in step 23, adjust the Sweep Length Control (see fig. 6-5) for a sweep length of 10.5 centimeters.

25. Check Time Base Sweep Rates—.1 mSEC/CM through 2 SEC/CM

With the same operating conditions as in the previous step, check the sweep rates and timing accuracy (±3%)

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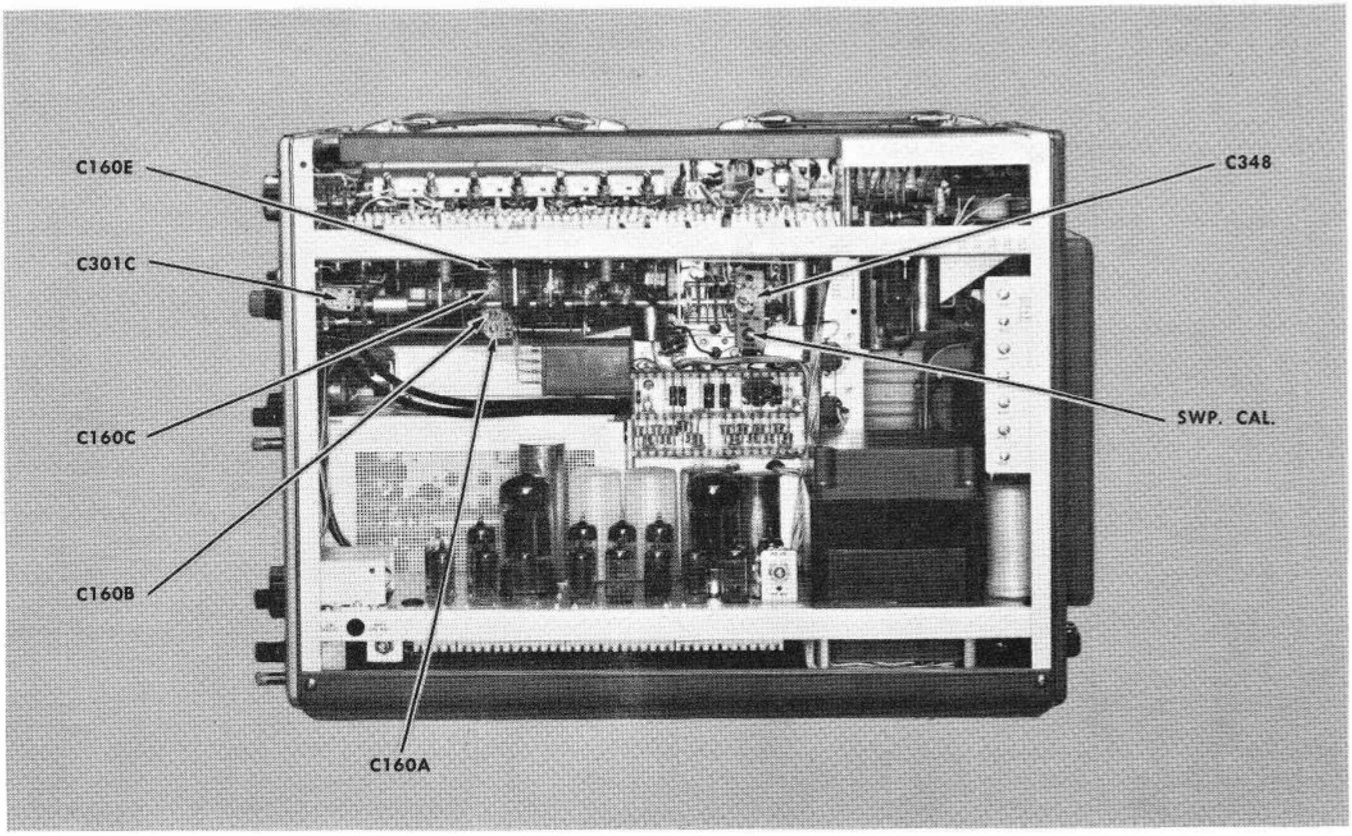


Fig. 6-13. Right Side View, showing location of internal adjustments for timing sweep rates.

according to the information provided in Table 6-1. As noted above, the checks are made from the 1-cm line to the 9-cm line of the graticule.

TABLE 6-1

TIME/CM	TYPE 180	MARKERS DISPLAYED
.1 mSEC	100 μSEC	1/cm
.2 mSEC	100 μSEC	2/cm
.5 mSEC	500 μSEC	1/cm
1 mSEC	1 mSEC	1/cm
2 mSEC	1 mSEC	2/cm
5 mSEC	5 mSEC	1/cm
10 mSEC	10 mSEC	1/cm
20 mSEC	10 mSEC	2/cm
50 mSEC	50 mSEC	1/cm
.1 SEC	100 mSEC	1/cm
.2 SEC	100 mSEC	2/cm
.5 SEC	500 mSEC	1/cm
1 SEC	1 SEC	1/cm
2 SEC	1 SEC	2/cm

26. Check TIME/CM VARIABLE Control and UNCALIBRATED Neon

The VARIABLE Control provides for a complete range of control between the calibrated TIME/CM steps. To check the operation of this control, set the TIME/CM switch at 1 mSEC-CALIBRATED and apply 5 mSEC markers from the Type 180A for a display consisting of 1 marker for each 5 cm. Next, turn the VARIABLE Control fully counterclockwise. The display should now consist of 1 or more markers every 2 cm. Check to see that the UNCALIBRATED neon indicator lamp lights in all positions of the VARIABLE Control except when switched to the CALIBRATED position.

27. Adjust Time Base Sweep Rates—50 μSEC/CM through .01 μSEC/CM

Set the TIME/CM switch at .1 mSEC. Apply 10 μSEC markers from the Type 180A and adjust the triggering controls for a stable display. Turn the 5X MAGNIFIER switch to ON and horizontally position the trace so that the beginning Time marker is aligned with the center graticule line. Then set the TIME/CM switch at 50 μSEC and check for horizontal shift of the beginning marker. If shift occurs, adjust C330 (see fig. 6-5) until the beginning marker of both the .1 mSEC and 50 μSEC positions occur at the same point.

Turn the 5X MAGNIFIER switch to OFF, the TIME/CM switch to 10 μSEC and position the display to start at the left vertical graticule line. Place the TRIGGERING SOURCE switch at EXT AC and connect 100 KC triggers from the Type

180A to the TRIGGER INPUT connector through a coax cable. Proceed with the following adjustments.

TABLE 6-2

TIME/CM	TYPE 180A	Adjust	Observe
10 μSEC	10 μSEC	C160E	1 marker/cm
1 μSEC	1 μSEC	C160C	1 marker/cm
5 μSEC	1 μSEC	C160B	1 marker/2 cm Position 2nd marker to 2nd line on graticule
.1 μSEC	10 MC	C348	1 cycle/cm
.1 μSEC 5X MAG.—ON	50 MC	C384 and C364	1 cycle/cm
.05 μSEC 5X MAG.—ON	50 MC	C160A and C372	1 cycle/2 cm

The following instructions will aid you in making the timing adjustments of Table 6-2.

Due to the interaction between C160B and C348 these adjustments must be repeated to obtain correct timing. Adjust C384 and C364 in equal increments or equal capacitance settings when making these adjustments.

Adjust C160A for correct timing over the center portion of the sweep length. Before adjusting C372, first horizontally position the display until the start coincides with the left edge of the graticule. Adjust C372 for accurate timing from the 4th to the 6th cm horizontal length of the display. Adjust the TRIGGERING LEVEL Control to align the sine waves with the vertical graticule lines. Recheck the accuracy of all the timing adjustments listed in Table 6-2 and check the timing of all the intermediate ranges. Use 10 KC triggers from the Type 180A to obtain a stable display when checking the .05 μSEC/CM sweep rate. After completing this step, disconnect the cable from the TRIGGER INPUT connector.

28. Adjust Ext Horiz DC Bal

Connect the EXT INPUT of the Type 84 with jumper to the SAWTOOTH OUT connector. Set the HORIZONTAL DISPLAY switch at EXT HORIZ ATTEN X1 and connect a jumper lead from the HORIZ INPUT connector to ground. Place the TIME/CM at 2 mSEC. Check to see that the STABILITY Control is set for free-running sweep. Horizontally position the vertical free-running sweep to the center of the graticule. Adjust the Ext Horiz DC Bal Control (see fig. 6-5) for no horizontal shift of the trace while rotating the EXTERNAL HORIZ ATTENUATOR 10-1 Control.

29. Check Horizontal Input Deflection Factor

With conditions as in step 28 above, connect the HORIZ INPUT to the CAL OUT connector. Set the AMPLITUDE CALIBRATOR switch at .2 VOLTS and rotate the EXTERNAL HORIZ ATTENUATOR 10-1 Control fully clockwise. Connect a second jumper lead from the HORIZ INPUT connector to the TRIGGER INPUT connector. Set the TRIGGERING SOURCE switch at EXT AC. Adjust the triggering controls to obtain a stable display. At least 1.2 centimeters of horizontal deflection must be displayed to indicate an adequate deflection factor. Horizontally position the display to start at the first vertical graticule line. Increase the AMPLITUDE CALIBRATOR output to 2 VOLTS. Adjust the EXTERNAL HORIZ ATTENUATOR 10-1 control for exactly 10 cm of horizontal deflection and leave the control at this position until you have completed step 30. Now place the HORIZONTAL DISPLAY switch at EXT HORIZ ATTEN X10. Increase the AMPLITUDE CALIBRATOR output to 20 VOLTS. The horizontal deflection should again be ten centimeters (attenuator accuracy ±3%).

30. Adjust External Horizontal Input Compensation

With the same conditions as in step 29, set the AMPLITUDE CALIBRATOR at 5 VOLTS. Horizontally position the display to the center of the graticule and adjust C301C (see fig. 6-13) for approximately the same waveform shape as obtained in the EXT HORIZ ATTEN X1 position. Place the HORIZONTAL DISPLAY switch at INTERNAL SWEEP and disconnect the jumper leads. Place the TRIGGERING SOURCE switch at the INT AC position.

31. Adjust Vertical System High-Frequency Compensations

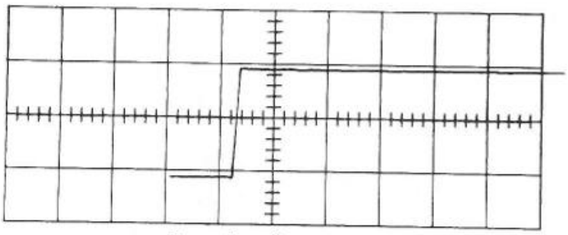
a. Check Vertical Gain

With the Type 84 Plug-In Test Unit in place, recheck the vertical amplifier gain as in step 11.

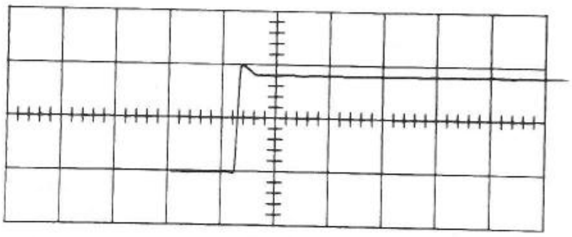
b. Check the Vertical System High Frequency Compensations

This step is a check on the transient response of the vertical amplifier. It can be considered a standardization check or adjustment. Adjustments may need to be made when the CRT is replaced.

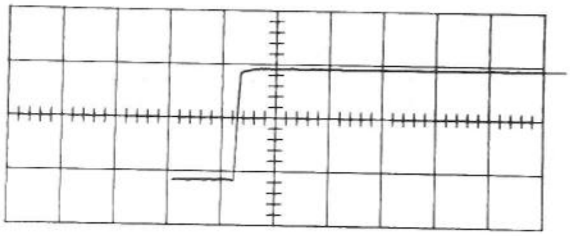
1. Set the oscilloscope TIME/CM to .05 μSEC, the TRIGGER SLOPE to + and the TRIGGERING SOURCE to INT AC LF REJ. Install a CRT viewing hood if working in a lighted room. Set the Type 84 DISPLAY SELECTOR switch to PULSER and adjust the PULSER AMPLITUDE Control for a stable display of about +2 centimeters. It may be necessary to turn the PULSER FREQUENCY knob for a stable display. The display should be similar to fig. 6-14a, with no more than one trace width of overshoot or ringing.
2. The b through g parts of fig. 6-14 indicate the effect upon the display for each of the indicated controls as described in 3 below. Checking your display, with the waveforms showing the effect of each control, can save valuable time when adjustments are required. All adjustments interact to some degree and should be made in the sequence that follows.
3. All adjustments described here are actually impedance matching adjustments. If the impedance of one section of a distributed amplifier does not match the impedance of the previous or following section, there will be an instantaneous change in gain as the signal passes the mismatched section. The result is a change in amplitude of the signal, shown as a bump or dip on the CRT squarewave display.



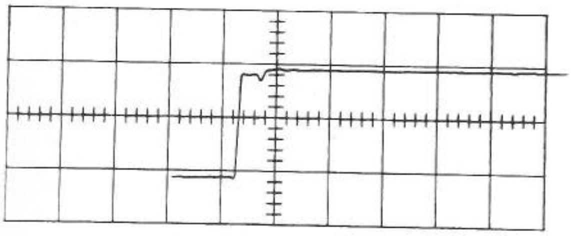
a. Properly adjusted vertical.



