

OPERATORS HANDBOOK

This Operators Handbook supplements the complete Instruction Manual provided for this instrument. For more detailed information, refer to the Instruction Manual.

454A

OSCILLOSCOPE

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454A
OPERATORS HANDBOOK

CONTENTS

Specifications	1
Operating Instructions	
Operating Voltage	5
Controls and Connectors	5
Simplified Operation Instructions	13
Users Calibration	17

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SPECIFICATIONS

The specifications given in this handbook are only a partial list condensed from the specifications listed in Section 1 of the Instruction Manual. These specifications most directly reflect the capabilities of the 454A.

Characteristic	Performance
VERTICAL DEFLECTION SYSTEM	
Deflection Factor	
Channel 1 or 2, or Added Mode Accuracy (With or without P6054 Probe)	Within 3% of indicated deflection factor with GAIN correctly adjusted at 20 mV/DIV.,
Maximum Risetime and Minimum Bandwidth at Upper -3 dB Point AC (capacitive) and DC (direct) Coupled, Four-Division Reference, 25-Ohm Source Impedance (0°C to +40°C)	

Characteristic	Performance
Deflection Factor	Direct or with P6054
2 mV/div	50 MHz, 7 ns
5 mV/div	100 MHz, 3.5 ns
10 mV/div to 5 V/div	150 MHz, 2.4 ns
Channel 1 and 2 Cascaded using an 18-inch 50 Ω cable, CH 1 and CH 2 VOLTS/DIV set to 2 mV/DIV, unterminated, TRIGGER switch set to NORM.	33 MHz, 11 ns
Bandwidth at Lower -3 dB Point, AC (capacitive) Couple Coupled	10 Hz or less (1 Hz with P6054 probe).
Common-Mode Rejection Ratio AC and DC Coupled	At least 20:1 at 20 MHz.

Characteristic	Performance
Maximum Safe Input Voltage	500 volts DC + peak AC (one kilohertz or less).
All V/DIV Settings	

TRIGGERING (A AND B SWEEP)

Trigger Sensitivity	See Fig. 1.
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HORIZONTAL DEFLECTION SYSTEM

Sweep Accuracy Over Center 8 Divisions	0°C to +40°C	
	Unmagnified	Magnified
	±3%	±4%

DELAYED/MIXED SWEEP

Calibrated Delay Time	Continuous from 50 seconds to 0.1 microsecond.
Delay Time Accuracy	0°C to +40°C
5 s/div to 0.1 s/div	Within 2.5%
50 ms/div to 0.1 μs/div	Within 1.5%

Characteristic	Performance
Delay Time Jitter	One part or less, in 20,000 of 10X the TIME/DIV setting.
Differential Time Measurement Accuracy	Within 1.5% and 4 minor DELAY TIME MULTIPLIER dial divisions for delay times 0.1 μs to 50 ms. Within 2.5% and 4 minor DELAY TIME MULTIPLIER dial divisions for delay times 0.1 second to 5 seconds.
Mixed Sweep Accuracy	Within 2% plus measured A sweep error.

X-Y OPERATION

Bandwidth at Upper -3 dB Point	At least 2 MHz.
Phase Shift Between Channel 1 (X) and Channel 2 (Y)	3° or less DC to 2 MHz.

