555/21/22
APRF
E. Allison

INSTRUCTION MANUAL

TYPE 555

CATHODE-RAY OSCILLOSCOPE

TEKTRONIX

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

TYPE 555

CATHODE-RAY OSCILLOSCOPE

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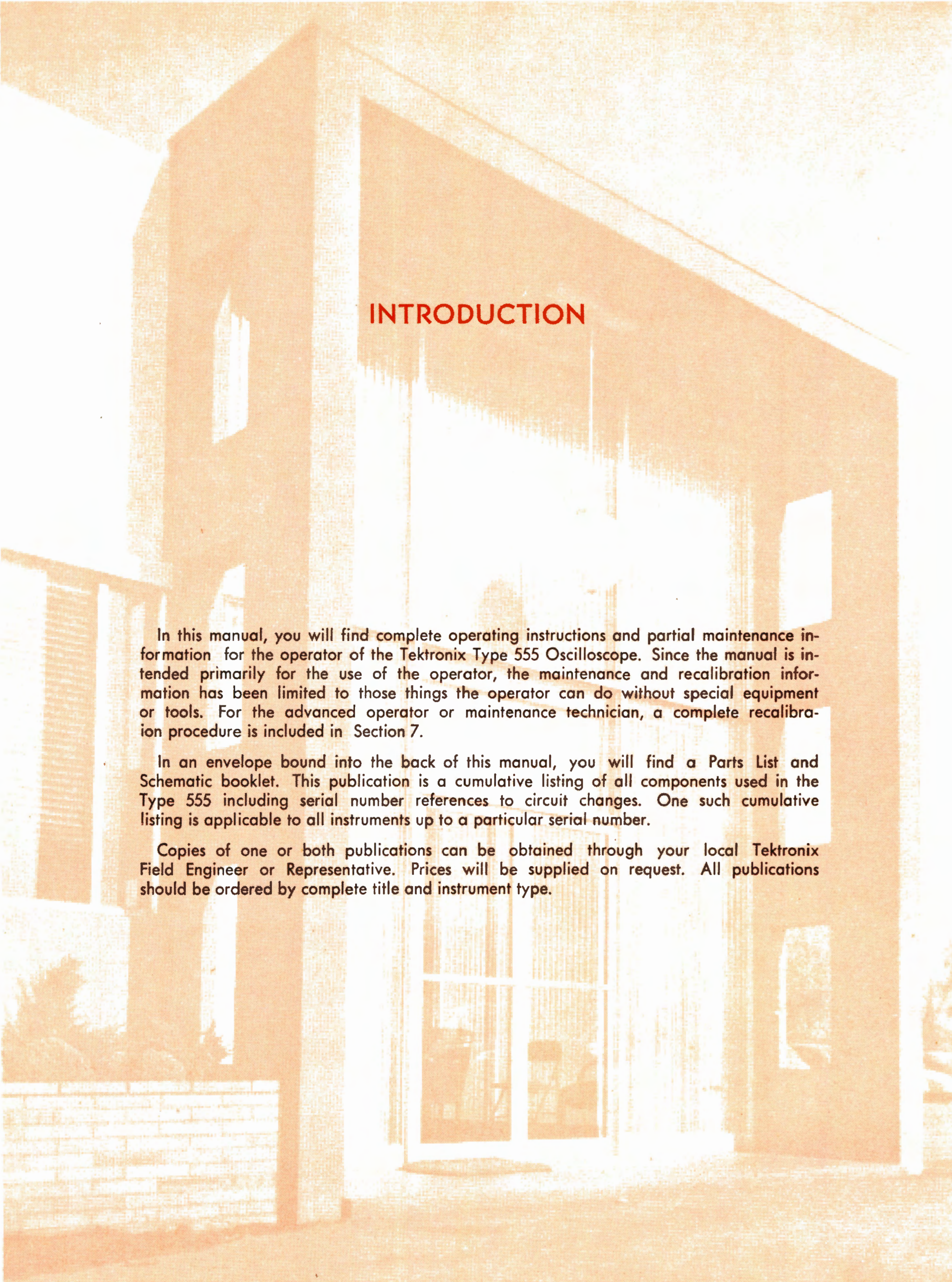

INTRODUCTION

In this manual, you will find complete operating instructions and partial maintenance information for the operator of the Tektronix Type 555 Oscilloscope. Since the manual is intended primarily for the use of the operator, the maintenance and recalibration information has been limited to those things the operator can do without special equipment or tools. For the advanced operator or maintenance technician, a complete recalibraion procedure is included in Section 7.

In an envelope bound into the back of this manual, you will find a Parts List and Schematic booklet. This publication is a cumulative listing of all components used in the Type 555 including serial number references to circuit changes. One such cumulative listing is applicable to all instruments up to a particular serial number.

Copies of one or both publications can be obtained through your local Tektronix Field Engineer or Representative. Prices will be supplied on request. All publications should be ordered by complete title and instrument type.

WARRANTY

All Tektronix instruments are fully guaranteed against defective materials and workmanship for a period of one year. Should replacement parts be required, whether at no charge under warranty or at established net prices, notify us promptly. You should include the instrument type, serial number, and sufficient details to identify the required parts. We will ship them prepaid (via air if requested) as soon as possible, usually within 24 hours.

Tektronix transformers manufactured in our own plant carry an indefinite warranty.

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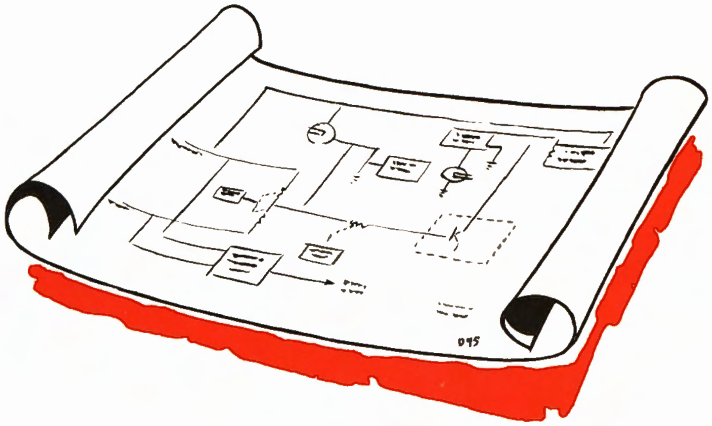
The Type 555 Indicator and Power Supply Units mounted on a Type 500/53A Scope-Mobile.



SECTION 1

SPECIFICATIONS

General Information

The Type 555 Oscilloscope is a wide-range, dual-beam, laboratory instrument providing accurate measurements in the dc to 30 mc range. Two complete horizontal and vertical deflection systems permit completely independent operation of the two beams. Either of two plug-in time base units can control the sweep of either or both of the beams.

Both vertical channels utilize Tektronix plug-in preamplifier units. This plug-in unit feature permits you to select the bandpass, risetime, type of input, and sensitivity required for your application. This selection is made by choosing the proper plug-in unit for the application.

Special circuits incorporated in the Type 555 permit you to select an accurate, continously variable, delay in presentation of one of the sweeps. The sweep may be delayed from .05 μseconds to 50 seconds after application of a triggering pulse. This feature allows you to expand a selected portion of the undelayed sweep thereby permitting precise time measurements. Both the delayed and the undelayed sweeps are presented on the oscilloscope screen.

Vertical-Deflection System

Specifications for both vertical channels are identical. The actual figures depend on the plug-in units used with the instrument. The following specifications are given assuming that Type K Plug-In units are used:

Bandpass	DC to 30 mc (3db down at 30 mc)
Risetime	0.012 microseconds

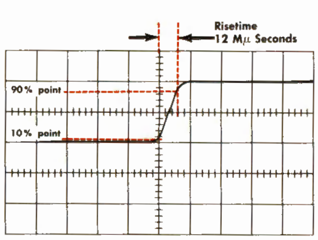


Fig. 1-1. Vertical risetime of the Type 555 Oscilloscope using a Type K Plug-In Unit.

Triggering Modes

Time Base A and Time Base B—AC, DC, and AC Automatic.

Triggering Signal Sources

Time Base A and Time Base B—External, Lower Beam, Upper Beam, and Line.

Triggering Signal Requirements

Internal from Upper or Lower Beam signal—A signal producing 2 mm of vertical deflection up to 2 mc. For frequencies above 2 mc increased signal amplitude is required.

External triggering—A signal of 0.2 to 10 volts.

Sweep Speeds

Time Base A and Time Base B—0.1 microseconds to 5 seconds per centimeter in 24 accurately calibrated steps. Uncalibrated vernier controls permit sweep speeds to be varied continuously between 0.1 microseconds and approximately 12 seconds per centimeter. Calibrated sweep speeds are typically within 1%, and in all cases within 3%, of the indicated sweep rate.

Magnifiers

Displayed waveforms on either the upper or the lower beams can be expanded horizontally by a factor of 5, by means of separate sweep magnifiers. The magnifiers extend the fastest sweep speeds to 0.02 microseconds per centimeter. Sweep speeds are accurate to within 5% with the magnifiers on.

External Horizontal Inputs

External signals can be applied to sweep either of the two beams. Characteristics for both beams are identical.

Deflection factors—approximately 0.2 to approximately 20 volts per centimeter.

Bandpass—dc to approximately 240 kc.

Input connector characteristics—1 megohm paralleled by approximately 40 μμf.

Delayed Sweep

Sweep delay continuously variable from .05 microseconds to 50 seconds. Actual delay steps are within 3% of the indicated delay. Incremental accuracy of the DELAYED TRIGGER control is within 0.2% on all ranges between 1 μsecond and 50 seconds.

Jitter—1 part in 20,000.

Cathode-Ray Tube

Type T555P

Phosphors—Type P2 phosphor normally supplied; P1, P7, and P11 phosphors optional. Other phosphors available on special order.

Unblanking—dc coupled.

Accelerating potential—10,000 volts.

Usable viewing area—total of 6 centimeters with 4 centimeters for each beam. At least 2 centimeters of overlap between the two beams.

Graticule

Illumination—variable edge lighting.

Markings—marked in 6 vertical and 10 horizontal 1-centimeter divisions with 2-millimeter markings on the center-lines.

Amplitude Calibrator

Waveform—square-waves at approximately 1,000 cycles.

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 the indicated voltage.

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 requirements—maximum of 1050 watts.

Line frequency—50 to 60 cps.

Output Waveforms Available (see Figure 1-2)

Delayed trigger pulse—approximately 5 volts in amplitude, occurring at the end of the delay period.

+Gate A—20 volts peak-to-peak with the same duration as the A sweep.

Sawtooth A—A sweep sawtooth waveform, 150 volts peak.

+Gate B—20 volts peak-to-peak with the same duration as the B sweep.

Sawtooth B—B sweep sawtooth waveform, 150 volts peak.

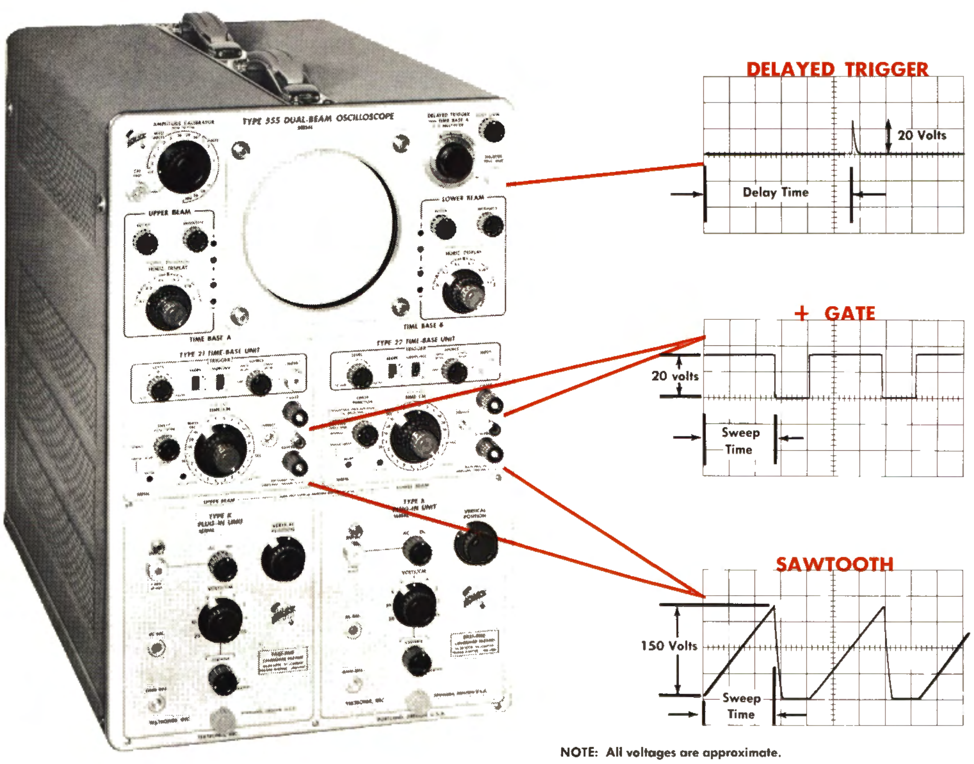
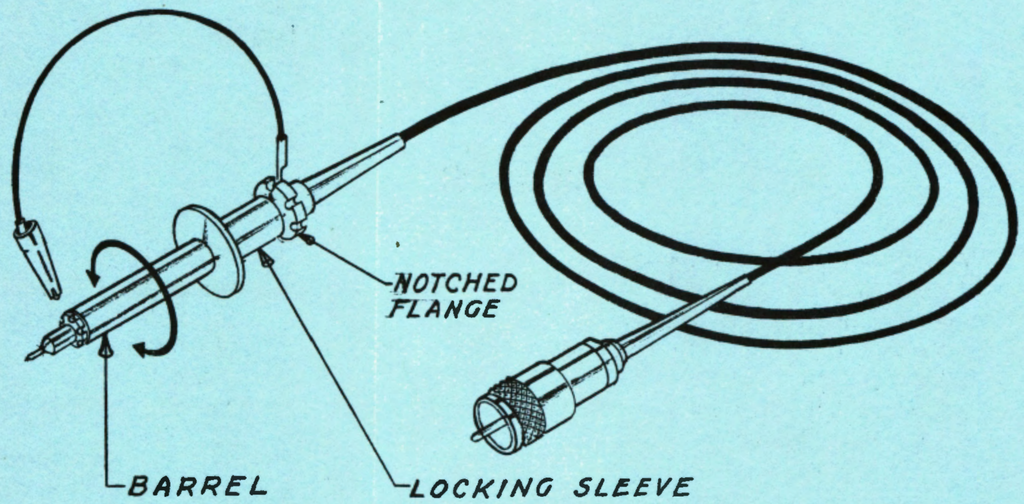
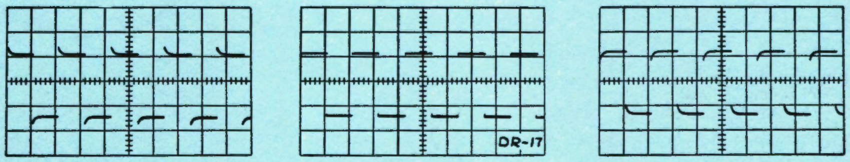


Fig. 1-2. Output waveforms available at the oscilloscope front panel.

P6000 PROBE





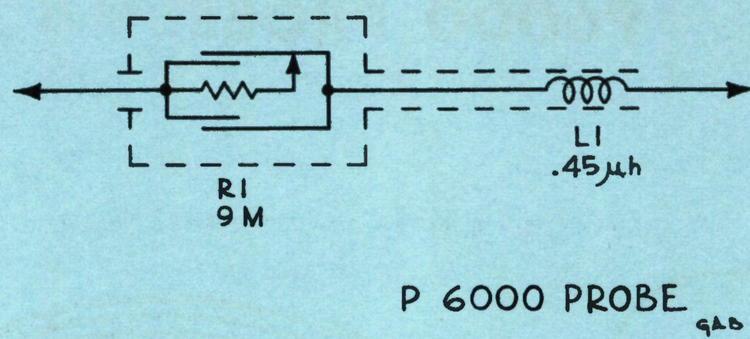
ADJUSTMENT PROCEDURE

A Type P6000 Probe is furnished as an accessory with your oscilloscope. Connected to the INPUT connector of the oscilloscope, the probe presents an input characteristic of 10 megohms shunted by 10 micromicrofarads and has an attenuation ratio of 10:1. The maximum voltage which may be applied to the probe is 1200 volts Exceeding this rating, either in peak ac volts or dc volts, may result in damage to the components inside the probe body.

An adjustable capacitor in the probe body compensates for variations in input capacitance from one instrument to another. To insure the accuracy of pulse and transient measurements, this adjustment should be checked frequently.

To adjust the P6000 probe, set the calibrator control for a calibrator output signal of suitable amplitude. Touch the probe tip to the CAL. OUT connector and adjust the oscilloscope controls to display several cycles of the waveform. Unlock the probe for adjustment by turning the locking sleeve at the rear of the probe body 4 or 5 turns counterclockwise. Hold the probe firmly by the notched flange at the base of the probe, and adjust by turning the probe barrel for an optimum waveshape as shown in the center waveform illustration.

After a good flat-top square-wave is achieved, turn the locking ring clockwise until it is fairly snug but not tight. Holding the probe by the barrel, make fine adjustments by turning the notched flange. Then carefully turn the locking ring down tight.



PARTS LIST

6000 Complete Probe Assembly	010-020
6000 Probe Tip Assembly	206-015
6000 Ground Lead Assembly	175-039
6000 Probe Pincher Tip Assembly	013-027
6000 Tek-Tip, Hook	206-023
6000 Tek-Tip, Straight	206-034
6000 Probe Holder	352-024

Ventilation

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

Construction

Aluminum-alloy chassis and three-piece cabinets. Photo-etched anodized panel, blue wrinkle-finished cabinet.

Dimensions: Indicator Unit: 24" long, 13" wide, 20" high.

Power Supply Unit: 17½" long, 13" wide, 10" high.

Weight—Indicator Unit: 68 pounds. Power Supply Unit: 45 pounds.

Accessories

1—Type 21 Time-Base Plug-In Unit.
1—Type 22 Time-Base Plug-In Unit.
1—Time-base plug in extension (013-013).
4—Attenuator Probes (10X Attenuation).
1—Inter-unit cable (012-032).
2—Binding-post adapters (013-004).
1—Test lead (012-031).
1—Green Filter (378-514).
1—3-conductor power cord (161-010).

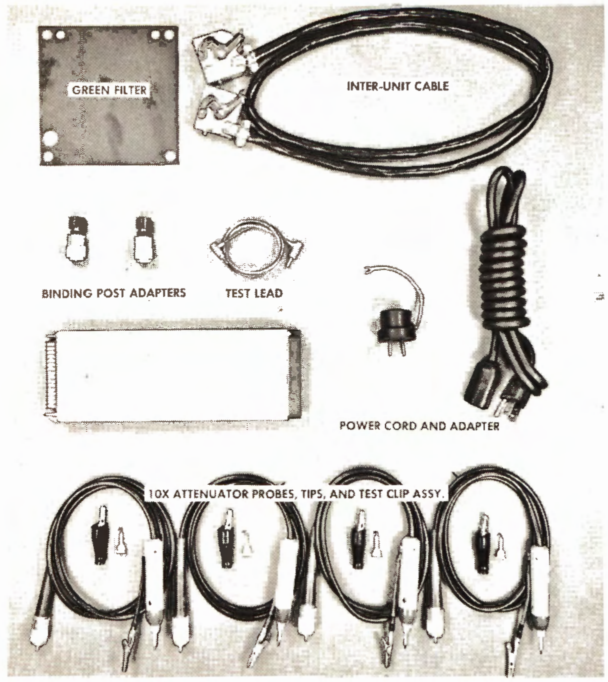
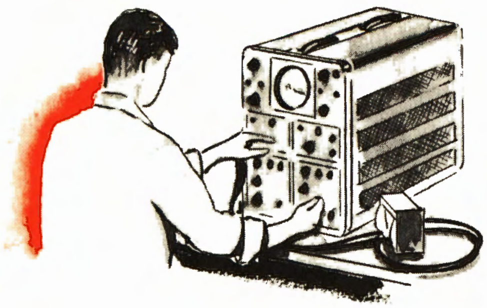


Fig. 1-3. Accessories for the Type 555 Oscilloscope.



SECTION 2

OPERATING INFORMATION

General Information

The Type 555 Oscilloscope is a 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 for you to understand the operation and function of each of the controls. This portion of the manual provides the necessary basic operating information. Information on triggering the sweep, use of probes, input signal connections, and functions of controls are included in this section. Operation of the delayed sweep feature is covered in detail.

Plug-In Units

The Type 555 Oscilloscope is designed to operate with Tektronix letter-series plug-in units in the vertical deflection systems. These plug-in units allow you to change the vertical characteristics of the oscilloscope to meet a wide number of applications. The particular plug-in units used must be selected by you to satisfy the requirements of your applications. In selecting the vertical plug-in units for any particular application, you must consider the bandpass, vertical risetime, sensitivity, and type of input required. The plug-in units presently available will satisfy the requirements for most applications.

Type 21 and 22 Plug-In Time Base Units are used with the Type 555 to generate the horizontal sweeps. Plug-in time base units are used primarily for ease of servicing. The plug-in extension supplied with the instrument allows either time base unit to be operated while partially withdrawn from the instrument. A Type 22 Time-Base Unit must be used for TIME BASE B in order to use the sweep delay feature. Either a Type 21 or Type 22 Time-Base Unit can be used for TIME BASE A.

The Type 555 Oscilloscope should not be used when one or more of the plug-in units is disconnected from the oscilloscope. A missing plug-in unit will not damage the oscilloscope, but may cause the power supplies to go out of regulation. Proper operation of the oscilloscope will not be obtained if the power supplies are not regulating correctly.

Preparation For Use

When the vertical plug-ins have been selected, insert them into the plug-in compartments of the oscilloscope and press firmly to insure that the connectors make proper contact. Tighten the plug-in unit locking controls to hold the units securely in place. The location of the vertical and the Type 21 Time Base plug-in unit locking controls is shown in Figure 2-1. The Type 22 Time Base locking control (not shown) is located on the right side of the oscilloscope indicator unit. Turn the oscilloscope INTENSITY controls fully counterclockwise. Connect the inter-unit cable to the rear of the indicator and power supply units. Connect the power cord to the rear of the power supply unit and to the power line. The metal tags located at the rear of both units indicate the operating range for which your instrument is connected. (To change the operating range, 105-125 or 210-250 VAC, refer to the 117 VAC or the 234 VAC wiring diagram in the Parts List and Schematic booklet.) Place the POWER switch in the ON position.

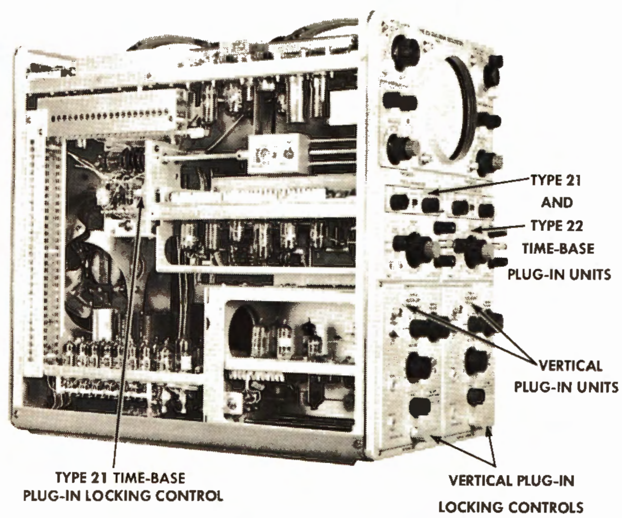


Fig. 2-1. Location of the Type 21 and vertical plug-in locking controls.

DC Power Time Delay

The time delay relay used in the Type 555 Oscilloscope delays the operation of the instrument for approximately 30 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 30-second delay will occur before the instrument returns to full operation.

Focus Controls

The focus controls allow you to obtain sharp, clearly defined spots or traces. The proper settings are obtained by adjusting the controls for a sharply focused spot or trace. If either beam does not focus properly, it may also be necessary to adjust the appropriate internal ASTIGMATISM control. The FOCUS and ASTIGMATISM controls should be adjusted simultaneously for the best possible display.

Intensity Controls

The INTENSITY controls are 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 controls are rotated clockwise to increase brightness and counterclockwise to decrease brightness. Care must be taken when using the INTENSITY controls that the brightness is not turned up to the point where the face of the cathode-ray tube is permanently damaged. If the intensity is turned up too far, the phosphor on the face of the crt may be burned. The intensity should never be turned up to the point where a halo forms around the spot.

Graticule Illumination Control

The graticule used with the Type 555 Oscilloscope is accurately marked with 10 horizontal and 6 vertical 1-centimeter divisions with 2-millimeter markings on the vertical centerline and on the two base lines. These graticule markings allow you to make time and voltage measurements from the oscilloscope screen.

The graticule is illuminated by two lamps located at the top edge of graticule. This illumination can be controlled so that the graticule markings appear either red or white, as desired. The graticule markings are changed from red to white or from white to red by removing the graticule cover and rotating the graticule (see Figure 2-2). As a general rule, white graticule markings are superior to red for photgraphic purposes. To obtain satisfactory waveform photographs, the intensity of the trace must approximately match the brightness of the graticule markings.

Graticule illumination is adjusted by the SCALE ILLUM. control. Rotating the control clockwise increases the brightness of the graticule markings and rotating the control counterclockwise decreases the brightness.

Positioning Controls

Four controls are used with the Type 555 Oscilloscope to allow you to position the trace of both beams to the desired points on the oscilloscope screen. Two of these controls are used to set the horizontal positions of the two beams and are located on the front panel of the instrument. The other two controls are used to set the vertical positions of the two beams and are located on the front panel of the plug-in units used with the oscilloscope. (Type CA Dual-Trace Plug-In Units have two Vertical Positioning controls.)

The two beams have independent horizontal positioning. The Upper Beam HORIZ. POSITION control positions the upper beam; the Lower Beam HORIZ. POSITION control positions the lower beam. The HORIZ. POSITION controls cause the traces to move to the right when rotated in the clockwise direction and to the left when rotated counterclockwise. The controls have sufficient range for you to view the entire trace even when the beam is expanded horizontally by a factor of 5 using the appropriate HORIZ. DISPLAY switch.

The vertical position controls have sufficient range to allow the beams to be positioned completely above or below the usable area of the screen. The traces move up when the controls are rotated clockwise and down when the controls are rotated counterclockwise.

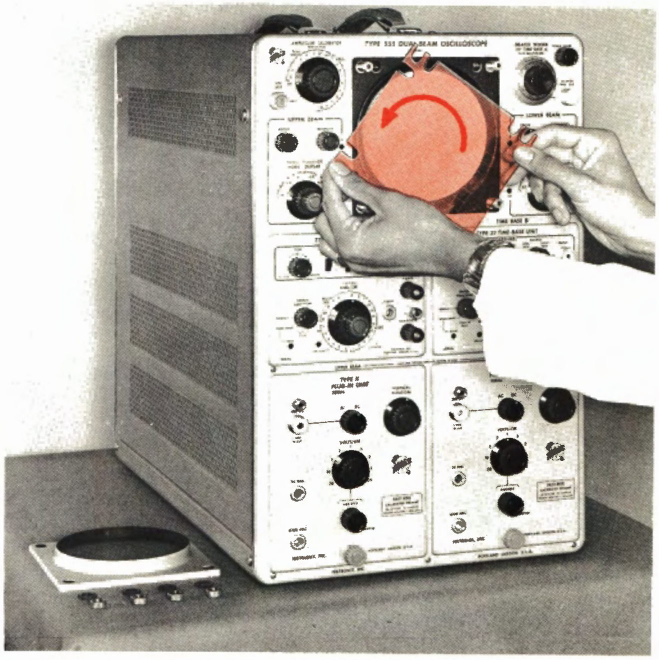


Fig. 2-2. Rotating the graticule to change the color of the graticule markings from red to white or from white to red.

Beam Position Indicators

Four small indicator lights, located on each side of the oscilloscope screen, indicate the position of the beams. When one of these lamps is lit, it indicates that the trace is off-centered in the direction of the arrow. These lights allow you to position each beam to the center of the usable area of the screen even though the intensity is so low that the trace is not visible. When the sweep is running, the beams move from the left side of the screen to the right and may cause both horizontal lamps to light each time the sweep runs.

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Input Signal Connections

Waveforms to be displayed on the oscilloscope are connected to the input connectors of the vertical plug-in units. The signals are then amplified and used to produce vertical deflection of the electron beams. Frequently it is possible to make the necessary input connections with unshielded test leads. This is true particularly when you are observing high-level low-frequency waveforms. When test leads are used, place a ground connection between the oscilloscope chassis and the chassis of the signal source.

In many applications unshielded leads are entirely unsatisfactory for making input connections due to the pickup resulting from stray magnetic fields. In such cases, shielded cables should be used. Care must be taken that the ground conductors of the cables are connected to the chassis of both the oscilloscope and the signal source.

In high frequency work it is usually necessary to terminate signal sources and connecting cables in their characteristic impedances. Unterminated connections result in reflections in the cables and cause distortion of the displayed waveforms. A properly selected coaxial cable will serve as the termination for the signal source. The appropriate terminating resistor or attenuation pad can then be connected to terminate the cable.

In general, a termination resistor connected at the input connector of the plug-in unit will produce satisfactory results. In some cases, however, it may be necessary to terminate cables at both ends. The need for proper terminations increases as the length of the connecting cables is increased.

In analyzing the displayed waveforms, you must consider the loading effect that the oscilloscope has on the signal source. The input resistance of the oscilloscope is 1 megohm and is usually adequate to limit low frequency loading to a negligible value. At high frequencies however, the input capacitance of the vertical plug-in unit and the distributed capacitance of input cables become important. Capacitive loading at high frequencies may be sufficient to adversely affect both the displayed waveform and operation of the signal source. Both capacitive and resistive loading can usually be limited to negligible values through use of attenuator probes.

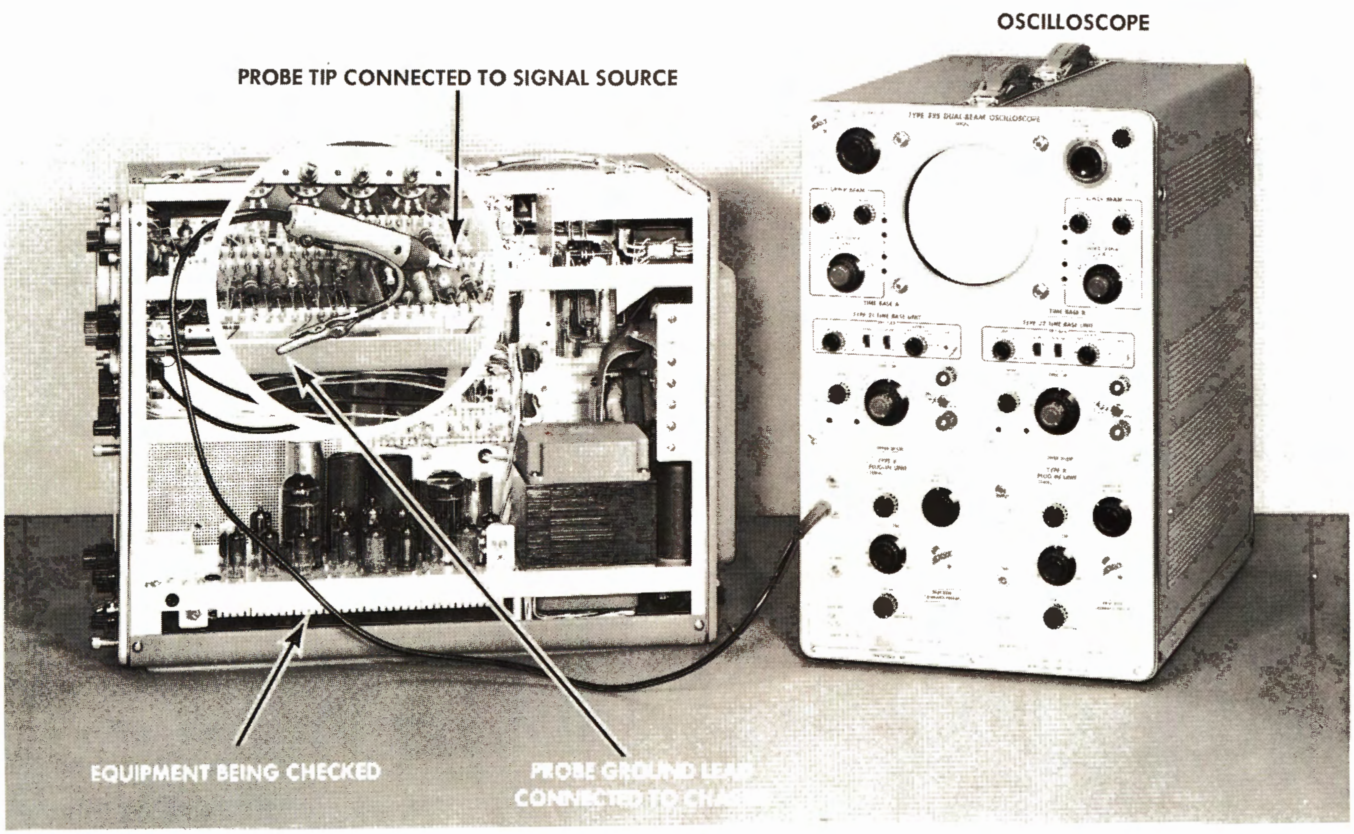
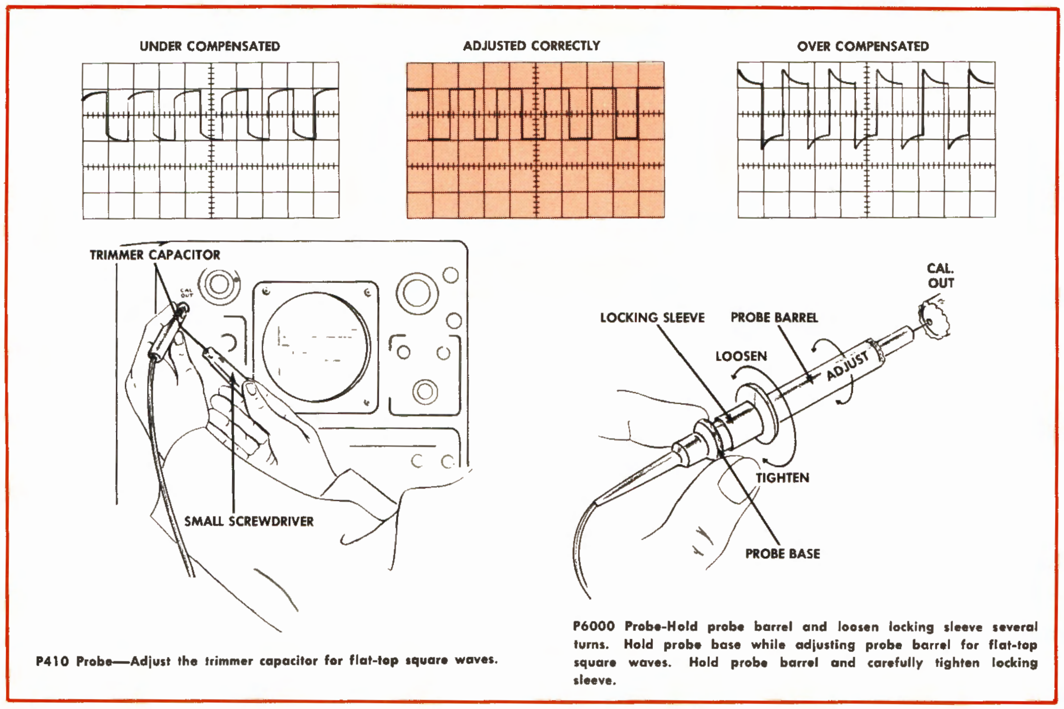


Fig. 2-3. Proper connection of a probe to the input signal source.



P410 Probe—Adjust the trimmer capacitor for flat-top square waves.

P6000 Probe-Hold probe barrel and loosen locking sleeve several turns. Hold probe base while adjusting probe barrel for flat-top square waves. Hold probe barrel and carefully tighten locking sleeve.

Fig. 2-4. Compensate the probe to obtain an undistorted presentation of the calibrator square-waves.

Use of Probes

Attenuator probes reduce loading of the signal source. However, in addition to providing isolation of the oscilloscope from the signal source, an attenuator probe also decreases the amplitude of the displayed waveform by the attenuation factor of the probe. Use of a probe allows you to increase the vertical deflection factors of the oscilloscope. This permits you to observe large-amplitude signals which are beyond the normal limits of the oscilloscope and plug-in combination. Signal amplitudes, however, must be limited to the maximum allowable value for the probe used. For Type P410 probes the maximum allowable input voltage is 600 volts; maximum voltage for Type P6000 probes is 1200 volts.

NOTE - Type P410 probes were furnished as an accessory to the Type 555 Oscilloscope before the Type P6000 probes were available. Type P410 probes were used for the illustrations in this manual.

Before using a probe you must check (and adjust if necessary) the compensation of the probe to prevent distortion of the applied waveform. The following instructions for setting the oscilloscope controls and compensating the probe are given for UPPER BEAM and TIME BASE A operation. Place the HORIZ. DISPLAY switch at X1 and rotate the LEVEL control counterclockwise to AC AUTO. Set the SLOPE switch at +, the COUPLING switch at AC, the SOURCE switch at UPPER BEAM, and the SWEEP FUNCTION switch at NORMAL. Connect the probe tip to the CAL. OUT connector and set the AMPLITUDE CALIBRATOR switch for 2 centimeters of displayed signal. Set the TIME/CM switch to display approximately 3 or 4 cycles of the calibrator waveform and adjust the probe compensation control to obtain flat tops on the displayed calibrator square-waves (see Figure 2-4). With the calibrator waveform displayed on the oscilloscope screen, the compensation control is adjusted to eliminate any distortion occurring in the leading edges of the calibrator waveforms.

Horizontal Sweeps

Horizontal sweeps for the Type 555 Oscilloscope are produced by the two plug-in time-base units. Either beam can

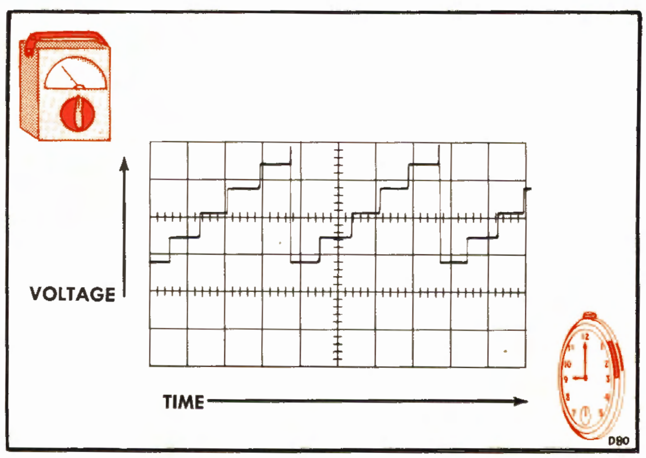


Fig. 2-5. The oscilloscope plots instantaneous voltage versus time, thereby serving both as a voltmeter and a timer. Voltage is represented by vertical deflection of the trace; time is represented by horizontal deflection. The horizontal deflection is known as as the horizontal sweep.

be deflected by either time base unit. Or, if desired, both beams may be swept simultaneously by the same time base unit. The selection of time base units is made with the Upper and Lower Beam HORIZ. DISPLAY switches.

In most applications, the time base units are used with the SWEEP FUNCTION switches in the NORMAL positions. This permits normal triggered operation of the time base units. Other switch positions are used for single sweep and delayed sweep applications.

The sweep rates of the two beams are determined by the settings of the appropriate TIME/CM and HORIZ. DISPLAY switches. The sweep rate in turn determines the duration of the trigger holdoff period. The sweep characteristics of each time base unit are identical. Each time base unit provides 24 calibrated sweep rates ranging from .1 μseconds to 5 seconds per centimeter. Uncalibrated VARIABLE TIME/CM controls permit sweep speeds to be varied continuously between .1 μseconds and approximately 12 seconds per centimeter.

Sweep Magnifiers

Waveforms displayed with either of the two beams can be expanded horizontally by a factor of 5 using the appropriate HORIZ. DISPLAY switch. This magnification is obtained when the HORIZ. DISPLAY switches are in either the TIME BASE A X.2 or TIME BASE B X.2 positions. The magnifiers increase the actual sweep speeds above those indicated by the TIME/CM controls. The true sweep time per centimeter is found by multiplying the settings of the TIME/CM controls by .2.

With the magnifiers on, the 2-centimeter portion at the exact center of the unmagnified display is expanded to the full 10-centimeter width of the graticule. Any other 2-centimeter portion of the original display can then be observed by using the HORIZONTAL POSITION control to position that portion on the screen.

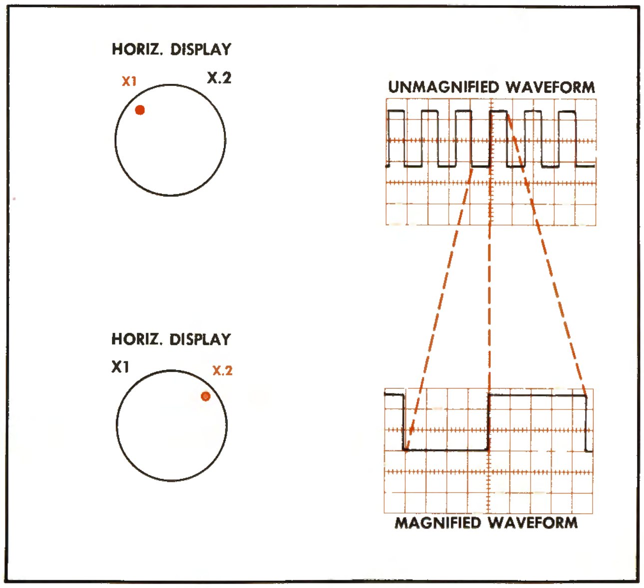


Fig. 2-6. Operation of the sweep magnifiers.

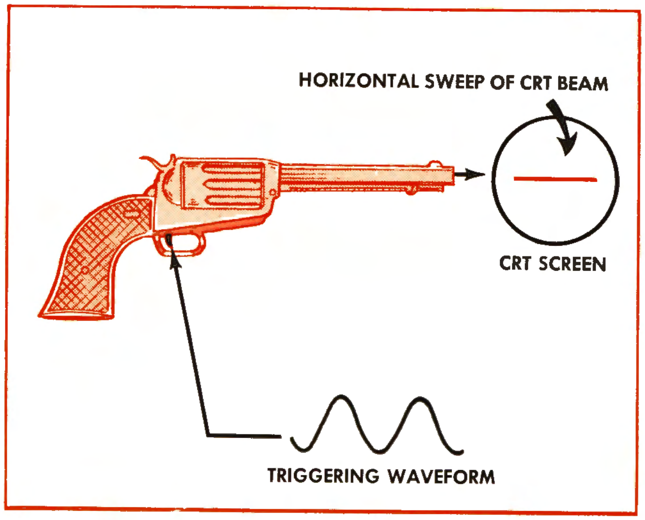


Fig. 2-7. In triggered-sweep operation the horizontal sweep of the crt beam is started by the triggering waveform.

Sweep Triggering

The oscilloscope display is formed by the repetitive sweep of the spot across the oscilloscope screen. If the sweeps are allowed to occur at random or at a rate unrelated to the rate of occurrence of the input waveform, the displayed waveform will be traced out at a different point on the screen each time the sweep runs. This will either cause the waveform to drift across the screen or to be indistinguishable.

In most cases it is desirable for a repetitive waveform to appear stationary on the oscilloscope screen so that the characteristics of the waveform can be examined in detail. As a necessary condition for this type of display, the start of the sweep must be bear a definite, fixed-time relationship to the appearance of the input waveform. This means that the sweep must be synchronized with the input waveform. In the Type 555 Oscilloscope this is accomplished by starting (triggering) the sweep with the displayed waveform or with another waveform bearing a definite time relationship to the displayed waveform.

The following paragraphs outline the means for selecting the triggering source, triggering slope, trigger input coupling, and triggering level with specific information regarding the operation of the controls affecting triggering. Triggering controls for Time Base A and Time Base B are identical so that the following information is applicable to both time-base units. Triggering of the sweep is adjusted by the respective TRIGGER LEVEL, COUPLING, SLOPE, and SOURCE controls.

Selecting The Triggering Source

In preparing the Type 555 for triggered operation of the sweeps, it is first necessary to select the triggering signal source which will produce the desired results. Either time base unit can be triggered from the upper beam waveform, the lower beam waveform, a line frequency waveform, or from an external triggering signal. The selection of triggering source is made with the appropriate SOURCE switch. Each triggering source has advantages for certain types of applications.

It is usually most convenient to trigger the sweeps internally from either the upper or lower beam signals. This is done by placing the SOURCE switch in the UPPER BEAM or LOWER BEAM position. Internal triggering is convenient since no external triggering connections are required. This method of triggering is excellent for most applications.

Triggering from the line is useful when the waveform being observed bears a definite relationship to the line frequency. This type of observation is frequently made when the displayed waveform is not suitable for triggering. When the SOURCE switch is placed in the LINE position, a constant amplitude line frequency signal is applied to the triggering circuits to insure stable operation.

Using external triggering, the triggering signal can be chosen to remain relatively constant in amplitude and shape. It is thereby possible to observe the shaping and amplification of a signal in an external circuit without resetting the oscilloscope triggering controls for each observation. Also, time and phase relationships between the waveforms at different points in the circuit can be seen. If for example, the external triggering signal is derived from the waveform at the input to a circuit, the time relationship and phase of the waveforms at each point in the circuit are compared to the input signal by the display presented on the oscilloscope screen.

Using external triggering and a stable triggering signal, it is possible to observe and accurately measure jitter of the displayed waveform. It is difficult to make accurate jitter measurements when the sweep is triggered internally.

To trigger one of the sweeps from an external waveform, connect the triggering waveform to the appropriate TRIGGER INPUT connector. Place the SOURCE switch in the EXT. position and adjust the other triggering controls for stable triggering.

Selecting The Triggering Slope

The horizontal sweeps can be triggered on either the rising (+slope) or falling (—slope) portion of the triggering waveform (see Figure 2-8). This selection is made with the TRIGGER SLOPE switches. In many applications the triggering slope is not important since triggering on either slope will provide a display which is suitable to the application. In other applications, however, it is important that the sweep be triggered on the proper slope in order to insure a useful display.

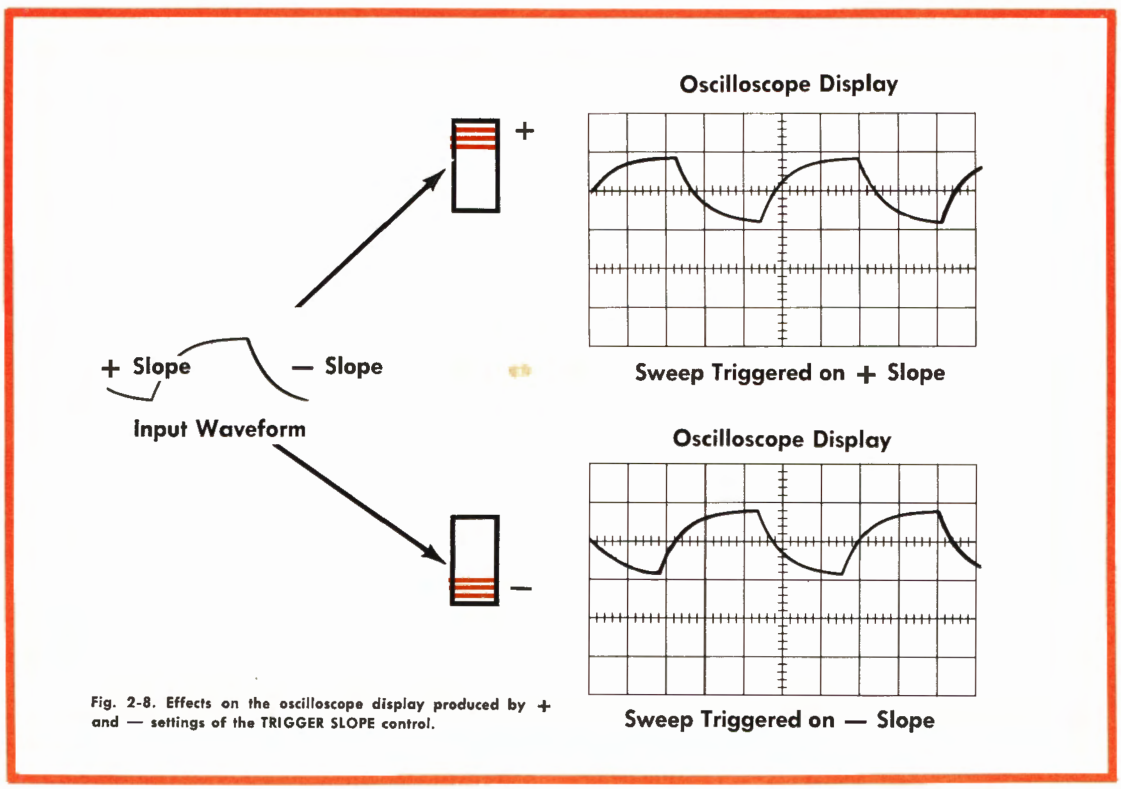


Fig. 2-8. Effects on the oscilloscope display produced by + and — settings of the TRIGGER SLOPE control.

Fig. 2-8. Effects on the oscilloscope display produced by + and — settings of the TRIGGER SLOPE switches.

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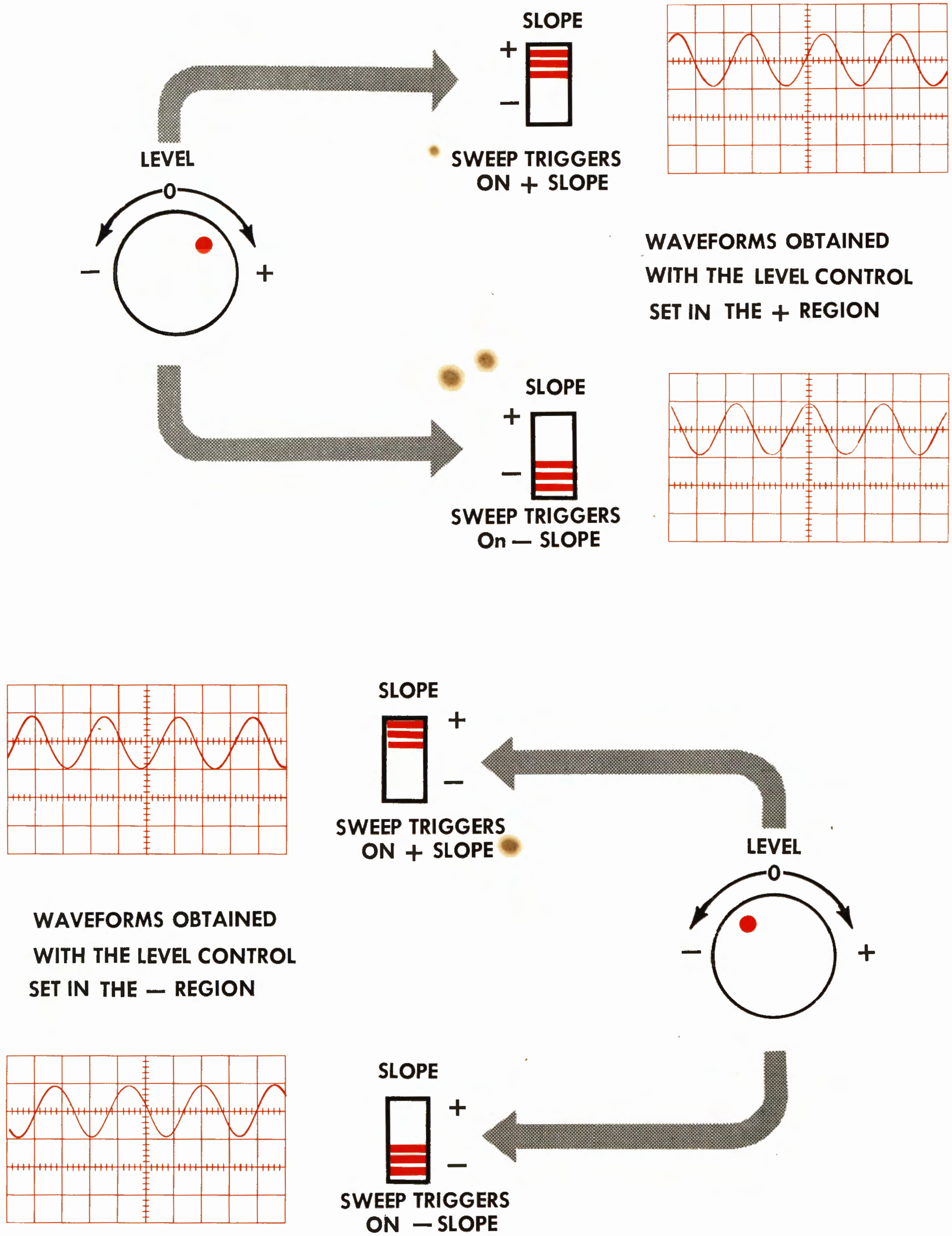

Fig. 2-9. Effects on the oscilloscope display produced by + and — settings of the TRIGGER LEVEL controls. In this illustration of the TRIGGER LEVEL control, the AC AUTO. and RECURRENT positions are not shown.

Trigger Input Coupling

Triggering waveforms can be either ac or dc coupled into the triggering circuits depending upon the position of the TRIGGER COUPLING switch. Using ac coupling, only the ac components of the triggering signal are applied to the triggering circuits. DC coupling applies both the ac and the dc components to the triggering circuit. In general, the AC position of the TRIGGER COUPLING switch should be used. If it becomes difficult or impossible to trigger the sweep using ac coupling, dc coupling should then be used. It will be necessary for you to use dc coupling when triggering from very low frequency waveforms.

Selection of Triggering Level

The TRIGGER LEVEL controls determine at which point on the triggering waveform triggering occurs (see Figure 2-9). Setting this control is the final step in triggering the sweep. Rotating the TRIGGER LEVEL controls in the clockwise direction causes the sweep to be triggered at more positive points on the triggering waveform. Rotating the controls counterclockwise causes the sweep to be triggered at more negative points on the waveform. In usual applications, the control is set near the zero position.

Automatic Triggering Mode

The automatic triggering mode is most frequently used because of its ease of operation. It can be used to observe a large number of waveforms without requiring changes in settings of the triggering controls. Automatic triggering is useful for obtaining stable displays of wavefroms lying in the range of approximately 60 cycles to 2 megacycles. In this mode the triggering level cannot be selected. Each sweep is instead triggered at the average voltage level of the wavefrom. In the absence of a triggering signal, the sweep continues to run to provide a convenient reference trace on the oscilloscope screen.

The automatic triggering mode is selected by rotating the TRIGGER LEVEL control fully counterclockwise to the AC AUTO. position. The triggering slope and source are then selected, and the input signal is applied to the oscilloscope. No other adjustments or settings of the triggering controls are required to obtain stable operation.

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 or SAWTOOTH connector is used to trigger or synchronize the input waveform. Either Upper Beam TIME BASE A, Lower Beam TIME BASE B, or a combination of both may be used. Figure 2-10 shows the Lower Beam TIME BASE B method of operation.

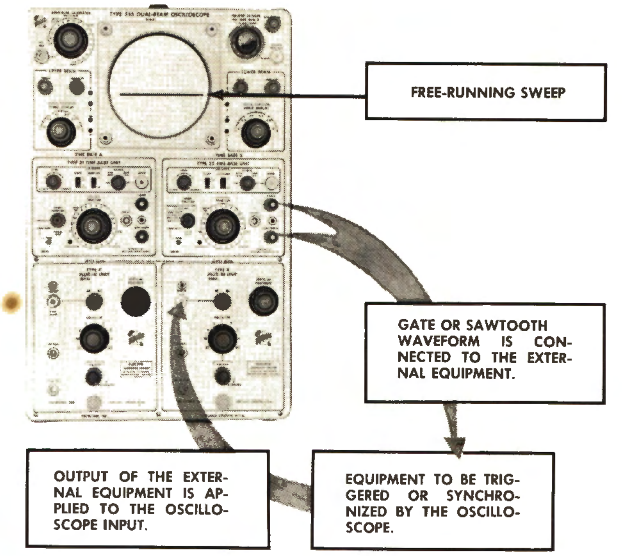

Fig. 2-10. Using the +GATE or SAWTOOTH waveform from TIME BASE B to synchronize or trigger external equipment.

The sweep for either time base can be made to free run by rotating the respective LEVEL control fully clockwise to the RECURRENT position. In this position the number of sweeps per second is determined by the setting of the TIME/CM controls.

In addition to providing the means for controlling an applied waveform, a free-running sweep also provides a convenient reference trace on the oscilloscope screen without requiring an input signal. This trace can then be used to position the sweep or to establish a voltage reference line.

Delayed Sweep

In the Type 555, Time Base A can be used to delay the start of a sweep by Time Base B for a period of from .05 μseconds to 50 seconds. Both the delayed and the undelayed sweeps can then be displayed on the oscilloscope screen. In the normal application the undelayed sweep is displayed on the upper beam; the delayed sweep is displayed on the lower beam. These conditions can be reversed however if desired by changing the positions of the HORIZ. DISPLAY switches.

Basically the delayed sweep feature of the Type 555 permits you to automatically start the sweep by Time Base A, wait a definite period of time, then start the sweep by Time Base B. This delay is continuously variable and is accurate to within 3% of the indicated delay. The delayed sweep by Time Base B allows you to examine a portion of the 'A' sweep presentation under high magnification. The magnification is the ratio of the 'A' TIME/CM switch setting to the 'B' TIME/CM switch setting. A portion of the 'A' sweep presentation is brightened to indicate the start and duration of the delayed sweep with respect to Time Base A.