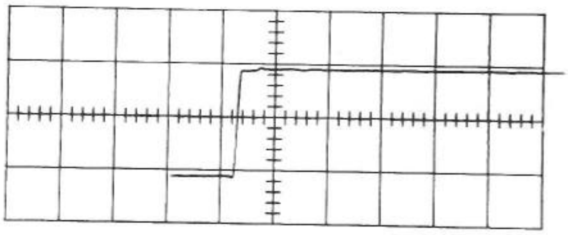
b. C1276 maladjusted



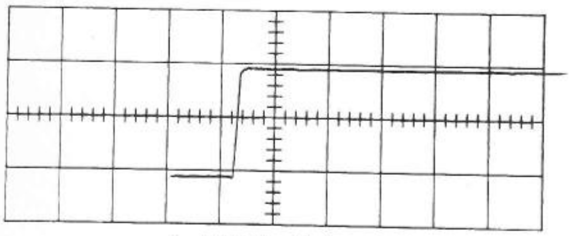
c. R1293 maladjusted



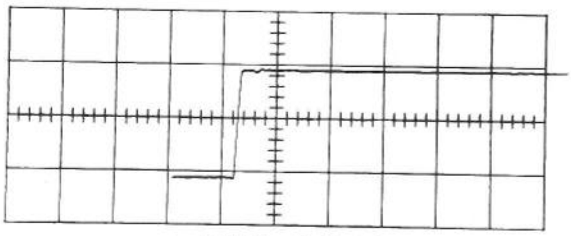
d. C1209 maladjusted



e. C1006 maladjusted



f. C1260 maladjusted



g. C1214 maladjusted

Fig. 6-14. Vertical amplifier transient response waveforms. All taken at sweep rate of .05 μSEC/CM, using a Type 84 Pulser.

Begin the check of the vertical amplifier transient response by comparing the CRT presentation with the waveform of fig. 6-14a. The seven pictures shown that all adjustment controls affect the leading edge of the waveform for about 25 nseconds. Any variations in amplitude in the square-wave shape more than 25 nseconds from the leading edge are not adjustable.

If adjustments are required due to CRT replacement (fig. 6-14b indicates a CRT impedance mismatch), the first adjustment will be R1293, permitting a correction of the mismatch and maybe even making additional adjustments unnecessary.

If after adjusting R1293 the leading edge is found to be spiked or rolled off (fig. 6-14c), this condition may be compensated for by C1276. C1276 is adjusted to give a sharp leading edge at the level of the waveform.

If adjustments are required due to replacement of tubes in the output vertical amplifier, the waveform will probably have a small dip or pip as in fig. 6-14g. Adjust capacitors C1214 through C1254 and C1260 as needed.

If the system risetime (see step 32) is longer than 3.9 nseconds, (10% to 90% part) improve it by adjusting C1260 and C1261. Remember that all adjustments interact, and it may be necessary to adjust R1293, C1276 and then C1260 and C1261. Include any geometry vertical tilt measured in Step 8.

If there have been a number of delay line driver tubes replaced, there may be a need to adjust C1006, as illustrated in fig. 6-14e.

If the waveform appears like figure 6-14d, then C1209 should be adjusted to raise the tunable position of the waveform up to the same level as the non-tunable position.

After any adjustment in the controls just discussed, check the risetime (step 32) before assuming the system is functioning properly.

This completes the transient response standardization of the Type 581A permitting it to be used with any 80 Series Plug-In units.

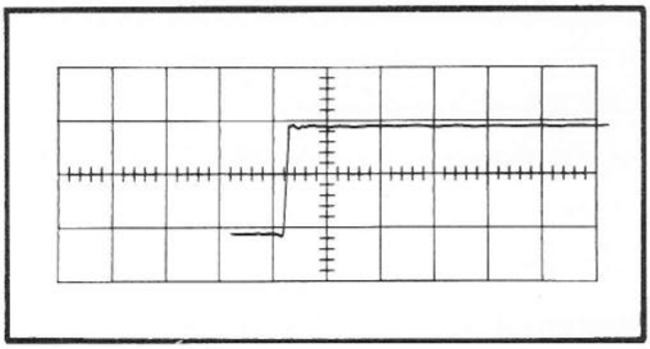


Fig. 6-15. Transient response waveform of Type 581A with Type 80/P80 input. Signal was from modified Type 107 (see text). Vertical amplifier was previously standardized using a Type 84 Plug-In Test Unit. Text describes method of improving the waveform for flatter top following the rise. Sweep rate: .05 μSEC/CM.

32. Check Risetime

A risetime check on the displayed waveform gives very good check on the completeness of your adjustments. To proceed with this step, leave the Type 84 as in step 31. Recheck the PULSE AMPLITUDE Control for exactly 2 centimeters of vertical deflection. Set the Type 581A TIME/CM Control to .05 μSEC and the 5X MAGNIFIER at ON. Under these conditions the time for the pulse to rise from 0.2 to 1.8 centimeters (the 10% to 90% points) should be not longer than 3.9 nseconds. To make this measurement accurately, first use the TRIGGERING LEVEL Control to position the waveform as far to the right as possible from where the sweep starts. Then use the HORIZONTAL POSITION Control so that the center vertical line of the graticule passes through the rising portion of the waveform 0.2 centimeters from bottom of the rise. Measure the horizontal distance between the 0.2 and 1.8 centimeter points. Multiply the horizontal distance measured by 10 nseconds per centimeter to obtain the risetime interval, and then add any vertical geometry tilt recorded in Step 8.

SECTION 7

PARTS LIST AND SCHEMATICS

ABBREVIATIONS

Cer.	Ceramic	p	Pico, or 10^{-12}
Comp.	Composition	PMC	Paper, metal cased
EMC	Electrolytic, metal cased	Poly.	Polystyrene
EMT	Electrolytic, metal tubular	Prec.	Precision
f	Farad	PT	Paper, tubular
F & I	Focus and Intensity	PTM	Paper, tubular, moulded
G	Giga, or 10^9	S/N	Serial number
GMV	Guaranteed minimum value	T	Turns
h	Henry	TD	Toroid
K or k	Kilohms, or kilo (10^3)	Tub.	Tubular
M or meg	Megohms, or mega (10^6)	v	Working volts DC
μ	Micro, or 10^{-6}	Var.	Variable
m	Milli, or 10^{-3}	w	Watt
n	Nano, or 10^{-9}	w/	With
Ω	Ohm	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, also reworked or checked components.

Use 000-000 Part number indicated is direct replacement.

HOW TO ORDER PARTS

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 Field Office will contact you concerning any change in part number.

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description		S/N Range

Bulbs

Ckt. No.	Tektronix Part No.	Description		S/N Range
B129	Use 150-027	Neon, NE-23	READY	
B160W	Use 150-027	Neon, NE-23	UNCALIBRATED	
B167	Use 150-027	Neon, NE-23		
B171	Use 150-027	Neon, NE-23		
B347	Use 150-027	Neon, NE-23		
B386	Use 150-027	Neon, NE-23		
B397	Use 150-027	Neon, NE-23		
B398	Use 150-027	Neon, NE-23		
B601	150-001	Incandescent, #47 Graticule Light		3975-4999
B601	150-031	Incandescent, #44 Graticule Light		5000-up
B602	150-001	Incandescent, #47 Graticule Light		3975-4999
B602	150-031	Incandescent, #44 Graticule Light		5000-up
B603	150-001	Incandescent, #47 Pilot Light		
B1088	Use 150-027	Neon, NE-23		
B1098	Use 150-027	Neon, NE-23		

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors are as follows (with exceptions):

3 V — 50 V = −10%, +250%
51 V — 350 V = −10%, +100%
351 V — 450 V = −10%, +50%

Ckt. No.	Tektronix Part No.	Value	Type	Voltage	Tolerance
C1	283-002	.01 μf	Disc Type	500 v	
C2	283-002	.01 μf	Disc Type	500 v	
C3	281-523	100 pf	Cer.	350 v	
C4	283-000	.001 μf	Disc Type	500 v	
C5	281-550	120 pf	Cer.	500 v	10%
C6	283-002	.01 μf	Disc Type	500 v	
C7	283-002	.01 μf	Disc Type	500 v	
C8	281-523	100 pf	Cer.	350 v	
C21	283-001	.005 μf	Disc Type	500 v	
C22	283-000	.001 μf	Disc Type	500 v	
C40	283-001	.005 μf	Disc Type	500 v	
C43	283-013	.01 μf	Disc Type	1000 v	
C44	281-524	150 pf	Cer.	500 v	
C45	281-536	1000 pf	Cer.	500 v	10%
C102	283-004	.02 μf	Disc Type	150 v	
C116	283-000	.001 μf	Disc Type	500 v	
C120	283-001	.005 μf	Disc Type	500 v	
C123	281-541	6.8 pf	Cer.	500 v	10%
C129	283-002	.01 μf	Disc Type	500 v	
C134	281-504	10 pf	Cer.	500 v	10%

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
C138	283-002	.01 μf	Disc Type		500 v		
C141	281-544	5.6 pf	Cer.		500 v	10%	
C150	281-528	82 pf	Cer.		500 v	10%	
C151	281-543	270 pf	Cer.		500 v	10%	
C154	281-543	270 pf	Cer.		500 v	10%	
C160A	281-005	1.5-7 pf	Cer.	Var.			
C160B	281-007	3-12 pf	Cer.	Var.			
C160C	281-010	4.5-25 pf	Cer.	Var.			
C160D	283-534	82 pf	Mica		500 v	5%	
C160E	281-010	4.5-25 pf	Cer.	Var.			
C160F	283-534	82 pf	Mica		500 v	5%	
C160G	*291-008	.001 μf				½%	
C160H }		.01 μf					
C160J }	*291-007	.1 μf		Timing Series		½%	
C160K }		1 μf					
C160M	281-513	27 pf	Cer.		500 v		X4060-up
C160L	281-543	270 pf	Cer.		500 v	10%	
C161	281-500	2.2 pf	Cer.		500 v	±.5 pf	
C163	283-006	.02 μf	Disc Type		600 v		
C165	281-523	100 pf	Cer.		350 v		
C167	283-000	.001 μf	Disc Type		500 v		
C170	283-001	.005 μf	Disc Type		500 v		
C180A	283-509	180 pf	Mica		500 v	10%	
C180B	285-543	.0022 μf	MT		400 v		
C180C	285-515	.022 μf	MT		400 v		
C180D	285-526	.1 μf	MT		400 v		
C180E	285-526	.1 μf	MT		400 v		
C181	281-516	39 pf	Cer.		500 v	10%	
C187	283-001	.005 μf	Disc Type		500 v		
C190	281-508	12 pf	Cer.		500 v	±.6 pf	
C193	283-002	.01 μf	Disc Type		500 v		
C196	283-000	.001 μf	Disc Type		500 v		
C197	283-001	.005 μf	Cer.		500 v		
C301C	281-012	7-45 pf	Cer.	Var.			
C301E	281-546	330 pf	Cer.		500 v	10%	
C301H	281-510	22 pf	Cer.		500 v		
C320	283-001	.005 μf	Disc Type		500 v		
C330	281-010	4.5-25 pf	Cer.	Var.			
C331	281-504	10 pf	Cer.		500 v	10%	
C336	283-001	.005 μf	Disc Type		500 v		
C340	281-504	10 pf	Cer.		500 v	10%	
C343	283-001	.005 μf	Disc Type		500 v		
C347	283-000	.001 μf	Disc Type		500 v		
C348	281-007	3-12 pf	Cer.	Var.			
C355	281-526	1.5 pf	Cer.		500 v	±.5 pf	
C356	283-001	.005 μf	Disc Type		500 v		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part. No.	Description					S/N Range
C364	281-036	3-12 pf	Cer.	Var.			
C372	281-023	9-180 pf	Mica	Var.			
C380	290-000	6.25 μf	EMT		300 v		
C384	281-036	3-12 pf	Cer.	Var.			
C390	281-501	4.7 pf	Cer.		500 v	±1 pf	
C393	285-519	.047 μf	MT		400 v		
C397	283-001	.005 μf	Disc Type		500 v		
C601	283-004	.02 μf	Disc Type		150 v		
C610	285-510	.01 μf	MT		400 v		
C617	285-510	.01 μf	MT		400 v		
C628	285-510	.01 μf	MT		400 v		
C640	use 290-016	125 μf	EMC		350 v		
C648	283-002	.01 μf	Disc Type		500 v		
C649	use 290-012	2 x 40 μf	EMC		250 v		
C650	285-510	.01 μf	MT		400 v		
C670	use 290-130	2 x 125 μf	EMC		350 v		
C671	use 290-173	200 μf	EMC		250 v		
C679	use 290-005	3 x 10 μf	EMC		450 v		
C680	285-510	.01 μf	MT		400 v		
C688	285-510	.01 μf	MT		400 v		
C700	use 290-017	125 μf	EMC		450 v		
C710	285-511	.01 μf	PTM		600 v		
C730	use 290-016	125 μf	EMC		350 v		
C740	285-510	.01 μf	MT		400 v		
C760	use 290-013	2 x 40 μf	EMC		450 v		
C770	283-001	.005 μf	Disc Type		500 v		
C771	283-001	.005 μf	Disc Type		500 v		
C782	283-003	.01 μf	Disc Type		150 v		
C783	290-135	15 μf	EMT		20 v		
C786	290-015	100 μf	EMT		25 v		
C790	use 290-174	4500 μf	EMC		25 v		
C791	use 290-174	4500 μf	EMC		25 v		
C792	use 290-174	4500 μf	EMC		25 v		
C793	use 283-057	.1 μf	Disc Type		200 v		
C801	285-519	.047 μf	MT		400 v		
C802	290-037	2 x 20 μf	EMC		450 v		
C803	285-501	.001 μf	MT		600 v		
C806	285-510	.01 μf	MT		400 v		
C808	285-501	.001 μf	MT		600 v		
C819	use 283-057	.1 μf	Disc Type		200 v		
C820	283-011	.01 μf	Disc Type		2000 v		
C821	283-011	.01 μf	Disc Type		2000 v		
C827	283-011	.01 μf	Disc Type		2000 v		
C828	283-011	.01 μf	Disc Type		2000 v		
C829	283-000	.001 μf	Disc Type		500 v		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C831	283-011	.01 μf	Disc Type		2000 v		
C832	283-034	.005 μf	Disc Type		4000 v		
C833	281-556	500 pf	Cer.		10000 v		
C834	281-556	500 pf	Cer.		10000 v		
C836	281-556	500 pf	Cer.		10000 v		
C841	283-006	.02 μf	Disc Type		600 v		
C842	283-011	.01 μf	Disc Type		2000 v		
C845	283-011	.01 μf	Disc Type		2000 v		
C848	283-011	.01 μf	Disc Type		2000 v		
C871	283-518	330 μf	Mica		500 v	10%	
C874	283-518	330 μf	Mica		500 v	10%	
C885	281-513	27 μf	Cer.		500 v		
C897	283-000	.001 μf	Disc Type		500 v		
C1004	290-111	250 μf	EMT		6 v		
C1006	Use 281-036	3-12 pf	Cer.	Var.			
C1011	281-557	1.8 pf	Cer.		500 v		
C1012	281-557	1.8 pf	Cer.		500 v		
C1013	283-000	.001 μf	Disc Type		500 v		
C1014	281-537	.68 pf	Cer.		500 v	±0.136 pf	
C1021	281-557	1.8 pf	Cer.		500 v		
C1022	281-557	1.8 pf	Cer.		500 v		
C1023	283-000	.001 μf	Disc Type		500 v		
C1024	281-537	.68 pf	Cer.		500 v	±0.136 pf	
C1031	281-557	1.8 pf	Cer.		500 v		
C1032	281-557	1.8 pf	Cer.		500 v		
C1033	283-000	.001 μf	Disc Type		500 v		
C1034	281-538	1 pf	Cer.		500 v		
C1041	281-027	.7-3 pf	Tub.	Var.			
C1042	281-027	.7-3 pf	Tub.	Var.			
C1043	283-000	.001 μf	Disc Type		500 v		
C1044	281-538	1 pf	Cer.		500 v		
C1051	281-557	1.8 pf	Cer.		500 v		
C1052	281-557	1.8 pf	Cer.		500 v		
C1053	283-000	.001 μf	Disc Type		500 v		
C1054	281-529	1.5 pf	Cer.		500 v	±.25 pf	
C1061	281-557	1.8 pf	Cer.		500 v		
C1062	281-557	1.8 pf	Cer.		500 v		
C1063	283-000	.001 μf	Disc Type		500 v		
C1064	281-529	1.5 pf	Cer.		500 v	±.25 pf	
C1071	281-557	1.8 pf	Cer.		500 v		
C1072	281-557	1.8 pf	Cer.		500 v		
C1074	281-557	1.8 pf	Cer.		500 v		
C1080	283-000	.001 μf	Disc Type		500 v		
C1082	283-000	.001 μf	Disc Type		500 v		
C1084	283-001	.005 μf	Disc Type		500 v		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
C1088	283-001	.005 μf	Disc Type		500 v	
C1090	283-000	.001 μf	Disc Type		500 v	
C1092	283-000	.001 μf	Disc Type		500 v	
C1094	283-001	.005 μf	Disc Type		500 v	
C1098	283-001	.005 μf	Disc Type		500 v	
C1101	283-006	.02 μf	Disc Type		600 v	
C1102	290-002	8 μf	EMT		450 v	
C1103	283-006	.02 μf	Disc Type		600 v	
C1105	283-006	.02 μf	Disc Type		600 v	
C1106	285-537	.5 μf	MPT		400 v	
C1107	283-006	.02 μf	Disc Type		600 v	
C1204	283-003	.01 μf	(nominal value)		Selected	
C1205	283-003	.01 μf	(nominal value)		Selected	
C1209	281-011	5-25 pf	Cer.	Var.		
C1210	283-006	.02 μf	Disc Type		600 v	
C1211	281-557	1.8 pf	Cer.		500 v	
C1212	281-557	1.8 pf	Cer.		500 v	
C1213	283-000	.001 μf	Disc Type		500 v	
C1214	Use 281-053	.35-1.37 pf	Poly.	Var.		
C1221	281-557	1.8 pf	Cer.		500 v	
C1222	281-557	1.8 pf	Cer.		500 v	
C1223	283-000	.001 μf	Disc Type		500 v	
C1224	281-027	.7-3 pf	Tub.	Var.		
C1231	281-557	1.8 pf	Cer.		500 v	
C1232	281-557	1.8 pf	Cer.		500 v	
C1233	283-000	.001 μf	Disc Type		500 v	
C1234	281-027	.7-3 pf	Tub.	Var.		
C1241	281-557	1.8 pf	Cer.		500 v	
C1242	281-557	1.8 pf	Cer.		500 v	
C1243	283-000	.001 μf	Disc Type		500 v	
C1244	281-027	.7-3 pf	Tub.	Var.		
C1251	281-557	1.8 pf	Cer.		500 v	
C1252	281-557	1.8 pf	Cer.		500 v	
C1253	283-000	.001 μf	Disc Type		500 v	
C1254	281-027	.7-3 pf	Tub.	Var.		
C1255	281-557	1.8 pf	Cer.		500 v	
C1258	283-001	.005 μf	Disc Type		500 v	
C1260	281-027	.7-3 pf	Tub.	Var.		
C1261	281-027	.7-3 pf	Tub.	Var.		
C1276	281-060	2-8 pf	Cer.	Var.		