Z AXIS INPUT

Sensitivity	Five volt peak to peak signal produces noticeable modulation at normal intensity.
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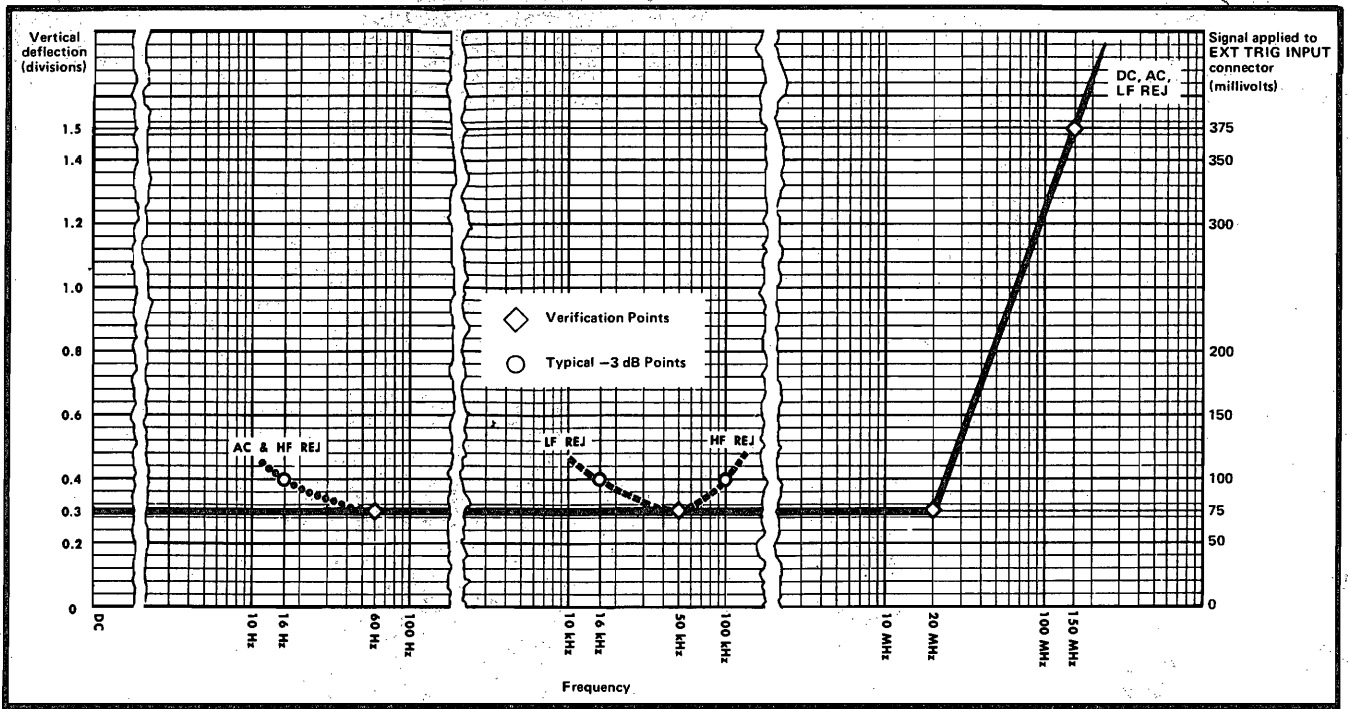


Fig. 1. Trigger sensitivity specification limit curve.

Characteristic	Performance
Usable Frequency Range	DC to 50 megahertz.

CALIBRATOR

Characteristic	Performance
Accuracy	0°C to +40°C
Voltage	1 volt within 1%
Current	5 mA within 1%
Repetition Rate	1 kHz within 0.5%
Risetime	One microsecond or less.
Duty Cycle	49% to 51%.
Output Resistance	250 Ω within 1%.

POWER SUPPLY

Characteristic	Performance
Voltage Range (AC, RMS)	
115 Volts Nominal	
Low	90 to 110 volts.

Characteristic	Performance
Medium	104 to 126 volts.
High	112 to 136 volts.
230 Volts Nominal	
Low	180 to 220 volts.
Medium	208 to 252 volts.
High	224 to 272 volts.
Line Frequency	48 to 62 Hz.
Maximum Power Consumption	.116 watts at 115 V, 60 Hz line.

CATHODE-RAY TUBE (CRT)

Characteristic	Performance
Resolution	15 lines or greater in one division.
Geometry	0.1 division or less.
Beam Finder	Limits display within graticule area when pressed.

OPERATING INSTRUCTIONS

Operating Voltage

CAUTION

This instrument is designed for operation from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multiphase system, or across the legs of a single-phase three-wire system.

The 454A can be operated from either a 115-volt or a 230-volt nominal line voltage source. The Line Voltage Selector assembly on the rear panel converts this instrument from one operating voltage to the other. This assembly also includes the fuses that provide protection for the line-input portion of the instrument. To convert from 115-volt to 230-volt nominal line voltage, or vice versa, remove the cover from the Line Voltage Selector assembly. Then, pull out the Selector switch bar and plug it back into the remaining holes. Change the line-cord power plug to match the power-source receptacle or use a 115- to 230-volt adapter. To change regulating ranges, pull out the Range Selector switch bar, slide it to the desired position and plug it back in. Select a range which is centered about the average line voltage to which the instrument is to be connected. Replace the cover and tighten the two captive screws.

Before applying power to the instrument, check that the indicating tabs on the switch bars are protruding through the correct holes for the desired nominal line voltage and regulating range.