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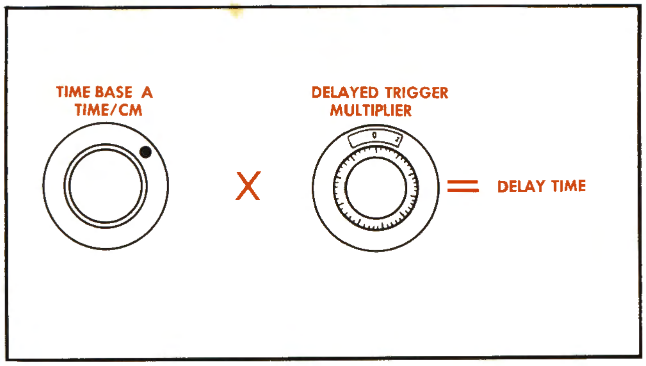
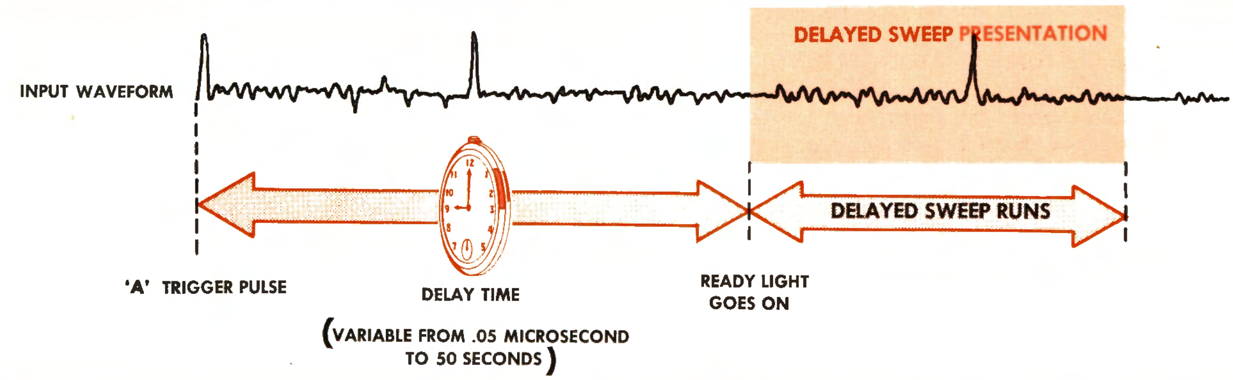


Fig. 2-11. Calculating delay time.

The delay period is determined by the settings of the 'A' TIME/CM and DELAYED TRIGGER controls. The delay time is found by multiplying the setting of the 'A' TIME/CM control by the setting of the DELAYED TRIGGER control (see Figure 2-11). For example, if the 'A' TIME/CM switch is set at 1 MILLISEC and the vernier dial of the DELAYED TRIGGER control indicates 6.75, the delay time is 6.75 milliseconds.

There are essentially two modes of delayed sweep operation (see Figure 2-12). The desired mode is selected by the setting of the Time Base B SWEEP FUNCTION control. One mode of operation is obtained with the SWEEP FUNCTION control in the SWEEPS ONCE FOR EACH "A" DEL'D TRIG. position. In this mode, the delayed sweep occurs immediately at the end of the delay period. This permits a continuously variable delay in the presentation of the sweep. Rotating the DELAYED TRIGGER control clockwise increases the delay time and causes the brightened portion of the sweep to move to the right. The size of the brightened portion of the sweep can be increased or decreased with the 'B' TIME/CM control. Through the use of both the DELAYED TRIGGER and the 'B' TIME/CM controls, any portion of the undelayed sweep can be included in the brightened section. This brightened portion is then expanded to the full width of the screen on the other beam (see Figure 2-13). The amount of magnification is the ratio of the 'B' TIME/CM control setting to the 'A' TIME/CM control setting. For example, if the 'B' TIME/CM switch is set at 1 MILLISEC and the 'A' TIME/CM switch is set a 1 SEC, the brightened portion of the sweep is magnified horizontally 1,000 times. Using this method, practical sweep magnifications up to approximately 10,000 times are attainable.

CASE 1: SWEEPS ONCE FOR EACH 'A' DEL'G TRIG.



CASE 2: TRIGGERABLE ONCE FOR EACH 'A' DEL'D TRIG.

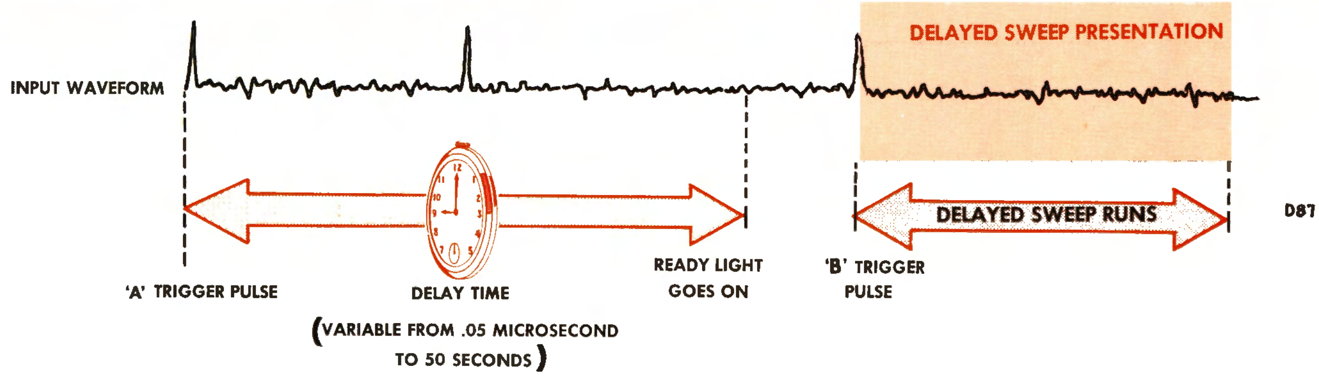


Fig. 2-12. Comparison of the two delayed-sweep modes. In each case the waveform shown represents the input to the oscilloscope. The waveform shown in the delayed-sweep presentation boxes represents the portion of the input waveform that is actually displayed on the oscilloscope screen. Note that in Case 1 an additional triggering pulse is required before the delayed sweep will occur.

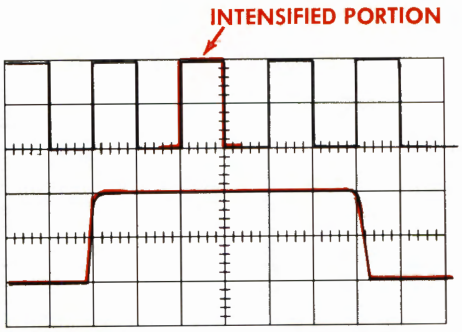


Fig. 2-13. The intensified portion of the upper beam is expanded and displayed on the lower beam.

The second delayed sweep mode is obtained with the Time Base B SWEEP FUNCTION switch in the TRIGGERABLE ONCE FOR EACH 'A' DEL'D TRIG. position. In this position the 'B' sweep is disabled for the period of delay. However, at the completion of the delay period the sweep will not occur until a triggering pulse is applied to Time Base B. The actual delay time in this mode is not continuously variable and is dependent not only on the settings of the delay-time controls, but on the occurrence of the Time Base B triggering signal as well. The TRIGGER LEVEL control must be in the position required for normal triggered operation. At the completion of the delay time, the ready light will go on to indicate that the sweep is ready to be triggered. When the triggering signal appears, the sweep runs and the READY light goes out.

Delayed Trigger

A delayed triggering pulse can be obtained from the DELAYED TRIG. OUT connector of the oscilloscope any time from .05 microseconds to 50 seconds after the start of a sweep. When the oscilloscope is set for delayed sweep operation, the delayed triggering pulse can be used to initiate some action after a known time interval, and when used with the delayed sweep, the delayed trigger permits you to observe the resulting action.

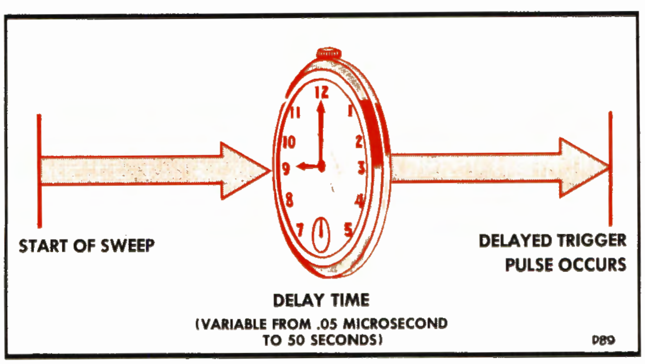


Fig. 2-14. Occurrence of the delayed triggering pulse. The delay time is adjusted with the DELAYED TRIGGER control. The delayed triggering pulse occurs at the end of the delay time.

To obtain a delayed trigger at the DELAYED TRIG. OUT connector, you must first adjust the TIME BASE A unit for triggered or for free-running operation, depending upon the application. The delay is then set and controlled by the 'A' TIME/CM control and the DELAYED TRIGGER control. The duration of this delay time is equal to the product of the settings of these two controls as shown previously in Figure 2-11.

Single-Sweep Operation

The usual oscilloscope display formed by repetitive sweep is satisfactory for most applications. However, in applications where the displayed waveform is not repetitive or varies in amplitude, shape, 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.

Both time base units in the Type 555 Oscilloscope are equipped to produce a single-sweep presentation. Also it is possible to obtain a single-sweep display using the same time base unit to deflect both beams. The single-sweep feature permits you to display one sweep and to eliminate all subsequent sweeps. In this way, information is clearly recorded without the confusion resulting from multiple traces. Single-sweeps are selected with each time base unit by placing the SWEEP FUNCTION switches in the SINGLE SWEEP position.

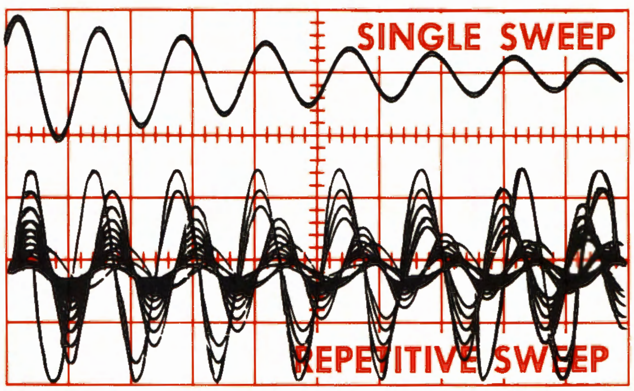
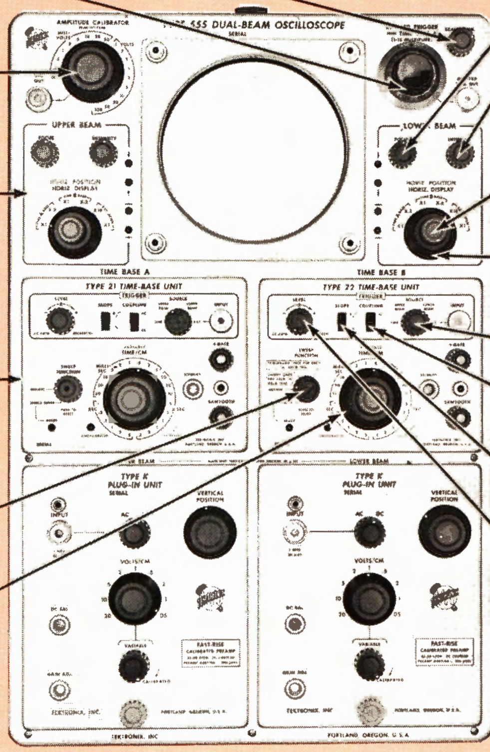


Fig. 2-15. Comparison of single sweep and repetitive sweep presentation of a damped sine wave. In the single sweep presentation the damped sine wave can be clearly seen.

The PUSH TO RESET buttons control the start of the sweep. When the TRIGGER LEVEL control is in the RECURRENT or AC AUTO. positions, the single-sweep occurs immediately each time the PUSH TO RESET button is depressed. When the TRIGGER LEVEL control is set for triggered operation, the single-sweep does not occur after the PUSH TO RESET button is depressed until a triggering signal is applied to the time



DELAYED TRIGGER—Used to adjust the sweep delay. Operates in conjunction with the TIME BASE A TIME/CM control.

SQUARE-WAVE CALIBRATOR—Sets the calibration voltage applied at the CAL. OUT connector.

UPPER BEAM—Upper Beam controls perform the same functions as corresponding Lower Beam controls.

TYPE 21 (Time Base A) UNIT—Type 21 controls perform the same functions as corresponding Type 22 (Time Base B) Unit except for delaying sweep operation.

SWEEP FUNCTION—Determines the type of sweep operation.

TIME/CM and VARIABLE—Used to adjust the sweep speed.

SCALE ILLUM.—Adjusts the brightness of the graticule markings.

FOCUS—Used to focus the lower beam trace.

INTENSITY—Controls the brightness of the lower beam display.

HORIZ. POSITION—Controls the horizontal position of the lower beam trace.

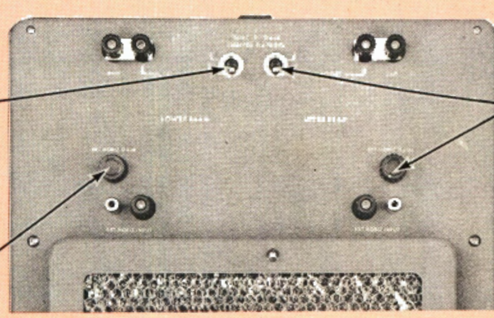
HORIZ. DISPLAY—Selects the waveform used to deflect the lower beam. Provides magnified displays using either Time Base A or Time Base B.

SOURCE—Selects the source of triggering signals.

COUPLING—Selects either AC or DC coupling of the triggering waveform to the triggering circuits.

SLOPE—Determines whether the sweep is triggered on the rise (+slope) or fall (—slope) of the triggering waveform.

LEVEL—Determines the point on the triggering waveform where the sweep is started. Also selects either AC Automatic or Recurrent sweep operation.



CRT CATHODE SELECTOR—Used in conjunction with the CHOPPED MODE of the CA Plug-in Unit and for beam-intensity modulation operation.

EXT. HORIZ. GAIN—Controls the horizontal defection factor for external signals. Used in conjunction with the Lower Beam HORIZ. DISPLAY switch.

CRT CATHODE SELECTOR and EXT. HORIZ. GAIN—Upper Beam controls perform the same functions as corresponding Lower Beam controls.

Note: POWER ON—Controls the power applied to the instrument. Located on the front panel of the Power Suppply unit (not shown).

Fig. 2-16. Functions of the Type 555 Oscilloscope front and rear panel controls.

base unit. Instead the READY lamp lights to indicate that the sweep can be triggered. When a triggering signal occurs, the sweep runs and the READY light goes out. This procedure is repeated each time the PUSH TO RESET button is depressed.

External Horizontal Inputs

For special applications you can deflect either beam horizontally with some externally derived waveform. This permits you to use the oscilloscope to plot one function versus another. The bandpass of the horizontal amplifier is dc to approximately 240 kc.

To use an external horizontal input, connect the external waveform to the EXT. HORIZ. INPUT connector for either the upper or lower beam. These connectors are located on the rear of the oscilloscope. Place the appropriate HORIZ. DISPLAY switch in one of the EXT. ATTEN. positions. The horizontal deflection produced by the external waveform can be either increased or decreased through use of the HORIZ. DISPLAY and EXT. HORIZ. GAIN controls. The horizontal deflection factors are continuously variable from approximately .2 to 20 volts per centimeter with the use of these two controls.

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 adjust probes and to verify the calibration of the vertical deflection systems of the oscilloscope.

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. The output is accurate within 3% of the AMPLITUDE CALIBRATOR switch setting when the output is connected to a high impedance load.

Dual-Trace Plug-In Units

Type CA Dual-Trace Plug-In Units can be used to obtain either 3 or 4 separate traces when used in conjunction with the Type 555 Oscilloscope. The number of traces depends upon whether one or two dual-trace plug-in units are used. The Type CA Unit operates on a time sharing basis in which sweep time is equally divided between the upper and lower traces of each beam. The CA units can be made to sweep alternately a lower and an upper trace. Or, if desired, a chopped mode permits rapid switching back and forth from upper to lower trace. Detailed instructions for operation of the Type CA Unit are contained in the CA Unit Instruction Manual.

When Type CA Units are used in the chopped mode, switching transients are displayed on the oscilloscope screen. These undesirable transients can be blanked so that they are not visible by placing the appropriate Cathode Selector switch in the DUAL-TRACE CHOPPED BLANKING position. These switches are located on the rear of the instrument. For normal applications, the switches are placed in the CRT CATHODE position and the binding posts jumpered to ground.

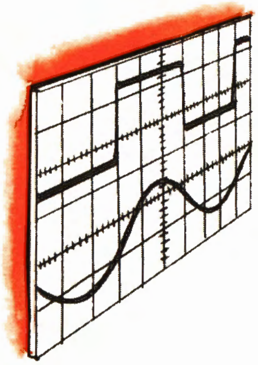
Intensity Modulation

Either beam of the Type 555 Oscilloscope can be intensity modulated by an external signal to display additional information. This is done by connecting the external signal to the appropriate CRT CATHODE connector on the rear of the instrument and placing the Cathode Selector switch in the CRT CATHODE position. This is done after first removing the grounding strap from the CRT CATHODE connector.

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 displayed on the screen. A positive signal of approximately 25 volts is required to cut off the beam from normal intensity.

SECTION 3

APPLICATIONS



Voltage Measurements

The Type 555 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 for each beam. 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.

When making voltage measurements, you should display the waveform over as large a vertical portion of the screen as possible 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 side of the trace is used for one reading, it should be used for all succeeding readings. The VARIABLE VOLTS/CM control must be in the CALIBRATED position.

AC Component Voltage Measurements

To measure the ac component of a waveform displayed by one of the beams, the plug-in unit input selector switch should usually be set to one of the AC positions. In these positions only the ac components of the input waveform are displayed on the oscilloscope screen. However, when the ac component of the input waveform is of very low frequency it is necessary for you to make voltage measurements with the input selector switch in one of the DC positions to prevent errors.

To make a peak-to-peak voltage measurement on the ac component of a waveform, perform the following steps (see Figure 3-1):

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

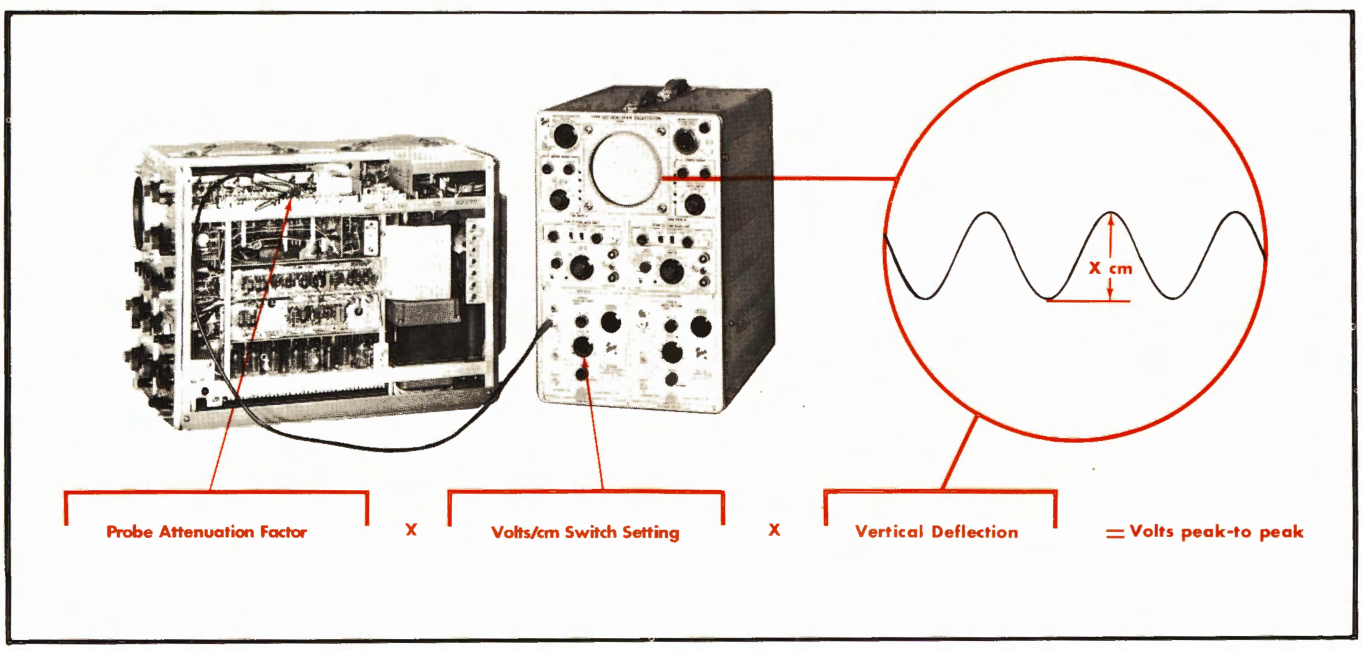


Fig. 3-1. Measuring the peak-to-peak ac component voltage of an applied waveform.

2. Multiply the vertical distance measured by the setting of the plug-in unit VOLTS/CM control to obtain the indicated voltage.

3. Multiply the indicated voltage by the attenuation factor of the probe to obtain the actual peak-to-peak voltage.

As an example of the method, assume that using a 10X probe and a deflection factor of 1 volt per centimeter, you measure a vertical distance between peaks of 4 centimeters. In this case then, 4 centimeters multiplied by 1 volt per centimeter gives you an indicated voltage of 4 volts peak-to-peak. The indicated voltage multiplied by the probe's attenuation factor of 10 then gives you the true peak-to-peak amplitude of 40 volts.

When sinusoidal waveforms are measured, the peak-to-peak voltage obtained can be converted to peak, rms, or average voltage through 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 components of a waveform. However for instantaneous voltage measurements the plug-in unit input selector switch must be placed in one of the DC positions. Also since instantaneous voltages are measured with respect to some potential (usually ground) a reference line must be established on the oscilloscope screen which corresponds to that potential. If, for example, voltage measurements are to be made with respect to +100 volts, the reference line would correspond to +100 volts. In the following procedure the method is given for establishing this reference line as ground since measurements with respect to ground are by far the most common type. 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 obtain an instantaneous voltage measurement with respect to ground, perform the following steps (see Figure 3-2):

1. To establish the voltage reference line, touch the probe tip to an oscilloscope ground terminal (or if the reference line is to represent a voltage other than ground, to a source of that voltage) and adjust the oscilloscope controls to obtain a free-running sweep. Vertically position the trace to a convenient point on the oscilloscope screen. This point 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. 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 and connect it to the signal source. Adjust the triggering controls for a stable display.

3. Using the graticule, measure the vertical distance in centimeters from the desired point on the waveform to the voltage reference line.

4. Multiply the setting of the VOLTS/CM control by the distance measured to obtain the indicated voltage.

5. Multiply the indicated voltage by the attenuation factor of the probe you are using to obtain the actual voltage with respect to ground (or other reference voltage).

As an example of this method, assume that you are using a 10X probe and deflection factor of .2 volts per centimeter. After setting the voltage reference line at the bottom division of the graticule using the lower beam, you measure a distance of 3 centimeters from the reference line to the

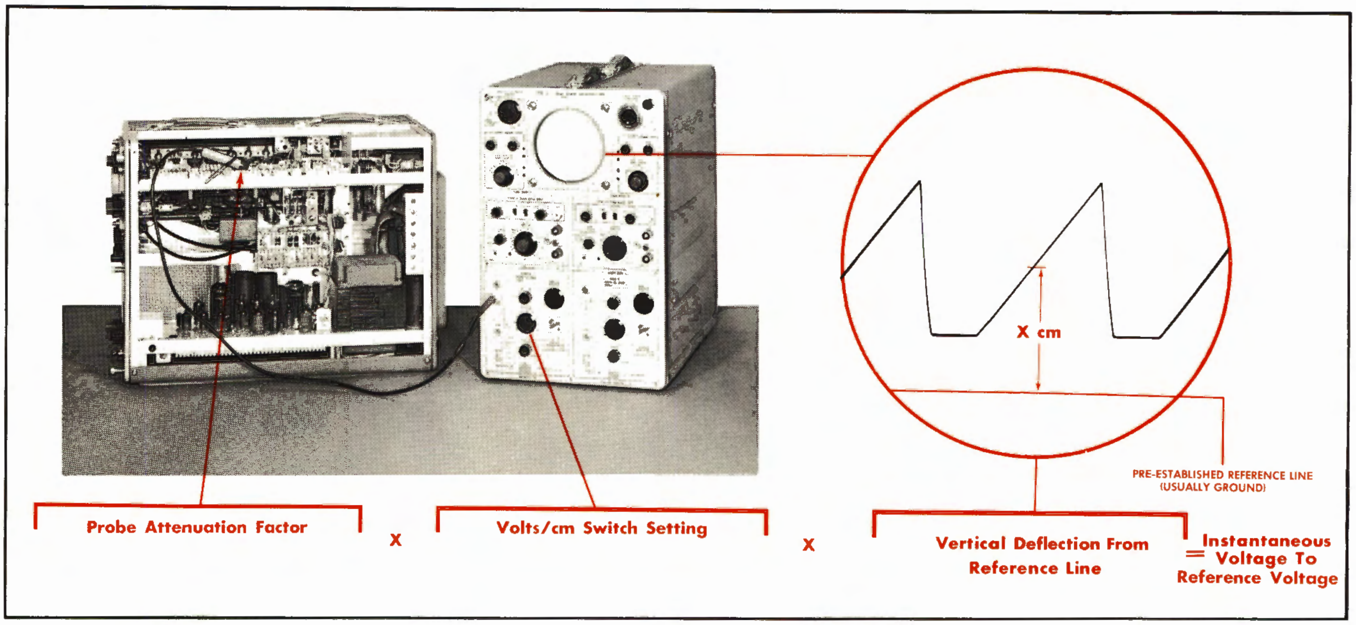


Fig. 3-2. Measuring the instantaneous voltage with respect to ground (or some other reference voltage).

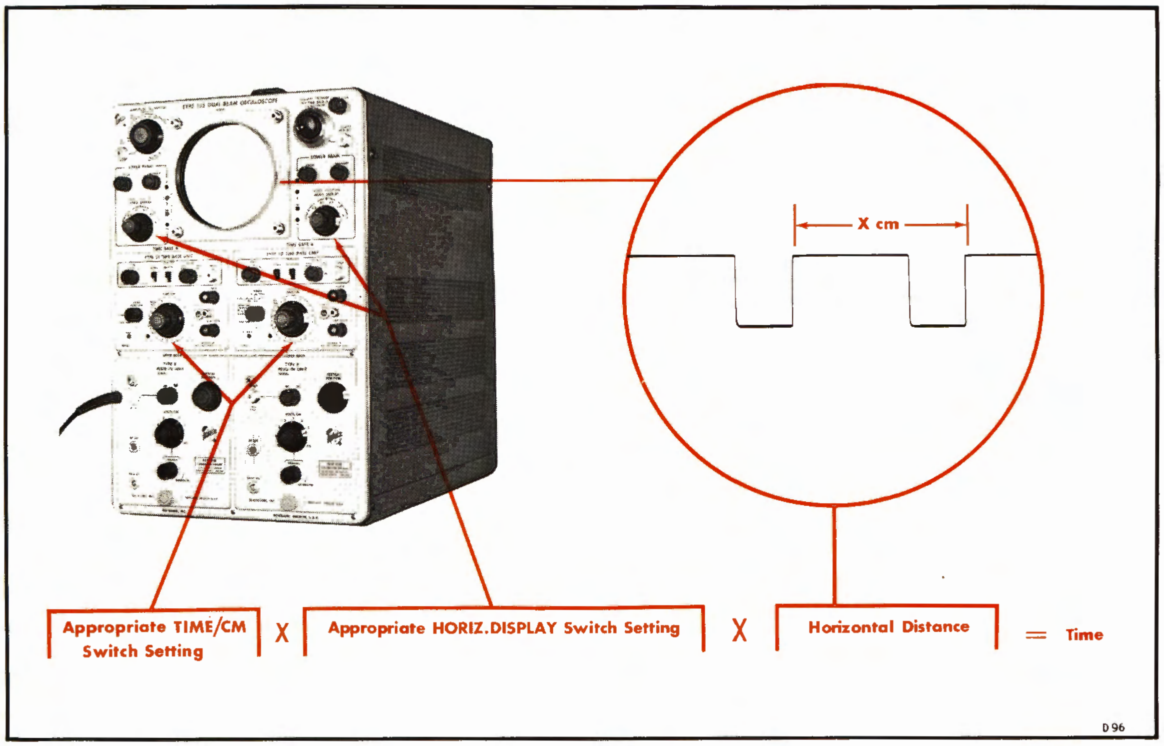


Fig. 3-3. Measuring time interval between events displayed on the oscilloscope screen.

point you wish to check. In this case 3 centimeters multiplied by .2 volts per centimeter gives you an indicated .6 volts. Since the voltage point is above the voltage reference line the polarity is indicated to be positive. The indicated voltage multiplied by the probe's attenuation factor of 10 then gives you the actual voltage of positive 6 volts.

Time Measurements

The calibrated sweeps of the Type 555 Oscilloscope cause any horizontal distance on the screen to represent a definite known interval of time. Using this feature you can accurately measure the time lapse between two events displayed by either trace on the oscilloscope screen. One method which produces sufficient accuracy for most applications is as follows (see Figure 3-3):

1. Using the graticule, measure the horizontal distance between the two displayed events on one trace 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. Multiply the apparent time interval by .2 if the X.2 position of the HORIZ. DISPLAY is used, and 1 if the X1 position is used, to obtain the actual time interval.

For example, assume that the TIME/CM switch setting is 1 MILLISEC, the HORIZ. DISPLAY switch setting is X.2, and that you measure a horizontal distance of 5 centimeters between events displayed by the trace. In this example then, 5 centimeters multiplied by 1 millisecond per centimeter gives you an apparent time interval of 5 milliseconds. The apparent time multiplied by .2 then gives you the actual time interval of 1 millisecond.

A second method for measuring time intervals involves the use of both beams and the delayed sweep feature of the Type 555 Oscilloscope. In this method the signal source is connected to both vertical amplifier inputs. The 'B'* SWEEP FUNCTION switch is placed in the SWEEPS ONCE FOR EACH "A" DEL'D TRIG. position to brighten a portion of the upper beam and to expand that portion on the lower beam. This method provides high sweep magnification for measuring on the lower beam while displaying the unmagnified waveform on the upper beam. This method is summarized as follows:

1. Connect the signal source to the Upper Beam and Lower Beam vertical amplifier input connectors.

2. Place the 'B' SWEEP FUNCTION switch in the SWEEPS ONCE FOR EACH "A" DEL'D TRIG. position.

3. Set the 'A'** TRIGGER LEVEL control at AC AUTO. and place the 'A' TRIGGER SOURCE control in the UPPER BEAM position.

4. Turn the upper beam intensity down until the brightened portion of the trace is easily distinguishable. Adjust the 'B' TIME/CM control to reduce the brightened area and rotate the DELAYED TRIGGER control to cover the portion of the display you wish to measure.

*** Used throughout the text as an abbreviation for TIME BASE B.**

**** Used throughout the text as an abbreviation for TIME BASE A.**

5. Multiply the setting of the 'B' TIME/CM control by the horizontal distance between events displayed on the lower beam.

6. Multiply the results obtained by either 1 or 0.2 depending on the setting of the HORIZ. DISPLAY switch.

A third method for measuring time intervals involves the use of the upper beam and the delay feature. The lower beam is used to magnify and to monitor the brightened portion. This method provides a very high degree of accuracy when care is taken in making the measurments. The procedure is given as follows:

1. Connect the signal source to the Upper Beam and Lower Beam vertical amplifier input connectors.

2. Place the 'B' SWEEP FUNCTION switch in the SWEEPS ONCE FOR EACH "A" DEL'D TRIG. position.

3. Set the 'A' TRIGGER LEVEL control at AC AUTO. and place the 'A' TRIGGER SOURCE control in the UPPER BEAM position.

4. Turn the upper beam intensity down until the brightened portion of the trace is easily distinguishable. Adjust the 'B' TIME/CM control to reduce the brightened area to a small spot or to cover as small a portion of the trace as possible.

5. Using the DELAYED TRIGGER control, position the start of the brightened portion to the beginning of the interval you wish to measure. Record the setting of the DELAYED TRIGGER control.

6. Using the DELAYED TRIGGER control, position the start of the brightened portion of the trace to the end of the interval you wish to measure. Again record the setting of the DELAYED TRIGGER control.

7. Subtract the first DELAYED TRIGGER control setting from the second and multiply the result by the setting of the'A' TIME/CM control. The figure obtained is the time interval between the two events.

Frequency Measurements

Using one of the three methods 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 microseconds, the frequency is the reciprocal of 0.2 microseconds, or 5 mc.

At any given oscilloscope sweep speed, the number of cycles of the input waveform that is displayed on 10 centimeters of the screen is dependent on the frequency of the input waveform. At a sweep speed of .1 microseconds per centimeter, for example, 6 cycles are displayed with a 6 mc input signal, 5 cycles with a 5 mc signal, and 4 cycles with a 4 mc input signal. By utilizing the pattern of these observations you can measure frequencies by counting the

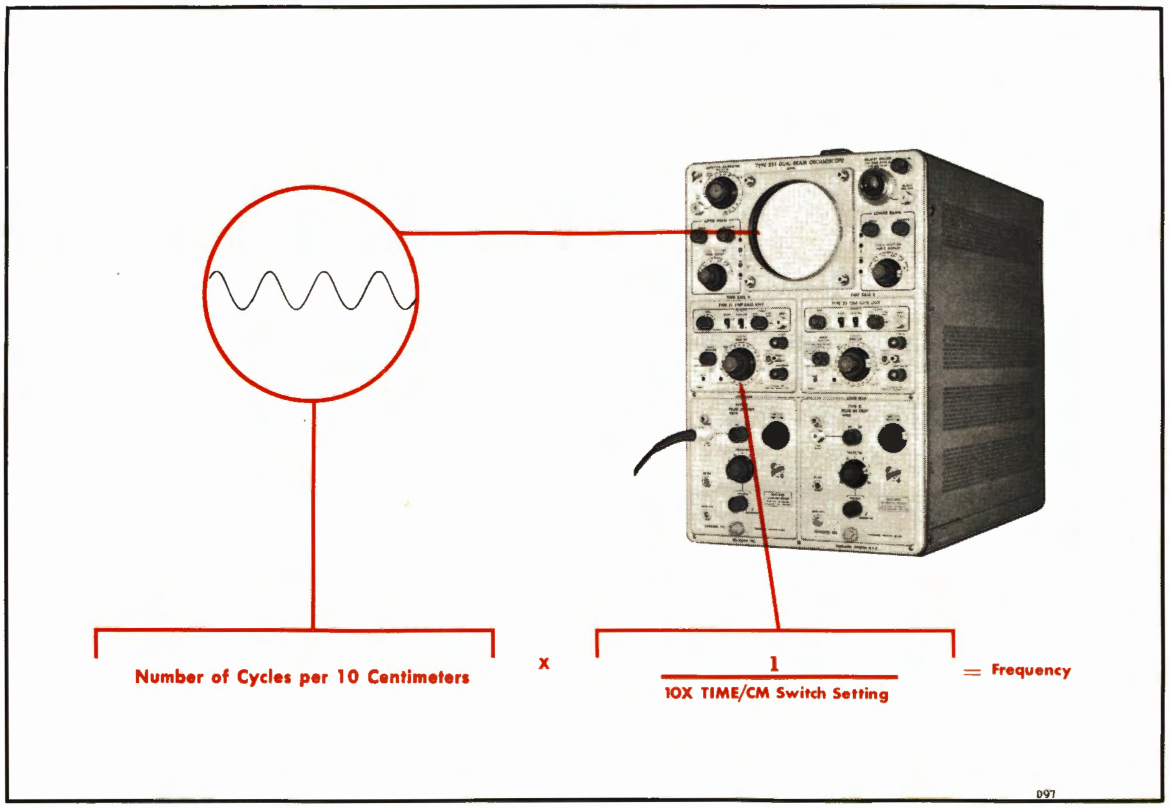


Fig. 3-4. Measuring the frequency of a repetitive input signal.

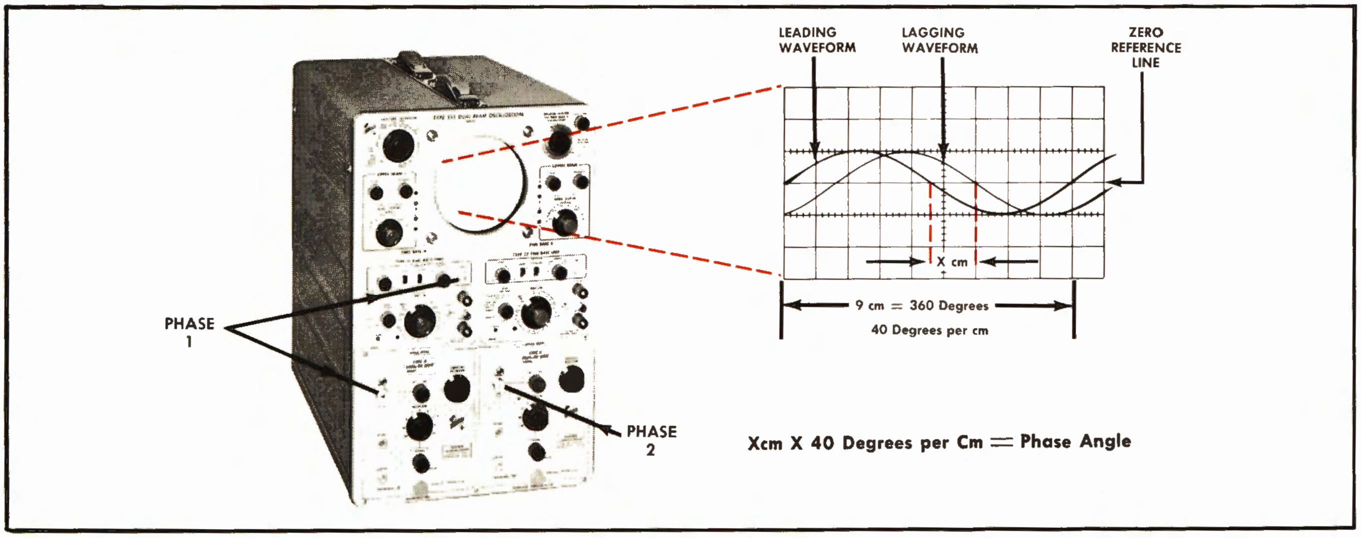


Fig. 3-5. Measuring the phase angle between two signals.

number of cycles of a waveform on 10 centimeters of the screen and multiplying this number by a factor which is dependent on the sweep speed used. Since each sweep speed produces a definite fixed multiplication factor, frequencies can usually be measured by this method much faster than by the previous method. The method is summarized as follows (see Figure 3-4):

1. Adjust the appropriate TIME/CM control to display several cycles of the input waveform. Insure that the VARIABLE TIME/CM control is in the CALIBRATED position.

2. Count the number of cycles of the waveform that are displayed on the 10 centimeters of the graticule.

3. Multiply this number by the multiplication factor for the sweep speed you are using. The product is the frequency of the input waveform.

NOTE

The multiplication factor for each sweep speed is found by taking the reciprocal of 10 times the sweep time per centimeter.

As an example, assume that when you are using a sweep speed of 50 milliseconds per centimeter, you count 7.2 cycles in 10 centimeters. The multiplication factor for a sweep speed of 50 milliseconds per centimeter is the reciprocal of 500 milliseconds (10 times 50 milliseconds), or 2 per second. The frequency is 7.2 cycles multiplied by 2 per second, or 14.4 cycles per second.

Phase Measurements

Phase-angle measurements, using both beams, can be made easily by allowing a 9-centimeter width of the horizontal graticule line to represent 360 degrees. Each centimeter would then represent 40 degrees. A typical setup for phase measurements using this method is shown in Figure 3-5. Examples of circuits that can be tested are amplifiers, transformers and filters. To make the phase measurements:

1. Select the coaxial cables and terminations to be used in your phase measurements.

2. Place both HORIZ. DISPLAY switches in the 'A' X1 position. Set the 'A' trigger controls at AC AUTO., +SLOPE, AC COUPLING, and EXT. SOURCE.

3. Set the 'A' SWEEP FUNCTION switch at NORMAL and position both traces to the middle horizontal graticule line. The middle graticule line is the zero reference line.

4. Connect the Phase 1 waveform to the 'A' vertical input connector and to the 'A' trigger INPUT connector. Connect the Phase 2 signal to the 'B' vertical input connector.

5. Adjust the 'A' TIME/CM switch and the 'A' VARIABLE TIME/CM control so that one cycle of the input waveform covers exactly 9 centimeters. Adjust both upper and lower beam vertical VOLTS/CM controls for a 2-centimeter peak-to-peak amplitude of both waveforms. Rotate the 'A' LEVEL control clockwise until the leading waveform starts at the zero horizontal reference line and horizontally position both waveforms to the left to start at the first vertical graticule line.

6. Measure the horizontal distance in centimeters between the leading waveform and the lagging waveform at the zero reference line. Multiply the horizontal distance times 40 degrees to obtain the phase angle in degrees.

To make precision phase angle measurements of a few degrees, the sine wave can be expanded horizontally by a factor of 2 or more by increasing the time base rate. The vertical sensitivity can be increased to allow an accurate intercept reading. Using this method, for example, if the time base rate is increased by a factor of 10, the new calibration rate is 4 degrees per centimeter.

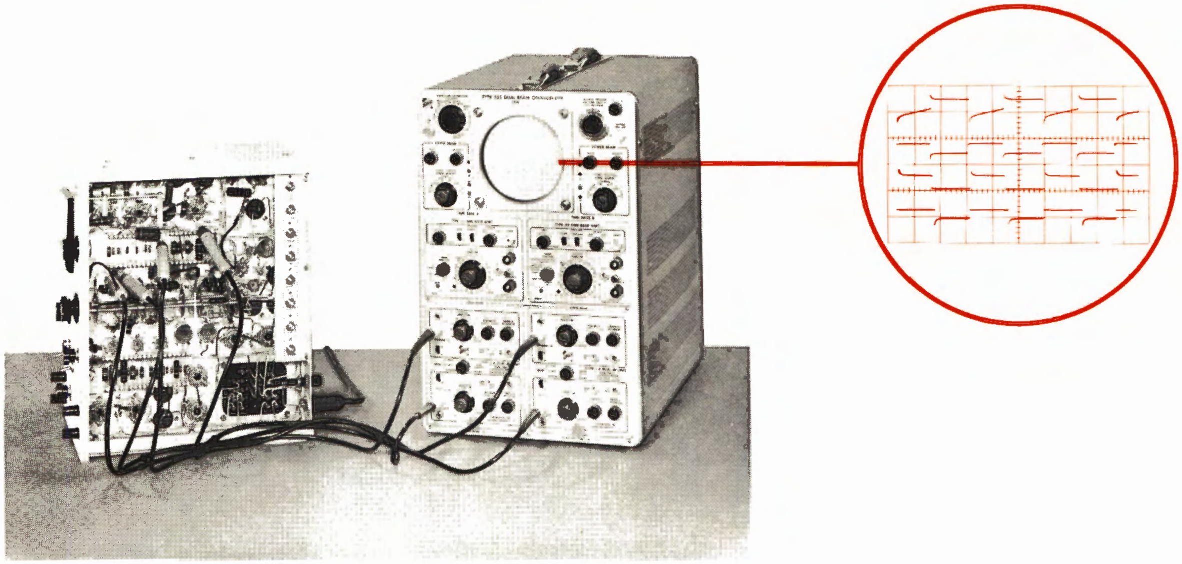


Fig. 3-6. Four trace operation using two Type CA Dual-Trace Plug-In Units.

Four Trace Operation With Dual-Trace Plug-In Units

A four-channel display is available through the use of the time-sharing characteristics of the Type CA Dual-Trace Plug-In Units in both vertical plug-in compartments of the Type 555 Oscilloscope.

The Type CA Unit can be used to perform three types of operation; the observation of repetitive waveforms, of signal transients, and of one waveform superimposed upon the other. Maximum flexibility is obtained by providing separate positioning, sensitivity, and polar-inverting controls for each channel.

In figure 3-6 four signals are displayed on the screen of the Type 555 Oscilloscope to demonstrate the versatility of the instrument. The MODE switch is set at the ALTERNATE position on both of the Type CA Units. For further information on the use of the Type CA Unit, refer to the Instruction Manual for that unit.

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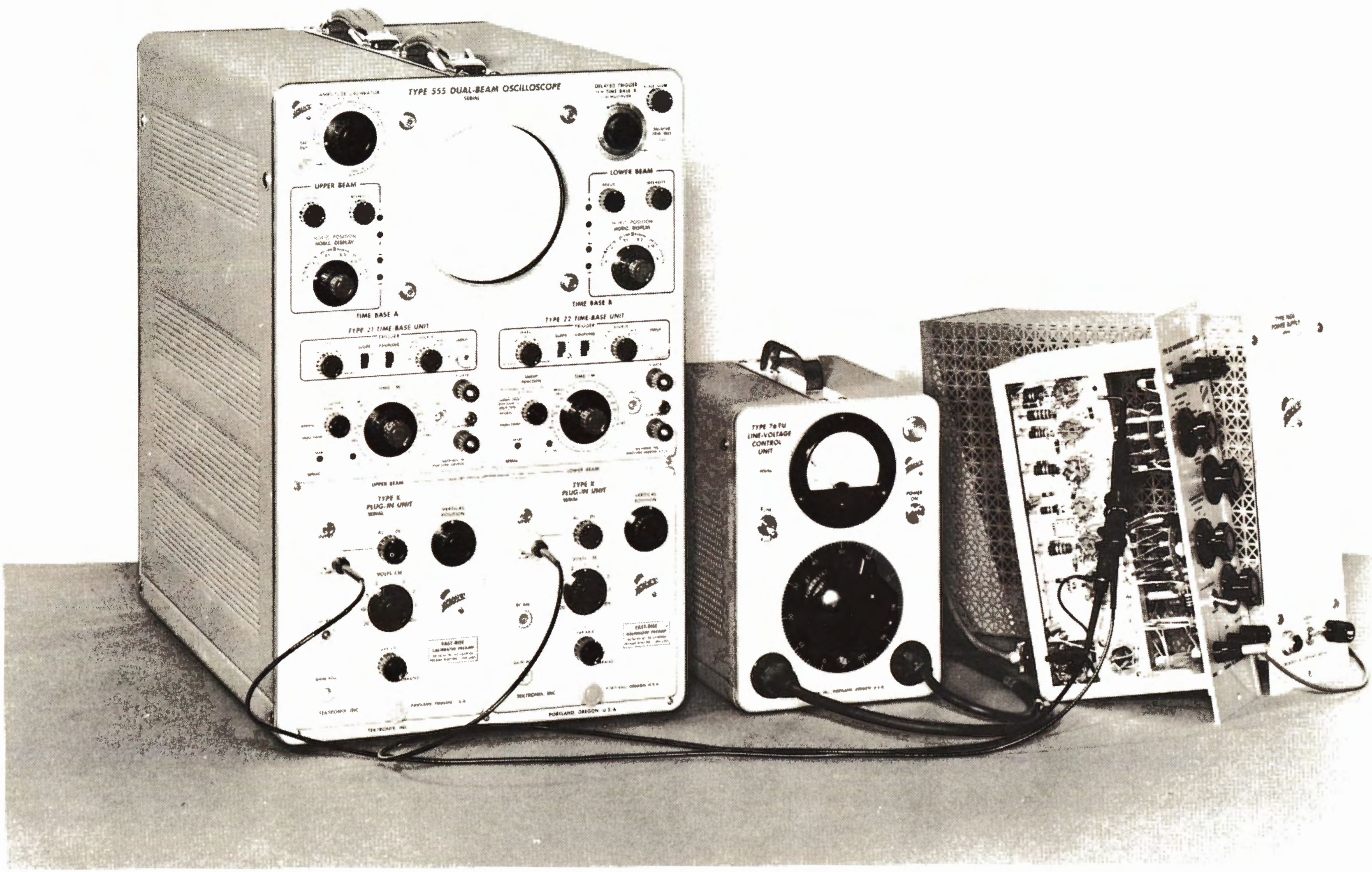
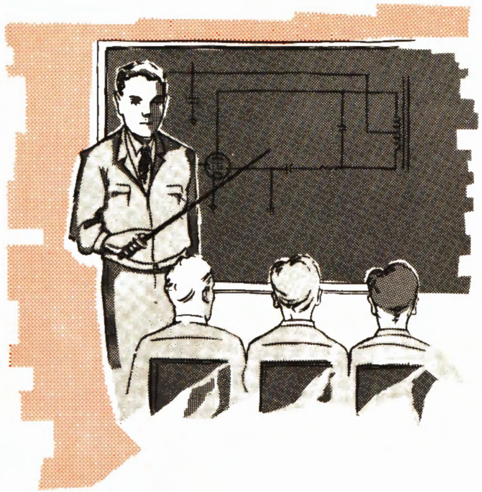


Fig. 3-7. Using the Type 555 to check the coincidence of fast-rise pulses.



SECTION 4

THEORY OF OPERATION

General Information

This portion of the Operator's Manual presents a brief discussion of the Type 555 Oscilloscope's circuit operation. This discussion is keyed to various block diagrams inserted with the text and to detailed circuit diagrams in the Parts List and Schematic Diagram Booklet. Emphasis is placed on the interrelation of circuits rather than on detailed operation.

Instrument Operation

The simplified block diagram of Fig. 4-1 illustrates the interrelation of the various circuits composing the Type 555 Oscilloscope. The instrument has identical vertical deflection systems, one for the Upper Beam and one for the Lower. The input waveforms to the oscilloscope can be connected to either or both vertical amplifiers. The waveforms are then amplified in the plug-in units and vertical amplifiers. The push-pull outputs of the vertical amplifiers are connected through delay lines to their respective vertical-deflection plates.

Trigger pickoff circuits in the Upper and Lower Beam vertical amplifiers apply a sample of the input waveforms to both trigger circuits. These waveforms samples can then be used to start or synchronize the sweep of either or both time-base units. In addition, an external waveform or line-frequency waveform can also be used to trigger the sweep.

Signals of widely varying shapes and amplitudes are applied to the two trigger circuits. The trigger circuits in turn produce constant amplitude output pulses which are used to start the horizontal sweeps at the proper instant of time to insure a stable display of the input waveform.

The output pulses from the two trigger circuits are applied to their corresponding time-base generators to initiate sweep sawtooth waveforms. The sawtooth waveforms are then amplified by the Upper and Lower Beam horizontal amplifiers and applied to their respective horizontal-deflection plates of the cathode-ray tube.

When external sweep waveforms are used, waveforms are connected through the EXT. HORIZ. INPUT connectors to the appropriate external horizontal amplifiers. The output signals from the external amplifiers are amplified by the horizontal amplifiers and applied to the horizontal-deflection plates to produce the desired deflection.

The sawtooth waveform from the Time Base A generator is applied to the delay pickoff circuit. This circuit utilizes the sawtooth waveform to generate an output pulse after an adjustable delay time. This delayed triggering pulse is applied to the DELAYED TRIG. OUT connector and to Time Base B. The delayed trigger pulse can be used to initiate a delayed sweep by Time Base B.

The amplitude calibrator produces a square wave output waveform which can be used to check the calibration of the vertical deflection system. The calibration voltage is also used to compensate probes.

There are six regulated low-voltage power supplies in the Type 555 Oscilloscope. These power supplies provide the operating voltages for all circuits except the cathode-ray tube. Operating voltages for the crt are provided by separate high-voltage power supplies contained in the crt circuit. In addition to the high-voltage power supplies, the crt circuit contains all the controls and circuitry which affect the crt display.

Vertical Deflection System

Since both Upper and Lower Beam vertical deflection systems are identical, the description that follows applies to both systems. The Upper Beam vertical deflection system block diagram is shown in Figure 4-2.

Input signals to the oscilloscope are applied to the input connector of the vertical plug-in unit used with the oscilloscope. The plug-in unit provides a balanced push-pull output to the oscilloscope vertical amplifier through the interconnecting plug.

The Type 555 vertical amplifier consists of three dc-coupled push-pull stages providing sufficient amplification to drive the vertical-deflection plates of the crt. The frequency response of the vertical amplifier is extended to dc to 30 mc through the use of low and high frequency compensation and a distributed amplifier output stage. The distributed amplifier consists of six push-pull sections, the separate gains of which are additive. Together these sections provide sufficient gain at high frequencies to bring the upper 3-db-down point to 30 mc.

The push-pull output of the vertical amplifier is applied through a balanced delay line to the vertical-deflection plates of the crt. The delay line delays the application of the vertical signal to the deflection plates until the crt has been unblanked and the horizontal sweep started. This delay allows the leading edge of the fast rising pulses to

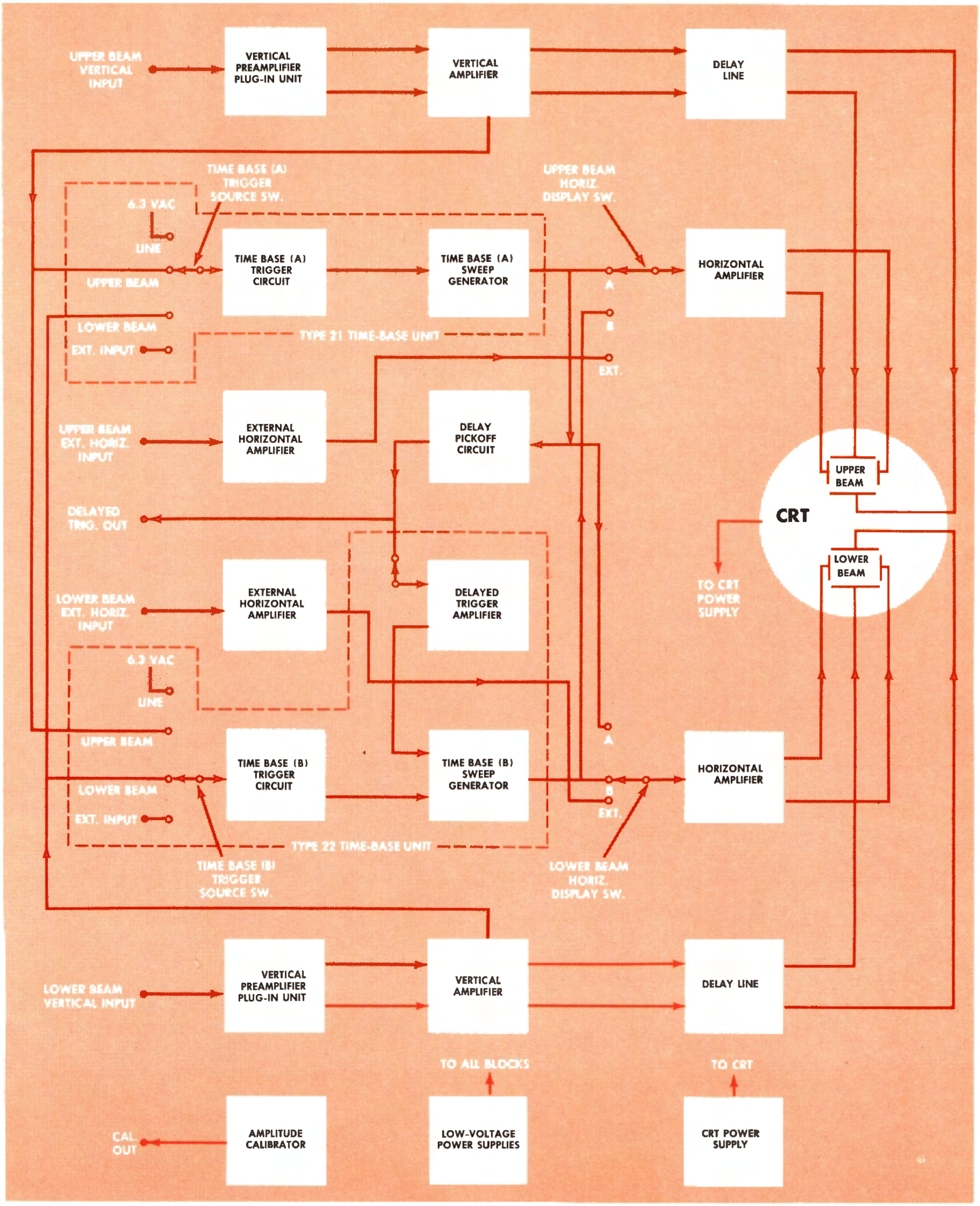


Fig. 4-1. Block Diagram of the Type 555 Oscilloscope.

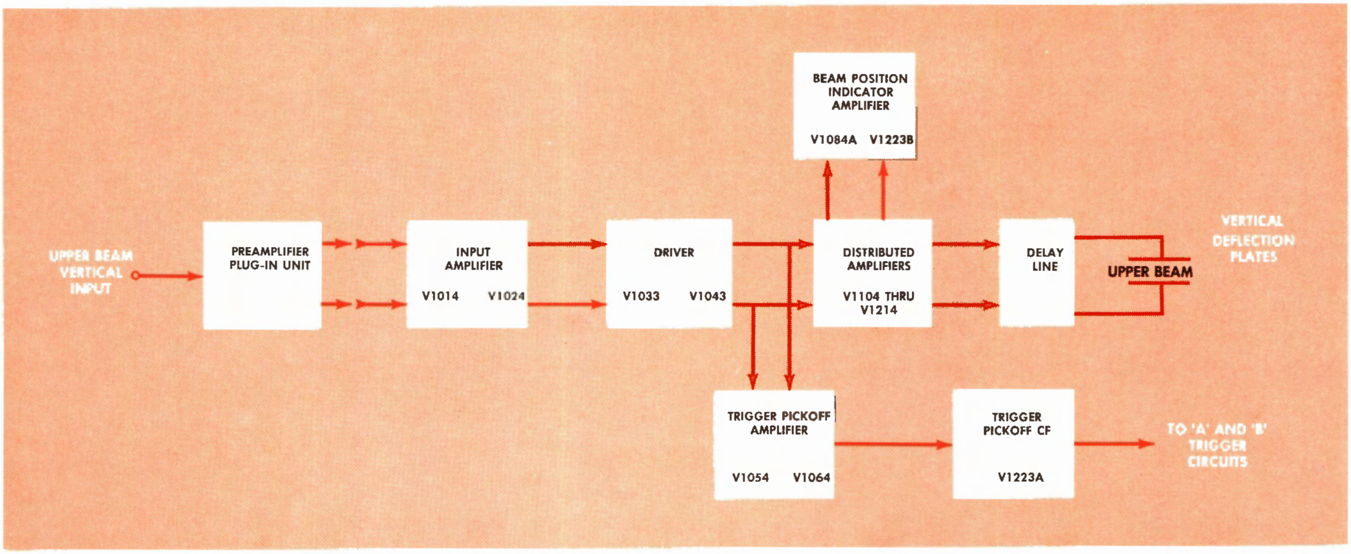


Fig. 4-2. Upper Beam Vertical-deflection system block diagram.

be displayed. The delay line is adjusted by means of variable capacitors for minimum waveform distortion.

A push-pull output from the vertical amplifier is also applied to the trigger pickoff circuit. This circuit consists of an amplifier stage and a cathode follower. The amplifier stage receives the push-pull input signal and provides a single-ended output signal which is in phase with the signal originally applied to the input of the plug-in unit. The output of the amplifier stage is applied through the trigger pickoff cathode follower to the triggering circuits of either or both time base units.

Triggering Circuit

The triggering circuits in both time base units are identical. Therefore, only one circuit is described and one block diagram, Figure 4-3, is shown.