Diodes

D36	*152-138	Point contact w/axial lead
D37	*152-138	Point contact w/axial lead

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D44	152-008	Germanium T12G	
D47	152-140	Tunnel 1N3848 10 MA	
D134	152-025	Germanium 1N634	
D142	152-008	Germanium	
D642A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D672A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D702A,B	*152-047	Silicon Replaceable by 1N2862	
D732A,B	*152-047	Silicon Replaceable by 1N2862	
D762A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D792A,B,C,D	152-113	Silicon RCA 40108	
D793	152-008	Germanium	
D1284	*152-075	Germanium Tek Spec	X5000-up

Fuses

Ckt. No.	Tektronix Part No.	Description	S/N Range
F601	159-013	6 Amp 3AG Fast-Blo 117 v oper. 60 cycle	
	159-011	6.25 Amp 3AG Slo-Blo 117 v oper. 50 cycle	
	159-015	3 Amp 3AG Fast-Blo 234 v oper. 60 cycle	
	159-005	3 Amp 3AG Slo-Blo 234 v oper. 50 cycle	
F790	159-038	15 Amp 3AG Fast-Blo	X4250-up
F1210	159-049	.15 Amp Fast-Blo w/Pig Tail	
F1260	159-049	.15 Amp Fast-Blo w/Pig Tail	
F1285	159-049	.15 Amp Fast-Blo w/Pig Tail	

Relays

Ckt. No.	Tektronix Part No.	Description	S/N Range
K600	148-002	6 v 45 Sec. Delay	3975-5049
K600	148-023	18 v 30 Sec. Delay	5050-up
K601	148-012	18 v DC 150 Ω	

Inductors

Ckt. No.	Tektronix Part No.	Description	S/N Range
L4	*108-220	.15 μh	
L12	*108-220	.15 μh	
L47	*108-057	8.8 μh	
L865	*108-296	Beam Rotator	X5000-up
L914	Use *108-267	Delay Line	
L1013	276-528	Core, Ferramic Suppressor	
L1014	*108-196	Plate Line, 8 Section	
L1015	*108-197	Grid Line, 7 Section	
L1023	276-528	Core, Ferramic Suppressor	
L1024	*108-196	Plate Line, 8 Section	
L1025	*108-197	Grid Line, 7 Section	
L1033	276-528	Core, Ferramic Suppressor	
L1043	276-528	Core, Ferramic Suppressor	
L1053	276-528	Core, Ferramic Suppressor	
L1063	276-528	Core, Ferramic Suppressor	
L1083	*108-221	.45 μh	

Inductors *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
L1093	*108-221	.45 μh	
L1214	*108-198	Plate Line, 6 Section	
L1215	*108-199	Grid Line, 5 Section	
L1224	*108-198	Plate Line, 6 Section	
L1225	*108-199	Grid Line, 5 Section	
L1282	*108-181	.2 μh	
L1283	*108-181	.2 μh	
L1286	*108-181	.2 μh	
L1287	*108-181	.2 μh	

Resistors

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

R1	302-185	1.8 meg	½ w			
R2	316-101	100 Ω	¼ w			
R3	316-105	1 meg	¼ w			
R4	316-104	100 k	¼ w			
R6	316-104	100 k	¼ w			
R7	316-470	47 Ω	¼ w			
R8	316-104	100 k	¼ w			
R12	316-105	1 meg	¼ w			
R13	301-223	22 k	½ w			5%
R14	316-823	82 k	¼ w			
R15	316-474	470 k	¼ w			
R16	302-475	4.7 meg	½ w			
R17†	311-096	100 k		Var.		TRIGGERING LEVEL
R20	316-470	47 Ω	¼ w			
R21	302-470	47 Ω	½ w			
R24	304-822	8.2 k	1 w			
R25	306-822	8.2 k	2 w			
R26	311-353	25 k	3 w	Var.		TRIG. LEVEL CENT.
R27	316-470	47 Ω	¼ w			
R28	308-069	12 k	8 w		WW	5%
R34	use 306-103	10 k	2 w			
R36	302-471	470 Ω	½ w			
R37	303-243	24 k	1 w			5%
R40	302-470	47 Ω	½ w			
R41	302-683	68 k	½ w			
R43	302-682	6.8 k	½ w			
R44	304-223	22 k	1 w			
R46	308-135	5 k	5 w		WW	5%
R47	311-238	30 Ω		Var.	WW	TRIG. SENS.
R48	301-180	18 Ω	½ w			5%

† Concentric with R110 and SW110. Furnished as a unit.

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R101	302-475	4.7 meg	½ w				
R102	302-185	1.8 meg	½ w				
R110†	311-096	100 k		Var.		STABILITY	
R111	311-219	200 k	.2 w	Var.		PRESET ADJUST	
R114	301-564	560 k	½ w			5%	
R115	301-154	150 k	½ w			5%	
R116	301-224	220 k	½ w			5%	
R119	302-101	100 Ω	½ w				
R120	302-470	47 Ω	½ w				
R121	302-470	47 Ω	½ w				
R122	302-223	22 k	½ w				
R123	302-334	330 k	½ w				
R124	302-334	330 k	½ w				
R125	311-023	50 k		Var.		LOCKOUT LEVEL	
R126	302-104	100 k	½ w				
R127	302-101	100 Ω	½ w				
R128	302-123	12 k	½ w				
R129	302-103	10 k	½ w				
R130	306-223	22 k	2 w				
R133	302-104	100 k	½ w				
R134	*310-555	6 k	3 w	Mica Plate		(3 k Tap)	
R137	302-470	47 Ω	½ w				
R138	302-101	100 Ω	½ w				
R141	310-093	45 k	1 w		Prec.	1%	
R143	310-070	33 k	1 w		Prec.	1%	
R144	308-053	8 k	5 w		WW	5%	
R146	302-470	47 Ω	½ w				
R147	302-103	10 k	½ w				
R148	304-183	18 k	1 w				
R149	302-470	47 Ω	½ w				
R150	302-271	270 Ω	½ w				
R151	302-102	1 k	½ w				
R152	302-681	680 Ω	½ w				
R153	306-333	33 k	2 w				
R154	302-102	1 k	½ w				
R160A	309-045	100 k	½ w		Prec.	1%	
R160B	309-051	200 k	½ w		Prec.	1%	
R160C	309-033	500 k	½ w		Prec.	1%	
R160D	309-014	1 meg	½ w		Prec.	1%	
R160E	309-023	2 meg	½ w		Prec.	1%	
R160F	309-087	5 meg	½ w		Prec.	1%	
R160G	310-107	10 meg	1 w		Prec.	1%	
R160H	310-107	10 meg	1 w		Prec.	1%	
R160V	302-105	1 meg	½ w				
R160W	302-104	100 k	½ w				

† Concentric with R17 and ganged with SW110. Furnished as a unit.

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R160X	302-103	10 k	½ w				
R160Y†	311-108	20 k		Var.	WW	VARIABLE	
R163	302-470	47 Ω	½ w				
R165	308-081	20 k	8 w		WW	5%	
R166	308-108	15 k	5 w		WW	5%	
R167	302-155	1.5 meg	½ w				
R168	302-473	47 k	½ w				
R170	302-470	47 Ω	½ w				
R171	302-470	47 Ω	½ w				
R172	302-470	47 Ω	½ w				
R173	302-471	470 Ω	½ w				
R174	308-053	8 k	5 w		WW	5%	
R176	311-008	2 k		Var.		SWEEP LENGTH	
R178	308-062	3 k	5 w		WW	5%	
R180A	302-474	470 k	½ w				
R180B	302-475	4.7 meg	½ w				
R181	302-475	4.7 meg	½ w				
R183	302-101	100 Ω	½ w				
R186	302-101	100 Ω	½ w				
R187	302-470	47 Ω	½ w				
R189	306-563	56 k	2 w				
R190	302-473	47 k	½ w				
R191	302-104	100 k	½ w				
R192	302-101	100 Ω	½ w				
R193	302-101	100 Ω	½ w				
R194	304-472	4.7 k	1 w				
R196	302-104	100 k	½ w				
R197	302-470	47 Ω	½ w				
R199	304-104	100 k	1 w				
R300	302-470	47 Ω	½ w				
R301C	309-111	900 k	½ w		Prec.	1%	
R301E	309-046	111 k	½ w		Prec.	1%	
R303	302-105	1 meg	½ w				
R311	302-102	1 k	½ w				
R313	306-333	33 k	2 w				
R314	use 311-0571-00	15 k		Var.		VARIABLE 10-1	
R315	306-333	33 k	2 w				
R317	311-026	100 k		Var.		EXT. HORIZ. DC BAL.	
R319	302-224	220 k	½ w				
R320	302-332	3.3 k	½ w				
R321	302-101	100 Ω	½ w				
R324	306-273	27 k	2 w				
R330	309-017	1.5 meg	½ w		Prec.	1%	
R332	309-086	3.5 meg	½ w		Prec.	1%	

† Furnished as a unit with SW160, and SW160Y.