CONTROLS AND CONNECTORS

Cathode-Ray Tube

- | | |
|-----------------------|--|
| FOCUS | Provides adjustment for optimum display definition. |
| BANDWIDTH-BEAM FINDER | Three position switch which provides bandwidth limiting and beam location.

20 MHz: Vertical Amplifier bandwidth limited to provide a reduction in displayed noise or interference.

FULL: Normal operation with full Vertical Amplifier bandwidth capabilities.

BEAM FINDER: Compresses display within graticule area, independently of display position or applied signals. |

Vertical (both channels except as noted)

VOLTS/DIV Selects vertical deflection factor in 1-2-5 sequence (VARIABLE control must be in CAL position for indicated deflection factor).

VARIABLE Provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch.

UNCAL (Uncalibrated) Light indicates that the VARIABLE control is not in the CAL position.

STEP ATTEN BAL (Step Attenuator Balance) Screwdriver adjustment to balance Input Amplifier in the 2, 5 and 10 mV positions of the VOLTS/DIV switch.

Input Coupling (AC-GND-DC) Selects method of coupling input signal to grid of Input Amplifier.

AC: DC component of input signal is blocked. Low frequency limit (-3 dB point) is about 10 hertz.

PROBE POWER

MODE

GND: (Ground) Input circuit is grounded (does not ground applied signal).

DC: All components of the input signal are passed to the Input Amplifier.

Power source for active probe systems.

Selects vertical mode of operation.

CH 1: The signal connected to the INPUT CH 1 connector is displayed.

CH 2: The signal connected to the INPUT CH 2 connector is displayed.

ALT: (Alternate) Dual-trace display of signals at both channels. Display switched at end of each sweep.

CHOP: Dual-trace display of signals on both channels. Display switched between channels at a repetition rate of about one megahertz.

ADD: Signals applied to the INPUT CH 1 and INPUT CH 2 connectors are algebraically added and the algebraic sum is displayed on the CRT. The INVERT switch in Channel 2 allows the display to be CH 1 + CH 2 or CH 1 - CH 2.

For X-Y mode operation, Channel 1 signal is connected to the Horizontal Amplifier.

INVERT
(CH 2 only)

Inverts the Channel 2 display when pulled out.

INT TRIGGER

(Internal Trigger) Selects source of internal triggering signal from vertical system. Also selects the source of the X signal for X-Y mode operation.

NORM: Sweep circuits triggered from displayed channel(s). Channel 1 signal available at CH 1 OUT connector.

CH 1 ONLY OR X-Y: Sweep circuits triggered only from the signal applied to the INPUT CH 1 connector. No signal available at CH 1 OUT connector. CH 1 lights, located beside A and B SOURCE switches, indicate that the INT TRIGGER switch is in the CH 1 ONLY OR X-Y position.

A and B Triggering (both where applicable)

LEVEL

Selects amplitude point on trigger signal at which sweep is triggered.

HF STAB (A Triggering Only)

(High Frequency Stability) Decreases display jitter for trigger signals above about 40 megahertz. Has negligible effect at lower repetition rates.

SLOPE

Selects slope of trigger signal which starts the sweep.

+: Sweep can be triggered from positive-going portion of trigger signal.

-: Sweep can be triggered from negative-going portion of trigger signal.

COUPLING

Determines method of coupling trigger signal to trigger circuit.

AC: Rejects DC and attenuates signals below about 30 hertz. Accepts signals between about 30 hertz and 150 megahertz.

LF REJ: (Low Frequency Reject)
Rejects DC and attenuates signals below about 50 kilohertz. Accepts signals between about 50 kilohertz and 150 megahertz.

HF REJ: (High Frequency Reject)
Accepts signals between about 30 hertz and 50 kilohertz; rejects DC and attenuates signals outside the above range.

DC: Accepts all trigger signals from DC to 150 megahertz or greater.

System. When CH 1 light is on, trigger signal is obtained only from the Channel 1 input signal; when the light is off, the trigger signal is obtained from the displayed channel(s). Source of internal trigger signal is selected by the TRIGGER switch.

LINE: Trigger signal obtained from a sample of the line voltage applied to this instrument.

EXT: Trigger signal obtained from an external signal applied to the EXT TRIG INPUT connector.

EXT ÷ 10: Attenuates external trigger signals 10 times.

CH 1

Light indicates that the internal trigger signal is obtained only from the signal connected to the INPUT CH 1 connector (see TRIGGER switch).

SOURCE

Selects source of trigger signal.

INT: Internal trigger signal obtained from Vertical Deflection

EXT TRIG INPUT

Input connector for external trigger signal.