The triggering signals from the line, external input, Upper Beam amplifier, and Lower Beam amplifer are connected to the input of the triggering circuit. The signal selected by the trigger SOURCE switch is then connected to one of the grids of the trigger-input amplifier through the COUPLING and SLOPE switches.

The trigger-input amplifier is a difference amplifier stage which compares the amplitude of the triggering signal on one grid to the voltage on the other grid obtained from the TRIGGER LEVEL control. The output of the trigger amplifier is applied to the trigger multivibrator, a Schmitt Trigger Circuit. When the output of the amplifier reaches a certain level the trigger multivibrator switches to produce a trigger pulse which is applied to the sweep circuit. The trigger multivibrator then resets to await the next triggering waveform.

When the trigger circuit is set for AC AUTO. operation, a feedback circuit is provided for the trigger multivibrator which causes the multivibrator to free run at approximately a 50-cycle rate. When a triggering signal is applied, the trigger multivibrator is synchronized by the triggering waveform, and the circuit operates as described in the previous paragraph.

Time Base Generator

The block diagram, Figure 4-4, shows the areas where differences occur between the type 21 and the Type 22 Time Base Units. In the following description the differences are noted in the text and on the block diagram.

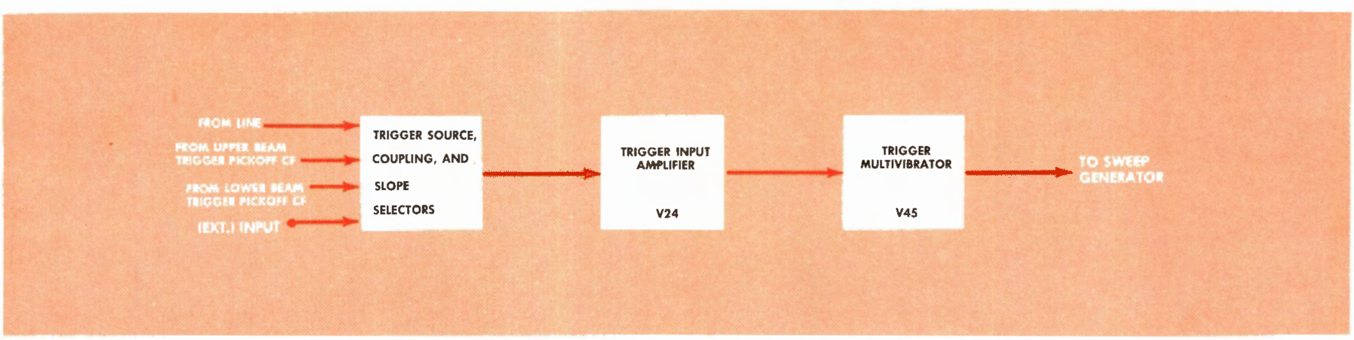


Fig. 4-3. Trigger-Circuit block diagram.

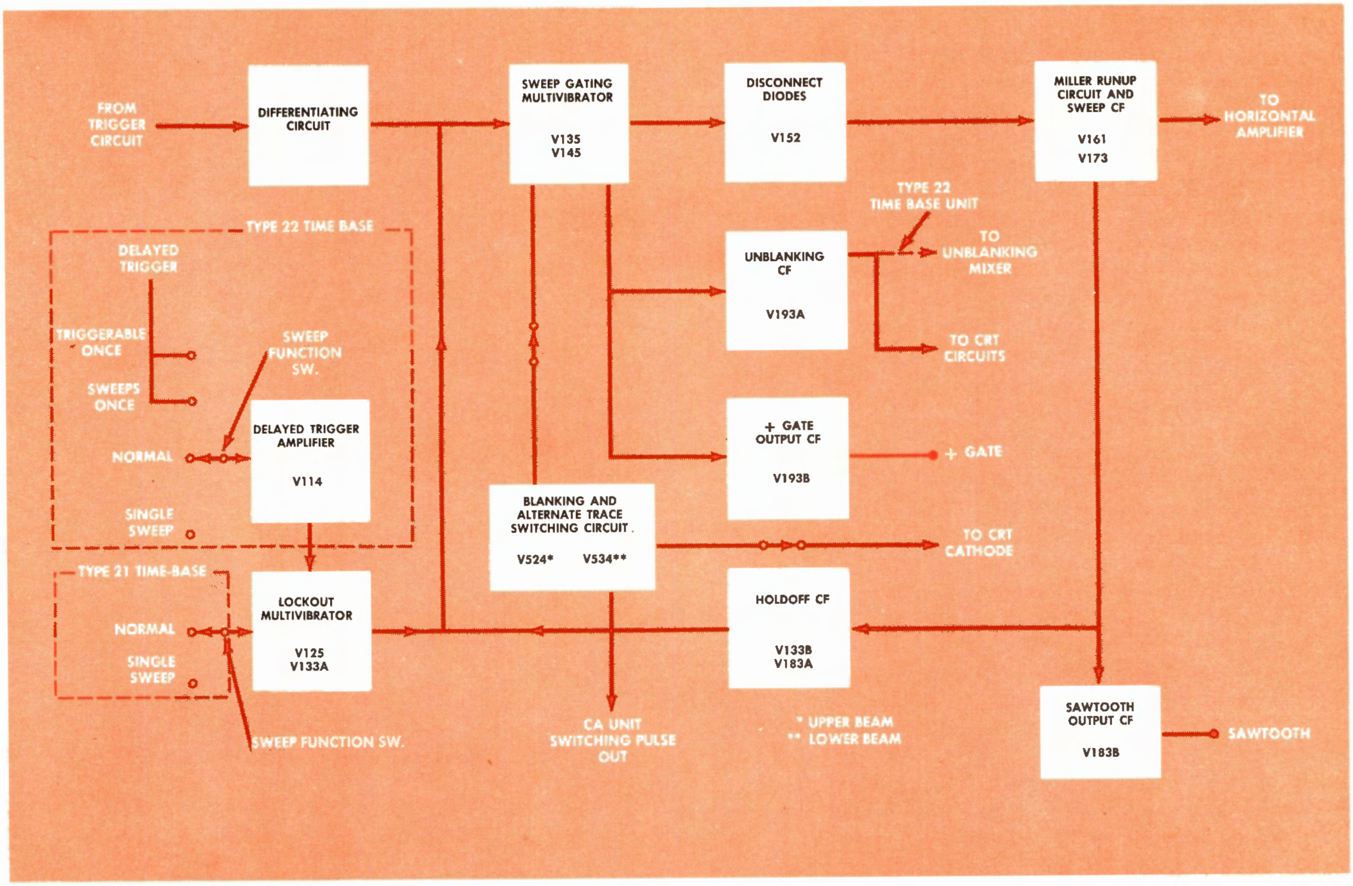


Fig. 4-4. Time Base Generator block diagram for the Type 21 and 22 Time Base Units. Differences between the two are marked.

The output pulse from the trigger multivibrator is applied to the sweep gating multivibrator through a differentiating network. The sweep gating multivibrator is a Schmitt Trigger Circuit which acts as an electronic switch for the sweep circuit. When the triggering pulse is applied, the sweep gating multivibrator switches, thereby cutting off the disconnect diodes and allowing the Miller Run-Up Circuit to operate. One output of the sweep gating multivibrator is connected through the unblanking cathode follower to the crt to unblank the tube. Another output is connected through the +gate output cathode follower to the +GATE connector on the front panel.

Synchronizing pulses are supplied by the sweep gating multivibrator to operate the blanking and alternate trace switching circuits. The switching circuits are used in the ALTERNATE mode of the TYPE CA Plug-In Unit with either one or both time bases.

The disconnect diodes clamp the sweep-circuit output voltage at a fixed level between sweeps. This prevents horizontal jitter at the start of the sweep. When the disconnect diodes are cut off, their clamping action stops and the Miller Run-Up Circuit operates.

The Miller Run-Up Circuit is a modified Miller Integrator circuit which provides an extremely linear output sawtooth waveform. The sawtooth waveform is built up on a timing capacitor which is an integral part of the circuit. The rate that the charge builds up on the timing capacitor determines the sweep time per centimeter. The rate of charge is in turn dependent on the time constant of the timing capacitor and timing resistor. The sweep timing is set with the TIME/CM control by varying this time constant. All sweep ranges are accurately calibrated by means of variable timing capacitors and resistors.

The output sawtooth from the Miller Run-Up Circuit is applied through the sweep cathode follower to the horizontal amplifier. Feedback from the sweep cathode follower is applied to the timing capacitor to eliminate nonlinearity in the charging of the capacitor. This feedback insures a linear sawtooth waveform. The sawtooth waveform from the sweep cathode follower is also connected through the sawtooth output cathode follower to the SAWTOOTH connector on the front panel.

The sawtooth waveform from the sweep cathode follower is applied through the holdoff cathode followers to reset the sweep gating multivibrator at the end of each sweep. The holdoff cathode followers then insure that the sweep gating multivibrator is not switched again until the Miller Run-Up Circuit has reset and become stabilized.

The dc level at the input of the sweep gating multivibrator is controlled by the lockout multivibrator, STABILITY control, the RECURRENT position of the trigger LEVEL control, and the SWEEPS ONCE position (Type 22 only) of the

SWEEP FUNCTION switch. In normal sweep operation, one half of the lockout multivibrator is disabled while the other half operates as cathode follower. The voltage at the input of the sweep gating multivibrator is then controlled through the cathode follower by the STABILITY control, the RECURRENT position of the trigger LEVEL control, and the SWEEPS ONCE position (Type 22) of the SWEEP FUNCTION switch. The STABILITY control is set to allow normal triggering of the sweep gating multivibrator without causing it to free-run. However, should a free-running sweep be desired, the trigger LEVEL control can be turned full right to the RECURRENT position. This action closes a switch, lowers the dc level at the input of the sweep gating multivibrator, and permits the next sweep to begin after the hold-off period. The same action occurs when the SWEEPS ONCE position (Type 22) is used for delayed sweep operation.

When the time base generator is used for either a SINGLE SWEEP or delayed-sweep TRIGGERS ONCE (Type 22) presentation, both sections of the lockout multivibrator operate and the multivibrator acts as an electronic switch to control operation of the sweep gating multivibrator. One condition of the lockout multivibrator disables the sweep gating multivibrator to prevent any horizontal sweeps. This condition exists until a delayed trigger is applied to the lockout multivibrator (Type 22) or until the PUSH TO RESET switch is depressed. When the lockout multivibrator switches, operation of the sweep gating multivibrator returns to normal to allow one horizontal sweep. Depending on the setting of the trigger LEVEL control, this sweep may occur immediately or be delayed until a triggering pulse is applied from the triggering circuit or from the delayed trigger amplifier (Type 22) to the sweep gating multivibrator.

When the sweep occurs, an output from the holdoff cathode follower is applied to reset the lockout multivibrator. The sweep gating multivibrator is again disabled by the lockout multivibrator until the next delayed trigger (Type 22) occurs or until the PUSH TO RESET button is again depressed.

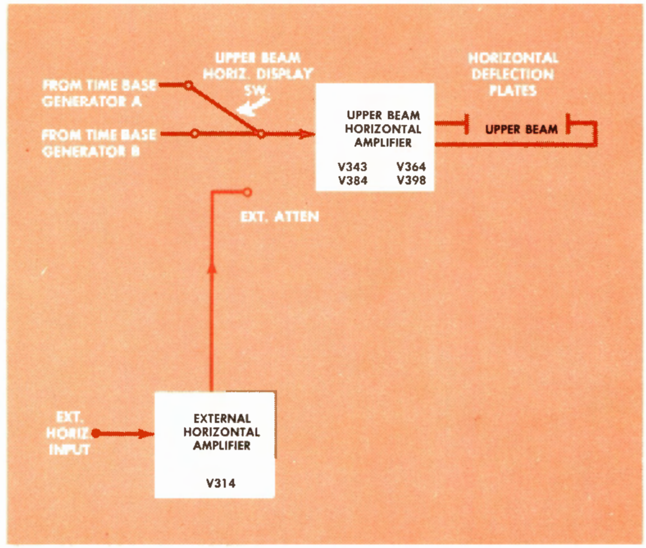


Fig. 4-5. Upper Beam Horizontal-deflection system block diagram.

Horizontal Amplifier

The Upper and Lower Beam horizontal amplifiers are identical. Although the block diagram, Figure 4-5, illustrates the Upper Beam horizontal-deflection system, the description applies to both.

The input to the horizontal amplifier is selected from waveforms applied from Time Base Generator A, Time Base Generator B, and the external horizontal amplifier. The

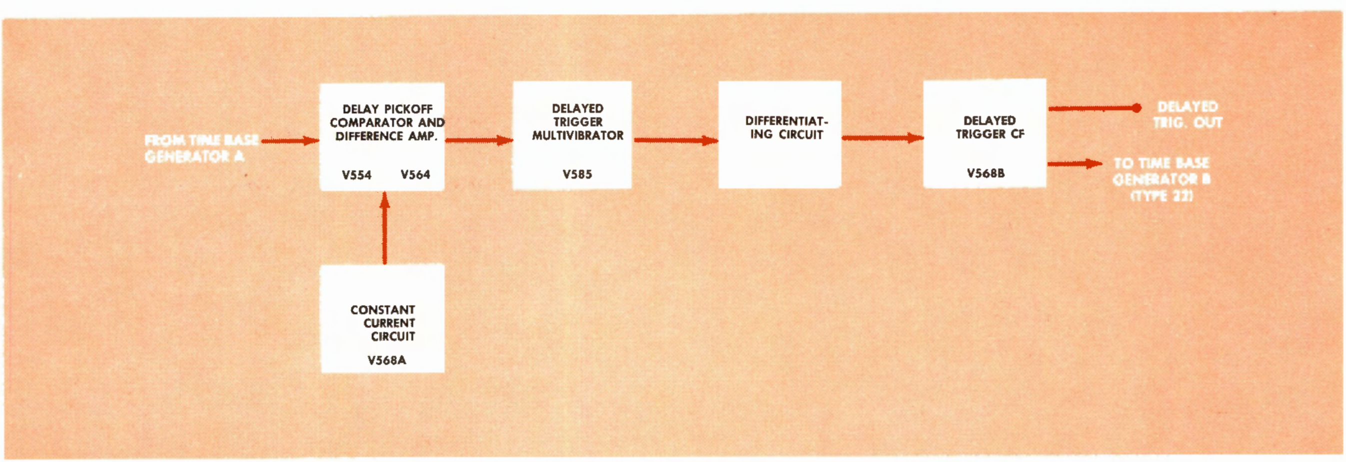


Fig. 4-6. Delay Pickoff Circuit block diagram.

selected input waveform is split in phase and amplified to drive the horizontal-deflection plates of the crt. The amplifier is designed for optimum operation with a sawtooth input waveform.

A feedback network from the output of the amplifier to the first amplifier stage is used to reduce the gain of the amplifier to the amount necessary for a normal-sweep presentation. The gain of the amplifier is controlled by adjustment of the feedback network. When the sweep magnifier is used, a portion of the degenerative feedback network is shorted out to increase the gain of the amplifier by a factor of 5. This provides the magnified-sweep presentation.

The external horizontal amplifier is a cathode coupled circuit which provides the necessary gain to drive the horizontal amplifier from external signals. An input attenuator and a gain control provide horizontal deflection factors between approximately 0.2 and 20 volts per centimeter.

Delay Pickoff Circuit

A sawtooth waveform from Time Base Generator A is applied to the input of the delay-pickoff comparator circuit. This circuit is a difference amplifier which compares the voltage level of the input sawtooth against a fixed voltage obtained from the DELAYED TRIGGER control. When the voltage level of the input sawtooth waveform reaches a certain level, as determined by the setting of the DELAYED TRIGGER control, the output of the comparator circuit triggers the delayed-trigger multivibrator. The delayed trigger multivibrator then initiates the delayed trigger which is applied through a differentiating circuit to the delayed-trigger cathode follower. Outputs from the delayed-trigger cathode follower are then applied to the DELAYED TRIG. OUT connector on the front panel and to the 'B' sweep circuit.

CRT Circuit

Cathode-ray tube operating voltages are obtained from two separate high-voltage power supply circuits. The circuits are the same for both supplies except that the post-accelerating voltage is supplied by the lower beam circuit. The outputs from the oscillator circuits are taken from the secondary windings of the high voltage transformers.

The primary winding of the high-voltage transformer forms a part of the oscillator circuit. The transformer steps up the oscillator output voltage to the required level. The voltage is then rectified, filtered, and applied to the appropriate crt beam circuits. Control-grid and cathode operating voltages are obtained from conventional rectifier circuits. A voltage-doubler circuit supplies the post-accelerating voltage.

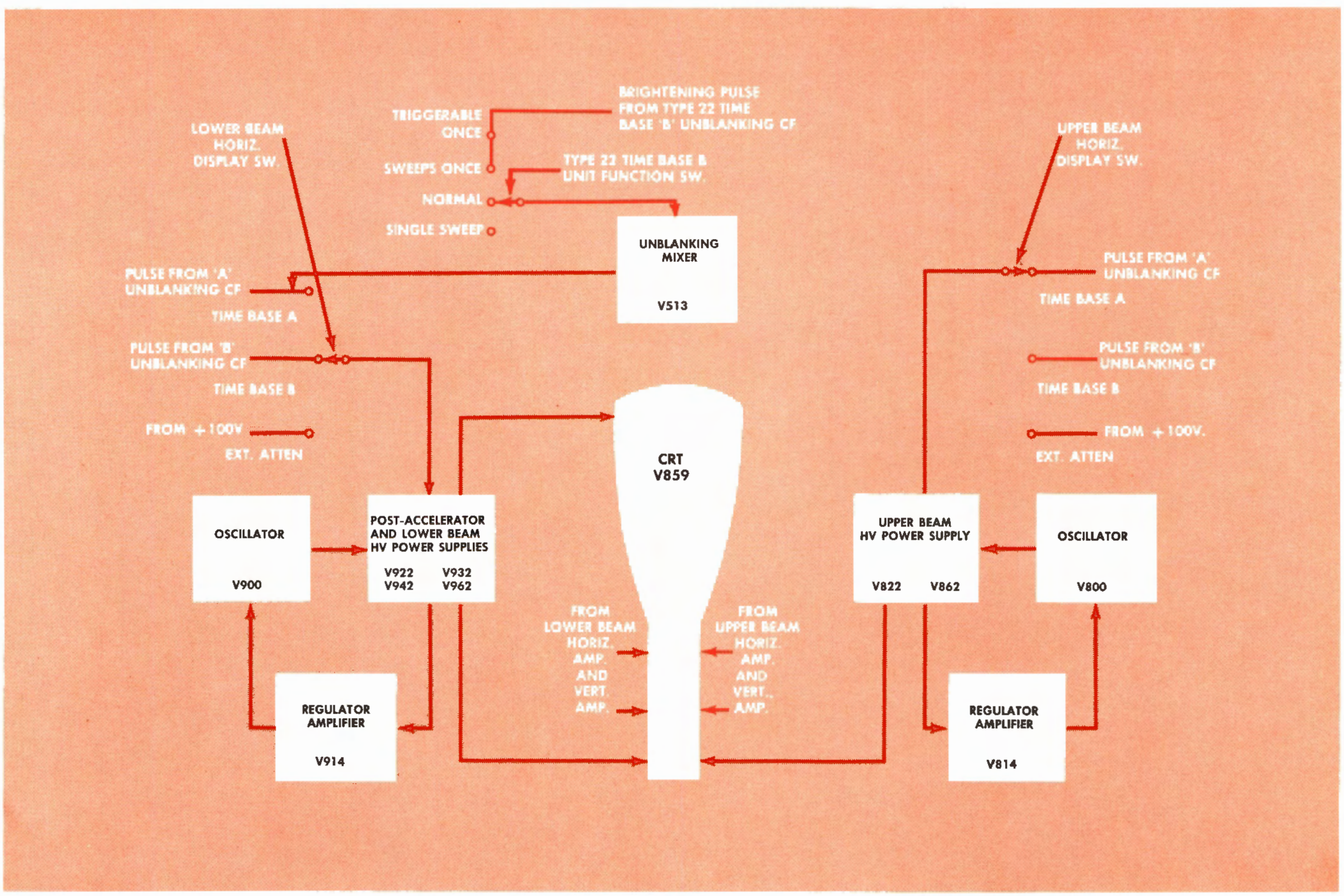


Fig. 4-7. CRT Circuit block diagram.

A sample of the power-supply voltage is fed back through the regulator amplifier to the high-voltage oscillator. This voltage controls the amplitude of the oscillator output and compensates for any changes in the output voltages of the high-voltage power supply.

Additional crt circuits control intensity, geometry, astigmatism, and focus for each beam of the crt display. Unblanking pulses from the two sweep circuits are applied to the appropriate crt control grid through the Upper and Lower Beam HORIZ. DISPLAY switches to unblank the trace during sweep time. In addition, a brightening pulse from the Type 22 Time Base 'B' Unit is applied through the TRIGGERABLE ONCE and the SWEEPS ONCE positions of the FUNCTION switch. The brightening pulse is coupled through the unblanking mixer tube, either or both HORIZ. DISPLAY switches, and to either or both crt control grids. A portion of either or both beams is intensified to indicate the delayed sweep duration. In the absence of an unblanking pulse, the blanked tube eliminates any visable sweep retrace.

Low-Voltage Power Supplies

The low-voltage power supplies produce all operating voltages for the oscilloscope with the exception of parts of the crt circuit. These power supplies produce regulated voltages of —150, +100, +225, +350, and 500 volts, and, an unregulated output of 330 volts. In addition, a separate circuit regulates the 6.3 volt filament power.

Each of the dc 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 then produces an error signal which is amplified and applied to the series regulator tubes, causing the series regulators to compensate for the error and return the output voltage to normal.

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

The regulated filament supply operates by regulating the voltage applied to the primary winding of the filament transformer. Errors in the filament voltage are sensed by the filament of a special diode. When an incorrect voltage is sensed, the diode conducts either more or less current depending on the direction of the error. The output from the diode is amplified by an additional stage. The amplifier controls the current through one winding of a saturable reactor. This in turn determines the amount of reactance presented by the reactor to the line voltage. The change in reactance compensates for any changes in the filament voltage.

Calibrator

The calibrator multivibrator, free running at approximately a 1000-cycle rate, produces the amplitude-calibrator square waves. The square waves are applied through the calibrator output cathode follower and a precision attenuator to the CAL. OUT connector on the front panel. Accuracy of the calibrator output is insured by adjusting the multivibrator output voltage.

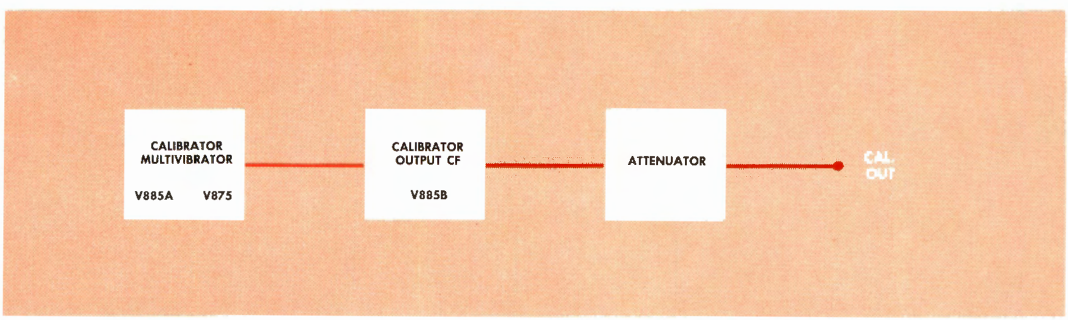
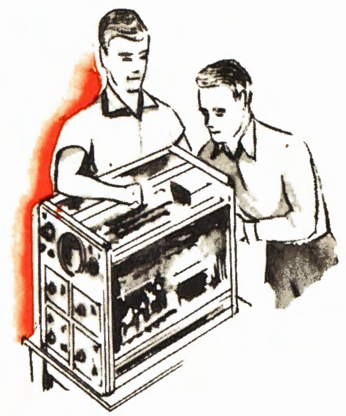


Fig. 4-8. Amplitude Calibrator block diagram.



SECTION 5

MAINTENANCE

PREVENTIVE MAINTENANCE

Air Filter

The Type 555 Oscilloscope is cooled by air drawn into both units through washable filters constructed of adhesive-coated aluminum wool. If the filters become dirty, they will restrict the flow of air and may cause the instrument to overheat. You should inspect and clean the filters every three or four months. Any time that the thermal relay in either unit opens up, the filters should be checked immediately.

To clean the filter, first remove loose dirt from the filter by rapping it gently on a hard surface. Then wash the filter briskly with hot soapy water. After rinsing and drying thoroughly, coat the filter with "Handi-Koter" or "Filter-coat", products of the Research Products Corporation. These products are generally available from air-conditioner suppliers.

Fan Motor

The indicator unit fan motor bearings should be lubricated every three or four months with a few drops of light machine oil (see Figure 5-1). Failure to lubricate the bearings periodically will cause the fan to slow down or stop thereby causing instrument overheating. The power supply unit fan motor bearings are factory sealed and no lubrication is required.

Visual Inspection

You should visually inspect the entire indicator and power supply units 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.

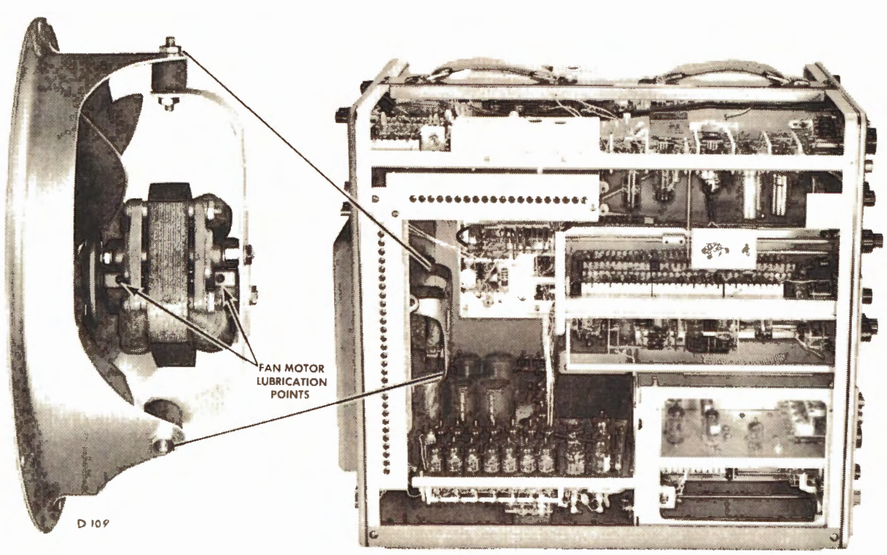


Fig. 5-1. Location of the indicator unit fan-motor lubrication points.

Recalibration

The Type 555 Oscilloscope is a stable instrument that will provide many hours of trouble-free operation. However, to insure the reliability of measurements we suggest that you recalibrate the instrument after each 500 hours of operation (or every six months if used intermittently). A partial calibration procedure is given in the Internal Adjustments portion of this manual. Complete recalibration procedures are given in Section 7.

REMOVAL AND REPLACEMENT OF PARTS

General Information

Procedures required for replacement of most parts in the Type 555 Oscilloscope are obvious. Detailed instructions for their removal are therefore not required. Other parts, however, can best be removed if a definite procedure is followed. Instructions for the removal of some of these parts are contained in the following paragraphs. Because of the nature of the instrument, replacement of certain parts will require that you recalibrate portions of the oscilloscope to insure proper operation. Refer to the Recalibration Procedure or to the Internal Adjustments portion of this manual for calibration procedures.

Removal of Panels

The panels of the Type 555 Oscilloscope are held in place by small screwhead fasteners. To remove the side panels, use a screwdriver to rotate the fasteners approximately two 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 approximately two turns counterclockwise, and pull off the panel. Panels are replaced by reversing the order of their removal.

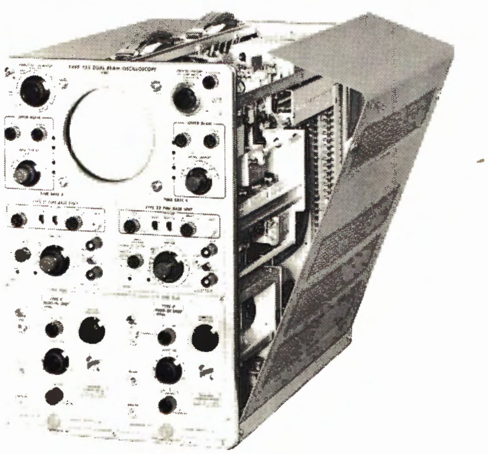


Fig. 5-2. Removal of the indicator unit side panels.

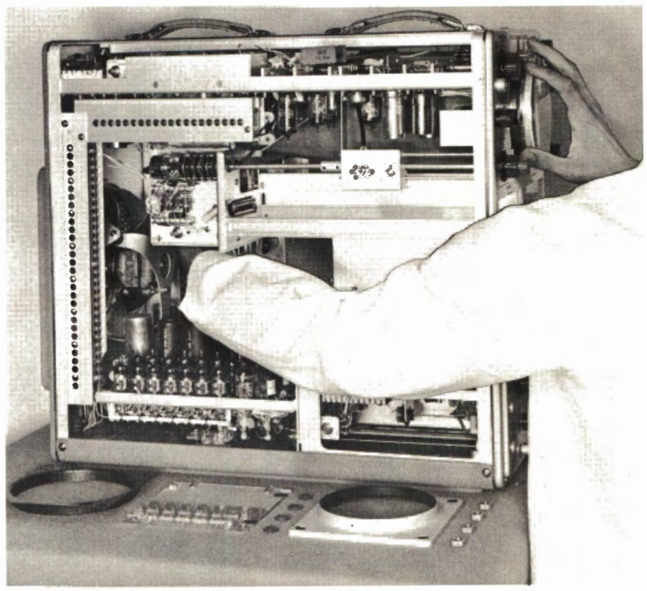


Fig. 5-3. Removing the cathode-ray tube.

Replacement of the Cathode-Ray Tube

To remove the cathode-ray tube, first, remove the time base units and disconnect all clip leads connected to the neck of the tube. Leave the beam rotation coil leads and the high-voltage nipple connected. Remove the graticule cover, spacer washers, graticule, and graticule light shield. Disconnect the crt from the socket at the base of the crt. If you have trouble separating the crt from the socket, the crt can be worked loose easily by carefully wedging a plastic tool between the socket and the base of the crt. By first loosening one side and then the other, the crt can be worked free of the socket. Remove the crt by pushing it forward through the front panel far enough to be removed from the front of the oscilloscope (see Figure 5-3).

When the new crt is in place, the leads can be properly connected to the neck of the tube by following the color code information provided on the tube shield. After replacement of the crt, it will be necessary to check the calibration of the oscilloscope.

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 555. If one wafer is defective, the entire switch should be replaced. Switches can be ordered from Tektronix either wired or unwired as desired.

Tube Replacement

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 sockets 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.

Soldering Precautions

In the production of Tektronix instruments, a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond can be broken by repeated use of ordinary tin-lead solder, or by the application of too much heat. However, occasional use of ordinary solder will not break the bond if too much heat is not applied.

It is advisable that you have a stock of solder containing about 3% silver if you frequently perform work on Tektronix instruments. This type of solder is used frequently in printed circuitry and should be readily available. It may also be purchased directly from Tektronix in one-pound rolls (order by part number 251-514).

Because of the shape of the terminals on the ceramic terminal strips, it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. A wedge-shaped tip allows you to apply heat directly to the solder in the terminals and reduce the amount of heat required. It is important to use as little heat as possible.

REPLACEMENT PARTS

Standard Parts

Replacement for all parts used in the Type 555 Osciiloscope can be purchased directly from Tektronix at current net prices. However, since most 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. The parts list gives the values, tolerances, ratings, and Tektronix parts numbers for all components used in the instrument.

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 555 Oscilloscope. These parts are manufactured or selected by Tektronix to satisfy particular requirements or are manufactured specially for Tektronix by other companies in accordance with Tektronix specifications. These parts and most mechanical parts should be ordered directly from Tektronix since they are normally difficult or impossible to obtain from other sources. All parts may be obtained either directly from the factory or through the local Tektronix Field Office.

Parts Ordering Information

Each part in the Type 555 Oscilloscope has a 6-digit Tektronix part number. This number and a description of the part, will be found in the parts list. When ordering parts, be sure to include both the description of the part and the part number. For example, if the serial number of your Type 555 Oscilloscope is 4987, a certain resistor would be ordered as follows: R160A, 100 k, ½ watt, fixed precision, 1%, part number 309-045, for Type 555 Oscilloscope, Serial Number 4987. When parts are ordered in this manner, we are able to fill your orders promptly, and delays that might result from transposed numbers in the part number are avoided.

Since the production of your instrument, some of the parts may have been superceded by improved components. In such cases, the part numbers of these new components will not be listed in your Parts List. However, if you order a part from Tektronix and it has been superceded by an improved component, the new part will be shipped in place of the part ordered. Your local Tektronix Field Engineering Office has knowledge of these changes and may call you if a change in your purchase order is necessary.

Replacement information sometimes accompanies the improved components to aid in their installation.

TROUBLESHOOTING

Troubleshooting Information

This portion of the Operator's Manual provides brief troubleshooting information which can be used, when a trouble exists, to isolate the defective circuit or stage. No attempt is made here to provide detailed information for troubleshooting within the circuits.

Before attempting any troubleshooting work, you should check all controls for proper settings. If you are in doubt about control settings you should review the Operating Information section of this manual. When you have ascertained that a trouble does exist in the instrument, you can then proceed to isolate the defective circuit using the procedures contained later in this section.

Although the Type 555 Oscilloscope is a stable instrument, many apparent troubles will be due to improper calibration of one or more circuits. One of the first steps in any troubleshooting procedure should be to check the calibration of the suspected circuit. Calibration of this instrument can be easily checked by comparing the upper beam operation to the lower beam. Partial calibration procedures are given in the Internal Adjustments portion of this handbook; complete calibration procedures are given in the Recalibration Procedure section.

Power-supply output voltages should be checked whenever any type of trouble occurs in the instrument. Due to the circuit configuration employed in the Type 555, it is possible for an incorrect power-supply voltage to affect one circuit more than others. When all but one circuit in the oscilloscope is functioning properly, there is a tendency to overlook the power supply as a source of the trouble and to concentrate on the circuit where the trouble apparently exists. In cases of this type (valuable time can be saved by checking the power supplies first. If the output and ripple voltages of the regulated power supplies are correct, the power supplies can be assumed to be operating correctly.

When a trouble has been isolated to a definite circuit, perform a complete visual check of that circuit. Many troubles can be found most easily by visual means. If a visual check fails to detect the cause of the trouble, check all tubes by substitution. Tube failure is the most prevalent cause of circuit failure. Do not depend on tube testers to adequately indicate the suitability of a tube for use in the instrument. The criterion for usability of a tube is whether or not it works satisfactorily in the instrument. Be sure to return any tubes found to be good to their original socket.

Separate schematic diagrams for each circuit are contained in the Parts List and Schematic Diagrams Booklet used in conjunction with this manual. In addition, a block diagram provides an overall picture of instrument operation. The reference designation of each electronic component of the instrument is shown on the circuit diagrams.

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 being 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.

All wiring used in the Type 555 Oscilloscope is color coded to facilitate circuit tracing. In addition, primary power, filament, and power-supply output leads are distinguished by specific color codes. All power-supply output leads follow the standard RETMA code. For example, the —150-volt bus is coded brown-green-brown and the +500-volt bus is coded green-black-brown. The widest stripe identifies the first color of the code.

The troubleshooting procedures that follow are divided into sections according to trouble symptoms. When a trouble occurs in the instrument, the proper troubleshooting section can quickly be found by using the trouble symptoms.

No Spot or Trace

No spot or trace on the crt screen is indicative of horizontal- or vertical-deflection system unbalance or of a failure of the crt circuits. When this trouble occurs, first check the beam position indicator lights for each beam and the setting of the INTENSITY controls. The lights will indicate whether the beam is deflected off the crt screen. If the beam is positioned off the screen, use the appropriate position controls and the beam-position indicators to attempt to center the beam. If the beam centers properly, as indicated by the beam-position indicators, but no spot or trace appears with normal INTENSITY control setting for that beam, the trouble is probably in one of the crt circuits. Additional checks should be made, however, before you start working on the circuits. The following checks can quickly be made to show conclusively whether or not the trouble exists in one of the crt supply circuits.

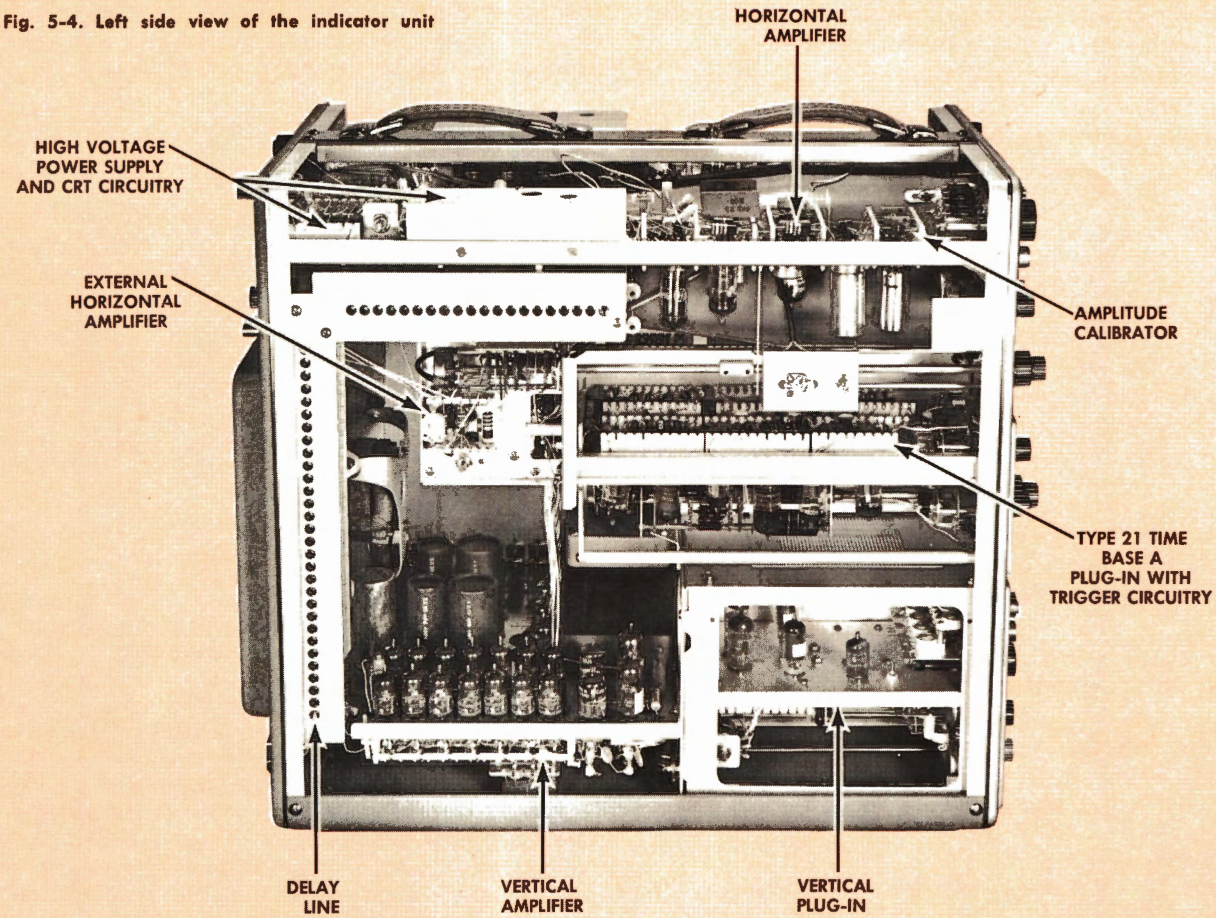
Center both beams using the indicator lights and turn up the INTENSITY controls to a setting a little higher than used normally. Be prepared to turn the appropriate INTENSITY control down to normal brilliance if the beam spot or trace suddenly appears. If the lower beam trace can be seen, but not the upper beam, then look for the upper gun's filament glow at the base of the crt. If the filament is operating, check for deflection unbalance even though the indicator lights show the beam to be centered. To do this, place a jumper between the upper beam horizontal- or vertical-deflection plates of the crt at the neck of the tube.

If the upper beam trace does appear when one set of plates are shorted together, an unbalance exists in the deflection system which is connected to those plates. The jumper can be used to move back through the push-pull amplifier stages to make point checks to isolate the area of original unbalance.

Horizontal unbalance is generally caused by an unbalanced horizontal amplifier. Vertical unbalance, however can be produced in either the plug-in unit or the vertical amplifier of the oscilloscope. Perhaps the easiest way to determine whether the plug-in unit or the oscilloscope is at fault is to check the operation of the instrument by exchanging plug-ins. Turn the instrument off, remove the two vertical plug-ins, re-insert them in the opposite compartments, and turn the instrument on. If the plug-in is not at fault, be sure to check the leads which go to the crt deflection plates are properly connected at the neck of the crt before checking for other causes of vertical unbalance.

If no upper beam unbalance condition exists and the spot is not yet visibile, then the upper beam crt circuit is at fault. Conversely, the same checks can be made to isolate lower beam troubles. However, if both filaments are oper-

Fig. 5-4. Left side view of the indicator unit



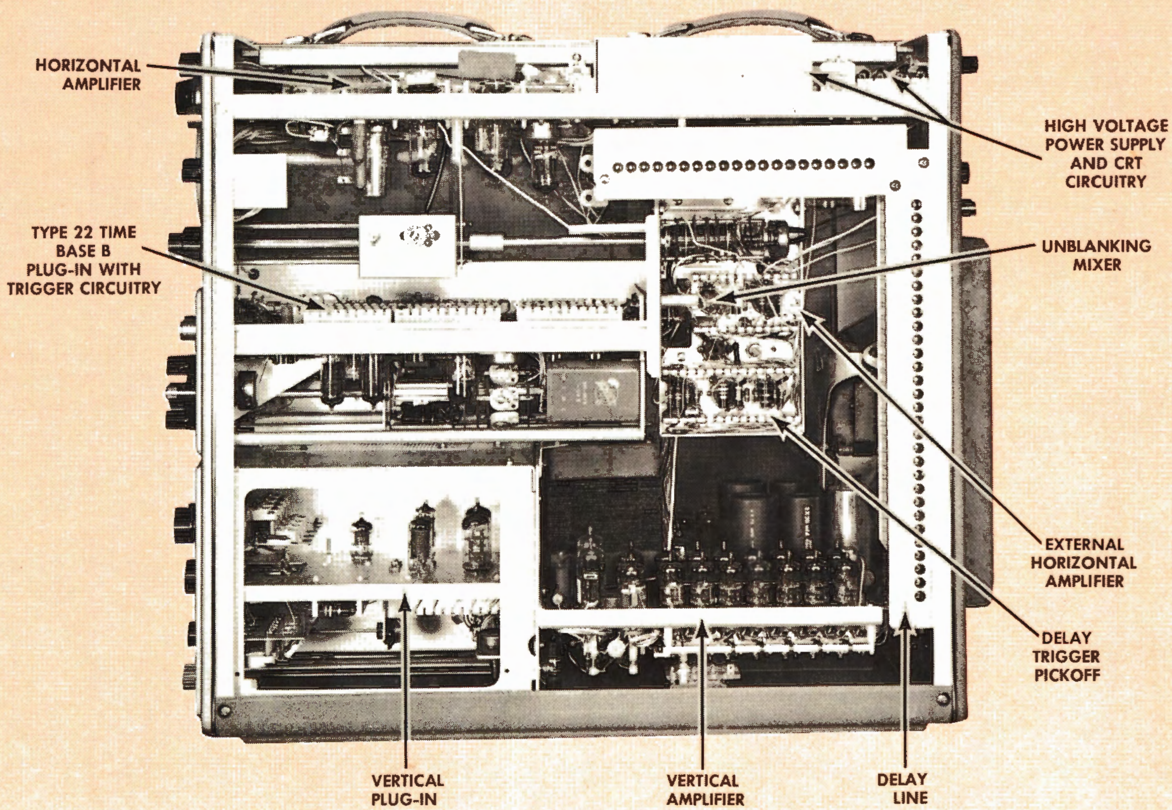


Fig. 5-5. Right side view of the indicator unit

ating and neither beam spot or trace appears, the trouble is probably in the lower beam crt circuit which supplies the common post-accelerating potential for both beams.

Waveform Distortion of Insufficient Vertical Deflection

Both of these symptoms can be caused by troubles occuring in either the plug-in unit or the vertical-deflection system of the oscilloscope. The trouble can be isolated to one unit or the other easily by checking the operation of the oscilloscope after exchanging vertical plug-in units from one side to the other and by comparing the operation of the lower beam vertical-deflection system to the upper beam.

Small errors in gain and slight waveform distortion can often be corrected by calibrating either or both vertical-deflection systems of the oscilloscope and the plug-in units. An improperly compensated probe is also a common source of waveform distortion. Waveform distortion occasionally results from various tube conditions.

Insufficient Horizontal Deflection

The Type 555 Oscilloscope contains two separate time-base units which can be used to isolate troubles in either horizontal-deflection system. When a trouble occurs, determine whether the trouble is present when you are using Time Base A, Time Base B, or an external horizontal input. When the trouble is present under all three conditions, the horizontal amplifier is at fault.

Troubles which occur only when you are using an external horizontal input voltage are probably due to a failure of the external amplifier being used. Try using the external horizontal amplifier for the other beam to compare differences between the two.

If the trouble occurs only when a particular time base is used, the trouble is in that time base unit.

Nonlinear Horizontal Sweep

The linearity of the horizontal-deflection system can be checked by connecting the calibrator waveform to the vertical input of the oscilloscope. If the sweep is linear, the calibrator waveforms should be spaced equally along the sweep. A nonlinear sweep can be caused by one of the time-base units or horizontal amplifiers. If the trouble exists when either time-base unit is used with one of the horizontal amplifiers, then the horizontal amplifier is at fault. If the trouble is present only when a particular time-base unit is used, that time base unit is at fault.

Poor Triggering

Troubles which affect triggering can be isolated by comparing the operation of the 'A' and 'B' trigger circuits. If, when using the same triggering source, only one triggering circuit operates abnormally, you can assume that the circuit is defective.

If neither trigger circuit operates properly when you trigger internally from the same beam source, the trigger pickoff circuit of that vertical amplifier is probably at fault. As is the case with other circuits, proper operation can often be restored by recalibration.

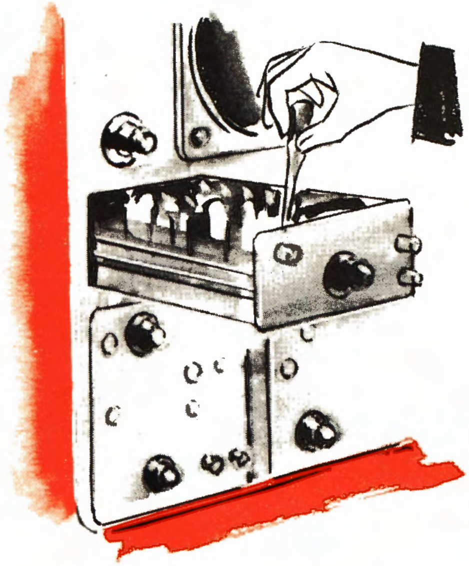
Change in Deflection Sensitivity

A change in the deflection sensitivity of the instrument is indicated if the deflection, both vertical and horizontal for both beams, is either greater or less than the value indicated by the front-panel settings. This can be caused by a change in the gain of both the vertical and the horizontal amplifiers due to improper output voltages from the low-voltage power supplies. Or, it can be caused by a change in the crt sensitivity due to improper output voltages from the high-volage power supply. If either the low or high-voltage power supplies require adjustment, these adjustments must be made in accordance with the procedures given in the Internal Adjustments or the Recalibration Procedure portion of this manual.

No Delayed Trigger or Delayed Sweep

When no delayed trigger is present at the DELAYED TRIG. OUT connector, the delay pickoff circuit has probably failed. However before attempting to repair the delay pickoff circuit, be sure that the 'A' and 'B' sweep circuits are operating correctly. This can be done by obtaining a normal-sweep presentation using first one, and then the other, time-base unit.

If the delayed trigger appears normal but no delayed sweep can be obtained, the trouble is in the Type 22 Time Base Unit sweep circuit. A trouble in the 'B' sweep circuit which prevents you from obtaining a delayed sweep presentation will probably also affect single-sweep operation.



SECTION 6

INTERNAL ADJUSTMENTS

Purpose

Procedures contained in this portion of the Operator's Manual permit you to calibrate certain portions of the Type 555 Oscilloscope. This section has purposely been simplified to include only the adjustments that can be made without special test equipment. It is assumed, however that an accurate dc voltmeter and an iron vane rms-reading ac voltmeter are available. The Type 555 is used as a test oscilloscope by using single-beam operation to make some of the adjustments.

Calibration procedures contained in this section cover controls which require adjustments most frequently. These procedures therefore provide sufficient information to correct most troubles which occur due to improper calibration. If it becomes necessary to calibrate the entire instrument, or to calibrate controls that are not covered here, you can refer to Section 7 where complete calibration procedures are given. All adjustments should be made with the plug-in units connected to the oscilloscope. The Time Base Plug-In Extension is used to make some of the time base adjustments.

If you find that it is impossible to adjust a particular control properly, there is a trouble in the instrument. This trouble must be located and corrected, before the adjustment can be made.

CAUTION

The first two steps in the following procedure are used to adjust the output voltages of the low- and high-voltage power supplies. These adjustments are extremely important to proper operation of the instrument and must be made as accurately as possible. Care must be taken, however, that these adjustments are not made unnecessarily. The power supplies do not require adjustments unless there is more than a 3% error in their output voltages. Be sure that your voltmeters are accurate when checking the power supply voltages. An accurate iron vane rms-reading ac voltmeter must be used for reading the 6.3 VAC. A dc voltmeter with known corrected readings must be available to read the —150 and —1350 volts. If the power supplies have more than 3% allowable error, they must be adjusted as described in the Power-Supply Output Voltage and High Voltage steps.

If the controls in these first two steps are adjusted, the sweep timing and vertical deflection factors should be checked before measurements made with the instruments are assumed to be correct. Also, the other circuits should be checked for proper calibration.

Power-Supply Output Voltage

Connect a dc voltmeter from the output of the —150-volt power supply (see Figure 6-1) to the chassis. Adjust the —150 ADJ. control for a voltage reading of exactly —150 volts.

Connect an iron vane ac voltmeter from the 6.3 VAC test point (see Figure 6-1) to the chassis. Adjust the REG. HTR. ADJ. for a voltage reading of 6.3 VAC.

High Voltage

Connect the dc voltmeter from the lower beam high-voltage test point (see Figure 6-1) to the chassis. Adjust the lower beam H.V. ADJ. control for —1350 volts.

Connect the dc voltmeter from the upper beam test point (see Figure 6-1) to the chassis. Adjust the upper beam H.V. ADJ. control for —1350 volts.

Amplitude Calibrator

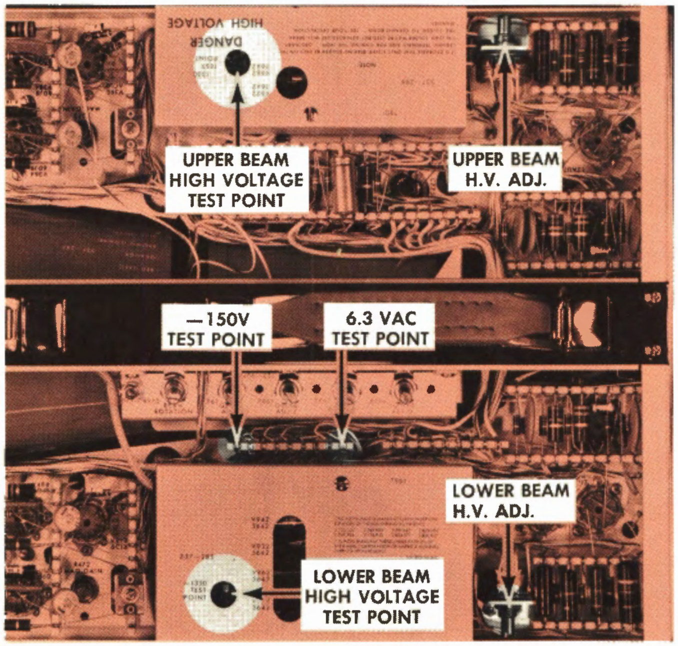
Place the AMPLITUDE CALIBRATOR switch in the OFF position. Connect the dc voltmeter to the Calibrator Test Point (see Figure 6-10) and set the CAL. ADJ. control for a meter reading of exactly 100 volts.

NOTE

The letter 'A' is used throughout this procedure as an abbreviation for "TIME BASE A" and the letter 'B' for "TIME BASE B". The 'A' triggering adjustments that follow must be made in the indicated sequence. Controls not mentioned in a particular step are assumed to be in the positions they were last in during the previous step.

Remove the Type 21 Time Base Unit, attach the Time Base Plug-In Extension to the Type 21 Unit, and install the unit with the extension in the TIME BASE A compartment of the Type 555.

Set the Upper Beam HORIZ. DISPLAY switch at 'A' X1. Place the 'A' SLOPE switch at +, 'A' COUPLING switch



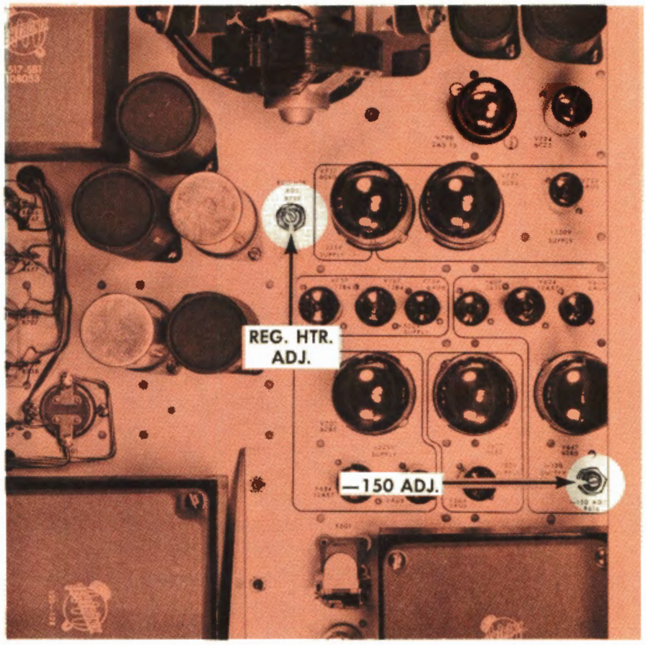


Fig. 6-1. Top view of indicator and power supply units showing location of low- and high-voltage adjustment controls and test points.

at DC, and 'A' SOURCE switch at UPPER BEAM. Rotate the 'A' LEVEL control to zero. Set the lower beam vertical plug-in VOLTS/CM switch at .05 and the input selector AC-DC switch at DC. Place the Lower Beam HORIZ. DISPLAY switch at 'B' X1. Set the 'B' trigger controls at AC AUTO., +SLOPE, AC COUPLING, and LINE SOURCE. Place the 'B' SWEEP FUNCTION switch at NORMAL and the 'B' TIME/CM switch at 2 MILLISEC. Center the lower beam trace at the lower horizontal centerline of the graticule and connect the 10X probe from the lower beam vertical input connector to the junction of R19 and R20 (see Figure 6-2). If the probe is being used with the clip lead ungrounded, position the probe body away from the 'A' SOURCE switch leads to prevent any feedback of signals. Rotate the 'A' LEVEL knob until the lower beam trace is again at the lower horizontal centerline. Loosen the 'A' LEVEL knob and set it at zero position. Retighten the knob and recheck it for exact zero setting and no vertical shift of the lower beam trace by disconnecting and connecting the probe a few times at the junction. Disconnect the probe from the junction.

'A' Upper Beam Internal Trigger DC Level

Set the 'A' TIME/CM switch at .1 MILLISEC and rotate the STABILITY control clockwise for a free-running sweep. Position the upper beam trace to the upper horizontal centerline. Connect a short jumper from the junction of R19 and R20 to the chassis; connect a dc voltmeter from the junction of R22 and SW22 to the chassis (See Figure 6-2). Place the 'A' SLOPE switch in the — position and adjust the 'A' UPPER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts. Slide the SLOPE switch from — to + to check for accuracy of the adjustment and no voltmeter needle shift. Leave the SLOPE switch at —.

'A' Lower Beam Internal Trigger DC Level

Position the lower beam trace to its centerline. Set the 'A' SOURCE switch at LOWER BEAM. Adjust the 'A' LOWER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts and no change in meter needle movement when the 'A' SOURCE switch is set at UPPER BEAM and back to LOWER BEAM. Disconnect the voltmeter.

'A' Trigger Level Centering

Rotate the lower beam vertical plug-in VOLTS/CM switch to the .5 volts position and set the input selector AC-DC switch at AC. Set the 'A' SOURCE switch at LINE. Connect the probe to pin 6 of V45 (see Figure 6-2). Preset the 'A' TRIG. LEVEL CENT. control so that the waveform on the lower beam is symmetrical. For precise adjustment set the Lower Beam HORIZ. DISPLAY switch at 'B' X.2 and horizontally center the + slope or switching portion of the multivibrator waveform using the 'B' HORIZ. POSITION control. Now slide the 'A' SLOPE switch up and down from — to + and, at the same time, readjust the 'A' TRIG. LEVEL CENT. for no horizontal shifting of the switching portion of the waveform. Leave the 'A' SLOPE switch at +.