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R333†	311-149	100 k		Var.		HORIZONTAL POSITION	
R336	309-268	12.1 meg	½ w		Prec.	1%	
R338†	311-149	200 k		Var.		VERNIER	
R340	302-272	2.7 k	½ w				
R341	302-101	100 Ω	½ w				
R343	302-470	47 Ω	½ w				
R345	306-473	47 k	2 w				
R347	302-104	100 k	½ w				
R348	311-125	50 k	.2 w	Var.		SWP. CAL.	
R349	309-151	174 k	½ w		Prec.	1%	3975-5099
	323-414	200 k	½ w		Prec.	1%	5100-up
R351	302-101	100 Ω	½ w				
R353	306-473	47 k	2 w				
R355	310-094	400 k	1 w		Prec.	1%	
R356	310-094	400 k	1 w		Prec.	1%	
R357	302-223	22 k	½ w				
R358	311-018	20 k		Var.		NORM. MAG. REGIS.	
R361	302-470	47 Ω	½ w				
R364	*310-558	15 k	7 w	Mica Plate (3 k Tap)			
R366	302-470	47 Ω	½ w				
R372	311-120	2.5 k	.2 w	Var.		MAG. GAIN	3975-5099
	311-323	1.5 k		Var.		MAG. GAIN	5100-up
R373	323-633	801 Ω	½ w		Prec.	1%	X5100-up
R374	308-053	8 k	5 w		WW	5%	3975-5099
R374	308-302	20 k	5 w		WW	1%	5100-up
R375	308-053	8 k	5 w		WW	5%	
R376	308-077	1 k	3 w		WW		X5100-up
R380	302-101	100 Ω	½ w				
R381	302-470	47 Ω	½ w				
R384	*310-558	15 k	7 w	Mica Plate (3 k Tap)			3975-5049
	*310-600	18 k/4.5 k	8 w		Prec.	1%	5100-up
R386	302-470	47 Ω	½ w				
R387	306-393	39 k	2 w				
R388	306-393	39 k	2 w				
R390	302-222	2.2 k	½ w				
R391	302-470	47 Ω	½ w				
R393	Use 302-271	270 Ω	½ w				
R396	302-474	470 k	½ w				
R397	302-155	1.5 meg	½ w				
R398	302-155	1.5 meg	½ w				
R399	302-474	470 k	½ w				
R600	306-330	33 Ω	2 w				3975-5049X
R601	308-142	30 Ω	3 w		WW	5%	3975-4999X
R602	311-055	50 Ω		Var.	WW	SCALE ILLUM.	3975-4999
R602	311-377	25 Ω		Var.	WW	SCALE ILLUM.	5000-up
R608	302-333	33 k	½ w				
R610	302-104	100 k	½ w				
R615	310-054	68 k	1 w		Prec.	1%	
R616	311-015	10 k		Var.	WW	—150 V	
R617	310-086	50 k	1 w		Prec.	1%	
R618	302-104	100 k	½ w				

† R333 and R338 are concentric. Furnished as a unit.

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R621	302-102	1 k	½ w			
R623	302-474	470 k	½ w			
R625	302-104	100 k	½ w			
R628	302-275	2.7 meg	½ w			
R629	302-275	2.7 meg	½ w			
R633	302-105	1 meg	½ w			
R635	304-153	15 k	1 w			
R636	304-153	15 k	1 w			
R637	302-154	150 k	½ w			
R638	302-273	27 k	½ w			
R639	302-683	68 k	½ w			
R640	304-100	10 Ω	1 w			
R641	304-100	10 Ω	1 w			
R642	Use 306-563	56 k	2 w			
R643	302-102	1 k	½ w			
R644	302-102	1 k	½ w			
R647	308-040	1.5 k	25 w	WW	5%	3975-5099
R647	308-102	1.25 k	25 w	WW	5%	5100-up
R648	302-100	10 Ω	½ w			
R650	310-056	333 k	1 w	Prec.	1%	
R651	310-057	490 k	1 w	Prec.	1%	
R663	302-155	1.5 meg	½ w			
R667	302-684	680 k	½ w			
R668	302-473	47 k	½ w			
R669	302-393	39 k	½ w			
R670	306-100	10 Ω	2 w			
R676	308-020	3 k	10 w	WW	5%	
R677	308-065	2 k	25 w	WW	5%	
R678	308-065	2 k	25 w	WW	5%	
R680	310-056	333 k	1 w	Prec.	1%	
R681	310-055	220 k	1 w	Prec.	1%	
R682	302-124	120 k	½ w			
R683	302-102	1 k	½ w			
R685	304-823	82 k	1 w			
R686	302-184	180 k	½ w			
R688	302-155	1.5 meg	½ w			
R689	302-225	2.2 meg	½ w			
R692	302-102	1 k	½ w			
R693	302-155	1.5 meg	½ w			
R697	302-105	1 meg	½ w			
R698	302-274	270 k	½ w			
R699	302-563	56 k	½ w			
R700	306-100	10 Ω	2 w			
R702	306-104	100 k	2 w			
R710	310-124	237 k	1 w	Prec.	1%	
R711	Use 323-385	100 k	½ w	Prec.	1%	
R712	302-154	150 k	½ w			

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R723	302-155	1.5 meg	½ w				
R727	302-105	1 meg	½ w				
R728	302-564	560 k	½ w				
R729	302-473	47 k	½ w				
R730	304-100	10 Ω	1 w				
R731	304-100	10 Ω	1 w				
R732	304-104	100 k	1 w				
R734	302-102	1 k	½ w				
R736	308-065	2 k	25 w		WW	5%	
R737	308-032	3.5 k	20 w		WW	5%	
R740	310-055	220 k	1 w		Prec.	1%	
R741	310-059	720 k	1 w		Prec.	1%	
R753	302-105	1 meg	½ w				
R757	302-154	150 k	½ w				
R758	302-124	120 k	½ w				
R759	302-273	27 k	½ w				
R760	302-100	10 Ω	½ w				
R767	308-113	3 k	8 w		WW	5%	
R770	302-104	100 k	½ w				
R772	302-104	100 k	½ w				
R773	302-104	100 k	½ w				
R780	303-303	30 k	1 w			5%	
R781A	309-154	30 k	½ w		Prec.	1%	
R781B	309-154	30 k	½ w		Prec.	1%	
R782	309-181	2.5 k	½ w		Prec.	1%	
R783	301-163	16 k	½ w			5%	
R784	304-104	100 k	1 w				
R785	311-017	10 k	.1 w	Var.		+12.6 V	
R786	304-271	270 Ω	1 w				3975-4999
R786	304-102	1 k	1 w				5000-up
R791A	308-142	30 Ω	3 w		WW	5%	
R791B	308-175	10 Ω	10 w		WW	5%	
R791C	308-175	10 Ω	10 w		WW	5%	
R791D	308-142	30 Ω	3 w		WW	5%	
R793	308-054	10 k	5 w		WW	5%	
R794	302-330	33 Ω	½ w				
R801	302-102	1 k	½ w				
R802	306-391	390 Ω	2 w				
R803	306-563	56 k	2 w				
R806	302-104	100 k	½ w				
R807	302-102	1 k	½ w				
R814	302-474	470 k	½ w				
R818	302-185	1.8 meg	½ w				
R819	302-185	1.8 meg	½ w				
R820	302-473	47 k	½ w				
R824	302-475	4.7 meg	½ w				
R825	302-475	4.7 meg	½ w				

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R826	311-041	1 meg		Var.		INTENSITY	
R827	302-333	33 k	½ w				
R828	302-105	1 meg	½ w				
R829	302-183	18 k	½ w				
R836	302-105	1 meg	½ w				
R840	311-042	2 meg		Var.		H. V.	
R841	302-225	2.2 meg	½ w				
R842	302-475	4.7 meg	½ w				
R843	302-475	4.7 meg	½ w				
R844	302-475	4.7 meg	½ w				
R845	302-103	10 k	½ w				
R847	302-273	27 k	½ w				
R848	302-105	1 meg	½ w				
R853	302-225	2.2 meg	½ w				
R854	302-225	2.2 meg	½ w				
R856	311-043	2 meg		Var.		FOCUS	
R857	302-105	1 meg	½ w				
R860	311-088	100 k	.2 w	Var.		VERT. SHIELD VOLTS	
R861	311-026	100 k		Var.		GEOM.	
R862	302-473	47 k	½ w				
R863	302-473	47 k	½ w				
R864	311-023	50 k		Var.		ASTIGMATISM	3975-4999
R864 }	Use 311-507	100 k		Var.		ASTIGMATISM	
R865 }		2 x 500 Ω				TRACE ROTATION	5000-up
R870	302-154	150 k	½ w				
R871	302-275	2.7 meg	½ w				
R872	302-102	1 k	½ w				
R874	302-395	3.9 meg	½ w				
R875	302-683	68 k	½ w				
R876	302-102	1 k	½ w				
R878	304-333	33 k	1 w				
R879	311-016	10 k		Var.		CAL. ADJ.	
R880	302-104	100 k	½ w				
R883	302-101	100 Ω	½ w				
R885	309-121	9.5 k	½ w		Prec.	1%	
R886	309-119	6.375 k	½ w		Prec.	1%	
R887	309-117	2.1 k	½ w		Prec.	1%	
R888	309-116	1.025 k	½ w		Prec.	1%	
R889	309-113	610 Ω	½ w		Prec.	1%	
R890	309-073	200 Ω	½ w		Prec.	1%	
R891	309-112	100 Ω	½ w		Prec.	1%	
R892	309-067	60 Ω	½ w		Prec.	1%	
R893	309-066	40 Ω	½ w		Prec.	1%	
R896	309-045	100 k	½ w		Prec.	1%	
R897	309-112	100 Ω	½ w		Prec.	1%	
R898	302-101	100 Ω	½ w				
R899	*308-090	.25 Ω	1 w		WW		

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description						S/N Range
R1004	319-060	1.24 k	¼ w		Prec.	1%		
R1005	319-060	1.24 k	¼ w		Prec.	1%		
R1007	302-150	15 Ω	½ w					
R1008	309-128	50 Ω	½ w		Prec.	1%		
R1009	309-128	50 Ω	½ w		Prec.	1%		
R1011	309-067	60 Ω	½ w		Prec.	1%		
R1012	309-067	60 Ω	½ w		Prec.	1%		
R1013	308-062	3 k	5 w		WW	5%		
R1014		Selected						X5590-up
R1015	311-005	500 Ω		Var.		VERT. GAIN		
R1017	316-151	150 Ω	¼ w					
R1023	308-062	3 k	5 w		WW	5%		
R1027	316-151	150 Ω	¼ w					
R1033	308-062	3 k	5 w		WW	5%		
R1037	316-151	150 Ω	¼ w					
R1043	308-062	3 k	5 w		WW	5%		
R1047	316-151	150 Ω	¼ w					
R1053	308-062	3 k	5 w		WW	5%		
R1057	316-151	150 Ω	¼ w					
R1063	308-062	3 k	5 w		WW	5%		
R1066	302-101	100 Ω	½ w					
R1067	316-151	150 Ω	¼ w					
R1073	308-062	3 k	5 w		WW	5%		
R1076	302-101	100 Ω	½ w					
R1077	316-151	150 Ω	¼ w					
R1079	306-822	8.2 k	2 w					
R1080	302-153	15 k	½ w					
R1081	*310-533	1.8 k	2 w	Mica Plate		1%		
R1082	302-101	100 Ω	½ w					
R1084	304-472	4.7 k	1 w					
R1085	302-123	12 k	½ w					
R1087	302-224	220 k	½ w					
R1088A	302-105	1 meg	½ w					
R1088B	316-333	33 k	¼ w					
R1089	302-474	470 k	½ w					
R1090	302-473	47 k	½ w					
R1091	*310-533	1.8 k	2 w	Mica Plate		1%		
R1092	302-101	100 Ω	½ w					
R1094	304-472	4.7 k	1 w					
R1095	302-123	12 k	½ w					
R1097	302-224	220 k	½ w					
R1098A	302-105	1 meg	½ w					
R1098B	316-333	33 k	¼ w					
R1101	302-100	10 Ω	½ w					
R1103	302-100	10 Ω	½ w					
R1105	302-100	10 Ω	½ w					

Resistors *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R1107	302-100	10 Ω	½ w				
R1202	302-101	100 Ω	½ w				
R1203	302-101	100 Ω	½ w				
R1204	309-060	4 Ω	(nominal value)		Selected		
R1205	309-060	4 Ω	(nominal value)		Selected		
R1207	309-360	170 Ω	½ w		Prec.	1%	
R1208	309-067	60 Ω	½ w		Prec.	1%	
R1209	309-067	60 Ω	½ w		Prec.	1%	
R1210	308-096	500 Ω	20 w		WW	5%	
R1212	309-128	50 Ω	½ w		Prec.	1%	
R1213	308-051	4 k	5 w		WW	5%	
R1214	309-128	50 Ω	½ w		Prec.	1%	
R1217	316-151	150 Ω	¼ w				
R1223	308-051	4 k	5 w		WW	5%	
R1227	316-151	150 Ω	¼ w				
R1233	308-051	4 k	5 w		WW	5%	
R1237	316-151	150 Ω	¼ w				
R1243	308-051	4 k	5 w		WW	5%	
R1247	316-151	150 Ω	¼ w				
R1253	308-051	4 k	5 w		WW	5%	
R1256	309-266	93.1 Ω	½ w		Prec.	1%	
R1257	316-151	150 Ω	¼ w				
R1258	302-100	10 Ω	½ w				
R1259	309-266	93.1 Ω	½ w		Prec.	1%	
R1271	302-181	180 Ω	½ w				
R1274	316-473	47 k	¼ w				
R1276	309-069	70 Ω	½ w		Prec.	1%	
R1278	309-069	70 Ω	½ w		Prec.	1%	
R1280	316-473	47 k	¼ w				
R1281	302-181	180 Ω	½ w				
R1282	308-072	1 k	5 w		WW	1%	
R1283	301-822	8.2 k	½ w			5%	
R1285	306-471	470 Ω	2 w				
R1286	309-175	156 Ω	½ w		Prec.	1%	
R1287	309-175	156 Ω	½ w		Prec.	1%	
R1288	309-175	156 Ω	½ w		Prec.	1%	
R1289	309-175	156 Ω	½ w		Prec.	1%	
R1290	309-072	180 Ω	½ w		Prec.	1%	
R1290	323-0108-00	130 Ω	½ w		Prec.	1%	5480-up
R1291	309-072	180 Ω	½ w		Prec.	1%	3975-547?
R1291	323-0108-00	130 Ω	½ w		Prec.		5480-up
R1292	301-471	470 Ω	½ w			1%	3975-547?
R1293	311-074	5 k	.1 w	Var.			
R1294	311-0433-00	100 Ω		Var.			X5480-up