A and B Sweep

DELAY-TIME MULTIPLIER

Provides variable sweep delay between 0.10 and 10.10 times the delay time indicated by the A TIME/DIV switch.

A SWEEP TRIG'D

Light indicates that A sweep is triggered and will produce a stable display with correct INTENSITY and POSITION control settings.

UNCAL A OR B

Light indicates that either the A or B VARIABLE control is not in the CAL position.

A VARIABLE

Provides continuously variable A sweep rate between the calibrated settings selected by the A TIME/DIV switch. A sweep rate is calibrated when control is set fully clockwise to CAL.

B SWEEP MODE

Selects B sweep operation mode.

TRIGGERABLE AFTER DELAY TIME: B sweep circuit will not produce a sweep until a trigger pulse is received following the delay time selected by the DE-

LAY TIME (A TIME/DIV) switch and the DELAY-TIME MULTIPLIER dial.

B STARTS AFTER DELAY TIME: B sweep circuit runs immediately following delay time selected by the DELAY TIME switch and DELAY-TIME MULTIPLIER dial.

HORIZ DISPLAY

Selects horizontal mode of operation.

A: Horizontal deflection provided by A sweep. B sweep inoperative.

A INTEN DURING B: Sweep rate determined by A TIME/DIV switch. An intensified portion appears on the display during the B sweep time. This switch position provides a check of the duration and position of B sweep (delayed sweep) with respect to the delaying sweep (A).

B (DELAYED SWEEP): Sweep rate determined by B TIME/DIV

switch with the delay time determined by the setting of the DELAY TIME (A TIME/DIV) switch and the DELAY-TIME MULTIPLIER dial. Sweep mode determined by B SWEEP MODE switch.

MAG

(Magnifier) Increases sweep rate to ten times setting of the A or B TIME/DIV switch by horizontally expanding the center division of the display. Light indicates when magnifier is on (magnifier inoperative in X-Y mode).

MIXED: First part of a horizontal sweep displayed at a rate set by the A TIME/DIV switch and the latter part of the sweep at a rate set by the B TIME/DIV switch. Relative amounts of the display allocated to each sweep rate are determined by the setting of the DELAY-TIME MULTIPLIER dial.

A SWEEP MODE

Determines the operating mode for A sweep.

X-Y: Permits X-Y operation when the TRIGGER switch is set to CH 1 ONLY OR X-Y. Signal applied to the INPUT CH 1 OR X connector provides the X-axis deflection, and the signal applied to the INPUT CH 2 OR Y connector provides the Y-axis deflection.

AUTO TRIG: (Automatic Trigger) Sweep Initiated by the applied trigger signal at point selected by the LEVEL/SLOPE control when the trigger signal repetition rate is above about 30 hertz and within the frequency range selected by the COUPLING switch. Triggered sweep can be obtained only over the amplitude range of the applied trigger signal. When the LEVEL/SLOPE control is outside the amplitude range, the trigger repetition rate is below the lower frequency limit (or above upper limit for AC HF

REJ) or the trigger signal is inadequate, the sweep free runs at the sweep rate selected by the TIME/DIV switch to produce a reference trace.

NORM TRIG: (Normal Trigger)

Sweep initiated by the applied trigger signal at any point selected by the LEVEL/SLOPE control over the frequency range selected by the COUPLING switch. Triggered sweep can be obtained only over the amplitude range of the applied trigger signal. When the LEVEL/SLOPE control is outside the amplitude range, the trigger repetition rate is outside the frequency range selected by the COUPLING switch, or the trigger signal is inadequate, there is no trace.

SINGLE SWEEP: After a sweep is displayed, further sweeps cannot be presented until the RESET button is pressed. Display is triggered as for NORM operation using the A Triggering controls.

RESET

When the RESET button is pressed (SINGLE SWEEP mode), a single display will be presented (with correct triggering). After the sweep is completed, the RESET button must be pressed again before another sweep can be displayed.

A SWEEP LENGTH

Adjusts length of A sweep. In the FULL position (clockwise detent), the sweep is about 11 divisions long. As this control is rotated counterclockwise, the length of A sweep is reduced until it is less than four divisions long just before the detent in the fully-counterclockwise position is reached. In the B ENDS A position (counterclockwise detent), the A sweep is reset at the end of the B sweep to provide the fastest possible sweep repetition rate for delayed sweep signals.

1 V CAL 1 kHz

Calibrator output connector.