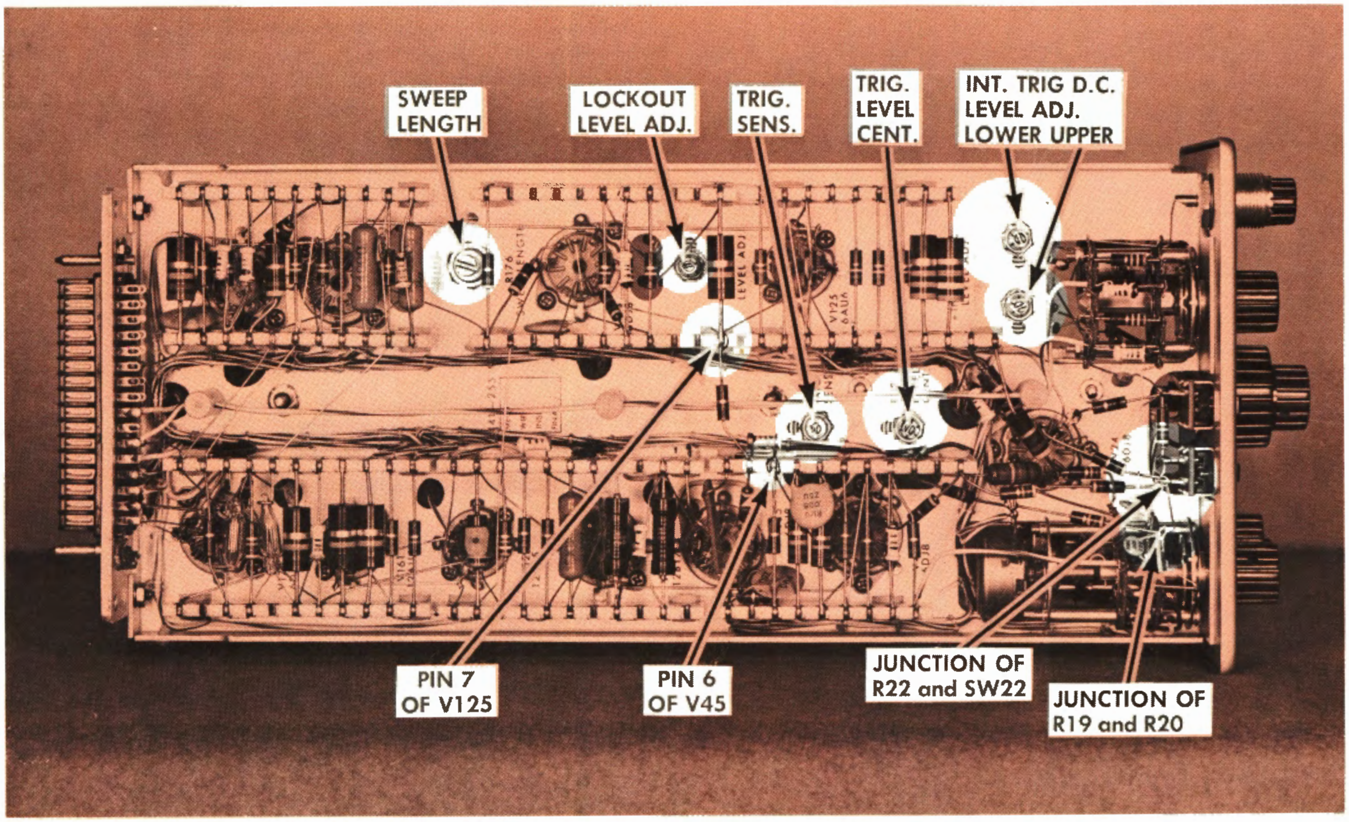


Fig. 6-2. Location of the Type 21 Time-Base Unit calibration controls and test points.

'A' Trigger Sensitivity

With the probe and jumper connected as described in the previous step, rotate the 'A' TRIG. SENS. control fully counterclockwise. Turn the control slowly clockwise and stop at the point where the oscillations cease to appear. Note the amplitude of the spike on the top corner of the multivibrator waveform. Then rotate the 'A' TRIG. SENS. control clockwise until this spike is slightly less than one half of the original size (see Figure 6-3). Disconnect the probe from the test point and remove the jumper lead.

'A' Lockout Level

Set the 'A' COUPLING switch at AC, and the 'A' SOURCE switch at UPPER BEAM. The approximate voltage at pin 7 of V125 is —55 volts. Connect a dc voltmeter at this test point (see Figure 6-2) and rotate the 'A' STABILITY control counterclockwise until the upper beam sweep just stops free-running. Record the meter reading of the dc voltmeter. Set the 'A' SWEEP FUNCTION switch at SINGLE SWEEP and trigger the sweep once by rotating the 'A' LEVEL control clockwise to + and then counterclockwise to —. If the 'A' STABILITY control setting is correct as explained above, the READY lamp should extinguish indicating that the upper beam trace is locked out. Now set the 'A' LOCK OUT LEVEL ADJ. control for a voltmeter reading of 11 volts lower (less negative) than the previous reading. To compare voltmeter readings, repeat the procedure given in this step.

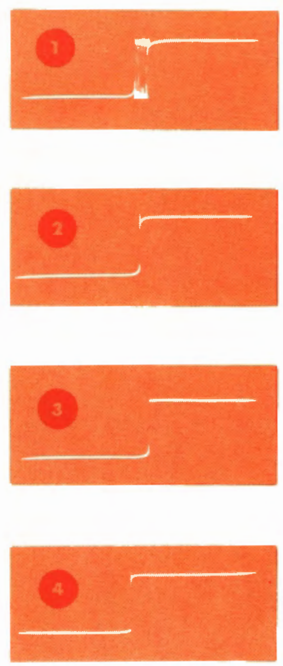


Fig. 6-3. Waveforms 1, 2 and 3 show changes in the waveform as the TRIGGER SENS. control is rotated clockwise. Waveform 4 is the display obtained when the control is adjusted correctly.

'A' Stability

Set the 'A' SWEEP FUNCTION switch at NORMAL. Set the 'A' trigger controls at + SLOPE, LINE SOURCE, and rotate the LEVEL control fully counterclockwise to the AC AUTO. position. The voltage reading at the junction of the 'A' STABILITY wiper arm and R114 is approximately —80 to —110 volts. Connect a dc voltmeter at this junction (see Figure 6-4) and rotate the 'A' STABILITY control fully counterclockwise. Turn the 'A' STABILITY control clockwise until the upper beam trace first appears. Record the reading of the dc voltmeter. Then continue to rotate the 'A' STABILITY control clockwise until the upper beam trace brightens and again record the voltage. Set the 'A' STABILITY control for a voltmeter reading midway between the two recorded voltage readings. (See Figure 6-4.) Disconnect the voltmeter leads and plug-in extension. Reinstall the Type 21 in the TIME BASE A compartment.

NOTE

The 'B' triggering adjustments that follow must be made in the indicated sequence. Controls not mentioned in a particular step are assumed to be in the positions they were last in during the previous step. Although the Type 21 Time Base Unit is shown in the illustrations, the same physical locations of the adjustments and test points apply to the Type 22 Time Base Unit.

'B' Trigger Level

Remove the Type 22 Time Base Unit, attach the Time Base Plug-In Extension to the Type 22 Unit, and install the unit with the extension in the TIME BASE B compartment of the Type 555.

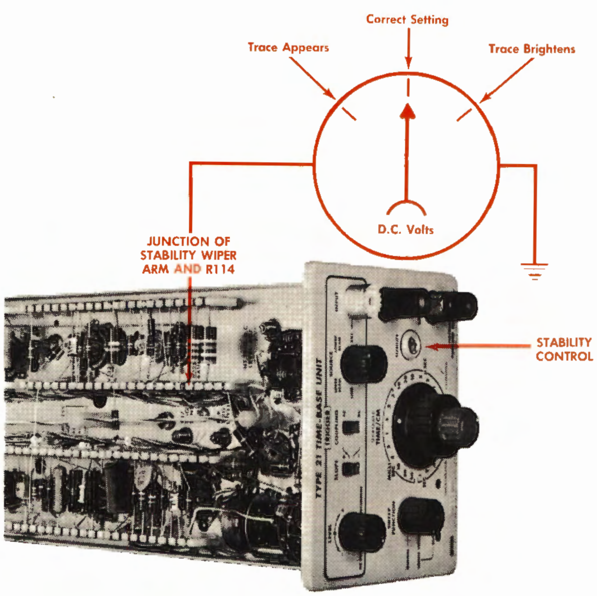


Fig. 6-4. Adjustment of the STABILITY control.

Set the Lower Beam HORIZ. DISPLAY switch at 'B' X1. Place the 'B' SLOPE switch at +, 'B' COUPLING switch at DC, and 'B' SOURCE switch at LOWER BEAM. Rotate the 'B' LEVEL control to zero. Set the upper beam vertical plug-in unit VOLTS/CM switch at .05 and the input selector AC-DC switch at DC. Place the Upper Beam HORIZ. DISPLAY switch at 'A' X1. Set the 'A' trigger controls at AC AUTO., + SLOPE, AC COUPLING, and LINE SOURCE. Place the 'A' SWEEP FUNCTION switch at NORMAL and the 'A' TIME/CM switch at 2 MILLISEC. Center the upper beam trace at the upper horizontal centerline of the graticule and connect the 10X probe from the upper beam vertical input connector to the junction of R19 and R20 (see Figure 6-2). If the probe is being used with the clip lead ungrounded, position the probe body away from the 'B' SOURCE switch leads to prevent any feedback of signals. Rotate the 'B' LEVEL knob until the upper beam trace is at the upper horizontal centerline. Loosen the 'B' LEVEL knob and set it at zero position. Retighten the knob and recheck it for exact zero setting and no vertical shift of the upper beam trace by disconnecting and connecting the probe a few times at the junction. Disconnect the probe from the junction.

'B' Lower Beam Internal Trigger DC Level

Set the 'B' TIME/CM switch at .1 MILLISEC and rotate the 'B' STABILITY control clockwise for a free-running sweep. Position the lower beam trace to the lower horizontal centerline. Connect a short jumper from the junction of R19 and R20 to the chassis; connect a dc voltmeter from the junction of R22 and SW22 to the chassis. (See Figure 6-2). Place the 'B' SLOPE switch in the — position and adjust the 'B' LOWER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts. Slide the SLOPE switch from — to + to check for no voltmeter needle shift. Leave the SLOPE switch at —.

'B' Upper Beam Internal Trigger DC Level

Position the upper beam trace to its centerline. Set the 'B' SOURCE switch at UPPER BEAM. Adjust the 'B' UPPER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts and no change in meter needle movement when the 'B' SOURCE switch is set at LOWER BEAM and back to UPPER BEAM. Disconnect the voltmeter.

'B' Trigger Level Centering

Rotate the upper beam vertical plug-in VOLTS/CM switch to the .5 volt position and set the input selector AC-DC switch at AC. Set the 'B' SOURCE switch at LINE. Connect the probe to pin 6 of V45 (see Figure 6-2) and preset the 'B' TRIG. SENS. control to the center of its rotation. Adjust the 'B' TRIG. LEVEL CENT. control so that the waveform on the upper beam is symmetrical. For precise adjustment set the Upper Beam HORIZ. DISPLAY switch at 'A' X.2 and horizontally center the + slope or switching portion of the multivibrator waveform using the 'A' HORIZ. POSITION control. Now slide the 'B' SLOPE switch up and down from — to + and, at the same time, readjust the 'B' TRIG. LEVEL CENT. for no horizontal shifiting of the switching of the waveform. Leave the 'B' SLOPE switch at +.

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'B' Trigger Sensitivity

With the probe and jumper connected as described in the previous step, rotate the 'B' TRIG. SENS. control fully counterclockwise. Turn the control slowly clockwise and stop at the point where the oscillations cease to appear. Note the amplitude of the spike on the top corner of the multivibrator waveform. Then rotate the 'B' TRIG. SENS. control clockwise until this spike is slightly less than one half of the original size (see Figure 6-3). Disconnect the probe from the test point and remove the jumper lead.

'B' Lockout Level

Set the 'B' COUPLING switch at AC and the 'B' SOURCE switch at LOWER BEAM. The approximate voltage at pin 7 of V125 is —55 volts. Connect a dc voltmeter at this point (see Figure 6-2) and rotate the 'B' STABILITY control counterclockwise until the lower beam sweep just stops free-running and record the meter reading of the dc voltmeter. Set the 'B' SWEEP FUNCTION switch at SINGLE SWEEP and trigger the sweep once by rotating the 'B' LEVEL control clockwise to + and then counterclockwise to —. If the 'B' STABILITY control setting is correct as explained above, the READY lamp should extinguish indicating that the lower beam trace is locked out. Now, set the 'B' LOCKOUT LEVEL ADJ. control for a voltmeter reading of 11 volts lower (less negative) than the previous reading. If you wish to compare voltmeter readings, repeat the procedure given in this step.

'B' Stability

Set the 'B' SWEEP FUNCTION switch at NORMAL. Set the 'B' trigger controls at +SLOPE, LINE SOURCE, and rotate the LEVEL control fully counterclockwise to the AC AUTO. position. The voltage reading at the junction of the 'B" STABILITY wiper arm and R114 is approximately —80 to —110 volts. Connect a dc voltmeter at this junction (see Figure 6-4) and rotate the 'B' STABILITY control fully counterclockwise. Turn the 'B' STABILITY control clockwise until the lower trace beam first appears. Record the reading of the dc voltmeter. Then continue to rotate the 'B' STABILITY control clockwise until the lower beam trace brightens and again record the voltage. Set the 'B' STABILITY control for a voltmeter reading midway between the two recorded voltage readings. (See Figure 6-4). Disconnect the voltmeter lead and plug-in extension. Reinstall the Type 22 in the Time Base B Compartment.

Beam Rotation

Set both beams for free-running sweeps by setting the LEVEL controls of both time base units to RECURRENT and the SWEEP FUNCTION switches at NORMAL. Position the beam traces behind the appropriate horizontal centerlines of the graticule. Adjust the BEAM ROTATION control so that the traces are parallel to the horizontal centerlines. The final setting of the BEAM ROTATION control should be near the center of its rotation range. You may find it necessary to loosen the crt base socket clamp (see Figure 6-10) and rotate the crt a few degrees in the direction that will acheive this final mid-range setting. Retighten the socket clamp.

Positioning the Graticule

With the control settings remaining as in the previous step, position the upper beam trace upward until the trace dims and then downward until the trace again becomes dim. Note the distance that the beam moved and position it to the middle of this distance. Remove the graticule cover and loosen the set screw which holds the nylon cam in the graticule slot. Rotate the cam with an allen wrench or a pointed tool and position the graticule until the upper beam graticule centerline coincides with the upper beam. While holding the cam with the tool, tighten the set-screw.

Follow the same procedure to determine the center of the lower beam viewing area. If the centered lower beam is not close to the centerline, re-position the graticule to obtain a compromise setting for the two beams. Replace the graticule cover.

Astigmatism Balance*

Lay the indicator unit on its side. Connect a dc voltmeter from the junction of R1054 and C1054 to the junction of R2054 and C2054 (see Figure 6-5.) Adjust the ASTIG. BAL. control for zero reading on the dc voltmeter.

Upper Beam Vertical D.C. Shift Compensation

Place the 'A' TIME/CM at 2 SEC. Rotate the 'A' LEVEL control full right to the RECURRENT position and set the vertical input AC-DC selector switch at DC. Intermittently apply the probe to the +100 v test point (see Figure 6-5), or other regulated dc supply, and set the Upper Beam vertical sensitivity to obtain about 3 cm deflection. Look for a slow rise or a slow fall of the beam with a time constant of one or two seconds. If necessary, adjust the Upper Beam D.C. SHIFT control until the spot comes immediately to the final level without drifting either up or down after each time the probe is applied.

Lower Beam Vertical D.C. Shift Compensation

Follow the same procedure as given in the previous step by using the Lower Beam and time base 'B' controls. The location of the Lower Beam VERTICAL D.C. SHIFT adjustment is shown in Figure 6-5.

Upper and Lower Astigmatism

Rotate both FOCUS controls fully clockwise and place both HORIZ. DISPLAY switches at the X10 EXT. ATTEN. position. Position both beams onto the screen, and adjust the UPPER ASTIG. and LOWER ASTIG. controls so that both de-

*** Make this adjustment on instruments having serial numbers lower than 220. Omit this step on instruments having serial numbers 220 or higher because the control has been removed.**

focused spots are as nearly circular as is possible. Adjust the FOCUS controls so that both spots are in sharp focus. To sharpen the focus further, place both HORIZ. DISPLAY switches at 'A' X1. Set both time base trigger controls at AC AUTO., +SLOPE, AC COUPLING, and UPPER BEAM SOURCE. Rotate the TIME/CM controls to the .5 MILLISEC position. Set the vertical plug-in VOLTS/CM controls at 1, the input selector AC-DC switches at AC, and position both beams to the appropriate horizontal center lines. Connect a 1-volt signal from the AMPLITUDE CALIBRATOR to both upper and lower beam vertical input connectors. Carefully readjust the Upper Beam FOCUS and UPPER ASTIG. controls for a sharper focus of the leading corner of one square-wave on the upper beam calibrator waveform. Adjust the Lower Beam FOCUS and LOWER ASTIG. controls for the same results on the lower beam calibrator waveform.

Geometry Adjustments 1 and 2

Place all controls in the positions they were in at the completion of the UPPER and LOWER ASTIGMATISM adjustments and leave the calibrator signal connected. Rotate the AMPLITUDE CALIBRATOR to the 10-volt position. Increase the intensity of both beams to allow the rising and falling portions of the waveforms to be visible. The tops and bottoms of the square-waveforms should extend beyond the usable viewing area of the beams. Horizontally align the rising and falling portions of the upper beam waveform with those of the lower beam by using the horizontal positioning controls. Adjust the GEOM. ADJ. 1 and GEOM. ADJ. 2 for minimum curvature and best vertical alignment of the vertical trace lines at the edges of the graticule (see Figure 6-6). Decrease the intensity of both beams to normal intensity and rotate the AMPLITUDE CALIBRATOR to the OFF position. Vertically position each beam 2 centimeters above and 2 centimeters below the appropriate centerline and check for excessive bowing of the horizontal trace. The bowing of the horizontal traces is minimized by a slight readjustment of either or both GEOM. ADJ. 1 and GEOM. ADJ. 2 controls.

Upper Beam Sweep Magnified Registration

The control settings that follow apply to the Upper Beam and Time Base A. Place the HORIZ. DISPLAY switch at 'A' X1. Set the trigger controls at AC AUTO., +SLOPE, AC COUPLING, and UPPER BEAM SOURCE. Set the SWEEP

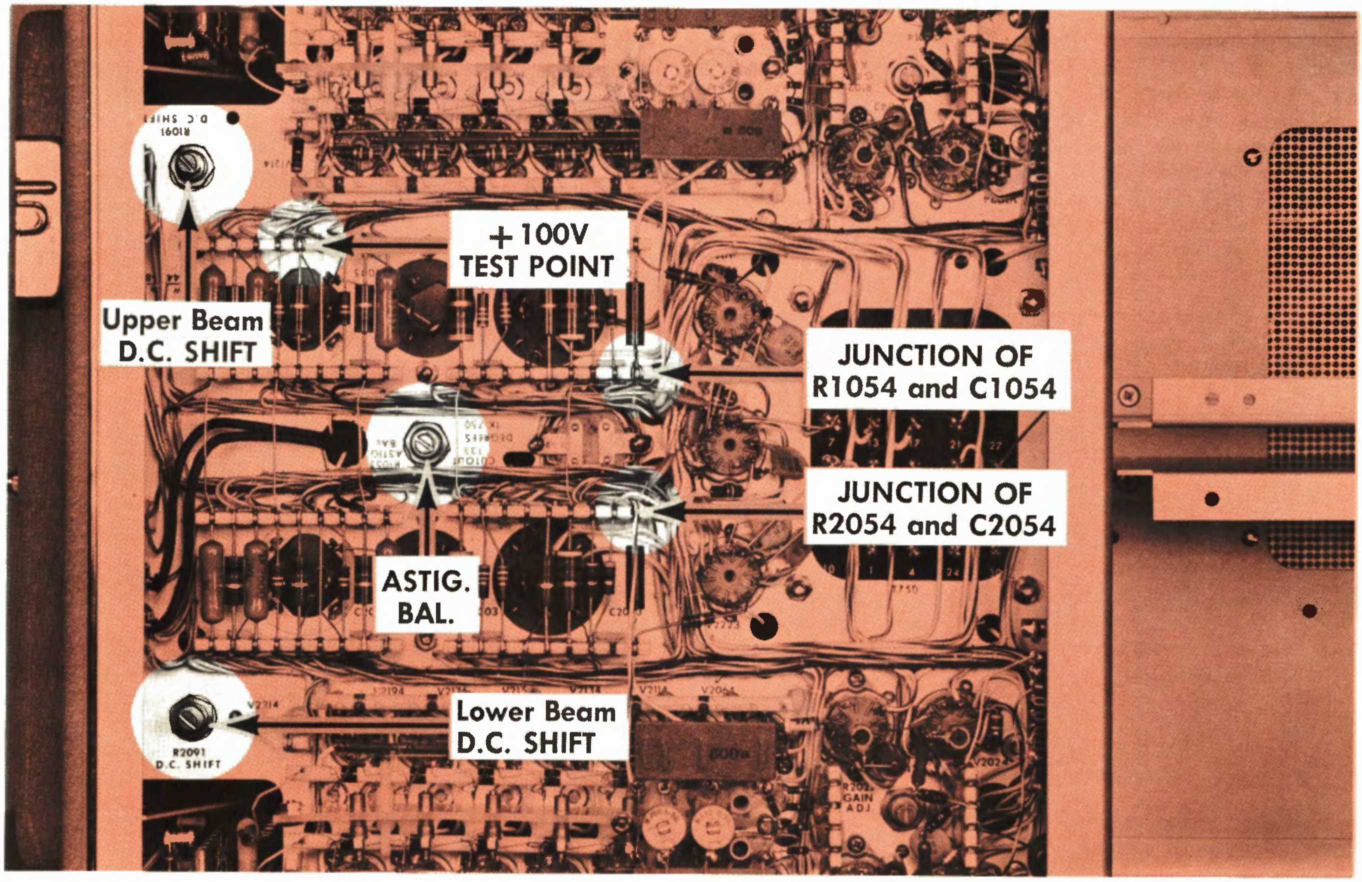

Fig. 6-5. Bottom view of indicator unit showing location of ASTIG. BAL. control the test point junctions*. Locations of the +100V test point and D.C. SHIFT adjustments are shown also:

*** Make this adjustment on instruments having serial numbers lower than 220. Omit this step on instruments having serial numbers 220 or higher because the control has been removed.**

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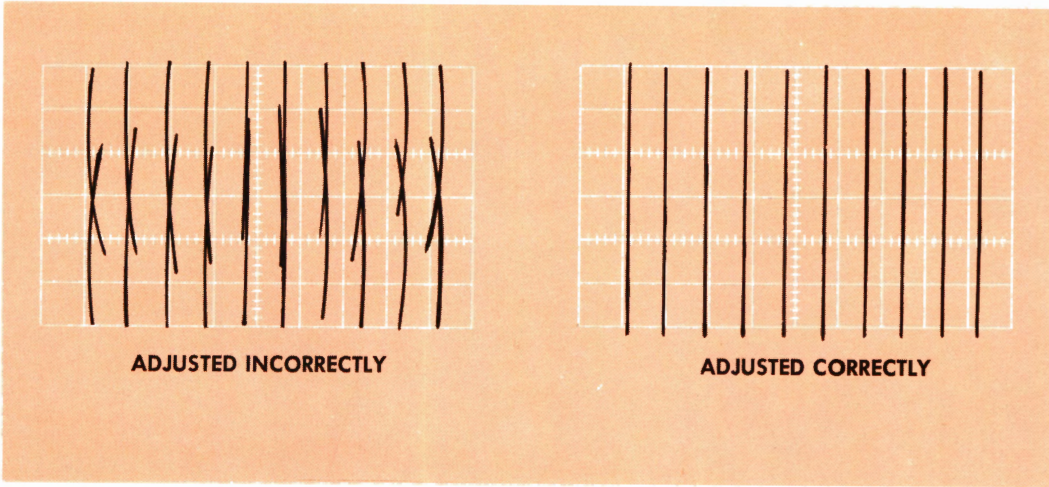

Fig. 6-6. Adjustment of the GEOMETRY controls.

FUNCTION switch at NORMAL and rotate the TIME/CM control to the .2 MILLISEC position. Set the vertical plug-in VOLTS/CM at 1, the AC-DC switch at DC, and position the upper beam trace to the upper horizontal centerline. Place the AMPLITUDE CALIBRATOR control at 2 volts and connect the calibrator signal from the CAL. OUT connector to the vertical plug-in input connector. Place the HORIZ. DISPLAY switch at 'A' X2. Position the trace so that the leading edge of the first square-wave is at the vertical centerline of the graticule. Then place the HORIZ. DISPLAY switch in the 'A' X1 position and adjust the SWP. MAG. REGIS. control (see Figure 6-10) until the leading edge of the first square-wave is again at the vertical centerline of the graticule. The leading edge of the square-wave should then remain stationary

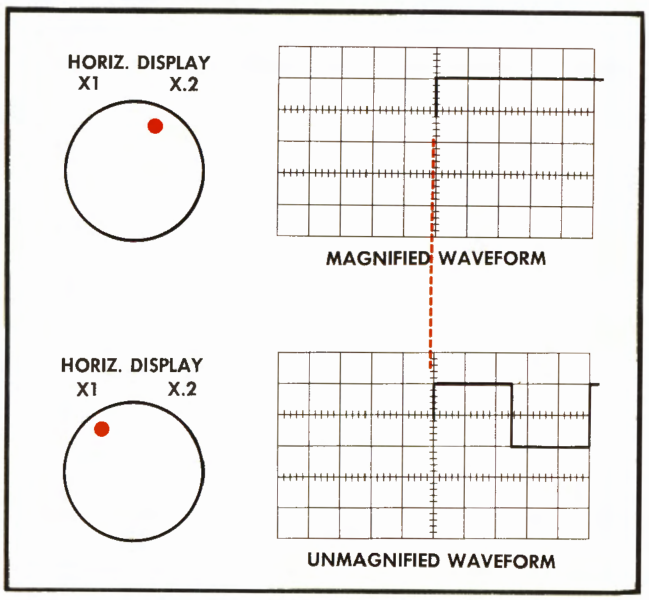

Fig. 6-7. When the adjustment of the SWP. MAG. REGIS. controls are made properly, the portion of the displayed waveform at the exact center of the graticule remains stationary as the appropriate HORIZ. DISPLAY switch is switched between the X1 and the X.2 positions.

as the HORIZ. DISPLAY switch is moved from the 'A' X1 to the 'A' X.2 position (see Figure 6-7). Disconnect the calibrator signal.

Lower Beam Sweep Magnified Registration

The control settings that follow for this adjustment apply to the lower beam and Time Base B. Place the HORIZ. DISPLAY switch at 'B' X1. Set the trigger controls at AC AUTO., +SLOPE, AC COUPLING, and LOWER BEAM source. Set the SWEEP FUNCTION switch at NORMAL and rotate the TIME/CM control to the .2 MILLISEC position. Set the vertical plug-in VOLTS/CM at 1, the AC-DC switch at DC, and position the lower beam trace to the lower horizontal centerline. Place the AMPLITUDE CALIBRATOR control at 2 volts and connect the calibrator signal from the CAL. OUT connector to the vertical plug-in input connector. Place the HORIZ. DISPLAY switch at 'B' X.2. Position the trace so that the leading edge of the first square-wave is at the vertical centerline of the graticule. Then place the HORIZ. DISPLAY switch in the 'B' X1 position and adjust the SWP. MAG. REGIS. control (see Figure 6-10) until the leading edge of the square-wave is again at the vertical centerline of the graticule. The leading edge of the square-wave should then remain stationary as the HORIZ. DISPLAY switch is moved from the 'B' X1 to the 'B' X.2 position (see Figure 6-7). Disconnect the calibrator signal.

'A' Sweep Length

Remove the Type 21 Time-Base Unit, attach the Time Base Plug-In Extension, and install the Type 21 with the extension in the 'A' plug-in compartment.

With controls set as in the Upper Beam Sweep Magnified Registration step, place the 'A' TIME/CM switch at .1 MILLISEC and rotate the 'A' LEVEL control fully clockwise to the RECURRENT position. Place the Upper Beam HORIZ. DISPLAY switch at 'A' X1 and adjust the 'A' SWEEP LENGTH control for a sweep length of 10.5 centimeters. Remove the Type 21 Time-Base Unit and the plug-in extension connector. Re-install the Type 21.

'B' Sweep Length

With the controls set as in the Lower Beam Sweep Magnified Registration step, place the 'B' TIME/CM switch at .1 MILLISEC and rotate the 'B' LEVEL control fully clockwise to the RECURRENT position. Place the Lower Beam HORIZ. DISPLAY switch at 'B' X1 and adjust the 'B' SWEEP LENGTH (see Figure 6-9) control for a sweep length of 10.5 centimeters.

Upper Beam External Horizontal Amplifier D.C. Balance

Place the Upper Beam vertical plug-in VOLTS/CM switch at 20 volts. Connect a jumper from 'A' SAWTOOTH to the vertical INPUT, place the Upper Beam HORIZ. DISPLAY switch at EXT. ATTEN. X1 and rotate the 'A' LEVEL control full right to the RECURRENT position. Turn the Upper Beam HORIZ. POSITION control to the left to position the upper beam vertical trace to the left graticule line. Adjust the Upper Beam HORIZ. AMP. D.C. BAL. control (see Figure 6-8) for no horizontal shift of the trace while rotating the Upper Beam EXT. HORIZ. GAIN control.

Check Upper Beam Ext. Horiz. Input Deflection Factor

With controls set as given in the previous step, connect a jumper from the CAL. OUT to the Upper Beam EXT. HORIZ. INPUT connector. Set the AMPLITUDE CALIBRATOR at .2 VOLTS and turn the EXT. HORIZ. GAIN control full right. At least one centimeter of horizontal deflection must be displayed. Increase the AMPLITUDE CALIBRATOR to 2 volts and adjust the EXT. HORIZ. GAIN control for exactly 10 cm of horizontal deflection. Place the Upper Beam HORIZ. DISPLAY switch at EXT. ATTEN. X10. The horizontal deflection should now be one centimeter. (Attenuator accuracy ±3%).

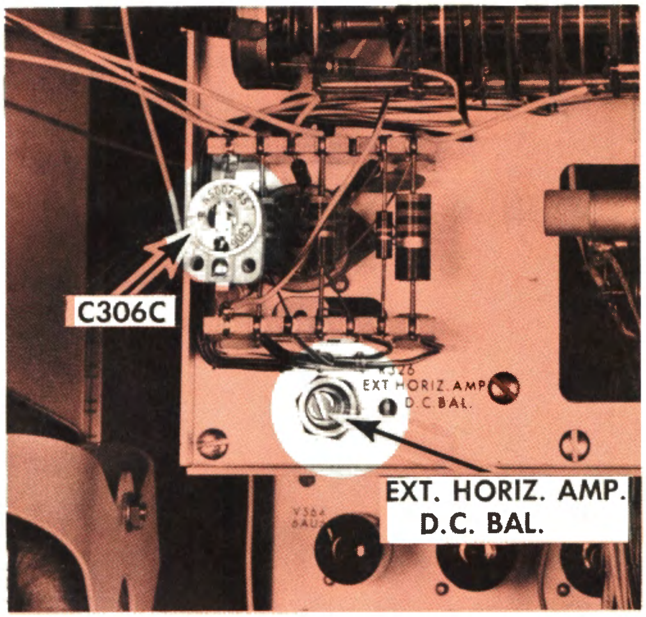

Fig. 6-8. Location of the upper beam external horizontal amplifier adjustments.

External Horizontal Input Compensation

With the jumpers connected as described in the two previous steps, set the AMPLITUDE CALIBRATOR at 5 VOLTS. Connect a third jumper from the CAL. OUT to the 'A' trigger INPUT connector. Set the Upper Beam and 'A' controls as follows:

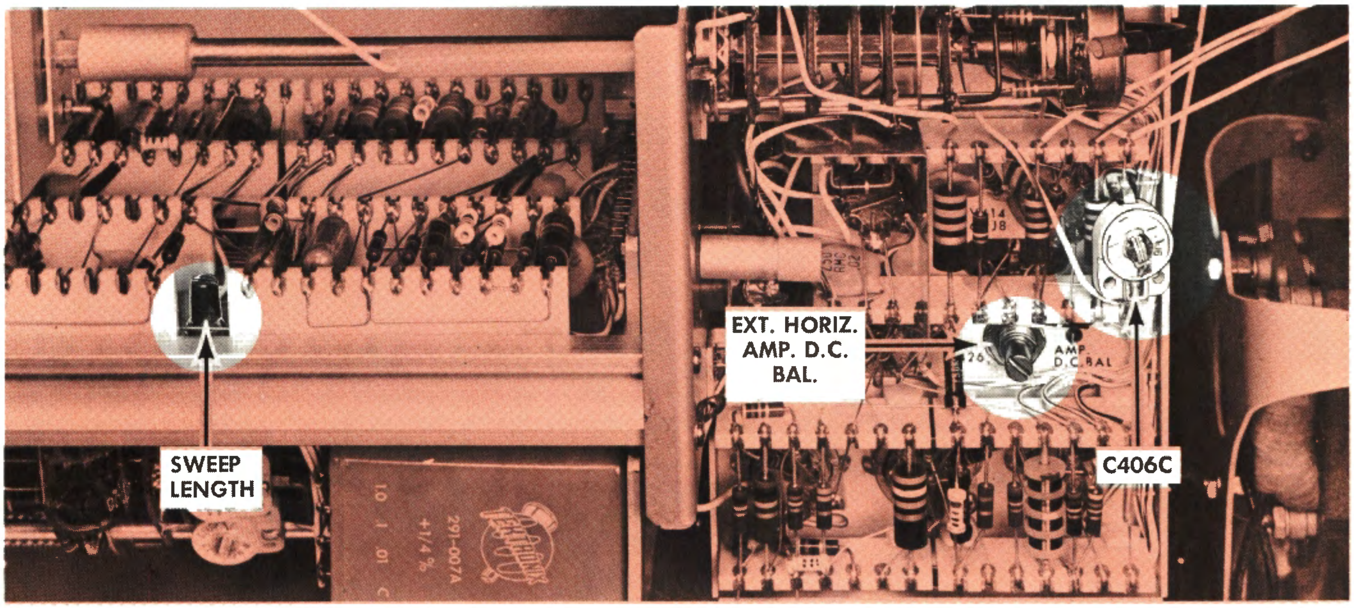

Fig. 6-9. Location of the lower beam SWEEP LENGTH and external horizontal amplifier adjustments.

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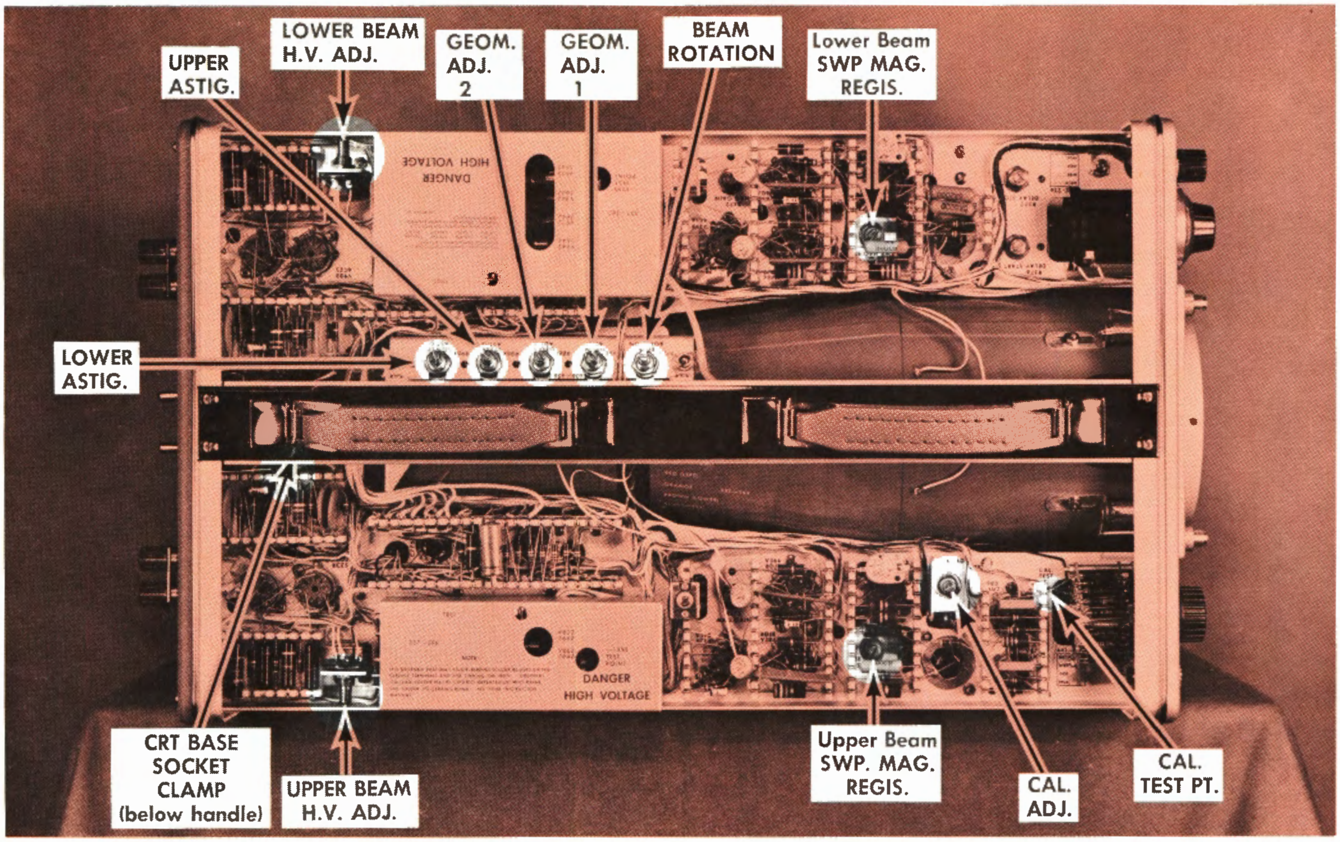

Fig. 6-10. Top view location of the internal adjustments, CAL. TEST PT., and crt socket clamp.

HORIZ. DISPLAY (Upper Beam)	EXT. ATTEN. X1
SLOPE	—
FUNCTION	NORMAL
TIME/CM	1 MILLISEC
VOLTS/CM (Vertical Plug-In)	10

Adjust the 'A' LEVEL control for a stable square-wave, displayed vertically. Adjust C306C (see Figure 6-8) for optimum flat top. Disconnect all jumper leads.

Lower Beam External Horizontal Amplifier Adjustments

Follow the same procedure as given in the last three steps by using the corresponding Lower Beam and time base 'B' front panel controls. Locations of the internal controls are shown in Figure 6-9. The capacitor, C406C, is adjusted in the same manner as C306C. The adjustment of C306C is explained in the previous step.

SECTION 7

RECALIBRATION PROCEDURE

The Type 555 Oscilloscope is a stable instrument and should not require frequent recalibration. 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 recalibration. Each numbered step contains the information necessary to make one adjustment. Sometimes, two or more adjustments are included in one step when the controls to be adjusted are related to each other and if several adjustments can be made easily at that time. If a complete recalibration is not necessary, you may perform individual steps, PROVIDING that the steps performed do not effect other adjustments. It is 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. In particular the sweep rates and vertical deflection factors must be checked.

EQUIPMENT REQUIRED

The following equipment is necessary for a complete recalibration of the Type 555 Oscilloscope:

(1.) A DC voltmeter having a sensitivity of at least 5000 Ω/v and calibrated for an accuracy of at least 1% at 100, 150, 225, 350 and 500 volts, and for an accuracy of 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 v operation).

(3.) AC voltmeter with a range of zero to 10 volts RMS of the iron vane or dynamometer type.

(4.) Variable auto-transformer (e.g. Powerstat or Variac) having a rating of at least 1.3 KVA.

(5.) Time-mark Generator, Tektronix Type 180, 180A or equivalent, having markers at 1 μsec, 10 μsec, 50 μsec, 100 μsec, 1 msec, 5 msec, 10 msec, 100 msec, 1 sec, and 5 sec and sinewave outputs of 10 mc and 50 mc, all having an accuracy of at least 1%.

(6.) Constant-Amplitude Signal Generator, Tektronix Type 190 or 190A, or equivalent, providing a 200 mv signal at constant amplitude through the frequency range of 500 kc to over 30 mc.

(7.) Square-Wave Generator, Tektronix Type 107 or equivalent, having a risetime of no more than 4 millimicroseconds, and a frequency of approximately 500 kc. The top of the square-wave must be free of overshoot and wrinkles. A Tektronix Type P Unit may be used in place of the Type 107. A Type P52 Coaxial Cable and a Type B52R Terminating Resistor is required with the Type 107.

(8.) Tektronix Type K or Type L Plug-In Unit. (If delay-line adjustment is not required, other Tektronix Plug-In Units may be substituted.)

(9.) Low-Capacitance Recalibration Tools: See Recalibration Tools in the Accessories Section of the Operator's Manual.

Additional Tools: A three-inch screwdriver, a 5/16" nut driver, and a .050" allen wrench.

(10.) Tektronix Type P410A or P6000 Probe.

(11.) Clip-lead adapter (013-003) and a 1 k, ½ w, composition resistor.

(12.) Gain Set Adapter, Tektronix Type EP53A.

(13.) Time-Base Plug-In Extension

(14.) The Type 555 is used as a test oscilloscope by using single-beam operation to make some of the adjustments.

ADJUSTMENT PROCEDURE

Preliminary

Remove the side covers and bottom plate from the Power Supply and Indicator Units to be recalibrated. Install the Type K or Type L Unit in the Upper Beam compartment. Set the front-panel controls for both beams as follows:

INTENSITY	full left
HORIZ. DISPLAY (Upper Beam)	'A' X1
HORIZ. DISPLAY (Lower Beam)	'B' X1
TIME-BASE UNITS	
LEVEL	full left, but **not** AC AUTO.
SLOPE	+
COUPLING	AC
SOURCE (Time Base A)	UPPER BEAM
SOURCE (Time Base B)	LOWER BEAM
SWEEP FUNCTION	NORMAL
TIME/CM	.5 MILLISEC
VARIABLE	CALIBRATED (full right)
VERTICAL PLUG-IN UNITS	
AC/DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED (full right)

NOTE: Settings for all controls not listed above are not pertinent to this part of the procedure and the controls may be left in any position. The letter 'A' is used through out the procedure as an abbreviation for "TIME BASE A" and the letter 'B' for "TIME BASE B."

Check the rear panel of the instrument to be sure the metal strap between the CRT CATHODE and GROUND binding posts for both beams are in place, and that the CRT CATHODE selector switches are at the CRT CATHODE position. Connect the instrument and the (0-150 or 0-300 volt) ac meter to the auto-transformer output and turn on all equipment. Adjust the autotransformer to the design-center voltage for which your instrument is wired (117 or 234 v.) and allow at least 5 minutes warmup before making any adjustments.

1. Low-Voltage Power Supplies

Measure the output voltage of the —150v, +100v, +225v, +350v and +500v supplies at the points indicated on the Power Supply Unit (see Figure 7-1). Be sure your meter is accurate (see Equipment Required, (1)). The output voltage of the —150v supply must be between —147v and —153v, and the other regulated supplies must be within 2% of their rated values. You should be able to set the —150 ADJ. control (see Power Supply Unit, Figure 7-2) so that all of these voltages are within the specified tolerance. Bear in mind that the calibration of the entire instrument is effected

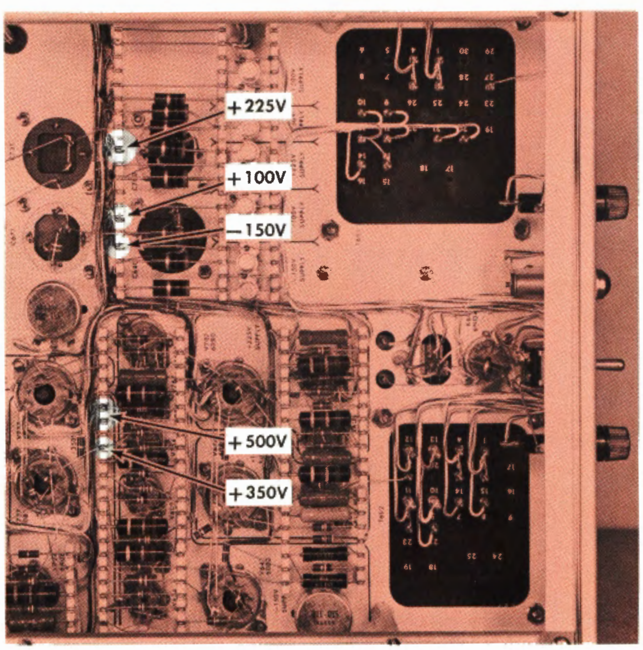

Fig. 7-1. Bottom view of the power supply showing the location of the test points.

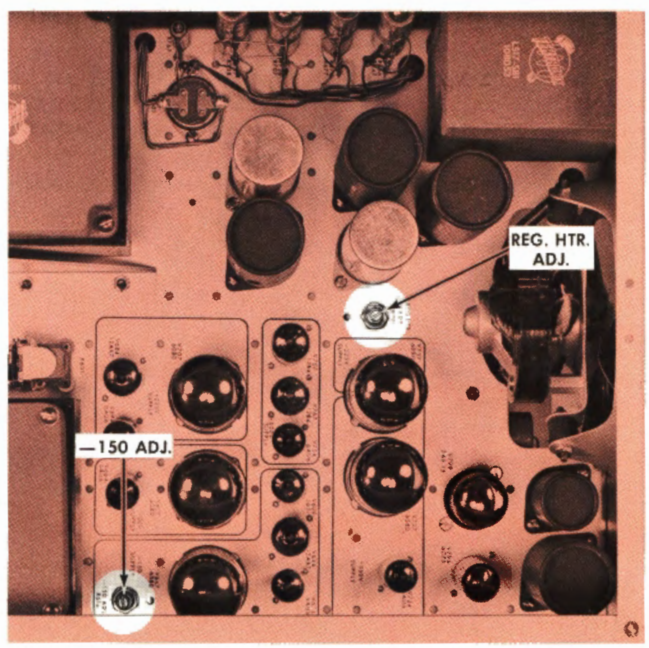

Fig. 7-2. Top view of the power supply unit showing the location of the power supply unit adjustments.

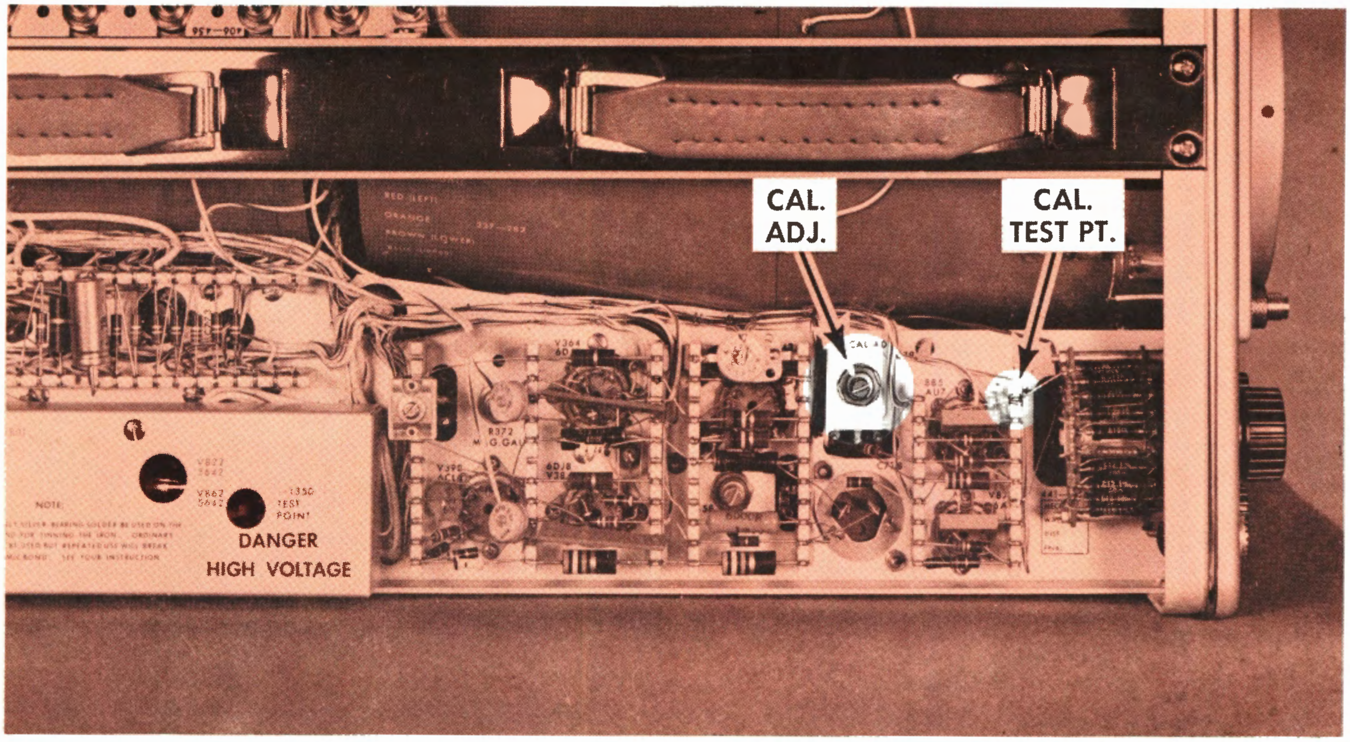

Fig. 7-3. Top view of indicator unit showing the location of the CAL. ADJ. control and the CAL. TEST PT.

by changes in the power supply voltages. Don't adjust the —150 unless one or more of the supplies is actually out of tolerance.

Connect the 0-10 volt ac meter between the test point shown in Figure 7-4 and ground. Adjust the REG. HTR. ADJ. for a voltage reading of 6.3 VAC.

To check the above supplies for proper regulation, vary the autotransformer voltage between 105v and 125v (or from 210v to 250v if the power transformer is connected for 234v operation). All of the regulated voltages should remain essentially constant.

The ripple present on any of the dc regulated supplies, as measured with one beam of the oscilloscope at the voltage check points, will be under 10 mv., with CALIBRATOR-OFF, and the sweep for the other beam not operating. When using the one beam for ripple measurements, place the TIME/CM control at 5 MILLISEC, the LEVEL control at AC AUTO., the SOURCE switch at LINE, and the vertical input selector AC-DC switch at AC. Use the coaxial cable and clip-lead adapter to connect the outer conductor to ground (chassis) and the center conductor to each test point. If the oscillations occur on the waveform, connect a 1 K resistor in series with the clip-lead center conductor.

2. Amplitude Calibrator Adjustment

The CAL. ADJ. control should be set to provide a dc output of 100 volts when the AMPLITUDE CALIBRATOR switch is in the OFF position. Under these conditions, the calibrator output will be within 3% of the front-panel readings.

To make this adjustment connect the voltmeter between the the CAL. TEST PT. jack and ground (see Figure 7-3), turn the AMPLITUDE CALIBRATOR switch to the OFF position, and adjust the CAL. ADJ. 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 45v nor more than 55 volts when the calibrator is turned on (to any of the output voltage settings). Readings outside this range are generally caused by unbalanced multivibrator tubes (V875 or V885).

3. High-Voltage Power Supply Adjustment

These adjustments determine the total accelerating potentials on the crt, and thus affect the deflection sensitivity.

Connect the dc voltmeter between ground and the upper beam high-voltage check point (see Figure 7-4), and set the Upper Beam H.V. ADJ. for a meter reading of exactly —1350 volts. If your meter has a full scale reading of 1200 v, you can connect the positive meter lead to the —150v supply, at any convenient point, and set the Upper Beam H.V. ADJ. for a meter reading of —1200v.

Connect the dc voltmeter between ground and the Lower Beam high-voltage check point (see Figure 7-4), and set the Lower Beam H.V. ADJ. for a meter reading of exactly —1350 volts. If your meter has a full scale reading of 1200 v, connect your meter as described in the previous paragraph.

4. Beam Rotation

If the crt has been replaced, or if, due to considerable handling, the trace does not align with the graticule, you should make this adjustment before proceeding with the calibration.

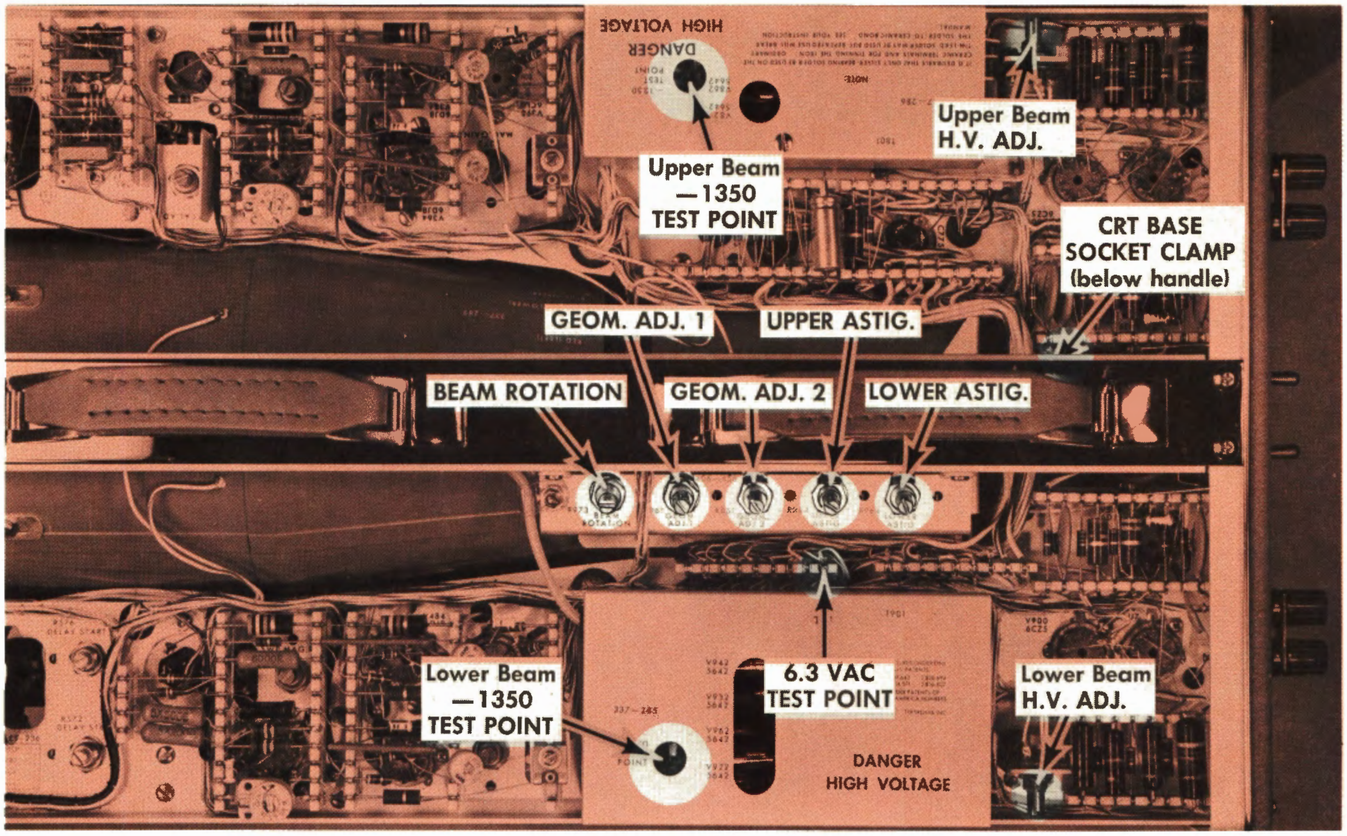

Fig. 7-4. Top view, rear section, showing the location of the test points, control adjustments, and crt socket clamp.

Set both beams for free-running sweeps by setting the LEVEL controls of both time base units to RECURRENT. With no vertical signals applied, position the beam traces behind the appropriate horizontal centerlines of the graticule. Adjust the BEAM ROTATION control (see Figure 7-4) so that the traces are parallel to the horizontal centerlines. The final setting of the BEAM ROTATION control should be near the center of its rotation range.

If the BEAM ROTATION control is not near the center of its rotation range, loosen the crt base connector clamp and rotate the crt a few degrees in the direction which will achieve this final mid-range setting. While aligning the crt, push it forward until it rests snugly against the graticule, and tighten the connector clamp. Recheck the alignment of the traces.

5. Graticule Alignment

With the control settings remaining as in the previous step, position the upper beam trace upward until the trace dims, and then downward until the trace again becomes dim. Note the distance that the beam moved and position the beam midway between this distance. Remove the graticule cover. Loosen the set screw which holds the nylon cam located in the lower left corner of the graticule. Rotate the cam with an allen wrench or a pointed tool and position the graticule until the upper beam graticule centerline coincides with the upper beam. While holding the cam with the tool, tighten the set screw.

Follow the same procedure to determine the center of the lower beam viewing area. If the centered lower beam is not close to the centerline, reposition the graticule to obtain a compromise setting for the two beams. Replace the graticule cover.

6. Astigmatism Balance*

Connect a dc voltmeter from the junction of R1054 and C1054 to the junction of R2054 and C2054 (see Figure 7-5). Adjust the ASTIG. BAL. control for zero reading on the dc voltmeter.

7. Upper and Lower Astigmatism

Rotate both FOCUS controls fully clockwise and place both HORIZ. DISPLAY switches at the X10 EXT. ATTEN. position. Position both beams onto the screen, and adjust the UPPER ASTIG. and LOWER ASTIG. controls so that both defocused spots are as nearly circular as is possible. Adjust the FOCUS controls so that both spots are in sharp focus. To sharpen the focus further, place both HORIZ. DISPLAY switches at 'A' X1. Set both time base trigger controls at AC AUTO., +SLOPE, AC COUPLING, and UPPER BEAM

*** Make this adjustment on instruments having serial numbers lower than 220. Omit this step on instruments having serial numbers 220 or higher because the control has been removed.**

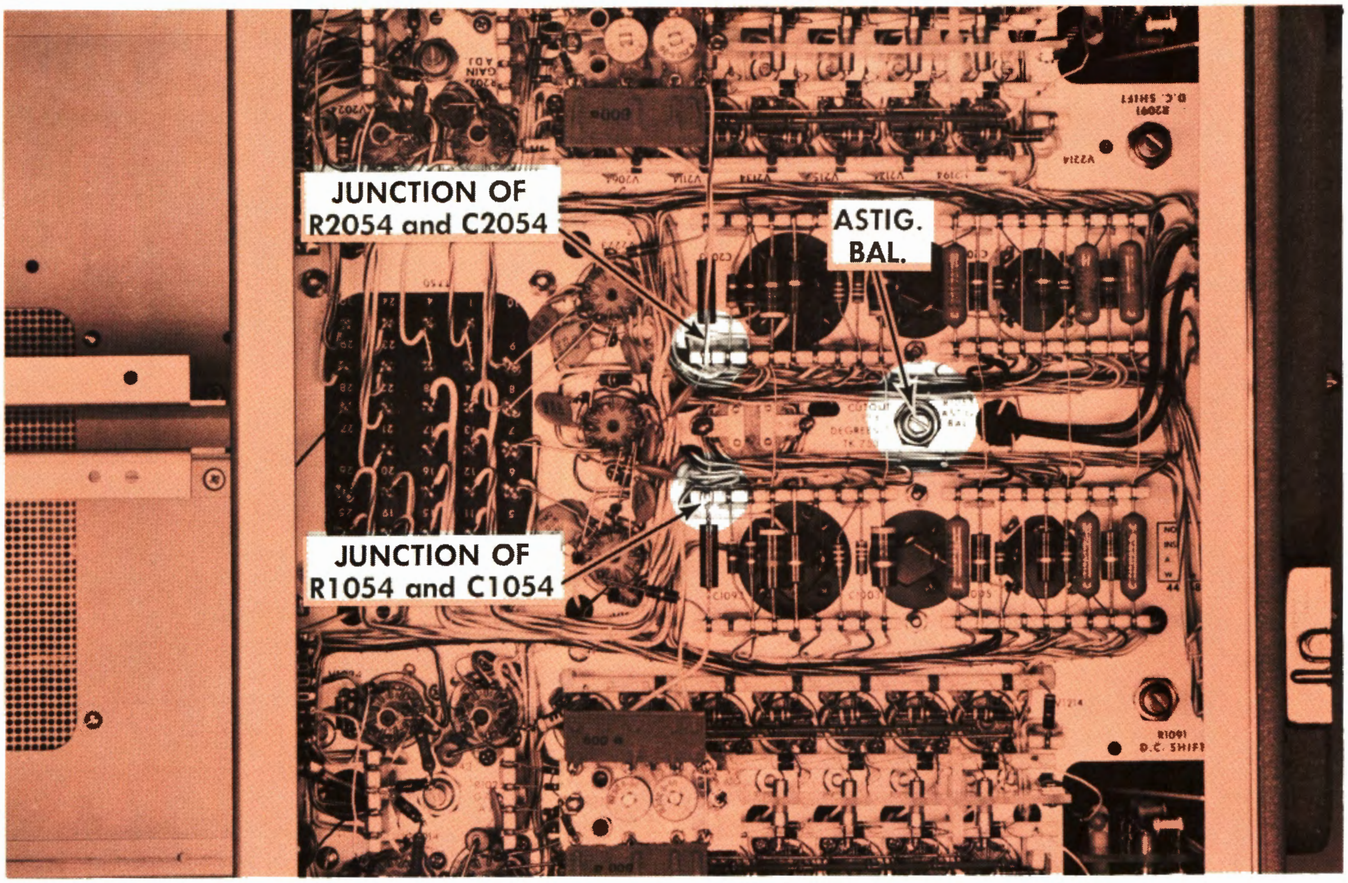

Fig. 7-5. Bottom view of inductor unit showing the location of the ASTIG. BAL. control and the junction test points.* (See footnote, Page 7-4).