Switches

Ckt. No.	Tektronix Part No. Unwired	Tektronix Part No. Wired	Description		S/N Range
SW10	260-554	*262-570	Rotary	TRIGGERING SOURCE	
SW20	260-212		Slide	TRIGGER SLOPE	3975-5509
SW20		260-0447-00	Slide	TRIGGER SLOPE	5510-up
SW101	260-017		Push-button	RESET	
SW110†	311-096			PRESET	
SW160††	260-268 use	*262-587	Rotary	SWEEP TIME/CM	
SW160Y	311-108				
SW300	260-266	*262-232	Rotary	HORIZONTAL DISPLAY, Front	
SW340A }	260-267	*262-557	Rotary	HORIZONTAL DISPLAY, Rear	3975-5099
SW340B }			Rotary	HORIZONTAL DISPLAY, Rear 5X MAG	
SW340A }	260-267	*262-690	Rotary	HORIZONTAL DISPLAY, Rear	5100-up
SW340B }			Rotary	HORIZONTAL DISPLAY, Rear 5X MAG	
SW601	260-134		Toggle	POWER ON	
SW870	260-253	*262-207	Rotary	AMPLITUDE CALIBRATOR	

Transformers

T44	*120-198	Toroid 4T TD29
T601	*120-141	Power
T801	*120-036	CRT Supply
T1014	*120-132	Toroid, on form 276-512
T1046	*120-148	Toroid, on form 276-507
T1214	*120-132	Toroid, on form 276-512
T1284	*120-132	Toroid, on form 276-512

Thermal Cutout

TK601	260-246	Thermal Cutout, 123° F ±5°

Transistors

Q44	151-076	2N2048
Q774	Use 151-040	2N1302
Q793	Use 151-137	2N2148
Q797	151-002	2N277

Electron Tubes

V24	154-212	6EW6
V34	154-212	6EW6
V125	154-022	6AU6
V133	154-187	6DJ8
V135	154-187	6DJ8

†Concentric with R17 and ganged with R110. Furnished as a unit.

††Concentric with R160Y, and SW160Y.

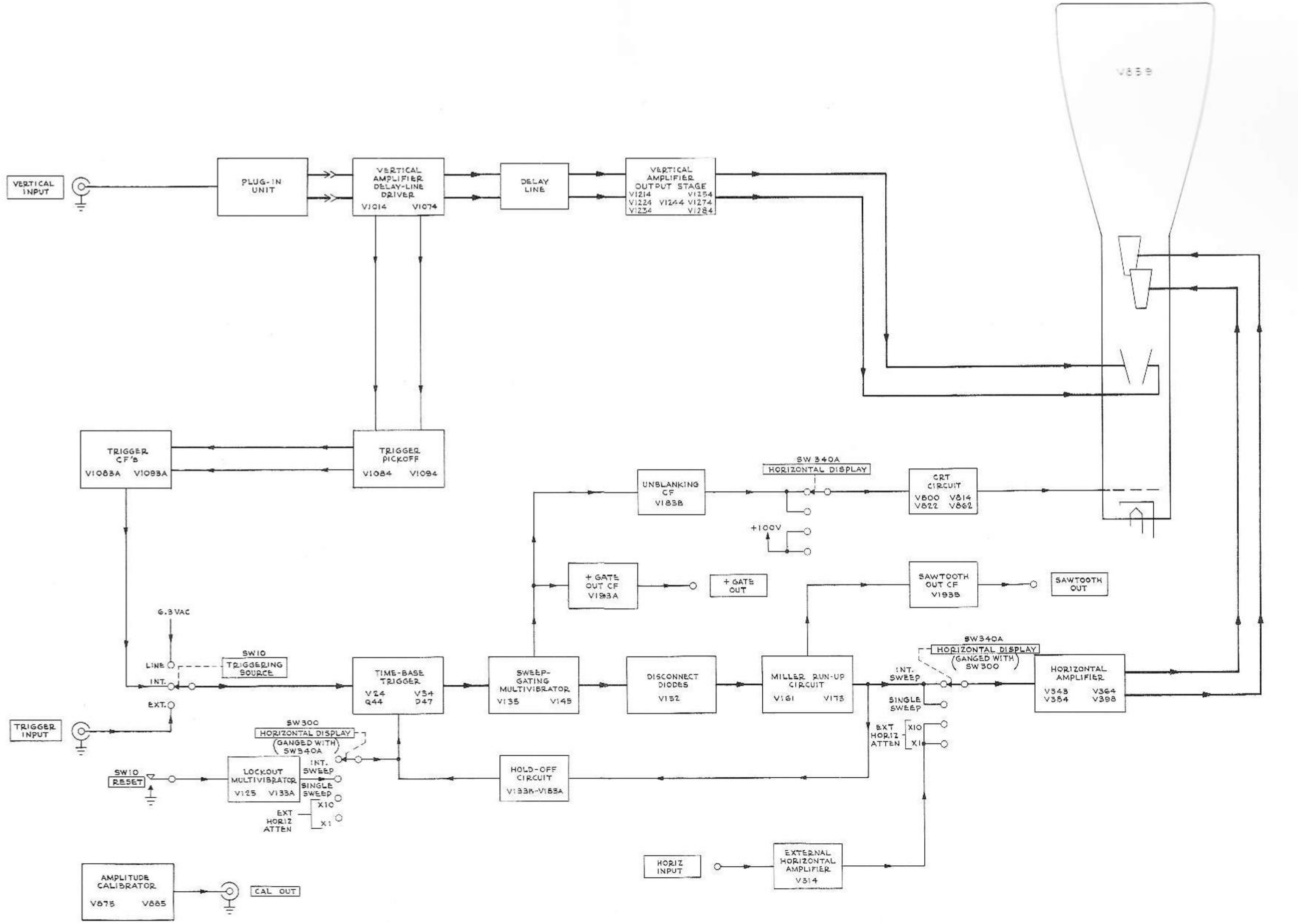
Electron Tubes *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
V145	154-187	6DJ8	
V152	Use *157-0104-02	6AL5 Selected	
V161	154-031	6CL6	
V173	154-187	6DJ8	
V183	154-187	6DJ8	
V193	154-187	6DJ8	
V314	154-187	6DJ8	
V343	154-187	6DJ8	
V364	154-187	6DJ8	
V384	154-187	6DJ8	
V398	154-031	6CL6	
V609	154-052	5651	
V624	154-043	12AX7	
V627	154-044	12B4	
V634	154-022	6AU6	
V637	154-044	12B4	
V647	154-044	12B4	
V664	154-022	6AU6	
V677	154-056	6080	
V684	154-043	12AX7	
V694	154-022	6AU6	
V724	154-022	6AU6	
V737	154-056	6080	
V754	154-022	6AU6	
V767	154-044	12B4	
V800	154-021	6AU5	
V814	154-041	12AU7	
V822	154-051	5642	
V832	154-051	5642	
V842	154-051	5642	
V852	154-051	5642	
V859	*154-354	CRT T5810-31 Standard Phosphor	3975-4999
V859†	Use *154-0479-00	CRT T5810-31-1 Standard Phosphor	5000-5389
V859	*154-0479-00	CRT T5810-31-1 Standard Phosphor	5390-up
V862	154-051	5642	
V875	154-022	6AU6	
V885	154-041	12AU7	
V1014	154-187	6DJ8	
V1024	154-187	6DJ8	
V1034	154-187	6DJ8	
V1044	154-187	6DJ8	
V1054	154-187	6DJ8	
V1064	154-187	6DJ8	
V1074	154-187	6DJ8	
V1083	154-187	6DJ8	
V1084	154-207	6CY5	
V1093	154-187	6DJ8	

† S/N 5000-5389 add *050-0246-00 kit.

Electron Tubes *(Cont'd.)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
V1094	154-207	6CY5	
V1214	154-187	6DJ8	
V1224	154-187	6DJ8	
V1234	154-187	6DJ8	
V1244	154-187	6DJ8	
V1254	154-187	6DJ8	
V1274	154-420	7788	
V1284	154-420	7788	