Side Panel

**B TIME/DIV
VARIABLE**

Provides continuously variable B sweep rate between the calibrated

settings selected by the B TIME/DIV switch. B sweep rate is calibrated when control is set fully clockwise to CAL.

the sawtooth signal produced by the A Sweep Generator.

TRACE ROTATION

Screwdriver adjustment to align trace with horizontal graticule lines.

X-GAIN (X-Y)

Screwdriver adjustment to calibrate X-axis deflection in the X-Y mode.

CURRENT PROBE CAL

Current loop providing five-milliampere square-wave current from calibrator circuit.

ASTIG

(Astigmatism) Screwdriver adjustment used in conjunction with the FOCUS control to obtain a well-defined display. Does not require readjustment in normal use.

CH 1 OUT

Output connector providing a sample of the signal applied to the INPUT CH 1 connector when the TRIGGER switch is in the NORM position.

Rear Panel

Z AXIS INPUT

Input connector for intensity modulation of the CRT display.

B + GATE

Output connector providing a rectangular 12.6 volt pulse coincident with B sweep.

Line Voltage Selector

Switching assembly to select the nominal operating voltage and the line voltage range. The assembly also includes the line fuses.

A + GATE

Output connector providing a rectangular 12.6 volt pulse coincident with A Sweep.

Voltage Selector: Selects nominal operating voltage range (115 V or 230 V).

A SWEEP

Output connector providing a sample (10 volts in amplitude) of

Range Selector: Selects line voltage range (low, medium, high).

GENERAL OPERATING INFORMATION

Simplified Operating Instructions

General. The following operating instructions will allow calibrated measurements in most applications. The operator should be familiar with the complete function and operation of the instrument as described in this section before using this procedure.

Normal Sweep Display

1. Set INTENSITY control fully counterclockwise.
2. Set Input Coupling switches to AC, VARIABLE VOLTS/DIV controls to CAL and vertical MODE switch to CH 1 (use ALT or CHOP for dual-trace display).
3. Push A SWEEP MODE, A SLOPE, A COUPLING, A SOURCE switches to up position.
4. Set A TIME/DIV switch to 1 ms/DIV, VARIABLE TIME/DIV controls to CAL and HORIZ DISPLAY switch to A.
5. Set POWER switch to ON. Allow several minutes warmup.
6. Connect signal to vertical INPUT connector.
7. Advance INTENSITY control until display is visible (if display is not visible with INTENSITY control at mid-range, press BANDWIDTH-BEAM FINDER switch down and adjust VOLTS/DIV switch until display is reduced in size vertically; then center compressed display with vertical and horizontal POSITION controls; release BANDWIDTH-BEAM FINDER switch). Set FOCUS control for well-defined display.
8. Set VOLTS/DIV switch and vertical POSITION control for display which remains within display area vertically.
9. Set A LEVEL control for stable display.
10. Set A TIME/DIV switch and horizontal POSITION control for display which remains within the display area horizontally.
11. To make a peak to peak measurement, use the following procedure:
 - a. Turn the vertical POSITION control so the lower portion of the waveform coincides with one of the grati-

cule lines below the center horizontal line, and the top of the waveform is in the viewing area. Move the display with the horizontal POSITION control so one of the peaks lies near the center vertical graticule line.

b. Measure the divisions of the vertical deflection from peak to peak. Make sure the VAR VOLTS/DIV control is in the calibrated position.

12. To measure the time between two points on a waveform, use the following procedure:

a. Set the TIME/DIV switch to the fastest sweep rate that displays less than eight divisions between the time measurement points.

b. Adjust the vertical POSITION control to move the points, between which the time measurement is made, to the center horizontal graticule line.

c. Adjust the horizontal POSITION control to center the display within the center eight divisions of the graticule.

d. Measure the horizontal distance between the time measurement points. Be sure the A VAR control is set to the calibrated position.

e. Multiply the distance measured in step d by the setting of the TIME/DIV switch.

Magnified Sweep Display

1. Follow steps 1 – 10 for normal sweep.

2. Adjust horizontal POSITION control to move area to be magnified within center division of CRT. If necessary, change TIME/DIV switch setting so complete area to be magnified is within center division.

3. Set MAG switch to X10 and adjust horizontal FINE control for precise positioning of magnified display.

Delayed Sweep Display

1. Follow steps 1 – 10 for normal sweep.

2. Set B SWEEP MODE switch to B STARTS AFTER DELAY TIME, HORIZ DISPLAY switch to A INTEN DURING B and A SWEEP LENGTH control to FULL.