SOURCE. Rotate the TIME/CM controls to .5 MILLISEC position. Set the vertical plug-in VOLTS/CM controls at 1, the input selector AC-DC switches at AC, and position both beams to the appropriate horizontal center lines. Connect a 1-volt signal from the AMPLITUDE CALIBRATOR to both upper and lower beam vertical input connectors. Carefully readjust the Upper Beam FOCUS and UPPER ASTIG. controls for a sharper focus of the leading corner of one square-wave on the upper beam calibrator waveform. Adjust the Lower Beam FOCUS and LOWER ASTIG. controls for the same results on the lower beam calibrator waveform.

8. Geometry Adjustments 1 and 2

The geometry of the crt display for both beams is adjusted by means of the GEOM. ADJ. 1 and the GEOM. ADJ. 2 controls. To achieve optimum linearity, vertical lines are displayed on the crt and controls are adjusted for minimum curvature of the lines. Nonlinearity is most noticeable at the edges of the graticule.

Place all controls in the positions they were in at the completion of the Upper and Lower Astigmatism adjustments and leave the calibrator signal connected. Rotate the AMPLITUDE CALIBRATOR to the 10-volt position. Increase the intensity of both beams to allow the rising and falling portions of the waveforms to be visible. The tops and bottoms of the square-waveforms should extend beyond the usable viewing area of the beams. Horizontally align the rising and falling portions of the upper beam waveform with those of the lower beam by using the horizontal positioning controls. Adjust the GEOM. ADJ. 1 and GEOM. ADJ. 2 (see Figure 7-4) for straight vertical lines running parallel to the left and right edges of the graticule (see Figure 7-6).

NOTE

The Type 180 or 180A may be used for this step to provide vertical lines of higher intensity. Use 500 μsec markers and position the base line below the viewing area of the beams.

TIME BASE A TRIGGER CIRCUIT ADJUSTMENTS

The time base 'A' triggering adjustments that follow must be made in the indicated sequence. Controls not mentioned in a particular step are assumed to be in the positions they were last in during the previous step.

9. 'A' Trigger Level

Remove the Type 21 Time Base Unit, attach the Time Base Plug-In Extension to the Type 21 Unit, and install the unit

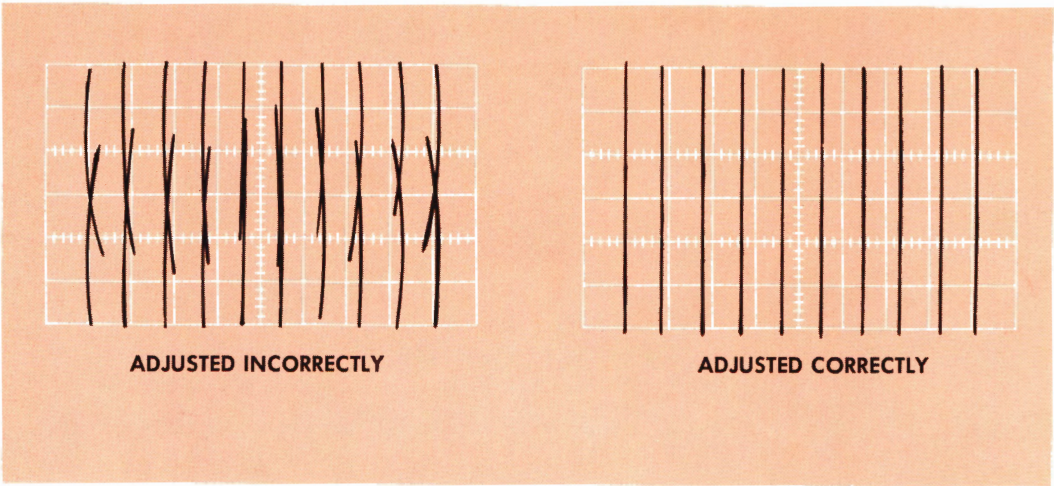

Fig. 7-6. Adjustment of the Geometry controls.

with the extension in the TIME BASE A compartment of the Type 555.

Set the Upper Beam HORIZ. DISPLAY switch at 'A' X1. Place the 'A' SLOPE switch at +, 'A' COUPLING switch at DC, and 'A' SOURCE switch at UPPER BEAM. Rotate the 'A' LEVEL control to zero. Set the lower beam vertical plug-in VOLTS/CM switch at .05 and the input selector AC-DC switch at DC. Place the Lower Beam HORIZ. DISPLAY switch at 'B' X1. Set the 'B' trigger controls at AC AUTO., +SLOPE, AC COUPLING, and LINE SOURCE. Place the 'B' SWEEP FUNCTION switch at NORMAL and the 'B' TIME/CM switch at 2 MILLISEC. Center the lower beam trace at the lower horizontal centerline of the graticule and connect the 10X probe from the lower beam vertical input connector to the junction of R19 and R20 (see Figure 7-7). If the probe is being used with the clip lead ungrounded, position the probe body away from the 'A' SOURCE switch leads to prevent any feedback of signals. Rotate the 'A' LEVEL knob until the lower beam trace is again at the lower horizontal centerline. Loosen the 'A' LEVEL knob and set it at zero position. Re-tighten the knob and recheck it for exact zero setting and no vertical shift of the lower beam trace by disconnecting and connecting the probe a few times at the junction. Disconnect the probe from the junction.

10. 'A' Upper Beam Internal Trigger DC Level

Set the 'A' TIME/CM switch at .1 MILLISEC and rotate the STABILITY control clockwise for a free-running sweep. Position the upper beam trace to the upper horizontal centerline. Connect a short jumper from the junction of R19 and R20 to the chassis; connect a dc voltmeter from the junction of R22 and SW22 to the chassis (see Figure 7-7). Place the 'A' SLOPE switch in the — position and adjust the 'A' UPPER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts. Slide the SLOPE switch from — to + to check for accuracy of the adjustment and no voltmeter needle shift. Leave the SLOPE switch at —.

11. 'A' Lower Beam Internal Trigger DC Level

Position the lower beam trace to its centerline. Set the 'A' SOURCE switch at LOWER BEAM. Adjust the 'A' LOWER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts and no change in meter needle movement when the 'A' SOURCE switch is set at UPPER BEAM and back to LOWER BEAM. Disconnect the voltmeter.

12. 'A' Trigger Level Centering

Rotate the lower beam vertical plug-in VOLTS/CM switch to the .5 volts position and set the input selector AC-DC switch at AC. Set the 'A' SOURCE switch at LINE. Connect the probe to pin 6 of V45 (see Figure 7-7). Preset the 'A' TRIG. LEVEL CENT. control so that the waveform on the lower beam is symmetrical. For precise adjustment set the Lower Beam HORIZ. DISPLAY switch at 'B' X.2 and horizontally center the +slope or switching portion of the multivibrator waveform using the 'B' HORIZ. POSITION control. Now slide the 'A' SLOPE switch up and down from — to + and, at the same time, readjust the 'A' TRIG. LEVEL CENT. for no horizontal shifting of the switching portion of the waveform. Leave the 'A' SLOPE switch at +.

13. 'A' Trigger Sensitivity

With the probe and jumper connected as described in the previous step, rotate the 'A' TRIG. SENS. control fully counterclockwise. Turn the control slowly clockwise and stop at the point where the oscillations cease to appear. Note the amplitude of the spike on the top corner of the multivibrator waveform. Then rotate the 'A' TRIG. SENS. control clockwise until this spike is slightly less than one half of the original size (see Figure 7-8). Disconnect the probe from the test point and remove the jumper lead.

14. 'A' Lockout Level

Set the 'A' COUPLING switch at AC, and the 'A' SOURCE switch at UPPER BEAM. The approximate voltage at pin 7 of V125 is —55 volts. Connect a dc voltmeter at this test point (see Figure 7-7) and rotate the 'A' STABILITY control counterclockwise until the upper beam sweep just stops free-

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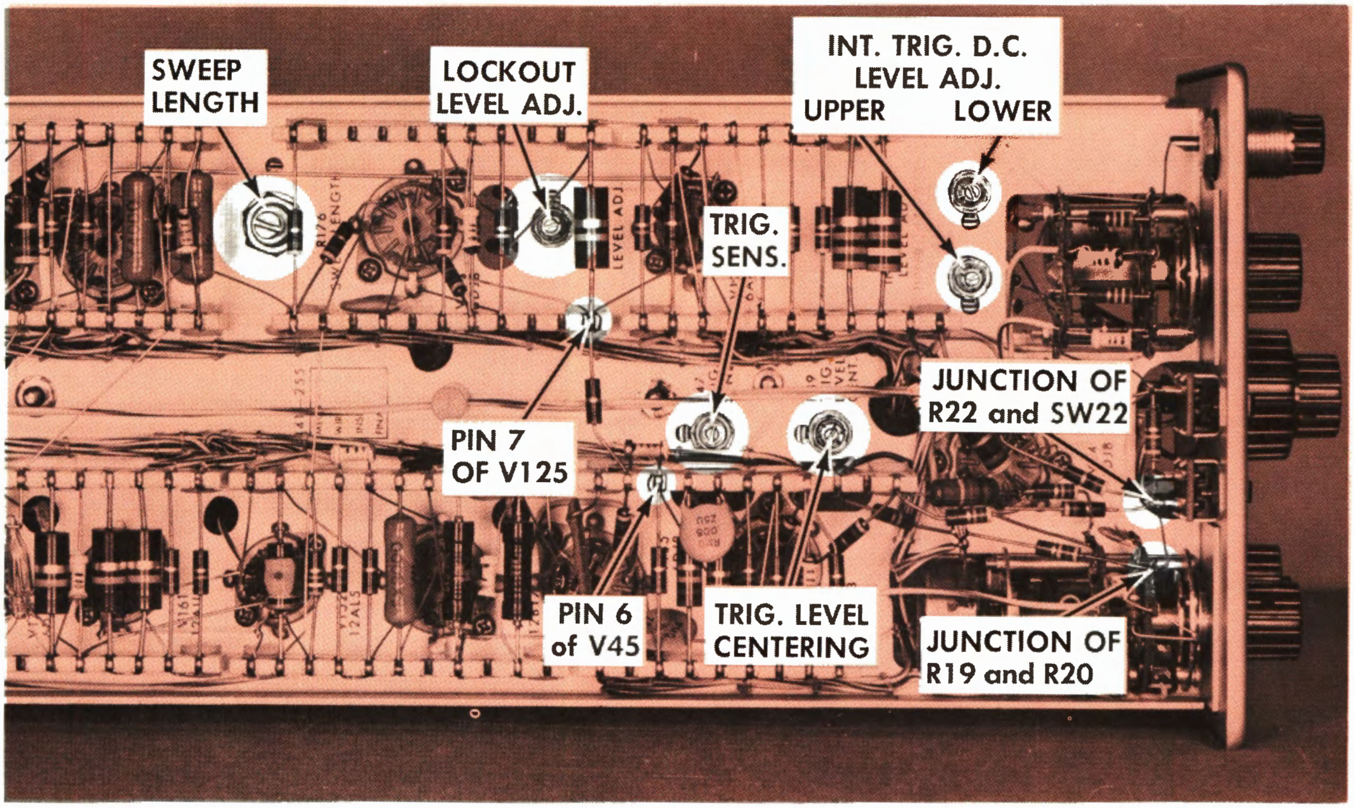


Fig. 7-7. Location of the Type 21 Time-Base Unit calibration controls and test points.

running. Record the meter reading of the dc voltmeter. Set the 'A' SWEEP FUNCTION switch at SINGLE SWEEP and trigger the sweep once by rotating the 'A' LEVEL control clockwise to + and then counterclockwise to —. If the 'A' STABILITY control setting is correct as explained above, the READY lamp should extinguish indicating that the upper beam trace is locked out. Now set the 'A' LOCKOUT LEVEL ADJ. control for a voltmeter reading of 11 volts lower (less negative) than the previous reading. To compare voltmeter readings, repeat the procedure given in this step.

15. 'A' Stability

Set the 'A' SWEEP FUNCTION switch at NORMAL. Set the 'A' trigger controls at +SLOPE, LINE SOURCE, and rotate the LEVEL control fully counterclockwise to the AC AUTO. position. The voltage reading at the junction of the 'A' STABILITY wiper arm and R114 is approximately —80 to —110 volts. Connect a dc voltmeter at this junction (see Figure 7-9) and rotate the 'A' STABILITY control fully counterclockwise. Turn the 'A' STABILITY control clockwise until the upper beam trace first appears. Record the reading of the dc voltmeter. Then continue to rotate the 'A' STABILITY control clockwise until the upper beam trace brightens and again record the voltage. Set the 'A' STABILITY control for a voltmeter reading midway between the two recorded voltage readings. Disconnect the voltmeter leads and plug-in extension. Re-install the Type 21 in the TIME BASE A compartment.

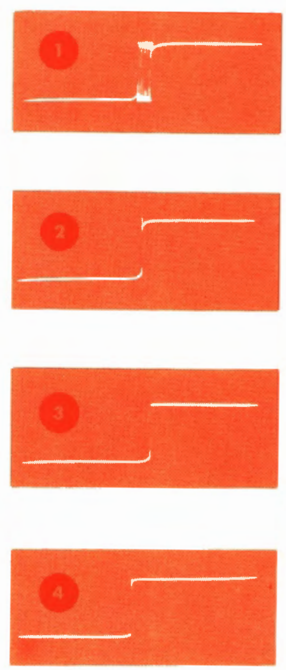


Fig. 7-8. Waveforms 1, 2 and 3 show changes in the waveform as the TRIGGER SENS. control is rotated clockwise. Waveform 4 is the display obtained when the control is adjusted correctly.

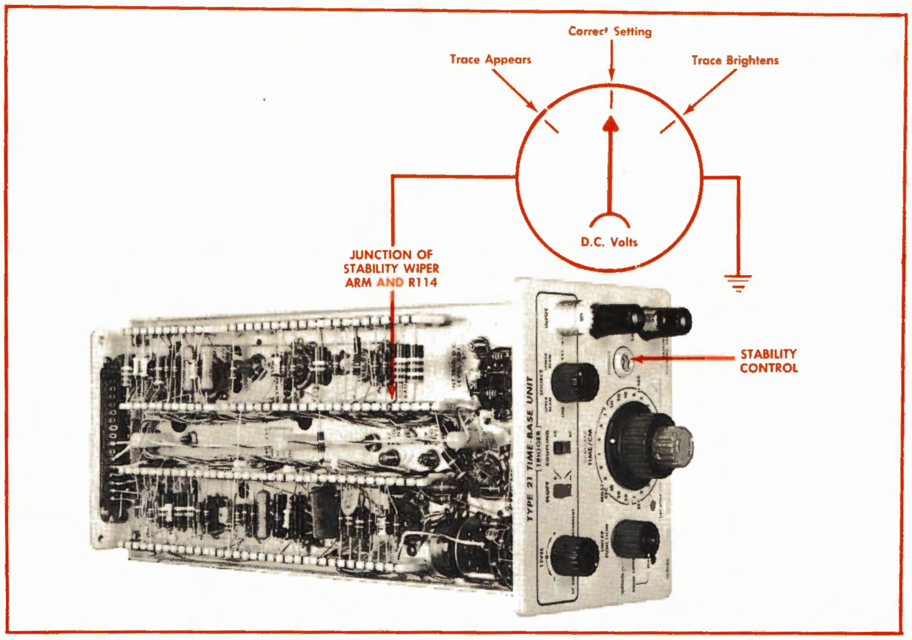


Fig. 7-9. Adjustment of the STABILITY control.

TIME BASE B TRIGGER CIRCUIT ADJUSTMENTS

The time base 'B' triggering adjustments that follow must be made in the indicated sequence. Controls not mentioned in a particular step are assumed to be in the positions they were last in during the previous step. Although the Type 21 Time Base Unit is shown in the illustrations, the same physical locations of the adjustments and test points apply to the Type 22 Time Base Unit.

16. 'B' Trigger Level

Remove the Type 22 Time Base Unit, attach the Time Base Plug-In Extension to the Type 22 Unit, and install the unit with the extension in the TIME BASE B compartment of the Type 555.

Set the Lower Beam HORIZ. DISPLAY switch at 'B' X1. Place the 'B' SLOPE switch at +, 'B' COUPLING switch at DC, and 'B' SOURCE switch at LOWER BEAM. Rotate the 'B' LEVEL control to zero. Set the upper beam vertical plug-in unit VOLTS/CM switch at .05 and the input selector AC-DC switch at DC. Place the Upper Beam HORIZ. DISPLAY switch at 'A' X1. Set the 'A' trigger controls at AC AUTO., +SLOPE, AC COUPLING, and LINE SOURCE. Place the 'A' SWEEP FUNCTION switch at NORMAL and the 'A' TIME/CM switch at 2 MILLISEC. Center the upper beam trace at the upper horizontal centerline of the graticule and connect the 10X probe from the upper beam vertical input connector to the junction of R19 and R20 (see Figure 7-7). If the probe is being used with the clip lead ungrounded, position the probe body away from the 'B' SOURCE switch leads to prevent any feedback of signals. Rotate the 'B' LEVEL knob until the upper beam trace is at the upper horizontal centerline. Loosen the 'B' LEVEL knob and set it at zero position. Retighten the knob and recheck it for exact zero setting and no vertical shift of the upper beam trace by disconnecting and connecting the probe a few times at the junction. Disconnect the probe from the junction.

17. 'B' Lower Beam Internal Trigger DC Level

Set the 'B' TIME/CM switch at .1 MILLISEC and rotate the 'B' STABILITY control clockwise for a free-running sweep. Position the lower beam trace to the lower horizontal centerline. Connect a short jumper from the junction of R19 and R20 to the chassis; connect a dc voltmeter from the junction of R22 and SW22 to the chassis. (See Figure 7-7). Place the 'B' SLOPE switch in the — position and adjust the 'B' LOWER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts. Slide the SLOPE switch from — to + to check for no voltmeter needle shift. Leave the SLOPE switch at —.

18. 'B' Upper Beam Internal Trigger DC Level

Position the upper beam trace to its centerline. Set the 'B' SOURCE switch at UPPER BEAM. Adjust the 'B' UPPER BEAM INT. TRIG. D.C. LEVEL ADJ. control for a voltmeter reading of zero volts and no change in meter needle movement when the 'B' SOURCE switch is set at LOWER BEAM and back to UPPER BEAM. Disconnect the voltmeter.

19. 'B' Trigger Level Centering

Rotate the upper beam vertical plug-in VOLTS/CM switch to the .5 volt position and set the input selector AC-DC switch at AC. Set the 'B' SOURCE switch at LINE. Connect the probe to pin 6 of V45 (see Figure 7-7) and preset the 'B' TRIG. SENS. control to the center of its rotation. Adjust the 'B' TRIG. LEVEL CENT. control so that the waveform on the upper beam is symmetrical. For precise adjustment set the Upper Beam HORIZ. DISPLAY switch at 'A' X.2 and horizontally center the +slope or switching portion of the multivibrator waveform using the 'A' HORIZ. POSITION control. Now slide the 'B' SLOPE switch up and down from — to + and at the same time, readjust the 'B' TRIG. LEVEL CENT. for no horizontal shifting of the switching portion of the waveform. Leave the 'B' SLOPE switch at —.

20. 'B' Trigger Sensitivity

With the probe and jumper connected as described in the previous step, rotate the 'B' TRIG. SENS. control fully counterclockwise. Turn the control slowly clockwise and stop at the point where the oscillations cease to appear. Note the amplitude of the spike on the top corner of the multivibrator waveform. Then rotate the 'B' TRIG. SENS. control clockwise until this spike is slightly less than one half of the original size (see Figure 7-8). Disconnect the probe from the test point and remove the jumper lead.

21. 'B' Lockout Level

Set the 'B' COUPLING switch at AC and the 'B' SOURCE switch at LOWER BEAM. The approximate voltage at pin 7 of V125 is —55 volts. Connect a dc voltmeter at this point (see Figure 7-7) and rotate the 'B' STABILITY control counterclockwise until the lower beam sweep just stops free-running. Record the meter reading of the dc voltmeter. Set the 'B' SWEEP FUNCTION switch at SINGLE SWEEP and trigger the sweep once by rotating the 'B' LEVEL control clockwise to + and then counterclockwise to —. If the 'B' STABILITY control setting is correct as explained above, the READY lamp should extinguish indicating that the lower beam trace is locked out. Now set the 'B' LOCKOUT LEVEL ADJ. control for a voltmeter reading of 11 volts lower (less negative) than the previous reading. If you wish to compare voltmeter readings, repeat the precedure given in this step.

22. 'B' Stability

Set the 'B' SWEEP FUNCTION switch at NORMAL. Set the 'B' trigger controls at +SLOPE, LINE SOURCE, and rotate the LEVEL control fully counterclockwise to the AC AUTO. position. The voltage reading at the junction of the 'B' STABILITY wiper arm and R114 is approximately —80 to —110 volts. Connect a dc voltmeter at this junction (see Figure 7-9) and rotate the 'B' STABILITY control fully counterclockwise. Turn the 'B' STABILITY control clockwise until the lower beam trace first appears. Record the reading of the dc voltmeter. Then continue to rotate the 'B' STABILITY control clockwise until the lower beam trace brightens and again record the voltage. Set the 'B' STABILITY control for a voltmeter reading midway between the two recorded voltage readings. Disconnect the voltmeter leads and the plug-in extension. Re-install the Type 22 in the TIME BASE B compartment.

TIME-BASE A (TYPE 21) GENERATOR AND UPPER BEAM HORIZONTAL AMPLIFIER CALIBRATION

In the instructions that follow, all of the adjustments, with the exception of Steps 23, 24, 28, 29, 30, 31 interact to some degree. For this reason it is important that you make the adjustments in the proper sequence.

23. Upper Beam External Horizontal Amplifier D.C. Balance

Place the Upper Beam vertical plug-in VOLTS/CM switch at 20 VOLTS. Connect a jumper from 'A' SAWTOOTH to the vertical INPUT, switch the Upper Beam HORIZ. DISPLAY switch at EXT. ATTEN X1 and rotate the 'A' LEVEL control full right to the RECURRENT position. Turn the Upper Beam HORIZ. POSITION control to the left to position the upper beam vertical trace to the left graticule line. Adjust the Upper Beam HORIZ. AMP. D.C. BAL. control (see Figure 7-10) for no horizontal shift of the trace while rotating the Upper Beam EXT. HORIZ. GAIN control.

24. Check Upper Beam EXT. HORIZ. INPUT Deflection Factor

With control settings as in Step 23, connect a jumper from the CAL. OUT to the Upper Beam EXT. HORIZ. INPUT connector. Set the AMPLITUDE CALIBRATOR at .2 VOLTS and turn the EXT. HORIZ. GAIN control full right. At least one centimeter of horizontal deflection must be displayed. Increase the AMPLITUDE CALIBRATOR to 2 volts and adjust the EXT. HORIZ. GAIN control for exactly 10 cm of horizontal deflection. Place the Upper Beam HORIZ. DISPLAY switch at EXT. ATTEN. X10. The horizontal deflection should now be one centimeter. (Attenuator accuracy ±3%).

25. External Horizontal Input Compensation

With the jumpers connected as in Step 23 and 24, set the AMPLITUDE CALIBRATOR at .5 VOLTS. Connect a third jumper from the CAL. OUT to the 'A' trigger INPUT connector. Set the Upper Beam and 'A' controls as follows:

HORIZ. DISPLAY (Upper Beam)	EXT. ATTEN. X1
SLOPE	—
SOURCE	EXT.
FUNCTION	NORMAL
TIME/CM	1 MILLISEC

Adjust the 'A' LEVEL control for a stable square-wave, displayed vertically. Adjust C330 (see Figure 7-11) for optimum square wave response. Place the Upper Beam HORIZ. DISPLAY switch at EXT. ATTEN. X10, increase

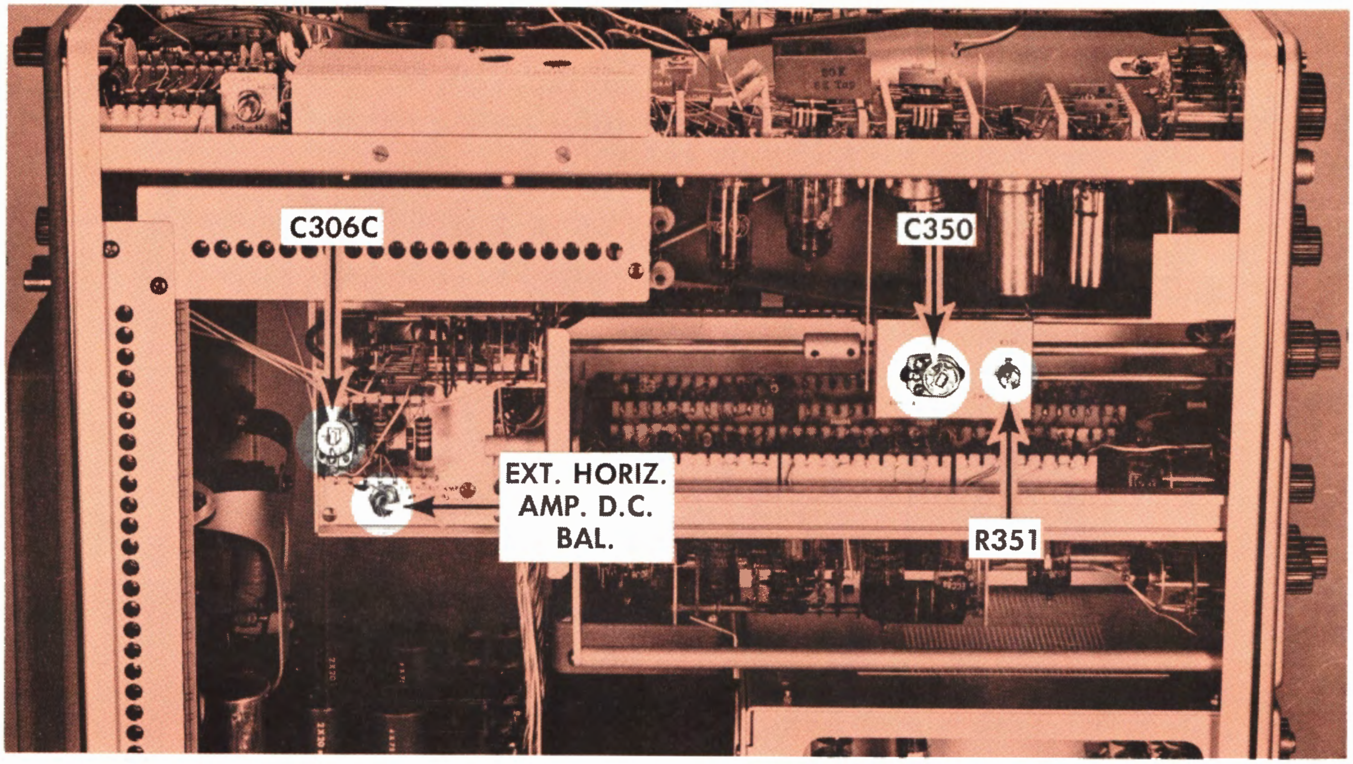


Fig. 7-10. Left side view of indicator unit showing location of upper beam adjustment controls.

the AMPLITUDE CALIBRATOR signal to 5 VOLTS and adjust C306C (see Figure 7-10) for optimum flat top. Disconnect all the jumper leads.

PRELIMINARY NOTE: For fast sweep rate timing accuracy and to make the Type 21 adjustments accessible from the right side of the Indicator Unit, turn off the oscilloscope and exchange the Type 22 Unit with the Type 21 Unit. The Type 21 Unit will now be in the TIME BASE B compartment and the Type 22 Unit in the TIME BASE A compartment. Turn on the oscilloscope, allow a few minutes for complete warm-up and stability, continue with the steps to follow.

26. Upper Beam Magnifier Gain

Set the Upper Beam and 'B' (Type 21) controls as follows:

HORIZ. DISPLAY (Upper Beam)	'B' X.2
SLOPE	+
COUPLING	AC
SOURCE	UPPER BEAM
TIME/CM	1 MILLISEC
VARIABLE (TIME/CM)	CALIBRATED
VOLTS/CM (Vertical Plug-In)	2

Connect 1 millisecond and 100 microsecond markers from the Type 180A to the vertical INPUT and adjust the 'B' LEVEL control for a stable display. Adjust the MAG. GAIN (see Figure 7-11) for a display of one large marker every 5 cm and two small markers every cm. Check the linearity of the display.

27. Upper Beam Sweep Calibration

Place the Upper Beam HORIZ. DISPLAY switch at 'B' X1 and apply only the 1 millisecond markers to the Upper Beam vertical INPUT. Adjust the 'B' (Type 21) LEVEL control for a stable display on the upper beam. Loosen the R351 locking nut and adjust R351 (see Figure 7-10) for one marker per cm. The adjustment is made accurately when each time marker from the 1 cm line to the 9 cm line coincides with a vertical line. Tighten the locking nut.

28. 'A' Sweep Length

With the same display as in Step 27 adjust the SWEEP LENGTH control (see Figure 7-12) for a horizontal sweep length of 10.5 centimeters.

29. Upper Beam Sweep Magnifier Registration

Place the Upper Beam HORIZ. DISPLAY switch at 'B' X.2. Position the 1 millisecond markers so that the first time marker is directly behind the center vertical graticule line. Set the Upper Beam HORIZ. DISPLAY at 'B 'X1 and adjust the SWP. MAG. REGIS. control (see Figure 7-11) so the first marker again falls behind the vertical centerline (Fig. 7-13).

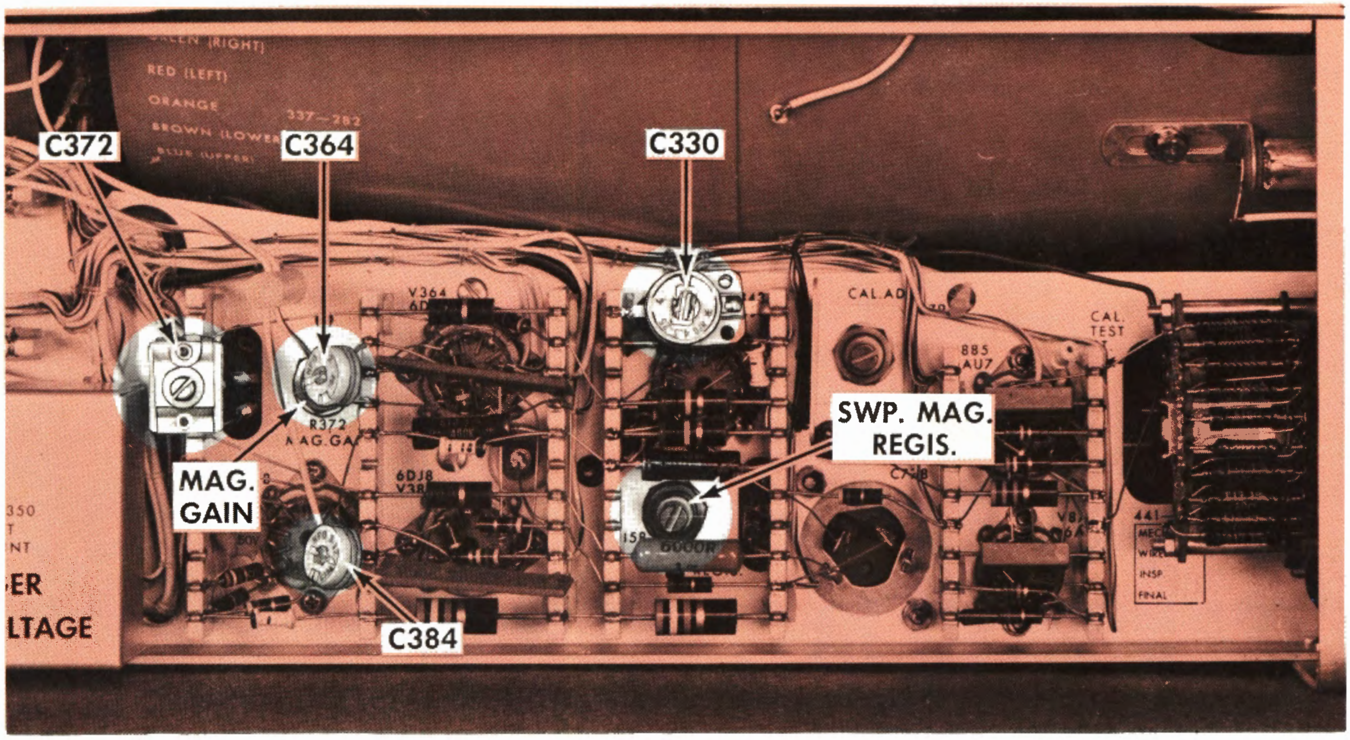


Fig. 7-11. Top view of indicator unit showing the location of upper beam adjustments.

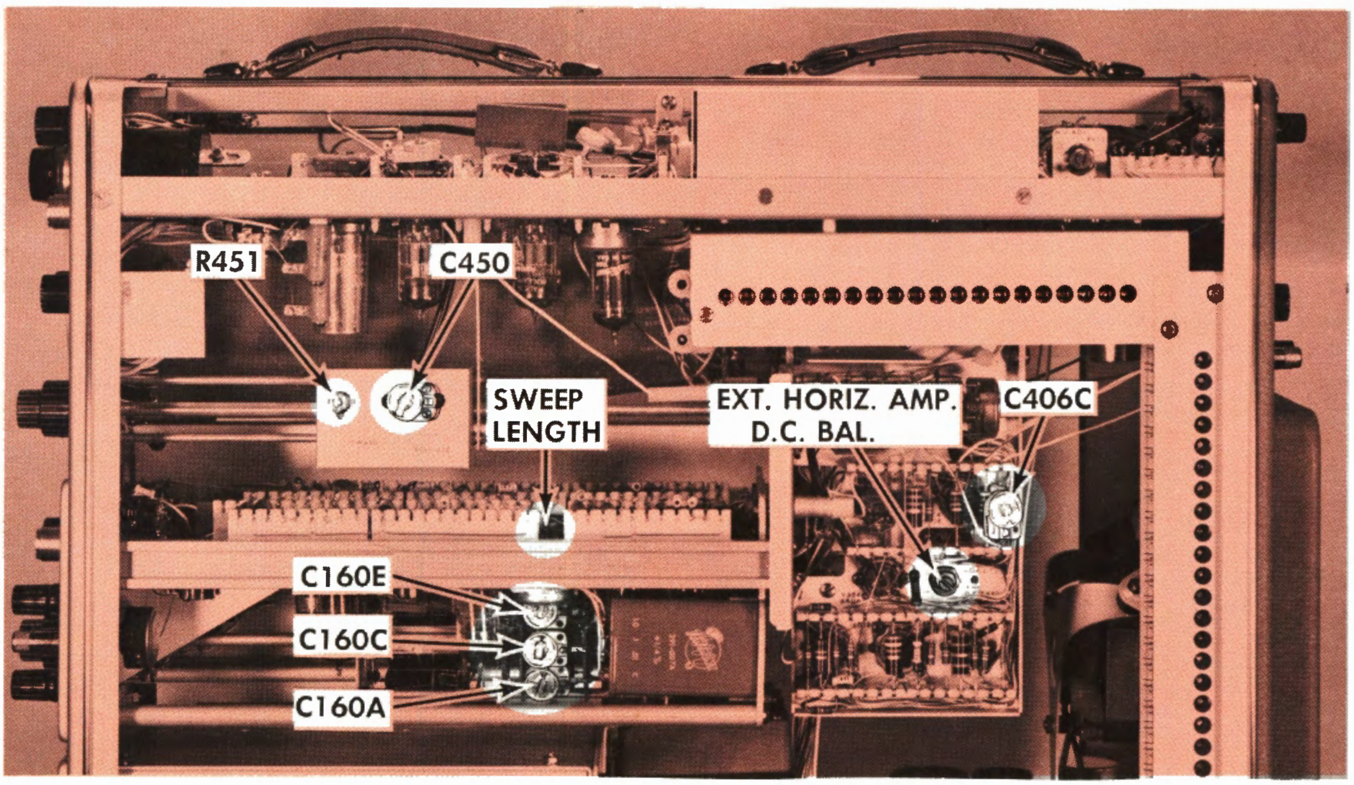


Fig. 7-12. Right side view of indicator unit showing the location of the time base and lower beam adjustments.

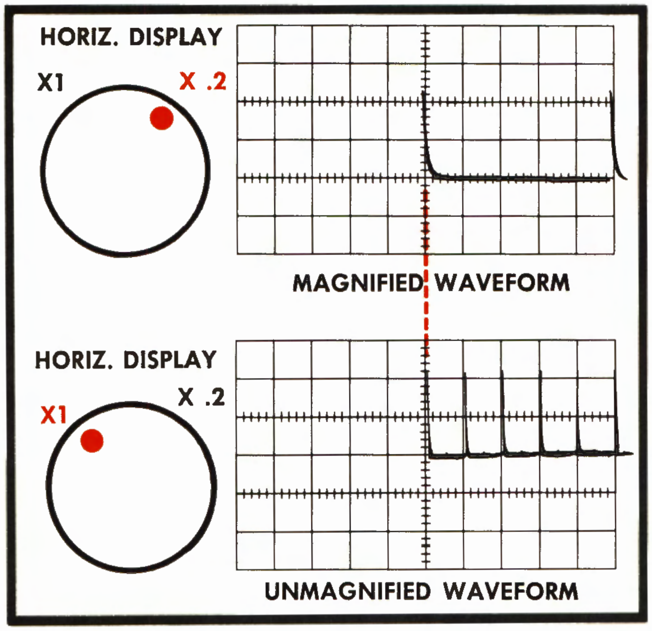


Fig. 7-13. When the adjustment of the SWP. MAG. REGIS. controls are made properly, the portion of the displayed waveform at the exact center of the graticule remains stationary as the appropriate HORIZ. DISPLAY switch is set at the X1 and the X.2 position.

30. Check Sweep-Rate Calibration

Set the Upper Beam and 'B' controls as follows:

HORIZ. DISPLAY (Upper Beam)	'B' X1
SLOPE	+
COUPLING	AC
SOURCE	UPPER BEAM
FUNCTION	NORMAL
TIME/CM	1 MILLISEC
VARIABLE (TIME/CM)	CALIBRATED
VOLTS/CM (Vertical Plug-In)	2

With I millisecond markers connected as in Step 27, adjust the 'B' trigger LEVEL control for a stable display. Horizontally position the display to start at the left vertical graticule line.

Check the Type 21 sweep rates over the one centimeter to the nine centimeter width of the graticule according to the following table:

TIME/CM (TYPE 21)	TYPE 180A	Markers Displayed
1 MILLISEC	1 MILLISECOND	1/cm
2 MILLISEC	1 MILLISECOND	2/cm
5 MILLISEC	5 MILLISECOND	1/cm
10 MILLISEC	10 MILLISECOND	1/cm
20 MILLISEC	10 MILLISECOND	2/cm
50 MILLISEC	50 MILLISECOND	1/cm
.1 SEC	100 MILLISECOND	1/cm
.2 SEC	100 MILLISECOND	2/cm
.5 SEC	500 MILLISECOND	1/cm
1 SEC	1 SECOND	1/cm
2 SEC	1 SECOND	2/cm
5 SEC	5 SECOND	1/cm

31. Check Type 21—VARIABLE (TIME/CM) control and UNCALIBRATED Neon.

The VARIABLE control provides for a complete range of control between the calibrated TIME/CM steps. To check operation of this control, set the 'B' TIME/CM to 1 MILLISEC-CALIBRATED, connect 5 MILLISECOND markers from the Type 180A to the Upper Beam Vertical INPUT and trigger the oscilloscope for a stable display consisting of 1 marker for each 5 cm. Next, turn the VARIABLE control full left. The display should now consist of markers every 2 cm or less. Check to see that the UNCALIBRATED neon indicator lamp lights in all positions of the VARIABLE control except when switched to the CALIBRATED position.

32. Adjust Type 21 Sweep Rates, 50 μsec/cm to .02 μsec/cm.

Set the 'B' TIME/CM to .1 MILLISEC, apply 10 MICROSECOND markers from the Type 180A to the Upper Beam Vertical INPUT, and adjust the 'B' LEVEL control for a stable display. Place the Upper Beam HORIZ. DISPLAY switch at 'B' X.2 and horizontally position the trace so that the first time marker is aligned with the center graticule line. Set the Upper Beam vertical VOLTS/CM switch at 1 VOLT. Then switch the 'B' TIME/CM switch to 50 μSEC and check for horizontal shift of the first marker. If shift occurs, adjust C330 (see Figure 7-11) until the first marker of both the .1 MILLISEC and 50 MICROSEC positions occur at the same point.

Set the Upper Beam HORIZ. DISPLAY switch at 'B' X1, the 'B' TIME/CM at 10 μSEC and position the display to start at the left side of the graticule. Proceed with the following adjustments:

TIME/CM	TYPE 180A	Adjustments	Observe
10 μSEC	10 MICROSECOND	C160E*	1 marker/cm.
1 μSEC	1 MICROSECOND	C160C*	1 marker/cm.
.5 μSEC	1 MICROSECOND	C160A*	1 marker/2cm. Position 2nd marker to 2nd line on graticule
.1 μSEC	10 MC	C372** for linearity and † C350 for time	1 cycle/cm
2 μSEC	1 MICROSECOND	Check Timing range	2 markers/cm.
5 μSEC	5 MICROSECOND	Check Timing range	1 marker/cm.
.1 μSEC (HORIZ. DISPLAY at 'A' X.2)	50 MC	C364 and C384**	1 cycle/cm.

*** See Figure 7-12.**

**** See Figure 7-11.**

† See Figure 7-10.

NOTE: C372 only affects the first part of the display. There is considerable interaction between C350, C372, C160C, and C160A. These adjustments should be repeated back and forth several times to obtain optimum linearity with correct timing. Timing adjustments should be made, as usual, between the first and ninth centimeter lines of the graticule.

In order to display the 50-MC output on the upper beam, trigger the Type 21 externally with 100 KC triggers from the Type 180A. Place the Upper Beam vertical VOLTS/CM switch at .2 VOLTS. Adjust C364 and C384 in equal increments until correct timing is obtained. Re-adjust C372 if the linearity of the display needs to be improved. If C364, C384 and C372 are adjusted, make a repeat timing check according to the table listed in this step. Interchange the time-base units.

TIME-BASE B (Type 22) GENERATOR AND LOWER BEAM HORIZONTAL AMPLIFIER CALIBRATION

Follow the same instructions as given for the Time-Base A (Type 21) Generator and Lower Beam Horizontal Amplifier Calibration steps 23 to 32. Keep in mind the following exceptions: The Type 22 Time-Base Unit remains in the Time Base B compartment. The **appropriate** control references in the procedure change to Type 22, TIME BASE B or 'B', and Lower Beam. The controls to be adjusted are located on the right-hand side of the Indicator Unit (see Figures 7-12 and 7-14). Also, 400 series numbers are used to designate the circuit numbers for the lower beam as compared to the 300 series numbers used for the upper beam.

33. Delay Start and Delay Stop (Type 22).

Set the 'B' SWEEP FUNCTION switch at SWEEPS ONCE. Using test leads, apply 500 μsecond markers from the time-mark generator to the Upper and Lower Beam vertical inputs. Place the Upper Beam HORIZ. DISPLAY switch at 'A' X1. Set the 'A' TIME/CM switch at .5 MILLISEC and the 'B' TIME/CM switch at 10 μSEC. Adjust the 'A' triggering controls for a stable display. A portion of the upper beam display will be brightened. Set the DELAYED TRIGGER control at 1.00. Adjust the DELAY START (see Figure 7-14) control until the brightened portion starts at the leading edge of the second time mark (one centimeter from the start of the trace). The start of the leading edge of the second time mark is expanded and can be clearly observed on the lower beam. Set the DELAYED TRIGGER control at 9.00 and adjust the DELAY STOP (see Figure 7-14) control until the brightened portion starts at the leading edge of the tenth time mark (nine centimeters from the start of the trace). Repeat the DELAY START and DELAY STOP adjustments until an accurate setting is obtained for both controls. Disconnect all the connecting leads and place the 'B' SWEEP FUNCTION switch at NORMAL.

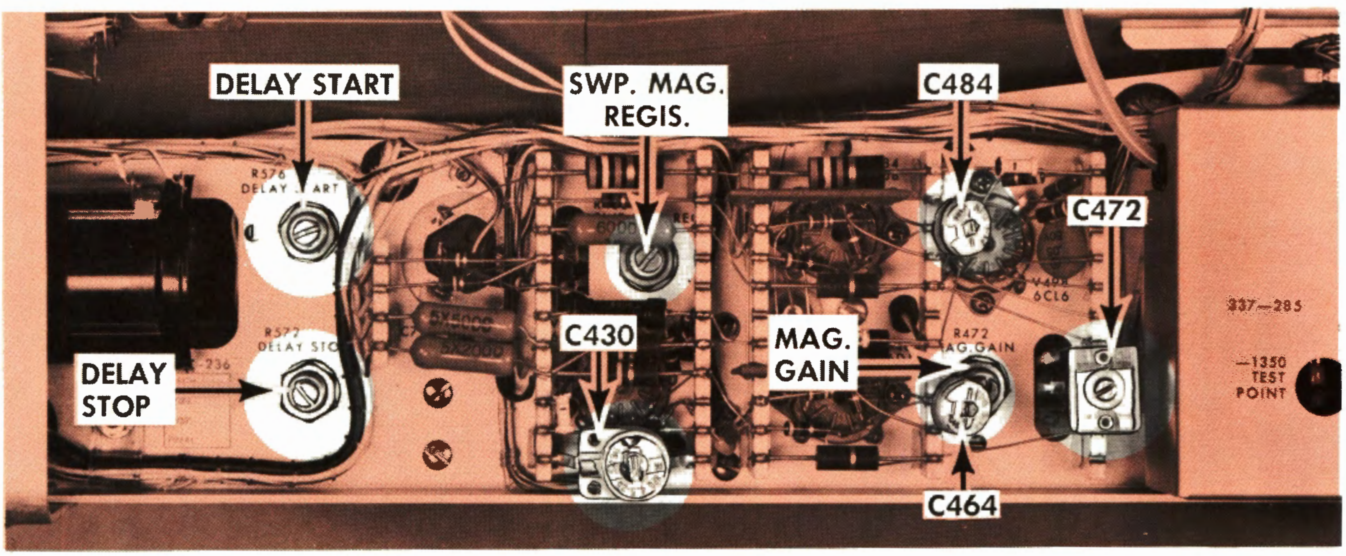


Fig. 7-14. Right top view of indicator unit showing location of lower beam adjustment controls.

UPPER BEAM VERTICAL AMPLIFIER ADJUSTMENTS

34. Upper Beam Gain Adjust

Connect the EP53A Gain Set Adapter between the upper beam vertical plug-in connector and the plug-in unit. Connect a jumper from the CAL. OUT connector to the connector on the gain set adapter. Place the AMPLITUDE CALIBRATOR switch in the .2 VOLTS position and adjust the oscilloscope for a stable upper beam display. Lay the in-

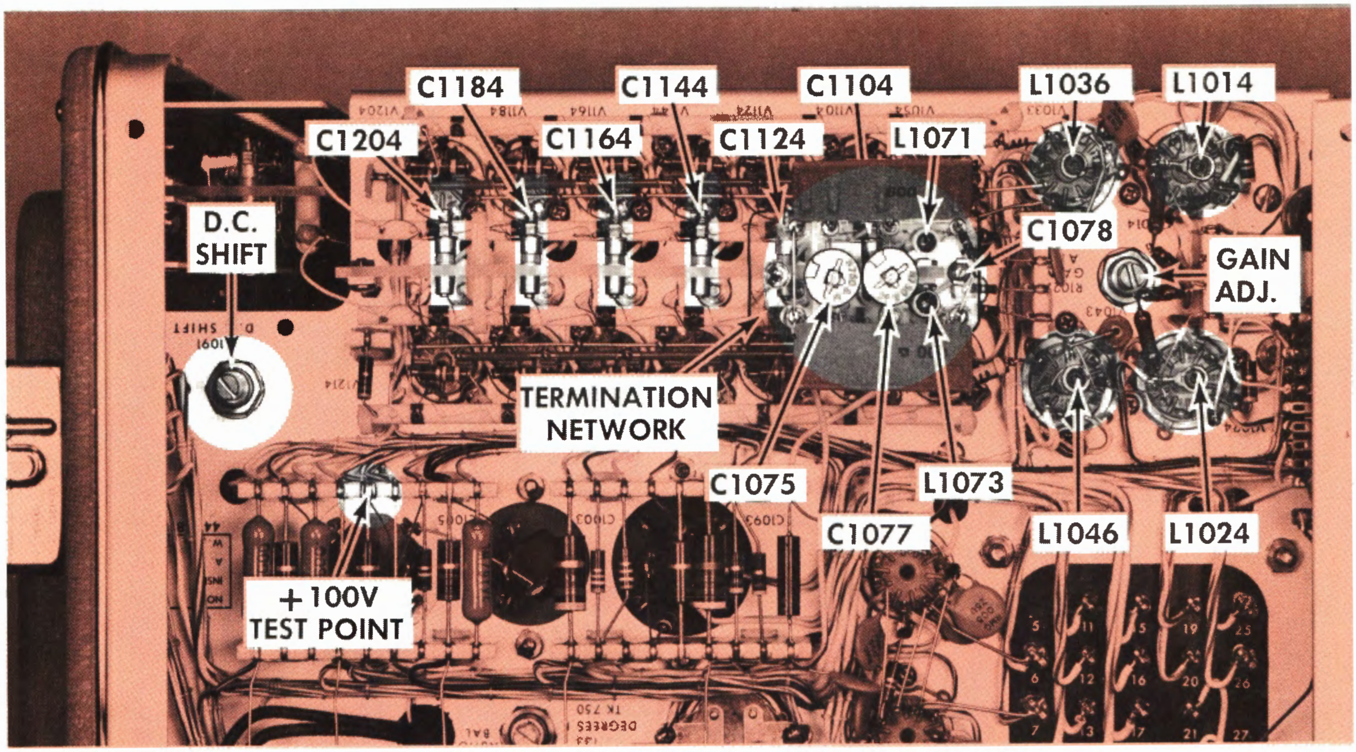


Fig. 7-15. Bottom view of indicator unit showing the location of the upper beam vertical amplifier adjustments and +100V test point. C1104 and C1124 are located below the termination network.

dicator unit on its side and set the Upper Beam GAIN ADJ. control (see Figure 7-15) for exactly 2 centimeters of vertical deflection. Remove the jumper lead and adapter. Re-install the plug-in.

35. Upper Beam Vertical D.C. Shift Compensation

Place the 'A' TIME/CM at 2 SEC. Rotate the 'A' LEVEL control full right to the RECURRENT position and set the vertical input AC-DC selector switch at DC. Intermittently apply the probe to the +100V test point (see Figure 7-15), or other regulated dc supply, and set the Upper Beam vertical sensitivity to obtain about 3 cm deflection. Look for a slow rise or a slow fall of the beam with a time constant of one or two seconds. If necessary, adjust the Upper Beam D.C. SHIFT control until the spot comes immediately to the final level without drifting either up or down after each time the probe is applied. Disconnect the probe at both ends and turn the indicator unit upright.

36. Adjust Upper Beam Delay Line and High-Frequency Compensations.

Delay line adjustments are probably the most difficult adjustments to make. This is due to interaction between the large number of controls. The adjustments can be made properly with a minimum of difficulty if the proper procedure is followed and if care is used in making the adjustments. In general, it is not necessary to completely readjust the delay line. Rather it is a case of occasionally touching up the line for best results. Before attempting to adjust the line, briefly run through this procedure to establish the basic concepts in your mind. This will make the actual adjustments considerably easier. Be sure that the circuits are operating normally and the line requires adjustment before attempting to adjust it.

In general the procedure for adjusting the delay line and high frequency control involves application of a fast rising pulse or square wave to the vertical amplifier. The delay line is then adjusted for minimum distortion of the pulse or square wave displayed on the screen. In particular, the delay line and amplifier high frequency controls are adjusted for three characteristics of the displayed waveform: fastest possible risetime without overshoot, minimum irregularities on the top of the pulse, and minimum slope of the top of the waveform.

37. Displaying the Test Signal

To determine the extent of misadjustment of the delay line you will need to closely examine a displayed fast rising pulse or square wave. The waveform used to make this examination should have a risetime of no more than 4 millimicroseconds. A Tektronix Type 107 Square-Wave Generator or a Tektronix Type P Plug-In Unit is recommended.

If a Type 107 Square-Wave Generator is used, the frequency control should be set to obtain approximately 400 kc square-waves. The output of the generator should be connected through a 52 ohm coaxial cable and termination resistor to the input of either a Type K or a Type L Plug-In Unit. The termination resistor should be connected at the input to the Upper Beam plug-in unit. The Upper Beam plug-in unit must be known to be correctly compensated for high-frequencies before checking or adjusting the Upper Beam delay line.

When a Type P Plug-In Unit is used, it is only necessary to insert the unit into the Upper Beam plug-in compartment of the oscilloscope. The pulse frequency of the P Unit is fixed.

If it is necessary to use a signal generator other than a Type 107 or Type P, you must check the output waveform from the generator for suitability. Obviously a waveform which is distorted in any manner is not suitable for adjusting the delay line of an oscilloscope. A good check on the suitability of your test equipment is to display the output waveform on the other beam if the delay line and the vertical plug-in unit are known to be correctly adjusted (see Figures 7-16 and 7-22).

When the input signal has been connected, adjust the oscilloscope 'A' triggering controls for a stable display. Rotate the 'A' TIME/CM control to .1 μSEC and adjust the oscilloscope and signal source for approximately 2 to 3 centimeters of vertical deflection.

With the oscilloscope display, it is possible to check the delay line and amplifier adjustments for proper setting. There are three general characteristics which you will have to appraise, and to do this, you will need to use three different sweep rates. The first characteristic to look for is the level of the display; the second is the amount of bumpiness contained in the flat top of the displayed waveform; and the third is the risetime of the displayed waveform.

DETERMINING THE LEVEL OF THE DISPLAY

The level of the display refers to the top of the displayed waveform. The waveform should show neither an upward nor a downward slope or level anywhere along the early part of the top of the waveform (see Figure 7-17). Any slope of the waveform can most easily be seen with a sweep speed of approximately 5 μseconds per centimeter.

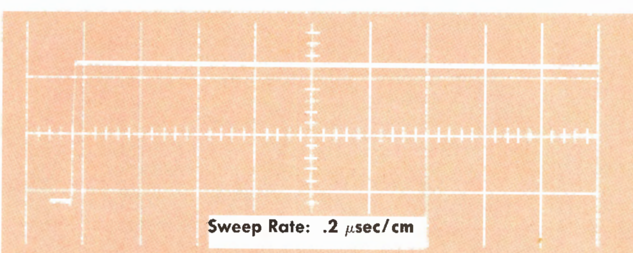


Fig. 7-16. Appearance of the display when the delay line and high frequency compensations are properly adjusted.

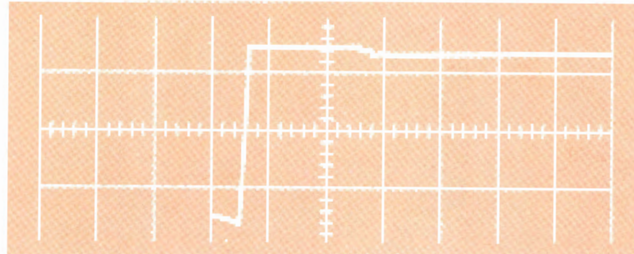


Fig. 7-17. Illustrating an upward level of early part of waveform. Complete readjustment is necessary. Sweep rate: .2 μSEC.

CHECKING THE BUMPINESS OF THE DISPLAY

The next characteristic to look for in the displayed waveform is the bumpiness in the top portion of the waveform immediately following the rise. This is the portion of the waveform affected by the delay line adjustments. To make this observation, use a sweep speed of approximately .2 μseconds per centimeter.

There are two general types of bumps to be found in a poorly adjusted delay line. The first type is the irregularity caused by the misadjustment of a group of capacitors. This type is indicated by a fairly long duration bump (see Figure 7-18). If the bumps occur at random intervals along the delay line, they are probably due to misadjustment of the delay line and can usually be corrected by a few slight adjustments. However, if there is a certain rhythmic waviness or symmetry to their appearance, the trouble may be due to a faulty adjustment in the terminating network. The trouble could also be an improper adjustment of the amplifire high frequency compensation. In either case a complete adjustment may be necessary (see Figure 7-19.)

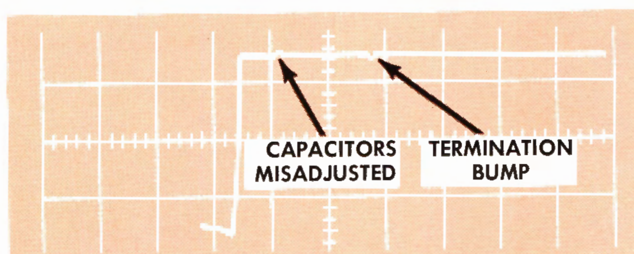


Fig. 7-18. Illustrating irregularity caused by a group of misadjusted capacitors. The termination bump is caused by faulty adjustment in the termination network.