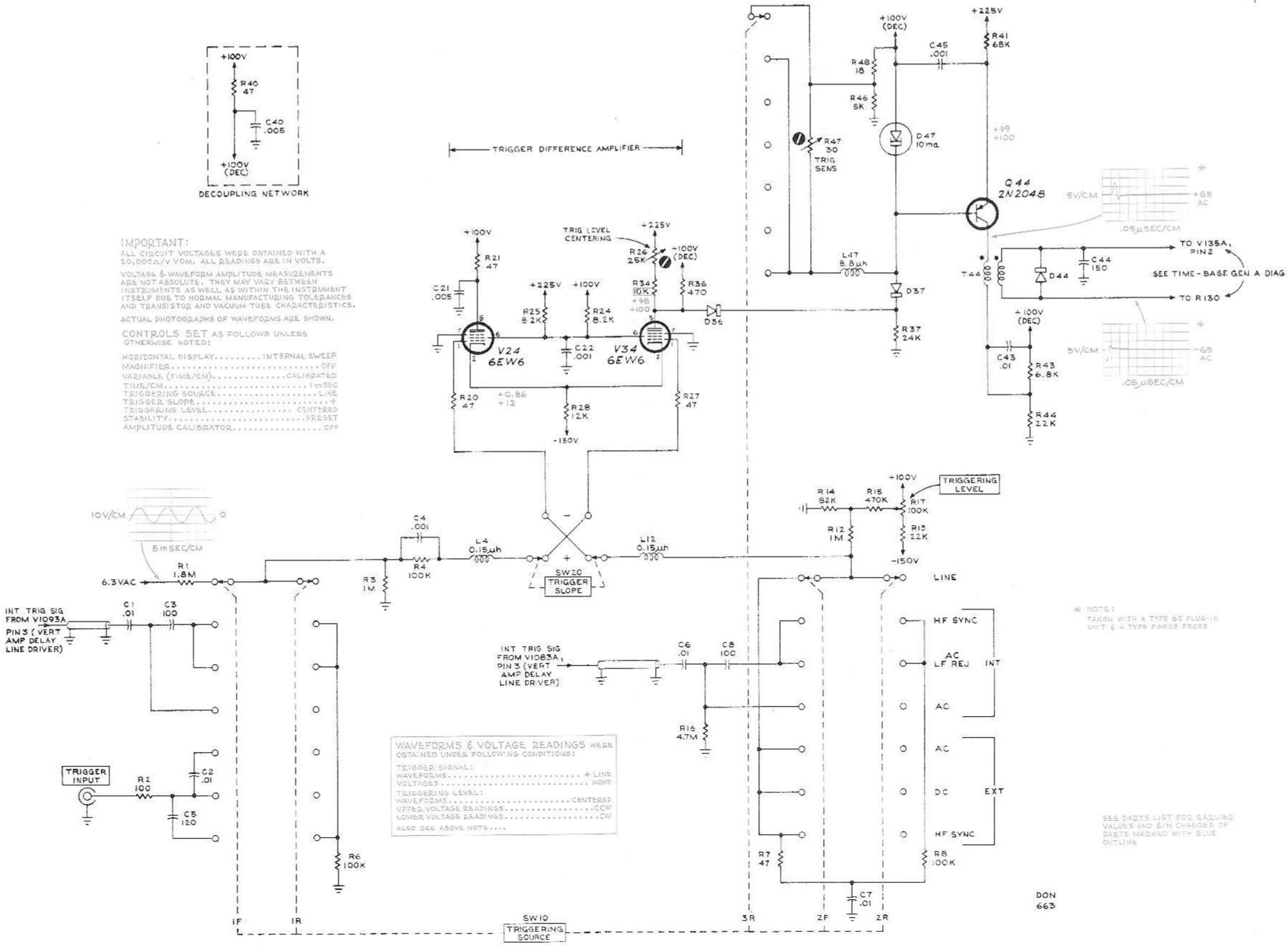


TYPE 581A OSCILLOSCOPE

BLOCK DIAGRAM

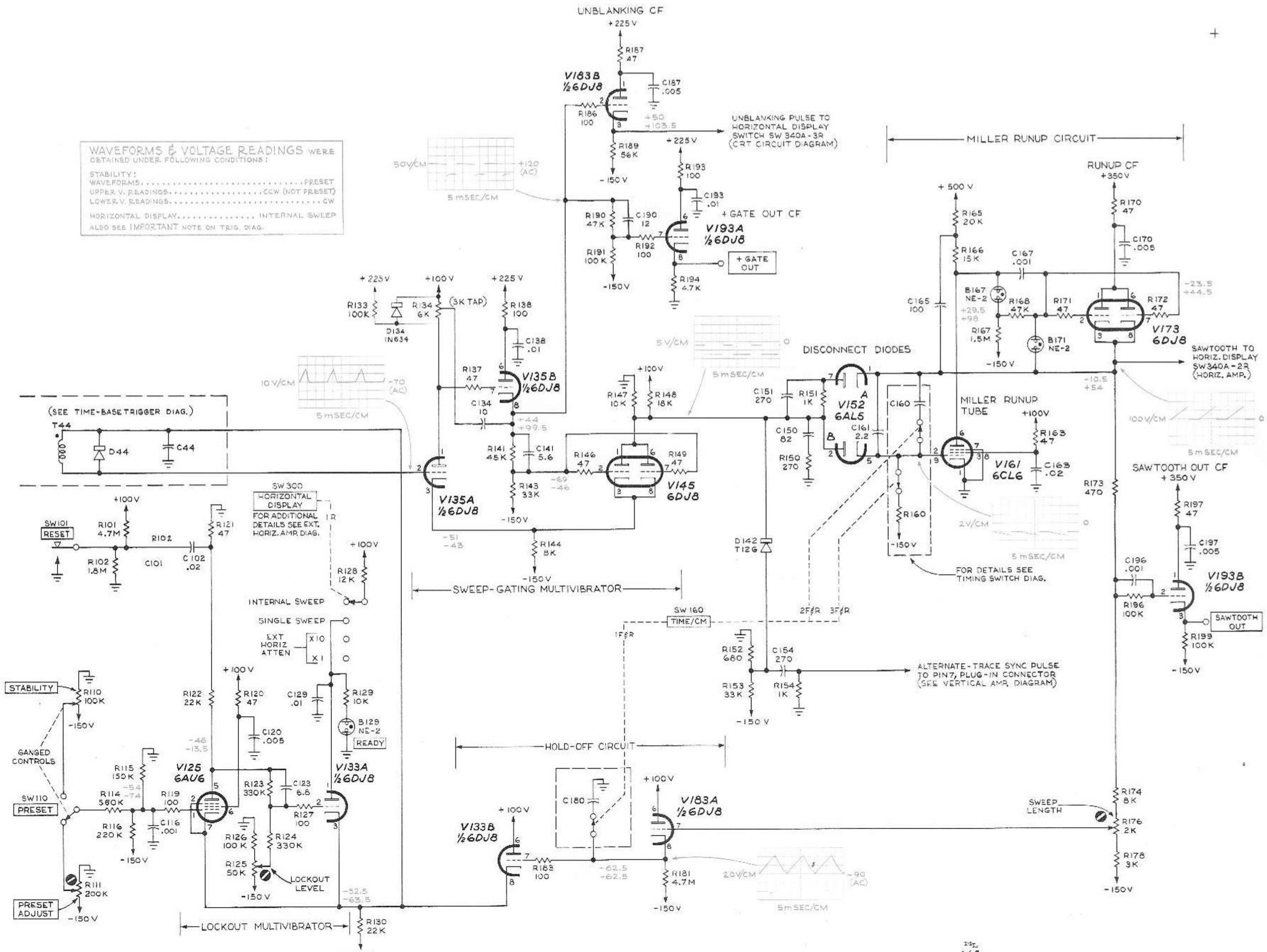
663

A



TIME BASE TRIGGER

CIRCUIT NUMBERS 1 THRU 49

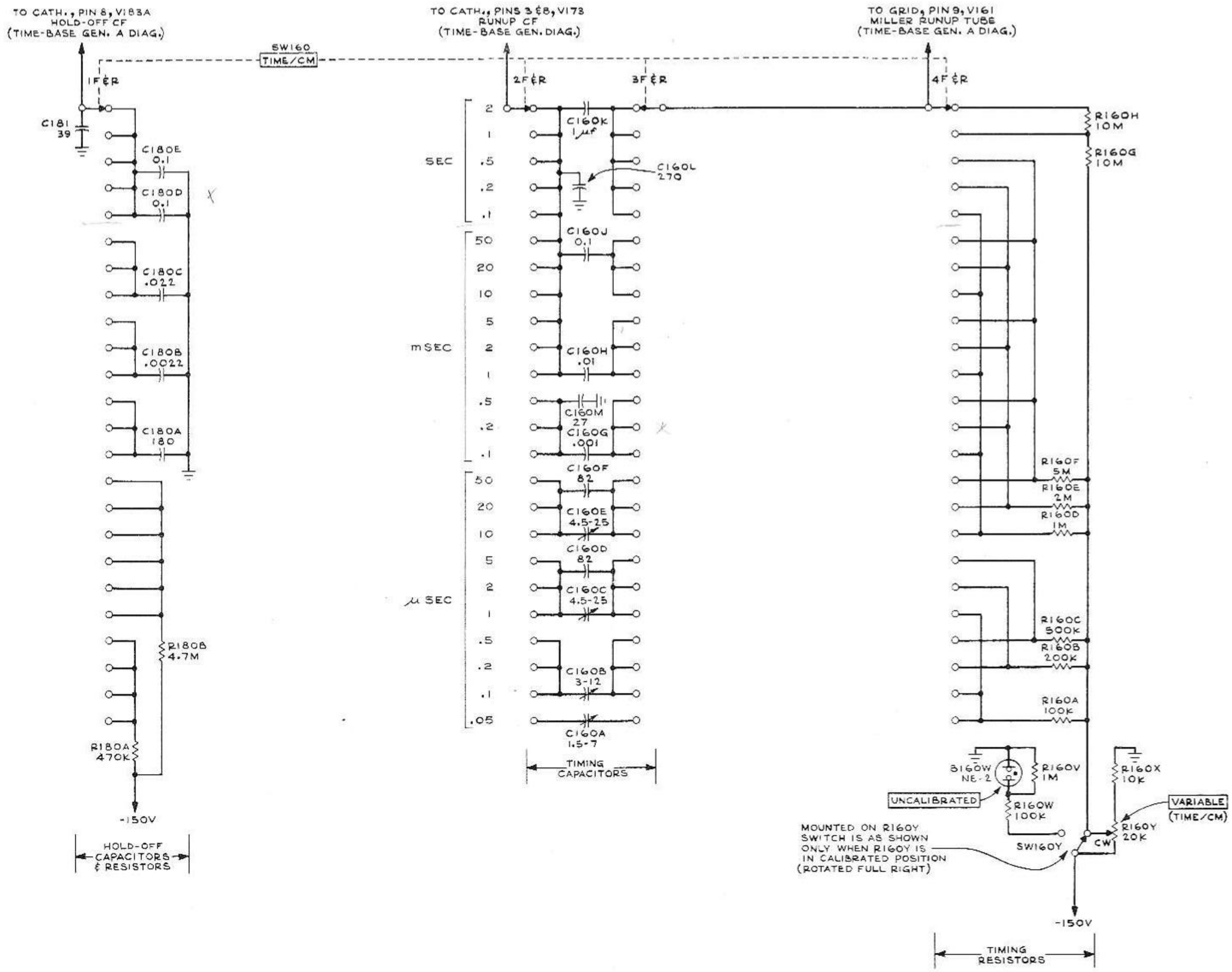


TYPE 581A OSCILLOSCOPE

663

TIME-BASE GENERATOR

CIRCUIT NUMBERS 100 THRU 199