3. Pull out DELAYED SWEEP (B TIME/DIV) switch and turn clockwise so intensified zone on display is desired

length (intensified zone will be displayed in delay form). If intensified zone is not visible, change INTENSITY control setting.

4. Adjust DELAY-TIME MULTIPLIER dial to position intensified zone to portion of display to be displayed.

5. Set HORIZ DISPLAY switch to B (DELAYED SWEEP). Delayed sweep rate is shown by dot on DELAYED SWEEP switch.

6. For delayed display with less jitter, set B SWEEP MODE switch to TRIGGERABLE AFTER DELAY TIME, all B Triggering switches up and adjust B LEVEL control for stable display.

Mixed Sweep Display

1. Follow steps 1 – 10 for normal sweep.

2. Set the B SWEEP MODE switch to B STARTS AFTER DELAY TIME, HORIZ DISPLAY switch to MIXED and A SWEEP LENGTH to FULL.

3. Pull out DELAYED SWEEP (B TIME/DIV) switch and turn clockwise to obtain the amount of magnification desired.

4. Adjust DELAY-TIME MULTIPLIER dial to vary the amount of delay time before the start of the magnified portion of the display.

5. For mixed sweep display with less jitter, set B SWEEP MODE switch to TRIGGERABLE AFTER DELAY TIME, all B Triggering switches up, and adjust B LEVEL control for stable display.

X-Y Display

1. Set INTENSITY control fully counterclockwise.

2. Set Input Coupling switches to AC and VARIABLE VOLTS/DIV controls to CAL.

3. Set TRIGGER switch to CH 1 ONLY OR X-Y and HORIZ DISPLAY switch to X-Y.

4. Set POWER switch to ON. Allow several minutes warmup.

5. Connect X (horizontal) signal to INPUT CH 1 or X connector and Y (vertical) signal to INPUT CH 2 OR Y connector.

6. Advance INTENSITY control until display is visible (if display is not visible, press BANDWIDTH-BEAM FINDER switch down and adjust CH 1 and CH 2 VOLTS/

DIV switches until display is reduced in size both vertically and horizontally; then center compressed display with CH 1 and CH 2 POSITION controls; release BANDWIDTH-BEAM FINDER switch). Set FOCUS control for well-defined display.

7. Set CH 1 and CH 2 VOLTS/DIV switches and POSITION controls for display which remains within display area. CH 1 controls affect horizontal deflection and CH 2 controls affect vertical deflection.

USER'S CALIBRATION

General

The following procedure provides calibration information for external adjustments of the 454A. See the complete Instruction Manual for detailed calibration instructions.

Astigmatism

Obtain a display of the calibrator waveform. Adjust ASTIG in conjunction with the FOCUS control for the best definition of the square-wave display.

Trace Rotation

Obtain a free-running trace. Adjust TRACE ROTATION so the trace aligns with the horizontal lines of the graticule.

Vertical Gain

Connect the 1 volt calibrator signal to the input connector of either vertical input channel. Set the vertical MODE switch to display that channel and set that channel's deflection factor to .2 V/div. Adjust the front-panel GAIN adjustment of the channel for exactly 5 divisions of deflection.

The best measurement accuracy when using probes is provided if the GAIN adjustment is made with the probes installed.

Step Attenuator Balance

Set both Input Coupling switches to GND and obtain a free-running alternate dual-trace display. Adjust the STEP ATTEN BAL control in each input channel for no trace shift when switching the appropriate attenuator switch between the 2 mV/div and 10 mV/div positions.

X Gain (X-Y Operation)

Set the HORIZ DISPLAY switch to X-Y and the INT TRIGGER switch to CH 1 ONLY. Set the CH 1 attenuator switch to .2 V/div and the CH 1 Input Coupling switch to DC. Apply the 1 volt calibrator signal to the CH 1 Input BNC connector. Adjust the X GAIN (X-Y) adjustment for exactly five divisions of horizontal deflection between the displayed dots.

Horizontal Gain

Connect the calibrator signal to the input of either vertical channel and set the vertical MODE switch to display this channel. Set the HORIZ DISPLAY switch to display either time base. Adjust the appropriate triggering controls for a triggered display at a sweep rate of one millisecond/division. Check the display for one cycle of the calibrator waveform for each horizontal division. For more precise timing measurements, refer to the calibration procedure given in the Instruction Manual.

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