The second kind of bump is caused by misadjustment of a single delay line capacitor. This is indicated by a very short duration bump. This type can easily be corrected by readjustment of the misadjusted capacitor. The proper capacitor can be determined by observing the location of the bump on the displayed waveform.

CHECKING THE RISE OF THE DISPLAYED WAVEFORM

The third characteristic to be investigated in the displayed waveform is the extreme leading edge and corner. This part of the waveform is affected by the vertical ampli-

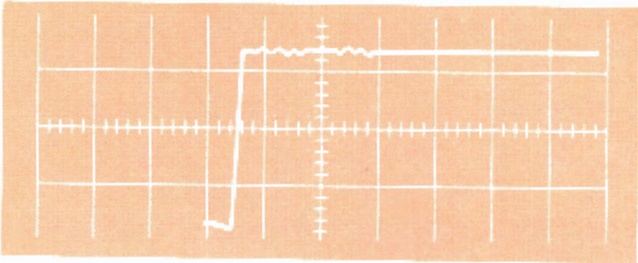


Fig. 7-19. Illustrating severe waviness where complete readjustment is necessary.

fier high frequency peaking coils and the delay line adjustments closest to the cathode-ray tube neck connections. These adjustments collectively determine the high frequency response of the vertical deflection system and for that reason are of the utmost importance.

The leading edge of the displayed waveform is best observed with a sweep speed of approximately .1 μseconds per centimeter. The corner should be as sharp as possible with no overshoot as shown in Figure 7-16. An example of overshoot caused by maladjusted inductors is illustrated in Figure 7-20. While it is necessary that the corner be as sharp as possible for optimum frequency response, it is also necessary that there be no wrinkling or bumpiness in this portion of the display.

There is a good deal of similarity in the effect of the amplifier peaking coils and the delay line adjustments. For this reason, it is sometimes difficult to ascertain which adjustments are faulty. The adjustments at fault can usually be determined by the location and occurrence of the waveform irregularities.

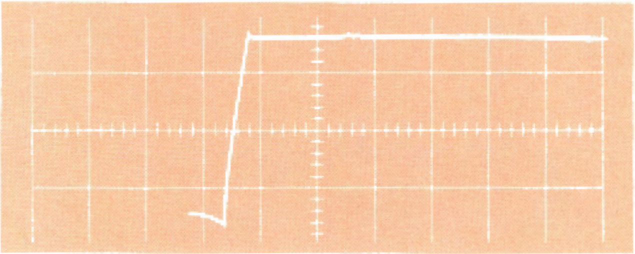


Fig. 7-20. Overshoot caused by maladjusted inductors.

NOTE

In the procedure that follows, the trimmer capacitors in the Type 555 Oscilloscope Upper Beam vertical amplifier are considered to be part of the delay line. They are adjusted in the same manner as other delay line capacitors.

38. Physical Presetting

Perhaps the most important single bit of information you should know is to observe the approximate positions of the various adjustments in a properly adjusted delay line. Since the Type 555 Oscilloscope has two delay lines, one delay line can be checked against the other. This knowledge can be used as a good starting off point. And later, during the adjustment procedure, comparisons can be made as a check on your progress.

The variable inductors in the vertical amplifier (see Figure 7-15) and at the neck connections (see Figure 7-21) to the crt are normally preset so that the slugs are just out of the coils. They can be set by shining a light through the coil forms and adjusting the slugs. By presetting the slugs in this manner you will reduce the effects of the inductors during the delay line adjustment procedure. Then, during the last step of the adjustment procedure, you will move the slugs into the coils (usually about two or three turns).

If in your preliminary investigation, you detected a cyclic waviness in the display, or if there was extreme overshoot at the leading edge, you will probably save yourself considerable time by presetting the variable inductors. Usually, turning the slugs too far out of the coil will only result in a round off of the leading edge. However, turning the slugs too far into the coil winding will result in severe wrinkles in the displayed waveform—wrinkles which can frequently be reduced by misadjusting the delay line. This might give you the impression that the delay line was at fault instead of the high frequency peaking coils.

The variable capacitors in the delay line will not, as a rule, require presetting. If the performance of the instrument has deteriorated as a result of normal use and handling, the delay line should require only touching up. The original physical positions of the capacitors should be very nearly correct. On the other hand, if the instrument has been tampered with, or if it has been subject to severe vibration or rough handling, it may be desirable to preset the delay line capacitors as described in the following paragraph.

In a properly adjusted delay line, the adjusting screw extends above the capacitor body $^3/_8$ inch. The important characteristic is that the tops of all the delay line adjusting screws should be about the same height. It is very important to keep this characteristic in mind as you adjust the delay line. Normally, trimmers located at points where fixed capacitors are connected across the delay line are somewhat higher than other trimmer capacitors.

If you can observe a waviness in the height of the adjusting screws (while at the same time, the display is level), the trouble is probably due to misadjustment of the inductors in the vertical amplifier. In this event, you should recheck the physical positions of the slugs as described in the previous paragraphs.

If, in the preliminary inspection, you notice a bump following the termination bump (that is, on the portion of the delay line not normally affected by delay line adjustments), be sure to check the termination inductors for balance. The slugs in both inductors should be equidistant from the coil windings. When you adjust the slugs, be sure to adjust each slug the same amount.

As a final step in the physical presetting procedure, dress the leads to the crt vertical-deflection plates. They are to be uniformly spaced both with respect to each other and with respect to the crt shield.

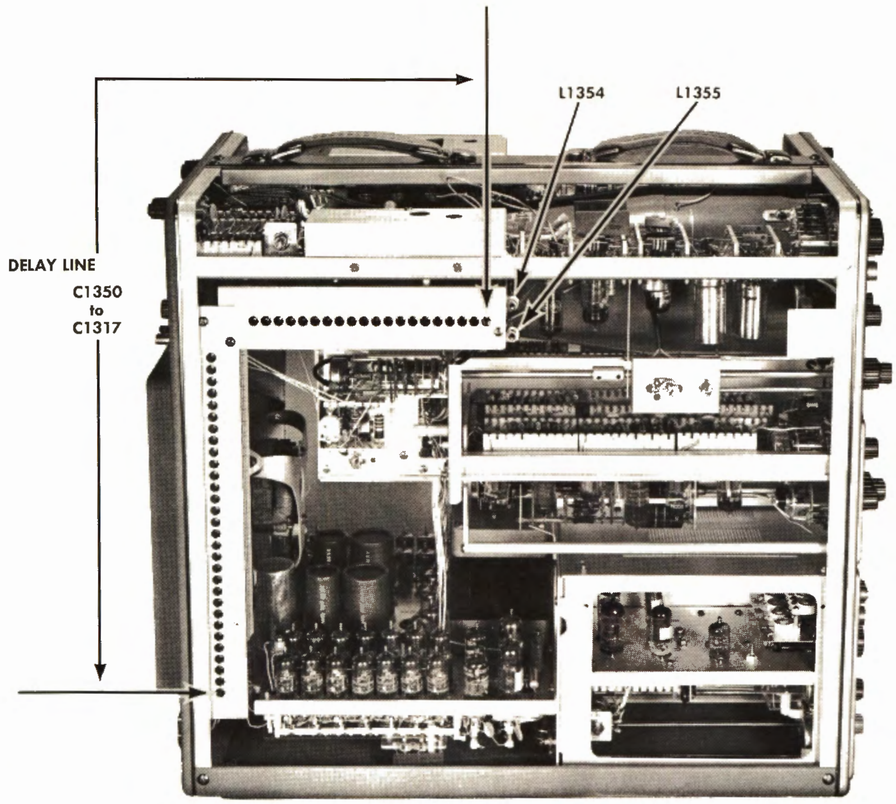


Fig. 7-21. Left side view of indicator unit showing the location of the upper beam delay line and inductor adjustments.

39. Establishing a Level Display

The level of the flat top of the displayed waveform is determined by the collective effect of all the delay line capacitors. When the delay line is properly adjusted, the top of the displayed waveform should be almost perfectly flat.

To make the display level, adjust each delay line capacitor a small amount in a direction that will result in a level display. Start at the termination network by adjusting the inductors and capacitors for a termination bump of minimum amplitude. Then, advance from capacitor to capacitor on the delay line, working toward the crt end. During your first attempt, you will probably find it most convenient to use a sweep speed of approximately 5 μseconds per centimeter. After you have adjusted all of the capacitors to gain an average level over the length of the flat top of the displayed waveform, you can advance the sweep speed to 2 μseconds per centimeter and repeat the procedure. This time, however, try to adjust the capacitors for a smooth transition from bump to bump, while at the same time maintaining a satisfactory level. The important thing to remember is to reduce the amplitude of all of the bumps by the same amount and not try to achieve a perfectly straight line at this time.

40. Removing the Bumps and Wrinkles

After you have established a level display with the amplitude of the bumps and wrinkles reduced to within a trace width of the level line, you can start to remove the wrinkles and bumps over smaller sections of the display. It is usually best to start at the terminated end of the delay line and work toward the crt end.

Set the 'A' TIME/CM switch at .5 μSEC. and proceed to remove the bumps caused by the termination network. Do not try to arrive at a perfectly straight line during your first attempt. Just reduce the bumps by one-half. Then, advance to the first group of 4 or 5 capacitors in the delay line and adjust them for a smooth line over the portion of the display that they affect. Keep in mind that each capacitor will only require a slight adjustment—a mere "touch"—and that it is the combined effect of the group of capacitors that you should be concerned with.

While you are adjusting a group of capacitors to remove a bump or wrinkle, be sure to frequently turn to a sweep rate of 2 or 5 microseconds/centimeter and check the level of the display.

Advance along the delay line from each group of capacitors to the next until you have traversed the entire length.

Then, turn the TIME/CM. switch to .2 μSEC and repeat the process. This time, however, you must be extra careful. The capacitors that require adjustment will only need a slight touch— to do otherwise might nullify all your efforts up to this point. Be sure to check the level of the display frequently. It is very easy to concentrate on removing a particular stubborn bump and, in so doing, introduce an upward or downward slope in the display.

At this point in the adjustment procedure, it will not be necessary to adjust every capacitor. Touching up here and there will probably produce the desired results.

41. Adjusting the High Frequency Compensation

If you have successfully completed the adjustment procedure up to this point, the display should be level and free of bumps and wrinkles with a pronounced rolloff on the leading edge. During this final part of the adjustment procedure, you will strive for a square corner on the leading edge, while at the same time maintaining the proper level without introducing wrinkles or bumps.

Set the TIME/CM switch at .2 μSEC and position the display to afford a good view of the leading edge and corner. The inductors in the vertical amplifier and near the crt affect this portion of the waveform. The delay line capacitors nearest the crt also affect the leading edge of the waveform. It is important that you adjust each pair of inductors in conjunction with each other. Each inductor should be set at the same position as its corresponding-opposite inductor.

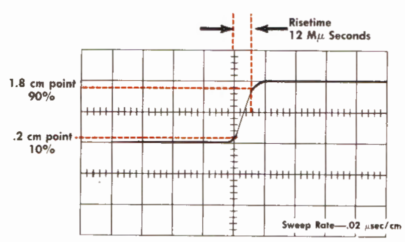


Fig. 7-22. Measurement of vertical risetime.

Adjust the inductors, in pairs, for the squarest possible corner. It may be necessary to readjust the first two or three capacitors closest to the crt in order to achieve a wrinkle-free corner.

At this time the displayed waveform should be level on top, there should be virtually no bumps or wrinkles, and the risetime of the displayed waveform should be within specifications for the instrument. A risetime check on the displayed waveform gives a very good check on the completeness of the adjustments.

42. Check Risetime

Display the fast rise pulse or square wave as described in Step 37. Place the Upper Beam HORIZ. DISPLAY switch at 'A' X.2. Adjust the oscilloscope and signal source for exactly 2 centimeters of vertical deflection. Under these conditions the time for the pulse to rise from .2 to 1.8 centimeters should be 12 Mμ seconds (see Figure 7-22). This can be checked using the HORIZ. POSITION control.

Use the HORIZ. POSITION control to position the display so that the center vertical line of the graticule passes through the rising portion of the waveform .2 centimeters from the bottom of the rise. Measure the horizontal distance between the .2 and 1.8 centimeter points shown in Figure 7-22. Multiply the distance measured by the setting of the 'A' TIME/CM control and then the product is multiplied by .2 to obtain the actual risetime interval. Disconnect the pulser or square-wave generator.

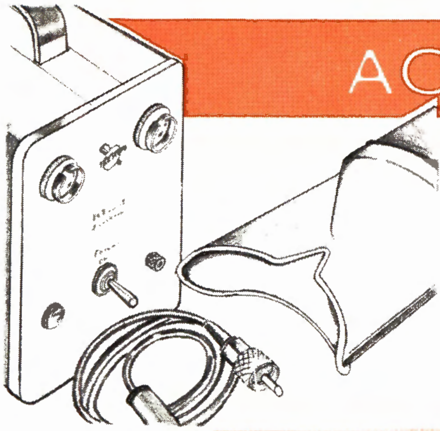
43. Check Vertical Amplifier Bandwidth

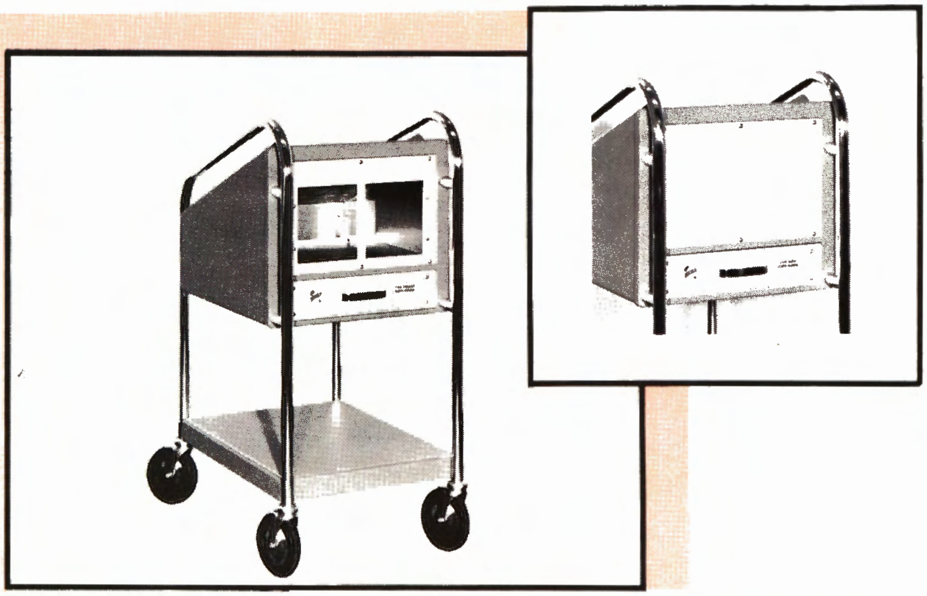
A good check on the completeness of your adjustments to the delay line and vertical amplifier is to measure the bandwidth of the vertical-deflection system. To make this check, connect the output of the Type 190A through a Type B52R Terminating Resistor to the upper beam vertical input connector. Rotate the 'A' trigger LEVEL control fully clockwise to the RECURRENT position. Set the 'A' TIME/CM switch at 1 MILLISEC. Place the upper beam vertical VOLTS/CM switch at .05 VOLTS. Adjust the output of the Type 190A to obtain a display of 2 mc sine waves at an amplitude of 4 cm peak-to-peak on the upper beam. Increase the frequency while maintaining the peak-to-peak volts reading constant on the Type 190A front-panel meter until the deflection decreases to 2.8 cm peak-to-peak on the oscilloscope display. Determine the oscillator frequency at this point. It should be 30 mc or higher.

LOWER BEAM VERTICAL AMPLIFIER ADJUSTMENTS

Follow the same procedure as given for the Upper Beam Vertical Amplifier Adjustment steps 34 thru 43. As explained previously, keep in mind that the Lower Beam and TIME BASE B or 'B' control settings will now be used. The adjustments and their location are shown in Figures 7-23 and 7-24.

ACCESSORIES SECTION





SCOPE - MOBILES

The Tektronix Type 500/53A Scope-Mobile is a sturdy, mobile support for Tektronix 5" Oscilloscopes. Convenient observation of the crt face is achieved by a 20-degree backward tilt of the top surface. The front panel has two supporting cradles to accommodate plug-in units. A drawer, felt-lined and operating on rollor bearings, provides handy storage for probes, cables, manuals, etc. An open shelf, topped with tough linoleum, is located at the bottom. Power input and three convenience outlets are mounted at the rear.

The Type 500/53A Scope-Mobile weighs 35 pounds. The outside dimensions are 18½" wide, 39" high and 30" deep.
Type 500/53A $110.00

Type 53A Scope-Mobile Panel. For Type 500A Scope-Mobiles. Converts the Type 500A to a Type 500/53A by replacing the standard blank panel.
Part No. 014-005 .... $10.50

Scope-Mobile Wheel Locks. The Type 500/53A Scope-Mobile may be ordered with two wheel locks by specifying Mod. 741A. The additional cost for this is $15.00. Four wheel locks may be ordered for the Scope-Mobiles by specifying Mod. 741B. The additional charge for this is $30.00.

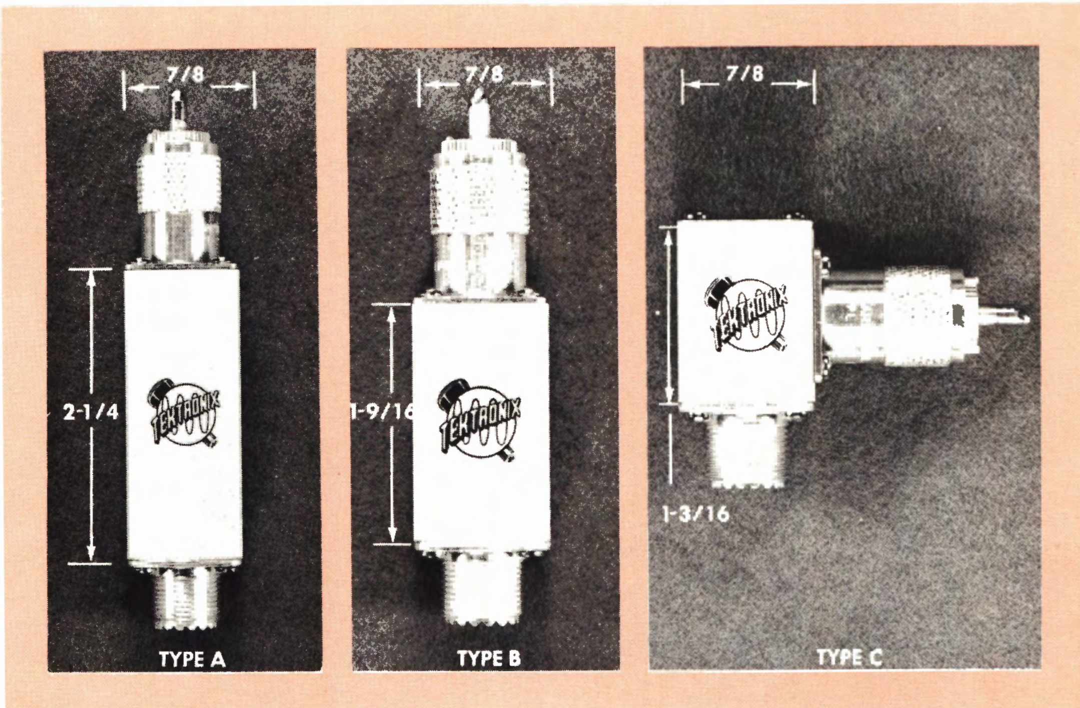
Scope-Mobile Fan Kit. For forced-air ventilation of the equipment compartment of the Type 500A Scope-Mobile. Contains motor, 5"-blade, filter, and mounting hardware.
Part No. 040-161 .... $15.00

Scope-Mobile three-wire power receptacle. Installation of this kit allows a three-wire receptable assembly to be added to the 500 or 500/53 scope-mobile.
Part No. 040-186 .... $8.50

The Tektronix Type 500A Scope-Mobile is identical to the Type 500/53A, except for the front panel. Auxiliary equipment can be mounted behind the blank front panel, but it will usually be necessary to provide forced-air ventilation for the equipment compartment. A fan kit, 040-161, is recommended for this purpose.
Type 500A $100.00

2

CABLE TERMINATORS



Type B52-R 52-ohm terminating resistor, 1.5 w, Type A case.
Part No. 011-001 .... $8.50

Type B52-L5 52-ohm 'L' pad, 5 to 1 voltage ratio, 1.5 w, Type A case.
Part No. 011-002 .... $8.50

Type B52-L10 52-ohm 'L' pad, 10 to 1 voltage ratio, 1.5 w, Type A case.
Part No. 011-003 .... $8.50

Type B52-75L Minimum-loss pad, 52 ohms to 75 ohms, Type A case.
Part No. 011-004 .... $11.50

Type B52-170L Minimum-loss pad, 52 ohms to 170 ohms, Type A case.
Part No. 011-005 .... $11.50

Type B52-T10 52-ohm 'T' pad, 10 to 1 voltage ratio, 1.5 w, Type B case.
Part No. 011-006 .... $11.50

Type B75-R 75-ohm terminating resistor, 1.5 w, Type A case.
Part No. 011-007 .... $8.50

Type B75-L5 75-ohm 'L' pad, 50 to 1 voltage ratio, 1.5 w, Type A case.
Part No. 011-008 .... $8.50

Type B75-L10 75-ohm 'L' pad, 10 to 1 voltage ratio, 1.5 w, Type A case.
Part No. 011-009 .... $8.50

Type B75-T10 75-ohm 'T' pad, 10 to 1 voltage ratio, 1.5 w, Type B case.
Part No 011-011 .... $11.50

Type B93-R 93-ohm terminating resistor, 1.5 w, Type A case.
Part No. 011-011 .... $8.50

Type B93-L5 93-ohm 'L' pad, 5 to 1 voltage ratio, 1.5 w, Type A case.
Part No. 011-012 .... $8.50

Type B93-L10 93-ohm 'L' pad, 10 to 1 voltage ratio, 1.5 w, Type A case.
Part No. 011-013 .... $8.50

Type B93-52L Minimum-loss pad, 93-ohms to 52 ohms, 1.5 w, Type A case.
Part No. 011-014 .... $11.50

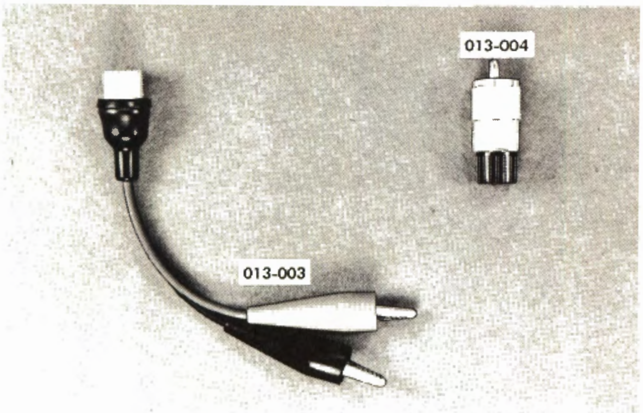
Type B93-T10 93-ohm 'T' pad, 10 to 1 voltage ratio, 1.5 w, Type B case.
Part No. 011-015 .... $11.50

Type B170-R 170-ohm terminating resistor, 1.5 w, Type C case.
Part No. 011-016 .... $8.50

Type B170-A 170-ohm pi-attenuator, using 2% precision resistors, 1 to 64 db in 1-db steps, 0.25 w, not shown in photograph.
Part No. 011-017 .... $45.00

Type B52-170T10, 52-ohm to 170-ohm 'T' pad, 10 to 1 voltage ratio. Type A case.
Part No. 011-026 .... $11.50

COAXIAL ADAPTERS

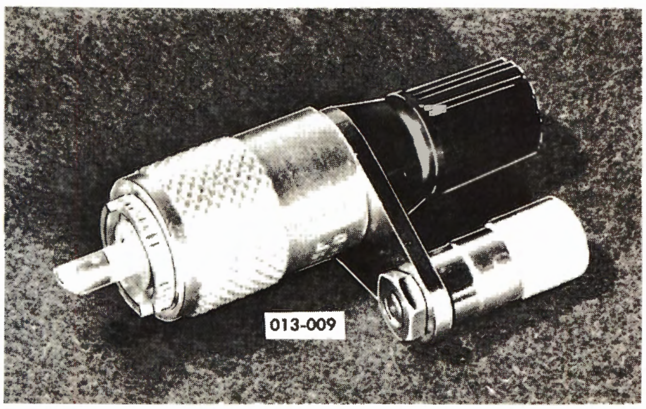


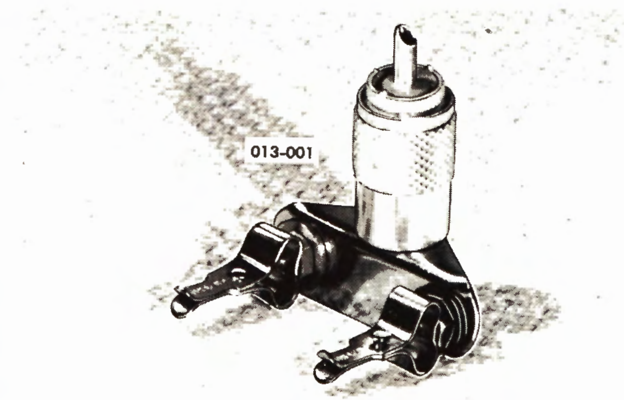
Type A100 Clip-Lead Adapter. Provides clip lead connections for a coaxial cable.
Part No. 013-003 .... $2.00

Type A510 Binding-Post Adapter. Provides permanent connection for a single wire to the center conductor of a coaxial connector.
Part No. 013-004 .... $2.00

Binding-Post Adapter. Similar to Type A510 binding post adapter, but includes ground terminal. $^{3}/_{4}$" spacing between connector centers.
Part No. 013-009 .... $3.00

Type F30 Production Test Fixture. This fixture was designed for use with the Type 130 L, C Meter in production line sorting and testing. It may be used to terminate the output of any standard coaxial connector.
Part No. 013-001 .... $3.00





INTERCONNECTING LEADS

Type W130B Black, 30" flexible output lead with banana-type connector at one end and alligator clip at other.
Part No. 012-014 .... $1.00

Type W130R Same as Type W130B except colored red.
Part No. 012-015 .... $1.00

Type PC-6B Black, 6" flexible cord terminated in combination male and female banana-type connectors. The combination type connectors permit "stacking."
Part No. 012-023 .... $1.25

Type PC-6R Similar to Type PC-6B except colored red.
Part No. 012-024 .... $1.25

Type PC-18R Similar to Type PC-6B except 18"long and colored red.
Part No. 012-031 .... $1.50

Type W531B Black, 6" flexible cord terminated in male banana-type connectors.
Part No. 012-028 .... $1.00

Type W531R Similar to Type W531B except colored red.
Part No. 012-029 .... $1.00

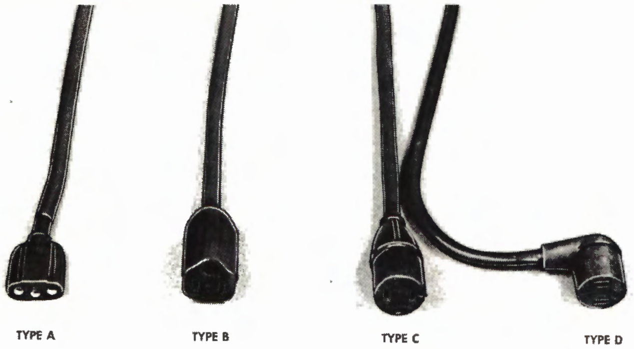
Suppressor cord for Type 570. Similar to Type W531 cords but includes 100 Ω resistor.
Part No. 012-025 .... $1.50

Suppressor cord for Type 570. Similar to type W531 cords except includes 300 Ω resistor.
Part No. 012-026 .... $1.50

Suppressor cord for Type 570. Similar to Type W531 cords except includes 1 k resistor.
Part No. 012-027 .... $1.50

Flexible plug-in extension, 30" for Tektronix Plug-In Preamplifiers.
Part No. 012-038 .... Price on request

POWER CORDS



2-conductor, 8′ rubber-covered power cord with Type C connector. No. 18 wire.
Part No. 161-001 .... $1.25

2-conductor 8′ rubber-covered power cord with no female connector. (For permanent connection to instrument).
Part No. 161-002 .... $1.10

2-conductor, 1′ rubber-covered power cord with Type C connector. No. 18 wire.
Part No. 161-003 .... $ .85

2-conductor, 8′ rubber-covered power cord with Type C connector. No. 16 wire.
Part No. 161-004 .... $1.75

3-conductor, 8′ rubber-covered power cord with Type A connector. No 16 wire.
Part No. 161-005 .... $2.00

3-conductor, 10′ rubber-covered power cord with no female connector. (For permanent connection to instrument). No. 16 wire.
Part No. 161-006 .... $3.00

2-conductor, 8′ rubber-covered power cord with Type D connector. No 18 wire.
Part No. 161-007 .... $1.25

3-conductor, 8′ rubber-covered power cord with Type B connector. No. 18 wire.
Part No. 161-008 .... $1.50

3-conductor, 8′ rubber-covered power cord with Type B connector. No. 18 wire.
Part No. 161-010 .... $1.75

3-conductor, 8′ rubber-covered power cord with Type B connector. No. 18 wire.
Part No. 161-011 .... $1.25

3-conductor, 8′ rubber-covered power cord with no female connector to instrument. No. 18 wire.
Part No. 161-012 .... $1.25

Power-cord adapter for connecting a 3-wire power cord to a 2-wire receptacle.
Part No. 103-013 .... $ .65

3-conductor, 20″ rubber-covered power cord.
Part No. 161-014 .... Price on request

COAXIAL CABLES

Type P75 Coaxial cable, 75 ohms nominal impedance, 42″ long.
Part No. 012-002 .... $4.00

Type P93 Coaxial cable, 93 ohms nominal impedance, 42″ long.
Part No. 012-003 .... $4.00

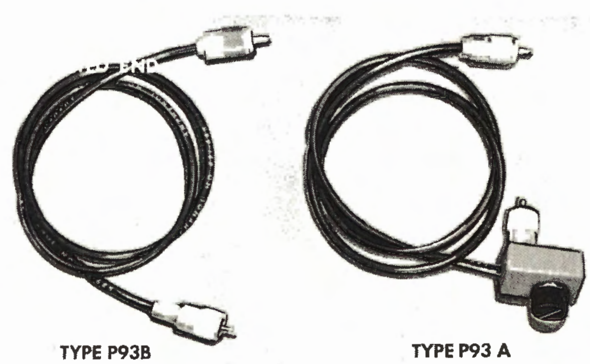
Type P93A Coaxial output cable, 93 ohms, terminated with variable attenuator, 42″ long. (See photo).
Part No. 012-004 .... $13.50

Type P93B Coaxial output cable, 93 ohms, terminated with ½-watt 93-ohm resistor, 42″ long. (See photo).
Part No. 012-005 .... $5.00

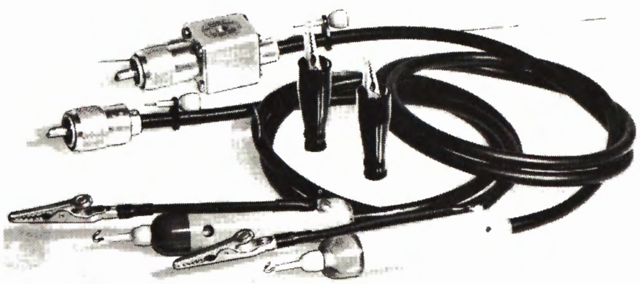
Type P170 Coaxial cable, 170 ohms nominal impedance, 42″ long.
Part No. 012-006 .... $9.50

Coaxial cable, 170 ohms nominal impedance, 5′ long.
Part No. 012-034 .... $4.00

Type P52 Coaxial cable, 52 ohms nominal impedance, 42″ long.
Part No. 012-001 .... $4.00



P400-SERIES PROBES



P400-Series Low-Capacitance Probes. This series of low-capacitance probes preserves the transient response of Tektronix fast-rise instruments. The P400-Series probes are free of overshoot and ringing and have relatively uniform high-frequency response. Input capacitance and insertion loss are affected by cable length. With cables up to 12′ in length, insertion loss is less than 3 db at 20 mc, and overshoot is less than 1%. With exception of the P450-L, these probes can be used on those instruments having input capacitances from 20 to 50 μμf.

General physical characteristics of the P400-Series probes are identical to the P510A probe. Color-coding of the plastic nose indicates attenuation ratio. Two interchangeable Tek-tips—a straight tip and a hooked tip—each adding less than 0.5 μμf to the input capacitance, and an alligator clip assembly are supplied with each probe.

PROBE	CABLE LENGTH	PART NO.	PRICE
P405	42″	010-006	$10.50
(green nose)	8′	010-013	12.50
P410	42″	010-007	10.50
(brown nose)	8′	010-014	12.50
P420	42″	010-008	10.50
(red nose)	8′	010-015	12.50
P450	42″	010-009	12.50
(clear nose, green inside)	8′	010-016	14.50
P450-L	42″	010-010	12.50
(clear nose, green inside)	8′	010-017	14.50
P4100	42″	010-002	12.50
(clear nose)	8′	010-018	14.50

P400-SERIES PROBE SPECIFICATIONS

PROBE TYPE	ATTEN. RATIO	INPUT CHARACTERISTICS			DB Loss at 30 MC	Maximum Voltage Rating
		Resist. (Meg Ω)	Capacitance Minimum*	Capacitance Maximum †		
P405	5:1	5	12 μμf 21 μμf**	19 μμf 30 μμf**	1-2	600
P410	10:1	10	8 μμf 12 μμf**	11 μμf 15 μμf**	1	600
P420	20:1	10	5.5 μμf 8 μμf**	7 μμf 9 μμf	1	600
P450	50:1	10	3.5 μμf 4 μμf**	3.5 μμf 4 μμf**	1	1000
P450-L	50:1	10	2.5 μμf 3 μμf**		1	1000
P4100	100:1	10	2.5 μμf 3 μμf**	2.5 μμf 3 μμf**	1	1000

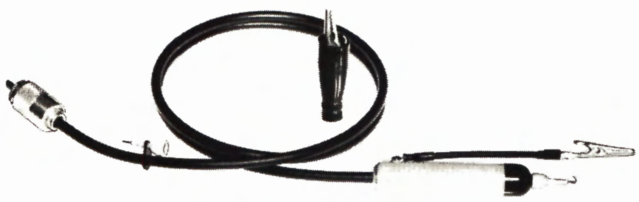
***When connected to instruments with 20-μμf input capacitance.**

† When connected to instruments with input capacitances up to 50 μμf.

****With 8-foot cable.**

6

P510A PROBES



P510A Attenuator Probe provides an attenuation of ten times when used with Tektronix oscilloscopes and amplifiers. The P510A is small and streamlined, and presents an input impedance of 10 megohms paralleled by 14 $\mu\mu$f. The probe is completely insulated—made of high-impact-strength fiber-glass-reinforced alkyd—and has an internal brass shield. Two interchangeable Tektips—a straight tip and a hooked tip—and an alligator clip assembly are furnished. Probe has a 42" cable with coaxial connector, and is rated at 600 v maximum.

Part No. 010-001 .... $8.50

P510A PROBES WITH LONG CABLES

P510A probe cables ring at a period that depends on the cable length and, to a lesser degree, on the input capacitance of the oscilloscope used. Each particular cable length will be satisfactory only when zero transmission of the oscilloscope does not extend to a frequency that includes the resonant frequency of the probe. This difficulty has been eliminated in the P400-Series Probes.

P510A with 6' cable, Part No. 010-004 .... $9.00

P510A with 8' cable, Part No. 010-005 .... $9.50

Prices for P510A Probes with other cable lengths available on request.

PROBE TIPS

Tek tip, Hook Shank, Part No. 206-008 .... $ .25

Tek tip, Straight Shank, Part No. 206-009 .... $ .25

Pin Jack Probe Tip, Bent Shank (fits 0.082" jacks)
Part No. 206-011 .... .25

Alligator Clip Assembly. Part No. 344-005 .... $ .40

CF PROBES

TYPE P170CF

The P170CF Cathode Follower Probe was developed for use with the Type 517 Oscilloscope. The cathode-follower is a 5718 triode with the 170-ohm termination of the pre-amplifier grid line in the Type 517 as a cathode load. Plate and heater voltages for this tube are provided at a four-terminal socket on the panel of the oscilloscope. The signal is attenuated by 2 times when using the P170CF. The input impedance of the probe will depend on the attenuator head being used, and because of the transit time in the cathode-follower, it will decrease appreciably at the higher frequencies. When the probe is used without on attenuator head, the input characteristic is 12 megohms shunted by 5 $\mu\mu$f. The probe cable is 42" long. Probe comes complete with 3 attenuator heads.

Part No. 010-101 .... $86.00

PAX-I Attenuator Head. Attenuation can be varied between 4 times and 40 times.

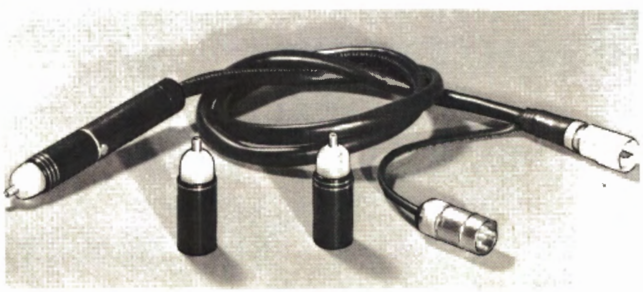
Part No. 010-301 .... $11.00

PAX-II Attenuator Head. Attenuation can be varied between 20 times and 200 times.

Part No. 010-302 .... $11.00

PAX-III Attenuator Head. Attenuation can be varied between 200 times and 2000 times.

Part No. 010-303 .... $11.00



CF PROBES

TYPE P500CF

Type P500CF Cathode-Follower Probe. For use with Type 524AD Oscilloscope. Presents low capacitance with minimum attenuation. Input characteristic is 40 megohms paralleled by 4 μμf. The gain is 0.8 to 0.85. Input to probe is ac-coupled, limiting its low-frequency response to 5 cycles. Amplitude distortion is less than 3% on unidirectional signals exceeding a few volts to minimize amplitude distortion. With the attenuator head attached, the probe input characteristic is approximately 10 megohms paralleled by 2 μμf. Probe output level is 11-v positive, making it necessary to use the AC-coupled position of the oscilloscope AC-DC switch. Probe cable is 42″ long.

Part No. 010-105 .... $64.00

PROBE POWER SUPPLY

The Type 128 Probe Power Supply. The Type 128 supplies the necessary plate and filament voltages for one or two probes, making it possible to use the Type P500CF and Type P170CF cathode-follower probes with oscilloscopes not equipped with a probe-power outlet.

DC Output Voltages:

+120 v regulated, at 25 ma
+6.3 v unregulated, at 150 ma
+6.3 v unregulated, at 150 ma

When a P170CF probe is to be used with an instrument other than the Tektronix Type 517, a 170-ohm terminating resistor is required. The Type B170-R Terminating Resistor is recommended for this purpose.

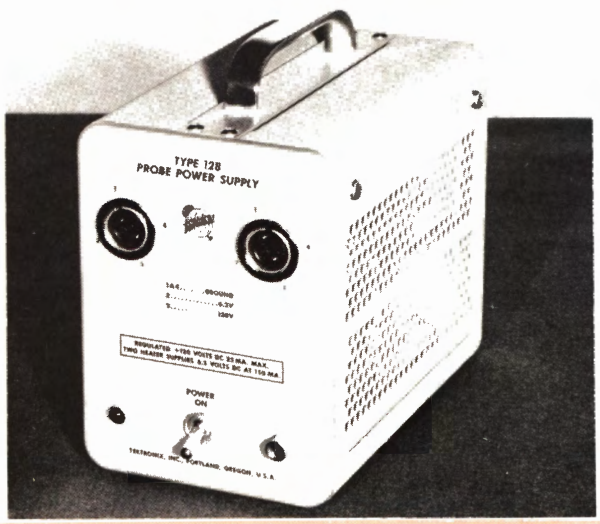
Ripple—Ripple on the 120 v supply is not more than 5 mv peak-to-peak, and not more than 75 mv peak-to-peak on the 6.3 v supplies.

Power Requirements—105 to 125 v or 210 to 250 v, 50 to 60 cycles, 25 watts using two P500CF probes.

Dimensions—4¾″ wide, 7¾″ high, 9″ overall depth.

Weight—6 lbs.

Part No. 015-006 .... $100.00



CATHODE-RAY-TUBES

The catalog description of each oscilloscope gives the kind of phosphor that is normally provided in the crt. In general, your oscilloscope can be provided, on order, with any commercially available phosphor.

Phosphors, other than those of short persistence may display an intitial fluorescence of one color, followed by a phosphorescence of the same or another color. The following table describes some of the phosphors we can provide in your crt. Other phosphors are available. We welcome your inquires.

PHOSPHOR CHARACTERISTICS

PHOSPHOR	FLOURESCENCE	PHOSPHORESCENCE	PERSISTENCE
P1	Green	Green	Medium
P2	Blue-green	Green	Long
P7*	Blue-white	Yellow	Long
P11	Blue		Short
P16	Violet and near ultra-violet		Extremely short
P24	Blue		Extremely short

***Double-layer type.**

Ⓐ

CATHODE-RAY-TUBES

PRICE LIST

Types 515A and RM15.

5CBP1	154-125	$60.00
5CBP2	154-120	60.00
5CBP7	154-126	60.00
5CBP11	154-127	60.00
5CBP16	154-161	60.00
5CBP24	154-177	60.00

Type 536.

T536P1	154-140	$60.00
T536P2	154-133	60.00
T536P7	154-135	60.00
T536P11	154-136	60.00
T536P16	154-169	60.00

Type 551.

T551P1	154-186	$150.00
T551P2	154-160	150.00
T551P7	154-189	150.00
T551P11	154-143	150.00

Type 502.

T502P1	154-172	$150.00
T502P2	154-144	150.00
T502P7	154-170	150.00
T502P11	154-173	150.00

Type 524AD.

5ABP1	154-068	$31.00
5ABP7	154-069	35.00
5ABP11	154-070	35.25

Types 581 and 585.

T581P1	154-228	Price on request
T581P2	164-224	Price on request
T581P7	154-229	Price on request
T581P11	154-230	Price on request

Types 531A, RM31A, 533, RM33, 535A and RM35A.

T533P1	154-178	$90.00
T533P2	154-165	90.00
T533P7	154-179	90.00
T533P11	154-180	90.00

Types 525, 532, RM32, 570 and 575.

5CAP1	154-093	$50.00
5CAP2	154-097	50.00
5CAP7	154-102	50.00
5CAP11	154-103	50.00
5CAP16	154-162	50.00

Type 517A.

T517P1H	154-107	$110.00
T517P2H	154-109	110.00
T517P7H	154-108	110.00
T517P11H	154-105	110.00
T517P16H	154-128	110.00

Types 541, RM41A, 543, RM43, 545 and RM45A.

T543P1	154-181	$110.00
T543P2	154-175	110.00
T543P7	154-182	110.00
T543P11	154-183	110.00

Type 555.

T555P1	154-219	Price on request
T555P2	154-199	Price on request
T555P7	154-220	Price on request
T555P11	154-221	Price on request

GRATICULES

Type 532 graticule. Centimeter ruling, 8 cm vertically, 10 cm horizontally.

Part No. 331-026 .... $1.50

Types 507, 531, 531A, 535 and 535A graticule. Centimeter ruling, 6 cm vertically, 10 cm horizontally.

Part No. 331-016 .... 1.50

Types 541, 541A, 543, 545 , 545A, 581 and 585 graticule. Centimeter ruling, 4 cm verically, 10 horizontally.

Part No. 331-034 .... 1.50

Types 536, 570 and 575 graticule. Division ruling, 10 divisions vertically, 10 horizontally.

Part No. 331-028 .... 1.50

Types 551 and 555 graticule. Centimeter ruling, 6 cm vertically, 10 cm horizontally.

Part No. 331-045 .... 1.50

CATHODE-RAY TUBE LIGHT FILTERS

Types 502, 507, 525AD, 531, 531A, 532, 535, 535A, 536, 570 and 575.

Amber. Part No. 378-501 .... .90

Yellow. Part No. 378-502 .... .90

Green. Part No. 378-503 .... .90

Blue. Part No. 378-504 .... .90

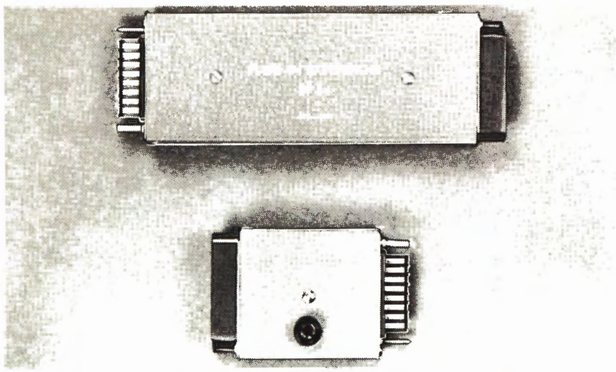
Types 515A, 517A, 533, 541; 541A, 543, 545, 545A, 551, 555, 581 and 585.

Green. Part No. 378-514 .... .90

Blue. Part No. 378-515 .... .90

Amber. Part No. 378-516 .... .90

AUXILIARY DEVICES



TYPE EP54 PLUG-IN EXTENSION

Permits the operation of the plug-in unit partially extended out of its housing in a 530-, 540-, or 550-Series Oscolloscope.

Part No. 013-002 .... $5.00

TYPE EP53A GAIN ADJ. ADAPTER

Permits the introduction of an external calibrating signal directly to the oscilloscope vertical amplifier input, by-passing the plug-in preamplifier. Useful for adjusting oscilloscope vertical amplifier gain in 530-, 540-, and 550-Series Oscilloscopes.

Part No. 013-005 .... $5.00

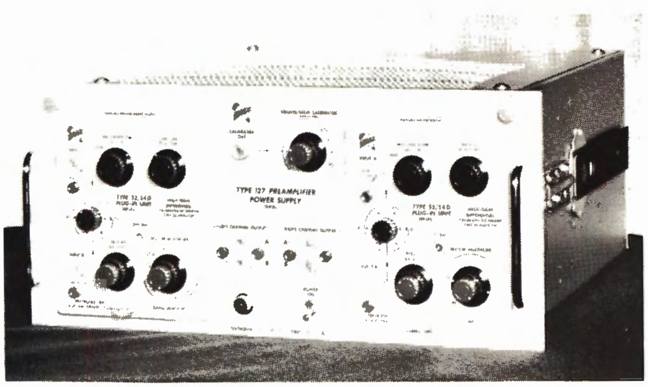
AIR FILTERS

Type 530-, 540-, 550-, and 580- Series Instruments. Disposable 10 x 10 x 3/4 spun -glass filter with back-up screens.

Part No. 378-009 .... $1.75

Type 530- 540-, 550- and 580- Series Instruments. Disposable 10 x 10 x 3/4 spun-glass filter.

Part No. 378-012 .... $1.00



PLUG-IN POWER SUPPLY

The Tektronix Type 127 Preamplifier Power Supply supplies proper operating power to one or two Tektronix plug-in preamplifiers. Any plug-in units powered by the Type 127, can be used to further increase the signal-handling versatility of Tektronix oscilloscopes employing plug-in preamplifiers. Double-differential dual-trace display may be obtained by employing 2 Type D, E, or G Differential Plug-In Preamplifier Units, in the Type 127 in conjunction with an oscilloscope using a Type CA Dual-Trace Plug-In Unit. The Type 127 also facilitates the use of plug-in units in other applications.

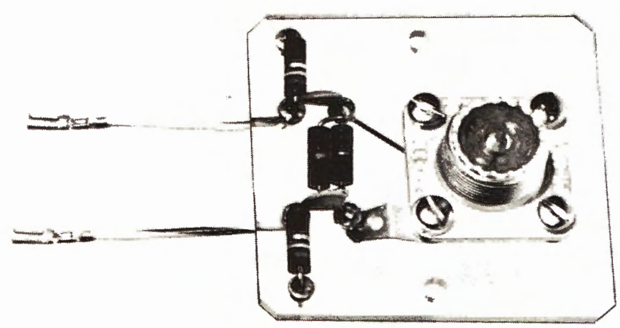
The outputs of plug-in units powered by the Type 127 are fed through dc-coupled differential amplifier stages and cathode followers to provide a push-pull signal at the output terminals. Risetime of the unit is 0.018 μsec, permitting maximum utilization of the response of Tektronix 530-Series Oscilloscopes. Output swing is linear $\pm 3\%$ over a range of ± 0.3 volt. Output dc operating levels are adjustable to ground potential.

The Type 127 has a gain of one, push-pull. With single-ended output, gain is one half.

Each channel has four output terminals, two on the front and two at the rear. Terminated 170-ohm output cables are furnished.

Price $525.00

DEFLECTION-PLATE CONNECTOR



The Type DP-52 Deflection-Plate Connector provides a convenient means for making direct connections to the CRT vertical-deflection plates in the 530- and 540-Series Oscilloscopes. With this device, front-panel control of the CRT beam position is retained. The connector is designed for use with a 52-ohm cable. For 530- and 540-Series Instruments with serial numbers 5001 and above order Part No. 013-007.

Price $5.00

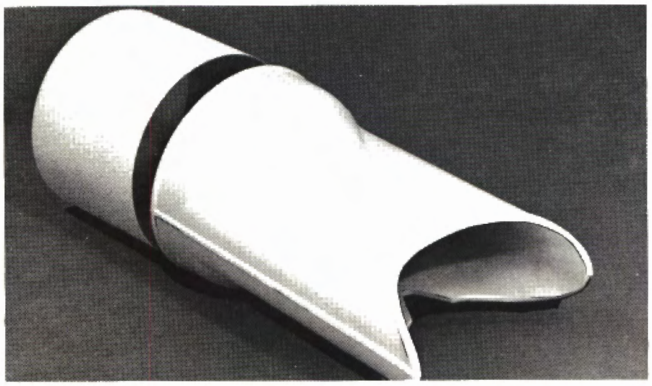
PROBE POWER-CABLE EXTENSION

A 24" 3-conductor power-cable extension for Tektronix cathode-follower probes. Permits wider separation of the probe power source from the instrument signal input.

Part No. 012 030 .... $5.00

AUXILIARY DEVICES

H510 VIEWING HOOD



Type H510 Viewing Hood for Tektronix 5" Oscilloscopes. Includes molded rubber eye-piece and aluminum light shield.

Part No. 016-001 .... $4.50

Molded rubber eye-piece.

Part No. 337-002 .... $3.35

Aluminum light shield.

Part No. 354-004 .... $1.15

UNIVERSAL PROBE REPAIR KIT

This repair kit includes all of the necessary electrical and mechanical parts to repair badly damaged Type P410 and P510 Probes. Includes repair and assembly instructions.

Part No. 040-180 .... $8.50

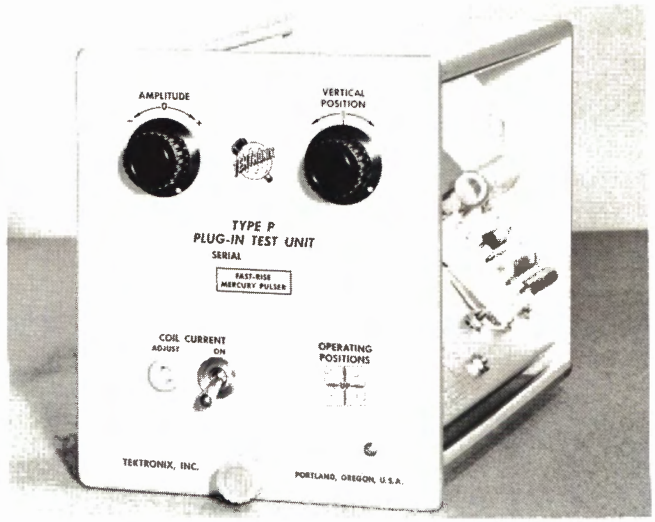
CAPACITANCE STANDARDIZERS

Type CS47 Input Capacitance Standardizer. This device is used for standardizing the input capacitance of those plug-in units having a 47 $\mu\mu$f input capacitance. Standardization of plug-in input capacity permits interchanging probes from one plug-in to the other without the need for probe readjustment. The Type CS 47 case is similar to the Type A attenuator case on Page A-2.

Part No. 011-021 .... $11.50

Type CS20 Input Capacitance Standardizer. Similar to the Type CS47 above but for standardizing 20 $\mu\mu$f input capacitances.

Part No. 011-022 .... $11.50

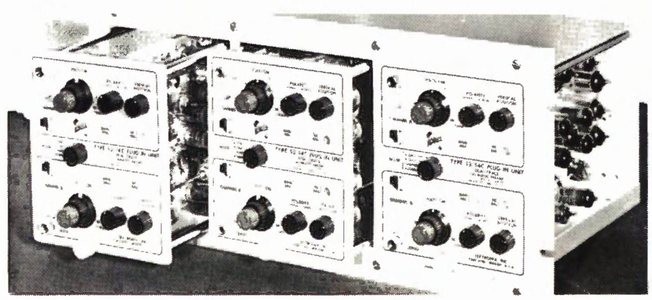


The Type P is a special-purpose test unit for Tektronix convertible oscilloscopes. You can use the step function generated by the Type P Unit to adjust an oscilloscope vertical amplifier and delay-line. By this procedure you can standardize the transient response of a number of like oscilloscopes. A plug-in preamplifier will exhibit identical transient-response characteristics in like oscilloscopes that have been standardized with the Type P.

Risetime of the step function generated by the Type P is less than 4 millimicroseconds. Polarity can be either positive or negative, and amplitude is continuously adjustable from 0 to 3 major graticule divisions. Repetition rate is 240/sec.

Price $60.00

PLUG-IN STORAGE CABINET

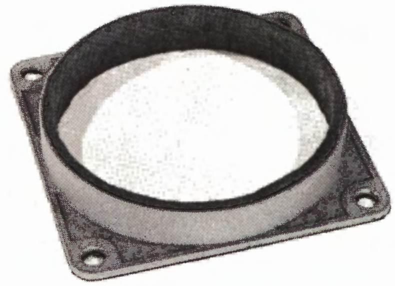


Plug-In Storage Cabinet. Mounts in standard rack, holds three Plug-In Units. Dimensions: 19" wide, 8¾" high, 9⅜" deep. Price without Plug-In Units.

Part No. 437-031 .... $25.00

AUXILIARY DEVICES

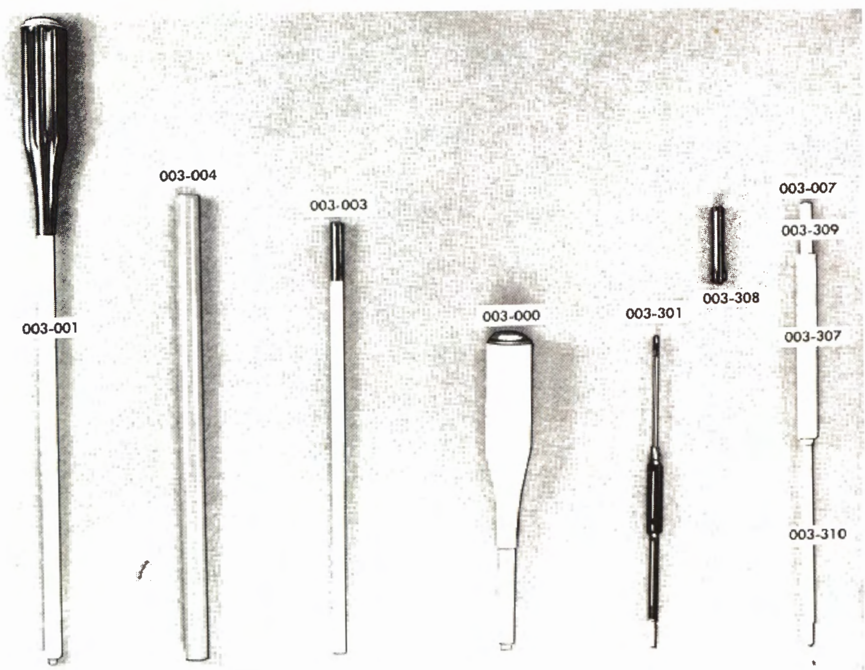
TYPE BE510 BEZEL



Type BE510 Bezel for mounting camera on Tektronix 5" oscilloscopes. Dimensions: $5\frac{7}{8}$" square; ring $\frac{7}{8}$" deep, diameter $5\frac{5}{8}$" outside, $5\frac{1}{8}$" inside. Die-cast construction, wrinkle finish, felt lined.

Part No. 014-001 .... $4.50

RECALIBRATION TOOLS



003-007 Tektronix recalibration tool assembly. This 4-unit tool assembly provides most of the necessary tools for adjusting variable inductors in Tektronix instruments. The price of this entire assembly is $2.50

Individual unit prices are as follows:

003-307 Handle .... $ .75

003-308 Red nylon insert with wire pin .... .50

003-309 White cymac insert with wire pin .... .50

003-310 Hexagonal core insert . .75

The tools shown above are handy—and in some cases, necessary—tools for the recalibration of Tektronix instruments. All of the tools except the assembly at the right (003-007) are available through most radio parts suppliers.

003-001 Jaco No. 125 insulated screw driver with 7" shank and metal bit. This tool is useful for adjusting hard-to-reach adjustments on oscilloscopes $1.25

003-000 Jaco No. 125 insluated screw driver. This tool is similar to 003-001 but has a $1\frac{1}{2}$" shank .... $ .75

003-003 Walsco No. 2519 insulated alignment tool. This double-ended tool is useful for adjusting variable inductors in Tektronix Instruments $1.25

003-004 Walsco No. 2503 $\frac{1}{4}$" insulated hexagonal wrench. This tool is useful for tightening variable inductor lock nuts on older Tektronix Instruments. Current production instruments do not have lock nuts on coil assemblies ...... $ .60

003-006 (Not pictured) Insulated alignment tool suitable for adjusting small capacitors $1.25

003-301 Walsco No. 2543 double-ended 0.1" hexagonal wrench. This tool is useful for adjusting variable inductors with hexagonal cores $1.00

Alignment tool kit. Contains the following alignment tools.