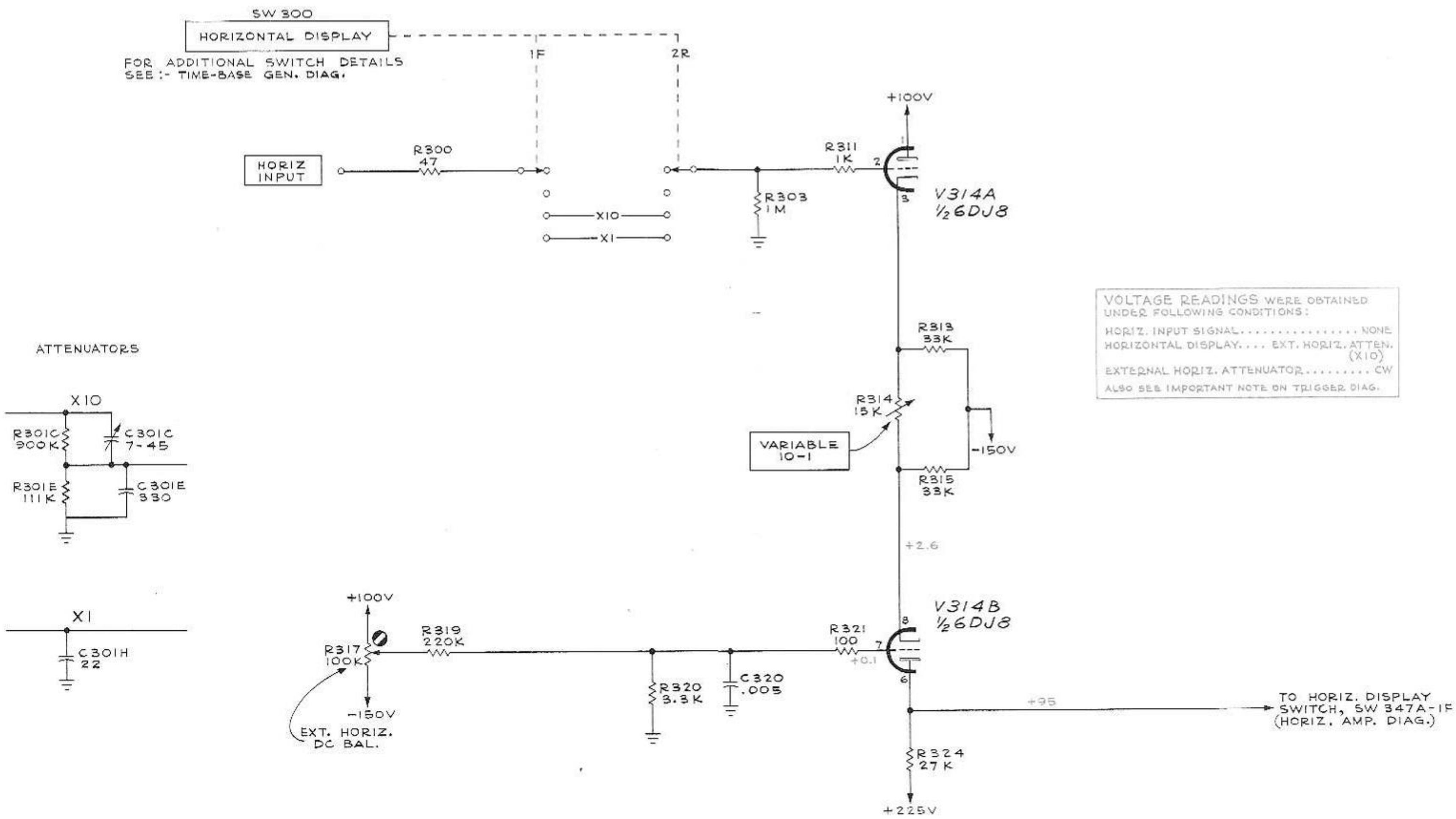


TYPE 581A OSCILLOSCOPE

TIMING SWITCH

A

TP
663

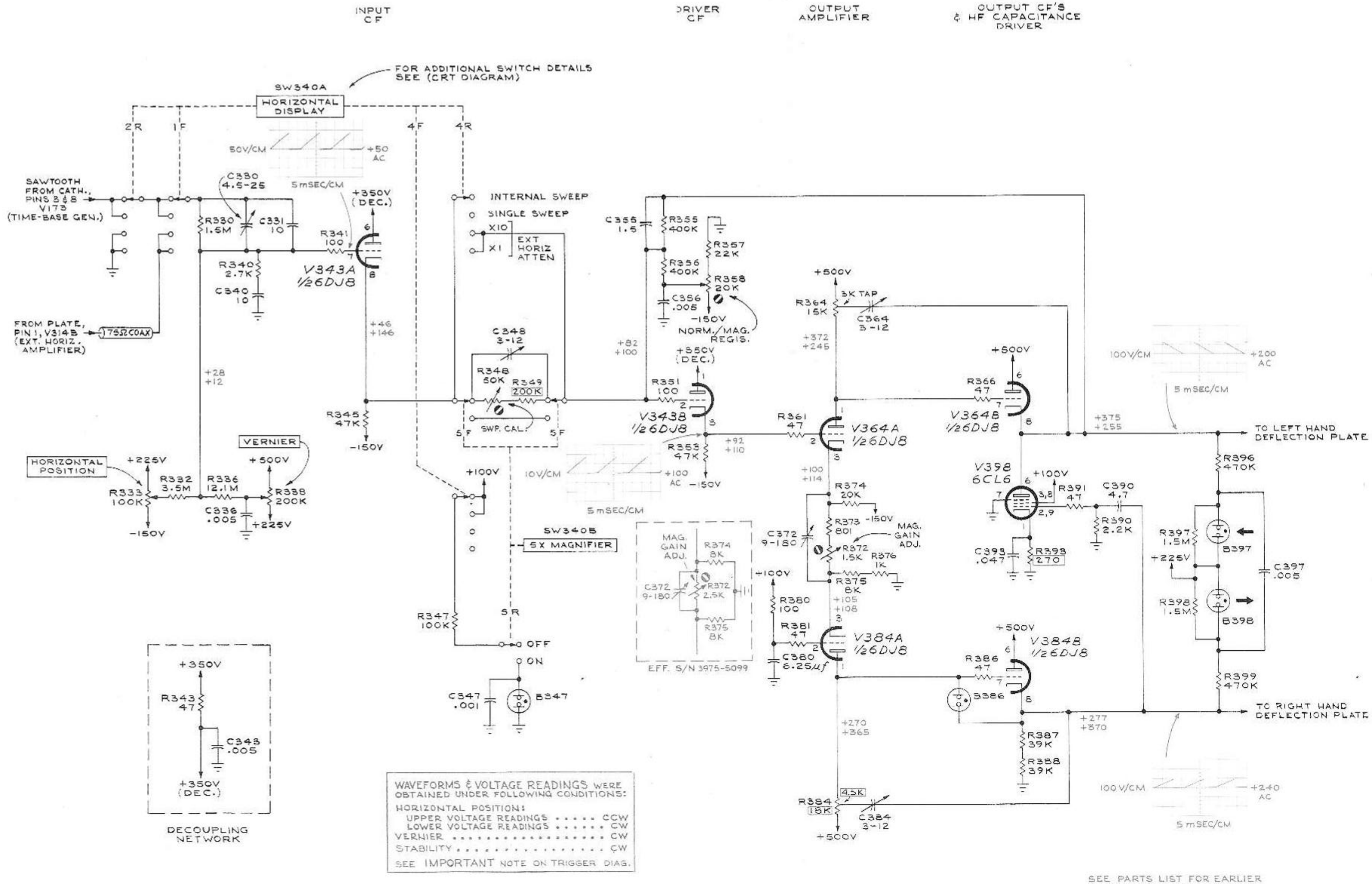


GAB
663

TYPE 581A OSCILLOSCOPE

EXTERNAL HORIZONTAL AMPLIFIER

CIRCUIT NUMBERS
300 THRU 329



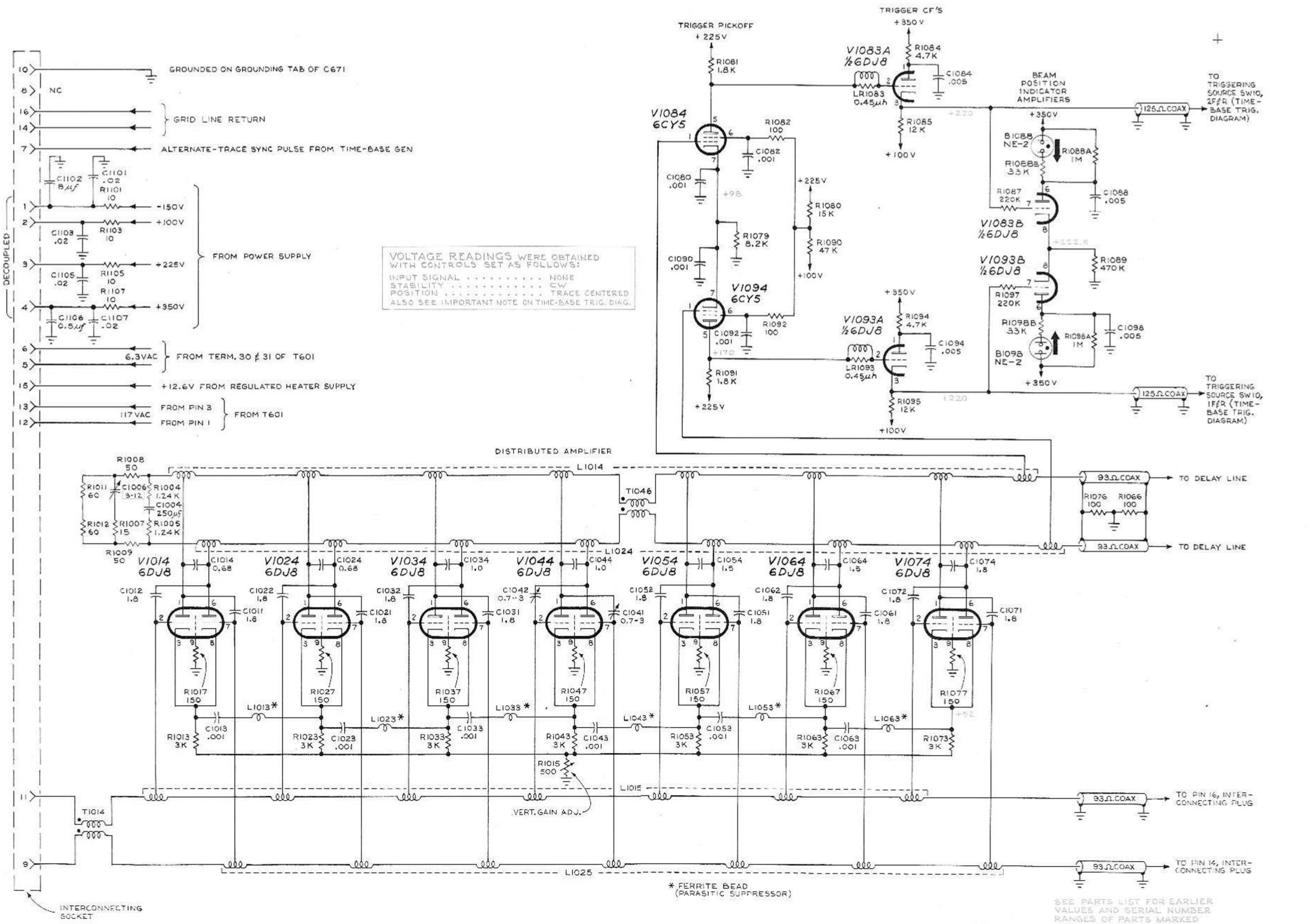
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

MRH
1164

TYPE 581A OSCILLOSCOPE

HORIZONTAL AMPLIFIER

CIRCUIT NUMBERS 330 THRU 399



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

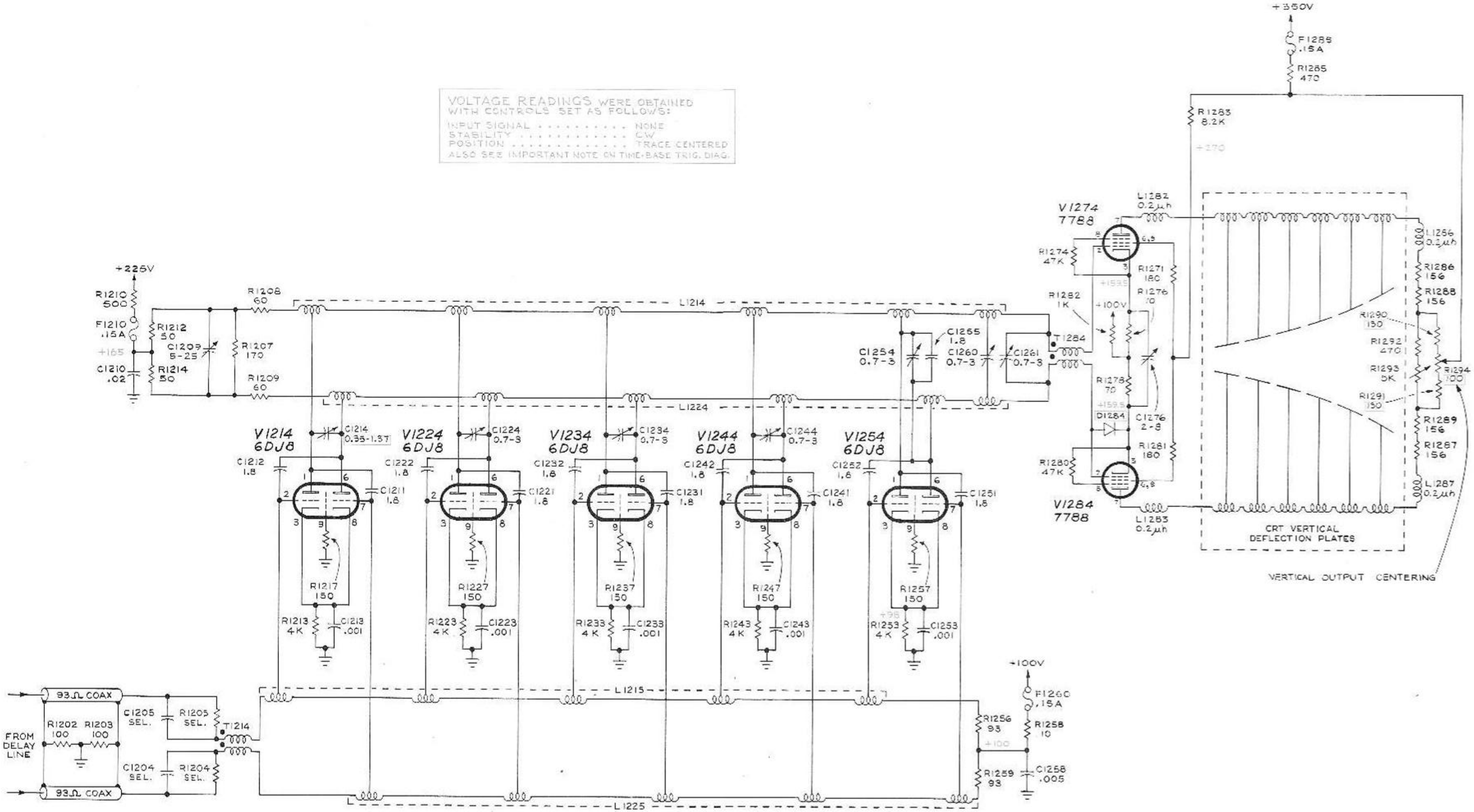
MT
664

TYPE 581A OSCILLOSCOPE

B

VERTICAL AMPLIFIER DELAY LINE DRIVER

CIRCUIT NUMBERS
1000 THRU 1109



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

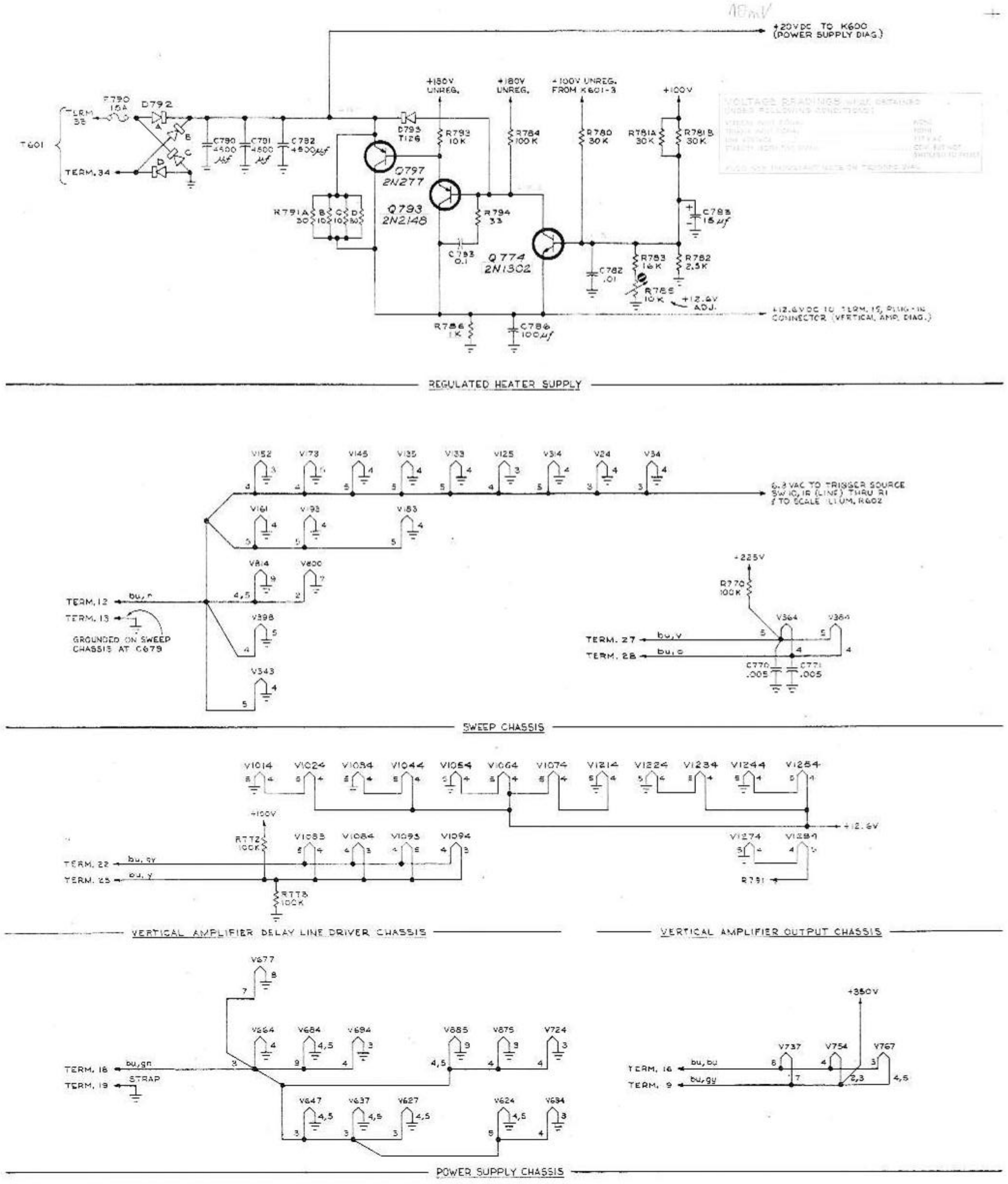
865
ML

TYPE 581A OSCILLOSCOPE

C

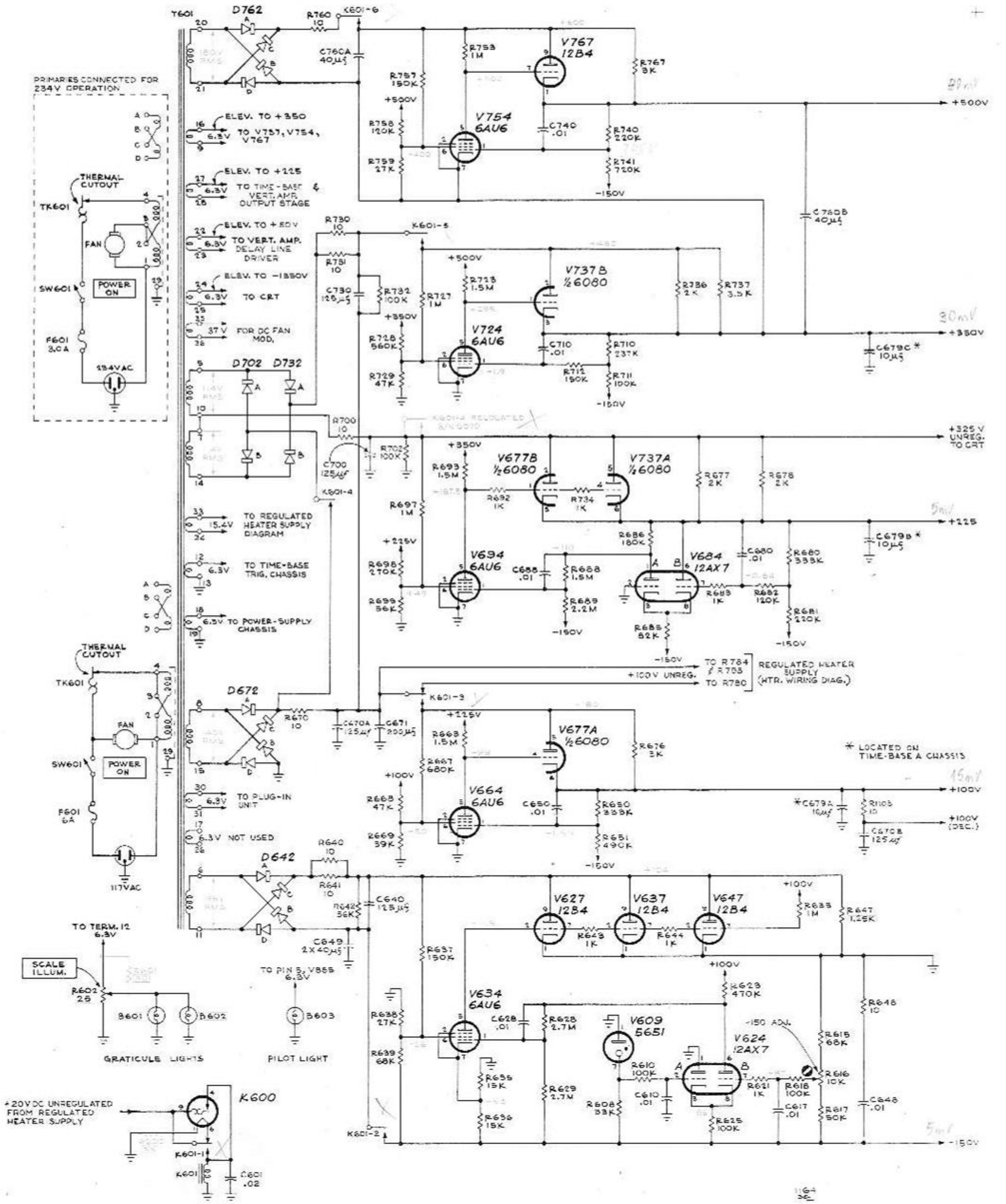
VERTICAL AMPLIFIER OUTPUT STAGE

CIRCUIT NUMBERS
1200 THRU 1299



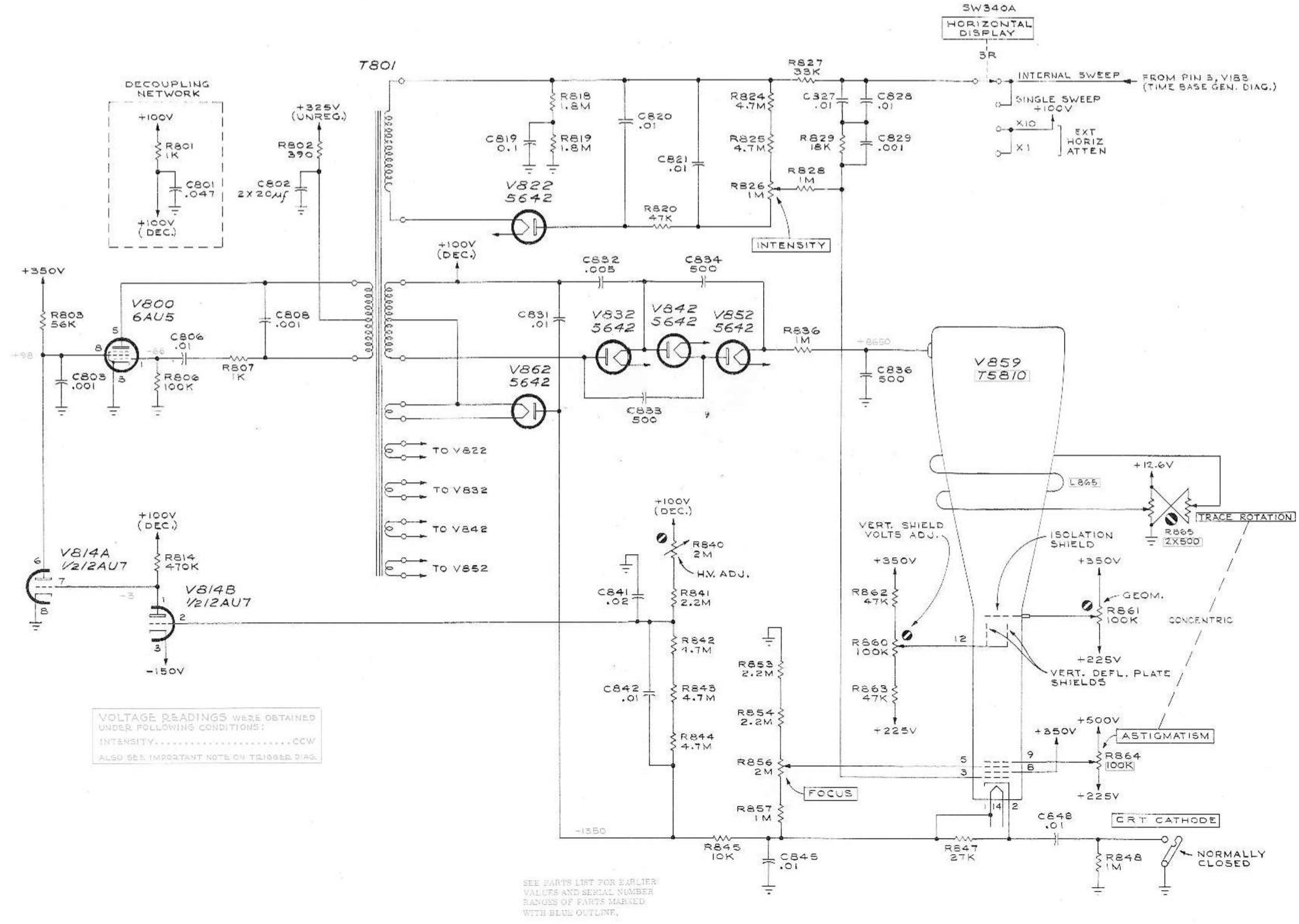
TYPE 581A OSCILLOSCOPE

HEATER WIRING DIAGRAM



POWER SUPPLY

CIRCUIT NUMBERS 600 THRU 799



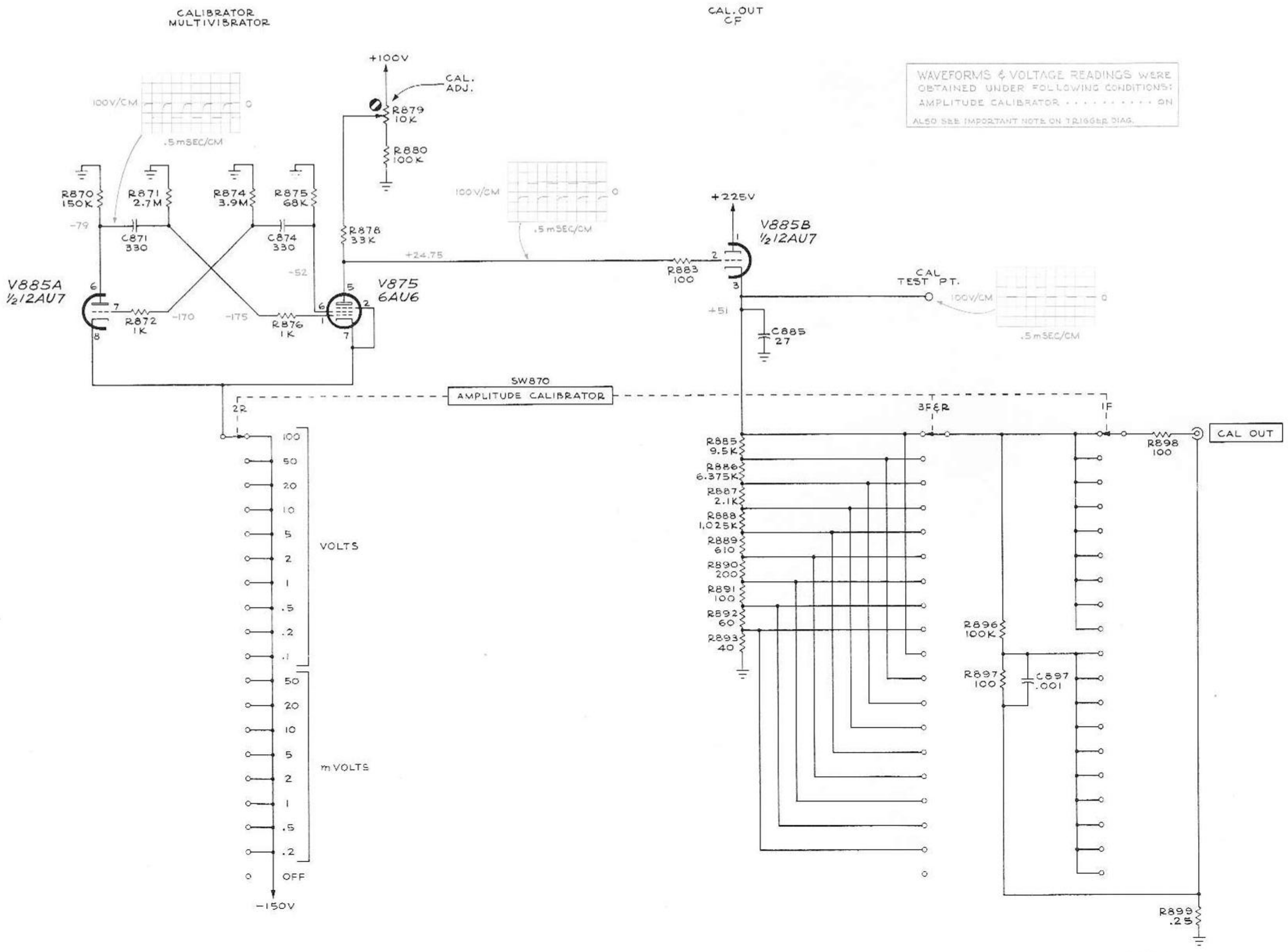
TYPE 581A OSCILLOSCOPE

C

MRH
265

CRT CIRCUIT

CIRCUIT NUMBERS 800 THRU 869 ALSO SW340A



TYPE 581A OSCILLOSCOPE

A

CALIBRATOR

CIRCUIT NUMBERS 870 THRU 899

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.

TEXT CORRECTION

OPERATING INSTRUCTIONS

See new Fig. 2-2 below

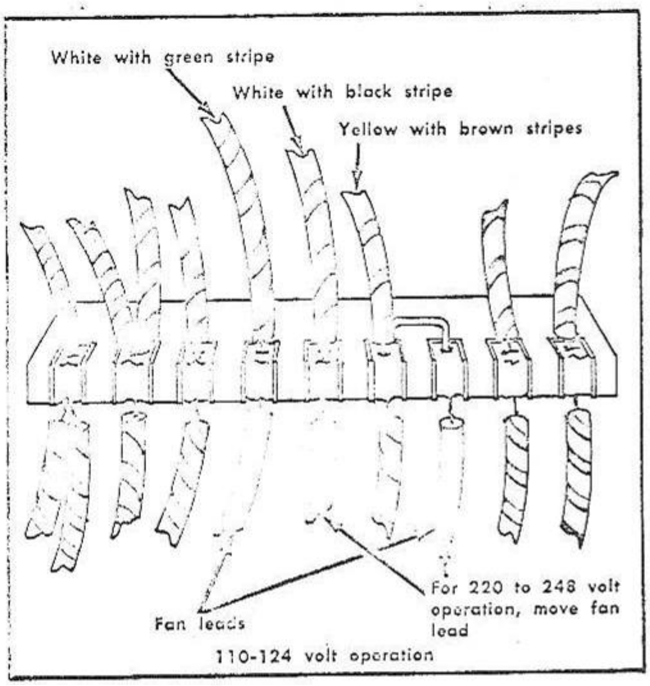


Fig. 2-2. Fan connections for 110 to 248 volts.

Type 581A Tent. S/N 5480
Type 585A Tent. S/N 10460
Type RM585A Tent. S/N1190

TEXT CORRECTIONS

Manual Reference:
Type 581A - Text page 6-6
Type 585A - Text page 6-6
Type RM585A - Text page 6-7

STEP 12 SHOULD READ AS FOLLOWS:

12. Adjust Vertical Output Centering R1294

Remove the Type 84 and install either a Type 82 or 86. Connect a jumper from the CAL OUT connector, to the INPUT connector on the Type 82 or 86.

Set the following Type 82 (channel A) or 86 controls:

V/CM	.5
AC-DC-GND	AC
VARIABLE VOLTS/CM	CAL
GAIN	X1
MODE (Type 82)	A only

Set the AMPLITUDE CALIBRATOR switch to obtain a 2-cm high display. Then, with the VERTICAL POSITION control, position the display so the top of the display is on the top graticule line. Note the amount of compression. Now position the display so the bottom of the display is on the bottom graticule line. Again note the amount of compression.

Center the 2-cm high display vertically upon the graticule horizontal center line. Then, adjust R1294 so as to move the display 1mm in the direction (toward top or bottom of graticule) which had the most compression.

Recheck the amount of compression at the top and bottom areas of the graticule and readjust R1294 if necessary until the amount of compression noted in each area is the same.

Remove the Type 82 or 86 and reinstall the Type 84.