003-001	003-004	003-308
003-000	003-006	003-309
003-003	003-307	003-310

Part No. for kit 003-500 .... $7.50

Tektronix, Inc., P. O. Box 831, Portland 7, Oregon

Telephone: CYpress 2-2611 TWX—PD 311 Cable: TEKTRONIX
AN OREGON CORPORATION

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***ALSO REPAIR CENTERS**

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Overseas Representatives

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BRAZIL .... Consulting & Suppliers Company for South America Inc., 61 Broadway, New York 6, New York ..BOwling Green 9-0610
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Palmar Ltda., Rua 7 de Abril 252, Sao Paulo, Brazil 34-4497
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FRANCE .... Maurice I. Parisier & Co., 741-745 Washington St., New York 14, N. Y. .... ALgonquin 5-8900
Relations Techniques Intercontinentales, 134 Avenue de Malakoff, Paris 16, France ...... Passy 08-36, Kleber 54-82
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INDIA .... Electronic Enterprises, 46, Karani Building, Opp. Cama Baug., New Charni Road, Bombay 4, India 75376
ISRAEL .... Landseas Products Corp., 48 West 48th Street, New York 36, New York .... COlumbus 5-8323
Landseas Eastern Co., P. O. Box 2554, Tel Aviv, Israel 66890
ITALY ....Silverstar, Ltd., 21 Via Visconti Di Modrone, Milan, Italy 792.791/709.536
Silverstar, Ltd., 12 Via Paisiello, Roma, Italy 867.886
Silverstar, Ltd., 3 Corso Mattcotti, Turin, Italy 524.021
JAPAN .... Midoriya Electric Co., Ltd., 3,2-Chome, Kyobashi, Chuo-ku, Tokyo, Japan...Kyobashi (56) 1786, 7415, 7416, 7439
NETHERLANDS .... C. N. Rood, n. v., 11-13 Cort van der Lindenstraat, Rijswijk, Z.H., Netherlands .... The Hague 98.51.53
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SWEDEN .... Erik Ferner AB, Bjornsonsgatan 197, Bromma, Stockholm, Sweden 870140
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SOUTH AFRICA ..... Protea Holdings, Ltd., 42, Faraday Street, Wemmer, Johannesburg, Union of South Africa 33-4762/3
URUGUAY .... Compania Uruguaya De Rayos X y Electromedicina S. A. Mercedes 1300, Yaguaron 1449, Montevideo, Uruguay
8 58 29
WEST GERMANY ..... Rohde & Schwarz Vertriebs, GmbH, Berlin W30, Augsburgerstrasse 33, West Germany 91 27 62
Rohde & Schwarz Vertriebs, GmbH, Hannover, Schillerstrasse 23, West Germany 1 33 80
Rohde & Schwarz Vertriebs, GmbH, Karlsruhe, Kriegstrasse 39, West Germany 25202
Rohde & Schwarz Vertriebs, GmbH, Koln, Habsburger-Ring 2-12, West Germany 215341
Rohde & Schwarz Vertriebs, GmbH, Munchen 9, Briennerstrasse 23, West Germany...................... 59 52 65

Other OVERSEAS areas please write or cable directly to the Export Department, Portland, Oregon, U.S.A.

Printed in USA

Type 555, 21A, 22A

INSTRUMENT MODIFICATION

INSERT

Type 555

Type 21A and 22A

The information following replaces part of the present data on the Type 21 and 22. For information not mentioned in this insert, refer to the Instruction Manual.

SECTION 1

CHARACTERISTICS

Triggering Modes
Type 21A and 22A--AC and DC

Triggering Signal Sources
Type 21A and 22A--External, Lower Beam Plug-in, Lower Beam, Upper Bèam Plug-in, Upper Beam, and Line.

Triggering Signal Requirements (Type 21A and 22A)
Internal sources (UPPER BEAM PLUG-IN, UPPER BEAM, LOWER BEAM, LOWER BEAM PLUG-IN)--A signal producing less than 0.2 cm of vertical deflection up to 5MC and a signal of less than 1cm up to 30MC will produce reliable triggering. External source (EXT)--A signal producing less than 0.2 v up to 10MC and a signal of less than 0.5 v up to 30MC will produce reliable triggering.

The instrument will trigger on larger signals, but the LEVEL Control operates over a ±10 v range with the VERNIER operating over a ±1 v range.

Sweep Rates
Type 21A and 22A--0.1 microsecond to 5 seconds per centimeter in 24 accurately calibrated steps. The VARIABLE Control permits the sweep rate to be varied continuously between 0.1μSEC/cm and approximately 12 SEC/cm. Calibrated sweep rates are typically within 1% and in all cases with 3% of the indicated sweep rate.

Sweep Modes
Type 21A--NORMAL, AUTO BASELINE, and SINGLE SWEEP.
Type 22A--TRIGGERABLE ONCE FOR EACH " A" DLY'D TRIG SWEEP ONCE FOR EACH " A" DLY'D TRIG, NORMAL, AUTO BASELINE, and SINGLE SWEEP.

The AUTO BASELINE operates with signals in the range of 20 cps to 30 MC only. For signals outside this range use NORMAL or one of the other modes.

Cathode-Ray Tube
Type T5550-2

Phosphor--Type 2 phosphor normally supplied; 1, 7, and 11 phosphors optional. Other phosphors available on special order.

Unblanking-dc coupled.

Accelerating potential--10,000 volts.

Useable viewing area--total of 6 centimeters with 4 centimeters for each beam. At least 2 centimeters of overlap between the two beams.

7114-7214-7225-7248/763

Construction
Aluminum-alloy chassis and three-piece cabinets. Photoetched anodized panel, blue vinyl-finished cabinet.

Dimensions
Indicator Unit: 24" long, 13" wide, 20" high.
Power Supply Unit: 17 1/2" long, 13" wide, 10" high.

Weight
Indicator Unit: 68 pounds.
Power Supply Unit: 45 pounds.

Accessories

1--Time-Base plug-in extension (013-013)
4--Attenuator probes, 10X Attenuation (010-127)
1--Inter-unit cable (012-032)
2--BNC-to-binding post adapters (103-033)
1--Test lead (012-031)
1--Green filter (378-514)
1--3-conductor power cord (161-010)
2--Instruction manuals.
1--3 to 2-wire adapter (103-013)

SECTION 2

OPERATING INSTRUCTIONS

Paragraph headings in the insert and the information which follows them, supersedes the information under the identical paragraph heading in the Instruction Manual. The Auto Baseline information supplements the present information in the Instruction Manual.

Positioning Controls

Four controls are used with the Type 555 Oscilloscope to allow you to position the trace of both beams to the desired points on the oscilloscope screen. Two of these controls are used to set the horizontal positions of the two beams and are located on the front panel of the instrument. The other two controls are used to set the vertical positions of the two beams and are located on the front panel of the plug-in units used with the oscilloscope. (Dual-Trace Plug-In Units have two Vertical Positioning controls.)

The two beams have independent horizontal positioning. The Upper Beam HORIZ POSITION Control positions the upper beam; the Lower Beam HORIZ POSITION Control positions the lower beam. The HORIZ POSITION Controls are backlash type potentiometers. The backlash feature allows both coarse and fine adjustments to be in the same control.

In using this type of control, assume you wish to have the ninth time-marker of the Upper Beam under the vertical centerline. The ninth time-marker is now under the ninth graticule line. Turn the Upper Beam HORIZ POSITION Control counterclockwise to position the ninth time-marker just past (to the left of) the vertical centerline. Now from the point at which the HORIZ POSITION Control now sits and for approximately 60° of the potentiometer in the clockwise direction, only the front section of the potentiometer (the fine adjustment) will move. Turn the Upper Beam HORIZ POSITION Control clockwise until the ninth time-marker is now under the vertical centerline.

In using the backlash type control, it is always necessary to go past the point you wish and then come back to the point from the other direction if you desire to use the fine adjustment.

The HORIZ POSITION Controls have sufficient range for you to view the entire trace even when the beam is expanded horizontally by a factor of 5 using the appropriate HORIZ DISPLAY switch.

The vertical position controls have sufficient range to allow the beams to be positioned completely above or below the useable area of the screen. The traces move up when the controls are rotated clockwise and down when the controls are rotated counterclockwise.

Use of Probes

Attenuator probes reduce loading of the signal source. However, in addition to providing isolation of the oscilloscope from the signal source, an attenuator probe also decreases the amplitude of the .displayed waveform by the attenuation factor of the probe. Use of a probe allows you to increase the vertical deflection factors of the oscilloscope. This permits you to observe large-amplitude signals which are beyond the normal limits of the oscilloscope and plug-in combination. Signal amplitudes, however, must be limited to the maximum allowable value for the probe used. For Type P6006 probes the maximum allowable input voltage is 600 volts.

Before using a probe you must check (and adjust if necessary) the compensation of the probe to prevent distortion of the applied waveform. The following instructions for setting the oscilloscope controls and compensating the probe are given for UPPER BEAM and TIME BASE A operation. Place the HORIZ DISPLAY switch at X1 and rotate the SWEEP FUNCTION switch to AUTO BASELINE. Set the SLOPE switch at +, the COUPLING switch at AC, and the SOURCE switch at UPPER BEAM. Connect the probe tip to the CAL OUT connector and set the AMPLITUDE CALIBRATOR switch for 2 centimeters of displayed signal. Adjust the LEVEL Control for a stable display. Set the TIME/CM switch to display approximately 3 or 4 cycles of the calibrator waveform and adjust the probe compensation control to obtain flat tops on the displayed calibrator square-waves (see P6000 Figure 2-4). With the calibrator waveform displayed on the oscilloscope screen, the compensation control is adjusted to eliminate any distortion occurring in the leading edges of the calibrator waveforms.

Selecting The Triggering Source

In preparing the Type 555 for triggered operation of the sweeps, it is first necessary to select the triggering signal source which will produce the desired results. Either time base unit can be triggered from the upper beam vertical, the lower beam vertical, the upper beam plug-in, the lower beam plug-in, a line frequency waveform, or from an external triggering signal. The selection of triggering source is made with the appropriate SOURCE switch. Each triggering source has advantages for certain types of applications.

It is usually most convenient to trigger the sweeps internally from either the upper or lower beam signals. This is done by placing the SOURCE switch in the UPPER BEAM or LOWER BEAM position to obtain the triggering signal from the appropriate vertical amplifier. If it is desired to obtain a low noise triggering signal then either UPPER BEAM PLUG-IN or LOWER BEAM PLUG-IN positions of the SOURCE switch should be used. Internal triggering is convenient since no external triggering connections are required. This method of triggering is excellent for most applications.

NOTE

> If a Type 555 serial number 7000-up is to be used with Type 21 and 22 Time Bases, it will be necessary to remove the wire between the ceramic strip in the Time Base and pin 19 on the Time Base connector.

If a Type 555 below serial number 7000 is to be used with Type 21A and 22A Time Bases, it will be necessary to modify the oscilloscope so that the UPPER BEAM PLUG-IN and LOWER BEAM PLUG-IN positions of the SOURCE switch may be used. Order modification kit number 040-328.

Triggering from the power-line is useful when the waveform being observed bears a definite relationship to the line frequency. This type of observation is frequently made when the displayed waveform is not suitable for triggering. When the SOURCE switch is placed in the LINE position, a constant amplitude line frequency signal is applied to the triggering circuits to insure stable operation.

Using external triggering, the triggering signal can be chosen to remain relatively constant in amplitude and shape. It is thereby possible to observe the shaping and amplification of a signal in an external circuit without resetting the oscilloscope triggering controls for each observation. Also, time and phase relationships between the waveforms at different points in the circuit can be seen. If for example, the external triggering signal is derived from the waveform at the input to a circuit, the time relationship and phase of the waveforms at each point in the circuit are compared to the input signal by the display presented on the oscilloscope screen.

Using external triggering and a stable triggering signal, it is possible to observe and accurately measure jitter of the displayed waveform. It is difficult to make accurate jitter measurements when the sweep is triggered internally.

To trigger one of the sweeps from an external waveform, connect the triggering waveform to the appropriate TRIGGER INPUT connector. Place the SOURCE switch in the EXT position and adjust the other triggering controls for stable triggering.

Automatic Triggering Mode

This mode of triggering does not exist on the Types 21A and 22A.

In the text where an auto triggering mode is referred to, it will now be necessary to use the LEVEL Controls to obtain a stable display.

Auto Baseline

The AUTO BASELINE position of the SWEEP FUNCTION switch causes a baseline to exist on the CRT in the absence of a signal. Auto Baseline is NOT an automatic trigger as on other Tektronix oscilloscopes. To trigger a signal in Auto Baseline, it is necessary to use the LEVEL Controls just as they are used to trigger a signal in any other sweep mode.

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 or SAWTOOTH connector is used to trigger or synchronize the input waveform. Either Upper Beam TIME BASE A, Lower Beam TIME BASE B, or a combination of both may be used. Figure 2-10 shows the Lower Beam TIME BASE B method of operation.

The sweep for either time base can be made to free run by rotating the respective SOURCE switch to LINE and the LEVEL controls to a free-running position. The number of sweeps per second is determined by the setting of the TIME/CM Controls.

In addition to providing the means for controlling an applied waveform, a free-running sweep also provides a convenient reference trace on the oscilloscope screen without requiring an input signal. This trace can then be used to position the sweep or to establish a voltage reference line.

SECTION 7

CALIBRATION PROCEDURE

The numbered paragraphs in this insert replace the equivalent numbered steps in the Instruction Manual. Steps not covered by the insert remain the same. The Calibration Procedure in the Instruction Manual should be followed with the data of the insert being substituted for the appropriate steps.

EQUIPMENT REQUIRED

(8.) One Tektronix Type K Plug-In Unit. The other plug-in used may be any of the letter series plug-in units with a vertical input connector on the front panel.

(9.) The Calibration Tools in Figure 7-1 along with Walsco tool #2519, Tektronix Part Number 003-003.

ADJUSTMENT PROCEDURE

Preliminary

Remove the side covers and bottom plate from the Power Supply and Indicator Unit to be calibrated. Install the Type K in the Lower Beam Compartment and the other vertical plug-in in the Upper Beam Compartment. Set the front-panel controls for both beams as follows:

INTENSITY	full counterclockwise
HORIZ DISPLAY (Upper Beam)	'A' X1
HORIZ DISPLAY (Lower Beam)	'B' X1

TIME-BASE UNITS

LEVEL (Type 21A and 22A)	full counterclockwise
VERNIER (Type 21A and 22A)	midrange
SLOPE (Type 21A and 22A)	+
COUPLING (Type 21A and 22A)	AC
SOURCE (Type 21A)	UPPER BEAM
SOURCE (Type 22A)	LOWER BEAM
SWEEP FUNCTION (Type 21A and 22A)	NORMAL
TIME/CM (Type 21A and 22A)	.5 mSEC
VARIABLE (Type 21A and 22A)	CALIBRATED (full clockwise)

Vertical Plug-In Units

AC/DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED

NOTE

Settings for all controls not listed above are not pertinent to this part of the procedure and the controls may be left in any position. The letter 'A' is used throughout the procedure as an abbreviation for "TIME BASE A" and the letter 'B' for "TIME BASE B".

Check the rear panel of the instrument to be sure the metal strap between the CRT CATHODE and GROUND binding posts for both beams are in place, and that the CRT CATHODE selector switches are at the CRT CATHODE position. Connect the instrument and the (0-105 or 0-300 volt) ac meter to the autotransformer output and turn on all equipment. Adjust the autotransformer to the design-center voltage for which your instrument is wired (117 or 234 volts) and allow at least 5 minutes warmup before making any adjustments.

1. Low-Voltage Power Supplies

Measure the output voltage of the -150 v, +100 v, +225 v, +350 v and +500 v supplies at the points indicated on the Power Supply Unit (see Figure 7-2). Be sure your meter is accurate (see Equipment Required, (1)). The output voltage of the -150 v supply must be between -147 v and -153 v, and the other regulated supplies must be within 2% of their rated values. You should be able to set the -150 ADJ (see Power Supply Unit, Figure 7-3) so that all of these voltages are within the specified tolerance. Bear in mind that the calibration of the entire instrument is affected by changes in the power supply voltages. Don't adjust the -150 v unless one or more of the supplies is actually out of tolerance.

Connect the 0-10 volt ac meter between the test point shown in Figure 7-5 and ground. Adjust the REG HTR ADJ for a voltage reading of 6.3 VAC.

To check the above supplies for proper regulation, vary the autotransformer voltage between 105 v and 125 v (or from 210 v to 250 v if the power transformer is connected for 234 v operation). All of the regulated voltages should remain essentially constant.

The ripple present on any of the dc regulated supplies, as measured with one beam of the oscilloscope at the voltage check points, with the AMPLITUDE CALIBRATOR OFF, and the sweep for the other beam not operating are listed below.

Typical Ripple Amplitudes

Supply Voltage	Typical Ripple
-150 v	5 mv + 50% at 105 and 125 v
+100 v	10 mv + 50% at 105 and 125 v
+225 v	5 mv
+350 v	20 mv + 50% at 105 and 125 v
+500 v	20 mv + 50% at 105 and 125 v

When using one beam for ripple measurements, place the controls of the beam used for measuring as follows: TIME/CM Control at 5 mSEC, the SOURCE switch at LINE, and the vertical plug-in input selector switch to AC. Use the coaxial cable and clip-lead adapter to connect the outer conductor to ground (chassis) and the center conductor to each test point. Adjust the LEVEL Control to obtain a stable display. If oscillations occur on the waveform, connect a 1K resistor in series with the center conductor.

4. Beam Rotation

If the CRT has been replaced, or if, due to considerable handling, the trace does not align with the graticule, you should make this adjustment before proceeding with the calibration.

Set both beams for free-running baseline by setting the SWEEP FUNCTION Control of both time-base units to AUTO BASELINE. Turn up the INTENSITY Controls and with no vertical signals applied, position the beam traces behind the appropriate horizontal centerlines of the graticule. Adjust the BEAM ROTATION Control (see Figure 7-5) so that the traces are parallel to the horizontal centerlines. The final setting of the BEAM ROTATION Control should be near the center of its rotation range.

If the BEAM ROTATION Control is not near the center of its rotation range, loosen the crt base connector clamp and rotate the crt a few degrees in the direction which will achieve this final mid-range setting. While aligning the crt, push it forward until it rests snugly against the graticule and tighten the connector clamp. Recheck the alignment of the traces.

8. Upper and Lower Astigmatism

Rotate both FOCUS Controls fully clockwise and place both HORIZ DISPLAY switches at the X10 EXT ATTEN position. Position both beams onto the screen, and adjust the UPPER ASTIG and LOWER ASTIG Controls so that both defocused spots are as nearly circular as possible. Adjust the FOCUS Controls so that both spots are in sharp focus. To sharpen the focus further, place both HORIZ DISPLAY switches at 'A' X1. Set the time-base trigger control of Time-Base 'A' at +SLOPE, AC COUPLING, and UPPER BEAM SOURCE. Rotate the TIME/CM Control to .5 mSEC. Set the vertical plug-in VOLTS/CM Controls at 1, the input selector AC-DC switch at AC, and position both beams to the appropriate horizontal centerlines. Connect a 1-volt signal from the AMPLITUDE CALIBRATOR to both upper and lower beam vertical input connectors. Adjust the LEVEL Control of Time-Base 'A' to obtain a stable display. Now readjust the Upper Beam FOCUS and UPPER ASTIG Controls for a sharper focus of the leading corner of one square-wave on the upper beam calibrator waveform. Adjust the Lower Beam FOCUS and LOWER ASTIG Controls for the same results on the lower beam calibrator waveform.

Replace all the steps under "Time-Base Trigger Circuit Adjustments" with the following.

TIME-BASE TRIGGER CIRCUIT ADJUSTMENTS

The time-base triggering adjustments that follow must be made in the indicated sequence. Controls not mentioned in a particular step are assumed to be in the positions they were last in during the previous step.

Each of the Trigger Circuits is set up in the same manner. Step 10 will tell how to use Time-Base 'B' as the test oscilloscope and step 10A will tell about using Time-Base 'A' as the test oscilloscope.

NOTE

> For accessibility to the adjustments it is suggested that the Type 21A be in the TIME-BASE A compartment and the Type 22A in the TIME-BASE B compartment.

10. Trigger Level for Time-Base A (Type 21A)

Remove the Time-Base Unit, attach the Time-Base Plug-In Extension and install the unit with extension in the TIME BASE A compartment of the Type 555.

Set the Lower Beam HORIZ DISPLAY switch to 'A' X1 and the TIME BASE A controls as follows.

SLOPE	+
COUPLING	AC
SOURCE	LOWER BEAM

SWEEP FUNCTION	NORMAL
TIME/CM	.1 mSEC

Set the Upper Beam Plug-In controls to:

AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED

Place the Upper Beam HORIZ DISPLAY switch at 'B' X1 and TIME BASE B controls to:

SLOPE	+
COUPLING	AC
SOURCE	LINE
SWEEP FUNCTION	AUTO BASELINE
TIME/CM	1 mSEC

Position the 'A' VERNIER Control to its mechanical center. Now center the upper beam trace at the upper horizontal centerline of the graticule and connect the 10X probe from the upper beam vertical input connector to pin 2 of V24.

Rotate the 'A' VERNIER Control to its mechanical center. Now center the upper beam trace at the upper horizontal centerline of the graticule and connect the 10X probe from the upper beam vertical input connector to pin 2 of V24.

Rotate the 'A' LEVEL knob until the upper trace is again at the upper horizontal centerline. Loosen the 'A' LEVEL knob and set it at zero position. Tighten the knob and recheck it for exact zero setting and no vertical shift of the upper beam trace by disconnecting and connecting the probe a few times at the junction. Disconnect the probe from the junction.

10A. Trigger Level for Time-Base B (Type 22A)

Remove the Time-Base Unit, attach the Time-Base Plug-In Extension and install the unit with extension in the TIME BASE B compartment of the Type 555.

Set the Lower Beam HORIZ DISPLAY switch to 'B' X1 and the TIME BASE B controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	LOWER BEAM
SWEEP FUNCTION	NORMAL
TIME/CM	.1 mSEC

Set the upper beam plug-in controls to:

AC-DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED

Place the Upper Beam HORIZ DISPLAY switch at 'A' X1 and the TIME BASE A controls to:

SLOPE	+
COUPLING	AC
SOURCE	LINE
SWEEP FUNCTION	AUTO BASELINE
TIME/CM	1 mSEC

Position the VERNIER Control to its mechanical center. Now center the upper beam trace at the upper horizontal centerline of the graticule and connect the 10X probe from the upper beam vertical input connector to pin 2 of V24.

Rotate the 'B' LEVEL knob until the upper beam trace is again at the upper horizontal centerline. Tighten the knob and recheck it for exact zero setting and no vertical shift of the upper beam trace by disconnecting and connecting the probe a few times at the junction. Disconnect the probe from the junction.

11. Tunnel Diode Adjustment

Reset the following:

Time-Base being calibrated

SOURCE	LOWER BEAM
TIME/CM	.5 mSEC
TD BIAS	full counterclockwise

Type 555

AMPLITUDE CALIBRATOR	1 VOLT
HORIZ DISPLAY (Lower Beam)	X1 of Time-Base being calibrated

Lower Vertical Plug-In

VOLTS/CM	1
AC-DC	DC
VARIABLE	CALIBRATED

Connect a jumper from the CAL OUT connector to the INPUT connector of the Type K. Rotate the TD BIAS Control clockwise and note the point at which a stable display appears; continue to rotate the control until the display free-runs. Set the TD BIAS Control halfway between the two points noted above.

Connect ½ cm of 30MC sine-waves from a Type 190 to the INPUT connector of the Type K. Reset the VOLTS/CM Control of the Type K to 1 and the TIME/CM switch of the Time-Base being calibrated to .1 μSEC. A stable display should appear. If necessary the LEVEL Control may be adjusted. Now turn the SOURCE Control on the unit under calibration to UPPER BEAM. The display should not trigger at any position of the LEVEL Control.

Remove all connections.

12. Adjusting Stability

Reset the following controls:

Time-Base under calibration

SOURCE	LOWER BEAM
TIME/CM	.5 mSEC

Lower Vertical Plug-In

VOLTS/CM	1

Upper Vertical Plug-In

VOLTS/CM	5

Connect a jumper from the CAL OUT connector to the INPUT connector of the Lower Vertical Plug-In. Connect the 10X probe from the Upper Vertical Plug-In to the junction of R111 and R114 in the unit being calibrated.

Rotate the STABILITY Control fully counterclockwise. Turn the STABILITY Control clockwise until the Lower Beam display just appears. Now set the Upper Beam trace on the top most graticule line. Start rotating the STABILITY Control clockwise again until the display free-runs. Note the distance the Upper Beam trace has moved on the CRT. Now rotate the STABILITY Control counterclockwise until the Upper Beam trace is halfway between the top most graticule line and the point noted when the display free-ran.

Remove all connections.

13. Lockout Level

Set the SWEEP FUNCTION switch to SINGLE SWEEP and adjust the LOCKOUT LEVEL Control to midrange. Set the VOLTS/CM Control of the Upper Beam Plug-In to 1 and connect a 10X probe from it to pin 7 of V125.

Push the PUSH TO RESET button. The ready light inside the button should light. If it does not, the STABILITY Control should be adjusted slightly counterclockwise until the READY light does light after pushing the button.

The READY light will normally alternate between ready (lamp lit) and not ready (lamp not lit) as the PUSH TO RESET button is depressed. With the ready lamp lit, set the upper beam trace to its centerline. Depress the PUSH TO RESET button to extinguish the lamp. Now adjust the LOCKOUT LEVEL for a difference of ten volts between the ready and the not ready conditions. Recheck the voltage difference by repeating the procedure.

Apply a square-wave signal of 1 VOLT from the CAL OUT to the INPUT of the Type K. Depress the PUSH TO RESET button. One sweep should occur each time the button is pushed.

Remove all connections.

14. Upper Beam Internal Trigger DC Level

Reset the following controls:

Time-Base being calibrated

SOURCE	UPPER BEAM
COUPLING	DC
SWEEP FUNCTION	NORMAL
TIME/CM	5 mSEC

Type 555 Oscilloscope

HORIZ DISPLAY (Upper Beam)	X1 of Time-Base being calibrated.

Upper Beam Plug-In

VOLTS/CM	0.5

Connect a 10X probe from the Upper Beam Plug-In to the junction of R5 and C5 in the Time-Base under calibration. Connect a jumper from ground to the junction of R18 and R19 in the unit being calibrated. Now rotate the UPPER BEAM TRIG DC LEVEL and if necessary the positioning control on the Upper Beam Plug-In until a stable display is obtained which starts positive at the upper beam horizontal centerline.

Leave all connections.

15. Lower Beam Internal Trigger DC Level

Set the SOURCE Control on the Time-Base under calibration to LOWER BEAM. Remove the 10X probe which now connects to the Upper Beam Plug-In. Install a T connector on the plug-in. Now attach the probe to the plug-in through the T connector. Connect a jumper from the other connection on the T connector, of the Upper Beam Plug-In, to the INPUT of the Type K. Set the VOLTS/CM Control of the Type K to 0.5.

Rotate the LOWER BEAM TRIG DC LEVEL and if necessary the positioning control on the Lower Beam Plug-In until a stable display is obtained which starts positive at the upper beam horizontal centerline.

Leave all connections as they are.

16. Trigger Level Centering

Turn the SOURCE switch of the Time-Base under calibration to UPPER BEAM. Now adjust the TRIG LEVEL CENT until the start of the waveform remains stationary as the SLOPE switch is moved from + to -.

Lower and Upper Beam Internal Trigger DC Level adjustments will interact with this adjustment, so it will be necessary to recheck these adjustments again.

Remove all connections at the completion of this step.

At this point the calibration procedure of the Type 555 manual is again used. Where the manual refers to a Type 21, substitute the Type 21A and for the references to Type 22 use the Type 22A.

Type 555

Electrical Parts List

C331	X7000-up	.005μf	cer	fixed	500v		283-001
C431	X7000-up	.005μf	cer	fixed	500v		283-001
R331	7000-up	12.1 meg	1/2w	fixed	prec	1%	309-268
R332	7000-up	5 meg	1/2w	fixed	prec	1%	309-414
R333†	7000-up	120k		var			311-425
R334	7000-up	10k	1/2w	fixed	comp	10%	302-103
R335	X7000-up	33k	1/2w	fixed	comp	10%	302-333
R336†	X7000-up	50k		var			311-425
R338	X7000-up	15k	1/2w	fixed	comp	10%	302-153
R431	7000-up	12.1 meg	1/2w	fixed	prec	1%	309-268
R432	7000-up	5 meg	1/2w	fixed	prec	1%	309-414
R433†	7000-up	120k		var			311-425
R434	7000-up	10k	1/2w	fixed	comp	10%	302-103
R435	X7000-up	33k	1/2w	fixed	comp	10%	302-333
R436†	X7000-up	50k		var			311-425
R438	X7000-up	15k	1/2w	fixed	comp	10%	302-153
R647	7000-up	800Ω	25w	fixed	WW	5%	308-155
R678	101-6999X	6k					
R736	7000-up	1k	25w	fixed	WW	5%	308-037
R737	7000-up	1k	25w	fixed	WW	5%	308-037
R738	7000-up	1k	25w	fixed	WW	5%	308-037

			Unwired	Wired
SW332	7000-up	Display Switch	260-270	262-613
SW432	7000-up	Display Switch	260-270	262-614

†R333, R336 and R433, R436 are ganged in pairs.

Type 22A
S/N 7000-up

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

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

Bulbs

B129	260-518	Part of SW101	READY	
B160W	150-002	Neon, NE-2	UNCALIBRATED	
B167	150-002	Neon, NE-2		
B170	150-002	Neon, NE-2		

Capacitors

Tolerance ±20% unless otherwise indicated.
Tolerance of all electrolytic capacitors are as follows (with exceptions):

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

C1	281-593	3.9pf	cer		500v	10%
C5	283-026	.2μf	Disc Type		25v	
C6	281-593	3.9pf	cer		500v	10%
C10	283-000	.001μf	Disc Type		500v	
C15	283-000	.001μf	Disc Type		500v	
C20	283-003	.01μf	Disc Type		150v	
C37	283-002	.01μf	Disc Type		500v	
C38	283-076	27pf	Disc Type		500v	
C40	283-076	27pf	Disc Type		500v	
C48	283-003	.01μf	Disc Type		150v	
C101	283-000	.001μf	Disc Type		500v	
C102	281-511	22pf	cer		500v	10%
C106	283-000	.001μf	Disc Type		500v	
C109	283-001	.005μf	Disc Type		500v	
C110	290-121	2μf	EMT		25v	
C112	285-572	.1μf	PTM		200v	
C117	283-001	.005μf	Disc Type		500v	
C123	281-504	10pf	cer		500v	10%
C129	283-001	.005μf	Disc Type		500v	
C131	281-549	68pf	cer		500v	10%
C134	281-501	4.7pf	cer		500v	±1pf
C138	283-002	.01μf	Disc Type		500v	
C141	281-503	8pf	cer		500v	±.5pf
C150	281-528	82pf	cer		500v	10%
C160A	281-007	3-12pf	cer	var		
C160B	283-534	82pf	Mica		500v	5%
C160C	281-010	4.5-25pf	cer	var		
C160D	283-534	82pf	Mica		500v	5%
C160E	281-010	4.5-25pf	cer	var		
C160F	*291-008	.001μf				1/2%

C160G		.01µf				
C160H	*291-007	.1µf		Timing Series		1/2%
C160J		1µf				
C165	281-528	82pf	cer		500v	10%
C167	283-000	.001µf	Disc Type		500v	
C174	281-513	27pf	cer		500v	
C180A	283-536	220pf	Mica		500v	10%
C180B	285-543	.0022µf	MT		400v	
C180C	285-515	.022µf	MT		400v	
C180D	285-526	.1µf	MT		400v	
C180E	285-526	.1µf	MT		400v	
C181	281-517	39pf	cer		500v	10%
C186	283-000	.001µf	Disc Type		500v	
C191	281-550	120pf	cer		500v	10%
C193	283-006	.02µf	Disc Type		600v	
C195	281-509	15pf	cer		500v	10%
C198	283-001	.005µf	Disc Type		500v	

Diodes

D24	152-141	Silicon	1N3605			
D25	152-141	Silicon	1N3605			
D38	152-125	Tunnel	TD 3A	4.7 MA		
D40	152-077	Back	BD 1			
D45	152-125	Tunnel	TD 3A	4.7 MA		
D122	152-008	Germanium	T12G			
D132	152-008	Germanium	T12G			
D134	152-061	Silicon		100 MA	200v	PIV
D135	152-061	Silicon		100 MA	200v	PIV

Inductors

L24	276-507	Core, Ferramic Suppressor		
L25	276-507	Core, Ferramic Suppressor		
T40	*120-329	Toroid	15T	TD111
L42	*120-291	Toroid	15T	TD81
LR149	*180-173	1.59 mh		

Resistors

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

R1	301-105	1 meg	1/2w		5%
R2	301-434	430k	1/2w		5%
R3	311-110	100k		var	TRIG. DC LEVEL (Lower Beam)
R5	316-103	10k	1/4w		
R6	301-105	1 meg	1/2w		5%
R7	301-434	430k	1/2w		5%
R8	311-110	100k		var	TRIG. DC LEVEL (Upper Beam)
R12	302-105	1 meg	1/2w		
R15	316-474	470k	1/4w		
R16	316-474	470k	1/4w		
R17 R21	311-414	2 x 100k		var	TRIGGER LEVEL VERNIER
R18	316-563	56k	1/4w		
R19	302-475	4.7 meg	1/2w		

R20	316-185	1.8 meg	1/4w			
R22	316-470	47Ω	1/4w			
R23	316-470	47Ω	1/4w			
R26	311-328	1k		var	TRIG. LEVEL CENT.	
R28	308-108	15k	5w	WW		5%
R30	308-212	10k	3w	WW		5%
R32	316-471	470Ω	1/4w			
R33	316-471	470Ω	1/4w			
R34	316-471	470Ω	1/4w			
R35	316-471	470Ω	1/4w			
R36	317-101	100Ω	1/10w			5%
R37	302-101	100Ω	1/2w			
R38	302-333	33k	1w			
R40	317-101	100Ω	1/10w			5%
R41	302-273	27k	1/2w			
R42	316-470	47Ω	1/4w			
R43	304-223	22k	1w			
R44	311-110	100k		var	TD BIAS	
R45	316-101	100Ω	1/4w			
R47	304-273	27k	1w			
R48	302-154	150k	1/2w			
R49	316-562	5.6k	1/4w			
R100	302-184	180k	1/2w			
R101	302-226	22 meg	1/2w			
R102	302-223	22k	1/2w			
R103	302-102	1k	1/2w			
R104	302-105	1 meg	1/2w			
R105	302-394	390k	1/2w			
R106	302-105	1 meg	1/2w			
R107	302-470	47Ω	1/2w			
R108	302-103	10k	1/2w			
R109	302-224	220k	1/2w			
R110	302-103	10k	1/2w			
R111	311-026	100k		var	STABILITY	
R112	302-153	15k	1/2w			
R113	302-334	330k	1/2w			
R114	302-474	470k	1/2w			
R115	302-274	270k	1/2w			
R116	301-184	180k	1/2w			5%
R117	302-183	18k	1/2w			
R118	302-684	680k	1/2w			
R119	302-470	47Ω	1/2w			
R120	302-104	100k	1/2w			
R122	304-683	68k	1w			
R123	302-274	270k	1/2w			
R124	302-474	470k	1/2w			
R125	311-329	50k		var	LOCKOUT LEVEL	
R126	302-104	100k	1/2w			
R127	302-470	47Ω	1/2w			
R128	302-123	12k	1/2w			
R129	302-103	10k	1/2w			
R130	306-223	22k	2w			
R131	302-102	1k	1/2w			
R132	302-470	47Ω	1/2w			
R133	304-473	47k	1w			
R134	*310-555	6k	3w	Mica Plate	(3k Tap)	
R135	316-470	47Ω	1/4w			

R136	302-825	8.2 meg	1/2w			
R137	302-470	47Ω	1/2w			
R138	302-101	100Ω	1/2w			
R139	302-104	100k	1/2w			
R140	308-206	7.5k	5w	WW		5%
R141	310-070	33k	1w		Prec	1%
R143	310-072	30k	1w		Prec	1%
R144	308-053	8k	5w	WW		5%
R146	302-470	47Ω	1/2w			
R147	302-102	1k	1/2w			
R148	302-393	39k	1/2w			
R150	302-271	270Ω	1/2w			
R160A	309-045	100k	1/2w		Prec	1%
R160B	309-051	200k	1/2w		Prec	1%
R160C	309-003	500k	1/2w		Prec	1%
R160D	309-359	1.meg	1/2w		Prec	1/4%
R160E	309-023	2 meg	1/2w		Prec	1%
R160F	309-087	5 meg	1/2w		Prec	1%
R160G	310-107	10 meg	1w		Prec	1%
R160H	310-107	10 meg	1w		Prec	1%
R160J	310-505	30 meg	2w		Prec	1%
R160W	302-104	100k	1/2w			
R160X	302-103	10k	1/2w			
R160Y†	311-108	20k		var WW	VARIABLE	
R162	304-682	6.8k	1w			
R163	304-123	12k	1w			
R164	306-223	22k	2w			
R165	306-223	22k	2w			
R166	306-223	22k	2w			
R167	302-155	1.5 meg	1/2w			
R168	302-473	47k	1/2w			
R170	302-470	47Ω	1/2w			
R172	302-470	47Ω	1/2w			
R174	308-053	8k	5w	WW		5%
R175	302-470	47Ω	1/2w			
R176	311-008	2k		var	SWP. LENGTH	
R178	308-066	4.5k	5w	WW		5%
R180A	302-474	470k	1/2w			
R180B	302-475	4.7 meg	1/2w			
R181	302-475	4.7 meg	1/2w			
R182	302-470	47Ω	1/2w			
R183	302-470	47Ω	1/2w			
R186	302-104	100k	1/2w			
R188	304-104	100k	1w			
R190	302-225	2.2 meg	1/2w			
R191	302-104	100k	1/2w			
R192	302-470	47Ω	1/2w			
R193	302-101	100Ω	1/2w			
R194	306-683	68k	2w			
R195	302-473	47k	1/2w			
R196	301-114	110k	1/2w			5%
R197	302-470	47Ω	1/2w			
R198	302-470	47Ω	1/2w			
R199	304-472	4.7k	1w			

†Concentric with SW160Y. Furnished as a unit.

Switches

	Unwired	Wired		
SW8	260-558	*262-578	Rotary	SOURCE
SW10	260-145		Slide	COUPLING
SW22	260-212		Slide	SLOPE
SW101	260-518		Push Button w/Neon Bulb	RESET
SW120	260-556	*262-576	Rotary	SWEEP FUNCTION
SW160	260-275	*262-577	Rotary	TIME/CM
SW160Y †	311-108			

Transistors

Q24	151-120.	2N2475
Q34	151-120	2N2475
Q44	*151-108	Tek Spec.
Q104	151-055	2N398A

Electron Tubes

V24	154-187	6DJ8	
V114	154-022	6AU6	
V115	154-187	6DJ8	
V125	154-022	6AU6	
V133	154-187	6DJ8	
V135	154-187	6DJ8	
V145	154-047	12BY7	
V152	*157-075	12AL5	checked
V161	154-040	12AU6	
V173	154-187	6DJ8	
V183	154-187	6DJ8	
V193	154-187	6DJ8	

† Concentric with R160Y. Furnished as a unit.

Type 21A
S/N 7000-up

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

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

Bulbs

B129	260-518	Part of SW101	READY
B160W	150-002	Neon, NE-2	UNCALIBRATED
B167	150-002	Neon, NE-2	
B170	150-002	Neon, NE-2	

Capacitors

Tolerance ±20% unless otherwise indicated.
Tolerance of all electrolytic capacitors are as follows (with exceptions):

3V - 50v = -10%,+250%
51V - 350V = -10%,+100%
351V - 450V = -10%,+50%

C1	281-593	3.9pf	cer		500v	10%
C5	283-026	.2µf	Disc Type		25v	
C6	281-593	3.9pf	cer		500v	10%
C10	283-000	.001µf	Disc Type		500v	
C15	283-000	.001µf	Disc Type		500v	
C20	283-003	.01µf	Disc Type		150v	
C37	283-002	.01µf	Disc Type		500v	
C38	283-076	27pf	Disc Type		500v	
C40	283-076	27pf	Disc Type		500v	
C48	283-003	.01µf	Disc Type		150v	
C101	283-001	.005µf	Disc Type		500v	
C102	281-525	470pf	cer		500v	
C105	290-121	2µf	EMT		25v	
C108	285-572	.1µf	PTM		200v	
C112	283-001	.005µf	Disc Type		500v	
C123	281-504	10pf	Cer		500v	10%
C129	283-001	.005µf	Disc Type		500v	
C131	281-549	68pf	cer		500v	10%
C134	281-501	47pf	cer		500v	±1pf
C138	283-002	.01µf	Disc Type		500v	
C141	281-503	8pf	cer		500v	±.5pf
C150	281-528	82pf	cer		500v	10%
C160A	281-007	3-12pf	cer	var		
C160B	283-534	82pf	Mica		500v	5%
C160C	281-010	4.5-25pf	cer	var		
C160D	283-534	82pf	Mica		500v	5%
C160E	281-010	4.5-25pf	cer	var		
C160F	*291-008	.001µf				1/2%
C160G }		.01µf				
C160H }	*291-007	.1µf	Timing Series			1/2%
C160J }		1µf				

C165	281-528	82pf	cer	500v	10%
C167	283-000	.001µf	Disc Type	500v	
C174	281-513	27pf	cer	500v	
C180A	283-536	220pf	Mica	500v	10%
C180B	285-543	.0022µf	MT	400v	
C180C	285-515	.022µf	MT	400v	
C180D	285-526	.1µf	MT	400v	
C180E	285-526	.1µf	MT	400v	
C181	281-517	39pf	cer	500v	10%
C186	283-000	.001µf	Disc Type	500v	
C191	281-550	120pf	cer	500v	10%
C193	283-006	.02µf	Disc Type		600v
C195	281-509	15pf	cer	500v	10%
C198	283-001	.005µf	Disc Type	500v	

Diodes

D24	152-141	Silicon	1N3605			
D25	152-141	Silicon	1N3605			
D38	152-125	Tunnel	TD 3A	4.7MA		
D40	152-077	Back	BD1			
D45	152-125	Tunnel	TD 3A	4.7MA		
D108	152-061	Silicon		100MA	200v	PIV
D132	152-008	Germanium	T12G			
D134	152-061	Silicon		100MA	200v	PIV

Inductors

L24	276-507	Core, Ferramic Suppressor	
L25	276-507	Core, Ferramic Suppressor	
T40	*120-329	Toroid 15T	TD111
L42	*120-291	Toroid 15T	TD81
LR149	*108-173	1.59mh	

Resistors

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

R1	301-105	1 meg	1/2w			5%
R2	301-434	430k	1/2w			5%
R3	311-110	100k		var	TRIG. DC LEVEL (Lower Beam)	
R5	316-103	10k	1/4w			
R6	301-105	1 meg	1/4w			5%
R7	301-434	430k	1/2w			5%
R8	311-110	100k		var	TRIG. DC LEVEL (Upper Beam)	
R12	302-105	1 meg	1/2w			
R15	316-474	470k	1/4w			
R16	316-474	470k	1/4w			
R17 } R21 }	311-414	2 x 100k		var	TRIGGER LEVEL VERNIER	
R18	316-563	56k	1/4w			
R19	302-475	4.7 meg	1/2w			
R20	316-185	1.8 meg	1/4w			
R22	316-470	47Ω	1/4w			
R23	316-470	47Ω	1/4w			

R26	311-328	1k		var	TRIG. LEVEL CENT.	
R28	308-108	15k	5w	WW		5%
R30	308-212	10k	3w	WW		5%
R32	316-471	470Ω	1/4w			
R33	316-471	470Ω	1/4w			
R34	316-471	470Ω	1/4w			
R35	316-471	470Ω	1/4w			
R36	317-101	100Ω	1/10w			5%
R37	302-101	100Ω	1/2w			
R38	304-333	33k	1w			
R40	317-101	100Ω	1/10w			5%
R41	302-273	27k	1/2w			
R42	316-470	47Ω	1/4w			
R43	304-223	22k	1w			
R44	311-110	100k		var	TD BIAS	
R45	316-101	100Ω	1/4w			
R47	304-273	27k	1w			
R48	302-154	150k	1/2w			
R49	316-562	5.6k	1/4w			
R100	302-184	180k	1/2w			
R101	302-475	4.7 meg	1/2w			
R102	302-222	2.2k	1/2w			
R103	302-105	1 meg	1/2w			
R104	302-103	10k	1/2w			
R105	302-103	10k	1/2w			
R106	302-153	15k	1/2w			
R107	302-825	8.2 meg	1/2w			
R108	316-470	47Ω	1/4w			
R109	302-334	330k	1/2w			
R110	302-183	18k	1/2w			
R111	311-026	100k		var	STABILITY	
R112	302-104	100k	1/2w			
R113	304-473	47k	1w			
R114	302-474	470k	1/2w			
R115	302-274	270k	1/2w			
R116	301-184	180k	1/2w			5%
R119	302-470	47Ω	1/2w			
R121	302-472	4.7k	1/2w			
R122	302-183	18k	1/2w			
R123	302-274	270k	1/2w			
R124	302-474	470k	1/2w			
R125	311-329	50k		var	LOCKOUT LEVEL ADJ.	
R126	302-104	100k	1/2w			
R127	302-470	47Ω	1/2w			
R128	302-123	12k	1/2w			
R129	302-103	10k	1/2w			
R130	306-223	22k	2w			
R131	302-102	1k	1/2w			
R132	302-470	47Ω	1/2w			
R134	*310-555	6k	3w	Mica Plate (3k Tap)		
R137	302-470	47Ω	1/2w			
R138	302-101	100Ω	1/2w			
R139	302-104	100k	1/2w			
R140	308-206	7.5k	5w	WW		5%
R141	310-070	33k	1w	Prec		1%
R143	310-072	30k	1w	Prec		1%
R144	308-053	8k	5w	WW		5%

R146	302-470	47Ω	1/2w				
R147	302-102	1k	1/2w				
R148	302-393	39k	1/2w				
R150	302-271	270Ω	1/2w				
R160A	309-045	100k	1/2w	Prec			1%
R160B	309-051	200k	1/2w	Prec			1%
R160C	309-003	500k	1/2w	Prec			1%
R160D	309-359	1 meg	1/2w	Prec			1/4%
R160E	309-023	2 meg	1/2w	Prec			1%
R160F	309-087	5 meg	1/2w	Prec			1%
R160G	310-107	10 meg	1/2w	Prec			1%
R160H	310-107	10 meg	1/2w	Prec			1%
R160J	310-505	30 meg	2w	Prec			1%
R160W	302-104	100k	1/2w				
R160X	302-103	10k	1/2w				
R160Y†	311-108	20k		var	WW	VARIABLE	
R162	304-682	6.8k	1w				
R163	304-123	12k	1w				
R164	306-223	22k	2w				
R165	306-223	22k	2w				
R166	306-223	22k	2w				
R167	302-155	1.5 meg	1/2w				
R168	302-473	47k	1/2w				
R170	302-470	47Ω	1/2w				
R172	302-470	47Ω	1/2w				
R174	308-053	8k	5w			WW	5%
R175	302-470	47Ω	1/2w				
R176	311-008	2k		var		SWP. LENGTH	
R178	308-066	4.5k	5w		WW		5%
R180A	302-474	470k	1/2w				
R180B	302-475	4.7 meg	1/2w				
R181	302-475	4.7 meg	1/2w				
R183	302-470	47Ω	1/2w				
R186	302-104	100k	1/2w				
R188	304-104	100k	1w				
R190	302-225	2.2 meg	1/2w				
R191	302-104	100k	1/2w				
R192	302-470	47Ω	1/2w				
R193	302-101	100Ω	1/2w				
R194	306-683	68k	2w				
R195	302-473	47k	1/2w				
R196	301-114	110k	1/2w				5%
R197	302-470	47Ω	1/2w				
R198	302-470	47Ω	1/2w				
R199	304-472	4.7k	1w				

Switches

	Unwired	Wired		
SW8	260-558	*262-578	Rotary	SOURCE
SW10	260-145		Slide	COUPLING
SW22	260-212		Slide	SLOPE
SW101	260-518		Push Button	RESET w/Neon Bulb
SW128	260-557	*262-574	Rotary	SWEEP FUNCTION
SW160	260-275	*262-575	Rotary	TIME/CM
SW160Y†	311-108			

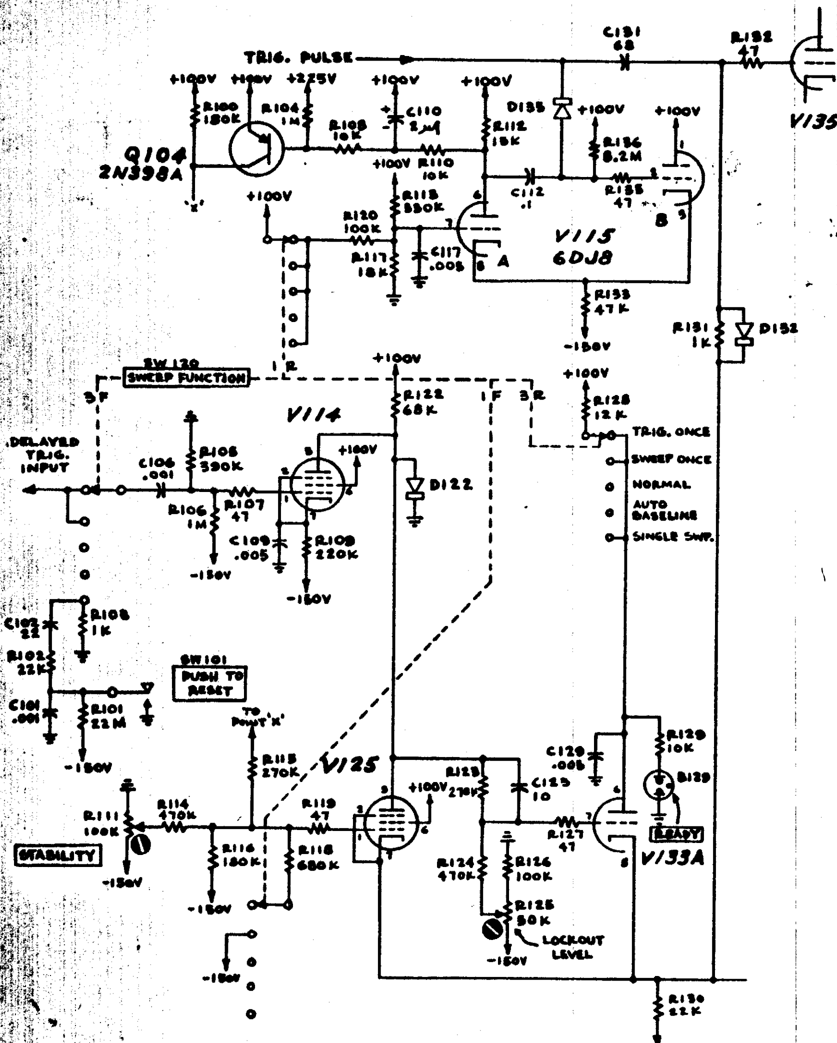
† R160Y and SW160Y are concentric. Furnished as a unit.

Transistors

Q24	151-120	2N2475
Q34	151-120	2N2475
Q44	*151-108	Tek Spec.
Q104	151-055	2N398A

Electron Tubes

V24	154-187	6DJ8	
V115	154-187	6DJ8	
V125	154-022	6AU6	
V133	154-187	6DJ8	
V135	154-187	6DJ8	
V145	154-047	12BY7	
V152	*157-075	12AL5	checked
V161	154-040	12AU6	
V173	154-187	6DJ8	
V183	154-187	6DJ8	
V193	154-187	6DJ8	



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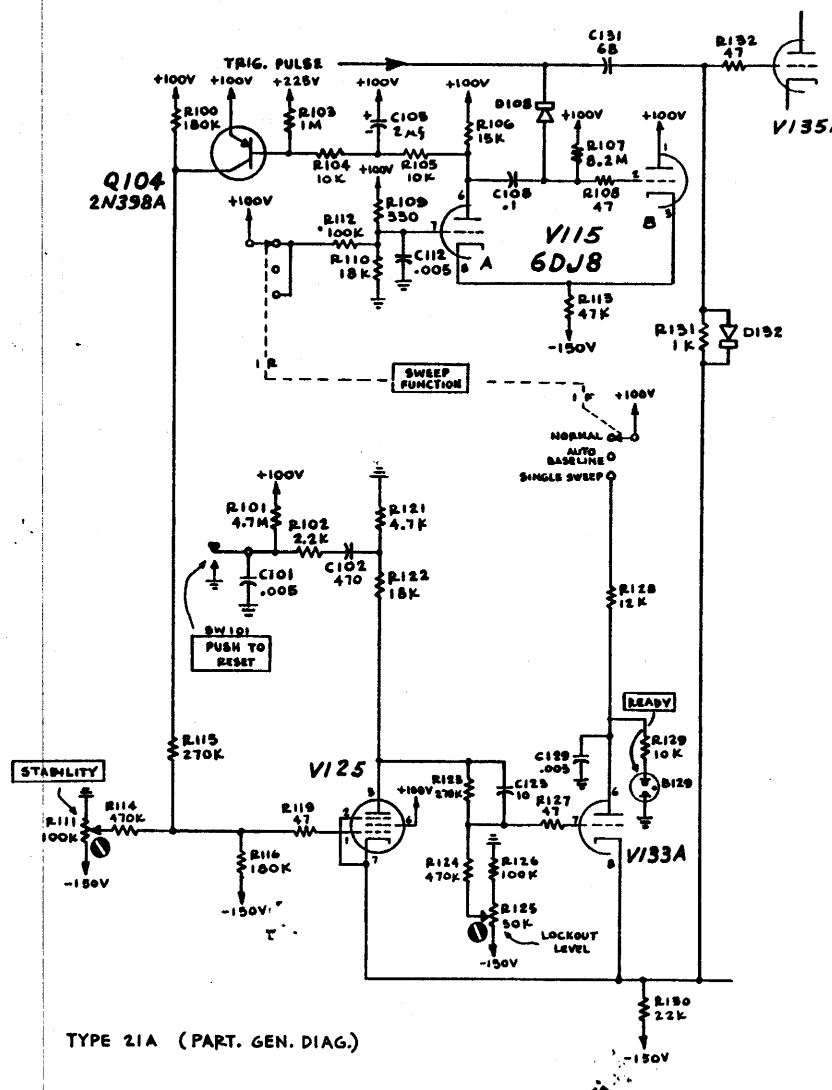

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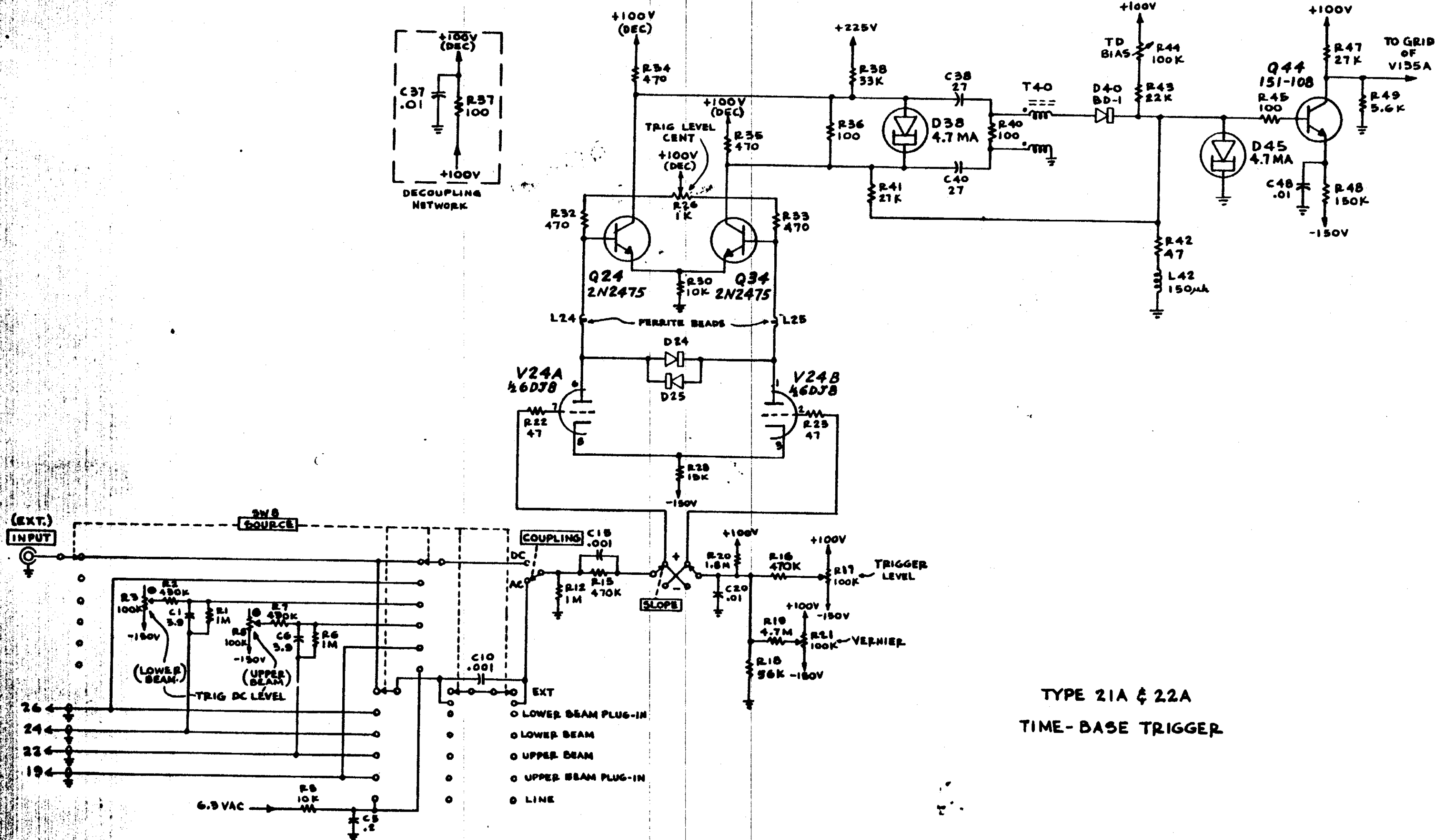
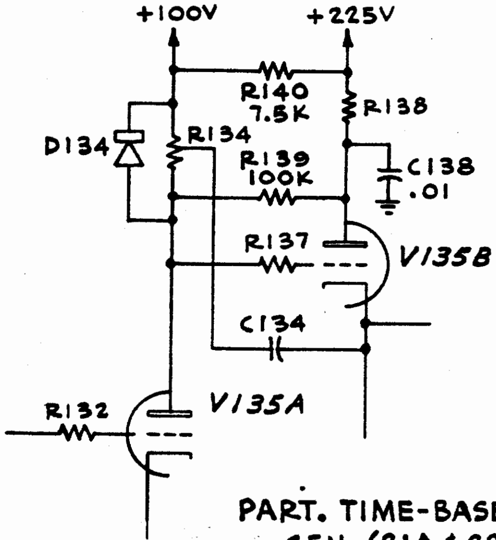
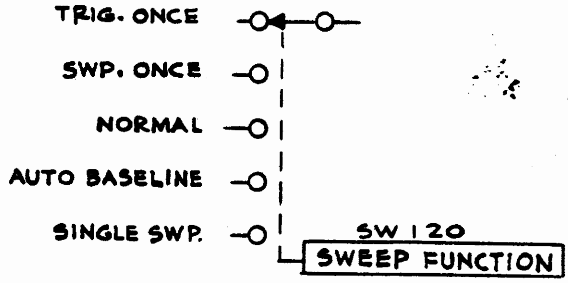


TYPE 21A & 22A

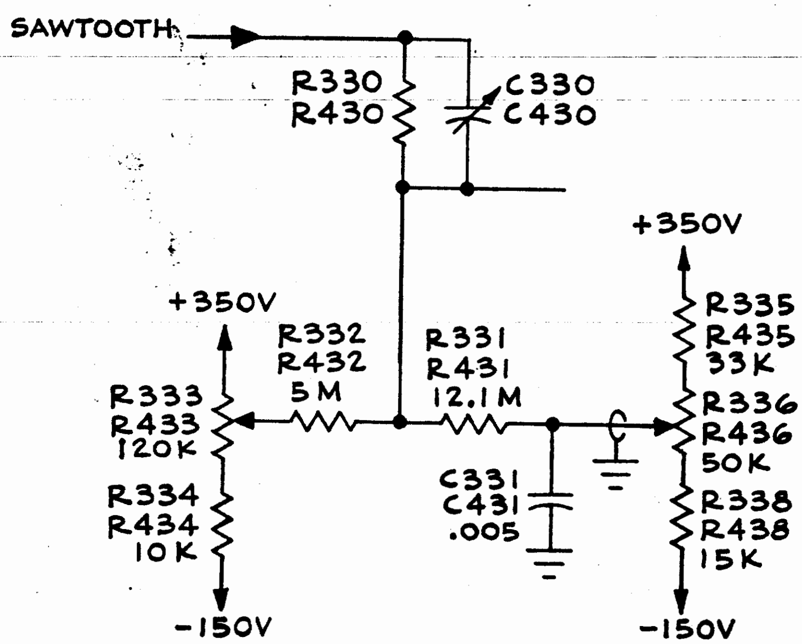
TIME-BASE TRIGGER



PART. TIME-BASE
GEN. (21A & 22A)



PART. 22A TIME-BASE
GEN.



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PART. DIAG. UPR-LWR BM.
HORIZ. AMP.

INSTRUCTION MANUAL

TYPE 555

CATHODE-RAY OSCILLOSCOPE

Extract for 21 and 22 non-A

Tektronix, Inc.

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

Tektronix International A.G.

Terrassenweg 1A ● Zug, Switzerland ● PH. 042-49192 ● Cable: Tekintag, Zug Switzerland ● Telex 53.574

070-165

PARTS LIST

TYPE 21

Bulbs

		Tektronix Part Number
B129	Type NE-2 Neon Bulb	150-002
B160W	Type NE-2 Neon Bulb	150-002
B167	Type NE-2 Neon Bulb	150-002
B170	Type NE-2 Neon Bulb	150-002

Capacitors

C1		10 μμf	Cer.	Fixed	500 v	±1 μμf	281-504
C2	X4730-up	.01 μf	Cer.	Fixed	500 v		283-002
C5	X4730-up	.01 μf	Cer.	Fixed	500 v		283-002
C6		10 μμf	Cer.	Fixed	500 v	±1 μμf	281-504
C10		.001 μf	Cer.	Fixed	500 v		283-000
C11	101-679X	.001 μf	Cer.	Fixed	500 v		283-000
C15		.001 μf	Cer.	Fixed	500 v		283-000
C20		.001 μf	Cer.	Fixed	500 v		283-000
C24		47 μμf	Cer.	Fixed	500 v	20%	281-518
C31		.01 μf	PTM	Fixed	100 v	10%	285-554
C37		22 μμf	Cer.	Fixed	500 v	20%	281-511
C47		.005 μf	Cer.	Fixed	500 v		283-001
C101		.005 μf	Cer.	Fixed	500 v		283-001
C102		470 μμf	Cer.	Fixed	500 v	±94 μμf	281-525
C116		.001 μf	Cer.	Fixed	500 v		283-000
C123		10 μμf	Cer.	Fixed	500 v	10%	281-504
C129		.005 μf	Cer.	Fixed	500 v		283-001
C131		27 μμf	Cer.	Fixed	500 v	±4.5 μμf	281-513
C134		4.7 μμf	Cer.	Fixed	500 v	±1 μμf	281-501
C138		.01 μf	Cer.	Fixed	500 v		283-002
C141		8 μμf	Cer.	Fixed	500 v	±0.5 μμf	281-503
C150		82 μμf	Cer.	Fixed	500 v	10%	281-528
C160A		3-12 μμf	Cer.	Var.			281-007
C160B		82 μμf	Mica	Fixed	500 v	5%	283-534
C160C		4.5-25 μμf	Cer.	Var.			281-010
C160D		82 μμf	Mica	Fixed	500 v	5%	283-534
C160E		4.5-25 μμf	Cer.	Var.			281-010
C160F		.001 μf	Mylar	Fixed		±½%	*291-008
C160G,H,J	.01 μf, .1 μf, 1 μf	Mylar Timing Series				±½%	*291-007
C165		82 μμf	Cer.	Fixed	500 v	10%	281-528
C167		.001 μf	Cer.	Fixed	500 v		283-000
C174		27 μμf	Cer.	Fixed	500 v	±5.4 μμf	281-513
C180A		220 μμf	Mica	Fixed	500 v	10%	283-536
C180B		.0022 μf	PTM	Fixed	400 v	20%	285-543
C180C		.022 μf	PTM	Fixed	400 v	20%	285-515
C180D		.1 μf	PTM	Fixed	400 v		285-526
C180E		.1 μf	PTM	Fixed	400 v		285-526

Capacitors *(continued)*

							Tektronix Part Number
C181		39 μμf	Cer.	Fixed	500 v	10%	281-517
C186		.001 μf	Cer.	Fixed	500 v		283-000
C191		120 μμf	Cer.	Fixed			281-550
C193		.02 μf	Cer.	Fixed	600 v		283-006
C195		18 μμf	Cer.	Fixed	500 v	10%	281-542
C198		.005 μf	Cer.	Fixed	500 v		283-001

Diodes

D132	X1433-up	Diode, Germanium, Type T12G	152-008

Inductors

LR149	1.59 mh	108-173
L1	Ferrite Bead, Parasitic Suppressor	276-507
L6	Ferrite Bead, Parasitic Suppressor	276-507

Resistors

R1	1 meg	½ w	Fixed	Comp.	10%	302-105
R2	390 k	½ w	Fixed	Comp.	10%	302-394
R3	50 k	.2 w	Var.	Comp.	±20%	311-125
R4	100 k	½ w	Fixed	Comp.	10%	302-104
R6	1 meg	½ w	Fixed	Comp.	10%	302-105
R7	390 k	½ w	Fixed	Comp.	10%	302-394
R8	50 k	.2 w	Var.	Comp.	±20%	311-125
R9	100 k	½ w	Fixed	Comp.	10%	302-104
R12	1 meg	½ w	Fixed	Comp.	10%	302-105
R15	470 k	½ w	Fixed	Comp.	10%	302-474
R17	100 k	2 w	Var.	Comp.		311-026
R18	22 k	½ w	Fixed	Comp.	10%	302-223
R19	470 k	½ w	Fixed	Comp.	10%	302-474
R20	56 k	½ w	Fixed	Comp.	10%	302-563
R22	47 Ω	½ w	Fixed	Comp.	10%	302-470
R23	47 Ω	½ w	Fixed	Comp.	10%	302-470
R24	4.7 k	1 w	Fixed	Comp.	10%	304-472
R25	4.7 k	1 w	Fixed	Comp.	10%	304-472
R28	33 k	2 w	Fixed	Comp.	10%	306-333
R29	39 k	2 w	Fixed	Comp.	10%	306-393
R31	47 k	½ w	Fixed	Comp.	10%	302-473
R32	47 k	½ w	Fixed	Comp.	10%	302-473
R33	47 Ω	½ w	Fixed	Comp.	10%	302-470
R34	680 Ω	½ w	Fixed	Comp.	10%	302-681
R35	1.5 k	½ w	Fixed	Comp.	10%	302-152
R37	100 k	½ w	Fixed	Comp.	10%	302-104
R38	100 k	½ w	Fixed	Comp.	10%	302-104
R39	100 k	.2 w	Var.	Comp.	±20%	311-088
R40	2.7 meg	½ w	Fixed	Comp.	10%	302-275
R41	47 Ω	½ w	Fixed	Comp.	10%	302-470
R43	1.5 k	½ w	Fixed	Comp.	10%	302-152
R46	18 k	1 w	Fixed	Comp.	10%	304-183
R47	500 Ω	.2 w	Var.	Comp.	20%	311-066
R48	18 k	1 w	Fixed	Comp.	10%	304-183
R101	4.7 meg	½ w	Fixed	Comp.	10%	302-475

							Tektronix Part Number
R102		2.2 k	½ w	Fixed	Comp.	10%	302-222
R111		100 k	2 w	Var.	Comp.		311-026
R114		470 k	½ w	Fixed	Comp.	10%	302-474
R115		100 k	½ w	Fixed	Comp.	5%	301-104
R116		180 k	½ w	Fixed	Comp.	5%	301-184
R118		680 k	½ w	Fixed	Comp.	10%	302-684
R119		47 Ω	½ w	Fixed	Comp.	10%	302-470
R121	101-589	1 k	½ w	Fixed	Comp.	10%	use 302-472
R121	590-up	4.7 k	½ w	Fixed	Comp.	10%	302-472
R122	101-589	22 k	½ w	Fixed	Comp.	10%	use 302-183
R122	590-up	18 k	½ w	Fixed	Comp.	10%	302-183
R123		270 k	½ w	Fixed	Comp.	10%	302-274
R124		470 k	½ w	Fixed	Comp.	10%	302-474
R125		50 k	.2 w	Var.	Comp.	±20%	311-125
R126		100 k	½ w	Fixed	Comp.	10%	302-104
R127		47 Ω	½ w	Fixed	Comp.	10%	302-470
R128		12 k	½ w	Fixed	Comp.	10%	302-123
R129		10 k	½ w	Fixed	Comp.	10%	302-103
R130		22 k	2 w	Fixed	Comp.	10%	306-223
R131		1 k	½ w	Fixed	Comp.	10%	302-102
R132		47 Ω	½ w	Fixed	Comp.	10%	302-470
R134		6 k	2 w	Fixed	Prec.	1%	310-555
R137		47 Ω	½ w	Fixed	Comp.	10%	302-470
R138		100 Ω	½ w	Fixed	Comp.	10%	302-101
R141		33 k	1 w	Fixed	Prec.	1%	310-070
R143		30 k	1 w	Fixed	Prec.	1%	310-072
R144		8 k	5 w	Fixed	WW	5%	308-053
R146		47 Ω	½ w	Fixed	Comp.	10%	302-470
R147		1 k	½ w	Fixed	Comp.	10%	302-102
R148		39 k	½ w	Fixed	Comp.	10%	302-393
R150		270 Ω	½ w	Fixed	Comp.	10%	302-271
R160A		100 k	½ w	Fixed	Prec.	1%	309-045
R160B		200 k	½ w	Fixed	Prec.	1%	309-051
R160C		500 k	½ w	Fixed	Prec.	1%	309-003
R160D	101-1679	1 meg	½ w	Fixed	Prec.	1%	Use 309-359
R160D	1680-up	1 meg	½ w	Fixed	Prec.	¼%	309-359
R160E		2 meg	½ w	Fixed	Prec.	1%	309-023
R160F		5 meg	½ w	Fixed	Prec.	1%	309-087
R160G		10 meg	1 w	Fixed	Prec.	1%	310-107
R160H		10 meg	1 w	Fixed	Prec.	1%	310-107
R160J		30 meg	2 w	Fixed	Prec.	1%	310-505
R160W		100 k	½ w	Fixed	Comp.	10%	302-104
R160X		10 k	½ w	Fixed	Comp.	10%	302-103
R160Y		20 k		Fixed	WW	±10%	311-108
R162	101-3519	6.8 k	½ w	Fixed	Comp.	10%	302-682
R162	3520-up	6.8 k	1 w	Fixed	Comp.	10%	Use 304-682
R163	101-3519	12 k	½ w	Fixed	Comp.	10%	302-123
R163	3520-up	12 k	1 w	Fixed	Comp.	10%	Use 304-123
R164		22 k	2 w	Fixed	Comp.	10%	306-223
R165		22 k	2 w	Fixed	Comp.	10%	306-223
R166		22 k	2 w	Fixed	Comp.	10%	306-223
R167		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R168		47 k	½ w	Fixed	Comp.	10%	302-470
R170		47 Ω	½ w	Fixed	Comp.	10%	302-470
R172		47 Ω	½ w	Fixed	Comp.	10%	302-473

Resistors *(continued)*

							Tektronix Part Number
R174		8 k	5 w	Fixed	WW	5%	308-053
R175		47 Ω	½ w			10%	302-470
R176		2 k	2 w	Var.	Comp.		311-008
R178		4 k	5 w	Fixed	WW	5%	308-051
R180A		470 k	½ w	Fixed	Comp.	10%	302-474
R180B		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R181		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R183		47 Ω	½ w	Fixed	Comp.	10%	302-470
R186		100 k	½ w	Fixed	Comp.	10%	302-104
R188		100 k	1 w	Fixed	Comp.	10%	use 304-104
R190		2.2 meg	½ w	Fixed	Comp.	10%	302-225
R191		100 k	½ w	Fixed	Comp.	10%	302-104
R192		47 Ω	½ w	Fixed	Comp.	10%	302-470
R193		100 Ω	½ w	Fixed	Comp.	10%	302-101
R194		68 k	2 w	Fixed	Comp.	10%	306-683
R195		47 k	½ w	Fixed	Comp.	10%	302-473
R196	101-589	100 k	½ w	Fixed	Comp.	10%	use 301-114
R196	590-up	110 k	½ w	Fixed	Comp.	5%	301-114
R197		47 Ω	½ w	Fixed	Comp.	10%	302-470
R198		47 Ω	½ w	Fixed	Comp.	10%	302-470
R199		4.7 k	1 w	Fixed	Comp.	10%	304-472

Switches

			Wired	Unwired
SW8		Source Switch	262-193	260-271
SW10		Switch Coupling		260-145
SW17	101-679	Level Switch	262-192	260-272
SW17	680-up	Level Switch	262-381	260-354
SW22		Switch Slope		260-212
SW101		Switch Reset		260-247
SW128		Sweep Function Switch	262-197	260-273
SW160	101-1432	Time/Cm	262-191	260-275
	1433-up	Time/Cm	262-418	260-275

Vacuum Tubes

V24	6DJ8	154-187
V45	6DJ8	154-187
V125	6AU6	154-022
V133	6DJ8	154-187
V135	6DJ8	154-187
V145	12BY7	154-047
V152	12AL5	154-038
V161	12AU6	154-040
V173	6DJ8	154-187
V183	6DJ8	154-187
V193	6DJ8	154-187

Type 21
Mechanical Parts List

	Tektronix Part Number
BUSHING, $^{3}/_{8}$-32 x $^{9}/_{16}$ x .412	358-010
BUSHING, HEX, PANEL, $^{3}/_{8}$-32 x $^{13}/_{32}$	358-029
BUSHING, NYLON, FOR 5-WAY, BINDING POST	358-036
BRACKET, CHASSIS SUPPORT	406-425
BRACKET, TIME/CM SWITCH	406-489
CABLE, HARNESS, SWEEP #1 (SN 101-1432)	179-288
CABLE, HARNESS, SWEEP #1 (SN 1433-up)	179-535
CABLE, HARNESS, SWEEP #2 (SN 101-1432)	179-289
CABLE, HARNESS, SWEEP #2 (SN 1433-up)	179-536
CHASSIS	441-255
CLAMP, #20 WIRE FOR NEON BULBS	343-043
CONNECTOR, CHASSIS MTD., 1 CONTACT, FEMALE, UHF	131-081
CONNECTOR, CHASSIS MTD., 32 CONTACT, MALE, AMPH.	131-096
COUPLING, POT	376-014
FOOT, WHITE NYLON	348-023
GROMMET, RUBBER, $^{1}/_{4}$	348-002
GROMMET, RUBBER, $^{5}/_{16}$	348-003
GROMMET, RUBBER, $^{3}/_{8}$	348-004
HOLDER, NEON BULB, SINGLE	352-008
KNOB, SMALL BLACK, $^{1}/_{4}$" HOLE PART WAY	366-033
KNOB, SMALL RED, $^{3}/_{16}$ HOLE PART WAY	366-038
KNOB, LARGE BLACK,	366-058
KNOB, SMALL BLACK, W/HOLE THRU	366-070
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. #10	210-010
LOCKWASHER, INT., $^{1}/_{4}$	210-011
LOCKWASHER, INT., POT, $^{3}/_{8}$ x $^{1}/_{2}$	210-012
LOCKWASHER, INT., $^{3}/_{8}$ x $^{11}/_{16}$	210-013
LOCKWASHER, SPRING, #5	210-117
LUG, SOLDER, SE4	210-201
LUG, SOLDER, SE6 W/2 WIRE HOLES	210-202
LUG, SOLDER, SE10, LONG	210-206
LUG, SOLDER, POT, PLAIN, $^{3}/_{8}$	210-207

	Tektronix Part Number
NUT, HEX, 4-40 x $^3/_{16}$	210-406
NUT, HEX, 6-32 x $^1/_4$	210-407
NUT, HEX, $^3/_8$-32 x $^1/_2$	210-413
NUT, HEX, 10-32 x $^3/_8$ x $^1/_8$	210-436
NUT, HEX, $^1/_4$-28 x $^3/_8$ x $^3/_{32}$	210-455
NUT, KEPS, 6-32 x $^5/_{16}$	210-457
NUT, HEX, $^3/_8$-32 x $^1/_2$ x $^{11}/_{16}$	210-494
PANEL, FRONT	333-444
PLATE, SUBPANEL, FRONT	386-870
PLATE, REAR	387-570
POST, BINDING, 5-WAY	129-036
POST, BINDING, ASS'Y	129-051
ROD, EXTENSION, NYLON, RED	384-179
ROD, EXTENSION, STEEL	384-183
ROD, FRAME, ALUMINUM (SN 101-650)	384-515
ROD, FRAME, BRASS W/CHROME PLATE (SN 651-up)	384-566
ROD, DELRIN $^5/_{16}$ x $^{15}/_{16}$ W/2 #44 CROSS HOLES	385-135
SCREW, 4-40 x $^5/_{16}$ BHS	211-011
SCREW, 4-40 x $^3/_8$ BHS	211-012
SCREW, 4-40 x 1 FHS	211-031
SCREW, 4-40 x $^5/_{16}$ FHS, PHILLIPS	211-038
SCREW, 6-32 x $^5/_{16}$ BHS	211-507
SCREW, 6-32 x $^5/_{16}$ FHS, 100°, CSK, PHILLIPS	212-538
SCREW, 8-32 x $^1/_2$ FHS, 100°, PHILLIPS	212-043
SCREW, 8-32 x $^1/_2$ RHS, PHILLIPS	212-044
SCREW, 5-32 x $^3/_{16}$ PAN H STEEL, THREAD CUTTING, PHILLIPS	213-044
SPACER, NYLON, $^3/_{16}$, FOR CERAMIC STRIPS	361-008
SOCKET, STM7G	136-008
SOCKET, STM9G	136-015
STRIP, CERAMIC, $^3/_4$ x 9 NOTCHES, CLIP MTD.	124-090
STRIP, CERAMIC, $^3/_4$ x 11 NOTCHES, CLIP MTD.	124-091
TAG, S/N INSERT	334-679
WASHER, STEEL, 6L x $^3/_8$ x .032	210-803
WASHER, STEEL, .390 x $^9/_{16}$ x .020	210-840

PARTS LIST

TYPE 22

Bulbs

B129	Type NE-2 Neon Bulb	150-002
B160W	Type NE-2 Neon Bulb	150-002
B167	Type NE-2 Neon Bulb	150-002
B170	Type NE-2 Neon Bulb	150-002

Capacitors

C1		10 μμf	Cer.	Fixed	500 v	±1 μμf	281-504
C6		10 μμf	Cer.	Fixed	500 v	±1 μμf	281-504
C10		.001 μf	Cer.	Fixed	500 v		283-000
C11	101-679X	.001 μf	Cer.	Fixed	500 v		283-000
C15		.001 μf	Cer.	Fixed	500 v		283-000
C20		.001 μf	Cer.	Fixed	500 v		283-000
C24		47 μμf	Cer.	Fixed	500 v	20%	281-518
C31		.01 μf	PTM	Fixed	100 v	10%	285-554
C37		22 μμf	Cer.	Fixed	500 v	20%	281-511
C47		.005 μf	Cer.	Fixed	500 v		283-001
C101		.001 μf	Cer.	Fixed	500 v		283-000
C102		22 μμf	Cer.	Fixed	500 v	20%	281-511
C106		.001 μf	Cer.	Fixed	500 v		283-000
C109		.005 μf	Cer.	Fixed	500 v		283-001
C116		.001 μf	Cer.	Fixed	500 v		283-000
C123		10 μμf	Cer.	Fixed	500 v	±1 μμf	281-504
C129		.005 μf	Cer.	Fixed	500 v		283-001
C131		27 μμf	Cer.	Fixed	500 v	±4.5 μμf	281-513
C134		4.7 μμf	Cer.	Fixed	500 v	±1 μμf	281-501
C138		.01 μf	Cer.	Fixed	500 v		283-002
C141		8 μμf	Cer.	Fixed	500 v	±0.5 μμf	281-503
C150		82 μμf	Cer.	Fixed	500 v	10%	281-528
C160A		3-12 μμf	Cer.	Var.			281-007
C160B		82 μμf	Mica	Fixed	500 v	5%	283-534
C160C		4.5-25 μμf	Cer.	Var.			281-010
C160D		82 μμf	Mica	Fixed	500 v	5%	283-534
C160E		4.5-25 μμf	Cer.	Var.			281-010
C160F		.001 μf	Mylar	Fixed		±½%	*291-008
C160G		.01 μf }					
C160H		.1 μf }		Mylar Timing Series		±½%	*291-007
C160J		.1 μf }					
C165		82 μμf	Cer.	Fixed	500 v	10%	281-528
C167		.001 μf	Cer.	Fixed	500 v		283-000
C174		27 μμf	Cer.	Fixed	500 v	20%	281-513
C180A		220 μμf	Mica	Fixed	500 v	10%	283-536
C180B		.0022 μf	PTM	Fixed	400 v	20%	285-542

Capacitors *(continued)*

C180D	.1 μf	PTM	Fixed	400 v		285-526
C180E	.1 μf	PTM	Fixed	400 v		285-526
C181	39 μμf	Cer.	Fixed	500 v	10%	281-517
C186	.001 μf	Cer.	Fixed	500 v		283-000
C191	120 μμf	Cer.	Fixed	500 v		281-550
C193	.02 μf	Cer.	Fixed	600 v		283-006
C195	18 μμf	Cer.	Fixed	500 v		281-542
C198	.005 μf	Cer.	Fixed	500 v		283-001

Inductors

LR149	1.59 mh	108-173
L1	Ferrite Bead, Parasitic Suppressor	276-507
L6	Ferrite Bead, Parasitic Suppressor	276-507

Resistors

R1	1 meg	½ w	Fixed	Comp.	10%	302-105
R2	390 k	½ w	Fixed	Comp.	10%	302-394
R3	50 k	.2 w	Var.	Comp.	20%	311-125
R4	100 k	½ w	Fixed	Comp.	10%	302-104
R6	1 meg	½ w	Fixed	Comp.	10%	302-105
R7	390 k	½ w	Fixed	Comp.	10%	302-394
R8	50 k	.2 w	Var.	Comp.	20%	311-125
R9	100 k	½ w	Fixed	Comp.	10%	302-104
R12	1 meg	½ w	Fixed	Comp.	10%	302-105
R15	470 k	½ w	Fixed	Comp.	10%	302-474
R17	100 k	2 w	Var.	Comp.		311-026
R18	22 k	½ w	Fixed	Comp.	10%	302-223
R19	470 k	½ w	Fixed	Comp.	10%	302-474
R20	56 k	½ w	Fixed	Comp.	10%	302-563
R22	47 Ω	½ w	Fixed	Comp.	10%	302-470
R23	47 Ω	½ w	Fixed	Comp.	10%	302-470
R24	4.7 k	1 w	Fixed	Comp.	10%	304-472
R25	4.7 k	1 w	Fixed	Comp.	10%	304-472
R28	33 k	2 w	Fixed	Comp.	10%	306-333
R29	39 k	2 w	Fixed	Comp.	10%	306-393
R31	47 k	½ w	Fixed	Comp.	10%	302-473
R32	47 k	½ w	Fixed	Comp.	10%	302-473
R33	47 Ω	½ w	Fixed	Comp.	10%	302-470
R34	680 Ω	½ w	Fixed	Comp.	10%	302-681
R35	1.5 k	½ w	Fixed	Comp.	10%	302-152
R37	100 k	½ w	Fixed	Comp.	10%	302-104
R38	100 k	½ w	Fixed	Comp.	10%	302-104
R39	100 k	.2 w	Var.	Comp.	20%	311-088
R40	2.7 meg	½ w	Fixed	Comp.	10%	302-275
R41	47 Ω	½ w	Fixed	Comp.	10%	302-470
R43	1.5 k	½ w	Fixed	Comp.	10%	302-152
R46	18 k	1 w	Fixed	Comp.	10%	304-183
R47	500 Ω	.2 w	Var.	Comp.	20%	311-066
R48	18 k	1 w	Fixed	Comp.	10%	304-183
R101	22 meg	½ w	Fixed	Comp.	10%	302-226

R102		22 k	½ w	Fixed	Comp.	10%	302-223
R103		1 k	½ w	Fixed	Comp.	10%	302-102
R105		390 k	½ w	Fixed	Comp.	10%	302-394
R106		1 meg	½ w	Fixed	Comp.	10%	302-105
R107		47 Ω	½ w	Fixed	Comp.	10%	302-470
R109		220 k	½ w	Fixed	Comp.	10%	302-224
R111		100 k	2 w	Var.	Comp.		311-026
R114		470 k	½ w	Fixed	Comp.	10%	302-474
R115		100 k	½ w	Fixed	Comp.	5%	301-104
R116		180 k	½ w	Fixed	Comp.	5%	301-184
R118		680 k	½ w	Fixed	Comp.	10%	302-684
R119		47 Ω	½ w	Fixed	Comp.	10%	302-470
R122		68 k	1 w	Fixed	Comp.	10%	304-683
R123		270 k	½ w	Fixed	Comp.	10%	302-274
R124		470 k	½ w	Fixed	Comp.	10%	302-474
R125		50 k	.2 w	Var.	Comp.	20%	311-125
R126		100 k	½ w	Fixed	Comp.	10%	302-104
R127		47 Ω	½ w	Fixed	Comp.	10%	302-470
R128		12 k	½ w	Fixed	Comp.	10%	302-123
R129		10 k	½ w	Fixed	Comp.	10%	302-103
R130		22 k	2 w	Fixed	Comp.	10%	306-223
R131		1 k	½ w	Fixed	Comp.	10%	302-102
R132		47 Ω	½ w	Fixed	Comp.	10%	302-470
R134		6 k	3 w	Fixed	Prec.		310-555
R137		47 Ω	½ w	Fixed	Comp.	10%	302-470
R138		100 Ω	½ w	Fixed	Comp.	10%	302-101
R141		33 k	1 w	Fixed	Prec.	1%	310-070
R143		30 k	1 w	Fixed	Prec.	1%	310-072
R144		8 k	5 w	Fixed	WW	5%	308-053
R146		47 Ω	½ w	Fixed	Comp.	10%	302-470
R147		1 k	½ w	Fixed	Comp.	10%	302-102
R148		39 k	½ w	Fixed	Comp.	10%	302-393
R150		270 Ω	½ w	Fixed	Comp.	10%	302-271
R160A		100 k	½ w	Fixed	Prec.	1%	309-045
R160B		200 k	½ w	Fixed	Prec.	1%	309-051
R160C		500 k	½ w	Fixed	Prec.	1%	309-003
R160D	101-1679	1 meg	½ w	Fixed	Prec.	1%	Use 309-359
R160D	1680-up	1 meg	½ w	Fixed	Prec.	¼%	309-359
R160E		2 meg	½ w	Fixed	Prec.	1%	309-023
R160F		5 meg	½ w	Fixed	Prec.	1%	309-087
R160G		10 meg	1 w	Fixed	Prec.	1%	310-107
R160H		10 meg	1 w	Fixed	Prec.	1%	310-107
R160J		30 meg	2 w	Fixed	Prec.	1%	310-505
R160W		100 k	½ w	Fixed	Comp.	10%	302-104
R160X		10 k	½ w	Fixed	Comp.	10%	302-103
R160Y		20 k		Var.	WW	10%	311-108
R162		6.8 k	1 w	Fixed	Comp.	10%	Use 304-682
R163		12 k	1 w	Fixed	Comp.	10%	Use 304-123
R164		22 k	2 w	Fixed	Comp.	10%	306-223
R165		22 k	2 w	Fixed	Comp.	10%	306-223
R166		22 k	2 w	Fixed	Comp.	10%	306-223

R167		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R168		47 k	½ w	Fixed	Comp.	10%	302-473
R170		47 Ω	½ w	Fixed	Comp.	10%	302-470
R172		47 Ω	½ w	Fixed	Comp.	10%	302-470
R174		8 k	5 w	Fixed	WW	5%	308-053
R176		2 k	2 w	Var.	Comp.		311-008
R178		4 k	5 w	Fixed	WW	5%	308-051
R180A		470 k	½ w	Fixed	Comp.	10%	302-474
R180B		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R181		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R182		47 Ω	½ w	Fixed	Comp.	10%	302-470
R183		47 Ω	½ w	Fixed	Comp.	10%	302-470
R186		100 k	½ w	Fixed	Comp.	10%	302-104
R188	X2410-up	100 k	1 w	Fixed	Comp.	10%	304-104
R190		2.2 meg	½ w	Fixed	Comp.	10%	302-225
R191		100 k	½ w	Fixed	Comp.	10%	302-104
R192		47 Ω	½ w	Fixed	Comp.	10%	302-470
R193		100 Ω	½ w	Fixed	Comp.	10%	302-101
R194		68 k	2 w	Fixed	Comp.	10%	306-683
R195		47 k	½ w	Fixed	Comp.	10%	302-473
R196		110 k	½ w	Fixed	Comp.	5%	301-114
R197		47 Ω	½ w	Fixed	Comp.	10%	302-470
R198		47 Ω	½ w	Fixed	Comp.	10%	302-470
R199		4.7 k	1 w	Fixed	Comp.	10%	304-472

Switches

			Wired	Unwired
SW8		Source Switch	262-193	260-271
SW10		Switch Coupling		260-145
SW17	101-679	Level Switch	262-192	260-272
SW17	680-up	Level Switch	262-381	260-354
SW22		Switch Slope		260-212
SW101		Switch Reset		260-247
SW120		Sweep Function	262-194	260-274
SW160		Time/Cm	262-191	260-275

Vacuum Tubes

V24	6DJ8	154-187
V45	6DJ8	154-187
V114	6AU6	154-022
V122	T12G, Diode	152-008
V125	6AU6	154-022
V132	T12G, Diode	152-008
V133	6DJ8	154-187
V135	6DJ8	154-187
V145	12BY7	154-047
V152	12AL5	154-038
V161	12AU6	154-040
V173	6DJ8	154-187
V183	6DJ8	154-187
V193	6DJ8	154-187

Type 22
Mechanical Parts List

	Tektronix Part Number
BRACKET, CHASSIS SUPPORT	406-425
BRACKET, TIME/CM SWITCH	406-489
BUSHING, 3/8-32 x 9/16 x .412	358-010
BUSHING, PANEL, 3/8-32 x 13/32 x .252	358-029
BUSHING, NYLON, FOR 5-WAY BINDING POST	358-036
CABLE, HARNESS, SWEEP #1	179-286
CABLE, HARNESS, SWEEP #2	179-287
CHASSIS	441-229
CLAMP, #20 WIRE FOR NEON BULB	343-043
CONNECTOR, CHASSIS MTG., COAX, 1 CONTACT, FEMALE, UHF	131-081
CONNECTOR, CHASSIS MTG., 32 CONTACT, FEMALE, AMPH.	131-097
COUPLING, POT	376-014
FOOT, WHITE NYLON	348-023
GROMMET, RUBBER, 1/4	348-002
GROMMET, RUBBER, 5/16	348-003
GROMMET, RUBBER, 3/8	348-004
HOLDER, NEON BULB, SINGLE	352-008
KNOB, SMALL BLACK, 1/4 HOLE PART WAY	366-033
KNOB, SMALL RED, 1/4 HOLE PART WAY	366-038
KNOB, LARGE BLACK	366-058
KNOB, SMALL BLACK, W/HOLE THRU	366-070
LOCKWASHER, INT. #4	210-004
LOCKWASHER, INT. #6	210-006
LOCKWASHER, INT. #10	210-010
LOCKWASHER, INT. 1/4	210-011
LOCKWASHER, INT., POT, 3/8 x 1/2	210-012
LOCKWASHER, INT., 3/8 x 11/16	210-013
LOCKWASHER, SPRING, #5	210-017
LUG, SOLDER, SE4	210-201
LUG, SOLDER, SE6 W/2 WIRE HOLES	210-202
LUG, SOLDER, SE10, LONG	210-206
LUG, SOLDER, POT, PLAIN, 3/8	210-207
NUT, HEX, 4-40 x 3/16	210-406
NUT, HEX, 6-32 x 1/4	210-407

	Tektronix Part Number
NUT, HEX, 3/8-32 x 1/2	210-413
NUT, HEX, 1/4-28 x 3/8 x 3/32	210-455
NUT, KEPS, 6-32 x 5/16	210-457
NUT, HEX, 3/8-32 x 1/2 x 11/16	210-494
PANEL, FRONT	333-445
PLATE, SUBPANEL, FRONT	386-870
PLATE, REAR	387-570
POST, BINDING, 5-WAY	129-036
POST, BINDING, METAL ASS'Y	129-051
ROD, EXTENSION, NYLON, RED	384-179
ROD, EXTENSION, STEEL	384-183
ROD, FRAME, ALUMINUM (SN 101-650)	348-515
ROD, FRAME, BRASS W/CHROME PLATE (SN 651-up)	348-566
ROD, DELRIN, 5/16 x 15/16 W/2 #44 CROSS HOLES	385-135
SCREW, 4-40 x 5/16 BHS	211-011
SCREW, 4-40 x 3/8 BHS	211-012
SCREW, 4-40 x 1 FHS	211-031
SCREW, 4-40 x 5/16 FHS, PHILLIPS	211-038
SCREW, 6-32 x 5/16 BHS	211-507
SCREW, 6-32 x 5/16 FHS, 100°, CSK, PHILLIPS	211-538
SCREW, 8-32 x 1/2 FHS, 100°, PHILLIPS	212-043
SCREW, 8-32 x 1/2 RHS, PHILLIPS	212-044
SCREW, 5-32 x 3/16 PAN HS, THREAD CUTTING	213-044
SOCKET, STM7G	136-008
SOCKET, STM9G	136-015
SPACER, NYLON, 3/16, FOR CERAMIC STRIP	361-008
STRIP, CERAMIC, 3/4 x 9 NOTCHES, CLIP MTD.	124-090
STRIP, CERAMIC, 3/4 x 9 NOTCHES, CLIP MTD.	124-091
TAG, SN INSERT	334-679
WASHER, STEEL, 6L x 3/8 x .032	210-803
WASHER, STEEL, 8S x 3/8 x .032	210-804

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.

TYPES 21, 22 (3)
Mod. 6431

	21 Eff. SN 4310		22 Eff. SN 4320	
V152	Change to	12AL5	Checked	157-075

MOD 6860

Type 21 - Tent S/N 4970

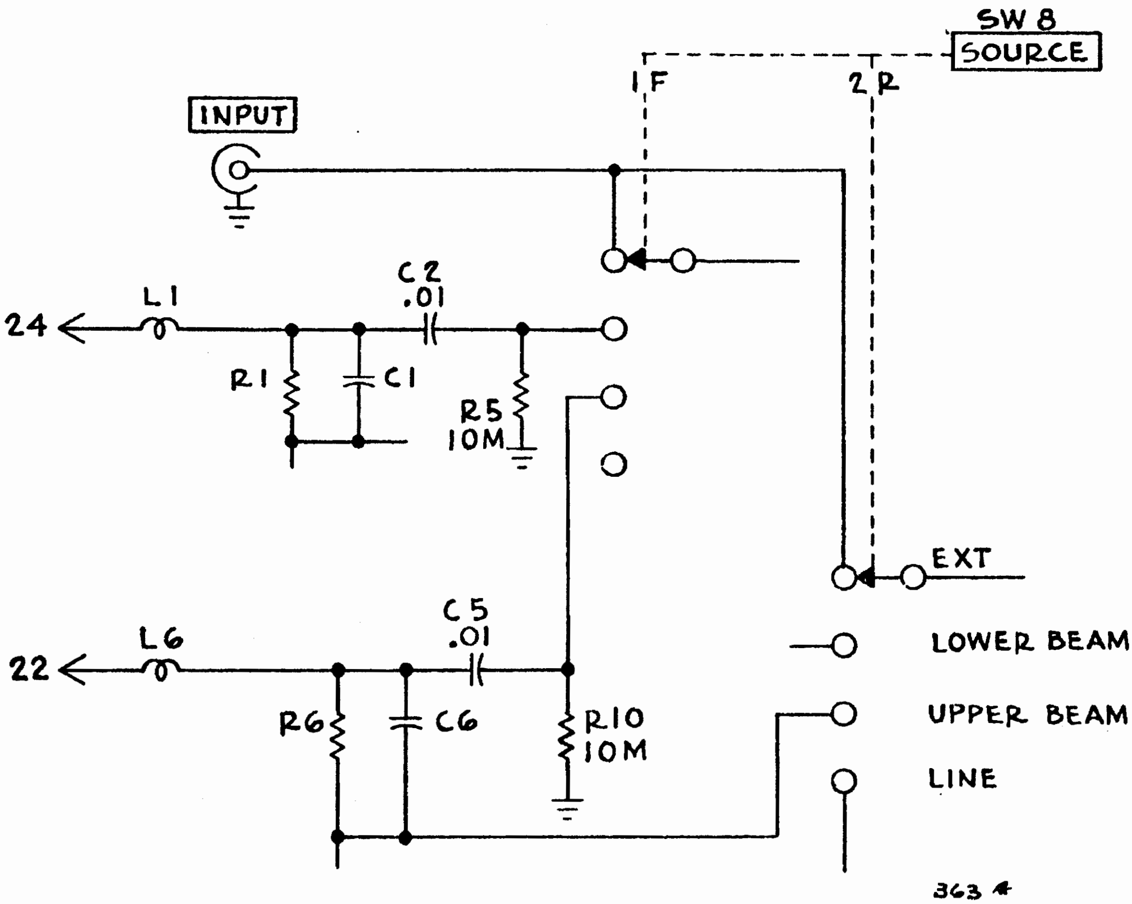
Type 22 - Tent S/N 4990

Connectors	Change to	Chassis Mtg.	"D" hole BNC	131-126

TYPE 21, 22 Plug-in
MOD 6779
21, Tent S/N 4730
22, Tent S/N 4750

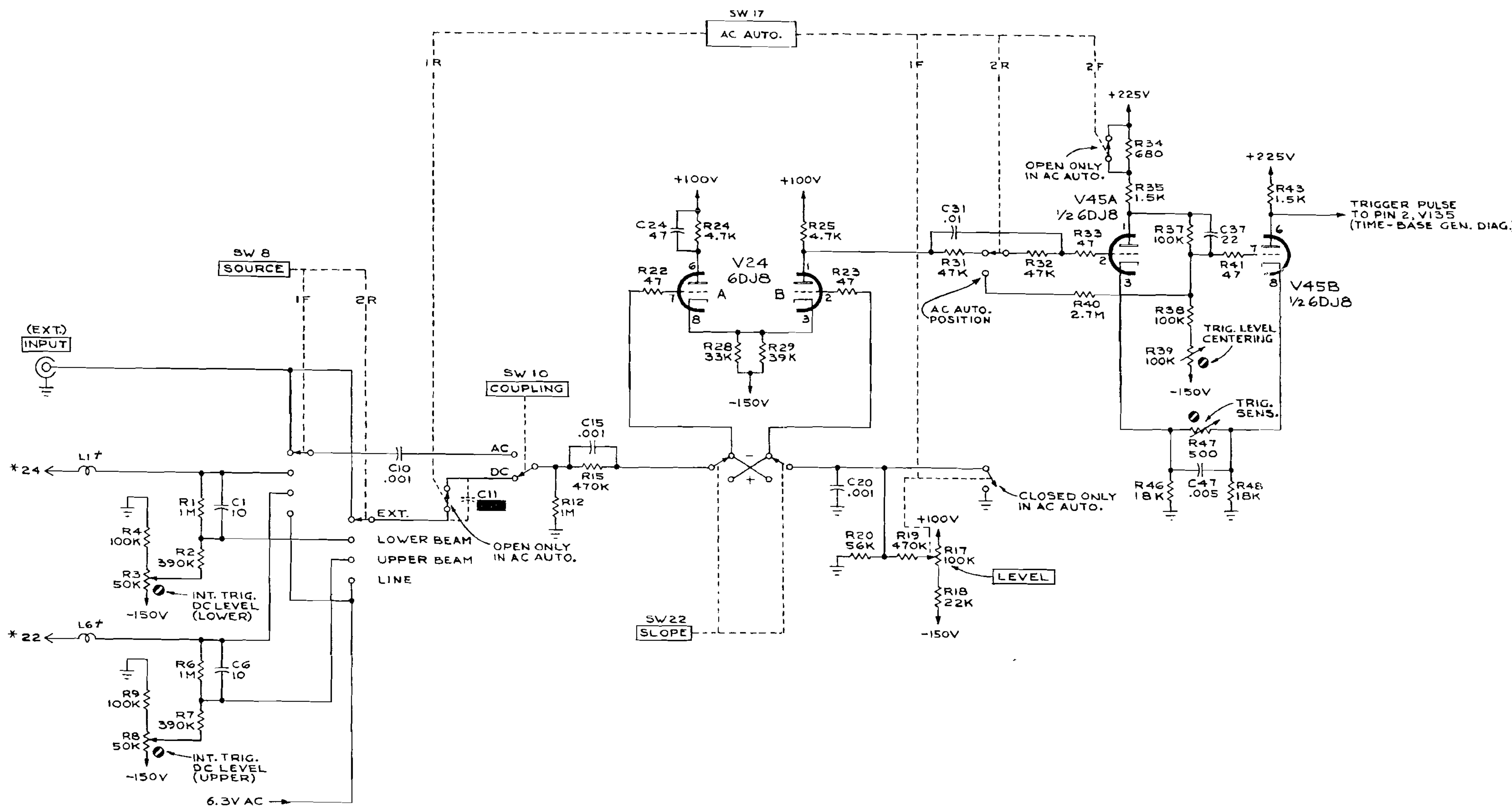
SW8	Change to				222-560
C2	Add	.01 µf	Cer.	500v	283-002
C5	Add	.01 µf	Cer.	500v	283-002
R5	Add	10 meg	1/2w	10%	302-106
R10	Add	10 meg	1/2w	10%	302-106

As per schematic attached.



PART. TIME-BASE TRIG. DIAG.
MOD 6779

SWITCH DETAIL



NOTE:
* INDICATES PINS ON INTERCONNECTING PLUG.
† FERRITE BEAD, PARASITIC SUPPRESSOR.

TYPE 21 TIME-BASE UNIT
TYPE 22 TIME-BASE UNIT

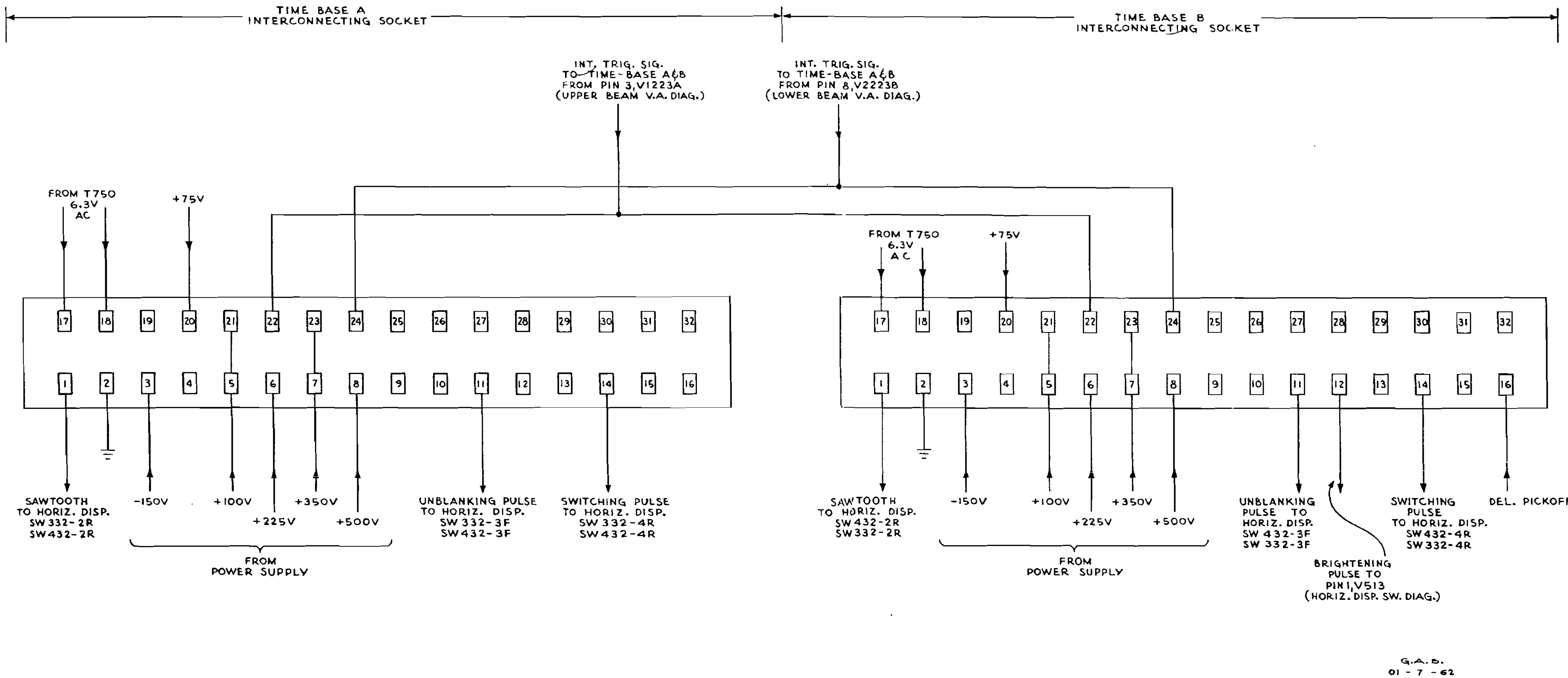
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

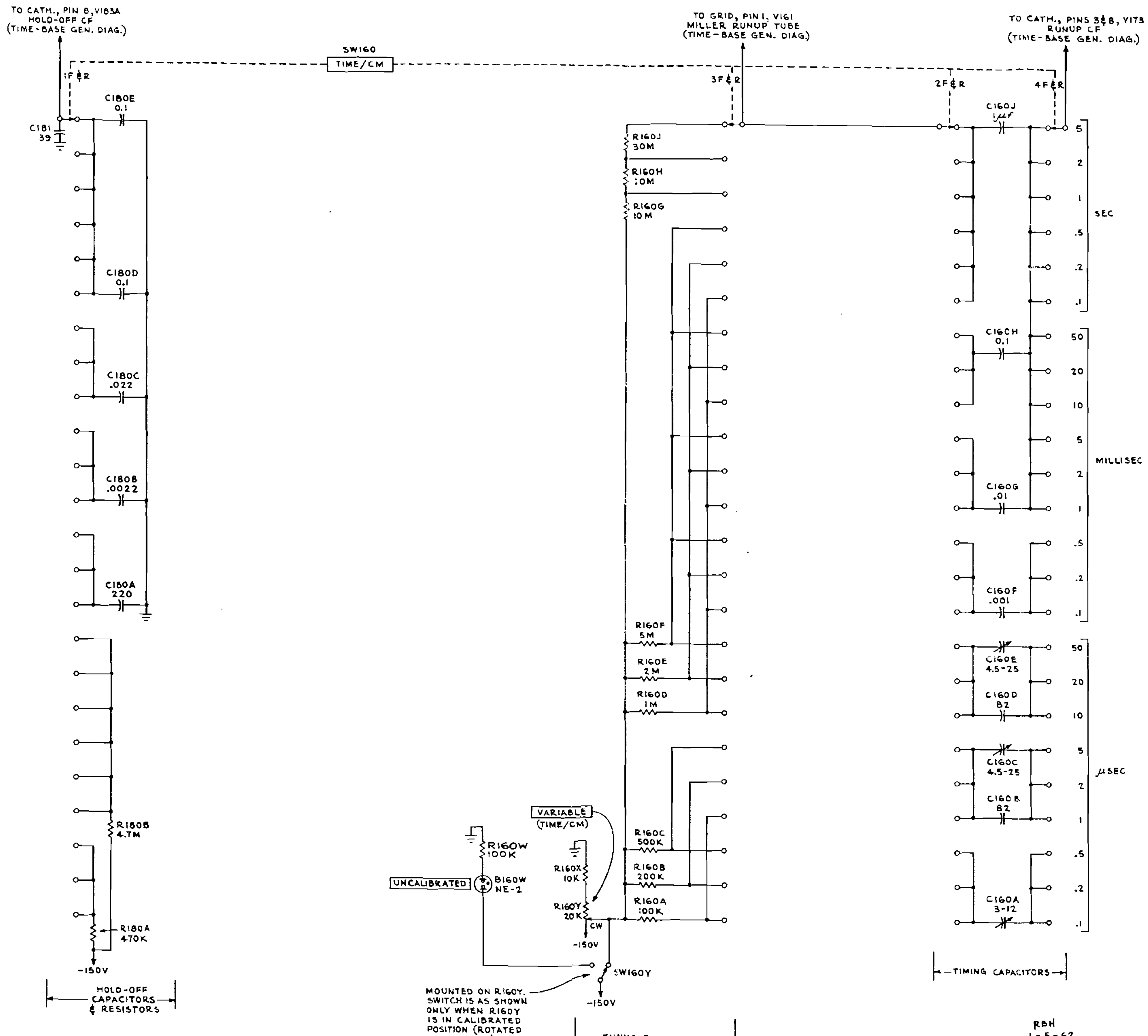
MH
01-24-62

TIME--BASE TRIGGER

CIRCUIT NUMBERS 1 THRU 49

TIME BASE A AND B INTERCONNECTING SOCKETS

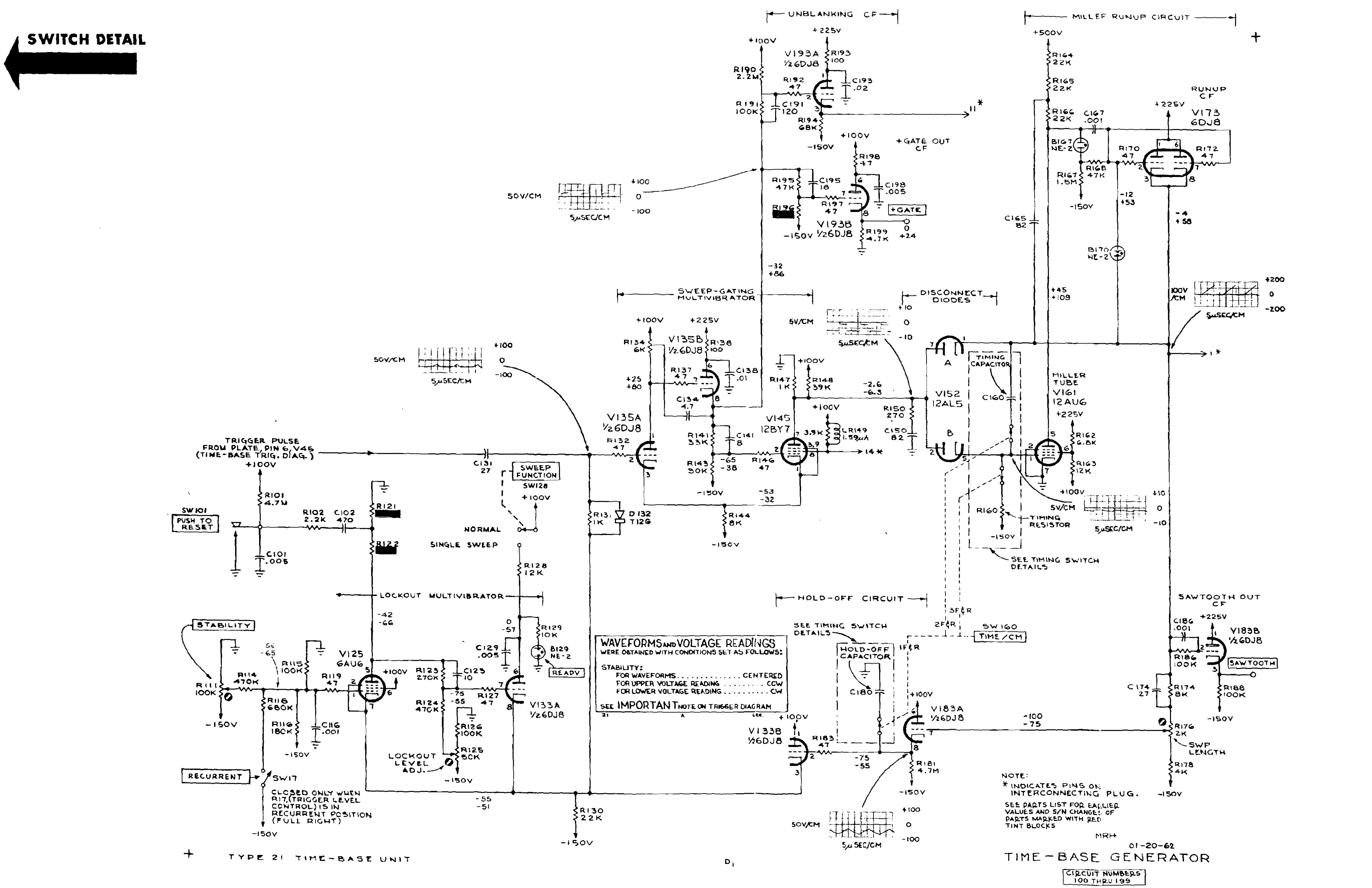




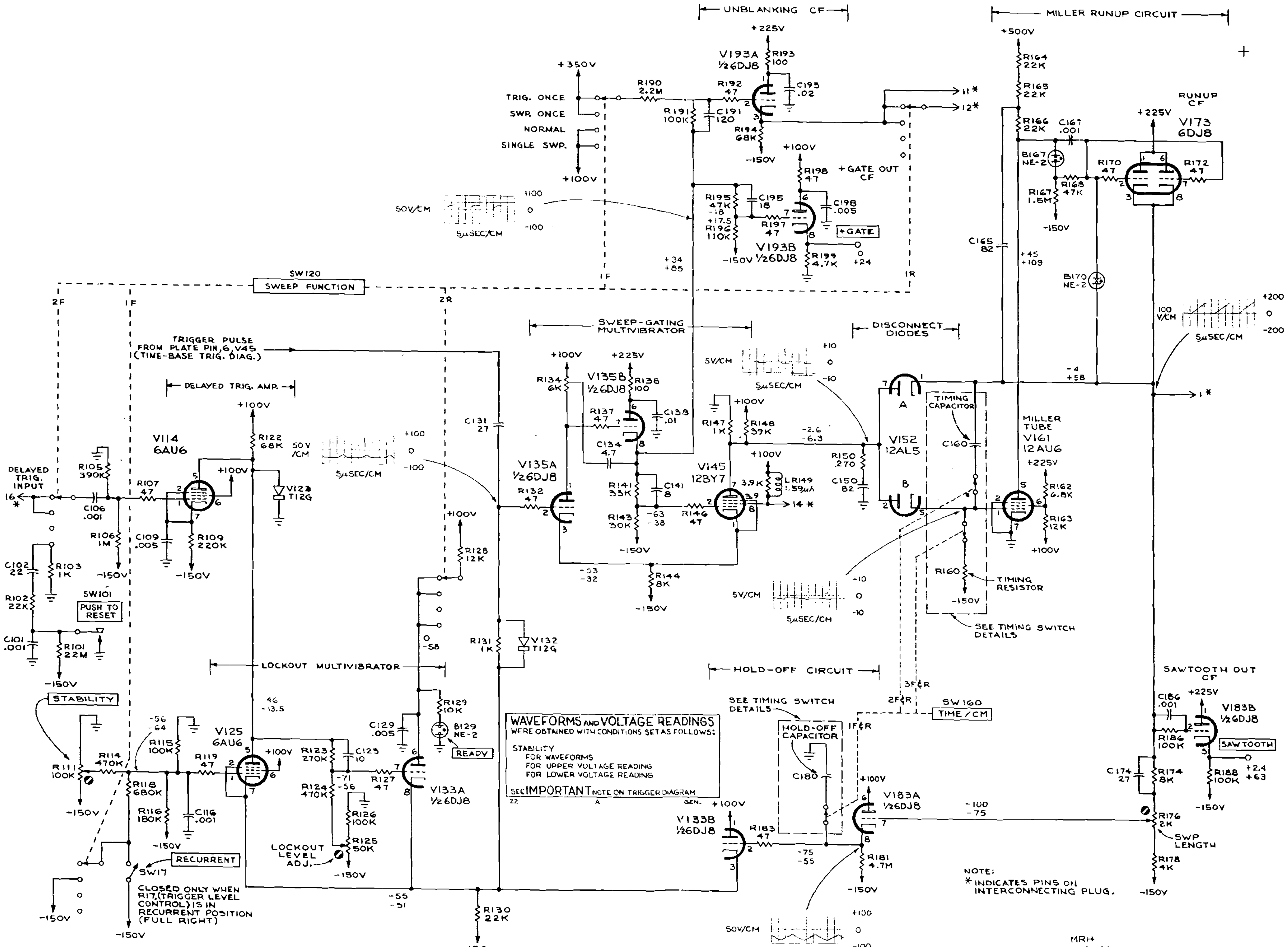
TYPE 21 TIME-BASE UNIT
TYPE 22 TIME-BASE UNIT

A_2

TIMING SWITCH



TIME BASE GENERATOR TYPE 21



TYPE 22 TIME-BASE UNIT

A3

MRH
01-26-62

TIME-BASE GENERATOR

CIRCUIT NUMBERS 100 THRU 199

TIME BASE GENERATOR TYPE 22